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Chandigarha

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"Environment Preservation in Sustainable Development"

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FOREWORD

Sustainable Development is a general term that describes an environmentally conscious development. The idea of sustainability is to leave the earth in as good or a better shape for the future generations.Human activity is environmentally sustainable when it is performed and maintained without exploiting the earth's limitednatural resources or degrading the natural environment. Today, nearly every human activity, in some way, results in the consumption of energy, the majority of which is produced from non-renewable sources such as fossil fuels. Not only is this exhausting our limited supply of available resources for future generations but is also polluting the atmosphere and effectively choking the world.

Infrastructure development is an expensive proposition. It is expensive not only in terms of the actual expenditure on land, material and labour costs but also in terms of the price that has to be paid due to environmental degradation. Modern building materials have high resource and energy consuming manufacturing processes. Most of these manufacturing processes also generate too much by-products and lead to a change in the environmental balance in terms of air, water and land pollution besides the noise and microbial disturbances. Buildings, by its very nature, disturb the natural environment. Where a balance in nature vis-à-vis land, space and air exists, the various activities of development by man change the natural conditions, as it exists for the natural flora and fauna. The existing balance in nature is uprooted and replaced by inorganic substances that change very nature of that land, space and air. Therein lies the importance of Environment Assessment of any development activity.

Environment Assessment, along with various clearances from various Govt. Departments,is necessary for all major development projects. Environmental Assessment helps to identify detrimental impact on surroundings in order to improve decision-making to ensure that the various project options under consideration are environmentally sound and sustainable. The main purpose of environmental assessment is to determine the potential impact of the project that may affect the environment adversely and to develop means/methodology for impact prevention, mitigation, minimization and compensation to ensure the overall benefits of the projects and maintenance of an environmental balance. Environmental Assessment is carried out for the entire project before the construction takes place. During the Environmental Impact Assessment stage, the representative baseline data on air, water, noise, soil quality, erosion factors, climatic condition, geology of the area, sensitive and critical natural habitats, ecological wealth, migratory species, nesting and breeding sites, land use, etc. are collected. Legal and administrative frameworks and policies are also studied to comply with the laid down requirements. A detailed analysis of various existing alternative is also carried out.

The Indian Buildings Congress has selected "Environment Preservation in Sustainable Development" as the theme of this National Seminar to be held along with the Mid Term Session and Seminar, in order to focus the attention of all concerned with the built environment on this vital topic. It is hoped that this Seminar will generate sufficient concern among the professionals and come up with positive and practical recommendations to make sustainability an integral part in the process of planning and construction of the Built Environment.

(Parimal Rai, IAS)
President, IBC &
Advisor to the Administrator
Chandigarh UT

PREFACE

Sustainable development is pattern of social and structural economic transformation development which optimizes the economic and societal benefits available in the present, without jeopardizing the likely potential for similar benefits in the future. A primary goal of sustainable development is to achieve a reasonable and equitably distributed level of economic well being that can be perpetuated continuously for a long time. This implies using natural resources in a renewable manner that does not eliminate or degrade them, or diminish their usefulness for future generations. It ensures that the rate of resource consumption and waste discharge for a selected development portfolio would be sustained indefinitely, without progressively impairing its bio-productivity and ecological integrity. Environmental conservation, therefore, accelerates rather than hinders economic development.

We depend on the environment to meet our basic requirements such as food, fuel, fibre, fodder, minerals and vital support systems (e.g. water and air). However, due to our continuous indulgence in the exploitation of nature for immediate gains, we contribute to environmental degradation and depletion of natural resources. It is, therefore, essential that we understand function and interaction of physical and biological elements of the environment and apply this knowledge for sound management programmes to conserve the natural resources we are endowed with.

Buildings have a tremendous impact on the environment-both during their construction and through their operation. The term green building refers to buildings that make use of land, design and construction strategies in such a way as to reduce environmental impacts. What this means is that green building practices offer an opportunity to create environmentally sound and resource efficient building by using an integrated approach to design. Green buildings promote resource conservation; consider environmental impacts and waste minimization; create a healthy and comfortable environment; reduce operation and maintenance costs and address issues such as historical preservation, access to public transportation and other community infrastructure systems. Green buildings consider the entire life-cycle of the building and its components as well as its economic and environmental performance.

Adequate and affordable energy is essentially needed for all walks of life. The major energy resources like coal, natural gas and petroleum products are non-renewable fossil fuels. These are finite and thus can be used only for a finite period. Also, emissions from non renewable sources are major environment pollutant. The major renewable energy sources include solar, wind, hydro, geo-thermal, tidal, biomass and bio fuels etc. In order to achieve maximum use of renewable energy sources and supplies, the principal task is therefore to integrate various forms of renewable energy.

Indian Buildings Congress has selected "Environmental Preservation in Sustainable Development" as the theme of seminar to be held along with the Mid Term Session at Chandigarh on April 7-8, 2017 in order to focus the attention of all the participants on this vital topic. It is expected that the deliberations amongst the professionals shall lead to useful and far reaching recommendations to make sustainability and environmental concerns an integral part in planning and construction of built environment.

(Deepak Narayan)
Convener, Technical Committee &
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TECHNICAL SESSION I
ENVIRONMENT, HEALTH & SAFETY

EIA AS TOOL FOR SUSTAINABLE DEVELOPMENT

RAJAT RASHMI* AND USHA BATRA**

Abstract

In the race to development and economic growth, the resources of our mother earth have been overexploited resulting to their depletion on one hand and on the other hand, pollution to environment reached to alarming levels. Thus, protection and improvement of environment and preservation of natural resources has emerged as a major global concern. Earlier, the laws were mostly related to air pollution, water pollution, wild life and factory acts. It was after the Bhopal gas tragedy of 1984 that the country took serious note of impact of polluting industry on the environment and human life and Environment Protection Act, 1986 was enacted considering the need of environment protection. In 1994, the Ministry of Environment and Forests, Government of India, under The Environmental Protection Act (EPA), promulgated an Environment Impact Assessment (EIA) notification making environmental clearance mandatory for setting up, expansion and execution of new projects covering 30 categories listed in Schedule 1 of EPA.

The paper covers the legislations related to EIA under EPA Act. Two case studies of Mumbai pertaining to recent EIA exercises and suggestions for improvement in assessment for sustainable development are presented.

INTRODUCTION

"Environment pollution" as stated in EPA means "the presence in the environment of any environmental pollutant; where environmental pollutant is any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment" (MoEF). There are about two hundred laws dealing with environmental protection both before and after independence in India, however, the pre-independence laws have not dealt with environmental protection exclusively for example, the Indian Penal Code (IPC), 1860, had a chapter (chapter XIV) which dealt with offences affecting public health, safety and convenience, which covered aspects like water, air and noise pollution, whereas the postindependence laws mentioned above deal exclusively with environmental protection. It was in the 1970's that the concern for environment grew all over the world. The Environment Protection Act, 1986, enacted under Article 253 of the constitution of India to implement the decisions made at the United Nations conference on human environment held at Stockholm, 1972 to take appropriate steps for the protection and improvement of human environment. As per The Environment Protection Act, 1986, environment includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro organism and property.

The United Nations world commission on environment and development defines sustainable development as, "it must meet the needs of the present generation without compromising the ability of future generations to meet their own needs and aspirations" (WCED, 1987). Natural resources such as air, water, and land get polluted due to unrestricted and environmentally detrimental development while non-renewable resources such as gas, oil, coal, etc are finite so they have to be used judiciously or their

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alternatives found. The government, which has legislative powers, does environmental protection through the formulation of policy, coordinating and monitoring environmental issues, environmental planning and policy-oriented environmental research. The Environment Protection Act does not provide for any system of monitoring the disturbance an activity would cause to the environment- biological as well as human environment. Thereby a need for environment impact assessment was felt wherein the exercise helped in determining the causes and effects of any economic activity, especially on a large scale, its mitigation leading to sustainable development and finally reaching to decision making.

ENVIRONMENT IMPACT ASSESSMENT AND ITS LEGISLATION

EIA notification of 1994 states that "expansion or modernization of any activity (if pollution load is to exceed the existing one, or new project listed in Schedule I (gives list of projects) to this notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the central government." (MoEF)

It is essential that consequences of projects, plans or policies at different levels be assessed before they are executed. The purpose of EIA is to identify and evaluate the potential impacts (beneficial and adverse) of development and projects on the environmental system and to ensure that decision makers consider environmental impacts before deciding whether to proceed with new projects. EIA examines these consequences and predicts future changes in the environment. It is a useful aid for decision making based on understanding of the environment implications including social, cultural and aesthetic concerns which could be integrated with the analysis of the project costs and benefits. Thus, in case of new projects or expansion of any activity, environmental clearance has to be sought if the project fell in the schedule 1 and requisite forms (given in schedule 2 of the notification) need to be submitted.

The Act was amended as many as 13 times whenever the necessity was felt.

- By the 2002 amendment, many industries such as nuclear power and related projects, river valley projects, ports, harbours, airports, petroleum refineries including crude and product pipelines etc were exempted from the EIA on the basis of the level of investment, that being less than 50 crores.
- In Aug. 2003, the Act was amended to bring location sensitivity in the environmental clearance process vide which project located in critically polluted areas, within a radius of 15 kilometres of the boundary of reserved forests, ecologically sensitive areas, etc and any state, had to obtain environmental clearance from the central government.
- As per July 7th, 2004 amendment, EIA was made mandatory for construction and building projects more than 20000 sq.mtrs built up area.
- Another amendment on 4th July 2005 provided that projects related to expansion or modernisation of nuclear power and related project, river valley project, ports, harbours and airports, thermal power plants and mining projects with a lease area of more than 5 hectares could be taken up without prior environmental clearance.

In 2006, a new EIA notification was issued which substituted old one. It placed the responsibility on authorities to ensure that project should cause minimal environmental impacts and brings maximum economic and social benefits. The environmental clearance process for new projects comprise of a maximum of four stages, all of which may not apply to particular cases as set forth below in this notification. These four stages in sequential order are.

- Screening only for category 'B' projects and activities. Category 'B' projects are determined as B1 or B2 depending on its activity and location so that B2 projects will not require EIA.

- Scoping refers to the process by which the Expert Appraisal Committee (EAC) in the case of Category 'A' projects or activities, and State level Expert Appraisal Committee (SEAC) in the case of category 'B1' projects or activities, determine detailed and comprehensive terms of reference addressing all relevant environmental concerns for the preparation of an EIA.
- Public consultation is in two parts as public hearing and written consent from project affected persons.
- Appraisal is conducted with a detailed scrutiny by the EAC in case of 'A' category projects and SEAC in case of category 'B1' projects with respect to detailed EIA reports, public hearing etc. (Fig.1&2)

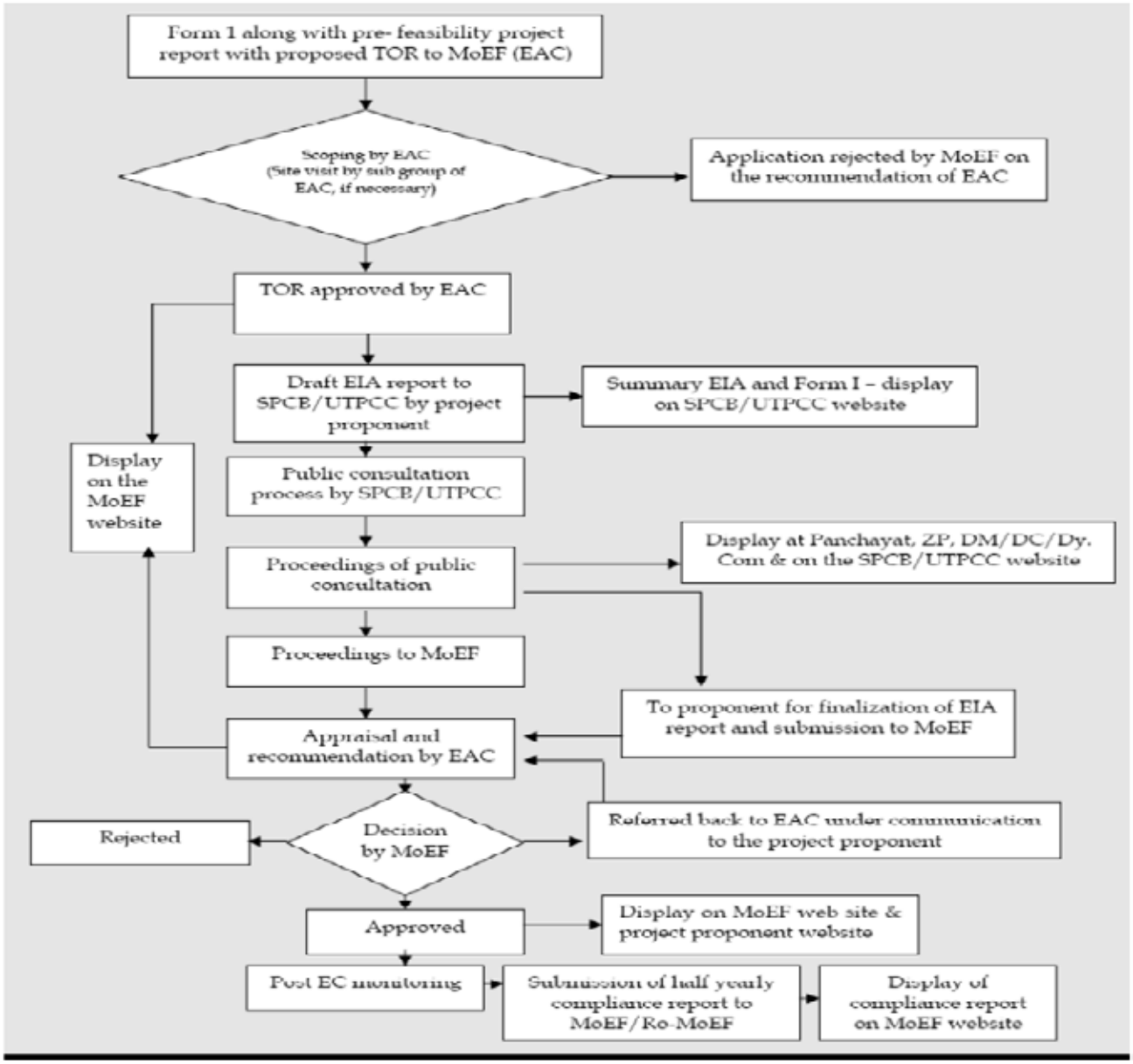

Fig. 1: EIA Clearance Process for Category "A" Projects (Source: CSE)

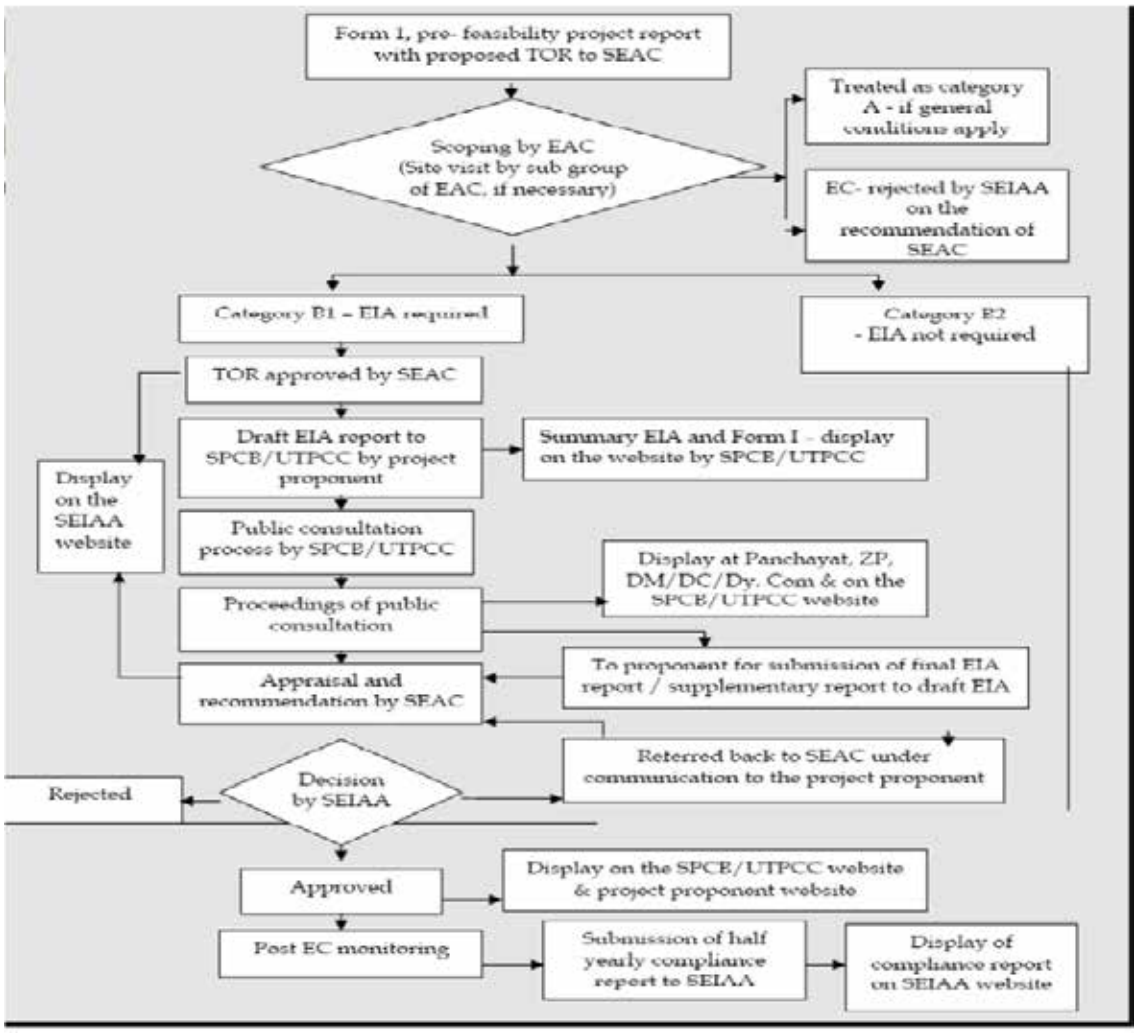

Fig. 2 : EIA Clearance Process for Category 'B' Projects (Source: CSE)

The Notification has tried bringing in more number of projects within the purview of the environmental clearance process. As a result, most importantly, there is no categorization of projects requiring EIA based on investment, rather size or capacity of the project determines whether it is cleared by the central or state government. Apart from as many as 28 amendments to this notification, other acts were added to Environment Protection Act umbrella such as National Green Tribunal, Coastal Regulation Zone (CRZ) etc.

From 2014 onwards, 1371 projects have come up for EIA under 'A' category, of which 21% approximately have been returned due to shortcomings, 14% in various stages of clearance while 65% have been cleared till now and about 22231 projects have come up for EIA under 'B' category of which 27% approximately have been returned, 58% pending under various stages and only 15% cleared from 2014 till date.

The 1991, CRZ notification declared "the coastal stretches including bays, creeks and backwaters upto 500 m on the landward side and the land between low tide line (LTL) and high tide line (HTL) as coastal regulation zone and imposed restrictions on setting up and expansion of industries, processes or operations etc. in the said zone."

A new CRZ Notification on 6th January, 2011 replaced the old notification where the CRZ redefined four zones according to sensitivity and activity while earlier it placed restrictions uniformly.

Hence, for regulating development activities, the coastal stretches within 500 metres of HTL on the landward side are classified into four categories, namely:

- CRZ-I: (a) The areas that are ecologically sensitive and had the geomorphologic features such as mangroves, corals and coral reefs and associated biodiversity, etc and other protected areas including biosphere reserves, areas or structures of archaeological importance; (b) The area between LTL and HTL.
- CRZ-II: The areas that have been developed upto or close to the shoreline.
- CRZ-III: The areas that are relatively undisturbed and those do not belong to either CRZ-I or II which include coastal zone in the rural areas and also areas within municipal limits which are not substantially built up.
- CRZ-IV: (a) The water area from the LTL to twelve nautical miles on the seaward side; (b) shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide.

The restrictions are varied as per the zone on which the area falls. Mumbai falls in the CRZII area where activities which were present on the landward side can now be redeveloped or remodelled subject to clearance from local authorities and coastal zone management authority of Mumbai.

CASE STUDIES

Case study 1: Coastal Road Project, Mumbai

The case study of coastal road project was taken up as it provides a unique outlook on environment versus sustainable development. The coastal road (Fig.3) is proposed from Malad in North Mumbai toNariman point in the south where parts of coastal road are already there in place such as the Marine

Fig.3: Coastal Road Project, Mumbai

Drive and the sea-link. Mumbai, being an island surrounded on the east, south and the west sides

by the Arabian Sea has no room to expand. To provide better connectivity, sea links are planned on the western flank and the trans-harbour link on the east to connect the island city to the main land.

One of the prime reasons sea links were planned as bridges (into the sea, about five hundred meters away from the coast) was the restriction placed by the earlier CRZ regulations preventing reclamation or stilt roads in the CRZ areas. The CRZ notification 2011 issued by the MoEF now makes it possible to envisage coastal roads on stilts (Fig.4). The CRZ notification amendment of 2015 allows roads on reclaimed land too, easing the process of setting up coastal road on reclaimed land in Mumbai. One of the key issues pertained to the possible impact of reclamation along the coastal freeway stretch on the tidal circulation around the city. It was the opinion of expert committee that such a move will not have any impact on the tides and tidal circulation around Mumbai. (JCT, 2011)

Fig. 4: Proposed Coastal Road

The coastal road has been considered as road on reclamation, road on stilts or as tunnel so as to affect the environment in the least possible manner and be sustainable. Wherever the road is planned on reclaimed land, there is possibility of bigger open spaces on either side of the road giving the city much needed open spaces. Wherever the water bodies meet the sea, roads on stilts is planned. Tunnel under the Malabar hill was a fit conclusion as it provided connectivity with least disruption. Some of the negative and positive impacts of the project are list below:

Positive impacts

- It is the view of the special committee that the proposed reclamation in an average width of about 100 m does not cause any impact on the tidal movements and no adverse effects to the coastline are envisaged.
- It generates the much needed recreational spaces (about 75 Ha) by the sea side through creation of beautiful sea side promenades,

green areas and cycle tracks.

- The coastal erosion protection measure at the end of sea side promenade could be in the form of tetrapods/sea walls etc. as suggested in the report.
- The coastal freeway system proposed provides a feasible solution to ameliorate traffic congestion and the consequent health hazards.

Negative impacts

- It is the view of several environmentalists and experts that the land reclamation alters the city's coastline, changes sea levels and tidal currents, and causes erosion of beaches (such as Dadar chowpatty due to reclamation in the Mahim Bay, as in case of existing sea-link).
- Land reclamation leads to depletion of vegetation cover and increases concretisation, reducing infiltration of rainwater into the earth.
- Reclamation has been seen to affect the flushing capacity of creeks and estuaries such as that of the Mithi river, which was a prime reason for the 2005 inundation in Mumbai.
- The fishing community, some of Mumbai's oldest residents, are against the coastal road, fearing it will threaten breeding grounds for fish, and impact aquatic life.

Though the project aims at reducing the travel time and environmental degradation by way of providing much needed open spaces, some critics in the media and NGO's claim that it will be for the benefit of small segment of population using cars and will lead to deterioration of quality of water and aquatic life.

EIA helped in arriving at the basic conclusions with respect to the necessity of the project and helped in giving directions for the management of the environmental issues and its mitigation in best way so as to make the project sustainable.

Though the analysis of environmental aspects and approval to environment management plan has been given, it may be interesting to see it in context to present sea-link and its advantages over the years. The critics at the time of construction of present sea link proclaimed loudly the negative effects stating that it will be un-aesthetic, flood the city and cause loss to fishing community. Some of the observations derived now are; (a) The bridge resulted in lower traffic congestion thereby improving the environment especially in terms of reduction in carbon monoxide, oxides of nitrogen and reduction in noise pollution in areas of Mahim, Dadar, Prabhadevi and Worli, (b) The travel time has been cut by 20-35 mins in case of present sea-link, (c) It saves in fuel costs and lower pollution levels due to signal less travel, the reduced level of pollution affects the whole city rather than the 4% or 6% of people using it, (d) benefits in terms of fuel saving and lower traffic on arterial roads resulting in lower pollution levels should offset the cost factor of its construction in the long run.

Case study 2: Navi Mumbai International Airport

A need was felt for another airport in the Mumbai Metropolitan region (Fig. 5) as the present airport can't sustain the passenger traffic and cargo. Initial site feasibility studies were undertaken by M/s RITES where a site near Panvel was selected.

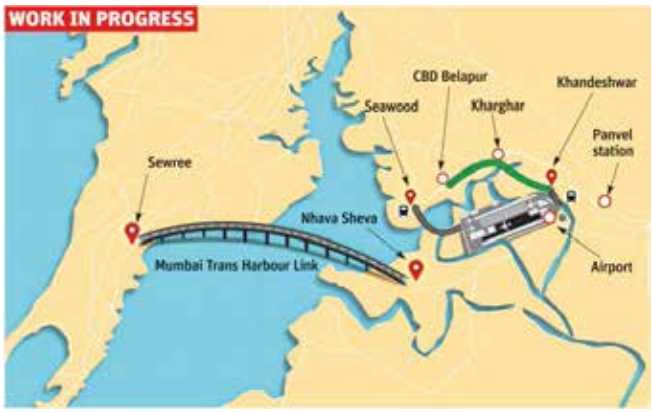

Fig. 5: Navi Mumbai International Airport

EIA study was carried out by CIDCO through its consultants. As per the EIA notification of MoEF issued on 14th September, 2006 an airport project is treated as category "A" which requires environment clearance from MoEF for which an EIA/EMP study is a primary requirement.(CIDCO, 2010)

Through the environmental impact exercise, it was brought forth that 415 ha. Of mangroves will be destroyed, green cover and agricultural land on the site will be lost, two rivers will have to be diverted and channelized, marshy land would be required to be filled up and other interventions will take place. Many activities during the construction phase and operation phase will compromise the environment. But an environment management plan will take care of most of the issues with compensatory plantation, resettlement of displaced villagers and villages, matters related to diversion of rivers and issues during construction and operation phase.

Positive impacts are (a).It will handle 60 million passengers per year and offers increased accessibility, which in turn fuels the tourism sector which causes more money flows into the local economy. (b)Raising the standard of living of people in the region will have a positive impact on National economy resulting in creating employment with around 11 lakh direct jobs and 4 lakhs indirect jobs due to this project. (c)Project will facilitate the fast movement of men and materials, thereby fostering trade and commerce.

EIA study considers both the adverse affects on environment and human health due to the development and suggests ways and means to mitigate and minimize the ill-effects.

SUGGESTIONS FOR IMPROVEMENT IN ASSESSMENT FOR SUSTAINABLE DEVELOPMENT

EIA identifies ways and means for improving the project to be environmentally friendly by preventing, mitigating or compensating for adverse impact, so as to achieve a sustainable development. Some of the suggestions and observations are listed:

- The lengthy process of EIA needs to be shortened and simplified for the benefit of project proponents (PP). It can take anywhere from 150- 210 days for the final process which leads to cost overruns and is time consuming.
- Many of the PP are responsible citizens who would like to help the society so EIA should consider their concerns and be a management tool for better planning.
- Monitoring and implementation are essential for environment protection hence agencies involved in such duties, must implement laws for environment protection.
- There is a need to relocate project affected persons prior to commencement of the project so that reservations regarding the project can be sorted out amicably and work commenced for the benefit of sustainable development.
- Clean technology, green processes, renewable resources need to be tapped so that the environment is least affected.
- A detailed study should be made by involving technical experts and environmentalists as it appears that sometimes rules and regulations are bent or modified to accommodate the infrastructure projects as was in case of both the coastal road project and a new airport in Navi Mumbai. In both the cases CRZ regulations were modified "The CRZ notification 2011 issued by the MoEF, now makes it possible to envisage coastal roads on stilts" and "development of green field Airport already permitted only at Navi Mumbai;"exempted from CRZ prohibited activities.

CONCLUSION

EIA as a process is a necessary exercise for sustainable development since it brings forth both the benefits and adverse effects of the project. When the two are compared and marks given, it allows better

judgement as to whether the activity is beneficial or detrimental. EIA also helps in determining the process of management during different stages of implementation for sustainability. The case studies pertaining to Mumbai brought forth the need of such infrastructure in a metropolitan city, which through EIA studied the impact on all levels- economic, socio-cultural and environmental, helped in determining its need and processes for sustainable development. The government has been proactive to modify the rules and regulations for faster clearances to infrastructure projects which are the need of the day. It would be better if post project monitoring can be done by an independent agency for efficient management.

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ENVIRONMENTAL CONSCIOUS INDUSTRIAL DEVELOPMENT

KANIKA BANSAL GOYAL*

Abstract

Industrial development is a resource intensive and waste generating sector of city structure, and is often regarded as one of the key contributors in degradation of environment. However, it is essential for economic and social development of the city. Many traditional and innovative new concepts are used to reduce the environmental footprint of industrial development and making it more sustainable. There exists a need for strategic framework which can be used in planning, developing and managing the industrial estate in an urban scenario which can improve the performance of an industrial area.

A study has been made starting with input-output flow and other components of the industrial system, followed by performance evaluation of the industrial estate based on the detailed analysis of the indicators for the indentified aspects like land, landuse, site planning, typology, energy, water, pollution, waste, vegetation and transportation. Analysis and performance evaluation of one of the planned industrial estate is carried out, to identify the problems, potentials and strengths in the existing planning guidelines. The result of this study lead to formulation of a proposal with Strategies for environmentally conscious industrial development for an urban area.

INTRODUCTION

The country's development is measured from its economic base in which industries play an important role. Industrial sector contribute to a major portion in the economy of India. Service industry and manufacturing industries contribute to approximately 57.2% and 28.6% (as per Economic Survey 2010) respectively in the GDP of the country. Also, Industrial development has the potential to help achieve a variety of social objectives such as employment, poverty eradication, gender equality, labour standards, and greater access to education and healthcare and ultimately to raise the standards of living of the people.

Industrial processes are identified as a key role player in the degradation of the global environment. It was since the beginning of industrialization that global warming and climate change processes are observed. Though environmental regulation and new technologies are reducing the environmental impact per unit produced by the industries, but industrial activities and growing demand are still putting pressures on the environment and the natural resource base. The resource consuming and waste generating tendency of industrialization has put a tremendous impact on the man-made and the natural environment. Development of industries has raised the level of pollution levels to a significant level and has caused the contamination of air, water and land. The increasing demand of resources from the industrial sector has led to the depletion of resources. The industries are also responsible for generating large quantities of hazardous waste which becomes difficult to handle. It has made the cities unhealthy and has affected the quality of life in cities.

It is very much evident that environment and industry are contradictory aspects. It is necessary to realize that any development will have an environmental footprint. It is also important to understand that without adequate environment protection, industry will lose its resource base and any further development will be hampered. But it is also important to realize that industrial development is required for country development. Hence, there is a need to identify/ prepare various strategies which will reduce and mitigate the environment impacts of industrial development and will enhance the economic benefits of the industrial sector.

**Asstt Professor, Ramaih Institute of Technology, Bangalore*

Various traditional as well upcoming concepts exist which are incorporated in the industrial development to reduce and mitigate its impact. The application is based on the intensity of impact of industries in a particular area. As diagnose and correct approach has been adopted widely, most of the concepts that have development are corrective in nature. Whereas only a few concepts like cleaner production, industrial ecology which are precautionary in nature and reduce the impact at the very initial stage of the development and makes the development sustainable. Also there are many technical solutions available to reduce the environmental impact.

IMPACT OF INDUSTRIAL DEVELOPMENT

Industry is related to a greater or lesser degree to all these environmental impacts. Global ecosystems are intimately intertwined with our economies; through the feedback loops so established, the degradations of the ecosystems will also have growing impacts on industry.

The impact of industries starts from the resource consumption that the industry has as its input. Mostly the industries are energy intensive and needs a large energy base for its operation. The energy required is for the operation of machines and for lighting the premises. Also many industries require water in their production process. The major environmental degradation takes place due to the disposal of the waste produced. The hazardous nature of the waste decays the environment and its disposal becomes an area for concern.

PERFORMANCE INDICATORS

The indicators should be selected as a part of the methodology to help us to measure the performance in a systematic, consistent and focused way. The performance indicators in this case can be designed to answer the question:

- How well are we doing?
- What are the other alternatives?
- How well are we doing compared to other alternatives?
- What are the benefits we are having?
- What are the shortcoming areas?
- How can we target to overcome the shortcomings and enhance the benefits?

The performance indicators also help us to articulate the key sustainability issues and the sustainable industrial practices. The indicators in this study are focused on environmental concerns to achieve the vision of the study.

In case of environmentally conscious Industrial Development the broad aspects of study will be land, energy, water, pollution, vegetation, transportation, waste, networking and industrial typology. The detailed indicators are given in Table 1.

Table 1. Aspects of Study

Aspects	Indicators
Land	Land Use Distribution, Area, Density
Layout / Site Planning	Orientation, Plot Sizes, Ecological Site Planning
Industries Typology	Environmental Impact, By-Product Utilisation, Networking
Energy	Requirement, Distribution, Renewable Energy- Types And Feasibility
Water	Requirement, Water Efficient Planning
Air Pollution	Levels, Sources And Impacts
Water Pollution	Levels, Sources And Impacts
Noise Pollution	Levels, Sources And Impacts
Waste	Nature , Disposal, Impact, Mitigation
Vegetation	Density, Type, Open Space Structure
Transp-ortation	Infrastructure (Pedestrian Friendliness, Road Widths, Parking Surface And Availability) Traffic Generation (Mode, Volume, Pollution Load)

Case Study: Mangolpuri Industrial Estate, Delhi

Delhi has undergone a rapid process of urbanization and industrialization. The industrialization has resulted in environmental degradation along with an increased stress on availability of infrastructure. The relocation policy of Delhi had shifted all the polluting units to the new industrial estates from the non-conforming areas. In turn, it created a situation of uncertainty, resulting in loss of confidence and productivity of the entrepreneurs. There is no doubt that strict regulations should be made for the polluting industries but better environmental management should be formulated even before introducing in land use and urban management policies.

The study is an attempt to explore of application of various upcoming in the context of the Indian cities like Delhi where the urbanization has already taken place to the extent possible. The focus is to identify environmentally conscious guidelines of developing industrial areas which could lay a basis to plan innovative industrial estates leading to social and economic gains. As the result of the study, areas of intervention were identified and guidelines are formed for different aspects of industrial development.

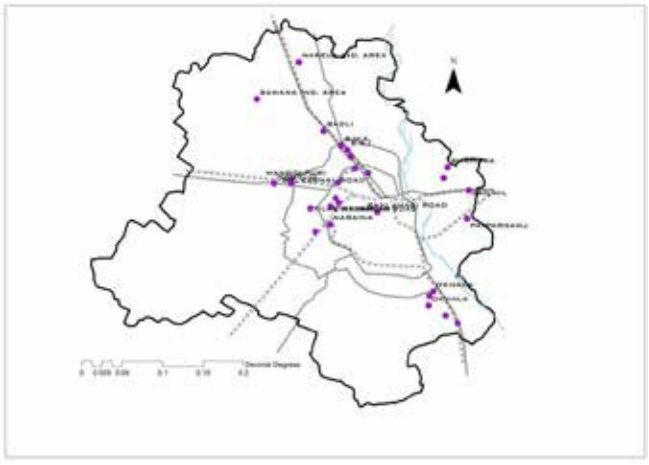

Fig. 1: Industrial Estates in Delhi

Delhi has 28 planned industrial estates (Fig.1) spread over an area of 4647 acres. In addition, four flatted complexes are developed. Out of 1.3 lakhs industrial units in Delhi, only around 25000-30000 are located in planned industrial areas- (Master Plan of Delhi, 2021). These industrial areas were developed in the 70s and over the years have deteriorated considerably in terms of physical infrastructure. The industrial estates in the city are owned by three agencies- Delhi State Industrial Development Corporation (DSIDC), Delhi Government Industries Department and DDA. Out of 32 industrial complexes, nearly 21 are maintained by MCD- (Department of Industries, 2010-11). The problem of multiplicity of organization can be observed.

MANGOLPURI INDUSTRIAL AREA

Mangolpuri industrial area was developed in 1976, to provide employment to the uneducated and unemployed people of the resettlement colony and the nearby areas. The area is developing since the very first master plan.The area is one of the planned conforming areas and complies with many environmental restrictions, still, a need for redevelopment of such planned industrial areas as per environmental considerations have been recognized in the recent zonal plan and master plan.

Mangolpuri is one of the planned industrial areas along with Badli, Wazirpur and Lawrence Road. These areas are developed as envisaged in the zonal plan. As per the MPD-2021, the unplanned industrial areas include Shalimar Village, Haider pur village and Rithala village.

Mangolpuri Industrial area is developed in two phases: Phase-1 and Phase 2. Apart from these two planned industrial areas developed by DDA, concentrated industrial development can been found in the flatted industrial complexes of engineering complex and community work centers near G-block developed by DSIIDC along with scattered household industries in the area.

The Mangolpuri industrial area including phase-1 and phase-2 along with engineering complex covers 119.48hectares of area. The industrial development consists of plotted and flatted industrial areas.

The following need to be indentified for the area:

- To identify the possibilities to improve the current industrial planning from environmental perspective.
- To identify the impact on the neighboring residential area
- To identify the mix of industry typology
- To identify the intra and inter industrial flow of resources
- To study the efficiency of the layout type (Fig. 2)

Fig. 2. Layout Plan

EVALUATION

Land/Layout

Deep plots with greater than 7 meters depth (open from one side) and 15 meters depth (open from both sides), (Fig.3) lacks in natural light and ventilation. Also the work space is often planned at the back of the plot which makes it completely dependent on artificial light. Only 50% of the plots in the case study area are having the suitable north south direction.

Considerations should be made according to the topography of the area specially while laying the services and planning the facility areas. For example: CETP should be planned on the lower side of the site. The diversity in plot sizes development typology will encourage intra estate networking among the units as smaller plots and flatted units will mostly cater to the auxiliary units. Incorporation of compatible land uses will also enhance sustainability of the estate.

Common facilities may be incorporated that will help the smaller units to be more environmentally friendly as the cost is distributed and becomes affordable. Also a compact development should be promoted so that the environmental management becomes easy to compliance.

Energy

D.G. sets are used as the alternate energy sources which has raised the air pollution and noise pollution levels to significant limits. No green energy alternative is being used in any industry.

Not many energy intensive units should be encouraged in the estates within the urban areas. Green energy should be incorporated and non-polluting and environmental friendly alternative should be identified and encouraged. Industries will be more inclined to incorporate such energy source if their products will get the credibility for green energy use in the market. Hence, environmental economics principles may be used for policy making instead of relying on implementation of environmental management system.

Water

Less percentage of permeable surfaces is found the case study area. Even the permeable surfaces which exist have been consolidated due to parking of heavy vehicles in the open grounds. This will result in reduced natural recharge on ground water on the site. Also no RWH systems were installed except in Mother dairy F&V unit.

Different quality of water is required for different purposes, which makes the potential of the water recycling and reuse high.

Alternate water conservation methods like RWH, Water Recycling etc. should be incorporated.

Typology

Major types of industries include footwear, plastic goods, engineering works, metal works, auto parts and electronic goods. 90% of the industries are covered in 21 categories of which the environmental impact is assessed based on:

- If it is water intensive
- If it is energy intensive
- If it is classified as water polluting industry by DPCC
- If it is classified as air polluting industry by DPCC
- If it is classified as hazardous nature industry by DPCC
- If it is noise polluting

The impact matrix is given in Table 2 which industries with low impact with ranking 0-2 and high impact with ranking 3-6

Table 2: Impact Matrix

Industry	Water Used In Process	Energy Consumption	Water Polluting	Air Polluting	Hazardous Nature	Noise	Final Ranking
Automobile Repair And Service	1	0	1	1	1	1	5
Helmets	0	0	0	1	1	1	3
Anodising	1	1	1	1	1	1	6
Sanitary Goods	1	0	1	1	1	1	5
Rubber Compound For Rubber Footwears	0	0	0	1	0	0	1
Wire Drawing	1	0	1	1	1	0	4
Electroplating	1	1	1	1	1	1	6
Corrogated Boxes	0	0	1	1	1	0	3
Automobile Building	0	1	0	0	1	1	3
Printing	1	0	1	0	1	0	3
Casting Of Ferrous/ Non Ferrous Metal	0	1	0	1	0	1	3
Rubber Autoparts	0	0	0	1	0	1	2
Eva Footwear	0	0	0	0	0	0	0
Autoparts W/O Rubber	0	0	0	0	0	1	1
Eletrical Goods	1	1	1	1	1	1	6
Apparels	0	0	0	0	0	0	0
Pvc Footwear	0	0	0	0	0	0	0
Engg	0	0	0	0	0	1	1
Pvc Granules and Other Injection Moulded Items	0	0	0	0	0	0	0
Leather Footwear	0	0	0	0	0	0	0
Plastic Goods	0	0	0	0	0	0	0
	7	5	8	11	10	11	

It can be seen that footwear industry, plastic industry and auto-parts industry without rubber are having low impact on environment as compared to other industries.

Higher percentage of orange industries is found in the case study area which is leading to environmental impact on environment. High impact industries can be identified from the typology like electrical goods, sanitary goods etc in the analysis

classification of plotted industries classification of flatted industries

Fig.3: Classification of Industries

Complementing industries should be clustered together with necessary infrastructure to reduce the impact as it will support the industrial networking (Fig.3).

Air Pollution

High number of air polluting units in both plotted and flatted industries leads to higher particulate matter. Also the unpaved parking surfaces with soil top also contributes to the air pollution adding the unconsolidated soil in the air. Lack of consideration of wind direction while planning makes residential areas impacted from the air pollution. Scattered air polluting units helps in dispersion of air pollution. Proper planning, management and monitoring can help in reducing the pollution levels.

Water Pollution

Treated water with high TDC and chloride content is disposed in the drain which leads to additional cost of treating the treated water downstream. Also linear shape of the site and scattered location of the industrial units has increased the cost of operation of the CETP.

which are in a considerable number in the area.

Low impact industries like footwear, plastic goods have low resource consumption and should be encouraged, though they also require proper environmental management system to be installed for minimum environmental impact. Diversity in typology will help in industrial networking in form of waste exchange and product exchange among the industries in the estate and with other estates.

CETP is one of the solutions to control the water pollution. The CETP should be planned considering the natural slope of the site for easy flow of effluents from the industries to the CETP plant. Water polluting units should be planned as a cluster near to the treatment plant.

Treated water can be recycled and reused. Units should take the initiative to control the pollution at individual level by providing at least the primary treatment. Also initiative for reducing the polluted water and exchange of effluents among the industries should be included.

Noise Pollution

Noise level has been raised primarily because of loading and unloading of goods on the road side. The impacts could be observed on the workers.

High noise levels are controlled by vegetation, though proper vegetation structure and vegetation species should be planted. Also noise reduction in shadow areas can be identified (Fig.4). Simple provisions can help in controlling the noise levels.

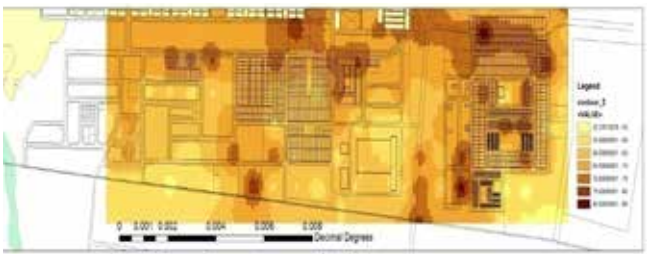

Fig. 4: Noise Contours of the Area

Waste

Waste disposal in open areas has lead to serious problems like contamination of soil,

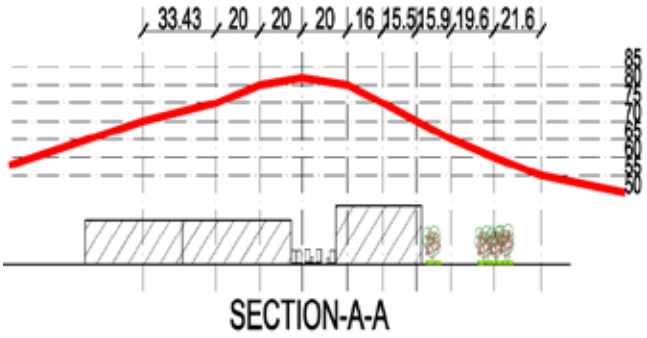

Fig. 5: Noise Reduction

contamination of ground water, visual pollution in the area, and health impacts. No proper hazardous waste disposal system has been adopted in the area.

Management and maintenance of proper disposal and treatment system is required. Also waste as a resource potential for another industries should be explored to the maximum extent. Recyclable waste can be re-utilized by recycling. Planning consideration should be made for treating waste a resource.

Vegetation

Among the prominent species, Ashoka, Neem, Banyan and Peepal tree are good in absorbing noise where as Vilayati Keekar has poor absorption.

Stress on vegetation can be observed in form of perforated and dusty leaves. No proper maintenance of the buffer as mostly only scattered trees can be found in the buffer. Vegetation helps in noise reduction and pollution reduction to a great extent (Fig.5). Pollution absorbing native species must be planted.

Transportation

Lack of pedestrian friendliness in the layout of the case study estate and lack of public transport has created problems for the workers. Insufficient parking leads to parking on open areas. High percentage of small commercial vehicles leads to high traffic generation and there by pollution.

High percentage of green commuters should be promoted and pedestrian friendly design concepts should be incorporated. Proper road width and layout is an important element for layout and should not be neglected. Traffic management and traffic reduction strategies should be incorporated.

AREAS OF INTERVENTION

After assessing the case study area it is found out that environmentally conscious can broadly be divided into three types of intervention

- Planning interventions
- Management interventions
- Technological interventions

Guidelines for Environmentally Conscious Industrial Development are given in Table 3.

Table 3: Guidelines for Environmentally Conscious Industrial Development

Predevelopment	Integration with existing development Market availability Networking Environmental impact
Planning and Layout	Ecological site planning Clustering of industries Typology Diversity in sizes Plot Dimensions and Orientation
Infrastructure Planning	Water management- Cascading, Recycling, Harvesting Waste Management- Waste Utilization, Recycling Energy Management- Alternate Sources
Transportation	Pedestrian friendly Design Common transportation systems for goods Adequate and proper Parking Design
Landscape	Width of Buffer, structure, Selection of species Maintaining links and nodes Multi-functional use
Green Building Design	Layout Noise reduction Passive solar lighting RWH

CONCLUSION

"Let every individual and institution now thinks and act as a responsible trustee of Earth, seeking choices in ecology, economics and ethics that will provide a sustainable future, eliminate pollution, poverty and violence, awaken the wonder of life and foster peaceful progress in the human adventure."

— John McConnel

There is no doubt that strict regulations should be made for the polluting industries but better environmental management should be first formulated before introducing in land use and urban management policies. The identified environmentally conscious strategies of developing industrial areas would lay a basis to make innovative industrial estates leading to social as well as economic gains with minimum environmental footprint.

ENVIRONMENTAL CONCERNS OF URBAN ROAD TRAFFIC IN CHANDIGARH

Dr. Umesh Sharma* And Dr. Siby John**

Abstract

Transportation has a pervasive influence on modern society. It plays a vital role in the economic growth of any region or nation. The ever increasing vehicular population has completely transformed the socio-economic scenario in urban areas all over the world. Notwithstanding the central role transport plays in the overall socio-economic development, environmental concerns have come to the forefront as one of the most important issues in transport policy debates. The need for maintaining a proper environment at balance in conjunction with continuing growth of urban transport has been recognized. The increase in the urban traffic is causing congestion and delays on the roads and hence the environmental degradation. Although the vehicular population in Indian cities is much less compared to those in more advanced countries, the noise pollution problem is quite formidable due to congested and slow moving traffic.

Noise Pollution due to urban road traffic has been a major cause of concern. This study presents the status of noise pollution of Chandigarh due to road traffic. A correlation model of noise level with traffic characteristics has been proposed. The model could be used as an effective tool in traffic planning, management and pollution control.

INTRODUCTION

The potential negative impacts of road transport on social and ecological environments, notably in terms of congestion, noise pollution, annoyance and accidents have already been established. Such environmental effects lead to high costs of transportation system.

The ever increasing vehicular population has completely transformed the socio -economic scenario in urban areas all over the world. Although the vehicular population in Indian cities is much less compared to those in more advanced countries, even then the traffic related noise pollution problem is quite alarming due to congested and slow moving traffic. Most of the Indian cities are facing serious noise pollution problems due to the concentration of motor vehicles and human population within the confined urban areas (Sarin, 1990; Bhattacharya, 2003; Vidyasagar and Rao, 2006; Banerjee and Chakraborty, 2006; Sharma and John, 2008). Noise is a form of pollution that is not recognized as such. Human response to noise displays a systematic quantitative pattern, but quantitative responses vary from one individual to another based on age, health etc. Continuous exposure to high levels of noise results in annoyance, fatigue and temporary shift of hearing which may lead to permanent loss of hearing. The dominant highway noise sources are noise from vehicles (engine), interaction of tyres with the road surface and mixed traffic flow conditions coupled with driving habits. In view of the rapid developments in highway sector, study of traffic noise with respect to various causative factors is necessary so that suitable remedial measures can be planned.

Chandigarh, the most modern city of India has been facing an unprecedented growth in vehicular

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population. The city has more than 6 lakhs vehicles which are shared by 9 lakhs population averaging one vehicle for less than 2 persons (Chandigarh 2001). This paper reports the noise levels due to traffic in the heavily trafficked areas of Chandigarh.

BACKGROUND OF CHANDIGARH

Chandigarh, the joint capital of Haryana and Punjab is one of the most beautiful and planned cities in the world. It is situated at a distance of two hundred and fifty six kilometers north of Delhi at the foothills of Shivalik range, looked over by the magnificent Himalayan Mountains having an area of 114 sq. kms. Geographically, Chandigarh has an altitude varying from 325 m to 400 m M.S.L with 1% grade. Physically two river beds 8 kms apart bound the city, the Patiali Rao to west and Sukhna Rao to east.

The basic unit of the city is a sector. The city consists of 56 sectors each about 1.2 x 0.8 sq. kms laid down pointing towards north east and facing lower Shivalik hills of Himalayas, so that the various sectors are arranged in rows and columns in the form of a chessboard. Each sector intended to be a self-contained unit, which provides for the basic needs of every citizen.

The city has a grid iron pattern of roads spread over the length and breadth of the city. The roads are divided into a system of traffic separation based on a scheme of organization which is termed as seven Vs'(Voies de circulation) system. These Vs' represent a fully organized universally acceptable system ensuring every level of circulation from arterial roads to apartments. A map of city of Chandigarh is given in Fig. 1. A large segment of population has personal vehicles. Rise in population coupled with inadequacy of public transport system has resulted in high private vehicle ownership in Chandigarh. The city has more than six lakhs vehicles which are shared by nine lakhs residents averaging one vehicle for less than two persons. It shows that the vehicle to population ratio is alarming and traffic is creating chaos on the Chandigarh Road. This paper reports the noise levels due to traffic in heavily trafficked areas of Chandigarh.

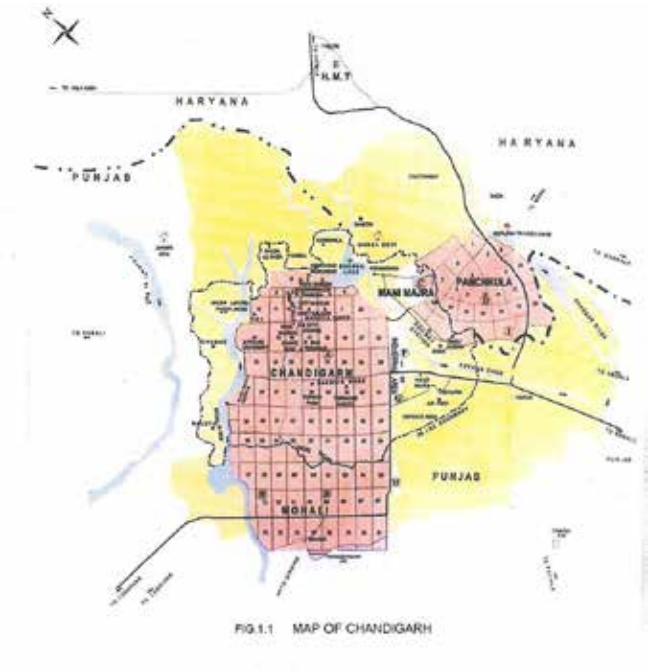

Fig. 1: Map of Chandigarh

NOISE POLLUTION

Noise is an unwanted sound, the degree of unwantedness being an aspect much based on personal evaluation. It differs from person to person, place to place and time to time. Noise is one of the environmental pollutants that are encountered in daily life. It has become a major concern for communities living in the vicinity of major highway corridors. Major highway noise comes from the motorized vehicle units.

For a given time interval, the noise levels may be fluctuating and may momentarily take exceptionally high and low values at the time of road traffic noise measurement. Noise source is found to be strongly time dependent. In such situations, a single value, which is representative of all the noise levels occurring over a given span of time, needs to be calculated. Most common traffic noise descriptors are L_{10}, L_{50}, L_{90} and Leq. The distribution function is determined by the analysis of the noise signal by some form of statistical analyzer. The range of noise level is divided into equal incremental percentage of total sample time for which the sound pressure level within each increment is found.

- L_{10} or ten percentile exceeding noise level which exceeds 10% of the total observation

time.

- L_{50} or fifty percentile exceeding noise level which exceeds 50% of the total observation time.
- L_{90} or ninety percentile exceeding noise level which exceeds 90% of the total observation time.
- Leq or equivalent sound energy level is the A- weighted energy mean of the noise level averages over the measurement period. It can be considered as the continuous steady noise, which would have the same total A-weighted acoustic energy, as the real fluctuating noise measured over the same period of time. The equivalent energy level.

  L_{eq} is the energy means of noise sample and is calculated from the expression.

$$L_{eq} = 10 - \sum_{i} Pi\ 10^{L1/10}$$

Where Li is the median sound pressure of the i^{th} measuring interval of stoichal analysis of sound and P_1 is the probability of the sound level lying in the i^{th} interval.

For Gaussian distribution of noise level with a standard deviation of, the following relationship holds.

$$L_{eq} = [L_{50} + (s^2/8.68)]$$
$$L_{eq} = [L_{50} + (L_{10} - L_{90})^2 / 56] \text{ dB(A)}.$$

The ambient noise standards for different areas in India and for different countries are given in tables 1 and table 2.

Table 1: Ambient Noise Standards (India)

Area	Leq Day * (dBA)	Leq Night** (dBA)
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone***	50	40

(CPCB, 2003)
* Daytime 6 am - 9 pm
**Night Time 9:00 pm - 6:00 am
***Areas up to 100 m around certain premises like hospitals, educational institutes and courts may be declared as silence zone.

Table 2 : Permissible Noise Level in Residential Areas in Different Countries

Country	L_{eq} Day (dBA)	L_{eq} Night (dBA)
Sweden	55	45
Germany	55	40
Australia	48-51	36-43
Switzerland	60	50

(Bhattacharya, 2003)
L_{eq} = Noise Equivalent.

METHODOLOGY OF DATA COLLECTION

The study was carried out in the most heavy trafficked areas of Chandigarh consisting of two sites (one site near Kisan Bhawan and another near Tribune Chowk). These areas are the most difficult areas for traffic planners. It is the area where the maximum numbers of vehicles passing are either entering the city or going out of the city. A long queue of vehicles can be seen on any of these locations on any days. The locations are shown in the map in Fig. 1. The data pertaining to traffic studies and noise levels was collected in the sites earmarked. The requisite data has been collected for all the 7 days of a week.

TRAFFIC STUDIES

Information on traffic characteristics is of paramount importance in the present study and it is carried out under the following heads.

- Traffic volume studies
- Traffic speed studies

Traffic volume studies

The flow of traffic on roads is non-homogeneous. The unrestricted mixing of different classes of

vehicles in the traffic stream forms the "mixed traffic flow" on the roads. This makes mixed traffic flow characteristics very much complex when compared to homogeneous traffic consisting of passenger cars only. Due to the above said reason, it is rather difficult to estimate the traffic volume under the mixed traffic flow conditions. When the traffic is of heterogeneous nature, it is normal practice to convert the number of types of vehicles, into equivalent passenger car units (PCUs) by using equivalency factors as prescribed by (IRC, 1990). The flow is then expressed as PCUs per day. The traffic volume data was collected on hourly basis on both the directions for ten hours of the day starting from 8.00 am - 6.00 pm and manual method of data collection was used.

Traffic speed studies

Speed is the rate of travel expressed in kilometers per hour. The speeds measured at any particular location will depend upon a number of factors such as geometric layout of a road, the volume of traffic, the composition of traffic, the condition of the road, environmental influences, the human element associated with individual drivers and the characteristics of the vehicles. Manual method of measurement of speed was used in the speed studies .The speed study was carried out for ten hours starting from 8.00 am - 6.00 pm. Manual method as used consisted of using stop watches and noting down the time to travel the distance between the two fixed points. The distance between the fixed points was kept as 30 meters.

Noise Pollution Studies

The noise pollution parameters were monitored at the locations identified. Sound level meter (SLM) model PSLM 100 HD (make Hi-Tech) was used for measuring the noise levels. The instrument was held in hand at an average height of 1.5 meters from ground level and at a distance of 5.0 meters from the pavement edge with its microphone pointing towards the noise source and noise level displayed in dB(A) is noted down after every 15 seconds. The traffic noise is analysed and the values of L_{10}, L_{90}, L_{50} were found from the cumulative plot of traffic noise and frequency using MS-Excel. The values of Leq were then determined.

RESULTS AND DISCUSSION

Traffic Volume

The total volume of vehicles per hour was calculated by converting the traffic volume into equivalent passenger car units and the total PCUs per hour were calculated.

The Traffic flow pattern in areas under study is observed to follow peak hours in between 9.00 - 10.00am and 5.00 - 6.00pm.The maximum traffic volume at Kisan Bhawan is 3028 PCU/hr towards Dev Samaj College and 4056 PCU/hr towards sector 21 on working day and 1550 PCU/hr and 1050 PCU/hr towards Dev Samaj College and Sector 21 on non working day respectively. At tribune chowk, the trend is a little bit reverse on the side as the traffic is more on non working day than on a working day. The maximum traffic is 1230 PCU/hr and 1282 PCU/hr towards Ambala and Chandigarh on a working day and 2005 PCU/hr and 2120 PCU/hr respectively towards Ambala and Chandigarh on a non working day. Obviously, the traffic volume at Kisan Bhawan on a non working day is less than on a working day but the reverse trend on the Tribune location is there because it is exit point of the city and may be due to the fact that the people do have a tendency to move out of the city on non working days.

Traffic Speed

The traffic speed has been summarized in the form of average traffic speed values calculated for every hour. The average speed has been calculated for both directions for the complete ten hours. The average speed at Kisan Bhawan site on a non working day is 39 km/hr and 36km/hr on working day. At Tribune Chowk the average speed is 36 km/hr on a non working and 35km/hr on working day respectively. Because of increase of traffic volume, the speed is less on working day than non working day at Kisan Bhawan but due to reverse trend in traffic volume at the tribune chowk the speed is more on working day and less on non working day.

Noise Pollution

The noise levels L_{10}, L_{50}, L_{90}, Leq have been calculated from the field data and tabulated in the tables 4.0 and 5.0.The noise levels expressed as L_{eq} at Kisan Bhawan varies from 80 and 82 dBA on a non working day and 80 to 85 dBA on working days respectively. Noise levels at tribune chowk vary from 73.55 to 83.94 dBA on working days and 80.62 to 85.04 dBA on non working days. The noise levels were found to vary with variation in traffic.

Noise Model

A model is proposed correlating the traffic volume and speed with respect to the Leq. The results have been tested by the statistical analysis package (SPSS) and are tabulated in Table 3. From the table, it is clear that a significant correlation exists between the noise levels and traffic characteristics.

Table 3 : Regression Analysis for Noise Pollutant

LINEAR EQUATION	MULTIPLER	STANDARD ERROR OF THE ESTIMATE	F –VALUE	P-VALUE
Leq=37.562+4.269logVn -0.144Sn-0.254logVf +0.973Sf	.510	2.80355	11.848	<.0001

where Leq = Noise equivalent (dBA), Vn= Volume of Traffic on near side of road (PCU/hr), Sn= Speed of Traffic on near side of road (km/hr) Vf= Volume of Traffic on far side of road (PCU/hr),Sf= Speed of Traffic on far side of road (km/hr).

VALIDATION OF MODELS

Statistical analysis of the results indicated that the heavy traffic zone exhibited significant correlation between traffic characteristics and noise pollution. Models correlating the traffic characteristics and noise pollution have been proposed. The proposed models have been validated by selecting another site of heavy traffic.

Selection of Site

The selected site consists of all types of vehicles and is located in sector 26 along the Madhya Marg near the Transport Chowk which is a gateway to the traffic moving towards Haryana and Himachal Pradesh. The traffic volume and speed studies have been done in this area. The maximum traffic volume at transport chowk is between 9.00– 10.00am and 5.00- 6.00 pm in the evening. The maximum traffic volume on the working day is 2940 PCU/hr and 1640 PCU/hr on non working day. The average weighted speed is 39km/hr on non working day and 38km/hr on working day.

For the selected site the noise levels of L10,L50,L90 and Leq have been calculated from the field data .The noise levels Leq obtained from the proposed models are compared with the observed Leq values from the selected site and tabulated in 7.0.From the table it is clear that the values are matching. A chi-square test has been performed at the 95% confidence interval and the predictability of the model is tested. 2 calculated is found to be 2.637 and from the critical standard table 2 is90.53 which means that the model is accepted.

Table 4.0 Noise values at Kisan Bhawan

Day ↓ / Time → / Noise levels		8:00 -9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
Sunday	L_{50}	83.400	83.172	82.714	82.859	81.372	83.932	82.141	82.433	82.951	83.138
	L_{90}	78.752	79.020	78.676	78.622	78.252	79.717	78.032	77.603	78.456	78.113
	L_{10}	87.551	87.867	88.337	88.033	85.845	87.643	87.474	87.305	87.817	87.825
	L_{eq}	81.1289	81.6516	81.3743	80.3502	81.3044	82.7756	80.0972	82.6491	81.595	82.9512
Monday	L_{50}	83.2679	81.8292	84.3151	82.9306	82.298	83.3267	82.1361	83.0342	81.7578	83.3162
	L_{90}	78.356	78.3622	77.6999	78.3016	78.4862	78.0216	78.3481	78.4822	77.6105	79.0584
	L_{10}	88.375	87.2314	87.9621	88.0884	87.3342	87.4428	88.2478	87.3032	87.4266	87.7429
	L_{eq}	85.0604	83.2339	86.1957	84.641	83.6959	84.9116	83.8862	84.4237	83.4784	84.663
Tuesday	L_{50}	83.400	83.172	82.714	82.859	81.372	83.932	82.141	82.433	82.951	83.138
	L_{90}	78.752	79.020	78.676	78.622	78.252	79.717	78.032	77.603	78.456	78.113
	L_{10}	87.551	87.867	88.337	88.033	85.845	87.643	87.474	87.305	87.817	87.825
	L_{eq}	84.7823	84.5693	84.3805	84.4408	82.4018	85.0537	83.7334	84.114	84.5158	84.822
Wednesday	L_{50}	81.834	83.315	83.172	84.402	84.166	81.989	83.130	84.218	84.064	82.106
	L_{90}	77.926	78.424	78.273	79.094	78.731	78.106	79.388	78.338	77.568	78.588
	L_{10}	88.360	87.185	87.336	88.142	87.588	88.235	87.501	87.655	88.505	86.289
	L_{eq}	83.7785	84.6852	84.6393	85.8638	85.5669	83.8209	84.3059	85.7685	86.2001	83.1648
Thursday	L_{50}	83.558	82.809	82.356	83.314	82.251	82.395	82.067	83.967	82.049	82.786
	L_{90}	78.000	78.269	78.053	79.226	77.436	78.916	78.428	78.642	77.899	78.068
	L_{10}	87.300	87.332	87.709	87.628	86.016	86.327	86.874	87.816	87.351	87.482
	L_{eq}	85.1032	84.2761	84.0212	84.5745	83.5653	83.3754	83.3407	85.4702	83.6441	84.3687
Friday	L_{50}	82.05	81.25	82.6085	83.405	83.9031	83.3772	82.6235	83.1696	83.006	81.8
	L_{90}	78.050	78.240	78.412	78.228	78.732	78.293	78.483	78.471	77.654	78.299
	L_{10}	87.730	86.920	87.071	87.626	88.169	87.412	87.847	87.850	87.244	87.266
	L_{eq}	83.7233	82.5954	83.9473	84.9824	85.4934	84.8621	84.1895	84.7403	84.6482	83.2358
Saturday	L_{50}	78.612	80.415	80.679	79.409	80.416	79.694	80.105	79.177	78.678	79.426
	L_{90}	74.633	75.676	75.766	75.027	75.173	75.683	75.455	75.531	74.774	75.532
	L_{10}	83.4615	84.1348	84.3571	83.8108	84.0506	84.0336	83.9068	83.3576	84.1665	82.9198
	L_{eq}	80.0038	81.6932	81.9975	80.7871	81.8234	80.9388	81.3802	80.2706	80.2527	80.401

Table 5.0 Noise values at Tribune Chowk

Day ↓ / Time → Noise levels		8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00
Sunday	L_{50}	77.361	76.961	77.278	77.985	80.987	75.575	76.680	78.975	78.990	77.839
	L_{90}	69.600	68.112	69.408	68.055	72.235	67.410	68.012	69.346	69.573	69.093
	L_{10}	84.801	85.071	85.920	86.646	87.298	84.212	85.611	83.744	86.313	87.013
	L_{eq}	81.487	82.096	82.146	84.157	85.038	80.616	82.210	82.676	83.994	83.573
Monday	L_{50}	75.204	73.856	75.96	74.402	75.404	74.312	73.886	75.472	75.190	74.747
	L_{90}	68.77	68.48	68.90	68.52	69.31	68.51	68.89	69.65	68.84	68.79
	L_{10}	81.34	80.90	81.56	81.02	81.38	81.11	80.96	81.34	81.23	81.32
	L_{eq}	78.314	75.338	78.318	77.326	78.438	77.531	75.605	77.943	76.965	77.143
Tuesday	L_{50}	77.337	76.483	78.667	76.772	78.769	78.266	77.338	77.874	74.129	77.092
	L_{90}	69.871	67.817	69.560	68.738	68.099	67.387	69.189	67.218	67.027	71.204
	L_{10}	86.676	86.695	86.345	85.203	84.623	85.212	86.263	86.643	86.303	87.045
	L_{eq}	82.3803	82.8470	83.698	81.613	83.644	83.939	82.543	84.612	80.763	81.573
Wednesday	L_{50}	74.311	72.250	73.580	73.450	74.062	71.265	72.689	74.165	73.439	71.854
	L_{90}	67.983	67.187	69.009	66.981	68.040	66.962	68.372	67.749	70.006	67.27
	L_{10}	78.683	78.805	78.400	78.526	78.225	78.278	78.106	78.965	78.377	78.71
	L_{eq}	76.355	74.66	75.154	75.830	75.914	73.551	74.381	76.411	74.690	74.189
Thursday	L_{50}	78.049	77.783	77.565	78.914	76.654	77.817	75.471	76.248	75.999	76.245
	L_{90}	71.533	70.420	70.541	71.280	70.158	69.752	69.275	69.492	69.995	70.089
	L_{10}	83.204	83.928	84.597	84.404	83.317	83.470	82.843	81.163	83.429	82.977
	L_{eq}	80.481	81.040	81.093	81.989	79.745	81.176	78.758	78.680	79.221	79.211
Friday	L_{50}	75.289	77.459	76.796	74.902	75.556	76.305	75.984	75.713	75.385	75.807
	L_{90}	69.663	69.502	70.178	69.886	69.373	69.448	69.637	69.150	68.627	70.139
	L_{10}	81.224	81.896	81.872	81.370	81.491	82.071	81.289	81.558	82.321	80.678
	L_{eq}	77.934	78.671	78.686	77.866	78.044	78.367	78.270	78.054	77.823	77.638
Saturday	L_{50}	75.289	77.459	76.796	74.902	75.556	76.305	75.984	75.713	75.38	75.807
	L_{90}	69.663	69.502	70.178	69.886	69.373	69.448	69.637	69.150	68.62	70.139
	L_{10}	81.224	81.896	81.872	81.370	81.491	82.071	81.289	81.558	82.32	80.678
	L_{eq}	78.6558	77.275	76.203	76.272	77.107	78.003	77.088	76.269	77.87	79.27

Table 6 : Comparison of Observed And Predicted Leq Values From Noise Model

Sr. No.	L_{eq} (OBS)	Leq (PRE)
1.	84.44394	82.36519
2.	87.10501	85.65229
3.	86.0814	84.42102
4.	84.00425	84.67708
5.	84.98138	82.57143
6.	86.0099	84.77163
7.	85.21255	82.76747
8.	85.28503	84.65235
9.	85.5981	82.71345
10.	84.54407	82.65402
11.	83.25362	81.37943
12.	83.74446	83.70761
13.	83.7115	83.5146
14.	84.56126	83.67872
15.	83.44131	80.48435
16.	83.03711	83.16362
17.	83.31772	82.58931
18.	82.46446	82.54203
19.	82.4608	82.68458
20.	82.89831	82.65127
21.	83.2685	82.49221
22.	83.91362	82.75423
23.	83.03886	82.51131
24.	82.92862	82.56004
25.	82.63514	81.59675
26.	84.68672	82.20343
27.	82.58711	82.44074
28.	83.97858	83.69582
29.	83.4144	81.60418
30.	83.318	82.8213
31.	83.19504	83.27843
32.	83.85603	84.97177
33.	84.03612	84.41396
34.	84.1304	82.36594
35.	83.9698	82.26279
36.	85.13606	83.29456
37.	83.13783	84.07592
38.	83.98794	84.68041
39.	82.83969	84.62677
40.	82.70606	84.42085
41.	84.06161	83.47238
42.	83.44571	82.05201
43.	83.85778	84.58937
44.	84.69754	82.57128
45.	85.10286	84.41185
46.	83.74229	80.43696
47.	84.10721	84.219
48.	84.00778	82.01272
49.	85.15378	82.9006
50.	84.28378	83.12017
51.	83.90451	85.38544
52.	81.05841	83.67275
53.	83.90414	83.47566
54.	82.95986	84.67479
55.	84.01174	85.20943
56.	83.14494	85.53666
57.	81.3404	85.30487
58.	83.56931	84.34979
59.	82.63801	84.57897
60.	82.77415	85.47355
61.	82.5525	80.02984
62.	81.07659	82.64532
63.	79.65091	82.45375
64.	79.70134	83.24455
65.	80.7288	83.25228
66.	81.86725	82.79374
67.	80.77265	83.11368
68.	79.8049	83.55494
69.	81.69298	84.05891
70.	83.57013	84.66224

CONCLUSION

The noise levels in the areas under consideration exceeded the permissible standards at the peak hours of traffic implying a clear correlation of noise level with the traffic characteristics. The noise levels were found to be more on working days than on non working days. The model correlating the noise pollution to the traffic characteristics could be used in traffic planning,

management and pollution control.

From the field observation and analysis of the data collected, the following specific conclusions could be drawn.

- The traffic is of heterogeneous nature in Chandigarh as different types of vehicles occupy the city roads.
- It has been observed that the city is experiencing the problems of traffic related congestion.
- The peak vehicular traffic was observed to be in the morning and evening hours.
- The average speed on the city roads is less than 44 Km/hr. However vehicles speed was found to be inversely proportional to the traffic volume.
- The noise levels were found to be more on working days than on non working days. The noise levels were found to be positively correlated to the traffic volume and speed of the vehicles.

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BIO-MEDICAL WASTE MANAGEMENT SYSTEMS IN CHANDIGARH

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Abstract

This paper highlights the procedure being followed to handle and dispose the Bio Medical Waste (BMW) in City Chandigarh. The main objective of this study is to recommend a design of a management system for BMW and follow it in Chandigarh city.

The production of BMW is assessed through direct measurements of produced waste and is compiled with taking literature sources in observance. On an average, BMW production of 1900kg/day is estimated for 10 hospitals. The doctors are observed to be good in knowledge about the regulations regarding waste disposal and handling. The need for comprehensive training programs regarding BMW management is highly recommended to all hospital staff. Indiscreetly, negligence and lack of adequate knowledge and practice on BMW disposal leads to effects on community and environment. If managed through inappropriate healthcare waste management systems, it can adversely affect the environment and public health.

INTRODUCTION

Due to rapid urbanization and rise in population there is substantial growth in generation of waste. BMW has emerged as a serious issue not only to hospital, nursing homes, but to the environment and general public."Bio-medical waste" (BMW) means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps.Approximately 10-25% of the Bio-Medical waste is hazardous and can be harmful to humans or animals and deleterious to environment. It is estimated that annually about 0.33 million tons of hospital waste are generated in India. Segregation plays a vital role because if non-hazardous waste is mixed with hazardous waste the whole waste will become harmful and will have to be disposed and treated in same way as infectious waste. The waste generation rate lies between the ranges of 0.5-2.0 kg/bed. There is risk of Human Immune deficiency Virus (HIV) and Hepatitis B and this has led to increase in awareness programs and betterment in handling and management systems.

To ensure proper management there should be proper awareness about the threat imposed by improper disposal system and practices, and active participation of trained staff along with full support from the organization. Looking at all existing scenario and seriousness of the issue, this study is conducted to assess the procedure being followed to handle and dispose BMW in the city Chandigarh.

BIO MEDICAL WASTE AND THEIR CATEGORIES

Bio Medical Waste (BMW) take in all the waste generated by health-care establishments like hospitals, medical and biomedical research facilities, first-aid posts blood bank and collection centers, biotechnology laboratories and institutions, animal

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research and testing laboratories and also the waste arising from treatment in the home.

Generally BMW is categorized into chemical waste, infectious waste, pathological waste, pharmaceutical waste, and radioactive waste.

Study Area

Chandigarh, is a city and a Union Territory of India that serves as the capital of the Indian states of Haryana and Punjab. It is located near the foothills of the Shivalik range of the Himalayas in northwest India. It covers an area of approximately 114 km2. It shares its borders with the states of Haryana and Punjab. The exact co-ordinates of Chandigarh are 30.74 N 76.79 E, with an estimated population of 1,055,450 and a population growth rate of 17.10% from 2001-2011. Seeing the demand of this huge increasing population, rapid growth in count of private clinics/hospitals is witnessed in the recent years in city. At present, about 780 nos. health care facilities (HCFs) are available in City that includes government hospital, private hospital,diagnostic center, nursing homes, clinics, dental clinics (Annual report CPCC, 2015).

But most of private HCFs are housed in residential building and do not have the facilities for acceptable BMW management system. The poor waste management system in these HCFs are posing a plain threat to public health and to the environment.

Selection of Health Care Facilities

Among 780 Health Care Facilities (HCFs) available in Chandigarh City, 10 HCFs are selected for this study. Table-1 shows the details about the HCFs.

The following aspects are well-thought-out for selecting Health Care Facilities (HCFs):

- Type and rate of waste generation
- Size of Health Care Facility
- Bed count in the facility

Table 1: List of healthcare facilities surveyed.

S.No.	Hospitals	Notation	No. of Beds	Category
1	Grewal Eye Institute, SCO 168-168 Sector 9 C, Chandigarh	GREWAL EYE INSTITUTE	16	Private
2	Postgraduate Institute of Medical Education and Research, Sector 12, Chandigarh	PGIMER	1948	Government
3	Govt. Multi-Specialty Hospital Sector 16, Chandigarh	GMSH 16	500	Government
4	Government Medical College and Hospital Sector 32, Chandigarh	GMSH 32	832	Government
5	INSCOL, SCO 18-19, Sector 34A, Chandigarh	INSCOL	50	Private
6	Mukat Hospital and Heart Institute, SCO 47-49, Sector 34A, Chandigarh	MUKAT HOSPITAL	72	Private
7	Guru Nanak Multispecialty Hospital, IMA Complex, Sector 35-B	GNMSH 35	*	Government
8	Chaitanya Hospital, Plot 1&2, Sector 44C, Chandigarh	CHAITANYA HOSPITAL	30	Private
9	Civil Hospital, Manimajra	CIVIL HOSPITAL	100	Government
10	ESIC MODEL HOSPITAL, Ind Area, Ph-2 Ramdarbar, Chandigarh	ESIC	70	Government

*only out patients.

Materials and Methods

The study is piloted for the period of four months from September 2016 to December 2016. The study is based on findings of initial survey, questionnaire survey, observation and survey for finding rates of waste generation. The information and collected data is critically analyzed to evaluate existing waste management system in the city, its impacts and limitation. An assimilated management plan is recommended for hospital waste disposal in effective manner. Production from health care facilities is likely based on limited measurements or

visual assessment of daily production by the persons in charge of waste management in the HCFs. Production by the waste generation sources was also estimated based on literature information from the previous researches.

RESULTS

The total quantity of BMW produced and its distribution in the city is necessary in order to design the management system at the regional level. The different sources producing BMW are classified by clinical activity in secondary health care facilities (hospitals, clinics) and primary health care facilities (social security health offices, health care centers, peripheral health offices, poly-diagnostic centers, and private practices). The sources, of BMW in the city are presented in Table 2 (CPCC 2015) In addition, there are 735 other healthcare facilities. (CPCC 2015).

Sources of Bio Medical Waste

The system of BMW production includes all the different sources in Table 1, and the by-products of health care services. The amount of BMW produced is likely from all the sources and then added the productions of all the sources to estimate the total production.

Table 2 : Sources of Bio Medical Waste in the Chandigarh

(Source: CPCC Annual Report 2015)

Hospitals and nursing homes(HCFs) in town	Total no. of HCFs	Total no. of Beds
Hospitals and nursing homes with 500 beds and above	3	3026
Hospitals and nursing homes with 200 beds and above but less than 500 beds	-	-
Hospitals and nursing homes with 50 beds and above but less than 200 beds	7	580
Hospitals and nursing homes with less than 50 beds	35	435
All others institutions generating BMW not included above	735	-
Total	780	4041

Effects of Biomedical Waste On Environment

The improper management of BMW can cause stern environmental problems that pose a threat to air, water and land pollution. The pollutants that cause damage can be classified into biological, chemical and radioactive. The complexity of infectious healthcare waste problems and the recent rise in the incidence of diseases such as AIDS, SARS and Hepatitis B open up greater risk of contamination through mishandling and unsafe disposal practices.

Handling, Segregation, And Temporary Storage At The Source

In every health care facility, handling, segregation, and temporary storage at the source will involve BMW separation into three categories, according to Bio-Medical Waste (Management and Handling) Rules, 2016:, hazardous waste of mixed character (e.g., infectious and toxic waste), infectious waste, and other hazardous waste. Separation is a very important, because each of the three produced categories will be subject to the appropriate management. One important issue related to waste segregation is the recovery of materials (plastics, paper, glass, metals) from health care waste.

Infectious waste should be temporarily stored in plastic bags, yellow in colour with proper bio hazard sign. Sharps should be stored in white puncture proof plastic bags. Both yellow and white plastic bags will be placed inside cylindrical plastic container or hospital boxes (40–60 L capacity), for safer and easier handling. Then, hospital boxes or plastic bags will be stored in storage rooms, in specially designed warehouses.

Technical specifications of temporary storage rooms must be as follow:

- Have easy access to collection and transport vehicles.
- Have industrial type floors with proper slope, to be easily cleaned and sterilized.
- Have adequate light, aeration, and firefighting equipment.

- Minimize contact of waste with working personnel.
- Equipped with secondary containment.

Temporary storage capacity for each BMW source depends on the daily production and maximum storage time. Untreated BMW shall not be stored beyond a period of forty eight hours.

System of Collection and Transport

Clinical wastes generated in the hospitals are collected on a daily basis and transported to the temporary storage area in the hospitals. The collection and transport program must comply with the maximum temporary storage time of forty eight hours. During collection, new clinical waste bags are being used in order to replace the old ones. The waste handlers are equipped with personal protective equipment during waste collections and transportation including gloves, safety boots, and face mask.

SYSTEM OF TREATMENT

The average total amount of bio medical waste to be treated was assessed at 1900 kg/day. (Table.4) The waste ought to be treated according to its category and method of treatment complied in the Bio-Medical Waste Management Rules, 2016.

Categories of biomedical wastes and the treatment required is given in Table 3.

Table3: Categories of Biomedical Wastes

Category	Source of waste	Treatment and Disposal
Yellow	Human Anatomical Waste (Human tissues, organs, body parts)	Incineration.
	Animal Anatomical Waste (Experimental animal	
	carcasses, body parts, organs)	
	Soiled Waste (Items contaminated with blood, body fluids like dressings)	
	Expired or Discarded Medicines	
	Microbiology, Biotechnology waste (Blood bags, Laboratory cultures.)	
Red	Contaminated Waste (Recyclable)	Combination of sterilization and shredding.
White (Translucent)	Waste sharps including Metals: Needles, syringes with fixed needles	Dry Heat Sterilization followed by shredding.
Blue	Glassware	Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment)
	Metallic Body Implants	

Table 4: Daily Production from each BMW Source. (Source: CPCC, Chandigarh)

S. No.	Hospitals	Daily production (kg/day)
1	Grewal Eye Institute, SCO 168-168 Sector 9 C, Chandigarh	6 – 8
2	Postgraduate Institute of Medical Education and Research, Sector 12, Chandigarh	1000 – 1200
3	Govt. Multi-Specialty Hospital Sector 16, Chandigarh	250 – 350
4	Government Medical College and Hospital Sector 32, Chandigarh	280 – 320
5	INSCOL, SCO 18-19, Sector 34A, Chandigarh	50 – 70
6	Mukat Hospital and Heart Institute, SCO 47-49, Sector 34A, Chandigarh	15 – 25
7	Guru Nanak Multispecialty Hospital, IMA Complex, Sector 35-B	5 – 8
8	Chaitanya Hospital, Plot 1&2, Sector 44C, Chandigarh	20 – 30
9	Civil Hospital, Manimajra	25 – 35
10	ESIC MODEL HOSPITAL, Ind Area, Ph-2 Ramdarbar, Chandigarh	20 – 24
	Total	1900

WASTE MANAGEMENT PLAN FOR HCCs:

The management of BMW necessitates its elimination and disposal from the HCFs as hygienically and economically as possible, by methods that curtail the risk to community and to the environment. The wastes produced in these HCFs are too detrimental to be treated negligently, and any negligence in the management of these wastes in a hospital have a tendency to spread infections and contaminate the entire existing environment.

Fig.1 shows a flow diagram for a management system of bio medical waste. Source segregation and materials and energy recovery is applied to some fractions, but not to the hazardous waste fraction.

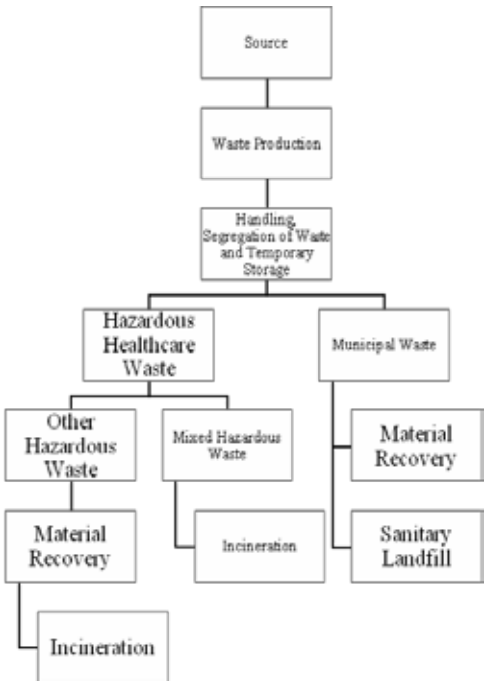

Fig. 1: Flow Diagram of Bio Medical Waste Management

Current Scenario

Of the total hospital waste generated, approximately 10% is hazardous, 85% is general (non risk) waste while a small percentage (5%) is labeled as highly hazardous. The untreated liquid waste from the health care facilities is let into drainage. Normally the waste is collected in open containers without disinfection. Bandages, cotton and other items used to absorb body fluids are collected in plastic or other non-specified containers.

In respect to the transfer of medical waste from hospitals, they are mixed with regular waste, without any classification or treatment of such waste, whether hazardous or infectious as well as the sharp tools that combine.

Even the incinerators being used are out of order while the ones in use are working with very low efficiency, and are in worn out conditions making the work area harmful for the healthcare workers.

CONCLUSION

Segregation of waste is the most fundamental step for proper management of BMW as waste is segregated into various colour-coded containers before it is finally taken for disposal. The study advocates that bio medical waste management should go beyond data accumulating and encourage enforcement of regulations and purchase of better equipment. It should be sustained through suitable edification, training and the commitment of the healthcare staff, management and healthcare managers within an effective policy and legislative framework because presence of a wrong kind of waste in a particular container will evidentlyinvalidate the efforts of proper dumping of waste and to insure proper segregation, proper training programs should be conducted regularly for all the health care workers. And moreover for proper segregation of waste, the waste bins appropriate colour-code are required to be placed at the source of generation of waste.

Considering all situation and field observation there are few recommendations for BMW management:

- All health care facilities generating Bio-medical waste shall strictly ensure segregation, color coding and other provisions of Bio-medical waste (Management and Handling) rules, 2016 and amendments thereof.

  The adoption of strict occupational health and safety frameworks within hospitals to protect health care works, complete with adequate human, technical and financial

resources to national authorities responsible for its enforcement.

- **Need of regular surveys**

  Lack of concern in persons working, less motivation, awareness and cost factor are some of the problems being faced in the proper hospital waste management, therefore proper surveys of waste management procedures in various practices are needed.

- **Public awareness:**

  Awareness building of hospital staff as well as the public about the harmfulness and proper handling of waste is necessary. Hospitals should conduct regular programs in order to create awareness about the importance of proper disposal of this infectious waste and how proper identification and segregation of hazardous medical waste will reduce the health risks involved.

Limitations of study

The study is carried out in few selected government, non-government hospitals, Chandigarh City. Selected HCFs are considered and visited to quantify the hazardous and non-hazardous percentage of BMW generated in Chandigarh. The rate of waste generation is known for selected HCFs. The seasonal deviation of waste generation rate could not be reflected due to lack of sufficient time.

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ADDRESSING DISASTER RISK REDUCTION CONCERNS INTO ENVIRONMENTAL ASSESSMENTS

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Abstract

Disasters are no longer viewed as natural events, but as the results of ill-planned development and poor governance. Though it has been generally accepted that instruments for environmental assessments such as Environmental Impact Assessment (EIA) reduce disaster risks of projects but in fact, poor environment management practices play major role towards amplifying the disaster risks. The linkage between environmental degradation and disaster risks has been an area of long term interests for researchers, planners and implementing agencies.

The paper first explores the inter-linkages between environment, disaster risk and development and further elaborates the existing approach towards environmental clearance using EIA as an assessment tool. The bottom line is that disasters do not occur 'by accident'. Underlying social, political and environmental factors determine the extent of the impact. Recognizing the environmental component of disaster risk and integrating disaster awareness into environmental assessments such as EIA are vital for sustainable development. Considering this fact, the paper examines the extent and effectiveness of the environment assessment process in addressing disaster risk concerns. The paper then suggests suitable measures for addressing disaster risk concerns into Environmental Assessment process.

INTRODUCTION

Rapid industrialization and population explosion in India and the resultant change in human settlement patterns in emerging urban space is persistently affecting ecosystems. The process of habitat development could be sustainable only if it establishes the requisite balance with the nature and environment. Environmental degradation increases vulnerabilities, exacerbates the impact of natural hazards, lessens overall resilience and challenges traditional coping strategies. While environmental degradation causes disasters, the impact of disasters are far-reaching including loss of life and property and damage to the environment. Although the links between disaster risks and environmental assessment are recognized, little research and policy work has been undertaken on the subject. The concept of using environmental assessment tools such as EIA for addressing disaster risks needs extra attention to ensure sustainable development.

It is essential that these environmental assessments incorporate natural hazards and related risk. The state of the environment is a major factor determining vulnerability to natural hazards. In order to help redress the rising trend in disaster losses, and also to help counter the anticipated rise in the frequency and intensity of climatological hazards associated with climate change, it is imperative not only that environmental degradation is reversed but also that the disaster-related consequences of potential projects are carefully spelt out as part of the environmental assessment process and taken into account in project planning and design. This paper intends to explore the extent to which disaster risk concerns are addressed in prevailing for environmental assessment tool i.e. EIA and suggests proactive approach for dovetailing disaster

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risk concerns into environmental assessment process throughout project's life cycle for ensuring sustainable development.

INTERACTION BETWEEN DISASTER AND ENVIRONMENT

To protect the environment as well as reduce disaster risk, we need to ensure that we understand the complete cycle of human-environment-disaster interactions. Environmental degradation is now widely recognised as one of the key factors contributing to increasing human, physical and financial hazard-related losses. For instance, in many countries deforestation has disrupted watersheds and resulted in siltation of riverbeds, leading to more severe droughts and floods. Increased siltation of river deltas, bays and gulfs, together with the destruction of mangroves, reefs and other natural breakwaters, has also increased the exposure to storm surges, tsunamis and seawater intrusion. Poor land use management, unsustainable agricultural practices and land degradation have further contributed to increasing flood losses and the rising incidence of drought. The inter-linkage between environmental degradation and disaster risk (Mondlane and Hassanien, 2003) is depicted in Fig. 1.

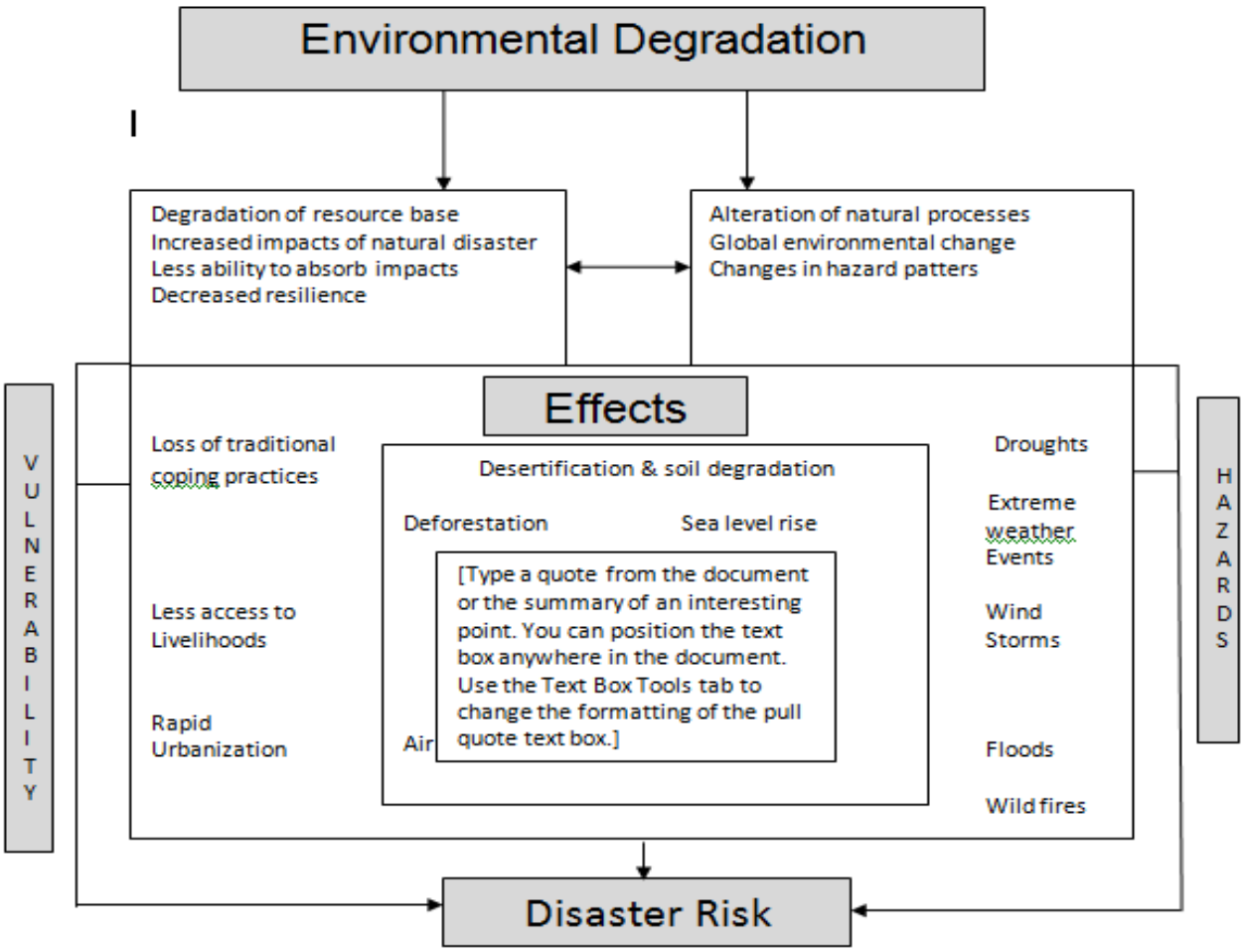

Fig. 1 : Linkage between Environmental Degradation and Disaster Risk

Disaster events, be of the environmental, technological or industrial, or civil origin, they cause significant effects on the ecology, infrastructure, people and properties. People and their properties are affected either directly in the form of death, injuries or damages, or due to disaster's impact on ecosystem-productivity, environmental services and supplies, and the natural resources. Table 1 below

provides an overview of environmental impacts of disaster and environmental factors causing disasters (Srinivas and Nakagawa, 2008) for certain key disaster events.

Table 1: Linkage between Disaster and Environment

Potential Environmental Impacts	Exacerbating Environmental Factors
Earthquake	
• Natural gas leaks, household and industrial chemical releases from damaged containers. • Damage to industrial facilities resulting in toxic release. • Building waste debris, and potential mix of hazardous materials	• T opography and land cover alterations • Inadequate provisions in Building codes and urban planning/ urbanization processes
Flood, storms, hurricanes, typhoons, cyclones	
• Sewage overflow and chemical releases from roads, farms and factories; • Hazardous debris, chemicals, medical and other materials as disaster debris; water-damaged household chemicals (paint, pesticides, solvents); unsafe water supplies • Ground and surface water contamination • Loss of topsoil due to rapid drainage or surface runoff.	• Habitat and ecosystem destruction (e.g. coral reefs and mangroves) • Deforestation and water siltation • Urbanization and land use/ land cover changes
Forest fires	
• Loss of biodiversity and ecologically sensitive habitats.	• Climate change
• Air pollution from smoke and haze	• Deforestation and land use/ land cover changes
Droughts	
• Habitat and crop destruction	• Urbanization and unsustainable resource consumption
• Water scarcity	• Deforestation and land use/ land cover changes
Landslides	
• Damage/deterioration of habitat ecosystems	• Deforestation
• Land use functions, including agriculture	• Land use/land cover changes
• Ground and surface water contamination	

At the global level, there is growing consensus around linking disaster risk concerns with environmental management. Several Initiatives including The Hyogo Framework for Action (HFA) 2005-2015, The Sendai Framework for DRR 2015-2030 (successor framework to HFA), UNISDR's (United Nations International Strategy for Disaster Reduction) Working Group on Environment and DRR, Millennium Development Goals (MDG) 2000-2015 and the recent United Nations Sustainable Development Goals (SDGs) (2016-2030) have been taken so far in this direction to promote sustainable development.

EXISTING APPROACH FOR ENVIRONMENTAL CLEARANCE

Environmental governance offers important opportunities for addressing disaster risk concerns into environmental management. Environmental governance includes policies, legal and regulatory

frameworks and institutional structures to promote sustainable resource management. Policy or regulatory frameworks often specify levels of environmental protection and establish the means for monitoring and enforcing protection. The important environment related legislative provisions in the country are Water Act (1974), The Indian Wildlife (Protection) Act (1972), The Air (Prevention and Control of Pollution) Act (1981) and The Environment (Protection) Act (1986).

Environmental Clearance (EC) for certain developmental projects was made mandatory by the Ministry of Environment and Forests (MoEF) through its Notification issued on 27.01.1994 under the provisions of the Environment (Protection) Act, 1986 called the "Environment Impact Assessment (EIA) Notification 1994". Subsequent Environmental Impact Notification dated 14-09-2006, and amended in 2009, issued under the same Environment (Protection) Act 1986, mandated prior Environmental Clearance for new projects or activities including expansion or modernization of existing projects for imposing certain restrictions and prohibitions based on their potential environmental impacts. EIA is the official appraisal process to identify, predict, evaluate and justify the ecological, social, and related biophysical effects of a proposed policy, program or project on the environment.

The notification has classified projects under different categories as category 'A' (requiring full EIA report) and category 'B' (Category 'B' projects further classified as 'B1' and 'B2' except for township and area development projects) depending on their threshold capacity and likely pollution potential. Clearance for Category A projects (including expansion and modernization of existing projects) are required from MoEF, Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA) or State Expert Appraisal Committees (SEACs), constituted by GOI. The EIA Notification 2006 has notified 39 developmental sectors, which require prior environmental clearance. The projects categorized as B1 require EIA report for appraisal and also have to undergo public consultation process. The projects categorized as 'B2' are to be appraised based on the application accompanied with pre-feasibility report and other relevant documents.

Considering the diversity of sectors, 37 sector specific technical EIA guidance manuals (for environmental clearance) on major sectors of developmental projects were prepared by MoEF. The EIA guidance manual intends to help the project proponent/consultant in the preparation of the EIA report and to the regulatory authority to review the report as well as to the public to become aware of the related environmental issues. The Manual for each sector includes a Model TOR, technological options, processes for cleaner production, waste minimization, monitoring of environmental quality, and related regulations and procedure of obtaining environmental clearance.

For sake of clarity, environmental clearance process of a typical housing project (Selvakumar and Jeykumar, 2015) falling under category – 8 (a) of EIA Notification, has been shown through self explanatory schematic flow diagram in Fig. 2.

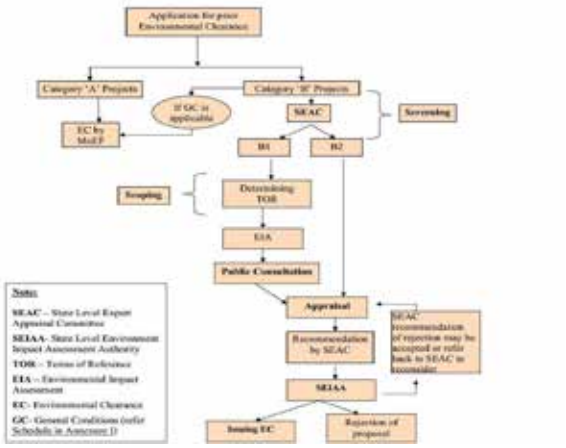

Fig. 2: Schematic Flow Diagram of Environmental Clearance for Typical Housing Projects

Validity of Environmental clearance as per new EIA notification is maximum 30 years for mining projects, 10 years for river valley projects and 5 years for all other projects.

EXISTING STATUS OF ENVIRONMENTAL ASSESSMENT

Though environmental assessments tool – primarily EIA notied as part of environmental clearance procedure have become mandatory for project appraisal and thereby environmental scrutiny of a proposed developmental project, much needs to be done to incorporate disaster risk concerns into such assessments at the policy and plan level and need not wait till the formulation of the particular projects. Existing approaches for EIA inadequately addresses residual risk of disasters and emergencies by just requiring a disaster management plan and emergency response plan along with environmental monitoring plan and auditing scheme. Thus, disaster risk concerns have so far not been given due importance in environment assessment process but have mostly been separately attended as a small part of "additional studies" with passing reference for Disaster Management plan (DMP) and emergency response plan (ERP) without any detailed procedure..

Existing sector specific EIA Guidance Manuals vary considerably in the extent to which they consider natural hazards and related risk. Only fire, gas leak and earthquake hazard has been indicated in the manual. Existing approaches for EIA focuses more on analyzing risk of disaster events on project in short term and not on the potential long term disaster risk added by the proposed project on environment.

Currently, EIAs only consider potential hazards from the proposed project to the environment without giving due attention to hazards from outside impacting the proposed project. Even though such external hazards could impact the project and its environment. Thus, analysis of potential hazard does not take into account cumulative environmental impact of projects in neighborhood localities in addition with proposed projects. While the increased threat to the environment is matched by the enactment of an increasing amount of legislation, the responsibilities and capacities of the various agencies, including the regional offices of the MoEF, to monitor compliance has not been appropriately strengthened.

MEASURES FOR ADDRESSING DISASTER RISK CONCERNS IN ENVIRONMENTAL ASSESSMENT

In view of the shortfalls in existing approaches to environmental assessments particularly EIA, following measures may be considered for incorporating disaster risk concerns in EIA.

- EIAs need to assess potential for all types of natural (geological: earthquake, tsunami, landslide; climate induced: drought, flood, cyclone, avalanche, cloud burst etc.) and man-made (fire, urban and mine flooding, building collapse, transport accidents etc.) hazards due to proposed project on the environment so as to propose suitable mitigation measures, technologies and project locations for effective disaster risk reduction.

- Hazard assessment shall incorporate geographical (location and extent), temporal (frequency and duration) and dimensional (scale and intensity) analysis.

- Concept of disaster impact assessment may be incorporated as an integral part of EIA.

- More holistic approach is required towards incorporating disaster risks in EIAs of all projects rather than just considering disaster management plan (DMP) and emergency response plan (ERP),.

- Assessment of impact of proposed project on microclimate and the resultant disaster risk (hazard and vulnerability analysis) needs to be incorporated in EIA study.

- There is an urgent need to build capacities of government agencies, communities, NGOs, judiciary and other stakeholders for effective implementation of the existing EIA notification and also for integrating disaster risk concerns into EIAs. Delegation of responsibilities, authorities and jurisdiction

of various appraisal/enforcement agencies at all levels need to be clearly defined and documented for this purpose.

- Ecosystem approach to Disaster Risk Reduction (DRR) with assessment of disaster risks as an integral component of environmental assessment process needs to be introduced as a compulsory module within the higher education, research and awareness courses in the Universities, colleges and even school curriculum in particular within the courses on environmental sciences and natural resources.

- Cumulative environmental impact of projects in neighborhood localities in addition to proposed projects needs to be systematically captured in EIA process.

- Disaster risk mapping shall be made an integral part of EIA.

- Environmental assessments of post-disaster relief and recovery interventions needs to be given due attention.

- Pooling of information by different development organizations working in the sphere of environment management and DRR would be an important step toward sustainable development.

CONCLUSION

Certain measures for addressing disaster risk concerns into environmental assessment process (EIA) have already been suggested above. Though it is presumed that EIA minimizes risks of environmental disasters as the legislation provides opportunity to integrate environmental consideration into developmental plans and policies, but in reality, it has been observed that environment assessment processes are not very effective in addressing disaster risks. This is due to inadequate policy integration of disaster risk into the environmental legislation that governs the environmental assessment process. Therefore, more specificity regarding provision of disaster risk reduction issues are needed in legislative provisions and environmental assessment process. It not only requires reforms and adaptation in legal but also in institutional and implementation framework of both – environmental governance, and disaster management, at different levels of planning and action.

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CRITICAL EVALUATION OF SUSTAINABLE DEVELOPMENT IN BUILT ENVIRONMENT

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Abstract

The main objectives of this paper are critical evaluation of assessment methods of sustainability in built environment, to examine the development, role and limitations of current environmental building assessment methods in ascertaining building sustainability.

The sustainable development is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their needs and aspirations. Sustainable development seeks to establish a path along which development can progress while enhancing the quality of life of masses and ensuring the viability of the natural systems on which that development depends. The built environment contributes significantly to the environment but is also one of the major factors in determining whether a community is sustainable in the longer term.

This paper has tried to throw light on various methods like Cost Benefit analysis (CBA), Life Cycle analysis (LCA), Multicriteria Assessment (MCA), Environment impact Assessment (EIA) and their limitations.

INTRODUCTION

By critical 'evaluation' of sustainable environment , it is generally meant a technical-scientific procedure for expressing a judgment, based on values, about the impacts of a policy or of an action on the physical environment, or for assessing the effects of these impacts on the community. It has often been recognized that planning and design can play an important role in the achievement of sustainable development of cities. Various problems still exist with regards to both a clear understanding of sustainability in the built environment and a means of evaluating it within the context of urban planning and design. The built environment represents the physical context in which people spend their time living, dwelling, working and recreating. The built environment is most obviously connected with urban form, planning, land-use and transport, housing and other infrastructure provision, it also has a significant impact on issues of social justice, sustainable communities and lifestyles, energy use and consumption,. The main principles of sustainable development outlined by various international forums are: • a need to consider, in an integrated way, the wider economic, social and environmental implications of our decisions and actions; • a need to take a long-term rather than a short-term view when taking decisions and actions; • a need to provide information for all citizens and the opportunity for them to participate in decision-making processes.

THE IMPACT OF BUILT ENVIRONMENT

There is need to examine a number of environmental issues that come under the broad umbrella of 'the built environment', such as regeneration, planning, rural development, sustainable communities and environmental inequalities. The unequal socio-economic effects of globalization and the continuing urbanization of the global population are key areas and new ideas like 'creative destruction' and 'mixed communities' have emerged as a response to this. Procurement,

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subsidies, minimum standards and information are all seen as central to adding a sustainable dimension to the way urban environments are being developed and managed. Maximum energy conservation and moving away from a reliance on fossil fuel-derived energy, in both the construction and lifetime use of housing and other buildings, are seen as critical within the Indian -level literature. Eco-efficiency is currently being touted as the most appropriate policy response in this respect, while the future of the social rented sector has become a topic of debate, given the trend in India towards more home ownership and the growing role of housing associations and corporations. There is a requirement to focus on improving energy efficiency in the context of the built environment, with particular emphasis addressing fuel poverty issues, to positively align social justice and environmental concerns.

PERCEPTION OF SUSTAINABLE DEVELOPMENT

At present, the issues related to a quality of life and those related to environmental quality are still often conflicting, particularly in planning, design, construction and maintenance for the built environment. Green approach of planning, design, construction, O&M is the art of development, which compiles, with the principles of economic, social and ecological sustainability. One of the main contributions to the debate on sustainability in planning and design is the particular concern for the ethical issues of preserving the quality of the environment and ensuring a non decreasing level of quality of life for present and future generations, including the possibility for all stakeholders and concerned citizens to participate in decision making. The above issues can be recognized in the well-known sustainability principles of intra-generational equity, infra-generational equity, subsidiary, transfrontier responsibility and the precautionary principle.

THE APPROACHES TO CRITICAL EVALUATION

The approaches for critical evaluation of sustainability are,

- The natural steps
- The concept to community capital
- The ecological foot print
- Monetary approach
- The driving force state response model
- Issue or theme based model
- Issue or theme based frame work model
- Farm work of assessment methods

CURRENT EVALUATION METHODS IN URBAN PLANNING AND DESIGN

The evaluation procedure emphasizes the relationships between objectives, means, results and effects, by using appropriate criteria. The present evaluation methods in urban planning are appended as under –

- Front-end analysis, which is used for selecting a type of evaluation.
- Evaluation assessment, which usually provides check-lists.
- Formative evaluation, which is used for selecting criteria and resources.
- Summate evaluation, which judges results.
- Monitoring, which is used for controlling a situation?

The more common evaluation procedures are listed as under:

- Goal-oriented evaluation- This assumes goals and objectives as criteria for measuring the performances of a plan
- Impact evaluation- This focuses on the relationship between objective and effects. In ex-ante evaluation, it tries to measure

both of them by using techniques such as the Delphi and multicriteria techniques.

- Operative evaluation- This focuses on efficiency and efficacy which are measured in relation to the type and the objectives of the project.

- Goal-free evaluation- This assumes objectives that are developed by needs, such as data, using ethical and political judgments for their assessment.

- Comprehensive evaluation- This is based on systemic theories, focusing on those processes which originate effects.

- Pluralistic evaluation-This is a decision-oriented evaluation. It focuses on the flow of information which can be developed on decision makers and their actions, in a systematical manner.

- Cognitive and visual maps- These try to find an agreed solution by ranking different options in order of priority.

OVERVIEW OF MAIN EVALUATION APPROCHES TO SUSTAINABILITY

An understanding of the complex relationships between the different factors and functions of the built environment contributing to urban sustainability is essential to the progress of scientific knowledge and to current decision making.

- It has been recognized that developers of assessment models for sustainability at the urban scale, mostly take into account economic-social and physical aspects of a sustainable development, while environmental assessment methods at the building scale, mainly emphasize the environmental and ecological issues related to sustainability and quality of life.

- Additional methods are the lists of sustainability indicators that have been suggested at different levels of government. - International, national and local level.

- All these indicators are quantitative in nature and are usually classified on the basis of a reductionist view of reality, in which one aspect is given undue emphasis to the detriment of others.

- These problems come from the empirical genesis of the lists: they are merely a compilation of people's ideas and have little theoretical, ontological foundation.

- They may also be misleading, suggesting an unbalanced path in the future developments of a town. Recent reviews of current evaluation methods in planning and design for sustainability show a lack of holism.

- The evaluation is mainly technical and economic and there is not a mechanism or tool that is able to take into account all sustainability issues in a comprehensive manner.

- A major problem with approaches based on the utility theory - which is still widely applied in spatial planning - is that because the subject is not emphasized, the effects of the action and knowledge on the subjects are often ignored.

- Decision-making for sustainability planning requires new approaches which are able to integrate and synthesize all the dimensions of an urban system and different point of views, in a holistic manner.

- Planning evaluation, in the age of sustainability, requires a change of emphasis and change in the criteria by which development is judged, moving towards environmental protection and social 'economic objectives. It needs to build social consensus as well as to improve technical results.

COST BENEFIT ANALYSIS (CBA)

CBA is concerned with setting the costs of construction, maintenance, renewals and other servicing costs over the life of a development against the benefits of function, convenience and appearance. CBA is concerned with which alternative gives the best return on capital. Thus CBA can be used to determine which of the possible projects to finance in order to maximize the return from a given amount of capital or public resources. The rate of discount affects the weight given to the items. The higher the rate, the less weight is given to costs and benefits arising well into the future. This tends to lead to the choice between alternatives being based on short-term considerations. The lower the rate of discount the more weight is given to items in the future. At zero rate of discount, equal weight is given to initial costs and benefits and to those in the future.

LIFE-CYCLE ASSESSMENT (LCA)

There are many methods available for assessing the environmental impacts of materials and components within the building sector. LCA is a widely used methodology, because of its integrated way of treating the framework, impact assessment and data quality. LCA is a methodology for evaluating the environmental loads of processes and products during their whole life-cycle. LCA is defined as a technique for assessing the environmental aspects and potential impacts associated with a product, by: compiling an inventory of relevant inputs and outputs of a product system; evaluating the potential environmental impacts; and interpreting the results of the inventory analysis and impact assessment phases. The assessment includes the entire life-cycle of a product, process, or system encompassing the extraction and processing of raw materials; manufacturing, transportation and distribution; use, reuse, maintenance, recycling and final disposal. LCA methodology consists of four distinct analytical steps: defining the goal and scope, creating the life-cycle inventory, assessing the impact and finally interpreting the results. LCA examines environmental inputs and outputs related to a product or service life-cycle from cradle to grave, i.e., from raw material extraction, through manufacture, usage phase, reprocessing where needed, to final disposal.

MULTICRITERIA ANALYSIS (MCA)

Multicriteria methodologies are often used in decision making processes with two objectives, giving a better definition of the parameters used in the selection process and when defining the action to be taken, providing a back-up for the decision-maker when one option is preferred to others or in order to know the possible consequences of an action that is about to be undertaken. Multicriteria analysis techniques are able to determine lists of priorities from a finite series of choice options on the basis of identifying characteristics of the problem, which is appropriately broken down into its fundamental elements. They consider the objectives and strategies of the various subjects involved in the decision-making process with respect to the resources available and the general goal of the evaluation. The criteria are measured according to suitable scales of measurement and different measurement units. All these methods require, on the part of the decision-makers, an explanation of the individual preferences assigned to the various objectives-criteria calling for decision.

LIMITATION OF EXISTING METHODS of EVALUATION

A major limitation of existing assessment methods is the focus on the empirical measurements of specific effects, economic as well as environmental ones, rather than an identification of the multiple effects the project has on human and natural resources. Some of the limitations to the economic measurement of sustainability and environmental effects are as follows

- Income distribution (infra-generation equity). One of the assumptions that underlie CBA is that a society will be economically efficient in its use of resources when net monetary social benefits - that is the difference between total monetary benefits and total monetary costs measured in socially desirable prices

are maximized. Efficiency is measured without regards to whom the benefit and costs accrue and irrespective of whether society considers the prevailing distribution of income to be desirable.

- Intergenerational equity. Both the choice of project selected and the discount rate to be used will affect the inter-temporal allocation of resources and thus have implications for intergenerational equity. In fact, the impacts of many projects are felt for long periods of time, and not all future impacts will be positive.

- Risk and uncertainty. All projects face some degree of uncertainty. The most common way of dealing with this is to use 'expected values' for prices, quantities and other variables whose precise values cannot be known in advance. Essentially, each potential outcome is weighted by the probability of its occurrence, and the weighted outcomes are then summed to arrive at a mean, or expected, value.

- Irreversibility. Many projects entail the modification of natural areas, reducing the supply of these and endangering the continued existence of plants or animal species, causing irreversible consequences.

- Instrumentalism. This is the term used to denote problems which arise from making decisions on an individual project basis without consideration of the cumulative effect of many such decisions.

- Cultural, historical and aesthetic resources. Losses of these resources are difficult to quantify and express in monetary terms because the perceptions of these losses depend on cultural traditions and value systems .Multicriteria methods have often been used as an alternative approach to cost benefit analysis.

- Non technical issues-very often the non-technical issues are not addressed, or insufficiently covered, in the evaluation.

- Although MCA methods- lack content and a conceptual framework or a theoretical guide that can help designers and decision makers to structure the problem of sustainability in the built environment.

CHARACTERISTICS OF EVALUATION APPROACH

It is suggested that appropriate evaluation approach should have a number of characteristics as follows:

- Include all the relevant effects generated by urban projects on the environment, in the long term.

- Provide information on the social, economic and environmental consequences of a design process through time.

- integrate different evaluation approaches and scientific disciplines which are required to verify' the socio-economic and environmental compatibility of urban projects;

- Take into account the different viewpoints, objectives and interests of decision makers, stakeholders and citizens within a participation process. Since different assessment techniques are required for different dimensions, and for the meso and macro scales, it is also clear that sustainability assessment of the urban may need to be more of a procedure or process using various techniques, rather than one integrated method.

ENVIRONMENTAL IMPACT ASSESSMENT

Prior to 1970, project and policy appraisals were based largely on technical and CBA. In January 1970, the US Environmental Policy Act (NEPA) introduced the first requirement and procedure for

EIA. EIA is 'a process having the ultimate objective of providing decision-makers with an indication of the likely consequences of their actions'. In last 46 years, EIA is undertaken in more than 100 countries, during this period, there has not only been widespread adoption of EIA, but also a number of adaptations. There is a shift from the focus on biophysical aspects, to the inclusion of social and economic issues; the inclusion of implementation aspects attempts to address sustainability issues such as biodiversity loss and cumulative effects; and application to higher levels of decision-making such as plans, policies and programs.

A number of the characteristics of the evaluation approaches may be theoretically included within the well-known procedure of E.I.A., which tries to answer the 'green' agenda, since it has been extended to include economic, social and ecological issues. E.I.A. is a comprehensive procedure which involves different dimensions of a planning problem, such as social, administrative and physical. EIA has been widely applied to planning processes which have strong environmental implications. Experience has shown that project level E.I.A. is feasible, that E.I.A. has altered decision-making to give more weight to the environment and that E.I.A. costs very little in relation to the costs of implementing the actions assessed.

However, at the moment, E.I.A. methods are able to take a limited perspective, as they are restricted to the ecological concerns towards the environment.

EIA is usually limited to a list of technical and environmental factors which do not take into account the complexity of interdependence between the ecological and the human system and within the latter, between the social and the economic system.

The evaluation methods are many and there is no agreement among scholars on the theoretical framework to be used.

Another problem is that experts use a specialized and codified vocabulary which is not common for all the disciplines and stakeholders involved in the planning process.

EIA IN INDIAN CONTEXT

EIA is 'a process having the objective of providing decision-makers with an indication of the likely consequences of their actions this is widely used in India. EIA is internationally recognized as a key tool to guide us on a path to sustainable development. For EIA to fulfill its real potential, India needs capacity-building for administrators, practitioners and the public; monitoring of compliance with EIA recommendations; sharing of 'best practice' in the country; linking EIA with the full project life cycle; harmonization of legislation within the country ; and strengthening the links between EIA, SEA, regional planning and other high-level decision-making processes.

STEPS IN EIA PROCESS

Although detailed steps in the EIA process vary from country to country, the generic steps which are followed internationally are listed as under

- Screening - Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be.

- Scoping- Scoping determines the nature and extent of the required impact assessment. This phase entails the identification of issues that are likely to be important during the EIA and eliminates those that are not. Scoping usually involves interaction between the public, government departments and proponents who assist in the identification of key issues for investigation. The scoping report forms the basis for the terms of reference for the impact assessment phase.

- Impact assessment - The objective of this phase is to identify how the activities of the proposed development will impact on the various components of the environment. The impact assessment entails the identification and analysis of impacts, as

well as a prediction of the significance of the impacts. Both negative and positive impacts are assessed.

- Mitigation- Mitigation entails the identification of ways in which negative impacts can be avoided or minimized to limit costs, and ways in which positive impacts can be enhanced to ensure maximum benefit.

- Reporting- A single EIA report is produced and contains the integrated findings of the impact assessment and mitigation studies.

- Reviewing- In all jurisdictions, the authorities must officially review the EIA report and decide whether it is of an acceptable standard or not. To improve rigor and ensure that relevant information is captured and reflected, the process often includes review by the public and independent specialists prior to finalization and decision-making.

- Decision-making- Decision-making refers to the final approval or authorization of the proposal. It usually includes a series of conditions under which development may proceed. The conditions are often translated into the management plan for the project.

- Implementation- If the development is approved, the developer might be required to implement an environmental management plan (EMP) for construction, operation and, in some instances, decommissioning of the project. The EMP is the tool used to ensure that the mitigation actions and the monitoring requirements recommended in the EIA are systematically implemented throughout all phases of the project.

INDICATORS AND MEASURES

The sustainability indicators are generally developed with the objective of illustrating current environmental problems, in order to assist local administration decision making processes. The interest in statistical indicators in the environment and urban sustainability has become increasingly apparent in recent years. Among other recent contributions, it is appropriate to cite International organizations such as the United Nations World Bank and OECD, the European Commission. There is a need for an Urban Audit, in order to establish the necessary environmental and urban indicators. This application, however, shows that the traditional indicators used in decision making for sustainability, do not put the same weight on the sustainability aspects recognized in literature. In turn, this also reveals a general imbalance in the decision making process, due to an over emphasis of certain issues rather than others. The Sustainable Infrastructure Land-use Environment and Transport Model (SILENT)" is an advanced geographic information system (GIS) and indicator-based urban sustainability indexing model. The spatial indexing nature of the model is particularly useful for the analysis and the visualization of comparative sustainability levels of urban localities. As a spatial indexing Endeavour, the specific aim of the model is to incorporate all related domains affecting urban sustainability into a practical assessment method that informs planning and decision making processes. Interlinking indicators in the four pillars sustainable development in built environment is described as under-

Linkage	Indicators
Environmental economic	Resource productivity
Socio-economic	Labour productivity
Socio-environmental	Environmental health problems
Economic institutional	Corruption rate
Socio-institutional	Co-decision rights of workers
Environmental	Nongovernmental organizational right to file

ANALYTICAL FRAMEWORK FOR CRITICAL EVALUATION

A number of current assessment methods and tools are specified for each sustainability aspect. These

results in a structured multi-layers tool-kit which makes use of current knowledge for pinpointing tools and problem solving methods for each situation related to sustainability in the built environment. The framework should be flexible and usable in different evaluation contexts, monitoring and ex-post planning situations, it should be specifically developed for ex-ante evaluation establishing Common Understanding and Language- Under what criteria should a planning scenario, say a (re)development, be evaluated to guarantee the sustainability of the future asset. It should consider-

- Main Stakeholders and their view of sustainability.
- Sustainability criteria and new definitions of the modal aspects
- Informing the framework for evaluation of sustainability
- Key-questions (PICABUE approach) examine sustainability within each aspect
- Current assessment methods for each sustainability aspect

ENVIRONMENTAL LEGISLATION IN INDIA

Environment Impact assessment S.O.60(E), dated 27/01/1994 (incorporating amendments vide S.O. 356(E) dated 4/5/1994, S.O. 318(E) dated 10/4/1997, S.O. 319 dated 10/4/1997, S.O. 73(E) dated 27/1/2000, S.O. 1119(E) dated 13/12/2000, S.O. 737(E) dated 1/8/2001, S.O. 1148(E) dated 21/11/2001, S.O. 632(E) dated 13/06/2002) is the basic law related to Environmental protection in India. Any person who desires to undertake any new project in any part of India or the expansion or modernization of any existing industry or project listed in the Schedule-I shall submit an application to the Secretary, Ministry of Environment and Forests, New Delhi.

The application shall be made in the performae specified in Schedule-II of this notification and shall be accompanied by a project report which shall, inter alia, include an Environmental Impact Assessment (EIA) Report, Environment Management Plan and details of public hearing as specified in Schedule-IV prepared in accordance with the guidelines issued by the Central Government in the Ministry of Environment and Forests from time to time. However, Public Hearing is not required in respect of (i) small scale industrial undertakings located in (a) notified/designated industrial areas/industrial estates or (b) areas earmarked for industries under the jurisdiction of industrial development authorities; (ii) widening and strengthening of highways; (iii) mining projects (major minerals) with lease area up to twenty five hectares, (iv) units located in Export Processing Zones, Special Economic Zones and (v) modernization existing irrigation projects.

CONCLUSION

A major limitation of existing assessment methods is the focus on the empirical measurements of specific effects, economic as well as environmental ones, rather than an identification of the multiple effects the project has on human and natural resources. Sustainability assessment of the urban environment may need to be more of a procedure or process using various techniques, rather than one integrated method since different assessment techniques are required for different dimensions, and for the meso and macro scales. This paper has tried to critically review a number of methods and approaches of evaluation, their limitations, development analytical framework, and indicators of evaluation.

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SEPTIC TANK SYSTEM: A THREAT TO THE ENVIRONMENT

NARENDER SINGH*

Abstract

In our country more than two-third population is residing in rural or sub-urban areas, where the sewerage facility is not available. A properly sited and regularly maintained Septic Tank System (STS) is the easiest and cheapest way for managing the sewage of households. However, when not properly sited or maintained, the STS can damage the environment by contamination of surface and ground water resources, which further leads to public health problems like dysentery, diarrhea, hepatitis, typhoid fever, etc. Now a days, the advanced and eco-friendly techniques like aerobic treatment units, re-circulating sand filter, mound septic systems, gray water systems, advanced toilets, etc. are being preferred than the conventional STS. These alternative systems/ advanced techniques cost more because they have more moving parts and electrical components like pipes, pumps, monitors, alarms, etc. and greater complexity. These require greater monitoring and maintenance, but safe for mankind as well as environment.

In this paper, efforts have been made to elaborate the consequences of existing STS along with finding the advanced and environmental friendly alternatives.

INTRODUCTION

Mostly habitations in our country are located in small or rural communities (village/Dhani/Kabila) where central sewerage systems are often not cost-effective, so many home owners rely on septic tank systems that treat and dispose of household waste water onsite. When properly sited and maintained on a routine basis, septic tank systems are an excellent waste management alternative. However, when not properly sited or maintained, they can cause contamination of surface and groundwater resources, which leads to public health and pollution problems.

Availability and Type of Latrine Facilities in India

As per Census of India- 2011, the septic tank system being used in India is 38.20% and the piped sewer system is 32.7% as shown in Fig. 1.

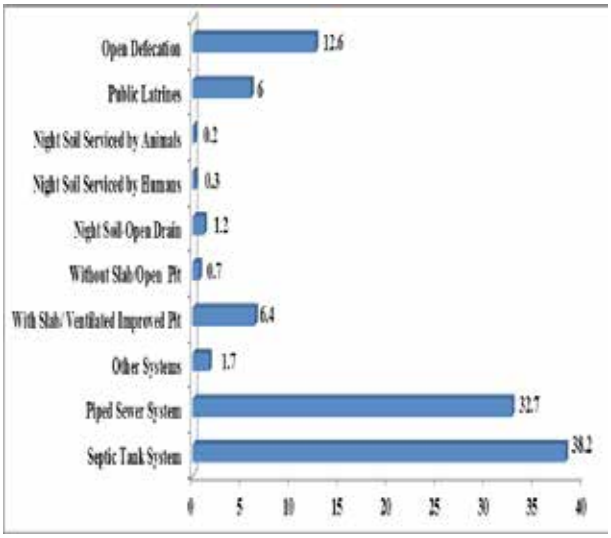

Fig. 1: Type of Latrine Facilities in India

From the above data, it is clear that septic tank system, open/improved pits, public latrines and open defecation is being used by nearly two-third population of India.

Septic Tank System

Septic Tank system has two key components, a receiving tank and a leaching system. A sewage line carries waste water from the kitchen, bathroom and laundry room to the underground septic tank, where heavy particles settle out of the liquid, forming a layer of sludge on the bottom of the tank. Light materials float, forming a layer of scum on top of the

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water in the tank as shown in Fig. 2.

Bacteria use the solid materials, liquefying these waste products. To allow sufficient time for particles to settle and for bacteria to break down the sludge, a septic tank should be large enough to hold at least one day's flow of waste water from the home, and to provide storage for sludge and scum. Each

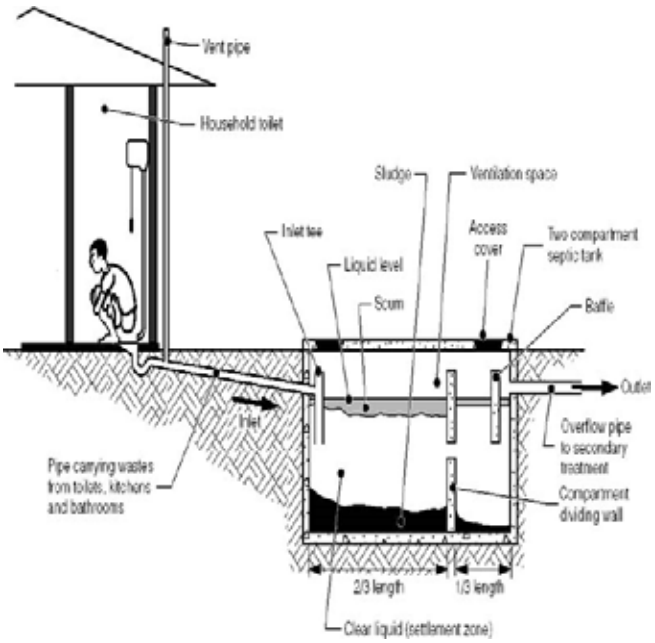

Fig. 2 : Septic Tank System

addition of wastewater to the septic tank displaces an equal amount of liquid into the leaching system. This may consist of a large perforated ring, leaching pit, or a series of absorption trenches.

Impact of Septic Tank System on Environment

STS will operate effectively if, and only if, they are designed properly, situated in areas that allow proper operation, used only for the purposes for which they were designed, and given periodic maintenance. Even a properly operating system will discharge nutrients (phosphates and nitrates) and some bacteria or viruses to the ground water. An improperly maintained or failing system will discharge even more contaminants to the groundwater. Domestic waste water can contain bacteria and viruses that cause dysentery, diarrhea, hepatitis, and typhoid fever. There is a risk to public; especially the children and animals that come into contact with surface flows and may drink contaminated ground water. According to the figures furnished by Ministry of Drinking Water and Sanitation in 2012, a total of 3,883 people died due to diseases caused because of drinking of contaminated water. The total cases and deaths observed in India because of drinking the contaminated water in year 2010, 2011 and 2012 are given in table 1.

Infectious diseases are spread by mosquitoes and flies that breed in areas where liquid wastewater reaches the surface. To protect public health, it is important to minimize the amount of these organisms that reach surface or groundwater.

The nutrients and some bacteria or viruses may be discharged from failing STS into the ground water, which contaminate drinking water supplies, and also represent a potentially important source of pollution to pond, stream, lake or an inadequately sealed well as shown in Fig. 3.

Table 1: Deaths Observed Because of Drinking Contaminated Water

	2010		2011		2012	
Disease	Cases	Deaths	Cases	Deaths	Cases	Dea
Acute Diarrhoeal Disease	1,07,42,327	1,562	1,02,31,049	1,269	1,17,01,755	
Typhoid	10,84,885	440	10,62,446	346	14,77,699	
Viral Hepatitis	89,150	430	94,402	520	1,18,880	
Cholera	5,004	9	2,341	10	1,583	
Acute Encephalitis Syndrome*	5,167	679	8,249	1,169	8,344	
Total	1,19,26,533	3,120	1,13,98,487	3,314	1,33,08,261	

ALTERNATIVE SEPTIC SYSTEMS

"Alternative Septic Systems" refer to any onsite waste water disposal methods other than the widely used conventional STS. These systems are used for new or replacement septic systems on difficult sites where soil conditions (such as a rocky site, limited soil percolation rate, or high ground water level), or other terrain conditions (such as limited space for a septic system or steeply sloped sites) do not permit the installation of a conventional STS and discussed below.

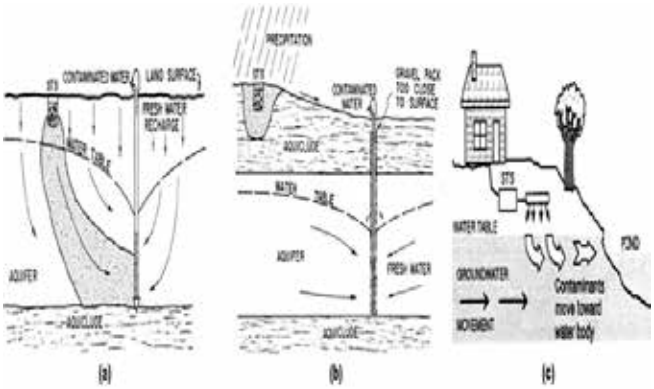

Fig. 3: Contamination of Sub-surface (a, b) and Surface (c) Water Sources by a Failing STS

Aerobic Treatment Units

Aerobic systems are similar to septic systems in that they both use natural processes to treat waste water. But unlike septic (anaerobic) treatment, the aerobic treatment process requires oxygen. Aerobic treatment units (ATU), therefore, use a mechanism to inject and circulate air inside the treatment tank. This mechanism requires electricity to operate. For this reason, ATU cost more to operate and need more routine maintenance than most septic systems. However, when properly operated and maintained, aerobic systems can provide a high quality wastewater treatment alternative to STS. Compared to conventional STS, ATU break down organic matter more efficiently, achieve quicker decomposition of organic solids, and reduce the concentration of pathogens in the waste water. By bubbling compressed air through liquid effluent in a tank, ATUs create a highly oxygenated (aerobic) environment for bacteria, which uses the organic matter as an energy source. In another stage bacteria and solids settle out of the waste water and the cleaner effluent is distributed to a soil treatment system. ATU are more complicated than STS. There are three basic ATU systems as discussed below.

Suspended-Growth Tank

A suspended growth tank has a main treatment chamber where bacteria are free-floating and air is bubbled through the liquid. The second chamber where the solids settle out is separated from the main tank by a wall or baffle. The two return and mixing is critical for proper operation. Treated effluent from the second chamber is piped to the soil treatment system (Fig. 4a).

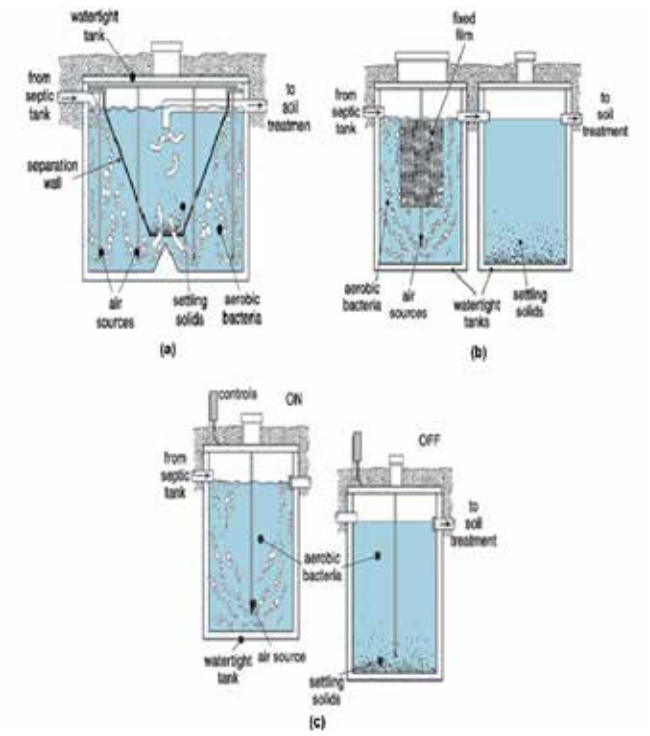

Fig. 4 : Aerobic Treatment Units

Though simple, the system is likely to have problems with bulking (the formation of chains or colonies of bacteria that don't settle or sink to the bottom as they should). Bulking is caused by changes in waste water strength or quantity. When too much waste water is added to the system, the bacteria can run out of food or become overloaded. Bulked bacteria remain suspended in the liquid and can clog the outflow.

Fixed-Film Reactor

A fixed film reactor has bacteria growing on a specific surface medium and air is provided to that part of the tank. The bacteria can grow on any surface including fabric, plastic, styrofoam, and gravel. Decomposition is limited to this area, and settling occurs in a second chamber. This design is expensive, but the effluent is of consistently high quality, and bulking is uncommon. There is no need for a return mechanism because bacteria stay on the film (Fig. 4b).

Sequencing Batch Reactor

In a sequencing batch reactor, aerobic decomposition, settling, and return occur in the same chamber. Air is bubbled through the liquid during the decomposition cycle. The bubbler shuts off, and the wastewater goes through a settling cycle (Fig. 4c). Once the bubbler turns back on, the tank re-enters the decomposition cycle, and settled bacteria mixes back into the aerobic environment. After settling of bacteria and solids, the treated effluent is discharged to the soil treatment system. Bacteria settle out more consistently in this kind of tank, but since it has more moving parts and requires a controller, it has more potential for mechanical and electrical failure.

RE CIRCULATING SAND FILTER

Re_circulating Sand Filter (RSF) is effective for the areas with high water table. RSF is placed between the existing septic tank and trenches. Waste water moves from the house into a septic tank where solids settle out and some organic matter is decomposed. Liquid effluent moves to the recirculation tank and from there to the sand filter. The effluent is pumped repeatedly through the sand filter and then flows out via gravity overflow to the drain field as shown in Fig. 5.

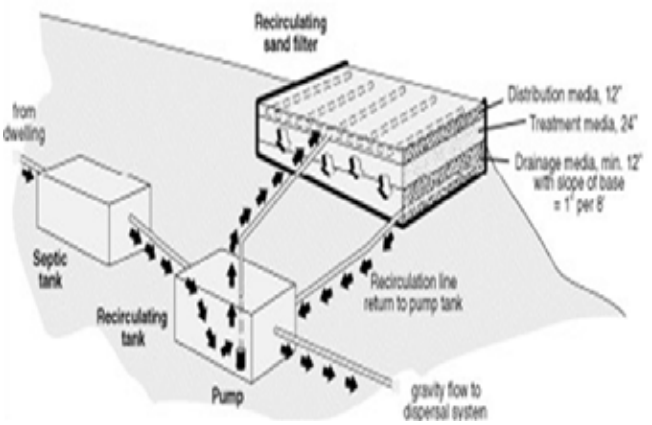

Fig. 5: Specific System Design Using a Re-circulating Sand Filter

The system is designed to re-circulate effluent through the filter at least five times before it is discharged into the trenches for final treatment. When waste water enters the system from the house, an equal amount is delivered into the trenches. A gravity-overflow system ensures that the re-circulating tank does not drain completely, which would reduce treatment efficiency and possibly allow the system to freeze during the winter. RSFs require regular observation and maintenance to make sure the timer control is working correctly. If the timer control fails, the system will not treat waste water, although there may be no obvious signs that untreated sewage is reaching the drainfield.

MOUND SEPTIC SYSTEMS

A mound septic system (MSS) is a drain field that is raised above the natural soil surface. The mound is composed of a sand fill that has a gravel-filled bed and a network of small diameter pipes known as the distribution system. From the pump chamber, effluent is pumped through the pipes in controlled, low pressure doses so that uniform distribution is achieved throughout the bed. The effluent comes out of the pipes through small holes and trickles downward through the gravel bed and into the sand. Treatment occurs as the effluent moves through the sand and returns to the natural soil as shown in Fig. 6.

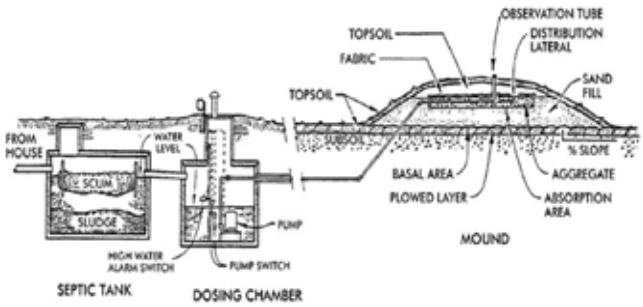

Fig. 6: Mound Septic System

A septic mound over rocky soil may cost double a conventional leach field even where a pumping station is not required. Septic mounds require a larger area than leach fields in good soil. If a pump station is required, some additional monitoring and maintenance is required, and of course if there is no electric power to run the pump, the size of the effluent holding tank will determine how many days of system operation are available in event of a power failure. A mound system may be used where all the following conditions are found:(i) the maximum high groundwater level must be at least one foot below the original ground surface; (ii) bedrock shall be at

least two feet below the natural ground surface; (iii) the percolation rate of the naturally occurring soil shall be faster than 120 minutes/inch and (iv) the natural ground slopes shall not exceed 12%.

GREY WATER SYSTEMS

Grey Water Systems (GWS) refer to onsite waste water systems which reduce the liquid effluent load on a septic system by separating grey water (from sinks and showers) from black water (from toilets). Grey water does not contain human waste products. Therefore when it is disposed of onsite, it does not need to be treated to the same extent as is required for sewage or black water. For building sites where there is limited space for septic black water disposal and treatment, one can install piping and equipment to separate the gray water from black water (human waste) which reduces the required size of the septic system. Grey water handling systems is being used to conserve and recycle water for re-use. In dry areas where there are limitations on the water supply, filtering and treating grey water can permit its use for watering lawns or crops as well as for tflushing toilets as shown in Fig. 7.

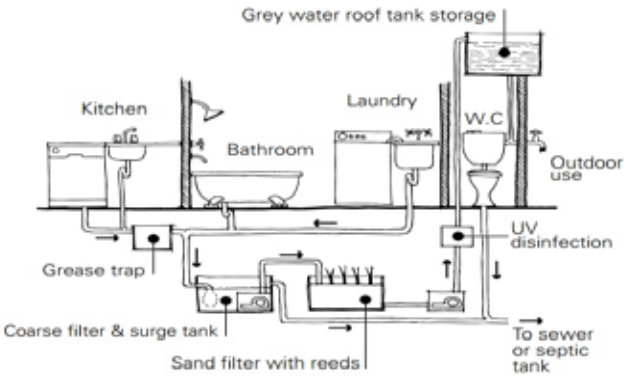

Fig. 7: Grey Water System

Nowadays, advanced toilets (Chemical Toilets. Composting Toilets, Incinerator Toilets, Low Water Toilets or Low Flush Toilets) are also being used worldwide to conserve, recycle or re-use the water.

Cost Comparison of STS with Alternative Septic Systems

The cost (in dollars) comparison of the conventional STS with Alternative Septic Systems over 25 years for a typical household is given in table 2.

Table 2: Cost Comparison in Dollars

Sr. No.	Type of System	Design atnd Installation	Annual Cost of Operation, Maintenance and Repair	Total Cost (Dollars)
1.	STS	3,000-6,000	30-200	6,300
2.	ATU	4,000-7,500	600-1,700	28,750
3.	RSF	5,000-15,000	500-1,000	22,000
4.	MSS	4,000-12,000	80-500	12,800

From the above table, it is clear that the total cost of the alternative septic systems is much more than that of conventional STS.

Comparison of Effluent Quality of STS with Alternative Septic Systems

The bio-chemical oxygen demand (BOD) is the most widely used parameter to evaluate waste water. It is a measurement of the dissolved oxygen used by micro-organisms in the oxidation of organic matter in sewage. Total suspended solids (TSS) are a measure of the organic and inorganic solids that remain in waste water after separation occurs in the septic tank. There are many pathogenic organisms present in waste water that are difficult to isolate and identify. Fecal Coliform bacteria exist in the intestines of warm blooded animals and humans, and are found in bodily waste, animal droppings, and naturally in soil. Most of the Fecal Coliform in fecal material (feces) is comprised of Escherichia coli (E. coli), and the serotype E. coli 0157:H7 is known to cause serious human illness. If coliform organisms (which are easy to test for) are present in waste water, this is a warning that pathogenic organisms may also be present. A comparison of effluent quality of STS with Alternative Septic Systems in respect of BOD, TSS and Fecal Coliform Bacteria is given in table 3.

Table 3 :Effluent Quality in Respect of BOD, TSS and Fecal Coliform Bacteria

Sr. No.	Type of System	B.O.D. (mg/L)	T.S.S. (mg/L)	Fecal Coliform Bacteria (MPN/ 100mL)
1.	STS	150 to 250	150 to 350	10,00,000 to 100,00,000
2.	ATU	< 30	< 25	< 10,000
3.	RSF	< 15	< 20	< 10,000
4.	MSS	< 25	<25	< 10,000

As per Environment (Protection) Rules, 1986 (Part-A: Effluents), the standards for discharge of environmental pollutants/ effluents are given in table 4.

Table 4 : Standards for Discharge of Environmental Pollutants/ Effluents

Sr. No.	Parameter	Inland Surface Water	Public Sewers	Land for Irrigation	Marine/ Coastal Areas
1.	B.O.D., mg/l, max.	30	350	100	100
2.	T.S.S., mg/l, max.	100	600	200	100
3.	Fecal Coliform, MPN/100mg/l, max.	1,000	10,000	10,000	10,000

From the above tables, it is clear that the alternative septic systems are much more effective to reduce the B.O.D. and also control the T.S.S. and Fecal Coliform Bacteria of the sewage or grey water than that of conventional STS. Therefore, it is safe to dispose the effluents of these systems in water resources or to use for irrigation purpose and thus prove environment friendly.

CONCLUSION

The septic tank system has now become a threat to the human health as well as environment. An improperly maintained or failing STS will discharge contaminants to the ground water and cause dysentery, diarrhea, hepatitis, and typhoid fever. The alternative septic systems are in fact costlier but proven as the best substitute for traditional STS and help to control the BOD, TSS and Fecal Coliform Bacteria of the sewage/ effluent. The government should enforce these advanced and eco-friendly techniques so as to safeguard the public health and the environment.

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EVALUATING THE HEALTH PROMOTION ORIENTATION OF A TERTIARY CARE HOSPITAL ENVIRONMENT

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Abstract

In context of environmental sanitation, the concept of health promotion has gained special importance over last 50 years. Health promotion implies 'those actions which are taken before disease onset to maintain and promote good health'. Hospitals and environment are important modifiable determinants of individual health. A model of health promoting hospital (HPH) has been developed by the authors. HPH concept recognizes that hospitals are also part of the environment. Structure and function of hospitals are affected by the overall environment and hospitals themselves affect the environment. Undoubtedly, hospitals and other health-care establishments have a "duty of care" for the environment and have to ensure that they practice no environmental degradation.

The paper focuses on the evaluation of 'Post graduate Institute of Medical Education & Research (PGIMER), Chandigarh', India as a health promoting hospital on the basis of WHO self assessment tools. Interviews of health care providers, patients and their relatives were conducted. Observations for HPH indicators were also considered. In addition, on-the-spot observation in PGIMER campus was also done for 15 HPH indicators like green cover, noise level, safe water sanitation, traffic safety, aesthetic design of hospital architecture – natural light and ventilation, disabled friendliness, seating facility, recreational and IEC activities, work place health promotion, health promotion services for staff, social and cultural activities for staff, welfare activities for staff and health promotion services for patients and their relatives. It scored 35/80 points. It has been concluded that health and environment must appear on the agenda of policy makers in all sectors and at all levels of the hospital and work carried out in a hospital must be organized so as to create a healthy hospital environment.

INTRODUCTION

In context of environmental sanitation, the concept of health promotion has gained special importance over last 50 years. Health promotion is a set of activities, which are not directed at any particular disease but are intended to improve the general health and well being of the individual and the community. Health promotion implies 'those actions which are taken before disease onset to maintain and promote good health'.

'Anatomical' analysis of health promotion: The three central elements of the health field concept are depicted in Figure1. They comprise first of all, environmental influences, which are under the control of 'healthy public policy'. Secondly, the impact on health of individual choice of lifestyle and, third, an expanded health services input. Thus, hospitals and environment are important modifiable determinants of individual health. Healthy public policy, then, is necessary for environmental change. Clearly, a health-promoting environment may operate at a macro level: for example, at national and international level.

Along with the tremendous advances in clinical care witnessed during the last part of 20th century, there was a shift in image of hospitals also. Traditional role of hospitals, focused mainly on curative services.

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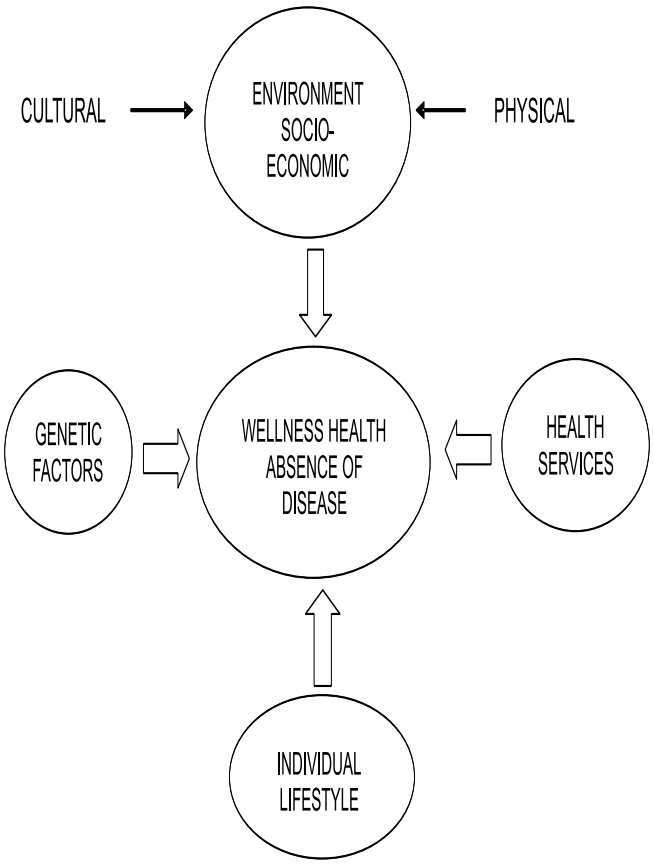

Fig.1: Health Field Concept

The image of the hospitals gradually changed for the better when the hygiene management improved. Today, hospitals are being reoriented from just being the centres for medical care and treatment to a facility providing comprehensive promotive, preventive, curative and rehabilitation services. In twenty first century, modern hospital pertains to multitude of services besides curative services. Community participation and involvement of various other groups besides medical and paramedical staff in running the hospital services in an eco-friendly manner is the backbone of this model.

This model is based on the concept of health promoting hospitals, which emerged in 1980's. To be health promoting in any meaningful sense, a hospital has to be committed to instituting a process of organization development and change. It must extend its activities in the health care system beyond merely providing clinical and curative services. Health and environment must appear on the agenda of policy makers in all sectors and at all levels of the hospital and work carried out in a hospital must be organized so as to create a healthy hospital environment.

Undoubtedly, hospitals and other health-care establishments have a "duty of care" for the environment and for public health. The onus is on such establishments to ensure that there are no adverse health and environmental consequences. In a society well protected against epidemics, each individual seeks medical advice 3 to 4 times a year either for protection of his or her health or because of illness or injury. The priority of a health institution is the care of the patient. Accordingly, its policy has been oriented traditionally to the health and well-being of the patient, which has less relevance to environmental problems. However, it is essential that health centers be concerned with environmental protection; otherwise, a vicious circle of diseases could be created. Although hospitals face many unique challenges in grappling with environmental hygiene compliance issues, the challenges tend to be similar for all hospitals.

In nutshell, incorporating environmental management into the running of hospitals is essential for improving standards in healthcare institutions along with increasing efficiency, satisfying legal requirements and reducing costs. But, it is really unfortunate, that the hospital administrators readily make cost cutting compromises, when called upon to meet environmental compliance standards.

As per HPH concept, hospitals impact on health not only through the provision of prevention, treatment and rehabilitation services of high quality, but also through their impact on the local environment. HPH concept recognizes that hospitals are also part of the environment. Structure and function of hospitals are affected by the overall environment and hospitals themselves affect the environment. Due consideration must be given to the impact on environment, especially to risk of pollution of water, air and soil, besides aesthetics. Afterall, hospitals and other health-care establishments have a "duty of care" for the environment and for public health, and have to ensure that they practice 'No Harm' policy.

CASE STUDY

Against this background, the authors conducted a study with an objective to evaluate 'Post graduate Institute of Medical Education and Research' (PGIMER), Chandigarh, India, as a health promoting hospital. After obtaining consent of hospital authorities, WHO self assessment tools for health promotion in hospital were used. Interviews of health care providers, patients and their relatives were conducted. Observations for HPH indicators were also considered. The tool sought information on 5 standards. Each standard was classified into sub-standards, comprising 13 in all. Each substandard was further supplemented by indicators quantifying sub standards comprising 40 indicators in all. (Annexure A).

The results are enumerated in Table No . 1

Table No. 1 Permisssible Values

S. No.	Standards of HPH	Maximum possible score	Observed score
1.	Management policy	18	5
2.	Patient assessment	14	5
3.	Patient information and intervention	12	8
4.	Promoting healthy work place	20	6
5.	Continuity and cooperation	16	11
	Total score	**80**	**35**

In addition, on-the-spot observation in PGIMER campus was also done for 15 HPH indicators like green cover, noise level, safe water, sanitation, traffic safety, aesthetic design of hospital architecture – natural light and ventilation, disabled friendliness, seating facility, recreational and IEC activities, work place health promotion, health promotion services for staff, social and cultural activities for staff, welfare activities for staff and health promotion services for patients and their relatives.

A short questionnaire based survey of patients and their relatives was done after taking their consent. For the study, a total of 30 patients and their relatives were randomly selected from those visiting PGIMER. The questionnaire comprised of 2 domains: Satisfaction of respondents with health promoting services and whether they were counseled or educated about their disease, diet, hygiene and precautions and preventions to be taken. (Annexure B).

STRENGTHS AND WEAKNESSES

Some of the other major strengths and weaknesses pertaining to PGIMER, Chandigarh as a HPH standards were also noticed.

Strengths:

- There is intra and inter sectoral collaboration of PGIMER with health and social care providers.
- Patients are given follow up instructions, rehabilitation plan, if needed at OPD, referral and discharge.
- Programmes like smoking cessation are successfully enforced.
- Staff complies with health and safety requirements at work place.
- Working condition of employees comply with directives.

Weaknesses:

- Hospital aims and mission as a HPH are not formally declared e.g., Health promotion policies have not been declared. No specific existing HPH policy document is available.
- No clearly labeled sets of health promotion activities are in force.

- Information on formal assessment for patient satisfaction is not available i.e., feedback is not taken from the patients as a regular feature.

- There is no evidence that staff is involved in HPH policy making, audit and review.

Besides above observations, other HPH indicators pertaining to PGIMER revealed following conclusion:

Green Cover – Studies by NASA and other scientists have produced documented evidence that interior plants and their root-associated microbes can remove harmful chemicals from sealed chambers. Therefore, hospitals in Japan are adding plants to take advantage of their air-cleaning properties. Takenaka Garden Afforestation, Inc. of Tokyo is adding "Ecology Gardens" in hospitals.

During the last few years, many new centers and buildings have come up in PGIMER campus. These buildings have open spaces and front lawns which are well maintained. The area under green cover is 36% of the total area of the hospital campus.

Noise Level - A hospital must ensure a quiet, calm environment for patients by providing a physical setting conducive to recovery. Surprisingly, the noise level was found to exceed the laid down standards at the various locations in PGIMER ranging between 57.2 db(A) to 87.2 db(A) against the noise level limit of 50dB (A) during daytime, laid down by The Noise Pollution (Regulation and Control) Rules 2000.It was found maximum near the chemist shop at the ground floor of Nehru hospital due to ongoing construction works. Concerted efforts are being made to curb the cause and adopt measures to reduce its impact.

Safe Water - Safe drinking water is one of the world's greatest needs, according to the World Health Organization. More than 1 billion people lack safe water, and an estimated 2.2 million children die each year because of diarrheal diseases, many of which could be prevented by safe drinking water. Therefore, all hospitals must ensure that clean drinking water is available. Municipal water works inside PGIMER campus provide filtered, chemically disinfected safe water. The total water requirement of the Institute of nearly 57 lac litres/ day is adequately being met by fourteen numbers of pumps of different capacities installed in the Institute. Water coolers were found at required places inside hospital. Recently, the decision to get the drinking water samples tested after every three months and overhead and underground water tanks to be cleaned after every six months has been taken.

Sanitation –Hospitals should be an epitome of cleanliness. Good hospitals are recognized by their clean sanitation. In PGIMER study, dustbins and toilets were found clean and well maintained inside hospital and OPD. PGIMER, Chandigarh has bagged the top prize of Rs.5.00 crore for its efforts in promoting hygiene and health facilities under the Centre's 'Kayakalp' programme in March 2016. The hospital induced infection rate would also come down if proper sanitation measures are adopted.

Traffic Safety – A good traffic design in a hospital would ensure road safety of the patients and their relatives besides providing pollution free atmosphere. In PGIMER, multilevel parking facility near new OPD has been constructed to tackle heavy vehicular rush during peak hours. Speed level limit below 20 Km is displayed at number of places inside campus for traffic safety. There is one-way traffic outside the hospital. Also signage boards are displayed at various locations in the complex.

Aesthetic Design of Hospital Architecture - The planning of all services should be in synchronization with all materials and design and should be comfortable to use. Designing of a hospital should be done utilizing knowledge of the latest and appropriate styles of architecture and furniture.

Access to natural light and fresh air at all levels inside New OPD and other hi-tech centers has been provided. See through windows from top to bottom in advanced eye centre provides eye catching view in addition to providing natural light and fresh air.

Disabled Friendly Nature - The Lok Sabha recently passed 'The Rights of Persons with Disabilities Bill' - 2016 which has replaced the existing Persons with Disabilities Act, 1995. The institute in its endeavor to provide barrier free environment has provided ramps, lifts , signage and proper parking facilities in most of the buildings. There are 16 ramps, 6 toilets and 9 lifts in the Institute designed for physically disabled persons.

Seating Facility - In hospitals, patients are accompanied by their relatives. They have to wait for their turn for hours. Therefore, adequate seating facility is provided for patients inside hospital and OPD.

Recreational and Health Educational Activities - Recreational and health educational activities boost up the image of the hospitals. Therefore, posters and panels are displayed inside hospital and OPDs for awareness of patients and their relatives. There are eye-catching fountains inside and outside OPD that provide soothing effect to ailing patients. Besides this, flourishing flowerbeds and flowerpots in and around campus provides a relaxing atmosphere for everyone.

Spiritual Health - Religious sentiments of patients are also taken care of in PGIMER campus. There are temples, gurudwara and church inside campus giving effect of spiritual well being to patients and their relatives. The gurudwara inside campus provides free breakfast and meals to needy patients.

Work Place Health Promotion - In order to ensure minimum distraction of the employees from their household and other concerns, steps should be taken so that they devote their attention thoroughly to the Institute.

There is 6-l ane swimming pool inside campus for staff and their families. Free yoga camps are also organized for staff from time to time. There is a school inside PGI campus for the children of staff.

Besides this, there are many staff canteens providing nutritious food according to menu suggested by residents. There are milk booths near the hospital which are quite popular among patients as well as hospital staff.

Strategies to reduce health risk to staff are also in place with the provision of adequate facility of gloves, masks, gowns, and needle destroyer at required place. Aprons are compulsory while at work.

Socio-Cultural Activities - In order to get rid of hectic and monotonous schedule, social and cultural activities should be a part of every organization. One week long spring festival is celebrated every year inside PGIMER campus. February is celebrated as sports month every year. Various inter and intra departmental as well as inter college championships are organized. Beside there are traditional celebrations of Diwali, Christmas, New Year and fresher's day, Saraswati Puja etc.

Welfare Activities for Staff - There is working woman's hostel, employees welfare canteens and a community centre inside campus for celebration of social and cultural functions. There is a crèche for children of staff. Besides this, to support employees financially in their hour of need, there is a provision of employees welfare fund scheme, income generating programme for families of staff (stitching of hospital linen and gowns by wives of hospital staff), vocational training for families for staff etc.

Health Promotion Services for Patients and their Relatives - In HPH approach, hospital services extend beyond the traditional 'cure' oriented approach. There are free counseling centers like VCTC and DDTC to help patients have their choice in their diagnosis and treatment. Various self-help groups like Sewa Bharti are operating in PGI to help needy patients in getting medicines and help for their basic needs during their stay in hospital. PGIMER also functions as a meeting place for voluntary groups like Alcohol Anonymous, Breath Free group etc. Beside this, there is a Blood Bank Society and a Thalasemia Society which represent NGO initiatives in PGIMER.

The baby friendly hospital and well baby clinics inside advanced pediatric centre and hospital are also functioning in PGIMER to serve the causes of health promotion among neonates, small children and antenatal mothers. The oral health science centre of PGIMER provides free demonstration on correct brushing technique to one and all.

A phone in programme is aired through the local studio. It involves interviews of faculty of different departments of PGI to create awareness among masses about their health and well-being. There is also a free shuttle bus service for facilitating transport of patients and their relatives inside campus from hospital to OPD. Besides this, there are Sarais and Dharamshalas inside PGI campus to facilitate the stay of patients relatives.

PATIENTS PERSPECTIVE OF PGI AS HPH

Majority of (65%) patients and their relatives were satisfied with preventive and health promoting services of PGIMER; 90% said they were educated about their disease and prevention and other 65% said that they were counseled for diet and hygiene.

Though the score of WHO standards of HPH was only 35 out of 80 (objective criteria as per the scoring parameters of scale), many other health promoting aspects of PGIMER were witnessed during our study. These do not figure in the parameters used in the scale but represent own initiative of the hospital administration. The low score obtained by PGIMER, Chandigarh can be attributed to the lack of a declared 'Healthy Public Policy' and related strategies.

CONCLUSION

In India, the concept of HPH is evolving rather slowly. Three hospitals in India namely Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow, JIPMER, Pondicherry and Ram Manohar Lohia Hospital, New Delhi have joined the WHO movement of HPH. SGPGIMS and JIPMER have started health promotion activities through hospital, schools and colleges.

The low score obtained by PGIMER was mainly due to lack of a declared 'Healthy Public Policy' and related strategies. A clear HPH policy and mechanism should be established for promoting healthy hospital environment. HPH activities should be declared and labeled. Time bound and quality assessment of HPH activities by a designated staff in a planned manner is required for desirable results. Requisite funds too should be earmarked specifically for this purpose. Undoubtedly, hospitals are in strong position within the health care system to be the advocates for health promotion. Therefore, besides curative services, the health promotion initiatives should also be amply visible in hospitals.

WHO self-assessment tool for Health Promoting Hospital

1. **Standard: Management Policy**

Substandard: 1. Organization identifies responsibilities for health promotion

Indicators:1.The Hospital's stated aims and missions include health Promotion Policy

Yes **partly** No

2. Minutes of governing body reaffirm agreement with in Past year to Participate in WHO HPH Project

Substandard: 2. The organization allocates resources for implementation of Health Promotion

Indicators: 1. There is an identifiable budget for HP services and Management

Yes **partly** No

2. Operational procedures such as clinical practice Pathways and guidelines are available in various tDepartments

Yes **partly** No

3. Specific structure and facilities for HP identified

Substandard: 3. Organization ensures the availability of Procedure for Collection and evaluation of data in order to monitor the Quality of HP activities

Indicators: 1. Data are routinely captured on HPinterventions and Available to Staff for evaluation

Yes **partly** No

Annexure-A

2. A programme for quality assessment for health Promoting activities is established

Yes **partly** No

Complementary indicators:

% staff aware of health promotion activities

% of patients or relatives aware of standards of HP
%budget dedicated to staff HP activities

2. Standard: Patient assessment and intervention

Substandard: 1. The organization ensures the availability of procedure for all patients to assess their need for HP

Indicators: 1.Guidelines on how to identify smoking status, alcohol Consumption, Nutritional status, socio economic status are Present

Yes **partly** No

2.Guidelines/procedure has been revised with in last year

Yes **partly** No

3 Guidelines are present on how to identify the needs for HP of group of patients (asthma, DM, COPD etc)

Yes **partly** No

Substandard: 2. The assessment of patient's need for health promotion is done at first contact with hospital. This is constantly reviewed.

Indicators: 1.The assessment is documented in patient's record at admission.

Yes **partly** No

2.There are guidelines for reassessing needs at discharge or end of intervention

Yes partly **No**

Substandard: 3. The patient's need assessment reflects the information provided by others and ensures sensitivity to social and cultural background

Indicators: 1. Information from referring physician available in patient's records.

Yes **partly** No

2.Patient's record documents social and cultural background as appropriate

Yes **partly** No

Complementary indicators: % patients assessed for generic risk factors.

% patients assessed for disease specific risk factors
Score on survey of patient's satisfaction with assessment procedure

3. Standard: Patient information and intervention

Substandard: 1. Based on health promotion need assessment, the patient is Informed of the factors impacting on their health

Indicator:1 Information given to patient is recorded in his record

Yes **partly** No

2.Health promotion activities and expected results are documented and evaluated in records

Yes **partly** No

3. Patient's satisfaction assessment of information given is performed

Yes partly **No**

Substandard: 2. The organization ensures that all patients, staff and visitors have assess to general information on factors influencing health

Indicators: 1.General health information is available.

Yes partly No

2. Detailed information about high-risk diseases is available.

Yes partly No

3. Information is available on patient's organization

Yes **partly** No

Complementary indicators: % patients educated about specific action in self management of their condition %patients educated about risk factors modification and disease treatment in the management of their condition.

Score on survey of patient's experience with information and intervention procedures.

4. Standard: Promoting a healthy workplace

Substandard 1. Organization ensures the development and implementation of healthy and safe workplace.

Indicators :1.Working condition comply with directives and indicators.

Yes **partly** No

2.Staff complies with health and safety requirements and all Workplace risks identified

Yes **partly** No

Substandard 2. Organization ensures the development and implementation of comprehensive strategy that includes staff training in health promotion skills

Indicators:1 New staff receives an induction training that addresses hospital's HP policy

Yes partly **No**

2. Staff in all department are aware of hospital's Health Promotion policy

Yes **partly** No

3. A performance appraisal system and continuing Professional Development including Health Promotion

Yes **partly** No

4. Working practices are developed by multi disciplinary team

Yes partly **No**

5.Staff is involved in Health policy making, audit and review.

Yes partly **No**

Substandard 3 : The organization ensures availability of procedures to develop and maintain staff awareness on health issues

Indicators: 1.Policies for health awareness issues are available for staff

Yes partly **No**

2. Smoking cessation programmes are offered

Yes partly No

3. Annual staff surveys are carried out regarding an assessment of individual`s knowledge, behaviour, on supportive services and policies.

Yes partly **No**

Complementary indicators : % staff smoking Smoking cessation Score on survey of staff experience with working conditions
% short term absence
% work related injuries
Score on burn out scale

5. STANDARD : CONTINUITY AND COOPERATION

Substandard: 1. Organization ensures that health promotion services coherent with current Provisions and Health policy plans

Indicators: 1The management is taking into account the regional Health Policy plan

Yes **partly** No

2.Management can provide list of health and social care Providers working in partnership with hospital

Yes partly No

3. The intra and inter sectoral collaboration is in line with regional health policy plan

Yes partly No

4.There is written plan for collaboration with partner improve the patient's continuity of care.

Yes **partly** No

Substandard : 2 The organization ensures the availability and implementation of Health promotion activities and procedures during OPD and after Discharge

Indicators:1 Patients are given follow up instructions at OPD, referral or discharge

Yes partly No

2.There is procedure for information exchange about patient's all relevant information between organizations.

Yes **partly** No

3. The written summary of patient's condition, health needs and intervention given are sent in time to referral organization.

Yes **partly** No

4.A plan for rehabilitation of patient if needed and cooperating partner is documented in record

Yes **partly** No

Complementary indicators: % Discharge summaries sent to general
Practitioner or referral clinic within 2 weeks or handed to Patient on discharge Score on patient discharge preparation survey.

Answers are marked in bold
(40 Items, Total marks-80; 2 marks-Yes, 1mark-partly,0 Mark No.)

Annexure - B

Development of PGIMER Chandigarh as a Health Promoting Hospital

Patient's perspective survey form

1. Do you find PGI too far and difficult to come from home?

Yes/No

How far _____(Km.)

2. Do you have to wait more for getting doctors consultation?

Yes/No

How long _____(Hrs.)

3. Are you5. Are you satisfied with health promotion services at PGI?

Yes/No

4. Are you counseled for healthy diet and hygiene by staff?

Yes/No

5. Are you satisfied with health promotion services at PGI?

Yes/No

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ENVIRONMENTAL IMPACT ASSESSMENT IN SUSTAINABLE DEVELOPMENT

DR. INDRASEN SINGH*

Abstract

Environmental Impact Assessment (EIA) is a procedure which serves to provide information to local authority planners, other regulators and authorizing bodies, other interested parties and the general public about certain proposed developments and their likely effects on the environment. It also enables developers on whose behalf the EIA is generally undertaken to meet their own environmental standards to minimize environmental impacts and facilitate the approval process.

It must be emphasized that EIA is part of the wider process of deciding whether certain types of development projects should be approved. Other dimensions political, local feelings and cultures, over riding need, competing proposals – also have to be considered. However by including environmental factors alongside social and economic considerations a more sustainable approach to development is ensured. The integration of the emerging design of a development into the EIA process can ensure that a proposal with the least damaging environmental effects is arrived at. This can facilitate consideration of alternative approaches to development and lead to a more robust environmental planning. By taking account of such issues as the design of the development, the process, the location and the site at the earliest possible stage, the design can be influenced such that major changes or onerous planning conditions are not required too late in the project programme.

INTRODUCTION

Environment Impact Assessment (EIA) is a procedure which serves to provide information to local authority planners, other regulators and authorizing bodies, other interested parties and the general public about certain proposed developments and their likely effects on the environment.

It also enables developers, on whose behalf the EIA is generally undertaken, to meet their own environmental standards to minimize environmental impacts and facilitate the approval process. It must be emphasized that EIA is a part of the wider process of deciding whether certain types of development projects should be approved. Other dimensions political, local, cultural, overriding needs, competing proposals also have to be considered. However, by including environmental factors alongside social and economic considerations, a more sustainable approach to development is ensured. EIA is an ongoing process; the collection and assessment of environmental information (usually undertaken by, or on behalf of, a developer or promoter/investor), the preparation of an environmental statement (ES), consultation with a wide range of parties and the consideration of the environmental information. This is then taken into account in the determination of the application for development approval (undertaken by the authorizing body). Early and continued positive dialogue is encouraged between the promoter, the authorizing body, other consultees and the public. The process identifies potential significant effects on the environmental and develops appropriate options for their mitigation.

DESIGN AND PLANNING

The integration of the emerging design of a development into the EIA process can ensure that a proposal with the least damaging environmental effects is arrived at. This can facilitate consideration of alternative approaches to development and lead to a more robust planning application. By taking account of such issues as the design of the development, the process, the location and the site at the earliest possible stage, the design can be influenced such that major changes or onerous planning conditions

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are not required too late in the project programme.

The presentation of the environmental information in a transparent and systematic way assists the competent authorities when determining the application for approval. This can also allay the general public concerns, which are often based on the fear of unknown effects.

MANAGEMENT

EIA can also be used as a management tool by contributing to environmental risk assessment, identifying hazards at the design stage and presenting the opportunity to design them out and ensuring that risks are managed throughout the project. The commitment to environmental management, which is made in the environmental statement can be conditioned by regulators and incorporated into the contract documents thus ensuring continued protection of the environment from construction through final restoration.

CONSULTATION AND PARTICIPATION

Government policy increasingly emphasizes the need to involve local communities and stakeholders in the planning of development to allow those affected to be properly informed and consulted and to participate in decisions affecting their environment. EIA is an important way of helping to ensure that those likely to be affected by a proposed development are better informed and involved in the development planning process.

THE PROCESS OF EIA

These environmental issues which may be significant in the context of the proposed development, and are the reasons why EIA is being undertaken are identified by scoping. Provision is made in the regulations for formal scoping by consultation with interested parties. For each significant environmental issue, base line conditions are identified through a review of existing information (desk study) and by site surveys. The likely effects of the development are then predicted. The magnitude and significance of the effects – including indirect and cumulative effects are assessed. Mitigation measures are incorporated throughout the iterative process of design and EIA in order to minimize any likely significant adverse effects and to maximize likely beneficial effects. This requires team effort and interactions both within the development team itself and with the external contributors.

Consultation is inherent in the EIA process, and is continuous throughout, involving statutory and non-statutory consultees as well as the public. It feeds into the evolving design in an interactive way. Early and thorough consultation will identify those interested parties who might be concerned about the proposed development. The regulations and the directive indicate what should be included within as environmental statement, important aspects being:

- Description of the site and development
- Outline of the main alternatives studied
- Significant direct and indirect effects
- Measures to prevent, reduce or offset significant adverse effects.
- A non technical summary (NTS)

The main steps in the EIA process are given in (Fig. 1) which make it clear that consultation is an integral part of the process. On receipt of the environmental statement (ES), the determining authority will review it for content and completeness, and (in the case of a planning authority) the officer's report on the application, based on considerations of planning policy and taking account of the responses from consultees and members of the public will be considered by the competent authority usually within 16 weeks of receipt of the ES.

THE SCOPING EXERCISE

While EIA is essentially an iterative process, the scoping exercise begins to define who is likely to be involved in the proposals, what studies are

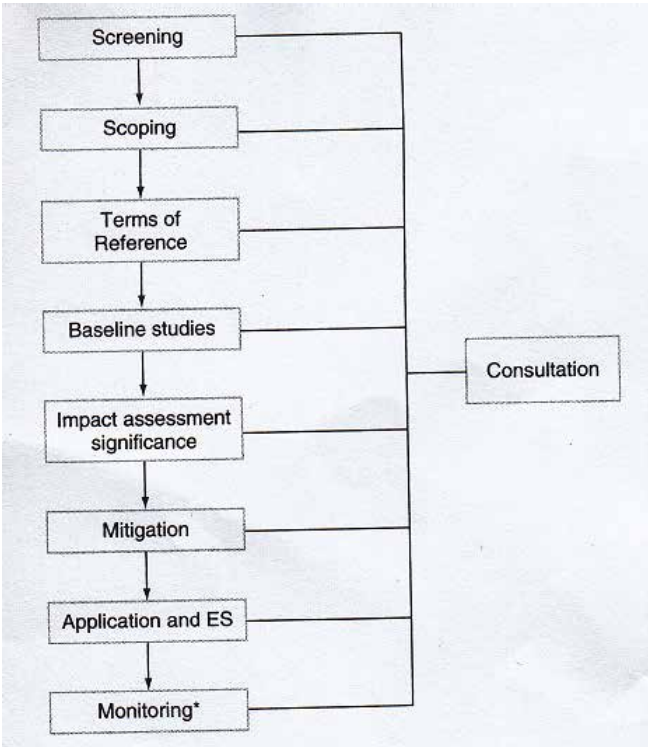

Fig. 1: Outline of the EIA Process

Formal scoping procedure is given in Fig. 2

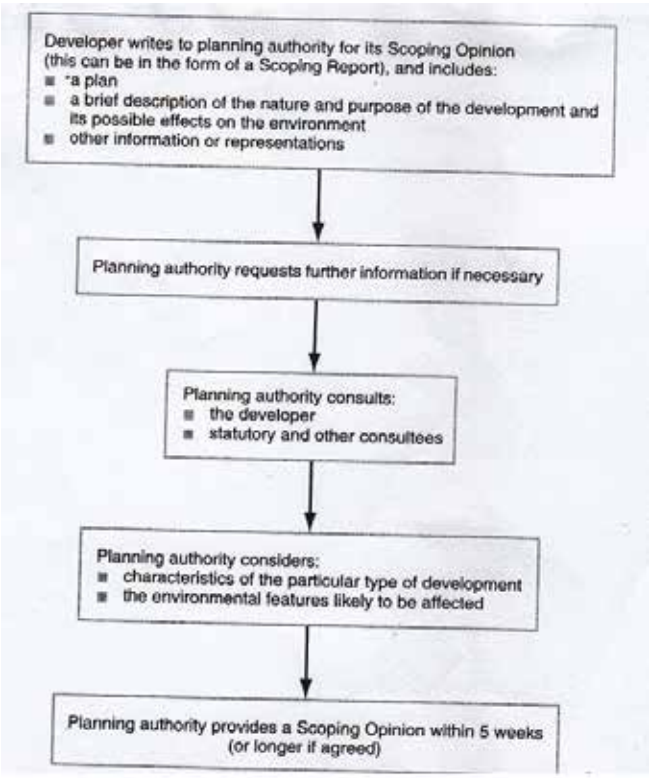

Fig. 2: Formal Scoping Procedure

necessary and to what level of detail the proposals are examined. Like all activities in the EIA process all requests and correspondence with consultees should be recorded for incorporation within a scoping report, which can form part of the ES. The scoping report is sent to the planning authority (or authorizing body) with copies to consultees.

The typical contents of a scoping report are:

- Brief description of the development and the alternatives considered.
- Principal emissions
- Sensitivity of the receiving environment
- Results of initial desk studies and site surveys.
- Location plan/site plan/ outline development plan.
- Consultations undertaken (e.g. record correspondence, meetings, exhibitions)
- Principal opinions (e.g. reports from statutory consultees, analysis of questionnaires)
- Principal issues to be addressed
- Outline of the methodology for collating baseline information, assessing impact magnitude and significance and identifying mitigation.
- Reasons for not addressing other issues.

IMPACT ASSESSMENT AND SIGNIFICANCE

Impact assessment refers to the change that is predicted to take place to the existing condition of the environment as a result of the proposed developments. Significance is commonly judged by comparing the extent of the change with particular standards and criteria relevant to each environmental topic.

The regulations require a description of the likely significant effects of the proposed project on the environment resulting from the:

- Existence of the project

- Use of natural resources
- Emission of pollutants, the creation of nuisances and the elimination of waste.

The potential significant effects of projects must be considered in relation to the characteristics and location of the project, with particular regard to the.

- Extent of the impact (geographical area and size of affected population)
- Transfrontier nature of the impact.
- Magnitude and complexity of the impact.
- Duration, frequency and reversibility of the impact.

Furthermore, the predictive methods used to asses the effects on the environment should be described. The description of the effects should address the following aspects:

- Direct, indirect and secondary
- Cumulative
- Short, medium and long term
- Permanent and temporary
- Positive and negative

Good practice for impact assessment and significance requires;

- A systematic approach, carefully organized, managed and recorded.
- An understandable method, clearly stated, reproducible and verifiable.
- A description of the basis on which judgments are made.
- Where difficulties are encountered or the impact predictions rely on subjectivity or unquantifiable, this should be stated.
- Assumptions made and levels of confidence to be stated.

MITIGATION

Mitigation has been defined as measures which are incorporated into the design or implementation of a development project for the purpose of avoiding, reducing, remedying or compensating for its adverse environmental impacts. Mitigation as part of the EIA process plays a key role in terms of sustainability, since it addresses issues such as resource usage, capacity and biodiversity within a project life cycle framework.

Mitigation is for negative impacts, other environmental measures might be enhancement, planning gain or compensation in kind. Mitigation is by definition, focused on identified significant negative impacts. To identify whether mitigation is actually necessary, cross reference to an environmental risk assessment exercise should be carried out. Risk assessment is a management tool that aids decision making, it considers of an event and how best to manage any unacceptable risks. This will have identified impact, their probability and their severity so that it can then be decided at what level of probability/impact, mitigation should be triggered. If this is implemented throughout the design process the impacts will be minimized-remembering to mitigate for cumulative and indirect impacts.

MITIGATION STRATEGY

Projects which comply with policy and have minimal impact on the environment are most likely to achieve planning consent. Mitigation should be considered at the commencement of the project design, and in this respect, choice of site and/or process can play an important part by avoiding or minimising the impact and thus reducing the need for mitigation. These considerations should be set out in the environmental statement in a transparent and methodical way. Option for mitigation could be strategic, through design or by management.

STRATEGIC MITIGATION

Strategic mitigation will consider the

alternative sites or processes available. The first step is to consider alternative ways of achieving the stated objective of the project. Using leakage control or public education to reduce water demand thus obviating the need for a new high impact reservoir is an example of strategic mitigation cited by the government.

The second step is to consider alternative sites which avoid or reduce the significance of a potential impact. Continuing with the example of the reservoir, a location outside of environmentally designated areas may be considered. This should be stated in the environmental statement even if the location is rejected on other grounds, e.g. safety or economic.

Finally a different process may be considered for the provision of water sourced by a desalination plant or by river regulation and abstraction.

MITIGATION THROUGH DESIGN

Mitigation through design is implemented once the strategic decision on the method, site and process has been determined. In the case of a reservoir, the dam may be curved to reflect its surroundings, wildfowl, construction access roads may be built below the final top water level, or new woodland may be planted to replace one lost as a result of the development.

MITIGATION BY MANAGEMENT

Mitigation by government is the final level of mitigation. This will include such measures as dust control during construction or operation working hours and reporting and control of pollution. These can most usefully be listed as a schedule of all key mitigation measures separately. The environmental management measures required to implement them can then be identified in a draft environmental management plan included in the environmental statement, and can therefore act as a checklist for conditions to be imposed by planning authorities as well as schedule for the developer and contractors to be taken into consideration when preparing and tendering for the construction contract. A contractor having a formal environmental management systems can assist the confidence level of regulators in this respect in the knowledge that auditing, monitoring and remedial action will take place. For commitment to mitigation, following are important:

- Consult early to identify mitigation opportunities.
- Consider mitigation from the earliest stage of project identification
- Select mitigation as high up the hierarchy as possible.
- Review mitigation options at all stages of the design, construction and management process.
- Clearly state the mitigation considered its likely effectiveness and the monitoring proposed.
- Commit to mitigation that will be implemented and monitored – via an EMP.
- State measures to correct unforeseen consequences.

APPROACH AND METHODOLOGY

Stages in the analysis of broad alternatives are given in Fig.3.

Having selected this short list of practicable alternative proposals, they are then examined in terms of their respective design, construction and operational alternatives, taking mitigation into account.

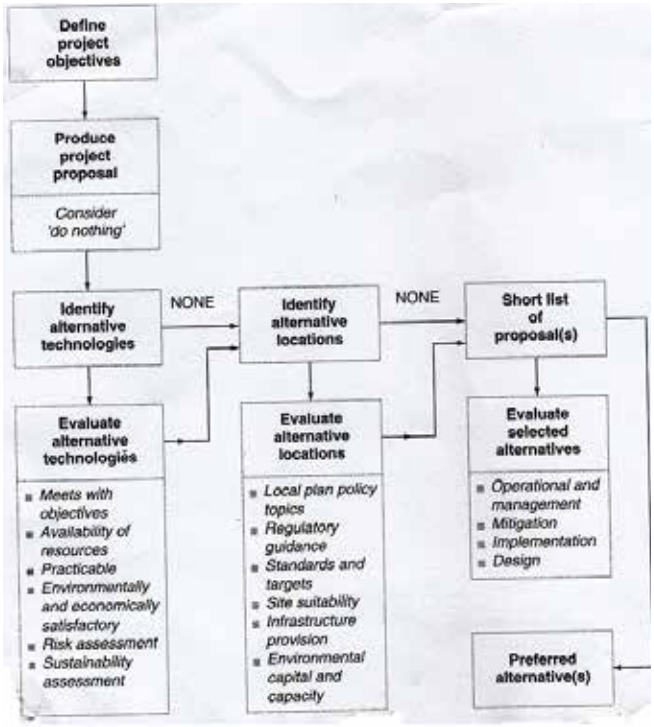

Fig. 3: Stages in the Analysis of Broad Alternatives

At this stage it is useful to hold an exhibition explaining the various identified options and inviting public comments recorded by means of questionnaire, however the views of the majority may not necessarily reflect the best practicable environmental option. It is for the planning authorities and regulators to explain their views. This systematic approach will identify the most robust development option – the process should be fully documented and reported. It is essential to be clear about the use of the criteria, which can be those presenting opportunities, e.g. near to a major transport route as well as constraints, e.g. near to an educational establishment.

MONITORING AND FOLLOW UP

- EIA follow up is the monitoring and evaluation of the actual impacts of a development project (subject to EIA) on the environment together with the management of and communication about the environmental performance of that project.

- Monitoring comprises the collection of data or information on a range of specific environmental variables. It is subject to a time related programme of measurements or observations.

- Evaluation or auditing is the objective comparison of monitoring results, with predefined criteria or predictions. It may also relate to and be a requirement of an organization or policy.

- Management is making decisions and taking appropriate action in response to issue arising from monitoring and evaluation. It can include decisions and actions by both the developers or regulators.

- Communication is informing stakeholders about the results of EIA follow – up by developers and regulators, which can include regular reporting and liaison to feedback information into future decision and the direct participation of stakeholders in monitoring, evaluation and management stages.

METHODOLOGY

The need and proposals for follow up should be explained in the environmental statement (ES), and drawn together in the environmental management section of the ES. This would describe what is proposed to be undertaken, who would undertake it, why, how and when. This may involve combination of site attendance by an environmental person of works during construction, specialist monitoring surveys and liaison with the developers' project management team and contractors.

The purpose of the follow up should be decided in advance. For any identified environmental issue the methodology should be clearly focused on the effects which will be attributable to the development rather than other external or natural pressures or changes. It should be clear from the follow-up proposals and reporting that the results of monitoring of the actual effects of the development

are to be used in managing the actual effects by implementing effective mitigation measures and communicating the results to local authorities and other stakeholders.

CONCLUSION

It must be emphasized that EIA is part of the wider process of decision making whether certain types of development projects should be approved. Other dimensions political, local feelings and culture, over riding need, competing proposals also have to be considered. However by including environmental factors alongside social and economic considerations a more sustainable approach to development is ensured.

Mitigation has been designed as measures which are incorporated into the design or implementation of a development project for the purpose of avoiding, reducing, remedying or compensating for its adverse environmental impact.

It may also include measures to create environmental benefits. The purpose of addressing mitigation is to develop a scheme which aims to progress towards a no net loss effect on the environment. The regulations allow for a hierarchy of mitigation; however sustainability principles require avoidance or compensation to achieve no net loss to the environment. Opportunities for environmental enhancement could also be identified. Mitigation as part of the EIA process plays a key role in terms of sustainability, since it addresses issues such as resource usage, capacity and biodiversity within a project life framework. Mitigation is for negative impacts; other environmental measures might be enhancement planning, gain or compensation in kind.

It must be remembered that the mitigation process is an iterative one which is continuous throughout the project design development. Each stage should be reported to and recorded by the EIA coordinator for inclusion in the environmental statement. The identification and incorporation of mitigation can be more effective if the EIA coordinator is engaged from the start.

To identify whether mitigation is actually necessary, cross reference to an environmental risk assessment exercise should be carried out. Risk assessment is a management tool that aids decision making. It considers the likelihood, the consequences of an event and how best to manage any unacceptable risks. This will have identified impacts, their probability and their severity so that it can then be decided at what level of probability/ impact, mitigation should be triggered. If this is implemented properly through the design process the impact will be minimized remembering to mitigate for cumulative and indirect impacts. Projects which comply with the environmental policy are most likely to achieve planning consent. Mitigation should be considered at the commencement of the project design and in this respect, choice of site and/or process can play an important part by avoiding or minimizing the impact and thus reducing the need for mitigation. The extent to which mitigation measures can be defined reliably is likely to depend on how the project is managed and the type of contracts that are awarded, particularly depending on how involved the actual site developer, construction contractors and other key parties in the project are.

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ENVIRONMENTAL IMPACT ASSESSMENT FOR MULTISTOREY HOUSING PROJECTS

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Abstract

Environmental assessment is a procedure that ensures that the environmental implications of decisions are taken into account before the decisions are made. In principle, Environmental Impact Assessment (EIA) is a tool generally used to identify the environmental, social and economic impacts of a project prior to arriving at decision. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to project proponent. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoid treatment/clean-up costs and impacts of statutory compliance. Any development project plans to improve the quality of life and has some built-in positive and negative impacts. These projects should be planned in such a manner that it has maximum positive impacts and minimum negative impacts on the environment.

This paper highlights the importance of EIA in the sustainable development of a construction project with a case study of an upcoming multistorey housing project in Chandigarh. An attempt has been made in this paper to study environmental impact of the proposed building construction project in Chandigarh using checklist methodology. The paper advocates that through early assessment during planning of the project as well as during construction phase of the project's development, if environmental concerns are considered simultaneously with other technical and economic criteria, it may be possible to develop the housing projects with least damage to the natural resources of that area.

INTRODUCTION

Environmental Impact Assessment (EIA) is a planning and decision making tool first manifested in the United States in the National Environmental Policy Act of 1969. It is a formal study process used to predict the environmental consequences of any development project. It is a procedure which helps us in understanding the potential environmental impacts of major development projects.

With an economic growth rate of approximately 8%, India is seen emerging as a major global business giant. With 35 cities with populations in excess of 1 million, and more cities joining the list, investments in urban infrastructure are projected to be higher than ever before. Infrastructure sector is one sector of the Indian economy that has activities, which are directly or indirectly linked to every other economic sector. Construction activities in India have been pursued without giving much attention on environmental issues. This has resulted in pressure on its finite natural resources, besides creating impacts on human health and well-being. Unplanned and unsustainable urban development has lead to severe environmental pressures. The green cover, ground water resources have been forced to give way to the rapidly developing urban centres. Modern buildings built in our cities have high levels of energy consumption because of requirements of air conditioning and lighting. Pollution sources from the construction process include harmful gases, noise, dust, solid and liquid waste. This issue has prompted many construction participants to attempt to control the impacts of their activities by adopting environmental management systems.

Types of EIA

EIA can be classified based on the purpose

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and the theme of development. EIA can be climate impact assessment, demographic impact assessment, development impact assessment, ecological impact assessment, economic and fiscal impact assessment, health impact assessment, risk assessment, social impact assessment, strategic impact assessment, technology assessment.

EIA is an iterative process and is integrated into the project development process without considering it as a barrier to development. Depending on the types of project and severity of impact mainly two types of EIA are conducted.

- **Comprehensive EIA** : It would be required if the assessment area, period and parameters are insufficient for a well defined decision on the establishment of a project. A comprehensive EIA would be essential for projects with high pollution levels. Meteorological conditions like air temperature, wind speed and wind direction for different seasons plays an important role in ascertaining the impacts of pollutants when the project discharges huge quantities of air pollutants.

- **Rapid EIA:** If it is felt that the project is likely to cause some detrimental effects on the environment, it is subjected to Rapid Environmental Assessment which involves:

  a) Identification of the important impacts of the project on the environment.

  b) Evaluation of the impact of the project on the locality or entire region.

  c) Listing of the issues which are unresolved and which need examination in detail.

  Rapid Environmental Impact Assessment, thus, attempts to identify the key issues in a particular case so that attention or resources could be directed to relevant aspects. Issues which are not important enough to deserve further studies are omitted. This helps in optimizing our resources. Data for rapid EIA is taken only for one season except the monsoon season.

EIA Scenario in India

In India, EIA was first introduced in India based on the Environmental Protection Act (EPA), 1986 and it formally came in to effect, when Ministry of Environment and Forest had passed a major legislative measure under EPA in January 1994 for Environmental Clearance (EC) known as EIA Notification, 1994. Subsequently, EIA process was strengthened by MoEF by a series of amendments. The current practice is adhering to EIA Notification, 2006 and its amendments. The EIA Notification 2006 not only reengineered the entire environmental clearance process specified under the EIA Notification 1994 but also highlighted the need to introduce specific sectors/categories under the sectors such as Industry and Infrastructure and also introduced new sectors such as Construction to be brought in the ambit of the EC process based on their extent of impacts on environment. The EIA Notification 2006 has notified 39 developmental sectors, which require prior environmental clearance. Based on the capacity, the Projects have been categorized into Category A or B which has been further categorized as B1 or B2.

Need of EIA for Building Construction Projects

Environment protection is an important issue throughout the world (Tse and Raymond, 2001). Compared with other industries, construction is a main source of environmental pollution (Shen et al., 2005). Building construction and operations effects the environment directly and indirectly (Levin, 1997). Pollution sources from the construction processes include harmful gases, noise, dust, solid and liquid wastes (Chen et al., 2004).

Enhancing the identification of the major environmental impacts of construction processes will help to improve the effectiveness of environment

management systems. Further, prediction of the correlated environmental impacts of construction before the construction stage, will lead to improvements in the environmental performance of construction projects and sites. The determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate those (Gangolells et al., 2009).

Environmental clearance for building construction projects

As per MoEF, New Delhi, S.O. 1533 (Published in the Gazette of India,Extraordinary,Part-II,and Section 3 Sub-section (ii)) dated on 14th September, 2006 the housing projects fall under category – 8 (a) of EIA Notification, 2006 (as amended). The built up area for the purpose of this Notification is defined as "the built up or covered area on all the floors put together including basement(s) and other service 8(b) of EIA notification deals with townships and area development projects.

STUDY AREA

The City of Chandigarh popularly named as the City Beautiful was planned by Le Corbusier, a famous French Architect and was founded in 1952 as the new capital of eastern Punjab. Subsequently at the time of the bifurcation of State in 1966-1967 into Punjab, Haryana and Himachal Pradesh the city assumed unique status of being the city of both Punjab and Haryana while declaring as a Union Territory. The city is spread over an area of 114 Sq. Km with 25.42 Sq Km of additional declared as 'Wildlife Sanctuary'. About 69.6% of land area of the city is under urban category. The estimated population of city is 1,054,686 in census of 2011 and more population is migrating to the city every year. To satisfy the need of housing accommodation in Chandigarh many multi-storey housing projects have been started in and nearby areas of Chandigarh.

Following this, Chandigarh Housing Board is planning to construct 200 dwelling units consisting of two bed rooms in Sector-51, Chandigarh. It is a multi- storey housing project with five storeys' building including the parking facility (Fig.1&2).

Fig. 1: Map of Study Area

Fig. 2 : Layout Plan of the Project

METHODOLOGY

Checklist method in general is strong in impact identification and is capable of bringing the impacts to the attention and awareness of the authorities. Checklists may be provided to facilitate rapid assessment of environmental impacts, qualitatively. Checklist method promotes the thinking about the array of impacts in a systematic way and allows concise summarization of effects. The checklist matrix is used for the evaluation of the building construction projects supported by extensive field checks and surveys. Checklists are of four broad categories and represent one of the basic methodologies used in EIA. They are:

- **Simple Checklists:** These are list of parameters without guidelines provided on how to interpret and measure an environmental parameter.
- **Descriptive Checklists:** This includes

an identification of environmental parameters and guidelines on how parameter data are to be measured.

- **Scaling Checklists:** These are similar to descriptive checklist with the addition of information basis to subjective scaling or parameter values.
- **Scaling Weighting Checklists:**Theseare capable of quantifying impacts.

RESULT AND DISCUSSIONS

This study of building construction project was administered via personal surveys, and details study of all EIA reports of selected study area was made to prepare a table of responses in a standard format covering various parameters of building construction projects as shown in Table 1. They have designed sewage-treatment plants which will be in operation once the people start dwelling there. The project has ground water and municipal water supply as a source of water.

Table 1: Study of Environmental Impacts Assessment Reports of Project Site

S.No.	Parameters	Study Area
1	Location	Sector 51, Chandigarh
2	Nearest railway station	Chandigarh Railway Station
3	Project costs	-
4	Power requirement	Yes
5	Size of area	31.483 acres
6	Green Area (%)	13.62 %
7	Parking Facility	Provided
8	Water requirement	Yes
9	Solid waste generation	Yes
10	Source of supply water	Groundwater and Municipal Water Supply
11	Sewage Generated	Yes
12	STP Facility	Provided
13	Rainwater harvesting system	Ground based
14	Distance from the city center	Sector 17,Chandigarh, 7.2 km
15	Nearest highway	NH 5, 5 km
16	Nearest sensitive zone	Sukhna Wildlife Sanctuary, 11 km
17	Nearest bus stand	ISBT Sector 43, 2.5 km
18	Nearest airport	Chandigarh International Airport, 8.7 km

Table 2: Checklists for Environmental Impact Assessment of Building Construction Projects in the Study Area

(As Per Form – 1 A for Construction Projects Listed Under Item 8 of the Schedule of EIA Notification, 2006)

S.No	1. Air Environment Information/ Checklist Confirmation	Study Area
1.	Emissions from combustion of fossil fuels from stationary or mobile sources.	✓
2.	Emission from construction activities including plant and equipment	✓
3.	Dust or odours from handling of materials including construction materials, sewage and waste	✓
S.No	**2. Water And Land Environment Information/Checklist Confirmation**	**Study Area**
1.	From handling, storage, use or spillage of hazardous materials	✓
2.	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)	✓
3.	By deposition of pollutants emitted to air into the land or into water	✓
4.	Is there a risk of long term buildup of pollutants in the environment from these sources	✓
S.No	**3. Noise Environment Information/ Checklist Confirmation**	**Study Area**
1.	From operation of equipment e.g. engines, ventilation plant and crushers	✓
2.	From construction or demolition	✓
3.	From blasting or pilling	✓
4.	From construction or operational traffic	✓
5.	From lighting or cooling system	✓
S.No	**4. Environmental Sensitivity Information/Checklist Confirmation**	**Study Area**
1.	Area protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value	✓
2.	Areas which are important or sensitive for ecological reasons-Wetlands, water courses or other waterbodies,coastal zone biosphere , mountains, forests	✓
3.	Areas used by protected, important or sensitive species of flora and fauna for breeding, nesting, foraging, resting, over wintering, migration	✓
4	Inland, coastal, marine or underground waters	✓
5.	State, National boundaries	✓
6.	Densely populated or built-up area	✓

7.	Areas occupied by sensitive man made land uses (hospitals, schools, places of worship, community facilities)	✓
S.No	**5. Risk Assessment Information/ Checklist Confirmation**	**Study Area**
1.	From explosions, spillages, fire etc, from storage handling, use or production of hazardous substances	✓
2.	From any other causes	✓
3.	Could the project be affected by natural disaster causing environmental damage (e.g. floods, earthquakes,landslides, cloud burst etc.)?	✓
S.No	**6. Solid Waste Management Information/Checklist Confirmation**	**Study Area**
1.	Municipal waste (domestic or commercial wastage)	✓
2.	Hazardous wastes (as per Hazardous Waste Management Rules)	✓
3.	Sewage sludge or other sludge from effluent treatment	✓
4.	Construction or demolition wastes	✓
S.No	**7. Vegetation Information/Checklist Confirmation**	**Study Area**
1.	Is there any threat of project to the biodiversity	✓
2.	Will the construction involve extensive clearing or modification of vegetation?	✓
S.No	**8. Fauna Information/Checklist Confirmation**	**Study Area**
1.	Is there likely to be any displacement of fauna-both terrestrial and aquatic or creation of barrier for their movement?	✓
2.	Are there any direct or indirect impacts on avifauna of the area?	✓
S.No	**9. Socio-Economic Status Information/Checklist Confirmation**	**Study Area**
1.	Will the proposal result in any change to the demographic structure of local population?	✓
2.	Will the project cause adverse effects on local communities, disturbances to sacred site or other cultural values?	✓

Note: Here indicate ✓YES and indicate X NO

For the above study the primary data is to be identified including air, water, land, noise, environmental sensitivity, solid waste management, risk assessment, vegetation, flora and fauna and socio-economic status in qualitative manner. Planned approach is essential by the project proponent for equilibrium between development, environmental conservation and overall well being of people. Thus, construction and maintenance of multi-storey housing project that balances the natural environment and resources use is an important component of sustainable system. The study area have rainwater harvesting system, proper parking facilities, adequate green area and contains the plants/trees that absorb the high level sound/ noise, waste water treatment facility and solid waste management facility. Possible mitigation measures are being made to improve the environmental quality by following some green practices, renewable energy sources, air quality monitoring sensors that could increase the level of environment.

CONCLUSION

Environmental Impact Assessment or EIA can be considered as the appraisal of the probable impact that a proposed project may have on the natural environment. In broad, EIA process calls for assortment of resources which include personnel resources, funding, time to perform entire task, and can be done only for large sized projects which are attaining Critisizm from community. Putting into practice a few site control measures for the duration of construction can lessen the environmental impacts on the neighboring areas near the construction site.

The review of the EIA of study area reveal that some of the newly developed projects are characterized by severe shortage of basic services like potable water, well laid-out drainage system, sewerage network, sanitation facilities, electricity, roads and waste disposal. These in turn result in to numerous environmental and health impacts that must be addressed. The green cover has been destroyed to give way to the rapidly developing urban settlements. The burden of resource use in upcoming buildings or urban housing projects can be minimized in many ways. Properly designed housing projects can provide numerous services such as purification of air and water, pollution control, mitigation of floods and droughts, re-generation of soil fertility, moderation of temperature extremes, climate change mitigation and enhancing the landscape quality.

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ENVIRONMENTAL IMPACT ASSESSMENT FOR ENVIRONMENTAL QUALITY EVALUATION: A CASE STUDY

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Abstract

Environmental impact assessment (EIA) is a tool for evaluating the effects of different developmental projects on environment. EIA is a planning and decision making technique. The assessment of potential impacts of a proposed project by EIA can provide a quantitative estimation of its sustainability. The rapid EIA is one of the widely used methods of impact assessment which can integrate all the related components and parameters to assess the impacts of a project in a short span of time.

Using the rapid EIA technique the environmental impacts of Bodhjungnagar Industrial Complex, the largest industrial estate of the state of Tripura is studied in the present paper. The results of the environmental quality evaluation of the industrial complex is used to interpret the overall environmental quality of the region and based on the present field based study a number of management approaches for maintaining and restoring the environmental balance in the study area is proposed in the paper.

INTRODUCTION

Environmental impact assessment (EIA) is a widely used decision making tool which helps in selecting environmentally sustainable decision for any proposed project. Environmental impact assessment is concerned with the systematic identification and evaluationof the potential impacts, both beneficial and detrimental, of a proposed project related to the physical–chemical, biological, cultural, and socio-economic components of the total environment. It was first introduced in United States in the late 1960. Since then EIA has been adopted and implemented by many developed and developing countries across the world (Sowman et al., 1995; Leu et al., 1996; Barker and Wood, 1999; Weston, 2000; Jay and Handley, 2001).Different types of EIA methodologies have been developed by researchers for making the EIA process more effective and rational. Such methodologies include interaction matrices, weighting-scaling checklists, multicriteria decision analysis, life cycle assessment, AHP, fuzzy AHP, Rapid Impact Assessment Matrix (RIAM), and data envelopment analysis (Canter, 1996,McDaniels, 1996; Hokkanen et al., 1998, Rogers and Bruen, 1998, Tukker, 2000, Ramanathan, 2001; Goyal and Deshpande, 2001; Singh et. al, 2015).In the present study an effort is made for evaluating the environmental quality of Bodhjungnagar industrial complex, the largest industrial complex of Tripura through the rapid EIA methodology.

CASE STUDY

Bodhjungnagar industrial complex is the largest industrial complex of the state of Tripura, located in the northeastern region of India, lies approximately between latitude 22°56/ and 24°32/ N and longitude 91°10/ and 92°21/ E.The total land area of the industrial complex is 238.53 acres.Presently there is a multi industry complex at Bodhjungnagar, which comprises of an Industrial Growth Centre, a food park and a rubber park. The topographical map of Bodhjungnagar industrial complex prepared by Tripura space application centre is shown in Fig. 1.

METHODOLOGY

Environment is a dynamic system consisting of a number of interrelated components which collectively made it possible to flourish life on earth.

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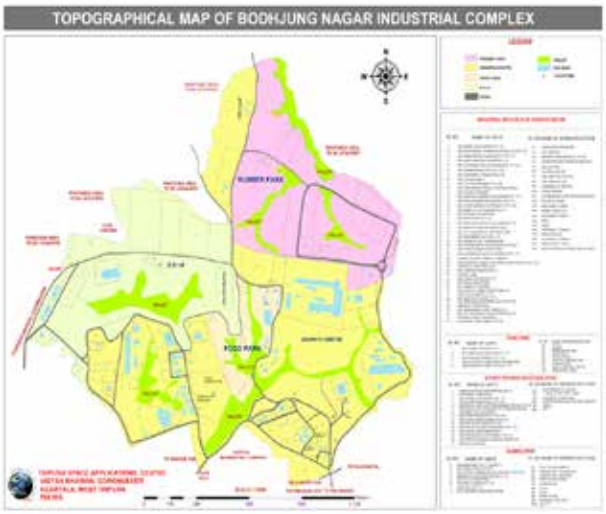

Fig. 1: Topographical Map of Bodhjungnagar Industrial Complex

(Source: TIDC)

Thus, for effective evaluation of environmental quality in a particular location, it is utmost important to examine the status of each and every individual component of environment. EIA includes the effect of all the components of physio-chemical and social environment in assessing the environmental quality. In the present study among various components of environment, the surface water, ground water, air and soil quality has been assessed.

Generally, the water quality parameters, both in case of surface and ground water are classified into three categories. The category 1 includes the parameters which can be monitored without any special infrastructure. Category 2 is for those parameters of water quality which need regular monitoring with simple laboratory facilities. And the 3rd category is for special parameters requiring sophisticated infrastructure for analysis. After a detailed field survey in the study area, it is detected that there are three major surface water sources and four ground water sources in the study area. Water samples are collected from those sources periodically for one season. Fourteen quality parameters in case of surface water and thirteen important parameters in case of ground water samples have been studied as per standard method of analysis.

The management of soil pollution is very important aspect of EIA study as the soil and the organisms residing in the soil plays an important role in maintaining the ecological balance. Soil samples are collected from three locations in the study area. The three sampling locations selected for soil quality analysis represents three different land use patterns. One of these stations represents agricultural field, another sample was collected directly from the vicinity of the industries. And the third sample is taken from the wastewater disposal site located at the industrial complex.

Air pollution is one of the major problems especially in industrial complexes and thus it require special attention in EIA process. Thus representative data is also collected for the ambient air quality in the study area from five sampling stations. Similarly, the waste water quality also plays a vital role in deciding the impact of any project on the environment. One waste water disposal lagoon situated in the study area from where the samples are collected to ascertain the waste water quality for the present study.

RESULT AND DISCUSSION

The results of the analysis of representative samples of surface water, ground water, soil, air and waste water using the standard technique of analysis prescribed by APHA, CPCB and BIS codes are presented in Table 1 to 5 respectively. The permissible limits of each of these parameters which are available in India are also depicted in these tables.

Table 1: Surface Water Quality Assessment

Sl No	Parameter	Station 1	Station 2	Station 3	Permissible Limit
1	pH	6.88	6.97	6.32	6.5 – 8.5
2	Turbidity (NTU)	84.9	50.6	44.5	1
3	Electrical Conductivity (µs/cm)	11.24	10.43	5.07	-
4	TDS (mg/l)	180	105	124	500
5	TSS (mg/l)	60	51	48	-
6	Alkalinity (mg/l)	52.62	76.54	14.35	200
7	Total Hardness (mg/l)	71.33	81.52	96.80	300
8	Calcium Hardness (mg/l)	25.47	30.57	61.14	-
9	Magnesium Hardness (mg/l)	45.85	50.95	35.66	-
10	Dissolved Oxygen (mg/l)	6.50	6.89	7.28	6
11	Bioche mical Oxygen Demand (mg/l)	1.65	1.55	2.43	0
12	Calcium (mg/l)	10.21	12.25	24.50	75
13	Magnesium (mg/l)	11.15	12.38	8.67	30
14	Chloride (mg/l)	58.73	78.30	19.58	250

Table 2: Ground Water Quality Assessment

Sl No	Parameter	Station 1	Station 2	Station 2	Station 3	Station 4	Permissible Limit
1	pH	6.52	7.78	7.78	6.39	6.30	6.5 – 8.5
2	Turbidity (NTU)	11.0	4.52	4.52	5.89	8.33	1
3	Electrical Conductivity (µs/cm)	9.32	11.74	11.74	7.84	7.43	-
4	TDS (mg/l)	60	70	70	55	72	500
5	TSS (mg/l)	8	12	12	7	10	-
6	Alkalinity (mg/l)	30.57	50.95	50.95	40.76	30.57	200
7	Total Hardness (mg/l)	45.80	64.12	64.12	54.96	41.22	300
8	Calcium Hardness (mg/l)	18.50	32.35	32.35	25.80	20.25	-
9	Magnesium Hardness (mg/l)	12.02	18.60	18.60	14.96	10.32	-
10	Nitrate (mg/l)	0.2	0.1	0.1	1.7	1.3	45
11	Dissolved Oxygen (mg/l)	4.9	3.3	3.3	4.1	2.9	6
12	Chemical Oxygen Demand (mg/l)	46	75	75	7	33	-
13	Iron (mg/l)	1.30	0.08	0.08	1.77	0.56	0.3

Table 3: Soil Quality Assessment

Sl No	Parameter	Station 1	Station 2	Station 3
1	pH	6.41	5.84	4.69
2	Conductivity(µs/cm)	16.82	12.48	13.46
3	Percentage of Nitrogen	0.081%	0.077%	0.076%
4	Total Hardness (meq/l)	163.04	142.66	163.04
5	Calcium Hardness (meq/l)	81.52	101.9	101.9
6	Magnesium Hardness (meq/l)	81.52	40.76	61.14
7	Nitrate (mg/l)	2.4	0.8	0.7
8	Phosphorous (mg/kg)	2.22	1.5	1.9
9	Calcium (mg/l)	63.58	39.741	39.741
10	Magnesium	63.58	31.79	47.68
11	Iron (mg/kg)	5.48	1.92	1.44
12	Cadmium (mg/kg)	0.312	0.056t	0.624
13	Chromium (mg/kg)	1.72	0.64	0.56

Table 4: Air Quality Assessment

Sl No	Parameter	Station 1	Station 2	Station 3	Station 4	Permissible Limit
1	PM 10 (µg/m3)	60	98	162	133	100
2	PM 2.5 (µg/m3)	47	77	48	50	60
3	SO2(µg/m3)	7	9	12	13	80
4	NO2(µg/m3)	11	16	19	21	80

Table 5: Waste Water Quality Assessment

Sl No	Parameter	Station 1	Station 2	Station 3	Permissible Limit to dispose in inland surface water sources
1	pH	8	8	8.5	5.5 - 9
2	Turbidity (NTU)	132	120	126	-
3	TDS (mg/l)	8540	6530	6020	-
4	TSS (mg/l)	310	185	290	100
5	Dissolved Oxygen (mg/l)	0.4	2.1	1.5	4
6	Biochemical Oxygen Demand (mg/l)	925	102	134	30
7	Chemical Oxygen Demand (mg/l)	6800	475	870	250

From the laboratory analysis results as depicted in the tables given, it can be said that, in case of surface water quality few parameters like turbidity, TDS and BOD shows slight deviation from the permissible range prescribed by regulating authorities. Similarly for ground water nitrate, COD and iron content is above permissible limit. The air quality assessment in the study area shows that the particulate matter content (both PM10 and PM2.5) are beyond the permissible limit prescribed in National Ambient Air Quality Standard. The waste water quality assessment shows the serious threat of soil pollution and ecological problems likely to be caused due to crude disposal of waste water in lagoons without proper treatment

RAPID ENVIRONMENTAL IMPACT ASSESSMENT MATRIX:

It often seems to be difficult to draw any conclusion regarding the overall impact of any

project on the environment only by analyzing only one time data. It is also equally true that a long time laboratory based analysis is needed for predicting the environmental quality at a particular place. Similarly it is another important fact that, the impact assessment study for any sort of development project is essentially to be done before the commencement of the project. But in case of Bodhjungnagar Industrial Complex, no such studies have been carried out. Rapid Impact Assessment Matrix (RIAM) is a tool to organize, analyze and present the results of such holistic studies in a comprehensive manner. RIAM provides the solutions to a number of criticisms that have affected EIA since their near universal acceptance as a necessary part of developmentplanning process.The RIAM method is based on a standard definition of the important assessment criteria, as well as the means by which semi quantitative values for each of these criteria can be collected, to provide an accurate and independent score for each condition (Pastakia, 1998). The scoring system used in RIAM requires simple multiplication of the scores given to each of the criteria in group (a).Scores for the value criteria group (b) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all value group (b) are fully taken into account.The sum of the group (b) scores are then multiplied by the result of the group (a) scores to provide a final assessment score (ES) for the condition.

(a1) (a2) = aT.....(1)
(b1) + (b2) + (b3) = bT.....(2)
(aT) (bT) = ES ..... (3)

where (a1) (a2) are the individual criteria scores for group (a); (b1)(b2) (b3) are the individual criteria scores for group (b); aT is the result of multiplication of all (a) scores; bT is the result of summationof all (b) scores; and ES is the environmental score for the condition (Pastakia, 1998).

Table 6: RIAM Method Assessment criteria (Pastakia, 1998)

Criteria	Scale	Description
a1:Importance of conditiont	4	Important to national/ international interest
	3	Important to national/ international interest
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
a2:Magnitude of change/effect	3	Major positive benefit
	2	Significant improvement in statusquo
	1	Improvement in statusquo
	0	No change/statusquo
	-1	Negative change in statusquo
	-2	Significant negative disbenefit or change
	-3	Major disbenefit or change
b1:Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
b2:Reversibility	1	No change/not applicable
	2	Reversible
	3	Irreversible
b3:Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

Table 7: Conversion of Environmental Scores to Range Bands in RIAM Method (Pastakia, 1998).

Description	Range Band (RB)	Environ mental Score (ES)
Major positive change/impacts	+E	+72to+108
Significant positive change/impacts	+D	+36to+71
Moderately positive change/impacts	+C	+19to+35
Positive change/ impacts	+B	+10to+18
Slightly positive change/impacts	+A	+1to+9
No change/ statusquo/not applicable	N	0
Slightly negative change/impacts	-A	-1to-9
Negative change/ impacts	-B	-10to-18
Moderately negative change/impacts	-C	-19to-35
Significant negative change/impacts	-D	-36to-71
Major negative change/impacts	-E	-72to-108

Table 8: Rapid Impact Assessment Matrix

Component	a1	a2	b1	b2	b3	aT	bT	ES	RB
Change in land use pattern	2	-1	3	3	3	-2	9	-18	-B
Construction of industrial buildings	1	0	3	3	2	0	8	0	N
Regular vehicle movement for transportation of workers and goods	2	-1	2	3	1	-2	6	-12	-B
Industrial solid waste disposal	2	-2	1	2	1	-4	4	-16	-B
Required water supply for industrial use	1	0	3	3	2	0	8	0	N
Disposal of industrial wastewater	2	-2	2	2	1	-4	5	-20	-C
Operation and maintenance of wastewater treatment system	1	1	1	2	1	1	4	4	+A
Discharge of gaseous exhaust from industries	2	-2	2	2	1	-4	5	-20	-C
Public problem caused by noise and dust from industries	1	-1	2	2	3	-1	7	-7	-A
Odour problem caused by industrial waste	2	-1	2	2	2	-2	6	-12	-B
Cost of industrial waste collection and treatment	1	0	3	1	1	0	5	0	N

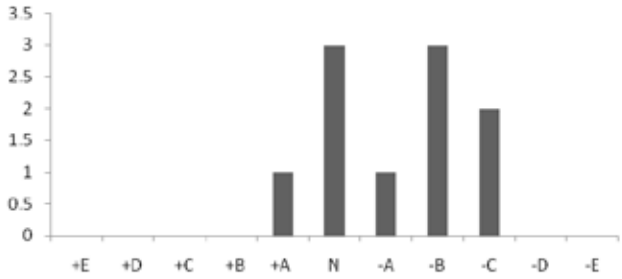

Fig. 2: RIAM Result

Table 6 and 7 indicates the assessment criteria and the conversion criteria of RIAM scoring into linguistic variables. For the present study the following operational components are chosen to determine the impact magnitude of Bodhjungnagar industrial complex.For collecting the individual scoring for each of the selected components of RIAM a perception study is carried out among the peoples working in the same area. The final scoring obtained from such studies is presented in Table 8 and also in Fig 2.

CONCLUSION

The RIAM developed in the present paper for impact assessment of Bodhjungnagar Industrial Complex depicts some serious negative scorings with respect to some important environmental parameters (Fig. 2). Although the RIAM approach was not initiated before commencement of the project, but it is providing some key facts regarding the environmental impact of the industrial complex. It is also evident from the present study that a gradual trend of quality degradation in the study area is under way. Hence, it is an alarming situation where effective mitigation steps are required to be taken to cope up with such problems. A comprehensive EIA is urgently required for the industrial complex for evaluating the detailed status of the area. Now based

- Regular monitoring of water and air quality in the industrial complex by setting up of permanent monitoring stations.
- Development of green belt around the industrial complex.
- Installation of air pollution control equipment in each of the industries.
- Construction of common effluent treatment plant in the industrial complex.
- Creation of lagoons in the area for bioremediation of effluent.
- Installation of less noise producing equipment in the industries.
- Adaptation of the methods of acoustic enclosure or acoustic treatment of the room depending upon the size of the unit.

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EIA OF POST VARDAH CYCLONE IN CHENNAI AND SUGGESTIVE FRAMEWORK FOR SUSTAINABLE DEVELOPMENT

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Abstract

A question was posed by teacher in a class of renowned school: "What makes man so powerful?" perhaps his ability to manipulate was answer from student. While assessing global consultations on climate change, it appears true. Query emerges: Is sustainable development process possible in all aspects? It seems like mythological story with a tinge of scientific fiction. Outline of inclusive development furnishing adequate emphasis on environmental protection and diminishing environmental damage is much desired. On Monday,12th Dec 2016, Cyclone 'Vardah' knocked Chennai, TN region and some Southern States ruining all vital identity means. Exotic and indigenous class trees got uprooted. Undefined boundaries, even pavements, open spaces were equally damaged. Losses to Built forms, Infrastructure viz electricity, cable networking, services etc too were affected. Intensity and consequences of natural disasters played role.

GoI-Ministry of Environment and Forest is a Government's Nodal Agency responsible for protection of the environment in country. Judiciousness and thoughtful planning shall alleviate impact of such disasters. Notion of sustainable development, having its three pillars on social, environment and economy, needs harmonious functioning. The subject being vast, this paper is restricted to analyse certain measures emerging with adequate solution in making sustainable viable environment.

INTRODUCTION

Originating in Southern Thailand, cyclone Vardah was a large scale air mass that had led to death of about a dozen people there, before crawling towards India. In December 2016 days, disturbances ensued in islands of Andaman and Nicobar resulting in several tourists getting beached. It had been moving away from islands towards coast of Tamil Nadu and Andhra Pradesh with a speed of 4 km per hour, exhilarated over time.

Very rough sea conditions were experienced in Tamil Nadu on 11th Dec,. Accompanied by heavy rains and high-velocity winds, Cyclone 'Vardah' pulverized Chennai and coastal districts of north Tamil Nadu on Monday killing several people in the state. Cyclone had caused severe destruction by uprooting trees, damaging houses, disrupting power services and cables, land as well air transport and throwing normal life out of gear (Fig.1).

In the course of action many more surprising and devastating actions took over and succession of activities came into force. Although topic is vast, due to limitations, scope of paper attempts to review post 'Vardah' effects. Further its impact on human life and built forms all-encompassing of city infrastructure. It analyses pin pointedly leaning by opting adequate path as challenge. These aspects are being discussed in the paper.

Cyclone 'Vardah' hit the Tamilnadu capital witnessing most severe cyclone in two decades resulting many homes flattened to ground and severe losses as below:

- Communication lines were disabled disconcerting the mobile towers.

**Joint Director (Arch), MES, Chennai ** Commander 202 Engineer Regiment C/o 56 APO*

Fig.1: Damage due to Cyclone

- Brought the transport system to a halt on 12th Dec16 as it crossed Chennai's coast with heavy rain and storm.
- Advertisement hoardings, name boards of offices and shops were damaged and glass panes of windows and buildings shattered due to the strong wind.
- Compound walls were damaged also vehicles were smashed under fallen trees.
- Power cut affected day to day life for more than 03 days.
- Lack of milk and essential food supplies on next day since roads blocked affected transportation network.
- As people remained in their residence, roads across city were virtually deserted.
- Tamilnadu government declared holiday for all government, government-aided private schools, colleges and other educational institutions in affected areas. Communication issued by the private sector to allow their workers to avail a holiday or work from home.

ANALYSING SUITABLE PLANNING AND ARCHITECTURE TRENDS

Planning and architecture support plays vital role for sustainable living environment during any natural or manmade disasters. Many more issues may be dealt with; relatively few imperative basics have been put forth:

Suggestive Measures for Specific Building Elements:

Planning and Sitting

Vulnerability of a human settlement to a cyclone is determined by its siting, probability that a cyclone will occur and the degree to which its structures can be damaged. Buildings are considered vulnerable if they cannot withstand forces of high winds. Furthermore, degree of exposure of land and buildings will affect velocity of cyclone wind at ground level, with open country, seashore areas and rolling plains being most vulnerable. Certain settlement patterns may create a "funnel effect" that increases the wind speed between buildings, leading to even greater damage. Though cyclonic storms always approach from the direction of sea towards coast, wind velocity and direction relative to a building remain random due to rotating motion of high velocity winds (Fig.2).

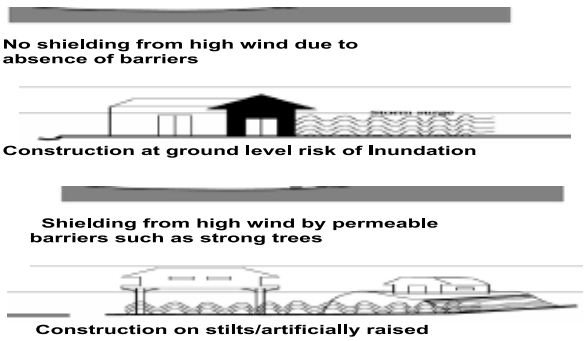

Fig. 2: Proper Planning

Foundations

Foundation is basic element of building which transfers its weight to ground. It is essential to construct a suitable foundation as stability of a building depends primarily on its foundation. Buildings usually have shallow foundation on stiff sandy soil and deep foundations in liquefiable or expansive clayey soils. It is desirable that information about soil type be obtained and estimates of safe bearing capacity made from the available records of past constructions in the area or by proper soil investigation. The uplift forces from cyclone winds can sometimes pull buildings completely out of the ground. In contrast to designing for gravity loads, lighter the building the larger (or heavier) the foundation needs to be in cyclone resistant design. Ignoring this precept has led to some dramatic failure of long-span structures.

Openings

Openings are areas of weakness and stress concentration; essentiality is for light and ventilation. Following principle prerequisites may be adopted for safety:

- Openings in load bearing walls should not be within a distance of h/6 from inner corner for purpose of providing lateral support to cross walls, where 'h' is storey height till eave level.

- Openings just below roof level shall be avoided except that two small vents without Shutter should be provided in opposite walls to prevent suffocation in case room gets filled with water and people may try to climb up on lofts or pegs.

  Since failure of any door or window on windward side may lead to adverse uplift pressures under roof, openings should have strong holdfasts as well as closing/locking arrangement.

Masonry walls

All external walls or wall panels must be designed to resist the out of plane wind pressure adequately. Lateral load due to wind is finally resisted either by walls lying parallel to the lateral force direction (by shear wall action) or by RC frames to which panel walls must be fixed using appropriate reinforcement such as seismic bands at window lintel level.

Strengthening of walls against high wind/ cyclones: For high winds in cyclone prone areas it is found necessary to reinforce walls by means of reinforced concrete bands and vertical reinforcing bars as for earthquake resistance.

Glass Panes

Apart from roofs, elements requiring attention are windows and doors. Desolately these are often neglected even when buildings are formally designed by professionals. Glass windows and doors are of course, very vulnerable to flying objects and there are many of these in cyclones. The way to reduce this problem is to afford well designed thicker glass panes. Further, recourse may be taken to reduce panel size to smaller dimensions. Also glass panes can be strengthened by pasting thin film or paper strips. This will help in holding the debris of glass panes from flying in case of breakage. It will also introduce some damping in the glass panels and reduce their vibrations.

How High Winds Damage Buildings

Contrary to popular belief, few houses are blown over. Instead, they are pulled apart by winds moving swiftly around and over the building. This lowers the pressure on outside and creates suction on walls and roof, effectively causing the equivalent of an explosion. The resistance to effects of wind does not depend on material used but the manner in which they are used. It is believed that heavier buildings made of concrete block are safer. It is true; a well built and properly engineered masonry house offers better margin of safety reasonably. Safe housing can be provided by a variety of other materials including wood and many others.

Design Wind Speed and Pressures

The basic wind speed is reduced or enhanced for design of buildings and structures due to following factors:

- Risk level of structure measured in terms of assumed return period and life of structures.
- Terrain roughness determined by surrounding buildings, trees, height and size of the structure.
- Local topography like hills, valleys, cliffs or ridges, etc.

Thus general basic wind speed being same in a given zone, structures in different site conditions could have appreciable modification and must be considered in determining design wind velocity as per IS:875 (Part 3) - 1987.

The value of wind pressure actually to be considered on various elements depends on

- Aerodynamics of flow around buildings.
- Windward vertical faces being subjected to pressure.
- Leeward and lateral faces getting suction effects and
- Sloping roofs getting pressures or suction effects depending on the slope.
- Projecting window shades, roof projections at eave levels are subjected to uplift pressures.

These factors play an important role in determining vulnerability of given building types and wind speed zones.

Components of Roof Failures

Windward face of the building collapses under pressure of wind force. Collapse start at roof building leaning in wind direction. It may be noted how various roof components react:

- Roof Sheeting-This is perhaps the commonest area of failure in cyclones. The causes are usually inadequate fastening devices, inadequate sheet thickness and insufficient frequencies of fasteners in the known areas of greater wind suction.
- Roof Tiling-These were thought to have low vulnerability in storms but past cyclones have exposed the problem of unsatisfactory installation practices.
- Rafters- Of particular interest in recent cyclones were the longitudinal splitting of rafters with top halves disappearing and leaving bottom halves in place. Splitting would propagate from holes drilled horizontally through rafters to receive holding down straps.

Lessons Learnt

It may be emphasised that good quality of design and construction practice is the sole factor confirming safety as well as durability in cyclone prone areas. Hence all building materials and techniques must follow applicable Indian Standard Specifications. As very valid facts are analysed, in case adopted certainly achieving sustainable built forms will be witnessed.

IMPACT OF VARDAH CYCLONE - AN ANALYSIS

Cyclone Vardah costed 16 lives, wrecked 7,000 houses, power infrastructure and thousands of trees. Nearly 14,000 people were evacuated to higher areas. The impact was such that other day morning the cyclone weakened into a depression and caused heavy rain in interior Tamil Nadu, Karnataka and north Kerala. Even Vardah did give much pain, the one essentiality Chennaites were hoping for was rains which would help fill city's water reservoirs and save the city from an impending water crisis. But only around 53 Mcft of water in the city's water reservoirs was filled. By analysing from the sources water of 1190 Mcfti.e.10% was only accumulated against total water storing capacity of 11,057 Mcft

projecting demand of much more rains in future to help and save from the water crisis during the coming summer.

- Power generation stopped at the North Chennai Thermal Power Station and Power System Operation Corporation Ltd. Subsequent other units went out of operation and restoration was uncertain which took 3 days to revert.

- More than 10,000 electric poles mangled and 800 plus transformers damaged in Chennai, Kanchipuram and Thiruvallur districts.

- It affected all major internet service providers. Through the day, internet service was patchy and slow across the country.

- Chennai airport, closed for whole day, was back in action, causing some flights delay.

Lessons learnt

With advent of satellite guided science and technology, it is again established that human power to control nature is eternally limited. Though we cannot stop incessant cyclonic winds or rains, attempt to reduce vulnerability by adopting innovative and corrective measures by means of therapeutic measures may be achieved.

TREE MANAGEMENT TECHNIQUES FOR CHENNAI'S GREEN COVER

It is important to pick right trees for right spots, opines a botanist and a scientist Dr. Pauline Deborah from Chennai. Vardah broke all ground rules concerning fundamental perceptive of trees. There was no precise pattern in types of trees that were lost; both exotic and indigenous species got uprooted. Trees along pavements and those within spacious boundaries were equally damaged. Exotic species viz Gulmohars and Copper Pods were consistently major casualties during squall, including Vardah.

Gulmohar (Delonix regia) was introduced to India more than 150 years ago when British foresters along with garden superintendents found the copious, scarlet flowers attractive. Being native to Madagascar, thousands of them were planted in Madras Presidency with seeds outsourced from Calcutta botanic gardens. This was era when Madras Agri-Horticultural Society enjoyed a cordial relationship with the curator of Calcutta Botanic Gardens. Copper Pod, native to Thailand, Malaysia, Indonesia, Philippines and Australia is other exotic tree that was widely grown in Chennai. Both these trees have shallow roots and are not wind-resistant. Either their branches snap or entire tree can get uprooted even at slight provocation. So in the statistics of lost trees during Vardah, about 75 % were Gulmohars and Copper Pods. Both these trees are planted, to eventually fall. Tamarind, though an exotic being native to Africa, is widely used in Indian cuisine.

Many mature trees (about 50 years old or more), with a girth of about 5 -7m have been uprooted in many places. Until now, it was considered a hardy tree, resistant to squalls, and a highly recommended species for social forestry and livelihood programmes. Rain Tree, another common tree in avenues, parks and large compounds are also an exotic species. It is native to Southern American countries like Venezuela, Colombia, Costa Rica, Nicaragua and Panama. Though an alien species, its wide-spreading canopy offers excellent shade and great reprieve from sweltering heat.

Since these trees are quite sturdy, entire trees did not fall during the cyclone, but their heavy branches snapped. Their numerous, small leaflets were swept away to distant terraces and clogged storm water pipes and other outlets. Diwi-diwi, often used in the tanning industry for its rich tannins is native to tropical America and is not common in Chennai. Few of these trees were lost due to Vardah, proving that their otherwise knotted and twirled trunks cannot withstand cyclones.

Vardah brought down quite a few native trees in the city, but in very few numbers as compared to Gulmohars and Copper Pods. Mango, Neem,

Java Plum (naval), Anjan (a very rare native tree), Peepul (arasamaram), Crepe Myrtle, Portia tree (poovarasam), Madras Thorn (kodukaapuli), and even the majestic banyan, are a few such affected native species. Though the mother trunk of the Adyar Banyan fell victim to one such cyclone in the 80s, this is the first time many have witnessed a Banyan tree collapse.

Analysing the Pro and Con Effects

While exotic species are good study materials and curio specimens to understand tree diversity, they need to be planted in small numbers in a few protected areas where they will be monitored constantly. Most rare exotics in Chennai have survived the cyclone.

Healthy trees are ecological indicators of a sustainable and providential ecosystem. When right trees are planted at the right places, they offer irreplaceable, irreversible, and invaluable services such as wind breakers, flood channelizers, carbon sinks, buffer zones, disaster barriers, dust, and noise filters.

It's not about numbers but about the species. Chennai needs trees suited to coastal zones, as these trees will face tidal fluxes, salt sprays, fierce winds, inundation, storm surges, high temperatures, and low humidity. Typical coastal trees such as coconut and Palmyra palms did not show any distress during the storm. Every open space may not be cluttered with trees under the pretext of greening, since open Space Reserves (OSRs) are necessary for refuge during certain calamities and as urban breathing-spaces.

Strategy which may be adopted

The loss of green cover in Chennai can be considered in the 21-40 per cent category, where the chances of restoration and enhancement of green cover are very high. This needs to be done with proper guidance from tree experts. Trees showing signs of distress can be axed so that they do not cause any fatalities in the future.

Before every monsoon, a survey has to be done to identify such trees for further action and follow-up. If trees like the Red Sander or Sandalwood have fallen even in private lands, it has to be reported and surrendered to the forest department, since these species are classified as 'Royal trees'.

Lessons Learnt and Suggestive Measures

Just the way buildings and waterways need maintenance; trees too need post-planting care and maintenance. Branches have to be constantly pruned, and pest control has to be administered if there are any symptoms of infestation. Dead wood can be put to discreet use as tree monuments and in carpentry.

Recommendations

- The databank shall be maintained as per the development activity.
- Planning and plantation of suitable local species of trees shall be essentially implemented.
- The Infrastructure services viz, Electricity, Sewage, telephone cable, TV cable water supply network etc are important aspects which requires serious planning and implementation going for underground.
- Insurance must be made compulsory for built forms, industry etc for loss in disaster.
- Disaster management training shall be included in professional courses.
- Any modification of drainage system in an area must take into account the overall topography of the city /town/ village, as it will affect flow of water during disaster.
- Laws must be framed to make stringent for any construction activity in such disaster prone zones and floodway plain zones.
- The engineering lessons from Netherlands which developed highly developed flood

control system may be taken into account while planning.

CONCLUSION

It's very difficult or rather even impossible to predict the intensity, characteristics, and consequences of natural disasters. Judiciousness and thoughtful planning, however, will always mitigate the impact of such disasters.

Potential for disaster management by these means is large. To accomplish it is essential to launch large-scale public education and information campaigns. Need of an hour is to create policies and incentives for users to adopt such practices. Vardah taught us hard lessons that will be etched in our memory for a long time. It is easy to be wise after event. But why wait to regret folly and then turn rational, when nothing much can be done to undo the past? Is prevention not better than cure? If not now then when?

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TECHNICAL SESSION II

SUSTAINABLE MATERIALS & DEVELOPMENT

BUILDING SUSTAINABLY- CURRENT PRACTICES IN NSW, AUSTRALIA

GURDEEP SINGH MAKKAR*

Abstract

Climate change is considered an issue of major significance. Most of the world's leading scientists agree that climate change is occurring due in large part to human activity. This presents challenges for the way we live and work and will require action from industry, governments at all levels, the broader community and individuals.

INTRODUCTION

Climate change is considered an issue of major significance. Most of the world's leading scientists agree that climate change is occurring due in large part to human activity. This presents challenges for the way we live and work and will require action from industry, governments at all levels, the broader community and individuals.

SUSTANABLE DEVELOPMENT

The GHG (Green House Gas Emissions and their influence on Global warming has grown significantly as per following details (Fig.1)

- In 1997, Prime Minister issue a statement in Australia's response to Global warming that include measures to reduce energy consumption in buildings.
- In 2000,Agreement by COAG to introduce energy efficiency regulations for domestic and commercial buildings
- In 2001, Australian Greenhouse Office (AGO) & ABCB enter into agreement to develop Energy Efficiency regulations and introduce these through BCA.
- 2001-2002-Energy Efficiency provisions were developed for housing.

The first stage of the initiative introduced energy efficiency requirements for housing into BCA Volume Two on 1 January 2003. The second stage introduced energy requirements or multi-residential buildings into BCA Volume One on 1 May 2005

BCA-2005 introduced the same star level energy efficiency requirement for Class 2 & 3 buildings and Class4 parts.

The third stage introduced energy efficiency requirements for all other building classifications in BCA Volume One for BCA 2006(Class 5 to 9 buildings). Also in 2006, the provisions for housing were increased in stringency to 5 star or equivalent.

In 2010 further stringency was incorporated with housing to a higher star rating level. Six star rating was adopted by some states.

In NSW,Residential energy efficiency is complied with BASIX targets.BASIX was introduced 1st July, 2004 by the NSW Government. Since its introduction BASIX has delivered equitable and effective water and greenhouse gas reductions across NSW and has received numerous awards.

In a nutshell, in New South Wales(NSW) Class2-Class 9 buildings are governed by BCA Part J requirements & Basix is the governing instrument for Energy efficiency of Class1 buildings (Residential).

Charted Engineer, Electred Councillor & Dy. Mayor, NSW Australia

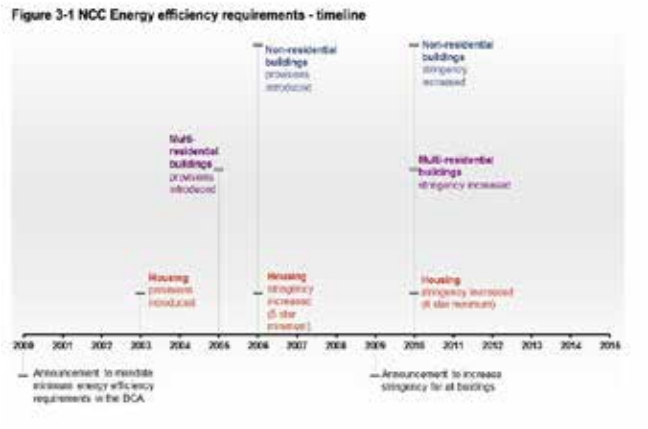

Fig. 1 (NCC Energy effficency requirements-timeline

NATIONAL CONSTRUCTION CODE, AUSTRALIA

The National Construction Code, incorporating the Building Code of Australia (BCA), requires that building work on Classes 2-9 buildings meet minimum energy efficiency requirements under its Section J Energy Efficiency provisions. NCC-Volume-1 contains requirements for the design and construction of commercial buildings (Class 2-Class9). Part J of BCA regulates the energy efficiency of buildings.

There are two approaches to achieve energy compliance: (Fig.2)

- Deemed-to-satisfy
- Performance solution(Verification methods or expert Judgment) The Section J targets energy consumption of building by achieving efficiency in:
- Building fabric of envelope (conditioned areas)-Walls, floors, roof construction with appropriate insulation.NSW is divided into different climate zones. Section J of BCA thus specifies minimumperformance of fabric according to climate zones. (Fig.3)
- Glazing compliance.
- Building Sealing
- Air conditioning & ventilation Systems

Fig.2 Approach to Energy Efficiency

- Artificial lighting & power
- Hot water/pool
- Access and energy monitoring

In 2010, BCA stringency levels were increased. In a nutshell the four major changes in the BCA2010 stringency of the deemed-to-satisfy glazing requirements for the building's thermal envelope are as follows:

- Non-residential commercial facade glazing energy allowances have been reduced by between 17 per cent (climate zone 2) to 51 per cent (zones 7 and 8) in the Method Two calculator;
- Residential commercial (hotel and aged care) facade glazing energy allowances have been reduced significantly with the deletion of the Method One calculator and replacement with a more stringent version of the Method Two calculator;

- Minimum energy performance of internal fabric glazing is now specified and assessed in the same way as if it were south-facing external glazing; and
- The total area of roof lights must not exceed 5 per cent of the floor area of the room or space served (previously it was 10 per cent).

Stringency in BCA2010 meant that there was now a greater likelihood that these deemed to satisfy measures will be exceeded in some areas of any building design.

The performance-based JV3 energy modelling compliance method allows the design team to demonstrate compliance with BCA2010 even if there are some areas of glazing that do not comply with the deemed to satisfy requirements. Effectively energy modelling permits the trading of glazing energy allowances between facade orientations or levels, thereby providing the architect with greater flexibility to incorporate external glazing into the building's design. Complying with the JV3 method still requires that the proposed design has the same building envelope thermal performance as one complying with the deemed to satisfy measures throughout.

After 2010, only minor changes have been incorporated in 2014 & 2015

BASIX in NSW for Residential Energy Efficiency

Building Sustainability Index(BASIX), is a planning initiative of the New South Wales Government that requires all new dwellings to be designed and built to achieve a 40% reduction in water consumption and in greenhouse gas emissions compared to the average pre BASIX dwelling.

Basix targets three key areas in Building:

- Water
- Thermal comfort
- Energyusage (lighting, airconditioning, hot water etc)

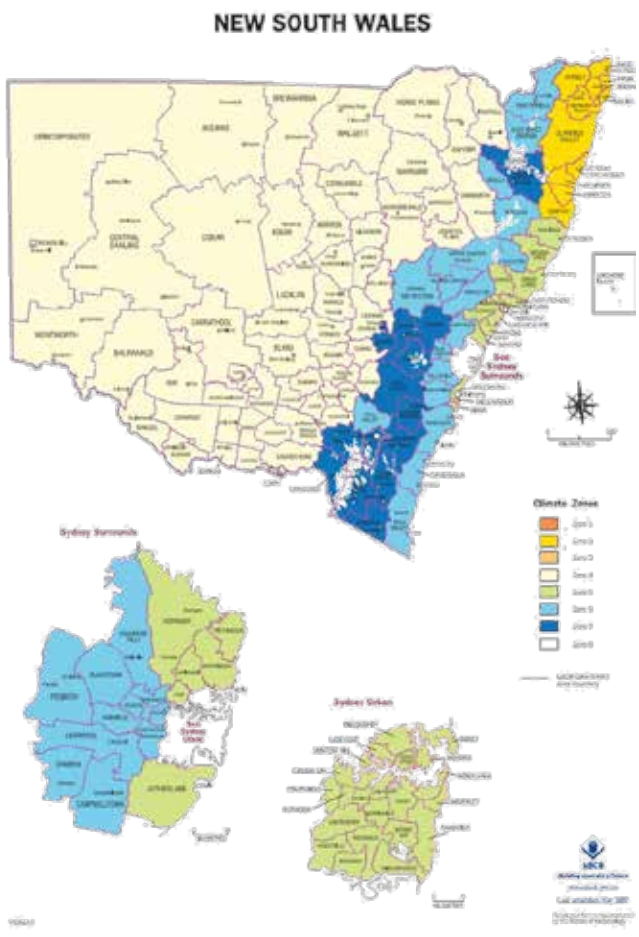

Fig .3 Climate Zones

Basix was introduced in 2004 and applied only to new single dwellings,dual occupancies, hostels, guest houses etc. under 300 sqm only and extended to apply larger building areas in 2005.In 2005, It also incorporated multi-dwelling buildings and later in 2006,alteration/addition to dwellings were included.

Thermal Comfort section of Basix defines heating & cooling load caps for each Climate Zone. The Loads can be calculated by use of approved Nathers Software simulation.There is also and quick option of compliance for single dwellings (DTS Thermal comfort tool)

The Nationwide House Energy Rating Scheme (NatHERS) is a star rating system (out of ten) that rates the energy efficiency of a home, based on its design.

By providing a 'measuring tape' to estimate a home's potential heating and cooling energy use, NatHERS helps to make Australian homes more comfortable for their inhabitants and also helps residents to save on energy bills through smarter design choices. Often good design can reduce the amount of energy needed to keep a home comfortable with no or little additional construction cost.

Accu Rate, FirsRate&BersPro are current regulatory softwares accredited to use for simulation in Residential dwellings nationwide.

In NSW current compliance is Basix caps, so less than 5 star rated dwellings can be complied Basix targets.ABCB is discussing to raise the minimum compliance to 6 stars rated homes by raising BASIX caps by 2019.

CONCLUSION

To sum up,I would say,NSW is doing great work to raise awareness in Building Industry,both Residential and Commercial and raising sustainable standards in buildings being built.It has come a long way slowly but still a lot to go as compared to other states & territories,(For example Queensland raised Residential minimum star rating to 6 star in 2010)

In order to bring Sustainable Buildings a priority, We need more policy regulations at design & construction stages (to ensure we are "actually" building it).We also need more education and awareness of importance of building sustainably in Building Practitioners and common user alike. So we can design, build and live in Sustainable environment.

BUILDING AND CONSTRUCTION MATERIALS FOR SUSTAINABLE DEVELOPMENT

Dr. K. M. Soni*

Abstract

India has already signed agreement on climate change on 2nd October 2016 and thus is determined to adopt green materials, methods and energy efficient resources. Though in the field of energy, India has already taken initiatives to increase use of solar and wind energy, probably steps to preserve natural materials in construction sector will also be taken up in near future. Ministry of Environment and Forests and Climate Change will be preparing guidelines in this regard in consultation with other ministries, particularly Ministry of Urban Development, Ministry of Road Transport and Highways, and Ministry of Rural Development. Once the guidelines are issued, the Courts and Tribunals will be passing orders for their implementation. It is therefore necessary that such green materials are available in the market to cope up the demand of construction industry well in time.

To assess the feasibility of using the materials in construction industry and their suitability for categorising as "green", research is required immediately so that same can be manufactured for use in the construction. Materials manufactured using waste industrial and agricultural products will find place in the construction industry and are likely to replace natural materials. Brief discussion is made on some of such sustainable materials in the paper.

INTRODUCTION

In construction of a building, large number of materials is required. These materials are either obtained from natural sources like rivers, hills, or manufactured. Due to depletion of natural resources, focus has shifted from use of natural resources to manufactured materials particularly waste materials which are often termed as green materials.

Though different definitions have been given by the experts for green materials, Spiegel and Meadows (1999) defined green materials as, "Green building materials are composed of renewable, rather than non-renewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product." As per Brian Milani (2001), "A green material is one that simultaneously does the most with the least, fits most harmoniously within ecosystem processes, helps eliminate the use of other materials and energy, and contributes to the attainment of a service-based economy." As per Soni (2014), "Green building concept is based on relative term and green is entirely considered on relative basis".

ASSESSMENT CRITERIA OF GREEN BUILDING MATERIALS

Brian Milani (2001) based on the information on Lynn Froeschle's article (1999), "Environmental Assessment and Specification of Green Building Materials", presented a selection criteria for assessment of green materials based on the following parameters;

- Resource efficiency
- Indoor air quality
- Energy efficiency
- Water conservation and
- Affordability

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As per the Milani (2001), resource efficiency can be accomplished by utilizing materials that meet the criteria of recycle content, natural, plentiful or renewable sustainably managed sources, resource efficient manufacturing process manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product packaging), and reducing greenhouse gases, locally availability saving energy and resources in transportation to the project site, salvaged, refurbished, or remanufactured for saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product, reusable or recyclable that can be easily dismantled and reused or recycled at the end of their useful life, recycled or recyclable product packaging enclosed in recycled content or recyclable packaging and durability longer lasting or are comparable to conventional products with long life expectancies.

Indoor Air Quality (IAQ) is enhanced by utilizing low or non – toxic materials that emit few or no carcinogens, reproductive toxicants, or irritants. Energy efficiency can be maximized by utilizing materials and systems that meet the criteria of helping in reduction of energy consumption in buildings and facilities. Water conservation can be obtained by utilizing materials and systems that reduce water consumption in buildings and conserve water in landscaped areas. Affordability can be considered when building product life-cycle costs are comparable to conventional materials or as a whole, and are cost efficient.

Green building rating organisations certify the green products just based on one or two criteria like waste content and/or energy efficiency. It is proposed that in case a product/material scoring minimum 60% marks considering parameters and weightages given in Table 1, should only be classified as a green material i.e. if the value of green index is 0.6 or more, then only material should be considered as green. It is pertinent to mention that the materials having high embodied energy will get lesser marks than having less embodied energy. Similarly materials generating high toxicity and requiring higher amount of energy during their use will score lesser points.

Soni (2016) gave the following criteria, given in Table 1 for classification as a green material;

Table 1: Parameters for Classification a Green Material

Sl. No.	Parameter	Weightage
1	Embodied energy	20
2	Waste content	10
3	Life cycle/durability	15
4	Maintainability	5
5	Toxicity including during fire	10
6	Safety during installation/ use, fire, earthquake etc.	10
7	Local Availability	5
8	Recyclability	5
9	Energy requirement during its use	20

BUILDING MATERIALS AND ENVIRONMENTAL REGULATIONS

As per "The Environment (Protection) Act, 1986", environment includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro organism and property. Environmental pollutant means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment and environmental pollution means the presence in the environment of any environmental pollutant. Thus there is no manufacturing process which does not affect the environment hence automatically comes under the Act. Therefore, permissible norms have been prescribed by Central Pollution Control board for industrial effluents. Then there are number of waste materials which are secondary or waste products in the manufacturing process. These products also pollute the environment. Since for the development process, manufacturing of all such products cannot be stopped, enforcing agencies and the courts will go on insisting/making orders for use

of such secondary or waste products. For example, various courts and National Green Tribunal have ordered mandatory use of fly ash through use of fly ash bricks/cement/earth filling in the embankments etc. in the area near thermal power plants generating fly ash. Similar orders may be passed in near future if engineers do not adopt the policy of using various waste products or products made of waste. But to gain the confidence for the suitability, research needs to be carried out on use of waste products or bye products from the industries or agriculture to convert them into resource materials.

WASTE MATERIALS TO BE USED AS RESOURCE MATERIALS

Some of the waste materials which have been used as resource materials or having scope of use as resource materials are discussed in the following;

Fly Ash

Fly ash (Fig. 1) is one of the coal combustion products having fine particles. Now each coal based power plant has electrostatic precipitator which captures fly ash at the bottom with other fine particles. Depending upon the source and coal being burned, quality of fly ash varies considerably, though includes substantial amounts of silicon dioxide (S_1O_2), aluminium oxide (Al_2O_3) and calcium oxide (CaO). Earlier it was considered as a hazardous and a waste material but after its pozzolonic properties were invented, fly ash is being used as a resource material by way of substitution of OPC in concrete and cement plaster. Fly ash is also being used in manufacture of bricks and autoclaved aerated concrete (AAC) blocks which are widely used in the country now. In future, use of OPC and burnt clay bricks might be negligible.

Fig.1: Flyash

Fig. 2: Red Mud

Red Mud

Red mud or red sludge (Fig. 2) is a highly alkaline waste product composed mainly of iron oxide that is generated in the industrial production of aluminium. With about 4 million tons of this hazardous material being produced annually in India, red mud poses a serious disposal problem as it is dumped on land or in ocean. It can be economically used in the production of cement, and road construction. Thus, potential applications include its use in the production of cement, manufacture of concrete, as part replacement of sand and in construction of embankment by way of mixing with natural soil and aggregates. Red mud was tried in manufacturing of red mud plastic corrugated sheets without much success. As red mud contains silica, aluminium, iron, calcium and titanium, it is going to be a highly resource material for enhancing the strength of concrete in future. Its use in making bricks can also not be ruled out.

Slag

The main components of blast furnace slag (Fig. 3) are CaO, S_1O_2, Al_2O_3, and MgO. In general, increase in CaO content of the slag results in increase in basicity and compressive strength. The MgO and Al2O3 content show the same trend up to certain limits. Ground Granulated Blast furnace Slag (GGBS) is used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzolonic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia, particularly in Japan and Singapore for its superiority in concrete durability. GGBS is also

used as a direct replacement for Portland cement. Though slag is being used at present but its large scale use is needed.

Fig. 3: Blast Furnace Slag

Fig. 4: Unfired Clay Bricks

Unfired Clay Bricks

Unfired clay bricks (Fig. 4) are said to offer a cost-effective form of construction of very low environmental impact having lower embodied energy, easier to recycle and dispose off at end of use than burnt clay bricks. Unfired brickwork has the ability to absorb more moisture from the air than block work or burnt clay brickwork, and therefore provides better passive humidity control. Unfired brickwork does not have the same moisture resistance and compressive strength as block work or burnt clay brickwork so it is kept dry during and after construction. Such brickwork cannot be used in high-load structural applications and thus there is a need to make research whether with mixing some other waste like red mud, flyash and some quantity of lime etc their properties can be improved for their use in infill walls and also in semi permanent, and low rise structures.

Manufactured Sand

Manufactured sand (Fig. 5) is a substitute of river or pit sand for construction purposes produced from stone crushing. The size of manufactured sand is less than 4.75 mm, therefore, it can only be used as a part replacement of natural sand as per the specifications and codes. Hence, research has to be carried out for its use in different proportion and different size of coarse aggregates so that it can be directly used without compromising of strength. Nevertheless, such sand will replace river/pit sand being green and sustainable. It is likely that concrete strength can be increased by reducing size of coarse aggregates and by mixing manufactured sand as observed in reactive powder concrete.

Fig. 5: Manufactured Sand

Fig. 6: Glass Masonry Units

Glass

Being amorphous and containing relatively large quantities of silicon and calcium, glass is, in theory, pozzolonic or even cementitious in nature when it is finely ground, thus, can be used as a cement replacement in Portland cement concrete though use of crushed glasses as aggregates does have some negative effect on properties of the concrete,

main concern being expansion and cracking caused by the glass aggregates. Still, in future, this material may be of interest for research particularly due to its use in the area where glass industries are located. Recycled glass has many benefits to concrete both as an aggregate and as a supplementary cementitious material as it replaces up to 20% Portland cement, and in addition to pozzolonic characteristics has high reactivity, improves durability, increases strength and density and decreases efflorescence. Glass concrete products include concrete masonry units (Fig. 6), paving stone, precast wall panels and floor tiles.

Construction and Demolition (C&D) Waste

Though India is a developing country, large scale of renovations are carried out in private and public sectors. Apart from this, poor quality construction leads to reconstruction activities in a short span hence large C & D waste is generated. If such C & D waste is mixed with municipal waste, it becomes difficult to use municipal waste also. Therefore, use of C & D waste is extremely essential not as a waste material but as a resource material.

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has recently notified the Construction & Demolition Waste Management Rules, 2016 on 29 March 2016. Ministry of Urban Development (MoUD) is also encouraging use of C & D waste and thus in few years use of products from C & D waste will also be common though present use of its products is limited to non structural members.

Fig. 7: C & D Waste Recycling Plant

Fig. 8: Recycled Paper Board

Paper

Use of recycled paper will increase in near future in construction industry particularly in architectural applications and furniture. Boards may be manufactured through use of recycled paper and resin having medium to high density for their use in panelling, false ceiling, table tops etc. Composed of approximately 65% recycled paper content and 35% phenolic resin, Richlite products (Fig. 8) are available for interior and exterior applications including furniture, cabinetry, cladding, etc.

Artificial Stones

Artificial stone is a synthetic stone product used in building construction. With various combinations, such artificial stones will have required architectural finish and durability and thus would replace natural stone. The use of waste materials particularly broken stones or stone powder cannot be ruled out and thus will prove to be a green material. Many such materials are already available in the market such as artificial marble and artificial quartz. Advantage of using artificial stones will be in the consistency, homogeneity and aesthetics.

Carbon Fibres

Carbon fibres are fibres of about 5 to10 micrometers in diameter and composed mostly of carbon atoms. To produce a carbon fibre, the carbon atoms are bonded together in crystals, bundled together to form a tow, which may be used by itself or woven into a fabric (Fig. 9). Carbon fibres have high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. Though they are expensive,

their use in rehabilitation and retrofitting of structural elements of the buildings like beams, columns and slabs will increase as the cost of natural materials like sand and cement will go up, particularly due to their low weight and high strength.

Fig. 9: Carbon Fibre Fabric

Fig. 10: Optical Fibre Concrete

Translucent Concrete

An optical fibre cable is now widely used in telecommunication for providing a high speed data connections between different places but optical fibres can be used to carry light also. The fibres can be embedded in concrete to make the concrete as translucent or light transmitting. Such concrete will prove to be sustainable due to less requirements of artificial light. Litracon is a light transmitting concrete produced from the combination of optical fibres and fine concrete. Due to the small size of the fibres, they blend into concrete becoming a component of the material like small pieces of aggregate. In the form of concrete blocks, it can also be used in flooring and pavement. Lucem is another company manufacturing translucent concrete panels.

Rubber Modified Asphalt (RMA)

Recycled tyre rubber is often added to the asphalt mix in order to improve its performance characteristics. The main advantages of RMA are that it is useful in areas with extreme climates, both in summer and in winter, reduces thermal cracking and rutting, has lower maintenance costs, and increases durability and skid resistance.

Plastic

Use of plastic has increased manifold even if it is not considered environment friendly. Small scale use of plastic waste has been tried in different forms. Polypropylene fibres have also been used in plaster and concrete roads. In future there is a likelihood of use of cut fibres. Such fibres are said to be arresting cracks, increasing resistance to impact/abrasion improving quality of construction. Few trials of bituminous road construction have been made in various states in India with plastic waste terming such roads as plastic roads (Fig. 11) in which waste plastic except PVC is used in shredded form. Since plastic roads use waste that too non biodegradable plastic, they are termed as green even though plastic emits toxic gases during heating process. Ministry of rural development, Government of India has issued guidelines for plastic roads.

Fig. 11: Plastic Road

Fig. 12: Road Asphalt Pavement

Recycled Bitumen

Deteriorated asphalt road materials can be recycled through two processes, in-place recycling and offsite recycling. Hot in-place recycling involves softening the surface through heating and then relaying the existing road. Cold in-place recycling involves removing the road to a certain level, pulverising it, mixing it with an additive, then it is laid, compacted and resealed. This process involves no heat and results in greater energy savings. Offsite recycling involves using recovered asphalt and remixing them at an offsite plant to be reused.

Bituminous pavement recycling technology is not yet popular in India. However, in advanced countries, bituminous material is the most recycled material in the construction industry. As the recycled asphalt pavement (RAP) is a deteriorated bituminous mix containing old bitumen and aggregates (Fig. 12), its performance may be poorer when compared to the fresh mix. The process of bituminous recycling involves mixing of the RAP, fresh bitumen, old and new aggregates in suitable proportions. One of the problems with its use is the content of low quantity of bitumen/asphalt in existing roads due to poor quality of original construction thereby resulting in wrong assessment of quantity of recycled bitumen. It is hoped that as quality of roads is improving, use of recycled bitumen/asphalt will increase as RAP does not increase the level of roads and as such has many other advantages.

Silica Fumes

It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm (Fig.13). The main field of application is as pozzolonic material for high performance concrete.

Bagasse

For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse and traditionally has been used as fuel but it is likely to be used as a sustainable resource material in generating power, and construction material in concrete, and as a wood substitute. Even there is a possibility of its ash being used in concrete. As per Almir Sales, a Researcher and Professor at the Federal University of São Carlos (UFSCar), "The ashes will no longer be discarded in cane plantations. In addition, any surplus can always be sold to another sector, which is important from an economic." Another advantage of bagasse is that it is fibrous material therefore, in future, it may be partially replaced with sand in plaster and concrete as it is likely to enhance the strength.

Fig. 13: Silica Fume

Fig. 14: Bagasse

Recognizing the huge potential of biomass though the government has taken several new initiatives to accelerate biomass power production, it is important that research is done for large scale use of bagasse in construction industry. However, on small scale, the construction industry has been making use of some of the agricultural products like bagasse, rubber, bamboo, jute etc.

Rice Husk Ash

Rice husk ash (Fig. 15) is a potential source of amorphous reactive silica. It is used in the production of Portland cement and is finer than cement which

provides a very compact concrete. The ash also is a very good thermal insulation material. The fineness of the ash also makes it suitable for sealing fine cracks in civil structures, where it can penetrate deeper than the conventional cement sand mixture.

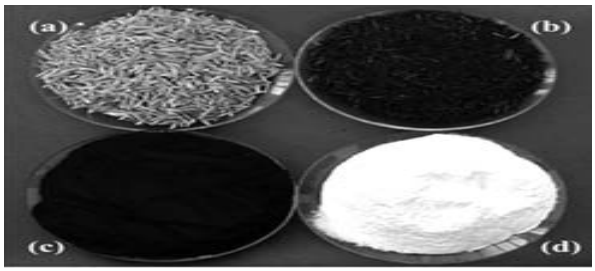

Fig. 15: Rice Husk Ash

Fig. 16: Recycled Wood

Wood

In future manufactured wood boards will be made from grain producing agricultural waste (Fig. 16) products like straw of wheat and shrubs like bamboo which are mostly being wasted either by burning at present or in producing household items. Such agricultural products with resins and recycled paper will prove to be good building eco-friendly materials.

Water

Use of domestic waste water is being encouraged by government and municipal corporations through recycling sewage treatment plants but main focus needs to minimise wastage of water in irrigation and adopt efficient techniques like sprinkler and drip irrigation in place of flood irrigation as more than 80% water is used in surface irrigation with efficiency of about 30-40%.

Clothes

In future, use of recycled clothes will be essential as the same will be a waste due to durability of many clothes. For example, old recycled jeans (Fig. 17) may be used as insulation material in itself or just for the protection of under deck insulated materials or for acoustic purposes. It is said to be having 30% better sound absorption than traditional fibreglass insulation. Thus, waste materials like jeans and polymeric low cost materials are likely to be used in construction and in insulation particularly in under deck insulation in future.

Fig.17: Use of Recycled Jean

Fig. 18: Insulated Concrete Panels

Special Concrete

Concrete in future will be used with various combinations suitable for specific requirements. For example insulated concrete blocks (Fig. 18) will be used in masonry work particularly for external infill walls for energy efficiency. High strength and high performance concrete will also be used for various applications. Reactive powder concrete being of high strength will also find place for various applications. This will lead to durability and low weight structures. Light weight concrete blocks, tiles, and concrete itself will be largely used to make structure light to save natural resources.

CERTIFICATION

Due to environmental considerations and image building, certification of products/materials and processes will increase manifold. Rating agencies will also change their criteria based on environmental Acts/

regulations/guidelines hence research on the products, their evaluation and selection will be essential. To cope up large demand of green materials for use in "Housing for all", and smart cities, it is essential that such materials are produced and certified to save the natural resources.

CONCLUSION

In construction industry, use of eco-friendly materials will be a necessity due to environmental regulations and non availability of natural materials. Such products will either be manufactured using waste materials or will be light weight to save natural resources. Main materials for which research is to be carried out include eco-friendly bricks, cement, plastic, bitumen, concrete and wood substitutes which form a major part of construction activities. Once their suitability is confirmed, their specifications will have to be prepared and included in the codes for their wide use.

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TECHNOLOGICAL ADVANCES LEADING TO SUSTAINABLE CONSTRUCTION OF STRUCTURES

VINAY GUPTA*

Abstract

The entire world is busy carrying out construction of a large number of projects that relate to infrastructure, real estate, power sector, industrial sector, etc. Needless to mention that civil construction is the first aspect of a project implementation that precedes functional installations. Large volumes of construction require an equated volume of cement production. Some 3 billion tonnes of cement produced world-wide produces 3 billion tonnes of CO2 gas, leading to greenhouse effect. Blending of cement is a technology used to cut down emission of CO_2. It also results into conservation of the natural resource, i.e. Lime Stone.

A structure would be disliked by masses, if it does not find enough aesthetic appeal. For that matter, even the infrastructure projects are making inception of aesthetics and architects are being involved in the design of flyovers. Use of fly-ash in construction of embankments, has helped conserving the environment, because the waste product of thermal power plants is successfully utilised. The paper discusses various advanced techniques used to achieve high speed of construction of building, bridges and chimney projects, reduction of site produced/ poured concrete, smart construction and launching techniques of building, bridge and chimney projects, use of fly ash, GGBS and SCC in various building and bridge projects, use of pre-stressing in industrial and hotel buildings for speedy construction, etc. All these issues are well narrated through practical examples of buildings, bridges and chimneys. Use of mould liners for segmental bridges, resin coated ply for architectural fair faced concrete etc are depicted through practical examples. Broad concepts of launching segmental bridges, slip-forming of chimneys are depicted through projects. Heritage conservation has also been an issue in many of these projects.

INTRODUCTION

The entire world is busy carrying out construction of a large number of projects that relate to infrastructure, real estate, power sector, industrial sector, etc. Needless to mention that civil construction is the first aspect of a project implementation that precedes functional installations. Large volumes of construction require an equated volume of cement production. Some 3 billion tonnes of cement produced world-wide produces 3 billion tonnes of CO2 gas, leading to greenhouse effect. Blending of cement is a technology used to cut down emission of CO2. It also results into conservation of the natural resource, i.e. Lime Stone.

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LARGE SCALE ARCHITECTURAL FAIR FACED CONCRETE

Khalsa Heritage Complex, Punjab

To celebrate 500 years of history of Sikhs and 300 years of establishment of the Khalsa, the mega project 'Khalsa Heritage Complex' was launched by the Punjab Government (Fig.1). The special highlights of the project include Inception of large volume of architectural fair faced concrete. Large scale use of portland slag cement (PSC) for the project, gives advantage of reduced consumption of lime stone leading to protection of environment and sustainable development.

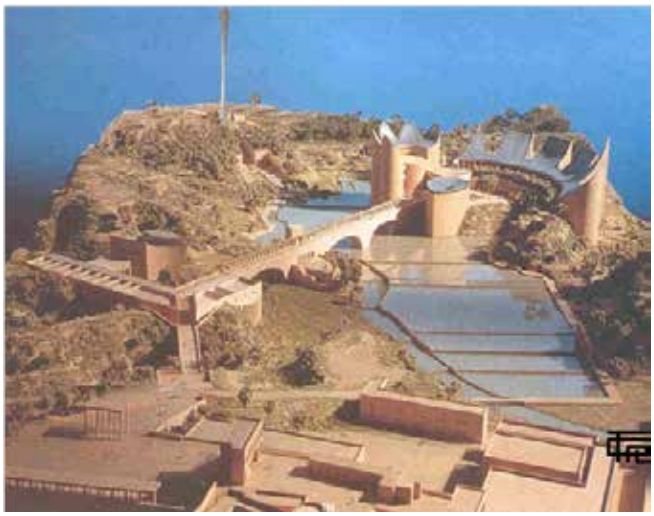

Fig. 1: Khalsa Heritage Complex Anandpur Sahib, Punjab

Use of ground granulated blast furnace slag in cement concrete has provided a pleasant light grey colour to the fair-faced concrete, exhibiting an aesthetically pleasing structure. Even at the locations of false ceiling, concrete ribs have been projected 150m below the false ceiling to show up the pleasing structure (Fig. 2).

Fig. 2: Fair Faced Concrete Beams Visible Below False Ceiling

The architectural conception demanded a 4 arch spans (35m each).The pedestrian bridge has been provided with a precast canopy, which was precasted and erected from top of the bridge itself. Each canopy unit comprises 3 pieces i.e. columns, slab and a concrete cap. All these elements comprise architectural fair faced concrete using PSC (Fig.3).

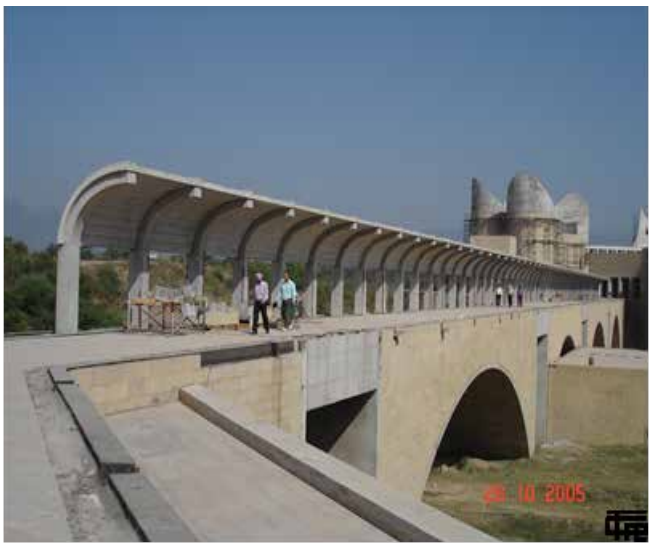

Fig.3: Precast Concrete Canopy Over Pedestrian Bridge

It was found that resin coated ply imported from Finland produced the most satisfactory surface finish. Mineral oil based form release agents were found to leave a brownish tinch on the concrete surface. So, it was decided not to use any

form release agent and do a very gradual de-shuttering, in order to prevent spalling of concrete.

In this project, the architects have done maximum justice to the concrete. This is by way of exposing most concrete columns, buttresses attached to RCC walls and down-turn beams apart from other elements indicated elsewhere in this paper. The false ceiling has been arranged between the beams (Fig. 3) in such a way that typically 150mm deep lower part of the beams projects below the false ceiling, as architectural fair faced concrete, comprising PSC.

A large scale use of portland slag cement (PSC), conforming to IS:455 has been made. PSC being blended cement, incorporates about 50% to 70% blast furnace slag (BFS). This is a bi-product (a waste product)of the steel industry, which is produced in the arc furnace. This way not only the wastage is utilized for a constructive use, quantity of lime stone required in producing cement is also reduced in a big way. Apart from conservation of natural resources, it also reduces the quantity of energy required to produce cement, as less clinker is needed. This way the CO2 liberation is reduced and green house effect prevented. It is said that globally, about 3 million tonnes of CO2 is liberated every year to produce 3 million tonnes of cement.

AIIMS Flyover, Delhi

AIIMS flyover in Delhi has successfully conveyed that even a fat structure can be made to look aesthetically pleasing, which is a must in an urban infrastructure project (Figs. 4, 5 & 6). The piers have been architecturally camouflaged with the corresponding superstructure. High seismicity of the area has been taken care of by incorporating separate seismic attachments, while the main POT bearings carry only the vertical loads.

Fig. 4: Plan of AIIMS Flyover

Fig. 5: Aesthetic View of AIIMS Flyover

Fig. 6: Transverse View of AIIMS Flyover

USE OF PRESTRESSING AND PRE-CASTING FOR SPEEDY CONSTRUCTION

Amari Atrium Hotel, Bangkok

While it is important to conserve the environment, it is also equally important to speedily complete the projects, which apart

from having financial benefits, also reduces disturbance to traffic and the neighbourhood. 25 storeyed Amari Atrium Hotel, Bangkok, built in the year 1991-93, incorporates prestressed floor slabs for the upper 20 floors (guest room floors). This way each floor could be completed in an average of 9 days per floor. Fig. 7 for overall view of the building.

Fig.7: Amari Atrium Hotel, Bangkok

The structural system comprises banded slab system with frames at 8.2m spacing. Each frame comprises 12m centre to centre span between columns flanked by 4m cantilever on either side. pre-stressed band beams are 400mm deep, that span 12m from column to column and 4m cantilever, on either side. The pre-stressed slab, that spans 8.2m, has a thickness of 200mm. Pre-stressing system comprises unbounded tendoms using grease coated factory extruded strands, housed in flat pre-stressing ducts for post tensioning the slab. Figs. 8 & 9 for pre-stressing system. Apart from speed of construction, pre-stressing gave a distinct advantage of reduced structural depth, reduced deflections, enhanced durability and reduced consumption of concrete, eventually leading to sustainable construction.

Fig. 8: Pre-stressed Banded Slabs

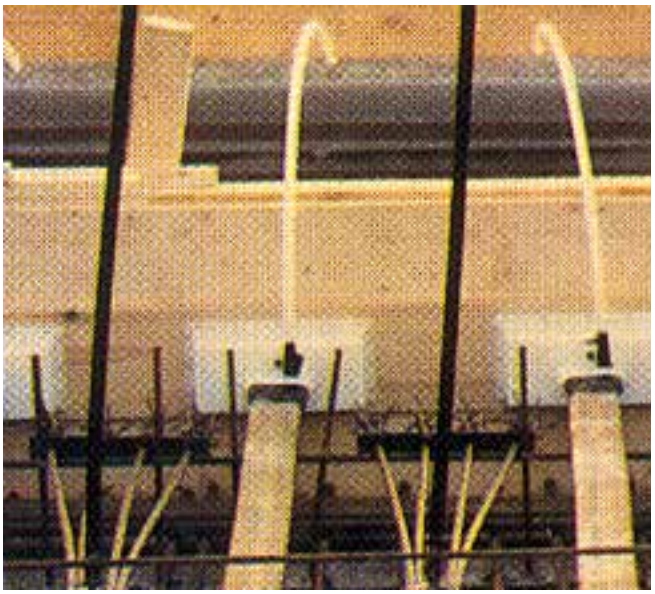

Fig. 9: Flat Pre-stressing Cables

Samtel Color Ltd, Ghaziabad

Use of pre-stressing is not only limited to buildings and bridges. It can as well be extended to industrial structures. Samtel Color Ltd, Ghaziabad is one such example, wherein a large scale use of precast pre-stressed trusses (post tensioned) has been made. This way the 25000 sqm of factory building could be constructed in merely one year. The 25m span trusses are spaced at 10m and they are supported over elastomeric bearings over the 10m high columns. The elastomeric bearing also

acts as seismic isolator to reduce seismic demand of the structure, leading to economy in columns and foundations. Figs. 10 & 11 for illustration. The roof slab, in this case comprises precast RCC inverted channel units topped with cast-in-situ RCC. The structure so constructed, apart form being fast, also proves to be weather tight for the air-conditioned electronics factory. This reduces long term air-conditioning load, hence cost savings leading to sustainable construction.

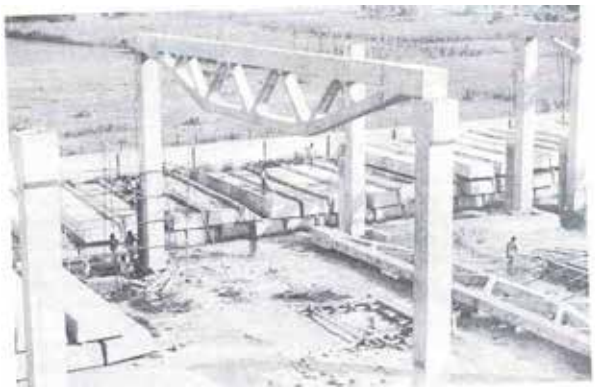

Fig. 10: Samtel Color Ltd. (Ghaziabad) Precast Post-Tensioned Roof Trusses

Fig. 11: Close Up View of Precast Trusses Resting over Elastomeric Bearings

Elevated Viaduct Over Barapulla Nallah

An innovative idea of providing an elevated viaduct over a city drain has been successfully implemented, just before commencement of the Commonwealth Games in Delhi. The project comprises of construction of elevated road over Barapulla Nallah from Ring Road near Sarai Kale Khan to Jawahar Lal Nehru Stadium. Fig. 12 shows general view of standard spans construction of the precast segmental structure.

Fig. 12: Construction of Standard Span Modules

In addition to standard span modules, there are special span modules at the road crossings and railway crossing. These are 3 to 5 span units with the largest central span of 84m. The special span modules have also been constructed as precast segmental balanced cantilever structures employing specially designed segment lifter. Figs. 13& 14 depict this type of construction.

Fig. 13: Use of Segment Lifter

The project alignment passes through the tomb of Abdul Rahim Khan-I- Khana at Mathura Road location. The mandate given by the ASI department was not to obstruct the view of the tomb. For this reason, the level of elevated viaduct was raised to obtain a clear height of 12m, Figs. 15 & 16.

Fig. 14 : Cantilever Construction Over Railways

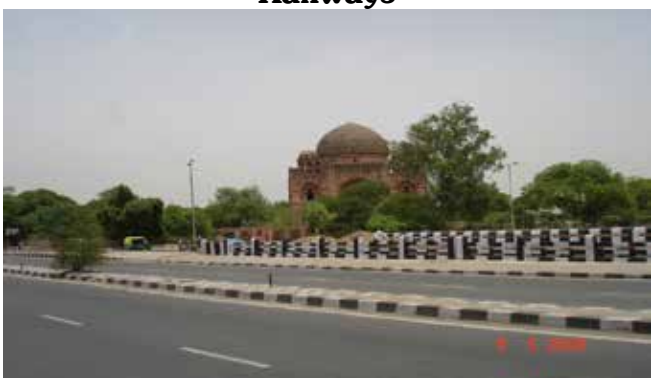

Fig 15 : Tomb of Abdul Rahim Khan-i-Khana-View from Mathura Road

Fig 16 :View of Khan-i-Khana Tomb from Mathura Road with Elevated Road at a Height of 12m

Bangalore Hosur Elevated Expressway

In line with promise to the nation, NHAI has completed the mega project of 10km long elevated viaduct from Silk board Junction to Electronic City in Bangalore. Twin carriageway (2 2 lanes) is carried over 16.3m wide twin cell box girder. About 3000 precast segments were constructed in 3 different pre-casting yards, specially designed to carry out short bench method of pre-casting. Erection of segments was carried out using 3 nos. of specially designed wireless remote controlled overhead Launching Girders (Figs.17&18). This way, a peak speed of days per span of the twin carriageway superstructure could be achieved for the important BOT project. The precast segments have been provided with surface texture with the help of high density/ high quality imported rubber liner stuck to the steel mould. This has led to much better surface appearance of the public structure in urban habitat, mainly serving the IT industry.

Fig. 17 : Launching Operation

Fig. 18 : Segments Suspended from Launching Girder

CONSERVATION OF EXISTING HABITATION

Mukerba chowk Interchange, Delhi

The award winning project has recently been completed by PWD, Delhi. Fig. 19 shows model

view plan of the project. The main flyover comprises composite steel-concrete box girder with 2 and 3 span, full depth continuity. Although expensive compared to concrete alternative, this option reduces consumption of cement, in turn leading to conservation of environment and natural resource (lime stone). Figs. 20 & 21 depict some of the structural features. The piles have been provided with portland slag cement (blast furnace slag cement) in order to reduce the heat of hydration and better resistance to chemical attack. Part replacement of OPC with blast furnace slag leads to conservation of resources and utilization of factory waste, resulting into sustainable construction.

Fig. 19: Model of Mukerba Chowk Traffic Interchange

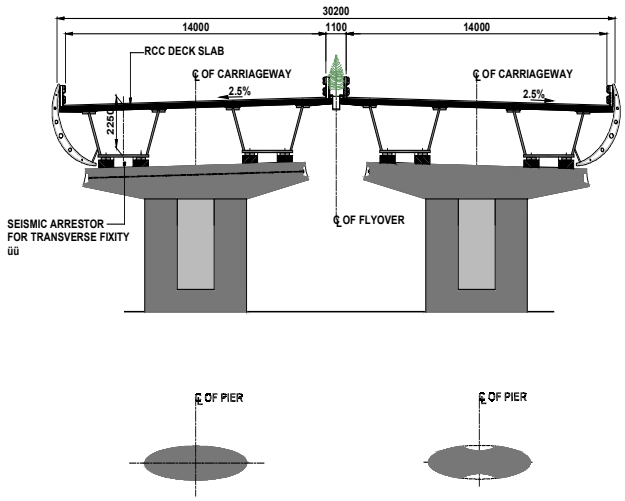

Fig. 20: Composite Steel Box Girder for Main Flyover

Fig. 21: Main Flyover

The project planning had to surmount several difficulties of accommodating nearby ground features. These include an archaeological monument, a burial ground, a major electric sub-station of 11KV and 33KV, garbage landfill site and a city waste drain running parallel to the main flyover, Fig. 22 for these features. At the burial ground, the pile foundation were provided in a way to escape the existing graves. At the location of electric sub-station, the superstructure had to be maintained at a safe distance, especially during construction. The pile foundations in the city drain were provided with permanent liner for protection against harmful chemicals. And the excavation for pile cap was assisted through sheet piling and suitable shoring. At the location of garbage landfill, the landfill was provided with geogrid tension membrane for enhancing the tensile flexural capacity of the subgrade before constructing the road over it. Adjoining landfill was provided with tensile membrane and seedlings to grow grass, for aesthetics. This way, removal of the landfill could be avoided and yet a green strip could be created.

Fig. 22: Existing Features at Site

Architectural features of the project include a specially designed form of voided slab superstructure and camouflaging shape of piers for the integral structure of the Clover Leaves, Fig. 23. The railing and the lighting posts were specially designed to be aesthetically pleasing. The project has obtained a wide public appreciation.

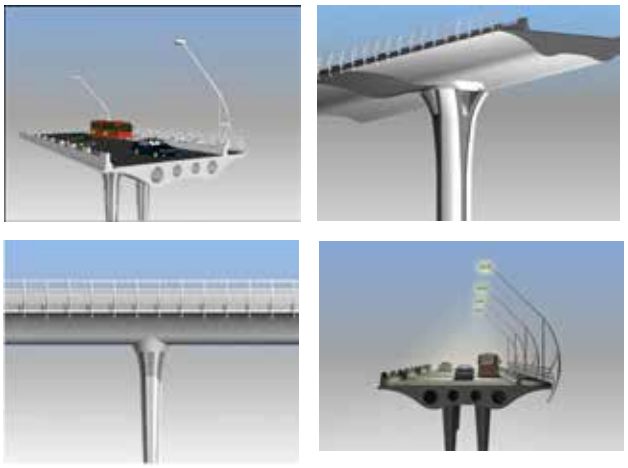

Fig. 23: Mukarba Chowk Architectural Views

USE OF SELF COMPACTING CONCRETE (SCC)

Where it is not feasible to achieve concrete compaction through needle vibrator due to narrow concrete section and/ or congested reinforcement, solution lies in incorporating SCC. Essentially, SCC incorporates larger percentage of fines and super-plasticisers. In order to maintain cohensivity of the mix, viscosity modifying agent (VMA) is added. As a result, we get slump/ spread of 600 mm plus, making it possible for the concrete to flow by itself and have self compacting properties.

In the project of Wazirabad Approches to the Signature Bridge in Delhi, comprising 4 span continuous precast segmental integrated modules have been provided with 600mm wide end piers with heavy reinforcement. All such piers incorporate SCC poured in single stage into the full height shuttering (Fig.24).

Fig. 24: Use of SCC in Wazirabad Approaches

TALL STRUCTURES SUCH AS CHIMNEYS

General

Pollution norms require chimneys of thermal power plants to be as high as 275 m, so that exiting gases get sufficiently diluted to keep the public living nearby, unharmed. Among the many types, multi-flue chimneys are more efficient, as they occupy lesser space and serve more number of boilers, simultaneously. Commonly used form incorporates steel flues (anywhere between 2 to 5 nos.) inside RCC shell. Easier said than done, design and construction of simple looking RCC chimneys has many complexities and difficulties to be surmounted. In most cases, wind load majorly governs the design, compared to seismic forces.

The RCC shell needs to be designed for along wind and across wind forces, which cause complex phenomena of ovalling etc. Presence of nearby chimney / tall structure causes an adverse effect of aerodynamic interference. This effect can pose a threat to an existing chimney by a nearby chimney constructed later. Slip-forming is a common technique of construction of chimneys but, it requires extreme care in execution. It may be worthwhile mentioning here that a bi-product of burning of coal is fly ash, which is produced in the process line between boiler and chimney. This fly ash is extracted using electrostatic precipitators, which incidentally can be used in blended cement and as mineral admixture in concrete. Use of flyash blending in cement has several advantages, such as reduced heat of hydration resulting into avoidance of early thermal cracks, enhanced chemical resistance leading to more durable concrete and importantly, utilization of a waste product.

Slipforming of Chimney Shell

Chimney shell is either constant in diameter or as is more common tapered. Construction is either done using slipforming (which is more common) or jump forms. Slipforming (most commonly used) is illustrated in Figs. 25, 26 & 27. slipforming requires placement of jack rods at 1.0m to 2.0m spacing along the shell to support and raise the shuttering and working platforms. The concreting in this case is a continuous process, without construction joints. During slipforming the projecting reinforcement dowels for corbels and platforms need to be tackled. A better solution is to provide reinforcement couplers at these locations, with internally threaded sleeves left inside the shell during slipforming. It becomes extremely important and challenging to maintain verticality and perfect round shape of circular chimney during the slipforming process. Tapered chimney poses additional challenge of successful taper and reduction of shell thickness.

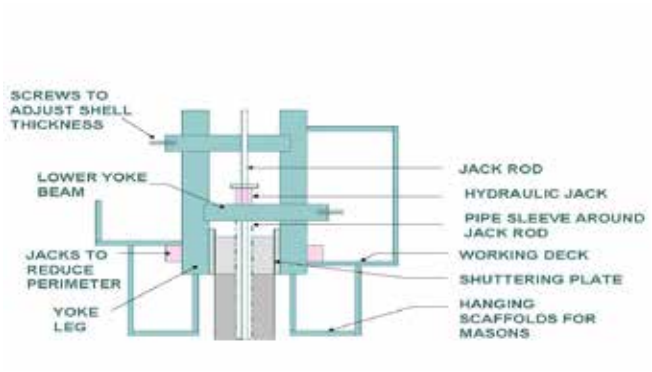

Fig.25: Slip Forming Equipment

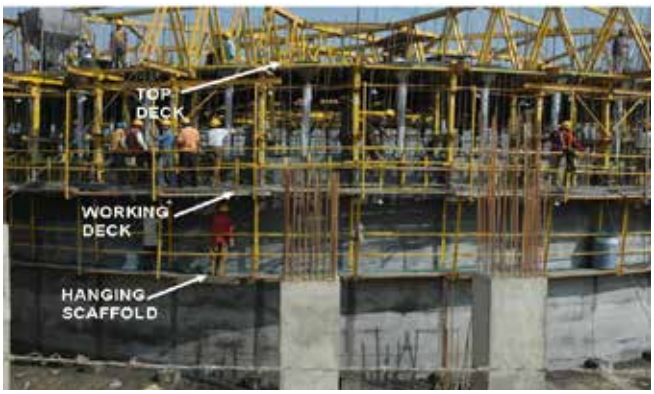

Fig. 26: Slip Forming in Progress

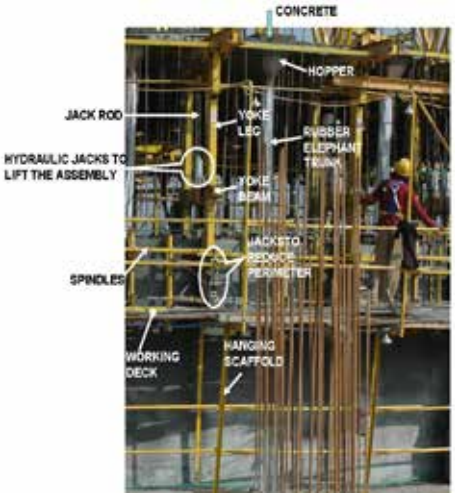

Fig. 27: Slip Forming Equipment

In the case of multi-flue chimney incorporating steel flues, flue erection needs to be planned in a careful manner because each flue segment is to be prefabricated and brought into position at ground level before being hoisted up. The hosting is carried out using strand jacks placed at the respective platform. Members of these platforms need to be strengthened to cater to the condition of

flue erection. Figs 28 & 29 for illustration.

Fig. 28: Flue Erection

Fig. 29: Strand Jacks for Lifting Flues

CONCLUSION

A constrained site requires careful planning to negotiate the existing features. Although removing the constraints may sound to be an easy solution, it is not always necessary to do so. Engineers have found ways and means to negotiate the ground features and yet make a structure that is economical, aesthetically pleasing and fast to construct. It is important to have an aesthetically pleasing structure, like the one in case of Khalsa Heritage Complex, Punjab, wherein large scale use of architectural fair-faced concrete employing blast furnace slag cement and resin coated plywood shuttering could produce an aesthetic structure. Use of pre-casting and pre-stressing in buildings produces fast, economical and sleek structure. These structures are durable and weather resistant. The solutions of using segment lifter in the case of Barapulla Nallah Viaduct, implanting seedlings over landfill site in Mukerba Chowk interchange etc are some of examples. On the whole, a carefully planned structure is bound to produce an efficient and sustainable structure.

PROMOTING URBAN ENVIRONMENT THROUGH ECO- CITIES

JIT KUMAR GUPTA*

Abstract

Cities, as conglomerate of people, population, buildings and activities, are known to be consumers of large amount of energy, variety of resources and generators of enormous waste. In the process, cities are known to be adversely impacting both local and global ecology and climate besides polluting environment. Studies made and analysis carried out, have distinctly shown that cities are responsible for consuming more than 75% of global energy and generating 70% of carbon footprints. Global warming and climate change can also be largely attributed to the way cities grow, operate and function. Studies have also revealed that cities, as consumers of energy and resources, have its genesis in the manner they are being planned and designed; pattern of growth and development which dictates the cities; way the majority of building are designed, constructed and operated besides the manner in which people are made to undergo long travel for meeting their basic needs and discharging their daily obligations. City planning process has also been found to be biased heavily towards land use planning with little focus and priority for protecting, preserving and promoting environment which has made cities highly polluted and environmentally degraded.

In order to make cities more livable, humane, sustainable and promoters of quality environment and ecology, it will be critical to have a relook at the way cities are planned and designed; rationalize the pattern adopted for designing buildings and the way people are made to move in cities. Paper defines a new order of planning and designing of cities with focus on environment; leveraging energy efficient and green buildings besides promoting green mobility.

INTRODUCTION

Cities as physical, economic and social system in space involving large concentration of population and activities; centers of trade and commerce, economy and polity; offering great opportunities for gainful employment; providing state of art services, amenities, physical and social infrastructure; large consumer markets and highly trained workforce, represent most viable, vibrant, happening and suitable places with significant, social and economic achievements. As engines of economic growth, cities contribute disproportionately to economic growth and social transportation by providing economy of scale and proximity that allows industry, trade and commerce to flourish. They are also known to be centers of excellence and innovations offering optimum location for services and facilities, which require large population threshold and markets for its operational efficiency. Despite housing large population at higher densities, cities are known to offer opportunities and quality of life better than its rural counterparts. U N Report on, 'State of World Cities', states that, 'Cities are where human beings find satisfaction of basic needs and essential public goods, where various products can be found in sufficiency and their utility enjoyed. Cities are also where ambitions, aspirations and other intangible aspects of life are realized, providing contentment and happiness and increasing the prospects of individual and collective well-being'.

Despite distinct advantages and critical role, emerging urban scenario is that of duality and contradictions, where slums and state-of-the-art buildings are rubbing shoulders; where poverty and prosperity compete ; where unplanned development has emerged as the order of the day; where informal sector dictates the growth and development and where basic amenities and services are eluding

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majority of urban residents. Cities in the Indian context continue to face problems of acute housing shortage and rapid uncontrolled growth, haphazard expansion with sub-standard infrastructure, inefficient traffic and transportation besides proliferation of informal sector, adversely impacting the quality of life and productivity in the process. Pollution and environment have emerged as the major issues and greatest threat to the urban dynamism. In addition, urban centers are fast emerging as large consumers of non-renewal resources and energy, adversely impacting the economy, environment, ecology and sustainability, both at local and global level besides generating enormous amount of waste which is grossly polluting water, air and land based necessities essential for human existence, growth and survival. This calls for looking ,critically and objectively, at the entire gammut of existing urban planning, development and management and putting in palce a new order to uleash the urban potential by eliminating and overcoming all existing road-blocks and effectively addressing the basic urban issues to create cities which are both harmonius and eclogically sustainable.

RE-INVENTING URBAN PLANNING

Urban planning, as a tool, has the capacity and potential to create environmentally sustainable urbanization, which can generate employment, promote economic growth, address urban poverty and reduce the ecological footprint of the urban settlements. Promoting planned development has amply demonstrated that good urban planning can lead to good urbanism and usher a new era of quality living and better community life. Studies carried out have shown that planned areas offer better quality of life and environment as compared to un- planned parcels. Chandigarh and Gandhinagar showcase best examples of the effectiveness of urban planning as determinant of quality environment/living. Appreciation of the importance of urban planning as a powerful tool to combat urban poverty, social inequality and negative environmental change has been increasing felt over the past few years. In Europe, urban planning is being given more and more importance considering its impact on social, environmental and economic sustainability. In many developing countries, lack of appropriate urban planning has been found to be one of the major causes for poverty creation and increasing exclusion of communities from the development process. Cities that develop chaotically see an increase in slums/crime, lack of basic public services and leave the door open to exploitation of the weakest. In developed countries, there is an increasing concern about the negative impact of resource-wasteful forms of city development on accelerating global climate change. Considering the critical role of environment and ecology, major cities of the developing world are beginning to address the issues of global warming and climate change through the mechanism of urban planning. However, It needs to be appreciated that present form and pattern of urban planning has not been able to meet effectively challenges of 21st century. It has done more damage than good to urban fabric by promoting urbanization of population, urbanization of poverty and urbanization of pollution besides manmade disasters. Planners need to revisit their planning tools, planning processes and planning options/ strategies in the changed context. They need to be made more innovative, effective and efficient in order to meet the emerging urban dynamism and challenges. In order to make urban planning supportive of environment and ecology, we have to look for innovative and better options and put in place a new planning order and regime, which is human centric and supportive of local/ global ecology and environment.

MASTER PLANS /DEVELOPMENT PLANS

Fig. 1: Master Plan

Master Plan, (Fig.1) as a tool, has been extensively used to usher an era of planned development; promote environment and ecology and redefine future growth pattern of the cities. But in practice, these plans have emerged as the major roadblocks in the planned growth and development of the cities for reasons of rigidity, requiring enormous time and resources for preparation/implementation; based purely on land use planning; ignoring people, communities and stakeholders; addressing merely physical issues etc. With considerable time taken for preparation and approvals, cities continue to grow in an illegal manner in the absence of these plans, with the result majority of Master Plan proposals become obsolete, outdated and accordingly non-implementable. Rigidly defined Land Use and Development Control Regulations often fall under public criticism, resulting in more violations than compliance. Agencies involved in planning are invariably far removed from ground realities, leading to formation of non-realistic proposals. Lack of technical and financial resources coupled with poor administrative capacity and dichotomy in planning has led to non-implementation of Master Plans. This calls for re-looking at the intent, content, approach and scope of Master plans for bringing more flexibility and making it people centric besides imparting required level of dynamism to meet the emerging needs of cities. These plans also need to be made user friendly and promoters rather than controllers of development. Master plans should not be based on merely land use planning to freeze the city for next twenty years. Instead of merely addressing physical issues, plans should also address and focus on issues of environment, ecology, poverty, economy, employment, energy, safety, global warming, mobility, land etc Mechanism of preparing the Master Plans should be made more simpler, faster, objective and transparent by involving technologies and large number of experts, to make it more rational and realistic beside involving local communities and stakeholders to create local ownership for ready acceptance and effective implementation. A new regime and order of planning and legal framework accordingly needs to be put in place for preparing better Master Plans to promote cities which are socially harmonious, environmentally sustainable, resource efficient and a role model of sustainable development. Such cities should be planned on a well defined planning and development matrix involving human scale, making available all infrastructure within walking distance, providing basic amenities of life even to the poorest of poor to lead a dignified life, bringing equity, integrating smart technologies with renewable energy and ensuring quality planned development.

GREEN BUILDINGS

Buildings have critical role in making the cities eco- friendly. No city can be made environmentally sustainable unless it is supported by energy/resource efficient built environment because buildings use over 40% global energy, 30% raw materials, 25% timber harvested, 16% fresh water withdrawal and generate 35% of CO2 emission, 40% municipal solid waste, 50% ozone depleting CFC besides making 30% residents sick. As per Mckinsey Global Institute Report, Urban India would require buildings to the tune of 700-900 million sqmts annually to meet the needs of built environment in urban centres . Buildings, being large consumers of energy and resources, are considered to have large impact on environment and ecology and are largely responsible for climate change and global warming. Thus building as a sector would require close scrutiny and monitoring for effecting overall economy in energy consumption and making cities environmentally sustainable.

Fig. 2: Green City

Buildings, as they are designed, constructed and used, have enormous energy implications. Experience has shown that buildings can be designed to meet the occupant's needs for thermal comfort at reduced level of energy consumption by adopting an integrated approach to building design involving efficient site planning; adopting appropriate shape and size of the building; innovative built form; sustainable building envelop; lower surface to volume ratio; high building efficiency; low ratio between length and depth of the building; efficient structural design; using solar passive techniques; using energy efficient equipment, control and operation strategies for lighting, heating, ventilation etc; using solar energy/air movement for meeting the energy / lighting/ ventilation needs of buildings; using low embodied and energy efficient materials made from waste/using local materials; using landscaping; promoting indoor air quality etc. Designing with nature and using natural elements of sun, wind and space would be most critical to create buildings which are not only more energy efficient but also environmentally sustainable. However, requirements of building design would vary from region to region, state to state and within regions and states. Accordingly, buildings with regard to sun, wind and topography will have to be oriented differently in different regions. In order to ensure that buildings make best use of solar and wind energy, it would be essential that majority of buildings should have the best orientation and site advantage. Accordingly, role of Town Planners will be important for ensuring that layout plans are evolved giving due consideration to orientation so that maximum number of plots have best orientation. Once this is ensured, it would be much easier for the architects to evolve an environmentally responsive and energy efficient design. Further, ratio of width and depth should be fixed in such a manner that entire built up area should have access to natural day light, minimizing requirement of artificial lighting. This would be particularly important in case of row housing where plots have limited option of drawing light from front and rear only. Professional bodies, academic institutions and state governments can join hand with promoters, colonizers and builders associations etc. to create awareness about the energy implications of buildings/materials in construction and operation. In fact it must be made mandatory that each architect should also clearly specify like structural safety that building is energy efficient, I.T. can effectively contribute by evolving appropriate softwares for assessing the energy implications of each building at the time of evaluating design which architects can effectively use in modulating/amending their design to bring it within the specified norms of energy/water for buildings. Specialized training programs/ short term courses must be run for creating awareness and capacity building among architects/engineers for ensuring that buildings have required professional input of making them energy efficient and green. Study curricula must be appropriately redefined to include designing/planning energy efficient built environment as integral part of professional education and professional practice.

GREENING CITY

Fig. 3: Greening City

Landscape has enormous capacity of modulating day temperature, heat island, humidity, purifying air and heat emissions from buildings etc for balancing temperature besides managing water resources. A single tree is said to transpire 450 liters of moisture on daily basis, equivalent to 5 room sized air conditioners working for 19 hours. A mature Beech tree has 80,000 leaves with each leave acting as a small organic filter. Canopy of a tree makes up a surface area of 10-12 times greater than area of the ground they shade. Trees have enormous capacity

to improve the quality of environment. A tree can filter 20 kg SO2 a year without causing harm to itself besides producing oxygen sufficient to cater to the needs of 10 people. A tree lined street can filter up to 80% of pollutants, reduces noise level up to 12 db and lowering of temperature up to 3.5%. Accordingly trees can play important role in creating Eco- cities. Promoting extensive landscaping, massive plantation and creating city forests can be effectively used for lowering the overall temperature and to bring climate within comfort zone leading to considerable reduction in energy expenditure besides reducing air pollution and improving quality of air. Shading of buildings through vegetation, using trees and shrubs as barriers to direct solar radiation can help in reduction in energy demand in buildings. Trees can effectively and efficiently modulate the area faced with adverse climatic conditions and solar radiation, minimize air related disasters, check soil erosion, improving water table and minimize flooding in urban areas. It can shade buildings during summer and heating interiors by solar radiations in winter, using deciduous trees. Green roofs and green walls are now being used extensively to create sustainable and energy efficient buildings. Choice of trees for greening, landscaping and shading will have to be made carefully and thoughtfully, based on detailed study and analysis of climatic conditions and available quality of soil. Exotic varieties will have to be avoided and locally available flora and fauna to be given highest priority for making landscape supportive of environment. Water requirement of selected varieties has to be minimal to make the entire system water efficient. Considering the distinct and long term advantages of trees, shrubs etc, mechanism of greening buildings/ cities should be extensively used to make cities highly energy efficient. For making cities green, adequate open spaces must be provided and developed in master plans on well defined norms. Eco- city Tianjin has been planned on the norm of open space @12 sqm for each resident,

GREEN MOBILITY

Traffic and travel are the two worst gifts of urbanisation. With expanding cities, travel demands have gone up considerably. Cities are known to contribute 70% of global green house gas emissions, with majority of contribution coming from transportation and buildings. With traditional fuels, transportation sector alone contributes 30% of total carbon emissions. Challenges posed by transportation sector accordingly remain daunting and formidable in creating eco-cities and improving urban environment. Promoting sustainable urban transport will be the best option to make cities cleaner and greener. This would require change of approach to transport 'from planning for vehicles to planning for people'. This would require re-ordering/ re-defining priorities of travel and transportation with first priority going to pedestrianisation then to cycling and public transport with least priority going to personal transport. Sustainable transport would essentially revolve around minimizing use of personalized vehicles; promoting non- mechanized/ non-fuel based options for travel; promoting public transport with large capacity run essentials on non-polluting fuels /electricity; making vehicles zero-emission; making cities more compact by adopting high rise high density pattern of development, adopting city shapes promoting minimum travel; promoting transit oriented development; promoting mixed land use rather than pure land use planning; creating user friendly infrastructure to promote pedestrianisation/cycling; road pricing; proportionate allocation of road space and using information technologies to rationalize the travel pattern

Fig.4: Sustainable Transport

CONCLUSION

The way cities use land, consume energy, gobble resources and impact the quality of life and environment, they are fast emerging as ecological

disasters. Uncontrolled and haphazard growth devours land, water and energy from the surrounding landscape. The emerging contemporary patterns of settlements have created cities which have high level of consumptions of energy due to auto dependence; high energy demand for buildings; water pollution from excessive toxic run off; air pollution and other environmental effects which considerably lowers down quality of life. World life habitats have become extinct; native species are replaced by consumptive exotics; streams are canalized, piped and buried; wetlands are filled and aquifers depleted. Urban heat islands drive up energy demand used for cooling besides trapping pollutants in the city. All these problems, collectively and individually, have the ability to adversely impact the local ecology, environment and sustainability. Accordingly, local ecological systems are rapidly losing their ability to produce clean water, air and food and to maintain rich variety of habitat. In short, they are fast losing their ability to sustain life. Each of these environmental problems has its genesis in the planning, designing and operation of cities, settlement patterns and urban spatial fabric. To minimize energy/resource consumption and ecological/environmental disasters caused by today's Grey Cities, we have to change our perception, understanding, philosophy, approach and strategy to learn to think ecologically to create Green and Eco- Cities by planning with people and nature involving sun, space and greenery

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GREEN ARCHITECTURE : A CONCEPT OF SUSTAINABILITY

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Abstract

In recent years, sustainability concept has become the common interest of numerous disciplines. The reason for this popularity is to perform the sustainable development. Sustainability has become an integral aspect of contemporary architectural design. As climate change becomes an increasingly pressing concern, so too does the need to create sustainable buildings that offer minimal environmental impact and maximum human comfort. The Concept of Green Architecture, also known as "sustainable architecture" or "green building," is the theory, science and style of buildings designed and constructed in accordance with environmentally friendly principles. Green architecture strives to minimize the number of resources consumed in the building's construction, use and operation, as well as curtailing the harm done to the environment through the emission, pollution and waste of its components. Sustainable considerations such as energy efficiency and water management are now regulated under national and state building codes, allowing today's architects to conserve resources and materials and construct dwellings that work with their natural surroundings rather than against them.

To design, construct, operate and maintain buildings energy, water and new materials are utilized as well as amounts of waste causing negative effects to health and environment is generated. In order to limit these effects and design environmentally sound and resource efficient buildings; "green building systems" must be introduced, clarified, understood and practiced. This paper aims at highlighting these difficult and complex issues of sustainability which encompass the scope of almost every aspect of human life.

INTRODUCTION

The concept of Sustainability has been misunderstood today. Acceptance of this new concept by the people has not really been satisfactory. People are reluctant to compromise the kind of lifestyle they live. This compromises the aim of achieving sustainability. Green buildings, improved sustainability, economy for all and thereby better future is an important issue that needs thought. Reducing energy consumption in a building is not enough. Many dimensions need to be considered to achieve sustainability like-transportation networks, environmental management etc.

Fig. 1: Solar Towers Utilize the Natural Resource of the Sun

The concept of sustainability is brought up for

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the betterment of human species and not for the earth. The Earth can survive without humans. Sustainability is for us to survive on earth. Architects all over the world have been focusing on the concept of sustainability. There has been a lot of chaos and confusion in actually understanding the gist of this unusual concept.

The definition of Sustainable Development is based on two concepts:

- The concept of needs, comprising of the conditions for maintaining an acceptable life standard for all people, and
- The concept of limits of the capacity of the environment to fulfill the needs of the present and the future, determined by the state of technology and social organization.

These are the two major concepts that the Architects have to keep in mind while executing any design concept which speaks of sustainability.

ARCHITECTURE AND SUSTAINABILITY FACTORS

Sustainability presents itself as a unique challenge in the field of architecture. Construction projects, typically consume large amounts of materials, produce tons of waste, and often involve weighing the preservation of buildings that have historical significance against the desire for the development of newer, more modern designs.

Sustainable construction is defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles". Sustainably designed buildings aim to lessen their impact on our environment through energy and resource efficiency.

Modern Concepts aiming at Sustainability should include the following principles:

- Minimizing non-renewable resource consumption
- Enhancing the natural environment
- Eliminating or minimizing the use of toxic materials

"Sustainable buildings" can be defined as those buildings that have minimum adverse effects on the built and natural environments, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting. Thus, the rational use of natural resources and appropriate management of the building stock will contribute to saving scarce resources reducing energy consumption and improving environmental quality.

SUSTAINABLE ARCHITECTURE IN THE 21ST CENTURY

Many cities around the world are experiencing intense, even explosive growth that often poses a significant threat to the natural environment. The skyscrapers and other "mega structures" that are commonly built to accommodate such growth consume enormous amounts of energy in their construction and day-to-day use, place great burdens on water and sewer systems, and typically isolate occupants from natural light and air.

Nonetheless, many architects, engineers, and planners believe that large, densely-packed urban buildings, when properly designed and constructed, represent an inherently "sustainable," or "green," form of development. That is, they can actually minimize negative impacts on the environment while protecting the health and well-being of their occupants. To achieve these goals, building professionals are increasingly resurrecting strategies that were routinely employed in smaller structures in the past - such as natural ventilation and shading devices to reduce heat gain - and adapting them to larger and more complex buildings. Meanwhile, they are exploiting new technologies, from solar power cells to sophisticated wind turbines, to create a new breed of large-scale buildings that are both comfortable and environmentally benign.

Sustainable Architecture in the 21st Century explores five categories of issues that design and building professionals are addressing in order to

reduce the deleterious environmental impact of skyscrapers and other mega structures: energy, light and air, greenery, water and waste, construction, and urbanism. The thoughtful design and careful management of the construction process, even the largest structures can further the cause of a more harmonious integration of the built and natural environments.

Architecture Unplugged: Energy

The profligate consumption of fossil fuels is one of our biggest environmental problems today. The insatiable demand for fossil fuels results in air pollution, water pollution (due to oil spills), and often. We may think of cars and factories as the most obvious enemies of the environment, but buildings consume more than half the energy used worldwide. Mechanical networks that supply air-conditioning, heating, lighting, and other building systems are now being redesigned to consume less energy, while alternate sources of energy are also being developed. As more and more communities are offering building owners the opportunity to purchase energy made from renewable or clean sources like the sun and wind, many architects are now designing buildings that generate their own energy (Fig.1).

Buildings that Breathe: Light and Air

Before the development of efficient artificial lighting, heating, and cooling systems in the 20th century, access to fresh air and daylight was a primary determinant of building form. In the last fifty years buildings have increasingly relied on mechanical systems for their light and air. Some contemporary architects, however, are once again promoting the importance of natural systems. They are designing large-scale buildings illuminated by the sun and naturally ventilated with double-skin windows that let in air but keep out noise and heat. Strategies for natural ventilation and illumination are now becoming more widely accepted as architects and engineers develop advanced techniques for providing natural air-conditioning in buildings of unprecedented size in the hottest of climates, as well as reviving older, forgotten strategies.

We Can Rebuild It: Construction

The materials used to construct large-scale buildings, concrete, steel, wood, plastics-all create environmental problems because of the energy used to fabricate them, the toxic chemicals that make them attractive, waterproof, or fireproof, and the energy needed to transport them. Some architects and engineers concerned with environmental sensitivity are now employing a variety of strategies to limit the environmental impact of building construction. Among these solutions is the reuse of existing buildings through adaptive reuse, which is a form of recycling on an architectural scale. For new construction, architects can better control the use of materials and reduce waste by utilizing materials that require little energy to produce and ship, are renewable, modular and prefabricated.

Green Giants: Greenery, Water and Waste

Greenery inside and outside of buildings is a crucial part of the cycle of water consumption and waste. Understanding this relationship is important, as architects attempt to curb water consumption, reduce waste water, and use natural plant materials to mitigate the impact buildings have on their surroundings. Large buildings can consume millions of gallons of water a day, while during a single rain storm millions of gallons can be lost, as untreated water runs off into sewers or the ground. Engineers and architects are now collaborating to develop ways of using this run-off as undrinkable “gray” water in sinks and toilets. Greenery cleans our air by converting carbon dioxide into oxygen, and cleans our water by filtering run-off water before it is released into the surrounding environment.

WHAT WE CAN CHANGE?

Ensuring an appropriate level of useful environment in the current urban environment today is a significant problem. Despite the development of science and technology, many elements of the environment are an urban problem today. To achieve this goal it is necessary to develop an awareness of not only the individual, but the entire society. Economics as one of the key factors should

determine priorities, the importance of projects that are invested and thus result. I think that knowledge of one key problem is important for further decision. Therefore, if we are aware, for example, the current state of energy availability in the world we should find a way to improve it. The problem arises because of not developed awareness for the benefit of mankind. The investor is willing to invest in a building of several thousand square meters, regardless of its architectural and social value, considering it will brings him a profit. Nevertheless, sustainable architecture and sustainable resources are completely ignored, because it might be unprofitable in a given time.

Energy efficiency is important as a essential for the survival of human society. In the future humanity should be significantly turn to the use of alternative (imperative) energy sources. Knowledge of markets, development needs and potential as a whole, established investigation strategies and strategies of industrial development, are essential in order to identify desirable investors who want a clear insight into the situation and potential of each sector, to invest in what interests them. In the cities of earlier epochs environmental problems were mostly related to the lack of proper infrastructure, underdeveloped hygienic level, overpopulation, over construction and others. Nowadays, problems related to the state of the environment are much more numerous and reaching to the very complex problems of technical nature and psychology of urban living . In order to enable further progress of the human population, it is necessary the adoption and implementation of sustainable development. The basic idea of sustainable development is meeting the needs of present generations, without compromising the possibilities for future generations to meet their own needs. Sustainable cities allow the architecture to transform itself, not to be traditional but useful, innovative and economical.

Sustainable development is based on protection, so it is conditioned by the need to upholding the concept of nature in order to provide the resources and services necessary for life. From this perspective, sustainable development means improving the quality of human life within the limits of the capacity of the submission of ecosystems that support it '. This definition of sustainable development is a normative concept that includes a standard of behavior that should be respected if the human community tends towards satisfying their own needs of survival and well-being. The definition includes three basic components, namely: economic, social and component of environmental protection, which form the basis of sustainable development. All three components are mutually linked and interdependent, and therefore require that everything is being done in the field of development is in line with each of them separately. When it comes to urban sustainability, it must be borne in mind that cities have never been self-sustaining through history, and that they probably never will be in the true sense of the word. The city, as a man's environment, had to meet its biological, environmental, social, economic, aesthetic and other requirements and needs that have evolved with the development of civilization. In addition, cities are 'producers' external influences on the environment, both positive and negative. How is the growing awareness of aspects of environmental pollution associated with urban living and quality of life in cities, increasingly provoking questions about the relationship of the positive to the negative impact and proof that this relationship is disrupted. As a result, more attentiveness to the capacity of the submission of a sustainable city overall area needed a system that would support life in the city, through the production of goods, resources and acceptance of waste materials from the city often called ecological rate city. It can be concluded that sustainable urban development can only be achieved if the system is established renewing his energy, human, environmental and technological potential.

Cities today are not only a reflection of the society within which the finding they are more a reflection of society is global. Or how Mumford wrote in 1961 in his book " The city in history ": " ... slowly we went from being a city that symbolizes the world, to the world that in many practical aspects of becoming a global city '. It can be argued that each generation has the right to regulate their environment according to their needs and capabilities, however there is also a parallel obligation of this generation

to their successors, in the coming generations, leave enriched, and not wrecked space. The city is one of the artificial creation and its sustainable development in terms of ecological balance can be achieved only if all urban processes are controlled and synchronized with the laws of the natural environment. To achieve the goals of sustainable development, it is necessary to understand that cities play a significant role in this process. As a example we can take the development of Dubai. Economics allowed expansion and development of the city. The city has in recent years significantly progressed, we cannot omit the worldwide economic crisis, which did not avoid this town, but good economic organization allowed the continuation of his progress, urbanization, and lately concept of green architecture. Projects are based on principles of lesser energy and water consumption.

Fig.2: Sustainable Landscape

To answer the question of what is a sustainable city, it is necessary to see sustainability in the wider context. It means that one should not only look and talk about the environment in the city, but also to take into account the role that the city has in a broader context. To achieve this goal should be to act as a company which has developed awareness about their future. The model sustainable city, besides it's strictly defined physical boundaries, reflecting the social and matrix of the city. This model is manifested through a myriad of different forms, depending on the historical heritage, culture, economic base, climatic, geographic and geopolitical characteristics, to all these forms at the end reduced to only a few variables that determine it. Sustainable city is no "recipe" behavior towards sustainability, but should have defined the elements of measurement achieved. The city can only be considered sustainable if its governing structure the entire planet is seen as unique. Cities should be considered for places that serve its attractiveness as drivers of economic development in terms of creativity, innovation and the creation and sharing of knowledge, the stimulation of proactive innovation and educational policies, on sustainable construction, architecture and urban space use, the high development of the local economy, the exploitation of the architectural values, historical heritage buildings and public spaces through the development and reconstruction of the urban landscape (Fig.2). Cities need to set the positive principles of urban spatial development, which will be based on: balanced economic growth and territorial organized activities, with a polycentric urban structure, strong metropolitan region that can provide services of general economic interest, compact structure of settlements with limited urban sprawl, a high level of environmental protection and quality of life in the city and surrounding areas. Sustainable cities must have attractive open public spaces and promote sustainable, inclusive and healthy mobility in a way that cycling and hiking trails that are attractive, and public transport favored. Increased energy efficiency in buildings reduces the economic and energy vulnerability, and associated innovations, technologies and services in the building and energy are important drivers of local development. Common approach to solving the problem of exclusion, the energy poverty and better housing conditions come to the key elements of development of the city so that the city becomes more beautiful and lively, but also more competitive and eco-friendly. Building "green and healthy" cities goes beyond simply reducing CO2 emissions.

CONCLUSION

The question is whether this problem can be solved on a global level in view of the disparities between the countries in the world have never been more obvious. How to awaken man's awareness of the efficiency of energy resources and the value of what we have to do. Why not let the natural functions, existing natural techniques to be used for greater efficiency. Every place in the world has ups and downs, problems to be solved but the problem lies in spreading the incentives of these functions. To

address this, man should have knowledge of urban development, urban environment, environmental problems and social and intellectual norms in society variable financial and political parameters. The large number of complex parameters are needed knowledge, patience, perseverance and wisdom in all of us.

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FIBRE – REINFORCED CONCRETE USING PLASTIC AS FIBRE

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Abstract

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lend varying properties to the concrete.

The addition of steel fibre increases the properties of concrete, viz, flexural strength, impact strength and shrinkage properties to name a few. A number of papers have already been published on the use of steel fibres in concrete and a considerable amount of research has been directed towards studying the various properties of concrete as well as reinforced concrete due to the addition of steel fibres.

Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and/or thrown over land area. If not recycled, their present disposal is either by land filling or by incineration. Both the processes have certain impact on the environment. Under this circumstance, an alternate use for the waste plastics is also the needed. The use of plastics in various places as packing materials and the products such as bottles, polythene sheets, containers, packing strips etc., are increasing day by day. This results in production of plastic wastes from all sorts of livings from industrial manufacturers to domestic users. To circumvent this pollution crisis, many products are being produced from reusable waste plastics.

On the other side, the Indian construction industry is facing problems due to insufficient and unavailability of construction materials. So, we need to search for new construction materials as well as a method to dispose the plastic waste. To find a solution to the above problems, one of them can be used to solve the other. In this experimental study, an attempt has been made to use the waste plastics in concrete and studies have been conducted to focus particularly on the behavior of compression members with various proportions of plastic wastes. The plastic used in this investigation is obtained from the disposal plastic bottles. The above plastic waste is mixed with cement concrete in various proportions (0.5% to 2%) and test specimens were cast to study the behavior of plastic mixed concrete.

INTRODUCTION

Concrete is a versatile material for civil engineering construction. It has many advantageous properties such as good compressive strength, durability, specific gravity and fire resistance. It has some bitter properties, like - low tensile strength, brittleness, lower impact strength, heavy weight, etc. Still concrete is better option than any other available materials for civil engineering constructions. Some of the properties can be enhanced by adding fibers with another ingredients of the concrete. The fibers inclusion in concrete acts as unwanted micro crack arrester. In presence of fibers the crack prorogation is delayed which helps in improvement in static and dynamic properties of concrete.

The consumption of plastic has grown substantially all over the world; it leads to create large quantities of plastic-based waste. Plastic waste is the one of the challenge to dispose and manage as it is non biodegradable material which is harmful to our beautiful environment. The polyethylene teraphthelne (PET) bottles are recycled and used for different purposes.

Further research to evaluate the use of plastic waste in concrete production is therefore required. This is the background of our present study. The waste polyethylene terephthelne (PET) bottles were converted into fibers (Fig.1) and added

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in concrete as an additional ingredient of concrete. The cube and cylinder compressive strength of conventional and plastic fiber reinforced concrete were determined. The results are then analyzed and compared.

Fig.1: Plastic Fibres

LITERATURE REVIEW

A comprehensive review of the work carried out by various researchers in the field of using recycled plastics in concrete is discussed below.

Dora Foti, 2011: experimented on fiber-reinforced concrete; the improvements in ductility of the concrete were reported. R. N. Nibudey et al., 2013: optimized the benefits of using post consumed waste PET bottles in the fiber form in concrete. The concrete of m30grade with two aspect ratios 30 and 50 of waste plastic fibers were experimented to determine green and harden properties concrete. It was observed that slump, compaction factor and dry density of concrete reduces as compared to normal concrete when fiber content increases and reduction in these values found higher for larger value of aspect ratio. It was observed from test results of compressive, split tensile and flexure test that at 1% of fiber content improvement in strengths was higher for aspect ratio 50 than aspect ratio 30.

The past research encourage that the recycled plastics can be use in concrete for improving its property. The use of plastics in fiber form has given better results than granule forms. The aim of this paper is to explore the possibility of using a waste material like used mineral water bottles in concrete and compare cube and cylinders compressive strengths.

TESTS ON MATERIALS

Materials

- **Cement:** Cement is a binding material invented by Joseph Aspdin in 1824. It is manufactured from calcareous materials, such as limestone or chalk, and argillaceous material such as shale and clay.

- **Coarse Aggregate:** If the size of aggregate is bigger than 4.75 mm, then the aggregate is considered as coarse aggregate eg. Stone, ballast, gravel, brick ballast.

- **Fine Aggregate:** According to IS 383, most of the aggregate which will pass through 4.75 mm IS sieve and entirely retained on 75 μ sieve is considered as fine aggregate eg: Sand crushed stone, ash or cinder and surkhi.

- **Water:** Water is the main ingredient used to mix all the contents. Potable water is used as usage of any other water may contain salts and cause decrease in strength of concrete.

- **Plastic:** A synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be moulded into shape while soft, and then set into a rigid or slightly elastic form.

TESTS ON CEMENT

- **Normal Consistency of Cement**

The standard consistency of a cement paste is defined as percentage water which will permit the vicat plunger having 10mm diameter and 50mm long to penetrate to a depth of 5 to 7 mm from the bottom of the vicat mould or 33-35mm from the top of the mould.

Fig. 2: Standard Consistency

- **Initial and Final Setting Time of Cement**

The time interval for which the cement products remain in plastic condition is known as the setting time. Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain pressure.

- **Fineness of Cement**

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat.

- **Specific Gravity of Cement**

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water at a specified temperature.

Fig. 3: Specific Gravity Bottle

Formula = {(W2-W1) [(W2- W1)- (W3-W4)] X 0.8

- **Compressive Strength of Cement**

Compressive strength or compression strength is the capacity of a material or

structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate.

- **Soundness of Cement**

Soundness of cement is the property by virtue of which the cement does not undergo any appreciable expansion (or change in volume) after it has set, thus eliminating any chances of disrupting the mortar or concrete

Fig. 4: Vibrator and Compression Strength Mould

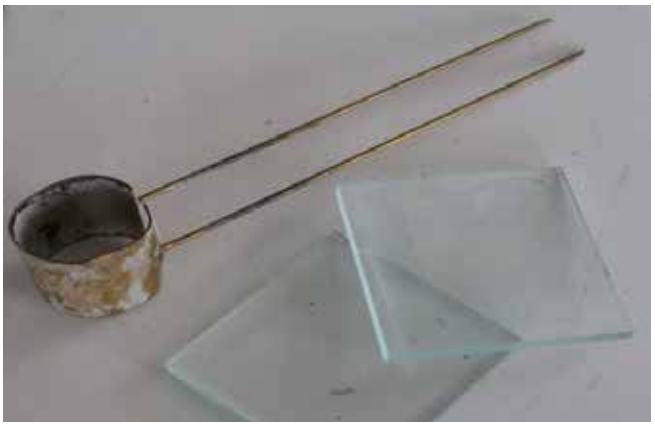


Fig.5: Le-chatlier Apparatus

Table 1: Test Report of Cement

TESTS ON CEMENT	VALUES
Standard consistency	34%
Initial setting time	30 Min
Final stetting time	8 hours
Fineness modulus	2.5%
Compression strength	52.5MPa
Soundness	2mm
Specific gravity	3.14

Tests on Aggregates

Aggregates typically make up 70-80% of the volume of Portland cement concretes and over 90% of asphalt concretes. Thus, their properties play important roles in determining the properties of the composite materials in which they are to be used.

- **Fineness Modulus of Sand**

Fineness modulus is only a numerical index of fineness, giving some idea about, the mean size of the particles in the entire body of concrete. Determination of fineness modulus is considered as a method of standardization of grading of aggregates i.e. the main object of finding fineness modulus is to grade the given aggregate for the most economical mix and workability with minimum quantity of cement.

Fig.6: Set of Sieves with Sieves Shaker

Table 2: Grading of Fine Aggregates

Sieve Size	Weight retained (gm)	% weight retained	Sum of Cum ulative % retai ned	Per centage finer
4.75mm	2.5	0.25	0.25	99.75
2.36mm	23.5	2.35	2.6	97.4
1.18mm	239	23.9	26.5	73.5
600µm	134.5	13.45	39.95	60.5
425µm	139.5	13.95	53.9	46.1
300µm	101.5	10.15	64.05	35.95
150µm	77.5	7.75	71.8	28.2
75 µm	146	14.6	86.4	13.6
Empty pan	135	13.5	99.9	0.1
Total	**999**		**445.35**	

- **Specific Gravity of Aggregate:**

  Specific gravity is the weight of aggregate relative to the weight of equal volume of water. The specific gravity of an aggregate is generally required for calculations in connection with cement concrete design work for determination of moisture content and for the calculations of volume yield of concrete.

Fig.7: Specific Gravity Bottle for Aggregates

- **Bulk Density:**

  The bulk density of an aggregate is used for judging its quality by comparison with normal density for that type of aggregate.

- **Water Absorption and moisture:**

  The main objective of this test is to determine the water absorption of the aggregates such as sand, gravel and recycled aggregate.

Test Results for Materials

Test Conducted on Materials	Coarse Aggregate	Fine Aggregate
Specific Gravity	2.6	2.72
Bulk Density	1.60 gm/cc	1.656gm/cc
Fineness Modulus	3.07	6.73
Moisture Content	0%	0%

CONCRETE MIX DESIGN

Concrete mix design is the method of correct proportioning of ingredients of concrete, in order to optimize the above properties of concrete as per site requirements.

Mix Design is carried out in B.I.S Method (Bureau of Indian Standards)

As per IS:10262:2009(Revised)

MIX DESIGN

Taken M 35 Grade

- Type of cement (O.P.C) = 53 grade
- Size of coarse aggregate= 20mm

Step 1: Target mean strength for mix proportion: (Fck = Fck + K*S)

Here Fck = 35

K= Risk factor = 1.65

S = Standard deviation = 5 (IS:10262:2009)

Hence Fck = 35 + (1.65*5)

= 43.25 N/mm^2

Step 2: Selection of water content:

Maximum water content = 186 liters (it is selected based on size of aggregate)

Step 3: Corrected water content:

Maximum water content for 50mm slump is 186 liters

If 3% of water is added then 25mm slump will increase

Now assuming slump as 75mm, then

W= 186+(186*(3/100))

W=191.58 liters

Step 4: Calculations for cement content:

W/C= 0.42

Hence W/C= Water Cement ratio

191.58/C = 0.42

Cement = 457 kg/m^3

Step 5: Determination of aggregates:

From (Table 3 IS 10262: 2009) zone 2 and coarse aggregate (20mm) at W/C ratio 0.5 Volume of coarse aggregate= 0.62 m^3

Corrected Volume = 0.01/0.05*0.08= 0.016

(0.5-0.42=0.08)=0.6 + 0.016

Coarse aggregate = 0.0636 m^3

Fine aggregate = 1-0.636=0.364 m^3

Calculations

- Volume of Concrete= 1 m^3
- Absolute volume of cement = (C/S.P gravity of cement) * (1/1000)

  = (457 /3.15)* (1/1000) = 0.145 m^3
- Volume of water = (W/1000) = 191.58/1000

  = 0.19158 m^3
- Volume of materials = Absolute volume of cement+ volume of water

  = 0.145 + 0.1915

  = 0.33658 m^3
- Absolute total aggregate = 1- 0.3365 = 0.66342 m^3
- Weight of coarse aggregate:
- (Absolute total aggregate* volume of C.A * S.P gravity of C.A* 1000)

  = 0.66342 * 0.636* 2.72 * 1000

  Coarse aggregate = 1147 kg/m^3

- Weight of Fine aggregate :
- (Absolute total aggregate * Volume of F.A * S.P gravity of F. A * 1000)

  = 0.66342 * 0.364 * 2.6 * 1000

  Fine aggregate = 627.86 kg/m^3

- Total Density :
- (Weight of cement + weight of water + weight of C.A + Weight of F.A)

  = 457 +192+1147.66+627.86

  Total Density = 2424.52 kg/m^3

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**
192 kg/m^3	457 kg/m^3	650 kg/m^3	1100 kg/ m^3

Mix Proportion Ratio:

Water: Cement: Fine aggregate: Course aggregate

0.42:1:1.42:2046

QUANTITY ESTIMATION FOR CASTING CUBES CYLINDERS AND BEAMS:

Standard mix at 0% of Plastic:-

Cement	Coarse aggregate	Fine aggregate	Water
408 kg/m^3	1143.21 kg/m^3	698.499 kg/m^3	191.58 kg/m^3

Quantity of Material Required For 6 Nos. of Cubes, Cylinders and Beams at 0% of Plastic:

The Volume of one Cube = 0.15 (length) x 0.15(breadth) x0.15 (depth)

= $3.375x10^{-3}$ m^3

We have to cast 6 cubes

= 6 x $3.375x10^{-3}$ m^3 = **0.020 m^3**

The volume of one Cylinder=(π/4) x depth2x height

= (π/4) x 0.15^2x 0.30 = $5.301x10^{-3}$

We have to cast 6 Cylinder = 6 x $5.301x10^{-3}$

= 0.031 m^3

The volume of one Beam = 0.50 * 0.10 * 0.10

= $5 * 10^{-3}$

We have to cast 6 beams = 6 x $5 * 10^{-3}$
= 5.301x10-3 **= 0.03 m^3**

1(A) Cement required for 6 cubes

= Volume of 6 cubes x weight of cement

= 0.020 x 457=**9.618 kgs**

1(B) Cement required for 6 Cylinders

= Volume of 6 Cylinders x weight of cement

= 0.301 x 457= **14.53kgs**

1(C) Cement required for 6 Beams

= Volume of 6 Beams x weight of cement

= 0.03 x 457= **13.71kgs**

2(A) Coarse aggregate required for 6 cubes

= Volume of 6 cubes x weight of Coarse aggregate

= 0.020 x 1100 = **22.27kgs**

2(B) Coarse aggregate required for 6 Cylinders

= Volume of 6 Cylinders x weight of coarse aggregate

= 0.031 x 1100= **34.98kgs**

2(C) Coarse aggregate required for 6 Beams

= Volume of 6 beams x weight of coarse aggregate

= 0.03 x 1100 = **33kgs**

3(A) Fine aggregate required for 6 cubes

= Volume of 6 cubes x weight of Fine aggregate

= 0.020 x 650 = **13.16 kgs**

3(B) Fine aggregate required for 6 Cylinders

= Volume of 6 Cylinders x weight of Fine aggregate

= 0.031 x 650 = **20.67kgs**

3(C) Fine aggregate required for 6 Beams

= Volume of 6 beams x weight of Fine aggregate

= 0.030 x 650 = **19.5kgs**

4(A) water required for 6 cubes

= Volume of 6 cubes x weight of water

= 0.020 x 192 = **3.88kgs**

4(B) water required for 6 Cylinders

= Volume of 6 Cylinders x weight of water

= 0.031 x 192 = **6.10kgs**

4(C) Water required for 6 Beams

= Volume of 6 beams x weight of water

= 0.030 x 192 = **5.76kgs**

Table 3: Material Required for 0% of Plastic

Name of the Material	Cubes	Cylinder	Beam	Total
Cement	9.618	14.53	13.71	37.858
Coarse Aggregate	22.27	34.98	33	90.25
Fine Aggregate	13.16	20.67	19.5	53.33
Water	3.88	6.10	5.76	15.74

Total Density for 0% Plastic :-

Total Density:-

(Weight of cement + Weight of Coarse Aggregate + Weight of Fine Aggregate + Weight of water)

= 457 + 1147.66 + 627.86 + 192

= 2424.52 kg/m^3

Quantity of Plastic Required For 6 Nos. of Cubes, Cylinders and Beams:

For 0.5 % of Plastic :

CUBES = 0.5/100 *3.375x10^{-3} *6*457 = 0.04627

CYLINDERS =0.5/100*5.301*10^{-3}*6*457 = 0.07267

BEAMS = 0.5/100*5*10^{-3}*6*457 = 0.06855

For 1 % of Plastic :

CUBES = 1/100 *3.375x10^{-3} *6*457 = 0.09254
CYLINDERS =1/100*5.301*10^{-3}*6*457 = 0.14535 BEAMS = 1/100*5*10^{-3}*6*457 = 0.1371

For 1.5 % of Plastic :

CUBES = 1.5/100 *3.375x10^{-3} *6*457 = 0.13881

CYLINDERS =1.5/100*5.301*10^{-3}*6*457

= 0.21803

BEAMS = 1.5/100*5*10^{-3}*6*457 = 0.2056

MIXING OF CONCRETE

Fig. 7: Cube and Cylinder Moulds

Fig. 8: Beam Mould

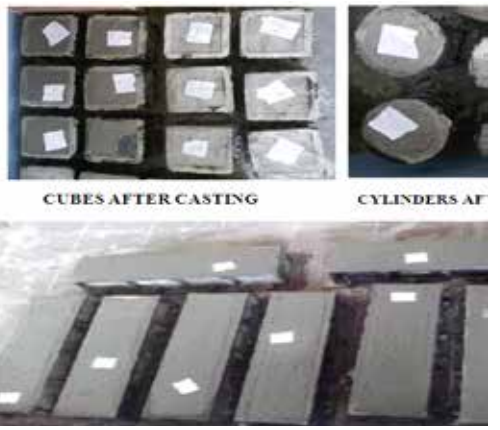


Fig. 9 :Casted Cubes, Cylinders and

Beams

Fig.10: Curing of cubes, Cylinders and Beams

EXPERIMENTAL METHODOLOGY

Tests on Fresh Concrete :

Workability Tests

- Slump Test: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete.

Fig-11 Apparatus to Determine the Workability of Concrete (Slump Test)

- **Compaction factor test:**

The compaction factor test is designed primarily for use in the laboratory. It is more precise and sensitive than the slump test and is mostly useful for very low workability concrete mixes.

Compaction Factor = weight of partially compacted concrete/weight of fully compacted concrete

Fig. 12: Apparatus for Compaction Factor Test

Tests on Hardened Concrete

- **Compression Test:**

The compression test is carried out on specimens cubical or cylindrical in shape. The cube specimen is of the size 150 150 150 mm. The test is conducted on Universal Testing Machine.

Fig. 13: Setup for Compression Test

- **Flexural Strength:**

Flexural strength is the measure of modulus of rupture.

Fig.14: Setup for Flexural Strength Test

TEST RESULT AND ANALYSIS

- **For 0% of Plastic Addition:**

The quantity of materials for 6 cubes casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water
9.618	13.6	22.27	3.88 lit

Compressive Strength of Cubes:

Addition of Plastic (0%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	700	31	962.0	43
Trail-2	728.5	32.3	970.2	43.5
Trail-3	787.0	34.9	980.3	44
Trail-4	738.5	32.73	970.83	43.5

The quantity of materials for 6 cylinder casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water
14.53	20.67	34.98	6.10 lit

Split Tensile Strength of Cylinders:

Addition of Plastic (0%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	203	11	234.6	13.2
Trail-2	201.8	10.7	240.2	13.5
Trail-3	201.2	10.5	242.6	13.7
Trail-4	202	10.7	242.13	13.46

The quantity of materials for 6 Beams casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water
13.71	19.5	33	5.76 lit

Flexural Strength of Beams

Addition of Plastic (0%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	14	9.05	22	9.9
Trail-2	17	9.65	20	9.69
Trail-3	13	8.55	22	9.9
Trail-4	14.66	9.08	21.33	9.8

- **For 0.5% of Plastic Addition:**

The quantity of materials for 6 cubes casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
9.618	13.16	22.27	3.88 lit	0.0771

Compressive strength of cubes

Addition of Plastic (0.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	785.2	34.5	995.6	45.2
Trail-2	803.4	36.8	1100.7	48.9
Trail-3	802.5	36.5	1022.8	46.3
Trail-4	797.03	35.93	1039.7	46.8

The quantity of materials for 6 cylinder casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
14.53	20.67	34.98	6.10 lit	0.0847

Split Tensile Strength of Cylinders

Addition of Plastic (0.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	207.5	11	254	14.3
Trail-2	208.2	11.5	250	14.25
Trail-3	208	11.3	248.3	14
Trail-4	207.9	11.26	250.76	14.18

The quantity of materials for 6 Beams casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
13.71	19.5	38.5	5.76 lit	0.2399

Flexural Strength of Beams

Addition of Plastic (0.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	18.7	10.32	20	9
Trail-2	18.5	102.20	21.5	10.54
Trail-3	18	9.86	22.5	10.125
Trail-4	18.4	10.12	21.33	10.46

- **For 1% of Plastic Addition:**

The quantity of materials for 6 cubes casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
9.618	13.16	22.27	3.88 lit	0.1542

Compressive strength of cubes

Addition of Plastic (1%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	815.3	39.5	1043.8	46.3
Trail-2	818.1	40.2	1102.1	47.2
Trail-3	820.3	41	1132.4	48.8
Trail-4	817.9	40.23	1092.7	49.3

The quantity of materials for 6 cylinder casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
14.53	20.67	34.98	6.10 lit	0.1695

Split Tensile Strength of Cylinders

Addition of Plastic (1%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	211.9	11.9	292.9	16.5
Trail-2	220.2	12.5	298.5	16.8
Trail-3	225	13.2	303.3	17.1
Trail-4	219.03	12.5	298.23	16.8

The quantity of materials for 6 Beams casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
13.71	19.5	33	5.76 lit	0.1599

Flexural Strength of Beams

Addition of Plastic (1%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	18.9	11.54	22	11.46
Trail-2	19.2	11.89	23	11.78
Trail-3	20.13	12.10	25	12.08
Trail-4	19.41	11.84	23.33	11.77

For 1.5% of Plastic Addition:

The quantity of materials for 6 cubes casting(in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
9.618	13.16	22.27	3.88 lit	0.2313

Compressive strength of cubes

Addition of Plastic (1.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	805.7	37.2	1092.8	48.2
Trail-2	803.1	36.3	10527	47.5
Trail-3	803.4	36.8	1028.2	46.3
Trail-4	804.06	36.76	1057.9	47.33

The quantity of materials for 6 cylinder casting (in kgs)

Cement	Fine aggregate	Coarse aggregate	Water	Plastic
14.53	20.67	34.98	6.10 lit	0.2543

Split Tensile Strength of Cylinders

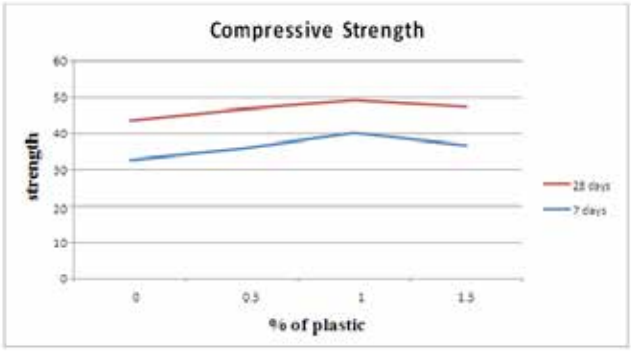
Addition of Plastic (1.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	201.2	10.5	272.3	15.5
Trail-2	198.4	10.35	289	15.8
Trail-3	200.2	10.4	290	16
Trail-4	199.93	10.4	283.76	15.7

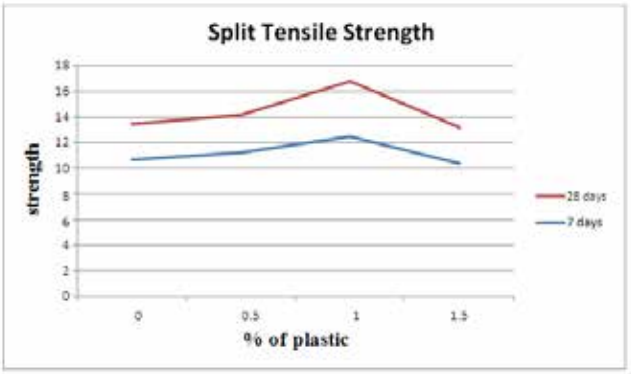
The quantity of materials for 6 Beams casting(in kgs)

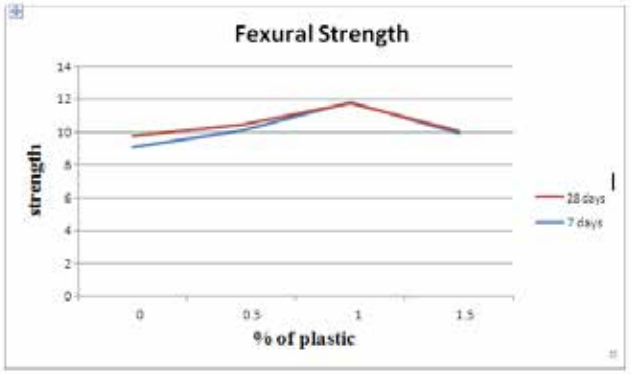
Cement	Fine aggregate	Coarse aggregate	Water	Plastic
13.71	19.5	33	5.76 lit	0.2399

Flexural Strength of Beams

Addition of Plastic (1.5%)	Compressive strength of cubes			
	7 days		28 days	
	Load	Stress	Load	Stress
Trail-1	17.1	9.64	22.5	1.125
Trail-2	18.2	10.36	20	9.78
Trail-3	17.7	9.82	23	10.35
Trail-4	17.66	9.94	21.83	10.08







ACHIEVEMENTS

In our study, we have added plastic in the form of fiber. Specimen were cast by addition of 0.5% , 1%, 1.5% plastic in concrete. Tests were conducted on the cast specimen after 28 days as mentioned in the IS Code . Tests for workability, Flexure, Compression and split tensile strength were conducted and results were obtained. Its corresponding Compressive Strengths were obtained as 46.8 N/mm2,49.3 N/mm2,47.33 N/mm2. The Split Tensile Strengths were 14.2 N/mm2, 16.8 N/mm2, 15.7 N/mm2 and the Flexural Strengths are 10.46 N/mm2, 11.77 N/mm2,10.08 N/mm2.

CONCLUSION

A Series of tests on plastic fiber concrete has been performed. The results were compared with those of the ordinary concrete obtaining the following main conclusions

- A high adherence between Plastic fiber and Concrete matrix was achieved.
- Waste plastic bottle fibers could be considered for the reinforcement of concrete further studies could elucidate if these fiber may be used as Structural material for construction.
- It is concluded that increase in percentage of plastic reduced the compressive strength of concrete

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MAKING DELHI AND CHANDIGARH INCLUSIVE, SAFE, RESILIENT AND SUSTAINABLE

A.K. JAIN*

Abstract

Delhi and Chandigarh are the two iconic cities in India. In spite of contrasting differences in their demography, physical, economic and social aspects, both cities are facing similar problems-such as shelter for the poor, environmental degradation, pollution, traffic congestion, shortages of infrastructure services, climate change, etc. The Government of India along with concerned State/UT Governments has taken up the implementation of UN Sustainable Development Goals (SDG) of which SDG 11 aims to make the cities inclusive, safe, resilient and sustainable by the year 2030.SDG 11 covers 10 targets including housing for all, sustainable urban transport, safeguarding cultural and natural heritage, disaster resilience and safety, reducing pollution, development of greenery and public spaces, mitigation and adaption of climate change and development of sustainable, green buildings. In this pursuit it is necessary to adopt an approach which engages with the identity of the city while meeting the urban challenges.

The paper provides a basket of innovative proposals, such as land reservation for social housing, emphasis on brown field development, integrated transit corridors, transit oriented development, walk to work, common utility ducts, pneumatic waste management, alternative and decentralised sanitation and sewage systems, vertical farming, geo-thermal cooling, etc., which can be the new frontiers of urban development.

INTRODUCTION

In the 1950s two major milestones were laid in India's urban pathway: i) Comprehensive, statutory planning of Delhi, the Capital of India, and ii) Planning and Development of Chandigarh, the new Capital of Punjab. These iconic cities, both Union Territories, have provided a direction to country's urban planning and development.

Notwithstanding tremendous demographic, economic and social changes and ad-hoc, mediocre suburban developments in the peripheries of Delhi and Chandigarh, the pride of living and working in these cities remains unabated. Delhi is the fifth most populous city in the world with a population of 18.6 million in 2016, covering an area of 1483 sq.km.Total population of Chandigarh in 2016 was 1.1million with an area of 114 sq. km. By 2021, population of Chandigarh is estimated to be over 19.5 lakhs. Both these cities have been incubating new ideas which have become their identities. Continued with the tradition of Delhi's historic cities, Edwin Lutyens made Delhi a World class Capital city. The Capital Complex (Viceroy House, Secretariats and Parliament), India Gate, Lutyens Bungalow Zone, Connaught Place, the vast greens, ridge /forests, Central Vista and roads as boulevards are the unique landmarks of Delhi. Chandigarh designed by Le Corbusier, though not a historic city, is known for its Secretariat, High Court, Assembly Building, Open Hand Monument, the Leisure Valley, green corridors, Sukhna Lake, Rock Garden, etc. Both these cities have about one-fifth of land under greenery. As such Vision 2030 for making Delhi and

**Former Commissioner Planning, DDA*

Chandigarh inclusive, safe, resilient and sustainable need exploring new ideas which are also bold and beautiful.

The Government of India along with GNCTD and Chandigarh UT administration has taken up the implementation of UN Sustainable Development Goals (SDG) of which SDG 11 aims to make the cities inclusive, safe, resilient and sustainable by the year 2030 and aims to achieve the following targets:

- Access for all to housing and basic services
- Sustainable transport for all
- Sustainable planning and management
- Safeguarding the cultural and natural heritage
- Disaster resilient, safety and management
- Reducing the environmental impact and pollution
- Universal access to green public spaces
- Strengthening integrated development planning
- Mitigation and adaptation to climate change
- Sustainable and resilient buildings and resources

In this pursuit, it is necessary to adopt an approach which engages with the identity of the city and meets the challenges of their population growth, housing, slums, addressing the problems of small enterprises, up-gradation of old and dilapidated areas and provision of adequate infrastructure services and transport.

A safe city aims to ensure safety of its citizens especially children, women and other vulnerable sections of society. A resilient city aims to ensure adjustments due to unforeseen disasters, emergencies and climate change. Making these cities sustainable involves the reversal of unprecedented air and water pollution, making urban areas clean and hygienic, conservation of natural resources, water bodies/rivers, biodiversity and heritage, along with provision of sustainable infrastructure services, urban transport and renewable energy. The approach has to be visionary, keeping in view the following core principles of the 2030 Agenda:

- Leave no one behind
- Localization
- Leave no place behind
- Access to development resources

Ad-seriatim to the ten targets of SDG-11, the following can be the key proposals:

ACCESS FOR ALL TO HOUSING AND BASIC SERVICES

Promote and incentivize brown field development, including in-situ slum rehabilitation, regularization and redevelopment, densification and up-gradation of unauthorised colonies/villages and old residential areas. This requires the reservation of minimum 15 percent of land/FAR or 35 percent of the dwelling units for the EWS and lower income category. Compact, high rise and high density housing pattern can enable optimum use of land and other resources. By using land as a resource, market sale component of housing can subsidize social housing. This requires:

- Promoting broader concept of upgrading with services, jobs and community participation,
- Variations rather than standard solutions,
- Promoting rental social housing,
- Local economic promotion and poverty reduction, and
- Security of tenure.

Inclusive housing involves the provision of mixed land use/jobs; social facilities and sustainable services, viz. drainage and flood control, sewerage, water supply, waste water recycling, rain water harvesting, solid waste management, public and individual toilets, roads, electricity, street lights, etc.

SUSTAINABLE TRANSPORT FOR ALL

It is time to think and provide Integrated

Transit Corridors (ITC) for BRT, Metro and trains linked with pedestrian and cycle lanes and flanked by public, semi-public, high density, high rise development. Metro, trains, sub-way and primary roads run underground for easy bike and pedestrian traffic on the grade. Besides controlling growth of private vehicles, it is necessary to explore parking space under stilts, multi-level, on roofs and underground. Seamless multimodal public transport system comprising bus rapid transit, rail based mass transport system would work only by adoption of single ticketing and restructuring land uses by transit oriented development. Subterranean garages near commuter destination reduce the need for ground parking. Digital parking meters tell mobile phone when a space opens up, reducing traffic caused by drivers trolling for space.

The concept of walk to work, transit oriented development, travel demand management and smart growth, promoting NMTs, multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. River/ water transport should be explored which is almost pollution free and most cost-effective mode. Introduce the concepts of cordon pricing, minimum occupancy vehicles, ceiling on new registration of private vehicles and establish a Unified Metropolitan Transport Authority for sustainable and coordinated urban transport.

SUSTAINABLE PLANNING AND MANAGEMENT

Intelligent, alternative and innovative ways to provide services, i.e. water, power, drainage and solid waste management and renewable energy have to be introduced with emphasis on servicing the informal, unplanned settlements.

Common utility ducts or tunnels carrying electricity, water pneumatic waste ducts, cable television and broadband internet minimize damage from traffic, road repairs, rains, etc. and make repairs easier. A series of low carbon zones across the city with co-located tri-generation energy systems (combining power, cooling and heating), dual piping for recycled water and automated, segregated waste collection and recycling would lead to bundling 'green infrastructure' together. Solid waste extracted from sewage at treatment plants is burned to make electricity. Three bins recycling is adopted with separate bins for trash, recyclable and compost. Collection charges drop as trash drops. Bio-technology, enzyme based STP, bio-remedial treatment, sludge gas/energy recovery, vermi-culture, fossilization and compositing options can be explored for waste treatment.

Rooftops painted white reflect heat, lowering a building's cooling cost and a city's heat build-up. Rooftop vegetation insulates building against heat and cold and absorbs storm-water. Passive evaporative draught cooling and Earth Air Tunnel incorporating ingress of naturally cooled air 4m below ground level via clay pipes saves about 60 per cent of air conditioning load.

Taxing property owners on the volume of storm-water and waste water from kitchen and toilets that runs off their property promotes retrofits that reduce waste water volume. Zero-run off, swales, porous paving, bio-drainage and storm-surge gates in river, drains and canals can be operated when storm surges are expected to protect low lying and subterranean infrastructure. The neighbourhoods should be planned to the highest leadership in energy and environment design (LEED) standards that save energy, materials and emissions.

SAFEGUARDING THE CULTURAL AND NATURAL HERITAGE

There is a need to adopt a comprehensive approach integrating conservation with improvement of the community in terms of livelihoods, incomes, education, health, recreation, culture and security. This involves the following:

- Listing of heritage/iconic buildings, parks and zones, and working out conservation guidelines and plans there of including taking up the repairs, retrofitting and maintenance. This will require creation of dedicated cell for conservation of cultural heritage in local bodies and planning departments.
- The rivers, drains and water bodies in urban areas usually have a high level of pollution,

which is mainly from the untreated sewer and waste from adjacent urban areas. This needs control of unauthorised development and land uses which are incongruous with the environment e.g. sanitary landfills, industry, thermal power station, etc.The development of greenways along drainage corridors and harvesting of rain water in balancing lakes and ponds can be a new frontier in city development.

DISASTER RESILIENCE, SAFETY AND MANAGEMENT

Comprehensive digitized and geo-referenced surveys and a systematic investigation of 'eco-determinants', which deal with relationship of humans and other forms of life to the natural and man made environment and local climate provide the basis for a sound land use planning. Micro-zonation surveys may be referred for land use planning, layout plans and building design.

Building bye-laws may incorporate the aspects of multi-hazard safety and retrofitting. Priority should be given to public buildings such as hospitals, educational, institutional, power stations, infrastructure, heritage, monuments and lifeline structures which attract large congregation.

The safety of women is a central issue. Various initiatives include the setting of the rescue and rehabilitation centres, re-integration of victims of trafficking; the setting up of 'One Stop Crisis Centres' provision of shelters, police desks, legal, medical and counselling service, and 24x7 help lines. This also needs incremental actions, such as enhancement of street lighting, establishment of 'Multi-Utility Zones', pedestrian safety, safer roads, provision of public toilets for women, especially in the slums and streets and safer public transport with CCTV and alarm system.

The planning of a city can contribute in crime prevention by gender sensitive design of shared, lively and defensible spaces, mixed land use and adequate shelter/tenements for the poor, together with spaces for vending and informal trades that promote livelihood and community surveillance.

REDUCING THE ENVIRONMENTAL IMPACT AND POLLUTION

The need to save air, water and land from pollution is a major concern. Drinking water, sanitation, solid waste treatment and drainage are important aspects of the human environment. The performance of present sanitation system needs to be reassessed with reference to environment, hygiene and their accessibility. The future city will be low carbon, low energy, smart, sustainable, safer and more efficient, and resilient. It will optimize the use of IT, simulation, automation and robotics that will make it smart and intelligent. Renewable, efficient energy and solar mapping would be key concerns in its planning and design. In contrast to emphasis on complex EIA, end of pipe pollution control measures, cleaner energy and fuels, car emission norms, etc. what most urban centres need is an environmental planning approach that facilitates meeting deficits in provision of basic services, e.g. water, sanitation, drainage, electricity, healthcare, emergency services, schools, public transport, etc.

Various alternative technologies, based on decentralized services, like extended aeration technique, bio-gas production, bubble diffusion process, flotation, anaerobic reactors, etc. which are already in vogue, can be explored for urban sanitation.

Widespread method of land filling for solid waste disposal is an environmental disaster. Decentralized systems based on recycling, energy generation and organic decomposing should be explored for solid and liquid waste treatment. Bio-reactor composting and vessel system, vermi-composting, etc. are new generation technologies for waste treatment.

The concept of energy efficiency, renewable energy and Zero-fossil Energy Development can reduce the level of energy demand and slow down the rate at which resources are depleted. Energy efficiency involves a synergy of the various levels of planning, design, construction and maintenance.

Smart and green buildings can give energy saving up to 30%, reduce carbon emissions, provide

higher efficiency and comfort with lesser energy consumption. The city and buildings have not only to be comfortable, green and efficient but also intelligent and integrated. The following measures are necessary in this regard:

- Replace high radiation absorbing surfaces such as dark roofs, asphalt streets and parking lots with highly reflecting materials.
- Adopt passive design to minimize energy use, including space heating, cooling and cooking, utilize higher efficiency air conditioning systems.
- Inclusion of green space, city forests, better spaced buildings, and better public transportation, including non-motorized transport.
- Landscape development, besides plantation, trees, vegetation, needs to ensure maintaining drainage channels of wind flow, recharging of sub-soil water by porosity for absorption of water and avoiding unnecessary paving and roads.
- Water, plantation, shade and channelling of cooling breeze are the prime elements for a comfortable micro-climate. Minimum exterior surface to maximum internal volume, correct orientation, atriums and internal courtyards reduce glare and heat. Drainage and flood control strategy may be linked with water supply and pollution control.

The urban form, land use planning, landscape and green buffers can help in reducing the noise levels. It is not desirable to locate residential area along major arteries and non-residential activities inside the residential localities that would invite traffic. By proper land use planning, mixed land use, location of public/ semi-public and commercial activities along major transport arteries, a green buffer can be created for residential zone. The green buffer with thin leave trees, land formation, mounds, embankments, etc. provides effective barriers to transmission of noise.

UNIVERSAL ACCESS TO GREENS AND PUBLIC SPACES

A vibrant public life can be possible by design of a wide range of diverse public spaces, such as river front, lakes, water bodies, square, the parks, boulevards, avenues, religious, social-cultural and other public facilities. Delhi and Chandigarh with one fifth of their lands under greenery are among the greenest cities in the world. They provide 9 sm per capita of recreational/green space, which is distributed @ 3 sm at local level, plus 3 sm at Zonal level and 3 sm at City/Master Plan level. However, there is shortage of greens/recreational space at the local levels due to encroachments and its diversion for other uses. These public greens need to be restored and scrupulously protected.

With the expanding city, agricultural land and food production is diminishing. This is making food more expensive with longer haulage. The concept of vertical urban farming can effectively address these issues. Satellite control park and lawn micro-irrigation system cuts water consumption and pumping power. Wastewater recycling, with dual piping would reduce water demand. Vertical farms could reduce fertilizer and freshwater use, shorten transport and recycle grey water otherwise dumped by treatment plants. This can be a new frontier in urban landscape of Delhi and Chandigarh.

STRENGTHENING INTEGRATED DEVELOPMENT PLANNING

The strategies for integrated planning comprise institutional and legal reforms, local area planning, new ways of land management and implementation, monitoring and consolidation. This involves the following key actions:

- Constitute DPC and MPC, strengthen urban planning capacity and constitute empowered Local Area/Ward Planning Committees
- Enact/review the town planning and municipal legislation
- Take up the preparation of a sub-regional plan

- Constitute a land management committee
- Bring a legislation on land pooling
- Take up physical, social, environment and financial audits
- Bridging the gap between planning and implementation by constitution of monitoring and coordination groups at policy, strategic and operational levels, and project management committees

MITIGATION AND ADAPTATION TO CLIMATE CHANGE

Planning strategies are crucial in mitigation and adaptation to climate change, disasters and risk management. Cities have to in particular address to the safety of women, old persons, children and other vulnerable sections of the society. In this regard following strategies may be adopted:

- Development of networked emergency response and safety centres integrating police, fire, disasters, accidents, crimes, traffic and women's safety.
- Avoid left over, undefined spaces such as roadsides, backyards, waste dumps, etc.
- Development of network of mohalla clinics, health infrastructure, dispensaries, trauma and accident centres.
- Improve urban infrastructure – CCTV, GIS, variable and intelligent traffic signage, lighting, maps, pavements, public transport, parks, drinking water points, lighting and police posts.
- Signage in all public places giving details of helpline numbers and persons to be contacted in case of emergency.
- Provision of clean and well lighted toilets on all public roads, in schools, markets and public buildings.
- Discourage unoccupied, speculative property ownership which causes urban deterioration and dereliction, known as "broken window" syndrome.
- Safety of children in educational institutes, buses, playgrounds and on roads.
- Safety oriented planning and engineering specifications, norms and practices.
- Improvement of public transport, non-motorized vehicles, sidewalks, cycle tracks, underpasses and overpasses.
- Upgrading traffic control systems, public transport, alarm system for safety of women passengers, intelligent signal control, drivers' training and management.
- Delink building plan approval from mandatory structural and fire safety approvals, which may be required every 5 years.
- Review and simplify building codes for non-engineered buildings.

SUSTAINABLE AND RESILIENT BUILDINGS AND RESOURCES

A Habitat Code for buildings may be adopted keeping in view the following principles and strategies:

- Sustainable site planning
- Building envelope design
- Building system design HVAC (heating, ventilation and air conditioning), lighting, electrical, and water heating
- Integration of renewable energy sources to generate energy onsite.
- Selection of ecologically sustainable materials (with high recycled content, renewable resources with low emission potential)
- Passive design of building for climatic comfort
- Optimum use of energy and reducing its need by day lighting, courtyards, green roof, ventilation, etc.

- Water conservation and recycling
- Solid and liquid waste management, its treatment and reuse
- Energy efficient transport
- Efficient building systems, construction and maintenance

It is always better to specify building materials which are locally sourced, require less energy for transportation to the site. These should have low embodied energy and should be preferably natural. Promote use of recycled materials, especially, in place of high embodied energy materials like steel and aluminium. Use of reclaimed materials such as construction and demolition waste should be promoted.

Some new green materials and technologies include the following:

- Swales, bio-drainage, porous paving, rainwater harvesting, waste water recycling, dual piping.
- Aerators for water fixtures
- Waterless urinals and other water saving systems
- Micro irrigation systems, xeriscaping
- Building integrated solar photovoltaic, wind energy, parabolic solar cookers
- Green roof, vertical garden, urban farms
- High COP Chillers
- Wind towers/tunnels/chimney/high albedo materials
- Geothermal system
- LED, CO2 sensors, intelligent, bionic sensors and controls
- Building information systems
- Rapid walls, precast, prefabricated components
- Low emitting adhesives, sealants and insulation products.

ACHIEVING THE OUTCOMES

The urban transformation can't be expected without a pathway which gives a clear orientation and a series of steps to be taken in a long journey. These steps include the following:

- Setting up the benchmarks, standards and norms
- Preparation of action plans at policy, strategic and operational levels
- Institutional/organizational capacity building
- Legal framework and procedural reforms
- Financial planning and harnessing theresources of Central/State/City, private and community sectors.

There is a need to develop a comprehensive insight into urban problems and policies and evolve a vision with the imperatives of decentralization, localization, partnership, equity, transparency and accountability. Civic engagement and participatory development are no more subsidiary to the main strategy of 'governance', but should be its basis.

CONCLUSION

Delhi and Chandigarh are the two iconic cities in India. In spite of contrasting differences in their demography, physical, economic and social aspects, both cities are facing similar problems-such as shelter for the poor, environmental degradation, pollution , traffic congestion, shortages of infrastructure services, climate change, etc. While addressing these issues, the proposals should celebrate the iconic status of these cities and become the models for other Indian cities.

USE OF C & D WASTE FOR STRUCTURAL APPLICATIONS FOR ENVIRONMENT PRESERVATION

J. BHATACHARJEE* PRAKHAR JAIN** AND ANKIT GAURAV**

Abstract

Today, construction, repair and demolition of infrastructures like buildings, roads and bridges, etc., place an enormous demand of natural aggregates as well as landfills for the disposal of the generated demolition wastes. As a result, these problems are becoming a concern for developing nations worldwide due to ever increasing generation of construction and demolition waste, the waste disposal problems and the decreasing sources of natural resources. A sustainable solution for these problems exists in recycling the construction and demolition waste (CDW) to produce recycled aggregates for producing concrete. Recycled aggregate till now have been mostly used in non-structural applications such as sub base material in road construction, but its use in structural applications has not been reported widely due to non-availability of the related specific standards and guidelines.

In this study, experimental investigation has been carried out on concrete grades M35 and M40 at various replacement levels of natural aggregate with recycled aggregate. Several concrete specimens such as cubes, cylinders and beams were casted for determining the various mechanical properties of concrete. The results obtained after conducting experimental investigation indicate that the mechanical properties of concrete made with recycled aggregate are somewhere inferior to that of normal concrete made with natural aggregate, but still up to some replacement level of natural aggregate with recycled aggregate the properties seems close to natural aggregate concrete. Thereby use of C & D waste for structural concrete has got tremendous potential of addressing the environment concern and for sustainable development.

INTRODUCTION

Construction and Demolition Waste (CDW) has been defined as a waste which arises from construction, renovation and demolition activities. CDW (Fig.1) consists mostly of inert and non-biodegradable materials such as concrete, metal, wood, plastics etc. These wastes are usually heavy, bulky and occupy considerable space in huge piles where disposed off. Construction wastes are generally leftovers items from the used construction materials like cut-offs, impaired materials, packaging waste, used materials during construction and other wastes used at construction sites. Demolition waste is mainly the collection of all construction materials after removing some of the components of a structure or completely demolishing the structure. Demolition wastes are much larger in volume than the construction wastes [1].

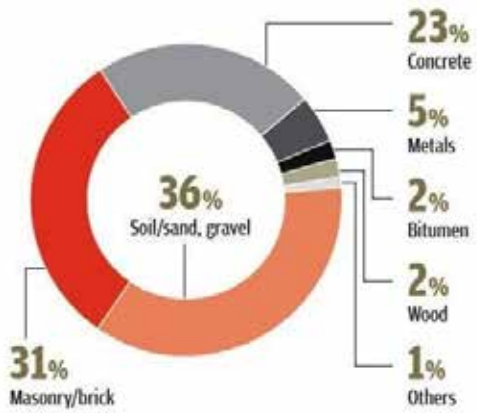

Fig. 1: Typical Composition of CDW

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Due to the rapid growth in the construction industry, it will be appropriate to link the issue of construction and demolition waste generation with the Indian economic growth. It becomes necessary to estimate the amount of construction and demolition waste being generated. Suitable strategies are also needed to manage the waste generated for the sustainable development approach. The construction, repair and demolition of infrastructures like buildings, roads and bridges, etc., place an enormous demand of natural aggregates as well as landfills for the disposal of demolition wastes. This CDW is becoming a concern for developing nations worldwide. Firstly, there is the continuous industrial development which is coupled with the ever increasing world population. Secondly, the major problem of land paucity has resulted in the increasing unavailability of space to dispose-off the waste. Finally, there is increasing awareness of sustainability and environmental management so that to maintain the global balance of production and consumption [2].

In India, a huge quantity of CDW is produced every year. Due to generation of huge amount of CDW, much more space is needed in future for its disposal. These wastes represent huge masses that are often disposed without any consideration, causing a lot of trouble and also inviting illegal deposits of other kinds of waste and garbage. The management of CDW has become a major concern due to increased quantity of demolition rubble, continuing shortage of dumping sites, increase in cost of disposal and transportation and above all the concern about environment degradation.

GENERATION OF CONSTRUCTION AND DEMOLITION WASTE

Indian Scenario

It was estimated in the year 2000, that India would generate about 10-12 million tons of C&D wastes annually. According to a report by McKinsey and Company, the real estate grew by 6-7 per cent a year between 2001 and 2010. With this rate, shows CSE (Centre for Science and Environment) estimated that, the country would have generated 531 million tons of CDW by 2013. This is in addition to the large quantities CDW that are dumped illegally. At this rate, India would need nearly a landfill area of 8.65 million hectares by 2030 to dispose of its CDW.

International Scenario

About 850 million tons of construction and demolition waste is generated in Europe per year, which represents 31% of the total waste generation. In USA, it is estimated to be 480 million tons per year. In 2012, UK generated 44.8 million tons of non-hazardous CDW, out of which 38.8 million tons was recycled [3]. In Germany, about 285 million tons of per annum construction waste was produced, out of which 77 million tons was demolition waste. Approximately 70% of it was recycled and reused in new construction work. In France, it is estimated that about 13 million tons of concrete is demolished every year whereas in Japan, the total quantity of concrete debris was reported to be in the range of 10-15 million tons each year. Hong Kong CDW generation was reported to be in the order of about 20 million tons demolition debris per year whose disposal was a serious problem [4].

Globally, very little demolished concrete has been currently recycled or reused. Mostly, the recycled waste has been mainly used as un-stabilized base or sub-base in highway construction, the rest has been disposed off. There is pressure for more sustainable development have led to a significant amount of research focusing on the development of technologies for recycling these wastes, primarily in the construction activities as the recycled aggregates. Recycled aggregates generated from CDW have been used as a substitute to natural aggregates and their applications has been popularized mainly in road construction, but its use in structural applications has not been reported widely due to non-availability of the related specific standards and guidelines.

RECYCLED AGGREGATE CONCRETE

Use of recycled concrete aggregate provides an effective solution for sustainable growth of modern infrastructure. Primarily, recycled concrete

aggregate reduces the demand of non-renewable natural aggregate sources. Recycling of CDW saves energy and thus reduces the adverse environmental impact. It creates employment opportunities in terms of establishing recycling industries. A lot of money can be saved by reducing the disposal costs, transportation costs and the cost of new construction materials by recycling the CDW onsite. Use of recycled aggregates also reduces the need for mining of natural aggregates, thus helps in sustainable development and economic benefits [5].

CDW usually consists of concrete, masonry, plastics, metals, steel, timber, glass before recycling. CDW must be made free from all contaminants because of their deleterious effects in new concrete. Contaminants are usually removed at the site by the sorting process, either manually or automatically. Complete removal of the contaminants is not technically possible, so the remaining traces of contaminants govern the chemical characteristics of the recycled aggregate [2]. The most commonly adopted process for producing recycled aggregate from CDW is as shown in Fig. 2.

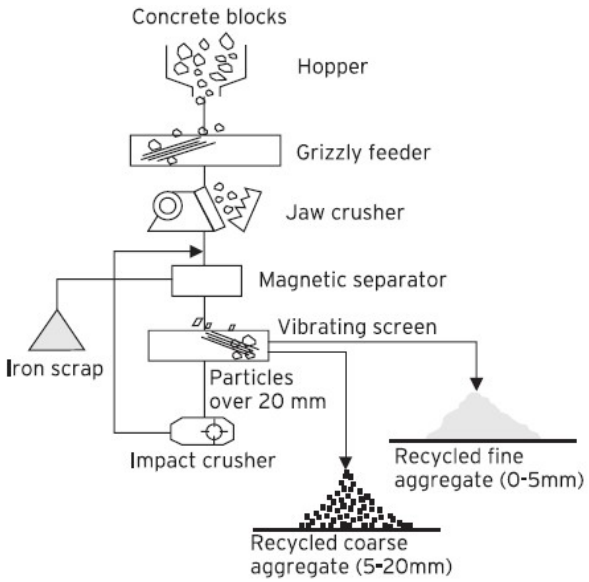

Fig.2: Processing of Concrete Waste into Aggregate

EXPERIMENTAL METHODOLOGY

All the experimental work of the present research has been carried out as per the IS codes. The physical properties of recycled and natural aggregate (both coarse and fine) such as gradation, specific gravity, water absorption, crushing value and impact value were determined. Properties of cement such as consistency, setting time and compressive strength were also determined.

To study the mechanical properties of structural grade concrete, two different grades of concrete mixes M35 and M40 were designed. Concrete specimens were prepared for each grade were prepared with four replacement namely 0%, 30%, 50% and 100% of recycled coarse aggregates to natural coarse aggregates. So a total of eight concrete mixes were designed for preparing concrete test specimens. A total of six cubes each of size 15cm*15cm*15cm, two cylinders each of size 30cm height and 15cm diameter. Slump cone tests were carried out on green concrete to know its workability. The material properties of hardened concrete were determined using destructive testing to know the compressive strength, indirect tensile strength, flexural strength and modulus of elasticity of concrete by using Amsler type Compression Testing Machine of capacity 200T and Shimatzu make Universal Testing Machine of capacity 2000T. The tests were carried out at the age of 7 and 28 days.

MIX DESIGN

Concrete mixes of M35 and M40 grades using recycled coarse aggregates of maximum size 20mm and 10mm were designed for the replacement options of natural coarse aggregate in the proportions of 0%, 30%, 50% and 100%. The concrete mixes of M35 grade using recycled aggregate were designed as per the suggested guidelines of RILEM [6] and IS: 10262-2009.

The brief outline of the RILEM guidelines is as follows.

- Higher value of standard deviation should be used while determining target mean strength of recycled aggregate concrete mixes.
- Same water cement ratio may be assumed as of conventional concrete mixes. If resulting

compressive strength is lower, adjustments could be made.

- To obtain the same slump, water requirement for concrete mixes made entirely of recycled aggregate should be 10 liters/m3 higher than that of conventional concrete mixes.
- Maximum size of aggregate should be 16-19mm for the reasons of frost resistance.
- Due to higher water requirement, cement content should be higher.
- Mix design should be based on measured density of recycled aggregate at hand.

RESULTS AND DISCUSSION

Experiments as per the BIS norms were conducted on green and hardened test specimens of concrete to determine the mechanical properties of concrete i.e. compressive strength, indirect tensile strength and flexural strength. On green concrete, slump cone test was performed whereas on hardened concrete test specimen, Destructive tests were conducted to determine the compressive strength, indirect tensile strength and flexural strength.

Physical Properties

To determine the physical properties different tests were conducted on recycled coarse aggregate and the results obtained are compared to natural aggregate has following properties:

- More angular and rough surface.
- Increased water absorption.
- Decreased bulk density.
- Decreased specific gravity.
- Increased abrasion loss.
- Increased crushability.
- Increased quantity of dust particles.
- Increased quantity of organic impurities if concrete is mixed with earth during building demolition.
- Possible content of chemically harmful substances.

Other researchers have done the comparative studies pertaining to the properties of recycled aggregates with respect to those of natural aggregates and shows similar properties.

TEST ON FRESH CONCRETE

Slump Cone Test is performed to determine the workability of concrete. Workability of concrete may be defined as the property of green concrete due to which it can be easily transported, placed, compacted and finished. This test was done as per IS: 1199-1959.

In the present study, in concrete mixes made entirely with natural aggregate i.e. 100% natural aggregate, the designed slump values were observed. As the percentage of replacement level of recycled aggregates increased the observed slump value decreased. Low value of slump was observed in case of 100% replacement of natural aggregates with recycled aggregates. Satisfactory slump values were observed in the mix of 30% replacement of natural aggregate with recycled aggregate.

TESTS ON HARDENED CONCRETE

Testing of hardened concrete is of vital importance for determination of mechanical properties of concrete as it can give a reasonable estimation of the fundamental physical behavior of concrete such as elastic modulus, compressive strength, hardness and homogeneity of concrete and for quality control aspect.

Destructive Tastings

The compressive strength and indirect tensile strength were determined using Compressive Testing Machine (CTM) and the flexural strength and modulus of elasticity were determined using Universal Testing Machine.

In compressive strength from various tests specimens it can be observed that for all the mixes of M35 and M40 grade concrete achieve 70% or more of the strength in 7 days that is to be achieved in 28 days age. For both grade concrete mixes, the compressive strength decreases for both 7 and 28 days period as the percentage of replacement of natural aggregates with recycled aggregates increases.

In case of M35 grade concrete, it is observed that for 28 days age, the reduction in compressive strength was 9.15%, 17.29% and 24.08% for 30%, 50% and 100% replacement levels of natural aggregate by recycled aggregate respectively. Whereas, in case of M40 grade concrete, at 28 days age, the reduction in compressive strength is 12.66%, 15.65% and 18.66% for 30%, 50% and 100% replacement levels of natural aggregate by recycled aggregate respectively.

The Indirect tensile test was carried out according to IS: 5816-1999. It can be seen that the indirect tensile strength after 28 days decreases as the percentage of recycled coarse aggregates increases. In case of M35 grade concrete, at 30%, 50% and 100% replacement levels, the indirect tensile decreases by 2.52%, 7.52% and 12.46% respectively. On the other hand, the observation in case of M40 grade concrete is that the indirect tensile strength does not reduce at 30% replacement level, but at 50 % and 100% replacement levels, indirect tensile strength decreases by 2.52% and 10.1% respectively. The reduction in indirect tensile strength with increment of recycled aggregate is due to the weak interfacial bond created between the recycled aggregate and the mortar.

The flexural strength of concrete beam specimen under four-point loading and the loading span is one-third of the support span can be calculated by the following equation: =FL/bd2

Where, F = Load (force) at the fracture point in Newton; L = Length of specimen in mm; b = Width of specimen in mm; d = Thickness of specimen in mm

It is observed from results that the flexural strength of concrete decreases as the percentage replacement of natural aggregate with recycled aggregate increases. In case of 30% and 50% replacement of natural aggregate with recycled aggregate, the flexural strength of concrete did not decrease significantly for both M35 and M40 grade concrete. For M35, flexural strength decreased only by 1.41% and 3.85% and for M40, it decreased by 3.48% and 6.4% for 30% and 50% replacement respectively. But in concrete mixes with 100% replacement of natural aggregate by recycled aggregate, the flexural strength of concrete reduced significantly. At 100% replacement of natural aggregate, the flexural strength decreased by 13.8% and 14.34% for M35 and M40 grade concrete respectively.

The modulus of elasticity test was carried out as per IS: 516-1959. The readings were recorded from the extensometer after applying the respective loads (calculated as per IS: 516-1929) and the stress vs. strain curve was plotted for each mix. The slope of the stress vs. strain curve was calculated and the Modulus of Elasticity of that mix was obtained. The results obtained indicate that the concrete having recycled aggregate has less modulus of elasticity than normal concrete made with natural aggregate. For M35 grade, concrete mix made with recycled aggregate up to 30%, 50% and 100% replacement of natural aggregate, the reduction in the values of modulus of elasticity was found to be 5.20%, 10.30% and 24% respectively. In case of M40 grade concrete, the reduction in modulus of elasticity was 3.8%, 10.05% and 19.3% for 30%, 50% and 100% replacement of natural aggregate respectively.

CONCLUSION

The current study was undertaken to explore the probability of using recycled aggregate in structural applications in terms of developing standard procedure for concrete mix design for structural grade concrete of M35 and M40 using the recycled aggregate. Through the present study, it has been observed that the recycled aggregate can be a suitable alternative to natural aggregate and the concrete made with recycled aggregate has a

good potential to be used in structural applications. The results obtained after conducting experimental investigation indicate that the mechanical properties of concrete made with recycled aggregate are somewhere inferior to that of normal concrete made with natural aggregate, but still up to some replacement level of natural aggregate with recycled aggregate the properties seems close to natural aggregate concrete.

The optimum compressive strength was achieved till 50% replacement of natural aggregate with recycled aggregate in case of M35 grade concrete. For M40 grade concrete, the desired compressive strength was achieved even after 100% replacement of natural aggregate with recycled aggregate. The indirect tensile strength, flexural strength and the modulus if elasticity of concrete decreased as the quantity of recycled aggregate increased. The concrete with up to 50% replacement level exhibited excellent quality of concrete for both M35 and M40 grade concrete and the concrete with 100% replacement of natural aggregate with recycled aggregate showed good quality of concrete. The indirect tensile strength after 28 days got decreased as the percentage of recycled coarse aggregates increases. The flexural strength of concrete also decreased as the percentage replacement of natural aggregate with recycled aggregate increased. Concrete having recycled aggregate showed reduced value of Elastic Modulus than normal concrete made with natural aggregate.

Hence it can be inferred that we can go ahead with the partial use of C & D waste for structural applications for addressing environment preservation and ultimately achieving sustainable development.

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ENVIRONMENT PRESERVATION IN SUSTAINABLE DEVELOPMENT: A PERSPECTIVE

PARVEEN KUMAR*

Abstract

Though, the key to the environment preservation and sustainable development is present in the most ancient literature – The Vedas, from the time immemorial, speaks of sustainability of the universe viz –a- viz mankind and its development, yet we have fallen for the borrowed and copied high sounding jargons of "Environment Impact Assessment." We assess the viability of our projects through environment legislation namely water act (1974), wildlife protection act (1972), prevention and control of pollution act (1981), Environment protection Act (1986), Biological Diversity Act (2002) etc. In spite of all these legislations and efforts, our objectives have not been – "Fully Met." We overlook the facts that how such a project will be in total harmony with the ecology having a net transaction with nature... a zero or as close as to zero. Thus a balance is a must between sustainable development goal 2030 and their cost to the environment. The method by which this can be achieved through is fine tuning the delivery system by integrating the good of old and modern.

INTRODUCTION

Since the UN conference on Human Environment in 1972 at Stockholm, (Fig.1) we have witnessed a successive transformation in Environment vs development debate. At the Stockholm conference, the Indian delegates led by the then Prime minister Mrs Gandhi emphasized upon the interrelation of poverty, population viz a viz environmental resources. Things moved further and culminated in the Rio Declarations on Environment and Development at UN Conference on Environment and declaration in 1992, and The Global Community adopted the United Nations

Framework Convention on Climate Change. The word "sustainable development" came on to the centre stage at the World Summit on Sustainable Development, 2002. Then, finally this word has become all pervasive since United Nations Conference on Sustainable Development, 2012. Since then, the environmental issues have served to remind us about the "Future we want" and the development policies need to look beyond the present generation and the most widely cited definition of the term "sustainable development (1)" is "meeting the need of the present generation without compromising the ability of future generations to meet their own needs". Therefore, it reinforces the need for long-term strategies rather than short-term policies in economic and political spheres.

Fig.1: Transformation in Environment

ENVIRONMENT PRESERVATION

Environment, as an all encompassing term, covers the wide range of topics including the land, water, vegetation, air and an array of the socio

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economic activities in this. Environment, being such a diverse concept viz a viz transactions of the living beings, has many view points to explain it. But, all said and done, the Vedas, the oldest literature, give most holistic explanation about the relationship between environment and living beings. Vedas concern about people's ability to adapt both physically and mentally to the continuing changes in environment.

"He, who has created this multiform universe, and is the cause of its sustenance as well as dissolution, the Lord of the universe in whom the whole world exists, is sustained and then dissolved into elementary condition, is the Supreme Spirit. Know Him, O man, to be your God and believe in no other as the Creator of the Universe." RIG VEDA 10: 126, 8." (2)

This quotation explains the universe, which is also an environment at macro level, through the Eternal Trinity Principle of Vedas. (2 a) The Universe is an interrelation of god, jeev (living being) and prakariti (matter) and environment preservation can truly take place only when these three element are in a state of equilibrium. This is what is termed as the balance of nature. But when people try to exploit it beyond economical repairs, this equilibrium is disturbed and lead to the detriment of all forms of life.

The efficient cause is the one by whose direction a thing is made, and by the absence of whose direction nothing is made. It does not change itself, though it effects changes in other things. The material cause is one without which nothing can be made.

The common cause is one that is a common instrument in the making of things.

In Artharva veda, there is a "Bhumi Suktam" i.e the Hymn of Earth.

This hymn explains the environmental values in the most holistic and eloquent manner. It means you (fire) pervade the earth and you are supreme in heaven. Therefore the teachings in Vedas are really basics and foundation to our culture. We can certainly achieve the environmental preservation in sustainable development. (3)

DIMENSIONS OF SDGs AND KEY CHALLENGES FOR ENVIRONMENT

Recently UN has passed resolution to implement Sustainable Development Goals (SDGs). On 25 Sep 2015, 193 countries including India adopted 2030 developmental agenda. Our developmental planning needs to calibrate itself and focus on sustainable and equitable use of resources and to prevent further damage to our environment. Though there are 17 SDGs, but if it is talked strictly in terms of built up environment then there are two sustainable goals, of which it will be eloborated in this paper.(4)

- Sustainable cities and affordable housing for communities
- Affordable and clean energy

Key Environmental Challenges Before Us-are given in Fig.2

Fig.2: Key Environmental Challenges

In addition, there are two more challenges which are making the situation complicated. These are population growth and inappropriate use of technology (Fig3).

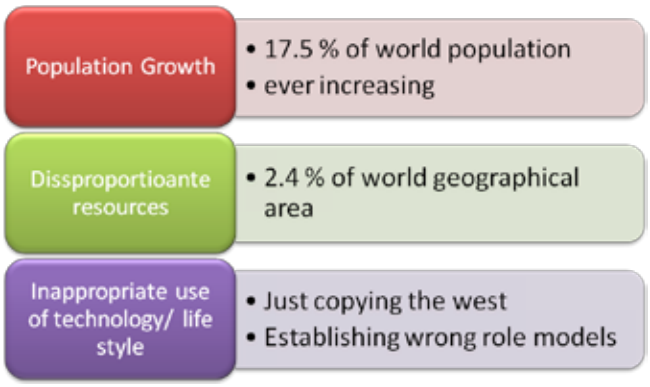

Fig. 3: Additional Environment Challenges

Keeping the objectives of the task in mind and the constraints of the situation, let's focus on the viable solutions.(5)

SUGGESTED MEASURES TO MEET THE OBJECTIVE

From the above depicted bullets, it is crystal clear that our sustainable developmental goals have to cater for the needs, not only of the back log of housing, electricity and hunger of approx 30% poor people, but also the same for the ever increasing population. Thus, the ample resources have to be left for future generation as well, without degrading them beyond the critical point. To attain this, we can not simply copy and paste a model which is not constrained by the similar limitations. Therefore, the western model is not going to fit India, because all the variables – i.e. the backlog needs, net additions and resources are different for them. So, this model is best suited for them, but ill suited for us. So, the million dollar question is what will suit us the best. My answer is again quoted from the trusted and most worthy of the texts- the Vedas. (6). It implies- Integrate the Good practices from the "Old Knowledge" with that of the "Modern Knowledge". Integrate the Science and Spirituality. Integrate experienced knowledge and experimental knowledge. Integrate spiritual comfort and with physical comfort. Then only we can make a best headway.

Let's understand this hitherto flawed model of development in context of a case study of a village.

Name of village- Khidwali, Distt- Rohtak (Haryana).
Population as per census 2001- 7635
No. of households – 1311
Population as per census 2011 – 7853 (2.8% population growth rate) (7)
No. of households – 1495 (14 % increase)
Literacy rate in 2011 – (74.60 %)
Work profile – (86. 65 % are working in employment or other regular earning activities and 13.35 % are marginal worker)

Some of us may be aware about the concept of "Lal Dora" in most of the villages of Haryana. It must be prevalent elsewhere in the country in one form or the other. This Lal Dora was a kind of geographical boundary of residential land of a village. It distinguished the residential land from the agricultural land. It was a manifestation of old ancient knowledge of our ancestors about geography and ecology, as it factored in various aspects of ecology and geography in mind like slope of the village, location of reservoir/johads/ponds and drainage of all the households etc. It was like that in this village as well. The residential area of the village was located at relatively higher slope. The watershed point was somewhere in the middle of the village. The village was surrounded by six ponds which used to collect the runoff of the rainwater, on all sides. The village panchayat used to facilitate de silting of these in the months of May – June when almost 90 percent of water used to be dried up. There was a state of natural equilibrium.

Then came the new millennium and associated "development". With the onset of new millennium, all the factors of development which a typical village can aspire of (Being from home constituency of Ex CM of Haryana Sh. Bhupinder Singh Hooda) i.e pucca concrete streets, piped water, exponential increment in settlements, breaching the "Lal Dora" attributable some to the population growth and some to rise in nuclear families. This led to the excessive run off of water into johads, johads turning into open sewage storage of village. This perpetual flow of waste water along with other household discharges, filled these ponds beyond their capacities and the barsaati nallas

which were supposed to drain out the surplus water, were also turned inward because of the new settlements beyond the "Lal Dora". Waste water and other household discharge filled these johads and continuous silting changed the slope. Now the same johads, which had been serving as an equilibrium agent of the ecology, turned into a big menace. This perpetual filled johads brought lot of foul smell and potential sources of the entire vector borne diseases. The problems were further compounded during monsoon season when the extra runoff water from concrete streets became back waters and flooded the low lying areas of villages.

Fig. 4: A google earth image of the village showing 3 perimeters of the village at different point of time

Length of perimeter at the outskirts of residential area in year 2001 – 3 km (Fig.4)

Length of perimeter at Lal Dora (traditional division between residential and agricultural area)- 3.54 kms

Length of perimeter at the outskirts of residential area as on date- 4 kms.

INFERENCES DRAWN

- For an almost 3 % rise in population in a decade, there is corresponding 14 % rise in number of households and 25 % rise in built up area.
- Residential perimeter could have been enforced by some legislation at 2.5 km and demand for extra housing could have been met by vertical spacing as in big cities.

WHAT WENT WRONG

It is not that I am against the modern civic amenities. I am for them. But I have been advocating against the present policies of working in isolation, not looking at the issue in its entirety and not devising a holistic approach to the development viz a viz the ecology and environment. Let us look at these one by one in table 1

Table 1: What Went Wrong

What went wrong	Possible reason	Remedial action
Single minded focus 'Pseudo Develo pmental' parameters like making pucca concrete street	Isolated model of Rural Development where one department is concerned to finish its task/budget	Integrated development plan analyzing affect on ecology and well being
Street	Neither thought enough and nor learned decision about consequences	Pucca street with bricks. It would have given enough porous runoff area for replenishing of ground water
Discharge of waste water and household muck in johads	Disruption in local governance and societal pressure due to wrong lifestyle, wrong role models, lack of moral education and increasing sense of individualism and decreasing sense of belongingness to a larger identity and decreasing mutual independence	Follow a civil code of conduct, establish and strengthen the community living
Breach of Lal Dora by exponential rise in Housing Needs	Population growth Glamorizing of nuclear families	Imbibing these ancient values in our children through education Society need to have better role models Planning of the sewerage before making the street pucca Vertical development of houses as Flats in big cities Glamorizing the joint families Bringing the legislation against breaching the Lal Dora for residential purpose

Preservation Ethos in Gandhian Approach and New Legislations

"Earth provides enough to satisfy every man's need, but not any mans greed".

To achieve all these, we certainly need to implement the teaching of Vedas in our day to day life. We need to integrate the best of the old practices with the best of the new practices. Stakeholders needs to be onboard and their needs, views and participation have to be roped in, given the vast diversity of Indian culture, traditions and geographical traits. We will have to integrate the science and spirituality, integrate experienced knowledge and experimental knowledge. Integrate spiritual comfort and with physical comfort. We must also revive some old ethos, traditions and also enact some new law for achieving all this.

Mahatma Gandhi was so peeved of the western culture and civilization that he wrote "if India followed the western model of development she would require more than one planet to achieve the progress they had attained" (8) – Mahatma Gandhi

The Constitution of India in its directives imposes duty to the state and citizens to make measure on conservation of resources towards environmental sustainability. In fact, there are legislative and policy measures on effective conservation of resources at different level. There are many legislations namely Water Act (1974), Wildlife Protection Act (1972), Prevention and Control of Pollution Act (1981), Environment Protection Act (1986), Biological Diversity Act (2002) and National Environmental Policy, 2006 etc. But still, the abidingness of the concept as well as ineffectiveness of the institutions has created a chaos in harmonizing developmental and environmental controversies. Realizing the mandate for achieving environmental sustainability, the constitutional courts relied on the soft law to transform the status of concept of sustainable development and incorporated as part of our municipal law. Critics argued that the courts, while handling issues relating to environmental degradation, generally apply the principles of sustainable development and administrative justice. Ignoring, the critics, it is need of the hour to make effective coordination among the existing institutions and establish broader understanding to achieve environmentally sustainable policies along with global trade targets. (09)

A CASE STUDY

Neemuch is a town in the state of Madhya Pradesh. Neemuch was the birthplace of the Central Reserve Police Force (CRPF). The CRPF still maintains part of Neemuch's British Military Cantonment, which was the first of its kind in India. The bungalow area, native troops area, bazar area and fields and gardens were maintained initially by the municipal board and later by the municipal council. When one visits the city, he is bound to be awestruck by its colonial heritage – the old sprawling bunglows of the RAJ period and the native troops barracks and other buildings of prominence. The point which I want to draw is that while the Neemuch Fort, the Victoria barracks and the Quarter Guard built in 1878 (Fig.5) are still being used to house CRPF personnel, the Ochterlony house built in 1822 serving as an officers' mess, are being preserved in best sustainable way without affecting the ecology around. These buildings are certainly masterpiece of construction. The Indian Building Congress should take up a research in the building material used and the efficient use of technology and should integrate the good practice of the past with the good technology of modern time. The Ochterlony house being 194 years old needs no testimony that it was built with best of the building materials and with apt use of artisans and craftsmanship.

Fig.5: Monomental Building

Please note the condition of both the buildings despite their life being 139 yrs and 194 years respectively. Whereas, many buildings, built

recently in the same CRPF Campus, have been "Abandoned" despite their life being even less than 50 years. Such is the level of our shortsighted approach today.

ENERGY CONSERVATION AND RENEWABLE ENERGY SOURCES

Now, we come to our second key challenge to our sustainable goals i.e Energy Needs. To effectively meet our energy needs, our energy pattern, which is fossil fuels centric, must be changed. Efforts must be made to harness the potential of alternative sources of energy, such as hydropower, solar, nuclear and wind to meet our long term energy needs. The nature has endowed us with renewable energy resources abundantly. Investment in R&D for renewable energy sources and low carbon infrastructure should be on top priority and a key result area (KRA). Unless, we are not able to ensure access to affordable, reliable, sustainable and renewable energy for all, we cannot attain sustainable development. We should progressively make transition to clean energy and try to increase the installed capacity of energy pattern up to its full potential. Let us understand this by a diagram. (10) (Fig.6&7).

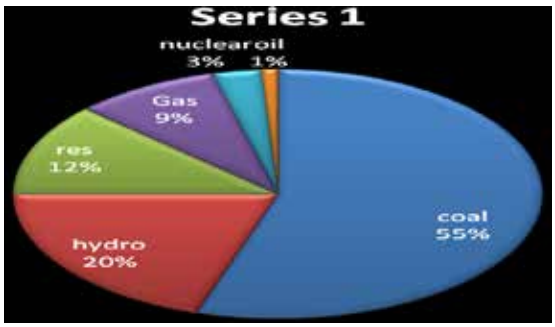

Fig.6: Energy Sources

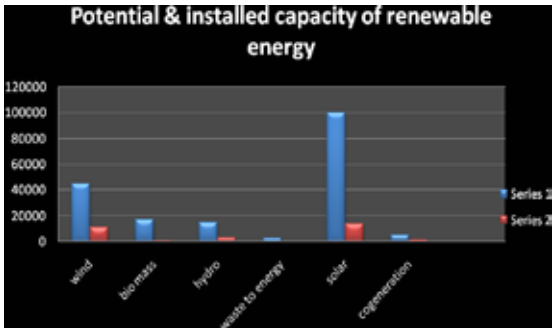

Fig.7: Potential and Installed Capacity of Renewable Energy

CONCLUSION

To sum up, I would like to reiterate that Sustainable development in Environment Preservation will be only "bookish and prerogatives of some intellectuals" here and there. For the masses, it shall be business as usual, until and unless, we analyze our goals most holistically, keeping the principal of responsible consumerism in mind viz a viz the environment resources available to the mankind duly factoring in the needs of future generations. And to achieve the objective, as it is called in military parlance, "Fully Met", we need to integrate all the best of "Old" and "Modern", "Spiritual and Science", "Experienced Knowledge and Experimental Knowledge", "Vidhyam and Avidhyam". This approach will only fine tune the delivery mechanism and we will get rid off this problem of working in isolation, because the future is fusion. We need to push this approach to make it as part of the life style. We need to make it part and parcel of education – formal or informal and it need to be done in all spheres of life – planners, executives, implementers and end users. Then only, we can prevent the Environment degradation beyond economical repair/ point of no return and also achieve the sustainable development goals for our not so lucky brothers and sisters and our coming future generation.

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METAKAOLIN: AN ENVIRONMENT FRIENDLY MATERIAL FOR HIGH PERFORMANCE CONCRETE

GURUDEV SINGH*

Abstract

High Strength and durable concrete will dominate the new and rehabilitated infrastructure of the new millennium. India is in the process of its infrastructure development and requires indigenous and cheaper materials like metakaolin, flyash and rice husk for high performance concrete. Use of these materials is not only economical but environmentally friendly also.

Metakaolin is most promising pozzolanic material which can replace Microsilica. During last few years, the developments that have taken place include increased awareness of the huge potential of production of metakaolin (kaolin is available across the country), start of indigenous commercial production and investigations on concrete mixes containing metakaolin. The concrete with metakaolin has high strength, durability, sustainability and improved early age behavior. As such it is suitable for prestigious structures like multi storey buildings, dams and nuclear installations. This paper is an effort to encourage the use of locally available and cheaper material like metakaolin.

INTRODUCTION

Cement concrete is the most extensively used construction material throughout the world. Maintenance and rehabilitation of concrete structures is also a challenging task due to high performance requirement of the repair materials involving high expenditure. Rehabilitation engineers are always on the lookout for the material to satisfy more stringent performance requirements, especially long – term durability. High performance is generally assumed to be synonymous with high strength, although this is not true in every case. Unacceptable rates of deterioration due to environmental effects indicate that only compliance with strength requirements, although need, is not adequate to ensure long-term durability, which is the primary requirement for high performance. It is generally accepted, that the high performance of the very concrete contributes to low permeability, stronger and denser transition zone between aggregate and cement paste in the concrete. This also adds to the abrasion resistance of concrete. High performance concrete (HPC), prepared mixing metakaolin, exhibits all these characteristics and fits well into its purview as valuable ingredient.

EVOLUTION OF HIGH PERFORMANCE CONCRETE

Admixture or superplasticizer was invented and began to be used to decrease the water/cement (w/c) or water/binder (w/b) ratios. It was found that in addition to improvement in strength, concrete with very low w/c or w/b ratios also demonstrates other improved characteristics, such as higher fluidity, higher elastic modulus, higher flexural strength, lower permeability, improved abrasion resistance, and better durability. These characteristics led to the development of HPC. It has become more popular these days and is being used in many prestigious projects such as Nuclear power projects, flyovers, multistoried buildings etc. In 1993, the American Concrete Institute (ACI) published a broad definition for HPC and is defined as the "Concrete which meets special performance and uniformity requirements that cannot always be achieved by using only the conventional materials and mixing, placing and

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curing practices.' The addition of mineral admixture in cement has dramatically increased along with the development of concrete industry, due to the consideration of cost saving, energy saving, environmental protection and conservation of resources. However, environmental concerns both in terms of damage caused by the extraction of raw material and carbon dioxide emission during cement manufacture have brought pressures to reduce cement consumption by the use of supplementary materials. Mineral admixtures such as fly ash, rice husk ash, metakaolin and silica fume etc are more commonly used in the development of HPC mixes. They help in obtaining both higher performance and economy. These materials increase the long term performance of the HPC through reduced permeability resulting in improved durability.

ROLE OF METAKAOLIN IN HPC

Metakaolin differs from other supplementary cementitious materials (SCM), like fly ash, silica fume, and slag, in that it is not a by-product of an industrial process. It is a calcined product of the clay mineral kaolinite. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. When kaolinite, a layered silicate mineral with a distance of 7, 13 Å between the layer of SiO2 and Al2O3 is heated, the water contained between the layers is evaporated and the kaolinite is activated for reaction with cement. (Fig 1)

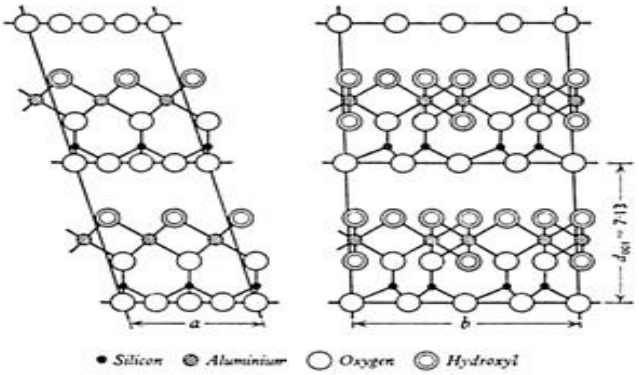

Fig. 1: Kaolinite

Calcined between 600 C and 850 C, the kaolin is transformed to an amorphous phase called metakaolin. This mineral is activated and metastable. Metakaolin can then react with cement and lime. Heating above 900 C produces mullite, a non pozzolanic material. Whenever metakaolin reacts with lime and cement, the following quality criteria are of importance:

- The amount of lime the metakaolin is able to bind.
- The velocity at which the hydrated lime is reacted. The reactivity depends upon the reactive surface and the chemical composition. Pure metakaolin contains about 44% aluminium.
- Mechanical properties of mortars and concrete are improved in terms of early strength and a denser cementitious matrix.
- Colour of metakaolin will influence the colour of final product. Higher whiteness gives lighter colour.

Reaction with Cement and Lime

Portland cement consists of about 80% calcium silicates: alite (C_3S) and belite (C_2S)

These will react with water according to the following reactions.

$C_3S + 3H = CSH + 2\ CH$
$C_2S + 2H = CSH + CH$

The final structure consists of about 75% calcium silicate hydrate (CSH) and 25% hydrated lime (CH).

The hydrated lime (CH) also called calcium hydroxide or Portlandite will react with pozzolana, forming more CSH-phases:

CH + S	CSH	gel-like structures
CH + S + A	C2ASH8	for instance Strätlingit

It is manufactured for a specific purpose under carefully controlled conditions. Metakaolin is produced by heating kaolin, one of the most abundant natural clay minerals, to temperatures of 600-850 C. This heat treatment, or calcination, serves to break down the structure of kaolin. Bound hydroxyl ions are removed and resulting disorder

among alumina and silica layers yields a highly reactive, amorphous material with pozzolanic and latent hydraulic reactivity, suitable for use in cementing applications. Metakaolin reacts with portlandite (CH) to form calcium-silicate-hydrate (C-SH) supplementary to that produced by portland cement hydration. This reaction becomes important within the interfacial transition zone (ITZ) located between aggregate and paste fractions. This region typically contains a high concentration of large, aligned CH crystals, which can lead to localized areas of increased porosity and lower strength. Metakaolin can react with some of the CH produced by cement hydration, there by densifying the structure of the hydrated cement paste. The rates of pozzolanic reaction and CH consumption in metakaolin systems have been shown to be higher than in silica fume systems, indicating a higher initial reactivity. Because this reaction with CH occurs early and rapidly, metakaolin incorporation may contribute to reduced initial and final set times. In addition, this refinement in the ITZ can result in increased strength in metakaolin concrete. As portlandite in the ITZ and elsewhere in the paste is, water soluble and is susceptible to deterioration in aggressive chemical environments, metakaolin has great potential for improving concrete durability.

Metakaolin has Edge over Microsilica

"As far as India is concerned metakaolin actually came into the market as a cheaper material than micro silica. It was only after reputed companies started using metakaolin that the product began to generate a buzz in the market." The supplementary C-S-H formed during the pozzolanic reaction with metakaolin has a lower Ca/Si ratio than ordinary C-S-H, these products are believed to be better able to bind alkali ions from the pore solution, thus reducing concrete's susceptibility to alkali-silica reaction (ASR). This potential beneficial use of metakaolin is particularly relevant, as silica fume agglomerates have been shown to contribute to ASR expansion in some cases. Metakaolin has also been shown to decrease concrete permeability, which in turn increases its resistance to sulfate attack and chloride ion ingress. Additionally, metakaolin may reduce autogenous and drying shrinkage, which could otherwise lead to cracking. Thus, when used as a partial replacement for Portland cement, metakaolin may improve both the mechanical properties and the durability of concrete. In general, metakaolin offers a set of benefits similar to those imparted by silica fume, including comparable strengths, permeability, chemical resistance, and drying shrinkage resistance. Physically, metakaolin particles measure approximately one-half to five micrometers across, making them an order of magnitude smaller than cement grains and an order of magnitude larger than silica fume particles. Both metakaolin and silica fume are typically used to replace 5 to 20 weight % of the cement.

Metakaolin is white in color, whereas standard silica fume ranges from dark grey to black (although white silica fume is available at higher cost) (Fig 2). This makes metakaolin particularly attractive in color matching and other architectural applications. For these reasons, metakaolin is increasingly used in the production of high-performance concrete. ASTM C618 and AASHTO M 295 classify metakaolin as a Class N (or natural) pozzolan.

Fig. 2: Metakaolin Mining

BENEFITS OF METAKAOLIN

- Increased Compressive and Flexural Strengths: Calcium hydroxide accounts for up to 25% of the hydrated Portland cement, and calcium hydroxide does not contribute to the concrete's strength or durability. Metakaolin combines with the calcium

hydroxide to produce additional cementing compounds, the material responsible for holding concrete together. Less calcium hydroxide and more cementing compounds means stronger concrete:

- Reduced permeability (including chloride permeability)
- Reduced potential for efflorescence, which occurs when calcium is transported by water to the surface where it combines with carbon dioxide from the atmosphere to make calcium carbonate, which precipitates on the surface as a white residue.
- Increased resistance to chemical attack
- Increased durability
- Reduced effects of alkali-silica reactivity (ASR): Alkali-silica reaction is a reaction between calcium hydroxide (the alkali) and glass (the silica) which can cause decorative glass embedments in concrete to pop out. Because metakaolin consumes calcium hydroxide, it takes away the alkali and the reaction does not occur.
- Enhanced workability and finishing of concrete: Metakaolin is very fine and highly reactive, gives fresh concrete a creamy, non-sticky texture that makes finishing easier.
- Reduced shrinkage, due to "particle packing" making concrete denser
- Improved color by lightening the color of concrete making it possible to tint lighter integral color.
- Re-bar corrosion resistance
- Prevents sulphate attack
- Resistant to acid attack (e.g. silage clamps, food factories)
- Prevents freeze-thaw damage uses
- High performance, high strength, and lightweight concrete
- Precast and poured-mold concrete
- Fiber cement and ferrocement products
- Glass fiber reinforced concrete
- Countertops, art sculptures
- Mortar and stucco

METAKAOLIN'S CONTRIBUTION TO HPC

Improved Strength: Metakaolin's reaction rate is rapid, significantly increasing compressive strength, even at early ages, which can allow for earlier release of formwork. Globally metakaolin is a very well accepted product. In India too the demand is fast picking up especially in high rise capital of India. This is because metakaolin finds use in the M60 or M80 grade concrete that is typically used in high-rise construction projects"

Improved Durability: In addition to increasing strength, the densification of the microstructure that results from the pozzolanic and hydraulic reactions of metakaolin also leads to greater impermeability. In concretes containing metakaolin at 8 to 12% of the total cementitious materials, 50-60% decreases in chloride diffusion coefficient suggest that significant improvements in service life can be achieved through metakaolin utilization in chloride environments. In addition, metakaolin has been shown to be highly effective in mitigating expansion due to alkali-silica reaction (ASR) and sulfate attack.

Improved Early Age Behavior: The relative fineness of metakaolin can result in decreased slump, but the use of water reducing admixtures or use in combination with fly ash in ternary mixes can compensate for this. Slumps of 125 to 180 mm have been achieved with metakaolin at water cementitious materials ratio (w/ cm) of 0.36 to

0.38, using 25-35% less high-range water reducing admixture than comparable mixes. Metakaolin concrete tends to exhibit a creamy texture, resulting in better finishability compared to other finely divided SCMs. This quality also improves pumpability and can be used to impart detailed surface textures to cast surfaces. In addition, the cohesiveness provided by the metakaolin allows for relatively simple formulation of self-consolidating concrete, when using an appropriate dosage of polycarboxylate water reducer. Data on the potential contributions of metakaolin to chemical, autogenous, and drying shrinkage are inconsistent, with authors reporting both decreases and increases in each form at various ages and at various addition rates. For applications with restrictions on shrinkage, additional testing, including the assessment of shrinkage-reducing admixtures and fiber reinforcement, may be advised.

Contributions to Sustainability: Because of the lower processing temperature compared to cement clinker, use of metakaolin can contribute to sustainability through energy savings, as well as reductions in greenhouse gas emissions. After examining various SCMs alone and in combination and considering performance, economic, and environmental criteria, metakaolin concrete was identified as a "very promising solution" for the precast industry for reducing clinker content in concrete.

In ternary blends with 25% fly ash and 8% metakaolin, concrete achieved equivalent strength to other concrete at just 3 days, while reducing cementitious materials content by more than 350 lb/yd3(208 kg/m3). Combinations of 25% fly ash and 3% metakaolin achieved strength equivalence by 28 days, at a w/c ratio of 0.30.

Alkali-activation of metakaolin, alone and in combination with slag or fly ash, has produced good quality geopolymers. Compressive strengths exceeding those of comparable Portland cement concrete have been demonstrated, suggesting that metakaolin may be commercially viable as an alternative binder, in addition to its currently more common use as an SCM.

QUESTIONNAIRE ON METAKAOLIN

How do I use Metakaolin?

The experiments have shown that optimal performance is achieved by replacing 10% to 15% of the cement with metakaolin. While it is possible to use less, the benefits are not fully realized until at least 10% metakaolin is used. The advantage of replacing some of the cement with metakaolin, rather than simply adding metakaolin to the mix, is that any existing color formulas or mix designs won't change, or will only very slightly change. This is because the dosage of pigments and superplasticizers are based on the cement content in the concrete. Of course, it is OK to simply add metakaolin to an existing mix, but it's important to realize that the total equivalent cement content will increase. Be aware that this will affect not only the pigment and admixture dosages but also the water to cement ratio, a critical factor in mix design. How well metakaolin behaves depends on your mix design and, more critically, on how much mix water is used. Keep in mind that any admixture must be used wisely. All the other factors (good mix design, proper reinforcing, etc) must also be properly designed and accounted for in order to take advantage of the benefits metakaolin can give. For example, making a very high compressive strength concrete is pointless if the reinforcing is inadequate.

Is Metakaolin Compatible with other Admixtures?

Metakaolin is compatible with most concrete admixtures, such as superplasticizers, retarders, accelerators, etc. If questions arise as to compatibility with any admixtures you use in your mix, consult with the admixture manufacturer for guidance.

What Effect does Metakaolin have on Colors?

Metakaolin is generally whiter than other pozzolans. Whiteness is a huge advantage over other pozzolans such as silica fume, which is a dark steel-gray, or fly ash, which is a lighter grayish

color. Because most metakaolin is light creamy-white in color, it does not affect the color of white concrete made with white Portland cement. Be aware, however, that different brands of metakaolin have different whiteness properties. Metakaolin may brighten some integral pigments. Test the color formulas to make sure that they come out the same (or better) with the use of metakaolin.

Fig. 3: PALAIS ROYALE, Mumbai

What Effect does Metakaolin have on Acid stains?

Because metakaolin aggressively consumes calcium hydroxide, acid staining concrete with metakaolin added to it might lead to disappointment. Acid stain needs the calcium hydroxide to react, and without enough of it in the concrete, the acid stain color might not develop enough, or even not develop at all.

Do I need to Change any of my Casting, Finishing or Curing Methods When Using Metakaolin?

Concrete made with metakaolin can be cast, finished and cured in almost the same fashion as ordinary concrete made without metakaolin. Metakaolin complies with ASTM C618 – Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a mineral admixture in concrete, Class N, and is accepted under 'ACI 318 – Building Code Requirements for Structural Concrete and Commentary" Available brands and applications

MetaStar 501: METASTAR 501 is a metakaolin pozzolanic additive that:

- Improves strength,durability, and workability of Portland cement concrete
- Makes Portland cement easier to apply
- Provides smoother finish
- Has bright white color for white and color plasters
- Reduces permeability, efflorescence, and cracking
- Reduces the porosity of hardened concrete
- Contains no undesirable impurities, such as carbon or sulphur, which could affect the curing rate or strength of the final PC product
- Readily disperses in cement-based systems
- Is safe and easy to handle

In India 20 Microns is considered one of the leading producers of white minerals. The company offers a wide range of products including functional fillers, extenders, and specialty chemicals. The company's mines are spread across the country. The company offers a diverse range of customized products based on specific industry requirements. 20microns has its calcined clay mines located in Gujarat, Bhuj. For the production of calcined kaolin the material has to be put through heating up to a certain temperature – around 1200. Metakaolin is an intermediary product which is produced at about 700-750' during the process.

PALAIS ROYALE, Mumbai: First project in India to use M80 grade of self consolidating concrete. The Project is around 300 metres high comprising of Duplexes and Villas in it. The developers have used metakaolin as one of the supplementary cementitious material (Fig 3).

CONCLUSION

The metakaolin is a low cost, locally produced, highly effective pozzolanic material, particularly for the early strength development, without appreciable loss in workability. It makes finish easier, reduces efflorescence, increase resistance to sulphate and chlorine attack. It maintains colour of concrete, especially in white concrete. So it can be very well used in Architectural work. As silica fume is to be imported, it is bare necessity to find locally available material at an affordable price, substitute of it. Metakaolin could be an answer to it seeing its vast exploring opportunity in India. It can bring a huge export possibility to India. The US is a high consumption market. It was during the last decade or so that people started to switch from microsilica to metakaolin there in a big way. Canada is another major market. In short as stated by "Mather" "Concrete is International and as we have air to breath, water to drink, earth to grow plant in, it is the foundation of civilization."

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USE OF ALTERNATIVE MATERIALS AS BINARY AND TERNARY BLENDS IN CEMENT AND CONCRETE

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Abstract

India is the second largest producer of cement in the world and the demand for cement is on a continuous rise. Globally, cement industry contributes about 6% of manmade carbon dioxide [1]. Hence, either the production of cement has to be reduced or the proportion of the calcined product in cement has to be reduced, if the release of the hazardous carbon dioxide is to be brought down. Alongside, there are a considerable number of waste materials which are industrial by-products, the unscientific disposal of which could cause contamination of soil, water and other natural resources.

Research has established that several such industrial waste materials have either pozzolanic or hydraulic or both pozzolanic and hydraulic properties. Using such materials as a partial replacement for cement or as an additive in concrete is found to enhance properties of the concrete. It has been possible to tailor make concrete for different applications and high performance by adjusting the volume of such materials in ternary and binary blends with cement. These materials are now known as supplementary cementitious materials (SCM). The SCM can be industrial or agricultural waste products or natural pozzolanic material.

This paper reviews the use of SCMs in concrete in binary, ternary and quaternary blends and the impact of the blending on the properties of the concrete.

INTRODUCTION

India is the second largest producer of cement in the world and the demand for cement is on a continuous rise. Globally, cement industry contributes about 6% of manmade carbon dioxide [1]. Hence, either the production of cement has to be reduced or the proportion of the calcined product in cement has to be reduced, if the release of the hazardous carbon dioxide is to be brought down. Alongside, there are a considerable number of waste materials which are industrial by-products, the unscientific disposal of which could cause contamination of soil, water and other natural resources. If alternative safe uses for these materials can be determined it would ensure "Environmental preservation in sustainable development". Besides there is a continuous depletion of raw materials and many a raw materials are facing extinction in the short to medium term [2].

Research has established that several such industrial waste materials have either pozzolanic or hydraulic or both pozzolanic and hydraulic properties. Using such materials as a partial replacement for cement or as an additive in concrete is found to enhance properties of the concrete. It has been possible to tailor make concrete for different applications and high performance by adjusting the volume of such materials in ternary and binary blends with cement. These materials are now known as supplementary cementitious materials (SCM). The SCM can be industrial or agricultural waste products or natural pozzolanic material.

There is a continuous exploration for such materials and also the percentage replacement of cement by such materials either in binary or ternary blends so that maximum benefit of use of these SCMs in concrete can be obtained and also to ensure that the quality of the concrete made with such materials is line with the expected performance from such concrete. Research has also established that several inert materials like stone dust, glass powder can also be used as supplementary cementitious materials in concrete [3, 4]. These materials despite being inert are found to enhance the performance of concrete through providing more nucleation sites for the hydraulic/pozzolanic action, better dispersion of cement particles, refinement of pore structure and increasing the packing density of concrete.

However, in the use of such materials in concrete, adequate care and caution needs to be exercised as the properties of such materials tend to vary from source to source. Also use of a Supplementary Cementitious Materials while enhancing property of concrete may cause certain negative effect on other properties. It is therefore becoming a normal practice to use SCMs in ternary or quaternary blends, so that quality of the resulting concrete is not compromised beyond requisite properties in the process of use of waste materials in concrete.

This paper reviews the use of SCMs in concrete in binary, ternary and quaternary blends and the impact of the blending on the properties of the concrete.

ROLE OF SCMs IN SUSTAINABLE CONCRETE

SCMs are used in concrete either as a partial replacement material for portland cement or an additional material along with other ingredients of concrete. It is at times also used as partial replacement of fine aggregates. While the use of SCMs in concrete reduces the CO2 imprint on the environment, the volume of SCMs in the concrete is dependent on the required properties of the concrete and also the cost of producing concrete using such SCMs. Since SCMs are by-products of different industries the quality of the SCM is dependent on the process adopted and its efficiency. The physical and chemical properties of SCMs, which pose challenges in its use in cement and concrete, are listed in Table 1.

Table 1: Challenging Physical and Chemical Properties of SCM for use in Concrete [5]

Physical Incompatibility	Effect on concrete properties
Very high fineness	Excessive water demand
Insufficient fineness	Lowered performance
High water absorption (porous particles)	Excessive water demand
Intense colour	Undesirable colour change
Chemical Incompatibility	Effect on concrete properties
Low reactivity	Low early strength
Expansive components (CaO, MgO,)	Volume instability, cracking
Corrosive components (Cl)	Corrosion of steel reinforcement
Durability impairing components (soluble alkalis, sulphate,)	Long term expansion/ cracking, efflorescence
Environmental quality	Leaching of contaminants

It is apparent from Table 1 that introduction of SCMs into the concrete can have negative effect at times. Berge 2 states that the introduction of alternative waste/recycled materials into the concrete should not down size the quality of the concrete. However, such negative effects can be overcome with the addition of admixtures, with the processing of the SCM or through the introduction of one or more SCMs in ternary or quaternary or multi blends.

The different materials identified for use as SCM and their chemical properties are detailed in Table 2. For a material to be called pozzolanic, the sum of SiO_2, Al_2O_3 and Fe_2O_3 must be greater than 50% along with maximum SO3 content of 5%, maximum moisture content of 3% and maximum loss of ignition of 6% 6. In addition, if the CaO content is greater than 10%, the material is calcareous possessing both pozzolanic and hydraulic properties. For a material to be hydraulic the ratio of either $(CaO+MgO+0.33Al_2O_3)/(SiO_2+ 0.67Al_2O_3)$ or (CaO+MgO+Al2O3)/(SiO2) has to be greater

than 1 7. The materials listed in the Table 2 satisfy either or both the requirements.

Table 2: Chemical Properties of Materials

	Chemical properties (%)								
Material	SiO_2	$Al2O_3$	$Fe2O_3$	CaO	SO_3	MgO	Na_2O	K_2O	LOI
Industrial wastes									
Silica fume [8]	97.00	0.52	0.14	0.58	0.01	0.13	0.04	0.42	1.50
Low calcium fly ash [8]	56.00	28.00	6.80	1.50	0.10	0.90	0.40	2.40	2.80
High calcium fly ash [8]	32.00	18.00	5.20	30.00	2.60	5.20	1.20	0.20	0.60
Ground granulated blast furnace slag [8]	36.00	10.00	0.50	35.00	3.5	14.00	0.35	0.48	1.70
Recycled glass powder [4]	71.00	8.00	0.90	8.50	0.40	0.38	9.80	0.37	0.36
Pulverized burnt clay [9]	54.8	19.7	8.9	0.1	0	1.1	0.3	1.5	0.74
Styrene butadiene rubber [10]	20.1	5.5	3.4	63.2	1.6	3.7	-	-	0.74
Residual calcium carbide [11]	6.5	2.6	3.3	70.8	0.7	0.7	-	7.9	1.35
Agricultural wastes									
Rice husk ash [12]	88.3	0.5	0.7	0.7	-	0.4	0.1	2.9	5.81
Palm oil fuel ash [13]	51.8	2.8	3.2	5.7	1.3	4.0	0.8	3.2	3.00
Sugarcane bagasse ash [13]	87.4	3.6	4.9	2.6	0.1	0.7	0.2	0.5	8.25
Wood waste ash [14]	65.3	4.3	2.2	10.0	-	5.3	2.6	1.9	4.67
Bamboo leaf ash [15]	80.3	2.0	1.9	6.0	3.3	1.7	0.3	3.1	0.23
Wheat straw ash [16]	50.7	0.5	0	10.6	6.1	2.2	5.4	11.4	10.0
Natural pozzolana									
Calcined clay [17]	67.4	14.7	7.8	2.2	0.2	1.7	1.2	1.2	4.01
Calcined shale [18]	65.4	14.6	5.7	2.4	0.4	2.3	1.1	2.9	0.36
Volcanic ash [19]	59.3	17.3	7.1	6.1	0.7	2.6	3.8	2.0	-
Metakaolin [8]	52.00	45.00	0.60	0.05	0.00	0.00	0.21	0.16	0.51

Table 3 gives the effect of these SCMs on the fresh and hardened properties of concrete when these SCMs are used in binary blends with cement. The effect of the SCM could however vary depending on its physical and chemical properties.

Table 3: Effect of SCMs on Concrete Properties

Fresh Concrete Properties	
Water requirements Reduced	Class F Fly ash [20, 21], Class C Fly ash [20, 21], Ground granulated blast furnace slag [20, 21]
Water requirements Increased	Silica fume [20, 21], Metakaolin [20, 21],
Workability Increased	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Calcined shale, Calcined clay [20, 21]
Workability Reduced	Silica fume, Metakaolin [20, 21], Bagasse ash [22]
Bleeding and segregation Reduced	Class F Fly ash, Class C Fly ash, Silica fume, Metakaolin [20, 21]
Air content reduced	Class F Fly ash, Class C Fly ash, Silica fume, Metakaolin, Ground granulated blast furnace slag [20, 21]
Heat of hydration reduced	Class F Fly ash, Metakaolin, Ground granulated blast furnace slag, Calcined shale, Calcined clay [20, 21]
Setting time increased	Class F Fly ash, Ground granulated blast furnace slag, Calcined shale, Calcined clay [20, 21], Pulverized burnt clay [23], Calcium carbide residue [24],
Finishability increased	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Calcined shale, Calcined clay, Metakaolin [20, 21]
Pumpability increased	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin [20, 21]
Plastic shrinkage cracking	Silica fume [30]
Hardened concrete properties	
Early strength reduced	Class F Fly ash, Calcined shale, Calcined clay, Ground granulated blast furnace slag [20, 21]
Early strength increased	Silica fume, Metakaolin [20, 21]
Long-term strength increased	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin [20, 21], Calcium carbide residue [24]
Permeability reduced	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin[20, 21], Bagasse ash [25]
Chloride ingress reduced	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin [20, 21],
ASR reduced	Class F Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin [20, 21]
Sulphate resistance increased	Class F Fly ash, Ground granulated blast furnace slag, Silica fume, Calcined shale, Calcined clay, Metakaolin [20, 21]
Resistance to freezing and thawing improved	Class F Fly ash, Class C Fly ash, Ground granulated blast furnace slag [26]
Abrasion resistance improved	Silica fume [27, 28], Ground granulated blast furnace slag [29]
Drying shrinkage reduced	Silica fume [30]

BLENDING OF CEMENT WITH SCMs

Binary, ternary and multi blending of SCMs with cement helps in enhancing certain high performance properties of concrete. However, the same needs to be done after careful consideration. Laplante et al. [28] state that silica fume tends to enhance the abrasion resistance of concrete when used in excess of 5 %. On the other hand GGBS tends to increase the abrasion resistance when its proportion is less than 25 % and further increase in GGBS quantity reduces the abrasion resistance [29].

Fly ash, silica fume and GGBS are the most popular SCMs. Thachaparambil and Thirugnanasambantham 31 found that silica fume in a binary blend with cement showed greater deterioration to sulphate attack than the control mix, but the binary blend of cement with fly ash and ternary blend of the two SCMs with cement showed lesser deterioration in comparison with the control mix suggesting synergetic effect of the SCMs in the mix. The ternary blend also showed higher strength than the binary blends of the two SCMs with cement. Shehata and Thomas 32 used 30% high calcium silica fume and 5% fly ash in a binary and ternary blend with high alkali portland cement, and studied the effect of this on the alkali-silica reaction in concrete. It is found by them that the reduction in expansion in the ternary blend concrete was 0.224%, at the age of two years, while the reduction due to binary blends of silica fume and high calcium fly ash was 0.034% and 0.112% respectively. The researchers have concluded that ternary blends play a synergic role in the concrete and are more effective in controlling the expansion due to alkali silica reaction.

Rupnow [33] has determined that the SCM combination of Class F fly ash +Class C fly ash; Class F Fly ash + GGBS and Class C Fly ash + GGBS when used in a ternary blend with ordinary portland cement, had greater compressive, flexural strength than their binary blends. Similar enhanced performance was found in respect shrinkage and chloride ingress. The coeeficient of thermal expansion showed significant reduction for ternary blends containing both Class F fly ash and Class C fly ash.

Shanahan et al. [34] have concluded that effect of SCM combinations on paste rheology was not additive and cannot be predicted from the results of their binary combinations. They also found that water demand for the binary combination of metakaolin and silica fume was not effected when fly ash or GGBS was introduced into the mix and the effect of SCM combination appeared to be additive in respect of water demand.

Parghi and Alam [4] found that fly ash, silica fume and glass powder in a quaternary blend with cement enhanced the strength properties of the concrete when compared to concretes containing the binary blends of fly ash or silica fume and ternary blend of fly ash and silica fume. Similar observations were made when styrene butadiene rubber was used instead of glass powder. Introduction of glass powder enhanced the resistance of the mix to alkali silica reaction, besides significant reduction in the water absorption.

Ramana et al. [35] found that chloride ingress into the concrete reduced when fly ash and silica fume were used as binary additives as part replacement of cement. In a ternary blend of flya ash, silica fume and cement, the chloride ingress further reduced indicating a synergetic effect. The ternary mix also exhibited higher compressive strength, improved abrasion resistance and enhanced homogeneity of the concrete.

Binary blend of metakaolin or Class C fly ash reduced expansion due to alkali silica reaction by 55-90 % and 25-37 % respectively in a study conducted by Moser et al. [36]. The ternary blend of the two SCMs with cement however showed a marginally higher expansion, indicating possible reaction between the SCMs.

Compressive strength and microstructure of mortar exposed to elevated temperatures was found to improve in the ternary blend of palm oil fuel ash and metakaolin compared to plain ordinary portland cement mix and binary combinations of palm oil,

fuel ash and metakaolin in a study conducted by Usman et al. [37]. The ternary blend was therefore fire resistant when compared to the control mix or the binary blends.

Rukzon and Chindraprasirt [38] have concluded that two ternary blends of (a) rice hush ash, fly ash and ordinary portland cement and (b) bagasse ash, fly ash and ordinary portland cement have performed better than the control mix containing no SCM or the binary mix of the SCMs, in resisting chloride penetration and corrosion. Fly ash in the mix was also found to enhance the workability.

Tironi et al. [39] blended calcined clay and limestone in a ternary blend with ordinary portland cement and could develop acceptable mechanical properties with a large reduction of energy consumption and carbon dioxide emission. Calcined shale exhibits performance comparable to that of metakaolin, but for early age compressive strength.

Temitope et al. [40] investigated the effect of blending bamboo leaf ash and pulverized burnt clay waste in a ternary blended with ordinary blended cement to conclude that there is loss of early age strength, but at later ages the strength was higher than that of the reference concrete. The workability of the concrete was reduced due to the two SCMs used and the effect of bamboo leaf ash on workability reduction was found to be more significant.

CONCLUSION

It is seen that waste materials of different industries, handling, storing and disposal of which is environmentally hazardous can be effectively used as SCMs in concrete. The chemical and physical properties of these materials can be used to produce concretes of higher strength and durability. The review also indicates that the properties of the materials could vary based on the sourcing and the efficiency of the process through which they have gone through. Some of these SCMs would require refining to overcome its incompatibility for use in concrete through the use of admixtures, use of more than one SCM in a mix, grinding, clacinating or through other means as required. The chemical and physical properties of the identified SCM are listed to serve as a ready reconer for researchers. The properties of the SCMs may not be additive or synergetic in all combinations and the same has to be verified through different methods of analysis. The volumes of the different SCMs in concrete in binary, ternary and multi blends are also to be assessed before use. Since a single failed project can overshadow several successful projects, the use of SCM on different type of projects, different environmental conditions and different design and construction requirements have to carefully analysed before adoption.

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A REVIEW ON SUSTAINABLE MATERIALS FOR AFFORDABLE AND ENERGY EFFICIENT CONSTRUCTIONS

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Abstract

Sustainable building materials are those materials which can reduce the burden to the environment. In present situation, building construction and operation contributes around 50% of all carbon dioxide emissions worldwide. Around five to ten tons of cement is required to construct an average middle class house, and for every ton of cement manufactured, approximately a ton of carbon dioxide is released, (Department of Local Government and Housing. 2007),polluting the environment. Therefore, materials emitting low CO2, structurally rigid, thermally sound and efficient and inexpensive materials should be selected for modern constructions which are otherwise called as green or sustainable building materials. These materials would have great potential for building such as sandbag construction, thatch, bricks, stone, and the use of recycled materials. Other low-cement options, includes compressed earth blocks are currently being investigated and proposed for sustainable future designs. Therefore, the construction industry must recognize that developers, designers, builders and suppliers who have a responsibility to develop systems, products and methods that are environmentally friendly.

In this paper, an attempt is made to discuss various types of sustainable construction materials which prove to be efficient in reducing the co_2 emissions.

INTRODUCTION

Selection of building materials are the most important part in the construction industry. Because the structural stability, strength and life of a structure mainly depends on the quality of the materials used. Moreover, now days the construction waste contributes to around 40-50% of the total waste generated worldwide (sources 2007). In order to reduce the environmental pollution caused by these construction and demolition waste an alternate option should be searched. Recyclable vs. Green vs. Sustainable Materials; Recyclable: A material that can be used again. Green: A material that has at least one positive environmental characteristic. Sustainable: A material that meets the needs of the present without compromising those of future generations. A modern sustainable building has to be a low construction impact while being energy efficient, long lasting, non toxic and aesthetics. Sometimes the mass-produced materials seem to be the right choice to serve these goals, but also we have to take into consideration, how and where they are produced, and how it is after the building's life cycle.

Many alternative materials for construction are available in market. Adopting these methodologies needs following considerations.

- The construction systems available shall ensure safety and shall be in compliance with the code of practice.
- The materials of construction should be easily available at reasonable price.
- The trained workforce should be available for construction activities resulting less dependence of labour.
- Locally available service systems like sanitary, water supply should also match to the newer systems.
- The maintenance should be minimum and structure shall be durable.

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Following are some of the alternative materials considered:

It is important to use local and unprocessed building materials that minimize transport and manufacturing energy and air pollution. This also creates local employment. The more localized the project, the more money stays within the community.

STRUCTURALLY INSULATED PANELS

Structural Insulated Panels (SIPs) are engineered building components made by joining high performance rigid insulation to oriented strand board, wafer board or plywood. The core, which is lightweight but relatively thick low density, is made of expanded polystyrene, extruded polystyrene or rigid polyurethane. They are used as floors, walls and roofs for all kinds of buildings. The panels are typically made by sandwiching a core of rigid foam plastic insulation between two structural skins.

These design capabilities, as well as the exceptional strength and energy saving potential, makes structural insulated panels an important twenty-first century building material for high performance buildings.

Construction

Installation of such wall panels require well established floor system (Fig.1&2). All the panels will rest on their edge to the beams spanning between the piers. A secondary member is needed tying the panels into the beams and making the beam rigid. Notching of panels is inconsistent with industry practices and may create stress fractures at the joint. At the end panel, there is dimensional lumber at the end and the stress fractures should be contained, but this can easily be avoided with plate modifications.

The screws cannot be driven straight because it will hit the concrete foundation. These screws are tying both the bottom plate of the wall and the floor system to the foundation plate not the concrete piers. This detail was modified by the manufacturer and clearly deviates from the engineering drawing set.

Notching of panels is inconsistent with industry practices and may create stress fractures at the joint. Because this is an end panel, there is dimensional lumber at the end and the stress fractures should be contained, but this can easily be avoided with plate modifications.

Fig.1: Installation of SIP

Fig.2: House made by SIP

Following are the steps to install panels:

- Installation of bottom plate: Connection to foundation system or horizontal plate.
- Installation of panel one: SIP panel slips over bottom plate. Blocking installed in window penetrations at window opening.
- Installation of spline
- Installation of band plate and top plate: installed with 2x6 #3 or better. Plates must be tied together horizontally with and to the panel, and must be tied together vertically.

AUTOCLAVED AERATED CONCRETE

Autoclaved aerated concrete (AAC) was

developed by Swedish architect Johann Axel Eriksson in the early 20th century and patented in 1924. The material is a mixture of sand, lime, cement, gypsum, water and an expanding agent that is cured in a pressurized steam chamber, called an autoclave, producing a cellular lightweight material.

AAC is a lightweight manufactured building stone. Comprised of all natural raw materials, AAC is used in a wide range of commercial, industrial, and residential applications and has been in use in Europe for over 70 years, the Middle East for the past 40 years, and South America and Australia for approximately 20 years.

The blocks are available in a variety of sizes and types, e.g., 1) standard blocks, typically measuring 24 inches long, 8 inches high, and in thicknesses between 6 (nonload-bearing) and 12 inches; 2) jumbo blocks, which reduce construction time; 3) U-blocks, which have a channel running the length of the block that once filled with concrete, provides structural support as headers and on the top course of each floor (the "bond beam"); and 4) cored blocks, which are used adjacent to corners and openings and have a centered, 4 inch vertical core at one end of the block to form a continuous vertical core through the wall that is then filled with rebar and concrete. Exterior surfaces can be finished with stucco, traditional veneers or siding, while interior walls can be plastered, painted, or left unfinished, in addition to traditional sheetrock finishes.

The walls, floors and roof of a building can be constructed with the system. Using one material to build the entire structural and insulation part of a building offers many advantages, allowing excellent design flexibility, quick construction and reduced waste.

Due to AAC's excellent insulation qualities, energy consumption for the heating and cooling of buildings are greatly reduced compared to most conventional wall and roof systems. In the finished structure, no pollutants or toxic substances are released that could affect indoor air quality, even in the event of fire.

The solid wall construction of a building made of AAC provides excellent sound abatement, greatly reducing outside environmental noise, providing a quieter, more comfortable interior for the occupants.

AAC has proven to be a very durable material. There are numerous structures worldwide, many over 50 years old, in excellent condition. AAC will not rot, warp, rust, corrode, or otherwise decompose. AAC provides a very low maintenance building, saving considerable time and money in upkeep over the life of the building

INSULATING CONCRETE FORMS

Insulating Concrete Forms (ICF) have become very popular as owners and builders look for alternatives to conventional wood frame systems. These stay-in place forms tout many advantages over wood frame, concrete and masonry systems. ICFs can be separated into two major categories: the shape of the form itself and the shape of the concrete within the walls. The units are shaped in panel, plank and block forms (Fig.3).

Panel forms usually come in 4' X 8' sizes; planks are normally 1' X 8'; and a common size for the block unit is 16" X 4'. The forms usually have teeth or grooves along the edges that connect the pieces together. The other category is the shape of the concrete within the walls. These shapes come in a flat, grid or post and beam shape.

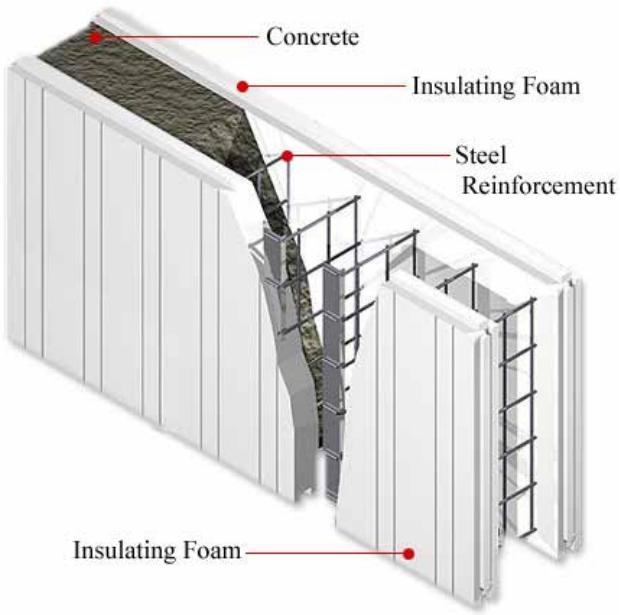

Fig. 3: Insulating Concrete Forms Installation

STABILIZED MUD BLOCKS

Earthen buildings have been built for thousands of years, and there is a strong tradition of earthen structures on the African continent. Traditional mud huts were the most common form of building before the advent of modern architecture and planning. Earth buildings still shelter more than a third of the world's population. Recently there has been a worldwide resurgence of interest in earth building, especially in developing countries where local earth is the most accessible source of building material. However, most soils do not contain the mix of clay, silt and sand required for good brick making.

Compressed stabilized earth blocks have the following advantages:

- An earth block walling system is much cheaper than bricks. The use of local soil and on-site manufacturing saves on transport costs and fuel consumption, especially in remote areas with poor road infrastructure.

  Pressed earth blocks have a low embodied energy value of around 0.42 MJ/kg and a negligible carbon foot print.

- Earth structures have good thermal properties which save on heating and cooling costs. A study by the Institute of Technology, University of Fort Hare found that traditional mud huts offer better thermal comfort than low-cost RDP houses, and ash brick houses had a better thermal performance than RDP houses (Makaka, G and Meyer, E. 2006).

- Stabilized block making is a non-toxic and environmentally safe process.

- Earth blocks are fire, noise and bug resistant.

- It is a labour-intensive brick-making process that can be easily taught, and the stabilizer can be used in remote areas to create earth building material.

FLY ASH BRICKS

The Fly Ash Bricks are promoted as an alternative to burnt clay bricks within the construction sector in India. Fly-Ash Bricks are an environment friendly cost saving building product. These bricks are with consistent strength. These bricks are ideally suited for internal, external, load bearing and non-load bearing walls. Fly Ash Bricks are durable, have low water absorption, less consumption of mortar, economical and eco-friendly, low energy consumption and no emission of greenhouse gases. These bricks are not affected by environmental conditions and remain static thus ensuring longer life of the building. Also, the savings with regard to wastages in fly ash bricks are considerable during unloading and construction due to true shape and size, consistency in quality, and the workability of the fly ash bricks unlike traditional clay bricks. These bricks are very economical / cost effective, nil wastage while transporting and handling.

The raw materials used for fly ash bricks are fly ash (45%), sand/stone dust (40%), lime (10%) and gypsum (5%). To manufacture fly ash bricks, first we have to mix fly ash with cement, sand and water

and then the mortar should be poured into moulds and then dry in atmospheric temperature proceeded with curing of 28 days. Different size and shapes of fly ash bricks can be obtained through the moulds.

Fig. 4: Building Made of Fly Ash Bricks

There are specific uses of fly ash bricks in green building and LEED projects (Fig.4) because they are considered as recycled materials. These bricks help in reduction of carbon footprint on environment and hence these bricks make the construction sustainable.

Quality of Fly Ash Bricks

- Eco-friendly material
- Reduces CO2 emission and balances the environment.
- Three times stronger than conventional clay bricks.

Present Scenario on Fly Ash in India

In India, over 75% of the total installed power generation is coal-based and around 230-250 million MT coal is being used every year. From this coal, around 110 million MT of ash is generated every year. Hence usage of such ash by-product into construction activities as a cement replacement material will reduce the burden over environment and helps in recycling the fly ash products.

A comparison of different sustainable materials is given in Table 1.

Table 1: Comparison Between Sustainable Building Materials

Structurally Insulated Panels	• Good insulation properties, • Easy to manufacture, • Can be easily automated and deployed, • Reduced workforce and time. • It offers versatility can be used in a wide variety of buildings
Autoclaved Aerated Concrete	• It is an environmentally friendly construction material. • Raw material consumption is very low for the amount of finished product produced. • In the manufacturing process, no pollutants or toxic by-products are produced. • It is also completely recyclable. • Aerated concrete have excellent insulation qualities, therefore, energy consumption for the heating and cooling of buildings are greatly reduced compared to most conventional wall and roof systems. • No pollutants or toxic substances are released in the finished structure, that could affect indoor air quality, even in the event of fire. • They have proven to be a very durable material. • AAC will not rot, warp, rust, corrode, or otherwise decompose.
Insulating Concrete Forms	• High energy efficiency • Safety and disaster resistance • Indoor air quality and comfort • Moisture and water management

Stabilized Mud Blocks	• An earth block walling system is much cheaper than bricks. • The use of local soil and on-site manufacturing saves on transport costs and fuel consumption, especially in remote areas with poor road infrastructure. • Earth structures have good thermal properties which save on heating and cooling costs. • Stabilized block making is a non-toxic and environmentally safe process. • Earth blocks are fire, noise and bug resistant. • It is a labour-intensive brick-making process that can be easily taught, and the stabilizer can be used in remote areas to create earth building material.
Fly ash bricks	• High Fire Insulation • Due to high strength, practically no breakage during transport and use. • Due to uniform size of bricks mortar required for joints and plaster reduces almost by 50%. • Due to lower water penetration seepage of water through bricks is considerably reduced. • Gypsum plaster (plaster of Paris) can be directly applied on these bricks without a backing coat of lime plaster. • These bricks do not require soaking in water for 24 hours. Sprinkling of water before use is enough.

CONCLUSION

From the features of all construction material which are socially, economically beneficial for construction industry and human health. Such sustainable materials reduce environmental pollution content, greenhouse gas emission, resource depletion, etc. Developing country like India needs much of these recycling materials or industrial by products which can be effectively utilized in infrastructure construction. We can efficiently plan for low cost affordable housing by increasing the standard of living in rural areas. Hence there is an urge to use the eco-friendly materials for the better tomorrow and healthy life of coming generation and economic development of the nation.

Green building reduces the impact on environment and indirectly helps to reduce the global warming effects. As the general public becomes more aware of the benefits of green buildings, developers will get creative and find new ways to brand and market green buildings, hence creating a conductive atmosphere for the sector to grow exponentially.

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ENVIRONMENT PRESERVATION IN SUSTAINABLE DEVELOPMENT: AN INTEGRATED APPROACH CONSIDERING ZERO WASTE PRACTICES AND LOW CARBON PATH

NEERAJ SUHAG*

Abstract

Industrialization, along with urbanization and economic growth, brought environmental degradation and exploitation. Since the age of mechanization, economic growth globally has increased to 5 times whereas world's ecosystem services have degraded by 60 percent. In 1962, the earth used to take 0.7 years to regenerate its annual biological harvest, whereas today it takes 1.25 years to regenerate. The enormous strain on environment urges the international agenda to preserve environment and make the development more sustainable.

The paper reviews historic theories on environment preservation which marched towards sustainable development, zero waste practices and path to low carbon cities which all plays a significant role in conserving natural resource management. The study investigates Pune's zero waste strategies for environment preservation. The paper concludes with the investigated relationship of Human Development Index with Environmental Performance Index through Environment Kuznets Curve and finally a conceptual framework for low carbon city.

INTRODUCTION

With the advancement of science and technology as well as dynamically enormous global level of economic activities, resulted a dramatic increment in the consumption and production rate of natural finite resources and waste respectively; causing an anthropogenic alternation in the atmospheric composition leading to climate change affecting and endangering the key stone species of diverse and different ecosystems.

The globe is marching forward towards an uncertain future with continuous depletion of natural finite resources resulted due to exponential growth rate of urban population and their over consumption. Therefore, to tackle with such situation a strategic management system is required in conserving the finite natural resources and least waste production. Studies find out that certain global finite natural resources whose recycling rate is significantly low around the globe such as Mercury, Cadmium and Tellurium will experience permanently shortage or shortfall in global supply within the next two to three decades so, need of the hour is the resource waste management and zero waste practice which includes 100 percent recycling of solid waste and recovery of all possible resources from waste materials. Zero waste concept emphasis on shifting societies from 'Low to No Carbon Emission'. In 1973, Dr. Paul Palmer gave this 'Zero Waste' concept for recovering resources from chemicals (Palmer, 2004). Such cities leave out no harmful waste for our environment and also urge us to consider resource conservation and product stewardship.

This enormous waste and pollution has become a potential environmental threat for the world and hampering the natural resource balance hence, resource and waste management has become crucial in safeguarding the environment and human being. After the industrial revolution, transformation of society from production driven to consumption driven which generates an enormous amount of waste, pollution (GHGs) and resource depletion brought out the most

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visionary concept of tackling growing waste problems through' Zero Waste Practice'. Zero-waste is a closed loop paradigm initially aiming in the elimination of unnecessary waste then marching towards optimum recycling or resource recovery from the waste with a guiding principles such as minimization of waste throughout the supply chain.

Waste from high consuming countries can be used as resources for low consuming countries e.g. e-waste, so until and unless it doesn't have any resources or economic value, it can't be termed as 'waste'. Waste is defined as garbage, refuses or abandoned materials which have no functions for anybody and have no economic values. Potential life cycle stages of product of the waste manegement chain pass through the manufacturing, production and consumption stages where various processes minimise the waste (Fig.1).

Fig. 1: New Waste Management Paradigm

Source:http://www.terutalk.com/images/LA_County-waste management paradigm-lg.JPG

URBANISATION

Human population took 3 million years to touch 1 billion in numbers (by 1880s) and now it takes every 12-14 years to gain 1 billion people whereas everyday 200,000 people grow around the world (Cointrean S., 2007). Over the last two decades or so, two major factor behind increased CO2 emission are population and economic growth (Pani and Mukhopadhyay, 2010). In 1900, only 15 percent of the world's population resided in urban areas whereas today more than 50 percent i.e. 3.2 billion people live in urban areas. According to the United Nation's projection, about 60 percent of the world population i.e. 4.9 billion people will be residing by 2030 and by 2050, this projection will touch 70 percent of the entire global population living in urban areas.

Global rapid urbanization pattern also has an impact on India's urbanization, which is increasing rapidly as never before. Estimates show that India's urban population will be doubled in the upcoming 2-3 decades. United Nation (2012) has predicted that in India, number of people residing in urban areas will be increased to two times i.e. 814 million people (reach about 55 percent urbanization level) by 2050 and will be the second largest in the world after China. According to Census of India (2011) about one third of the India's population live in cities where the growth percentage was nearly 32 percent in year 2001-2011, whereas rural population growth was 12.2 percent. In the year 2000, number of cities over 1 million population was 31 with 3 cities having more than 10 million population but by 2050, 63 cities would be there with more than 1 million population of which 6 cities would have population more than 10 million (Table 1 and Fig.2).

Table 1: Urbanization Status and Trends in India

Size Category (population)	No. of cities (% of urban population)		
	1975	2000	2025
>10 million	0 (0)	3 (15.5)	6 (21.4)
5-10 million	2 (11.3)	3 (6)	3 (4.5)
1-5 million	8 (13.7)	25 (14.7)	54 (19.5)
0.5-1 million	17 (8.3)	38 (9.4)	75 (9.6)
<0.5 million	~ 3,000(66.8)*	~ 4,000 (54.5)	~ 6,000 (45)

Source: World Urbanization Prospects 2011 revision, UN Population Division

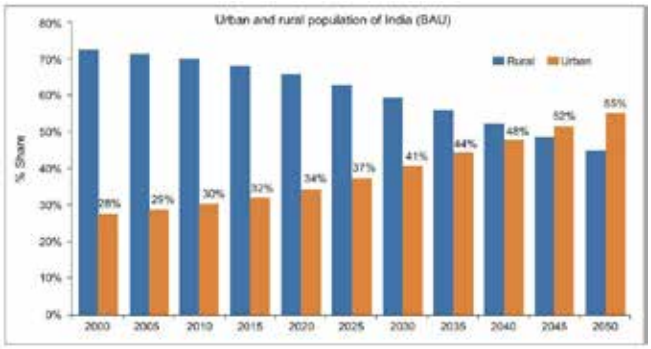


Fig. 2; Growth of Urbanization

Source: https://esa.un.org/unpd/wup/Country-Profiles

Urban population shares 60 percent of the India's GDP and would contribute nearly 70 percent of the national GDP in the next 2 decades (Indian Urban Infrastructure and Services, 2011). This tremendous urbanization growth has brought along with it many challenges such as increased energy demand, increased waste accumulation, and stress on existing resources and infrastructure with exponential increment in pollution level.

CLIMATE CHANGE

Climate is rapidly changing at an unprecedented pace and scales (IPCC, 2013) and there is much less global consensus in tackling this climate imbalance effectively, efficiently and in fairly competent manner. However, in the last decade, urge for strong consensus in the international agenda on stabilization of the GHGs and its emissions cannot be achieved without contribution and participation from developing countries, which presently emit about 50 percent of the global carbon dioxide emissions. And under "Business as Usual" (BAU) scenario would further increase at faster rate than the developed countries (den Elzen and Hohne, 2008). However, in developing countries climate change is a serious issue because as these countries urbanize, they will contribute disproportionately high CO2 and GHGs emission than in comparison to this population growth share. In 2000, out of global CO2 emission percentage, 59 percent were emitted by the developed countries and remaining by developing countries. But it is estimated that by 2020-2030, emission of developing countries would surpass the limit of emission of developed countries, and shall emit six times more than their present level and three times more than developed countries by 2100 (Yanase, 2005).

Across the globe, urban areas are the 'guzzling engines of energy and carbon' (Sethi, 2015) because of unprecedented demand of fossil-carbon to fuel their economics. Globally, 50 percent of the population lives in the cities which cover only 2 percent of the world's surface which consume over 75 percent of the world's natural resources and generate over 75 percent of all waste and pollution (Prevez Hayat, 2014). Urbanization has triggered the exceptional growth in our cities causing huge strain in the city's infrastructure and to cater this strain, city authorities need to resolve out the smart solutions.

In the last few decades, rapid climate changes caused by human activities has increased the pace of fluctuations between cold and hot periods such as, in 20th century, the global average temperature has risen by 0.4 to 0.8 degree Celsius and by the year 2100, will rise by 1.4 to 5.8 degree Celsius (Pani and Mukhopadhyay, 2010) which not only increases the global average temperature but also leads to rise in the sea level, ice melting at alarming rate and also gives rise to changes in wind pattern and so on.

This rapid change in climate is affecting the basic necessities of the people's lives such as access to water, food and also has major impact on societies, ecosystems and economics. For example, one metre rise in sea level will flood 17 percent of Bangladesh's land mass and will also threat coastal cities such as New York, Mumbai, London, etc. (APA, 2008) and as a result, hundreds of millions of people could experience water, food and housing shortages as well.

Stern (2007) under his economic model estimated that climate change costs us loss of 5 percent of GDP every year and will further continue to increase damage in GDP up to 20 percent over a period of time. Thus climate change has a vital role on societies, ecosystems, economies and also impacts the sustainable development. The primary cause of increase in GHG emissions and global warming is due to increased carbon-based energy consumption. So, there is an urgent need of shift from carbon based development to low-carbon based development.

Before the industrial revolution, the GHG level was 280 parts per million (ppm) in the atmosphere, whereas in 2008 this concentration level has reached to 480 ppm. This is due to increase in human induced GHG emissions in which energy

supply sectors are the major and topmost pollutant or emitter of GHG emissions, from transportation, agriculture, industries, buildings and the like.

Table 2: Probability Ranges for Temperature Increases and Related Risk

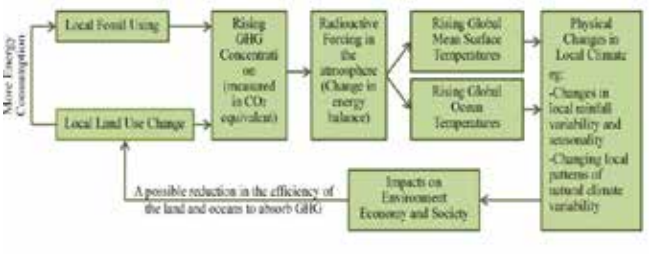
GHGs concentration level (CO_2 e)in ppm	Global Mean Temperature increase	Various risks induced due to particular rise in temperature
445-490	2.0-2.4	-Increase in Hunger rate (25-60% mainly in Africa and Asia) -Coral reef ecosystems extensively and eventually irreversible damaged
490-535	2.4-2.8	-Suffer water shortage -Crop yield decline
535-590	2.8-3.2	Onset of Amazon rainforest collapse
590-710	3.2-4.0	Many species face extinction (20-50 % in one study)
710-855	4.0-4.9	-Hurricanes intensity doubled on coastal areas -Melting of Greenland ice sheet at rapid rate
855-1130	4.9-6.1	-Yield in many developed regions decline even if strong carbon fertilization -Entire regions experience major decline in crop yields (one third in Africa) -Increase in sea level threatens major world cities London, Mumbai, and New York etc. -Major rain forests would collapse

Source: IPCC Fourth Assessment Report and The economics of climate change, N. Stern (2007)

Some slow changes resulted due to climate change estimates that if the concentration level of the GHG held at year 2000 level, a 0.2 degree Celsius warming would still be expected over the next 20 years and also estimate that if the temperature rises more than 2 degree Celsius, then nearly 33 percent of the earth's species could be at risk of extinction and if the sea level continues to rise, after several years, the world's land mass could disappear (Table 2). Therefore, it's time to think about climate change issue and ways to deal with it.

Local authorities through local actions can play vital role in reducing greenhouse gas emissions as one such significance was highlighted in the Brundtland Report in 1987 and also in the Rio conference 1992, which brought out cities sustainability concept. It is widely adopted as global sustainable development strategies in which addressing the climate change issues and environmental performance act as a key component. As stated by Betsill in 2001, global climate change has a critical "local dimensions" where local jurisdiction can address climate change through integrating the best local land use planning with principles such as compact or mix- land use strategies (Fig.3).

Fig. 3: Link between GHG Emission and Land Use Change



Source: The economics of climate change, N. Stern (2007)

Various relevant studies show that the increase in anthropogenic GHG emissions are primarily due to local burning of fossil fuels and land use changes. Local land use planning plays a vital role in minimizing climate change impacts (Tang, Hussey and Wei, 2009). Climate change and low carbon level can be addressed through local land use planning by two basic approaches; one is 'Mitigation' and other is 'Adaptation' which act as planning tools to achieve the sustainable development and modifying cities low carbon (IPCC, 2007a; APA, 2008).

Currently in global GHG emitters, India ranked fourth though its per-capita emissions are less than 50 percent of global average and in the India's emission sectors, major contribution is from energy, transport, industries and agriculture in which transport sector accounts 13 percent of the GHG emission (INCCA, 2010). Sustainable strategies (like low carbon path) can help in mitigating GHG emissions in which one strategy is promoting 'Low Carbon Transport' (LCT) in India through an amalgamation of effective measures such as e-vehicles, increased use of public transport and higher penetration of bio-fuels etc. Making policies at the national level to achieve sustainable growth and enhancing cities growth with lower resource consumption and GHG emissions are the two main objectives of the low carbon paradigm.

Developing countries' desperately desire for the wealth and economic development, and following the same consumption pattern and same track

for development is going against the nature's limit and destroying the ecological system on which life totally relies. One such example is increase in global warming and rapid climate change which resulted in melting of ice caps and glaciers at a faster rate leading the rise in the sea level and its temperature affecting the underwater flora and fauna such as coral reefs which are dying at a fast pace.

The need for sustainable development shows optimistic correlation between economic development and GHG per-capita emission which indicate us two things; first developing countries cannot follow the same economic path or pattern as by developed countries, and second challenge is to meet global demand and economic development without depleting the environment.

Sustainability is the harmonious correlation between ecology and human systems and ensures the long term needs of the human by conserving and allowing the regeneration of the natural resources and aimed at combating the problems (pollution, waste, etc.) through its three domains: ecological, economical and social leading towards the diverse habitat development.

Berke's in 2008 gave five pillars of green and sustainable cities which are oriented to somewhere with Low Carbon cities which are as follows (Table 3):

- Harmony with natural systems- Nature oriented
- Human health- Man oriented
- Livable built environment- Shell(Habitat) oriented
- Spiritual wellbeing and renewal- Society oriented
- Fair share community- Network oriented

Historic movements marching toward sustainability; and focusing the human health with conserving the environment all the time in which eco-city has all the elements of sustainable development.

Table 3: Through Visions of Planning Theories Promulgated Pillars of Low Carbon City

Urban Form	Nature oriented	Man oriented	Society oriented
Garden city	-Green Belts -Surrounded by agriculture lands	-Pure air and water	
Broad acre city	-Ecosystem part of an organic and built environment		-Lifestyle attached to land -Jeffersonian agrarian ideal
Radiant city		-Cure pollution and diseases	-Efficient -Neatness and self-control
Modern environmental movement	-Design with Nature -Land classification and sustainability	-Safety from disasters	
Eco-city	-Self contained	-Biodiversity	-Natural lands

Source: Building Low-carbon Cities through Local Land Use Planning: Towards an Appropriate Urban Development Model for Sustainability (Ting Wei, 2011)

ZERO WASTE CONCEPT DEVELOPMENT

Zero waste concept has a circular process (cradle to cradle) rather than traditional linear process (cradle to grave) in which first stage is reduce waste and its by products, second stage is reuse items as often as possible and third stage is recycling items which cannot be reused as raw materials.

Steffan Lehmann (2011) gave five principles to achieve Zero Waste City:

- Behavior change and sustainable consumption
- EPR (Extended Producer Responsibility)
- 100% recycling of Municipal Solid Waste
- Legislated zero landfill and incineration
- 100% resource recovery framework

Example of zero waste strategy in India: Pune (Maharashtra 2nd largest city) produces 1600 tonnes

of garbage daily. "Zero Garbage Pune" through "Zero Waste Ward Model" is a pioneering project for sustainable management of waste in tandem with the Swachh Bharat Mission. Pune Municipal Corporation's (PMC) zero waste strategy has crucial success factors: a) Waste segregation at source, b) Public awareness, c) Decentralized processing of waste (using different techniques like vermin-composting pits, bio-sanitizers, bio-methanation, and organic waste converter) d) Community composting system, and e) Incorporation of informal economy; which all attained through policy adopted by municipal corporation along with some incentive such as households are given dry and wet bins as an incentive, and property tax rebate for practicing eco-friendly method vermin-culture. Zero Waste Ward (ZWW) model adopted in Katraj Ward in 2010 where waste segregation at source increased from approx. 10% to 70% by 2012 and reduced waste sent to landfills from 10 tonnes/day to 2 tonnes/day and saved transportation cost (Fig.4).

Fig. 4: Closed Loop Flow of Material and Waste

Human development has optimistic correlation with environmental performance (Fig.5). Human development Index (per-capita income, education level and longevity) is one of the key factors of the development of the country. It also includes social variables such as health effects, political rights and civil liberties which are mutually connected as the level of education and awareness affect the political

Table 4: Pillars for Transforming Current Cities into Zero Waste Cities

Source: The zero waste index: a performance measurement tool for waste management systems in a 'zero waste city' by Steffen Lehmann and AtiqUz Zaman (2013)

HUMAN DEVELOPMENT INDEX VS ENVIRONMENTAL PERFORMANCE

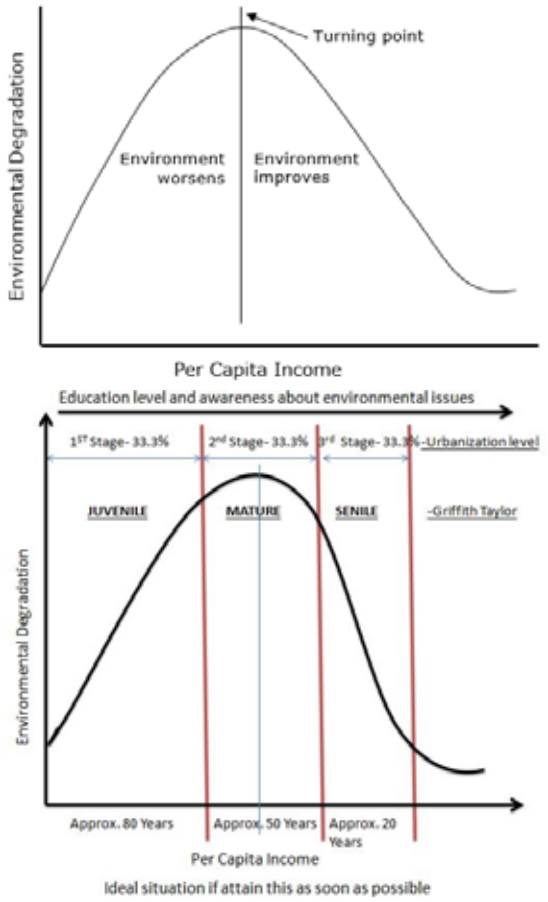


Fig. 5: Environmental Kuznets's Curve

reach top criteria as set by Maslow hierarchy (from basic need to self-fulfillment needs) i.e. turning point and will start getting awareness related to environment issues. People feel more concerned about the environment issues and will start forcing the government to implement environment concerned policies and strategies.

Income, education facilities and need for good infrastructure (both social and physical) and rights and civil liberties. Initially, increased per-capita income searches for better education facilities which decline population growth rate due to awareness and subsequently less pressure on the natural resources and as the income proportion increases they will also environmental issues is directly proportional. Yes, initially for the setup of good infrastructure there will be a problem of environmental degradation. If that infrastructure is applied through sustainable approach, we can mitigate that environmental degradation to lesser account. Once we crossed the turning point, environmental degradation will be in direct relationship with per-capita income.

If graph is divided into three categories according to the stages of urban development and apply it to India, our country entered in the second stage of the development which has crossed 33% limit of the first stage and the target to achieve or cross second stage i.e. 66 % within the lowest environmental degradation through sustainable approach (not under the 'Business as Usual' scenario) and towards the third stage i.e. sustainability within shortest time span – Ideal situation.

Framework for Low Carbon city model has three main classifications as (Fig.6):

- Low carbon city structural- to collect spatial data related to city
- Local jurisdiction governance- to prepare a long range policy
- Monitoring and evaluation- to supervise and assess the outcome

Fig. 6: Conceptual Model of Low Carbon City Land Use Planning

Source: Building Low-carbon Cities through Local Land Use Planning: Towards an Appropriate Urban Development Model for Sustainability (Ting Wei, 2011)

CONCLUSION

The objective of the paper is to integrate city's development or master plan with carbon issue. To implement sustainable development and to reduce GHGs emissions, it needs concerned and coordinated action at multiple levels through various levels of governance. Hence the need of multi-level governance paradigm for low carbon cities.

Principles of a low carbon city which helps in reducing the amount of CO_2 emissions are: a) Carbon minimization strategies at all level and b) Comprehensive local land use planning, which will be achieved through use of energy efficient design, using renewable energy, and appropriate spatial planning strategies. Local authorities can act as a facilitator and mediator in making low carbon cities and urge the state and central government to enact policies with respect to reduction in the GHG emissions and in management of energy and resources which are in direct contact or have direct control over emissions.

Environmental degradation is an irreversible process therefore sustainability with zero waste practice is the need of the day in making cities eco-friendly and future sustainable.

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GREEN BUILDING CHARACTERISTICS WITH SUSTAINABLE BUILDING MATERIALS AND ENERGY CONSERVATION

S.K. DHAWAN*, NABEEL KHAN AND B. BHATTACHARJEE*****

Abstract

The infrastructure development of the last few decades has resulted in higher resource consumption leading to environmental degradation. Use of large variety of manufactured building materials, high level of mechanization, and high energy resource has put a lot of strain on environment. The excessive consumption of land and other resources due to rapid urban growth causes depletion of its resources and may not be sustained in future. Today, sustainability of built environment is a big challenge due to inadequacy of land, water, energy and non-availability of clean air. The unprecedented rise in population has resulted in unplanned and haphazard development, migration to cities, incompatible land use, over-exploitation of resources, environmental pollution and all such associated problems.

This paper brings out the advantages of green building practices and measures required for saving energy by using green materials to reduce adverse impact on built environment including human health and natural environment. This could be mitigated by efficient use of energy, water and other resources: protecting human health and improving productivity, reducing waste, pollution, and environmental degradation. This paper also highlights that by using green materials, we can take the advantage of renewable resources, reducing energy use and reduced waste.

INTRODUCTION

Sustainability is the capacity to endure or support sustainable materials that would meet the current needs and requirement with the ability of future generations to meet their needs. Use of sustainable materials; energy, materials and water with increased efficiency for its production and induction, while reducing the impact on human health and environment during the life cycle, up to demolition, disposal or recycle and reuse the construction waste by use of recycled aggregates.

Global population and resource consumption are increasing very fast. The production wastes are increasing in spite of use of modern methods causing problems of pollution and water management. The humanity is now consuming over 20% of environmental resources than nature can produce. By measuring the footprint of a population, individual, city, business, nation, or all of humanity — we can assess our pressure on the planet, earth, causing negative impact on environment. There is need to manage our ecological assets more wisely and take personal and collective action in support of a world where humanity lives within the earth. The important measures for achieving growth and sustainable development are:

- Minimize the impact of climate change using appropriate adaptation and mitigation technologies.
- Address socio-economic development (poverty reduction, local job opportunities etc.)

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- Meet the requisite sustainable development goals.
- Push country's natural resources towards reducing carbon footprint.
- Harness the potential of local resources and developing technologies suitable for rural and urban development.
- Use smart technologies like energy efficient technologies.
- Maximize the use of local resources to meet the local needs.

By re-engineering materials used in the built environment we can reduce the consumption including wastes that could deliver environment friendly and cost effective solutions.

GREEN BUILDING FEATURES

Building envelope acts as a membrane which filters unwanted external influences, shall allow light to enter for visual comfort with least need for artificial lighting and block the heat in tropical climate for thermal comfort. The building envelope needs to be designed to receive at least 75% of natural daylight to reduce the energy consumption. Proper site selection, enhanced outdoor lighting, system efficiency, efficient water use during construction are needed.

Green Buildings or sustainable buildings are those that are constructed in an environmentally responsible and resource efficient manner, which would be green and clean throughout their life cycle - construction, maintenance, renovation to demolition. This requires a close connection between design, planning, landscaping, building and construction and energy generation and usage.

Green buildings is the practice of use of resources like energy, material and water with increased efficiency while reducing impact on human health and environment during the life cycle of building through better site planning, design, construction and maintenance. Factors affecting the sustainability of built environment are the life cycle energy implications, greenhouse gas emissions, contribution to natural resource depletion including use of fossil fuels. Green buildings need to be designed with proper site assessment, energy efficiency, material efficiency, water efficiency, air quality, proper waste management consistent with practices prescribed by Indian Green Building Council.

Green Buildings need to be designed with proper site assessment, energy efficiency, material efficiency, water efficiency, air quality, solid waste management etc. According to Indian Green building council (IGBC); there should be minimum disturbance to nature, use of recycled building materials, efficient use of water, use of eco-friendly equipment, use of renewable energy etc.

USE OF SUSTAINABLE MATERIALS

Sustainable building materials are environmentally friendly materials or recyclable and are sustainable in their use of resources – water, energy light etc. The buildings with their efficient use of resources reduce waste, pollution and environmental degradation, thus protecting the health and well being of the inhabitants. Renewable materials like recycled stone, bricks or other non toxic recyclable materials are suitable.

Ready mix concrete with PPC having more than 30% fly ash content, use of fly ash bricks, stone, locally available in nearby area for flooring, terrazzo flooring with locally available stone materials, use of autoclaved aerated concrete blocks, jute-bamboo composites for door, frame and shutters are suitable materials. UPVC windows with thermally sealed double glass using low heat transmittance index glass, use of high reflective terrace tiles for low heat ingress, use of low VOC paints, adhesive, sealants etc could also be used.

The green materials which are locally available and have low embedded energy should be utilised. Use of engineered concrete by use of recycled aggregate, and use of other cementitious (pozzolanic materials) like flyash rather than OPC alone is to be encouraged. Ready mix concrete using engineered

materials for mixing through mechanization by variation in properties of materials, variations in proportion, variation due to mixing process, efficient and effective use of concrete mix could reduce cement consumption. Use of mechanical admixtures could improve the long term strength and durability performance while chemical admixtures used for specific performance enhancement. Therefore, by use of suitable admixtures together, cement consumption could be reduced thereby reduction in carbon dioxide emission.

By mechanical process of production, minimum transportation, optimum use of concrete ingredients like cement, fine aggregate, coarse aggregate, mineral admixture etc. this could result in reduction in embedded energy. In the process of change like reducing, reusing, recycling, re-engineering of the materials, it would be possible to reduce the environmental impact.

CONSERVATION OF ENERGY AND RENEWABLE ENERGY

With increasing impact of GHG emissions and energy usage on environment, it is necessary to develop smart energy usage. It not only involves the usage of renewable and sustainable energy, requires using the energy resources efficiently and optimally, to reduce the overall energy consumption and carbon footprint.

In energy efficient buildings, we need to have energy saving potential through building envelope, natural lighting, chillers, and automation. Enabling mechanism for energy efficient buildings in India through application of ECBC, NBC and star rating of appliances, use of smart energy meters. In smart city construction program, we require 80% of buildings to be green and energy efficient and remaining energy should come through renewable energy source. Artificial lighting systems should be by use of LED installations, daylight control etc. In Heating ventilation and air conditioning (HVAC) we need to provide chiller plant optimizer installations, replacement of inefficient pumps, and VFD installation in CFD pumps.

To minimize the wastage energy, to reduce energy consumption, use of low embodied energy materials in interiors and other construction works, onsite renewable energy systems with solar photo voltaic cell to meet the total energy, renewable energy for hot water supply, solar power generation system through PV panel placed at the terrace area and make efforts for GRIHA 4-5 rating buildings.

CONCLUSION

The importance of energy conservation and increasing use of renewable sources of energy in the transition to a sustainable development has already been recognized in the country. Energy efficient building design is an integrated approach of architectural intervention, building materials technologies and design methodologies. The green building concept integrates the aspects of sustainability and emphasizes the reduction of environmental impact through a holistic approach to land and building usage. It uses less energy, water and resources, creates less waste and provides a healthier living environment. Such buildings incorporate several sustainable features such as efficient water use, energy efficiency, eco-friendly construction materials, use of renewable or alternative energy sources and recyclable materials.

TECHNICAL SESSION III
ENERGY CONSERVATION

ROLE OF RENEWABLE ENERGY AND ENERGY CONSERVATION IN SUSTAINABLE DEVELOPMENT

USHA BATRA*

Abstract

With growing population and rapid shift towards energy intensive lifestyle, the demand for energy will keep on increasing. At all India level, total installed power capacity in March 2016 was 302 GW where coal based power accounted for 61.25 percent at 185 GW and solar was merely 2.2 percent with 6.7 GW. The share of thermal power including coal, gas and diesel was 69.53 percent with about 210.67 GW which shows a great dependence on polluting thermal sources, leading to environmental degradation.

Since, India has ratified Paris climate deal on 2.10.2016 as 62nd country and recently cabinet has given approval for ratification of Kyoto protocol on 23.01.2017, energy from renewable resources will have to be given priority. Although as per Kyoto Protocol only developed countries are mandatorily required to undertake mitigation targets, India will ratify Kyoto Protocol to encourage other developing countries to undertake this exercise.

Energy conservation is an effective counter measure of saving natural resources and global warming. The paper explains the importance of energy conservation and energy efficiency, possible savings along with measures to be adopted to achieve these savings. It also covers the potential of renewable energy resources in addition to the installed and targeted capacity by Government of India (GOI) up to 2022, especially the solar power. Recent schemes and programmes of GOI, other experimental initiatives and innovations in this field are also covered.

INTRODUCTION

Sustainable development is a pattern of economic growth in which resources are used to meet present human needs while protecting the environment for generations along with present generation's responsibility to improve the future generation's life by restoring the previous ecosystem damaged and reducing environmental pollution.

Energy is one of the most important building blocks in sustainable development. Production of energy particularly based on natural resources depletes them and also leads to environmental degradation.

India, home to 18% of the world's population, uses only 6% of the world's primary energy. India's energy consumption has almost doubled since 2000 and the potential for further rapid growth is enormous. This demand needs to be met with the production of energy through renewable energy resources, energy efficiency and energy conservation.

Energy efficiency measures in new construction and major retrofits could save 2988 MW of generation capacity up to 2030. Due to maximum consumption, maximum possible saving of energy is in industrial sector, followed by the building sector . As such, emphasis needs to be given in these two sectors.

Smart energy pyramid (Fig.1) shows the way to reduce demand through energy conservation, energy efficiency and lastly through renewable energy which serves the dual purpose of fulfilling the demand and simultaneously reducing the global warming.

Alarming air quality levels in many Indian cities and around the world have highlighted the deteriorating environment as well as health of the

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citizens thereby arising a desperate quest for clean

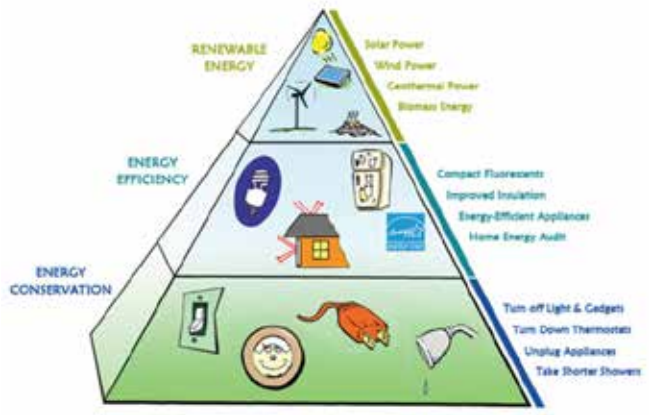

Fig. 1: Smart Energy Pyramid

energy. From May 7 to 11, 2016, Portugal made history by working only on renewable energy solar, wind and hydro for 107 hours. For the first time, on April 9, 2016, solar energy surpassed energy from burning coal in meeting power requirements in the UK, when solar energy generated was 29 GWh as compared to 21 GWh from coal power stations. Also in Germany, on May 8, 2016, renewable sources of energy produced 87percent of the energy consumed. As the world is slowly embracing green initiatives and moving towards renewable energy, India has also revised it's target of renewable power capacity from 20GW to 100GW by 2022.

ENERGY CONSERVATION

Energy Conservation is of great importance since we rely on energy for everything we do. December 14th is celebrated as World Energy Conservation day globally to highlight the importance of energy consumption and its use in our day-to-day life, its scarcity and impact on sustainability of global eco systems. Energy conservation is the most economical solution to energy shortages, reduce strain on the environment and bring down electricity expenses. Energy conservation is useful due to the followings:

- We use energy faster than it can be produced – coal, oil and natural gas – the most utilised sources take thousands of years for formation.
- Energy resources are limited – India has approximately 1% of world's energy resources but it has 18% of world population.
- Most of the energy sources we use cannot be reused and renewed – Non renewable energy sources constitute 70% of the fuel use which may last only for another 40 years or so.
- Energy saved is energy generated –saving one unit of energy is equal to 2 units of energy produced as it not only saves money but also reduces the demand for fossil fuels as coal, oil, and natural gas leading to lower emissions of carbon dioxide (CO^2), the primary contributor to global warming, and other pollutants.
- Conservation mitigates numerous adverse environmental and social impacts associated with energy production and consumption e.g. air pollution, acid rain and global warming, oil spills and water pollution, loss of wilderness areas, construction of new power plants.
- Extends the lifetime of equipment and reduces the maintenance cost by operating fewer hours and at less than maximum capacity.

"Energy conservation" and "Energy efficiency" are often used interchangeably, but there are some differences. At the most basic level, energy conservation means using less energy and is usually a behavioural change, like turning off lights or setting thermostat at lower temperature. Energy efficiency, however, means using energy more efficiently, and is often a technological change.

ENERGY EFFICIENCY, CONSUMPTION AND POSSIBLE SAVINGS

It is estimated that 40-60 % consumption can be reduced by adopting energy efficiency measures. Distribution of sector wise consumption in India during 2016 is given in Fig. 2.

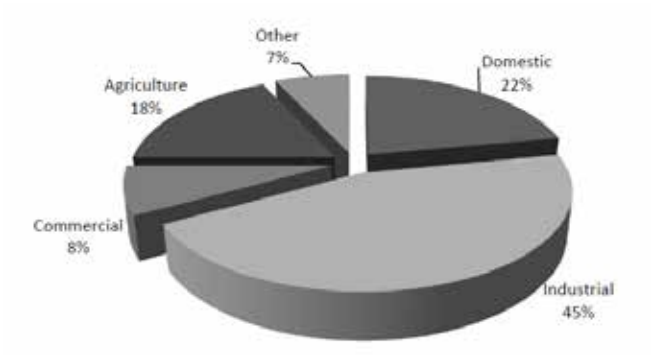

Fig. 2: Distribution of Sector Wise Consumption

It is seen above that maximum consumption is in industrial sector, which is 45%, followed by building sector which includes residential/ domestic and commercial -30%, agriculture -18% and others - 7%. PAT (Perform, achieve and trade) scheme under the Ministry of Power, Govt. of India is a mechanism to enhance energy efficiency in energy intensive large industries.

GRIHA and IGBC rate the green buildings with attempt to minimize resource consumption and wastage thereby reducing the environmental impact during the entire lifecycle of a building from construction to operation and then demolition consuming various resources like energy, water, materials while rating of green buildings. BEE and ECBC promotes energy efficiency in building sector to bring down the energy consumption by 40-60%. RAILSAVER (https://www.railsaver.gov.in/) launched in April 2014 is a scheme to improve energy efficiency in Indian Railways up to 15% by the year 2020.

Due to maximum consumption, maximum possible saving is in Industrial sector. The next highest consumption and possible saving sector is the building sector which includes residential and commercial buildings. By incorporating energy efficiency measures in new buildings, there can be a potential saving up to 40-60%. It is estimated that in case standard energy efficiency measures are implemented in new construction and major retrofits, India alone could save 2988 MW of generation capacity up to 2030. This can further be enhanced by construction of net zero buildings.

To achieve potential energy savings mentioned above, the following measures need to be taken on priority.

- Mandatory provision of waste heat recovery system in industries.
- Mandatory use of energy efficient appliances / machinery, lighting system and energy audit in all the sectors.
- Promoting use of energy efficient and environmental friendly electrical / hybrid vehicles.
- Mandatory capacity building and training programs regarding energy efficiency.
- Including energy conservation and energy efficiency issues in education curriculum, both at school and college levels.

It is expected that with the proposed energy saving measures, about 246 billion units of electricity, 88 million tonnes of coal and 12 billion litres of oil can be saved per annum. This will automatically help in reducing CO_2 emissions.

RENEWABLE ENERGY

Renewable energy sources have hardly been tapped so far as all renewable energy sources together have the potential to provide 3,078 times the current global energy needs, of which solar energy 2,850 times, wind energy 200 times, biomass 20 times, geothermal 5 times, wave-tidal energy 2 times, and hydropower 1 time (Fig.3). In order to promote renewable energy and energy security, it is decided that 8% of total consumption of electricity, excluding hydro power, shall be from solar energy by March 2022.

India has an estimated renewable energy potential of about 900 GW from commercially exploitable sources viz. wind – 102 GW at 80 metre mast height , small hydro – 20 GW; bio-energy –

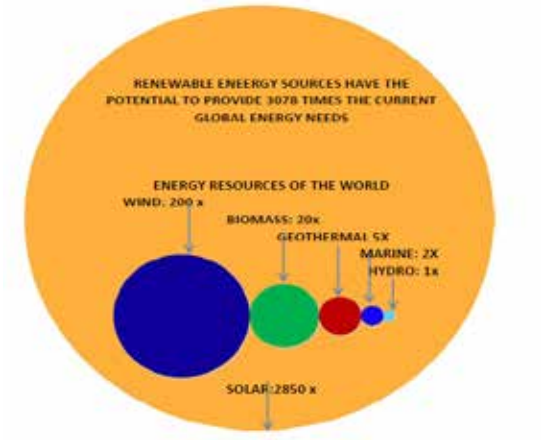

Fig. 3: Renewable Energy Sources Potential

Source: RE-Thinking 2050, (www.erec.org)

25 GW; and 750 GW solar power, assuming 3% wasteland is made available. National Institute of Wind Energy has used advanced modelling techniques and revised the estimate the wind power potential at 100 metre at 302 GW.

Installed grid interactive and off grid Renewable Power Capacity in India as of September 30, 2016 with targets up to 2022 is given in Table 1 and 2

Table 1: Installed Grid Interactive Renewable Power Capacity in India

	Total Installed Capacity (MW)	**2022 target (MW)**
Wind Power	28082.95	60,000
Solar Power	8513.23	100,000
Biomass Power (Biomass and Gasification and bagasse)	4882.33	*10,000
Waste-to-Power	115.08	
Small Hydro Power	4323.35	5,000
Total	44,783.33	175,000

Table 2: Off-grid Power as of July 31, 2016

Source	**Total Installed Capacity (MW)**
Waste to Energy	161.39
Biomass (non-bagasse) Cogeneration	651.91
Biomass Gasifiers	-
- Rural	18.15
-Industrial	164.24
Aero-Generators / Hybrid systems	2.79
SPV Systems	330.00
Water mills / micro hydel	18.81
Total	1,347.29

Solar Power

Solar potential, estimated by India's National Institute of solar energy is around 750 gigawatts (GW) based on the assumption that 3% of wasteland in each state can be used for solar power projects, plus an assessment of the potential for rooftop solar power. The solar resource is strongest in the north and northwest of the country e.g .Rajasthan, Jammu and Kashmir, but is also considerable in a number of other states, including Maharashtra, Madhya Pradesh, and Andhra Pradesh.

Solar power has played only a limited role in power generation so far, but is taking momentum to meet the target of 2022. Jawaharlal Nehru National Solar Mission, launched in 2010 with Initial target of 20 GW by 2022 was upgraded in 2014 to 100 GW by 2022 as shown in Table 1. It consists of 40 GW of rooftop solar photo voltaics (PV) and 60 GW of large and medium scale grid-connected solar power projects (Fig. 4 & 5) as part of a broader 175 GW target of installed renewable power capacity by 2022, excluding large hydropower. With this ambitious target, India will become one of the largest green energy producers in the world, surpassing several developed countries. The total investment in setting up 100 GW will be around Rs.6,00,000 crore.

Fig. 4: Rooftop Solar PV

Fig. 5: Solar Park

This total of 100GW is split between 60 GW of utility-scale projects (both solar PV and CSP), including a series of large solar parks, with capacity generally above 500 MW each, and a further 40 GW of rooftop solar applications for commercial users and households, together with some small-scale schemes and off-grid capacity.

Solar Rooftop

As regards solar rooftop, all major sectors i.e. railways, airports, hospitals, educational institutions, government buildings of central/state/PSUs are being targeted besides the private sector.

Solar PV Modules are of two types, silicon-based solar cells provide higher efficiency (15% - 20%) but are relatively costly to manufacture, whereas thin film cells are cheaper but less efficient (5% - 10%). Increased efficiency of cells will require less space for same capacity and is therefore more useful. Good quality PV modules generally have a useful life of 25 to 30 years, although the performance steadily degrades by about 20% over life time.

Mounting structures can be either fixed or tracking. Tracking systems on an average cost approximately 2 % more and produce about 20% more power compared to fixed tilt mounting system, therefore are beneficial to use.

A grid connected rooftop solar requires 10 square meter of area per KWp and on an average costs Rs. 8 crore per MWp thus 1KWp system costing around Rs. 80,000 generally has a payback period of 6-8 years. 40 GW target of solar rooftop capacity by 2022 will require 4,000 lakh sq. m. of area and will cost Rs.3,20,000 crore. So far solar PV panels of about 500 MW capacity have been installed and of about 3,000 MW have been sanctioned which are under installation.

CPWD has installed rooftop solar power plants on existing buildings having roof area of 1500 sqm or more and has already started electricity generation in many buildings. Total installed capacity as on December 2016 is 6.98 MW from solar plants installed on 47 buildings with 6.1 MW installed on 41 General pool office buildings (GPOA) and 0.88 MW on 6 non General pool office buildings.

A rooftop solar power plant set up by the Radha Soami Satsang Beas, Educational and Environmental Society, Punjab inaugurated on 17th May 2016 is the largest rooftop solar plant on a single roof spread across 42 acres, having a capacity of 11.5 MW. The campus holds a capacity of 19.5 MW across multiple roofs totalling 82 acres, the largest in India. The project would help in abatement of 4 lac ton of carbon dioxide emissions in the next 25 years which is equivalent to planting of 2 lac trees. Besides meeting its own power requirements, it will feed surplus power into the grid.

In Haryana, solar rooftop power plant installation of 3-5 % of connected load has been made mandatory for all residential buildings with plot size of 500 square yards and more, for all government and private educational institutions and offices with connected load of 30 KW and above and for private hospitals and nursing homes, malls, industrial and commercial establishments, hotels, banquet halls and tourist complexes of 50 KW and above. This

is on lines of San Francisco which has also passed legislation for mandatory rooftop solar installations for all commercial and residential buildings up to ten storeyes as an initiative of achieving solar power goal.

Solar Park

Solar park is a large chunk of land developed for setting up of a number of solar power projects wherein the solar power developers will be made available land which is free from statutory clearances with common infrastructure facility such as water, transmission lines, roads, drainage, communication network etc. in place. . Ultra Mega Solar Power project is a single power project with capacity of over 500 MW which may be set up in some of these Solar Parks.

The Government has also approved a scheme in December 2014 for setting up of 25 solar parks, each with the capacity of 500 MW and above and ultra mega solar power projects to be developed in next 5 years in various states which will require central government financial support of Rs.4050 crore. These parks will be able to accommodate over 20,000 MW of solar power projects. As on date, 33 parks with capacity of about 19,900 MW in 21 states have been sanctioned.

As minimum land requirement is approximately about 2ha per MW, this would require 39,800 ha land. From 2015-16 to 2021-22 the ground mounted target is 57000 MW including those underway as mentioned above which would need 1,14,000 ha land. This requirement can be reduced to a great extent by solar sharing method which was first adopted in Japan (Fig. 6).

In this method solar panels are set up over entire field like having a second crop of solar power at a height of 15-20 feet with the food crop below in the field. As the shade of solar panels have no negative impact on crop growth, if arranged in a particular configuration that allows sufficient sunlight and windto pass through to the plants especially for fruits and vegetables, it reduces irrigation requirements due to shading and farmers can meet

Fig.6: Solar Sharing- Solar Panels on an Agriculture Field in Japan

their electricity needs in addition to selling the surplus power to the grid. If implemented at a large scale, farmers can earn about 30-40 percent profit sharing in power generation revenue.

Gujarat Energy Research and Management Institute (GERMI) is also awaiting large scale implementation of another proposal that would involve putting a layer of solar panels over one another which would generate 70 percent more energy than a single layer panel.

Cochin international airport is the country's first airport in the world that completely operates on solar power. It has 12 MWp solar power plant with 46,150 solar panels, producing 50,000 to 60,000 units of electricity per day against consumption of around 48,000 units. Over the next 25 years, this green power project will avoid carbon dioxide emissions by more than 3 lakh metric tons, which is

equivalent to planting 3 million trees or not driving 750 miles.

The largest solar park in the world of 648-megawatt is spread across 2,500 acres in the town of Kamuthi in the Ramanathapuram district of India which will supply clean, and green energy for 3,00,000 homes.

Other solar parks more than 150 MW capacity are 21 in USA, 5 in China, 3 in India, 2 in Chile, 1 each in Pakistan, Germany, France and South Africa.

Studies have revealed that solar and wind are almost complementary to each other and hybrid of two technologies would help in minimizing the variability apart from optimally utilizing the infrastructure including land and transmission system. The existing wind farms have scope of adding solar PV capacity and similarly there may be wind potential in the vicinity of existing solar PV plant. Suitable policy interventions are required not only for new wind-solar hybrid plants but also for encouraging hybridization of existing wind and solar plant. Accordingly, draft national wind-solar hybrid policy has been prepared with goal to reach wind-solar hybrid capacity of 10 GW by 2022.

Recent Schemes of GOI

Government of India has taken up the following new projects/schemes during the current financial year:

- Setting up over 2,000 MW of grid-connected solar PV power projects with Viability Gap Funding under batch-III of phase II of the National Solar Mission (NSM).

- Creation of intra state transmission system in the states of Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan at an estimated cost of Rs.8548.68 crore with Government of India contribution from National Clean Energy Fund (NCEF) of Rs.3419.47 crore.

- Scaling up of budget from Rs.600 crore during 12th Five Year Plan to Rs.5000 crore for grid connected rooftop and small solar power plants programme over a period of five years up to 2019-20 under NSM.

- Scheme for setting up of over 5000 MW grid-connected solar PV power projects with viability gap funding under batch-IV of phase-II of the NSM.

- Scheme for setting up 1000 MW grid connected solar PV power projects by CPSUs.

- Scheme for setting up over 300 MW of grid connected solar PV power projects by defence establishments.

- Scheme for development of grid connected solar PV power plants on canal banks and canal tops during the 12th Plan period at an estimated cost of Rs.975 crore and with Central Financial Assistance (CFA) of Rs.228 crore.

The Ministry also took up an ambitious programme for installation of 31,472 solar water pumping systems during 2015-16 which present an immense potential towards growth and development of agriculture, irrigation and drinking water in different States of the country. This is more than cumulative pumps installed till 2014-15.

Other Experimental Initiatives

As part of reducing environmental pollution and consumption of non renewable resources, country has already started use of solar panels on car, train, bus, truck and aircraft on experimental basis which may be implemented later on large scale. Solar roof tiles and solar panels on vertical surface are also being experimented as shown in Fig. 7 and 8.Route 66 in Missouri, USA is underway construction of solar panelled roads that would also produce energy. The roads would be covered with tempered glass such that cars can drive on them.

Fig.7: Solar Panels on Aircraft, Car and Train

Fig.8: Solar Panels on Wall and Roof

The hexagonal panels (Fig.9) also have LED lights that would perform the task of signage eliminating the need of paint markers. Also, they would have heating features to prevent the accumulation of snow on the road which is a common problem in USA. Other than USA, France is also planning to make 600 miles of solar panelled roads.

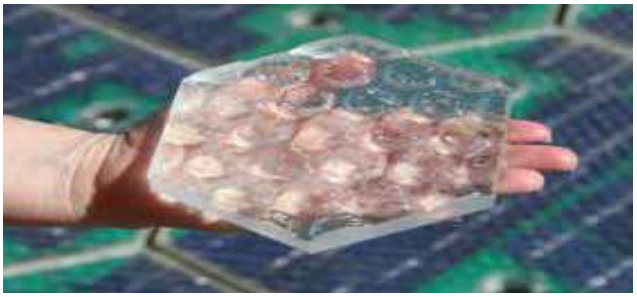

Fig .9: Solar Panelled Road

Fig. 10: Floating Solar Plant

To save on land, another innovation is floating solar plants as shown in Fig. 10. The first floating solar plant of 10KW was set up in Rajarhat, Kolkata in 2015 and occupies a mere 0.01 ha of land. SECI has initiated a hybrid solar-wind project with 300 MW capacity in Andhra Pradesh, 10 MW each in Andhra and Kerala and 5 MW in Lakshadweep. This innovation can help to electrify the very remote rural areas and villages that still await power supply through the existing water bodies in rural areas.

Innovations in maintenance of solar systems are also being attempted. With greater installations, there would be a rising need for cleaning of solar panels to maintain their efficiency which calls for time, labour and scarce resource like water. As a first time ever, Kibbutz solar park in Israel has been using robots to clean panels. Additionally, they do not use water and instead use microfibers to clean and for each minute a robot cleans about 100 sq feet panel area. According to a media report, Israel based company Ecoppia is setting up a robotic solar cleaner manufacturing unit in Chennai in foresight of the cleaning requirements that would arise with

rapid solar installations.

CONCLUSION

Energy conservation is an effective counter measure against the future exhaustion of resources and global warming. Renewable energy sources especially solar have huge potential to provide many times the current global energy needs.

Fulfilling the MNRE's solar target of 100G by 2022 can make India one of the largest green energy producers in the world. The fact that solar and wind power are almost complementary to each other has been used to achieve wind-solar hybrid capacity of 10 GW by 2022 which will save on cost of land and transmission lines and help in achieving the target in stipulated time.

Tracking system and high efficiency PV module can save roof space and increase capacity. Solar sharing, especially with double layer can tremendously reduce the requirement of land as well as irrigation along with extra income for farmers and must be used to avail the benefits. Innovative solutions like solar panelled roads, floating panels, robotic cleaning and use of microfiber instead of water for cleaning of panels address many of the issues like maintenance, water shortage , land availability and will prove to be very useful. Disposal or partial reuse of solar panel needs research looking at 25 years life of solar panel.

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RENEWABLE ENERGY : CASE STUDY OF MASDAR CITY, ABU DHABI

DR. DEEPAK SUNDRANI*

Abstract

The "Alliance to save energy" honoured Masdar city with a 2012 EE Visionary Award in recognition of the city's contributions to the advancement of energy efficiency. Masdar city, is a small emerging suburb of Abu-Dhabi, in UAE, which relies mainly on renewable energy. It is about 17 kilometres away from Abu-Dhabi near the Abu-Dhabi International airport. The area of the planned city is 6 sq. km. Construction began in 2008.The completion date is expected to be 2030. About 45,000 to 50,000 people are expected to live in the city. The city is expected to be a hub for Cleantech companies, and 1,500 businesses, primarily commercial and manufacturing facilities specialising in environmentally friendly products are expected to be located in it. 60,000 workers are expected to commute to the city.

The temperature in the streets is generally 15 to 20 C cooler than the surrounding desert. The temperature difference is due to Masdar's unique construction. A 45-meter-high (148 ft) wind tower modelled on traditional Arab designs sucks air from above and pushes a cooling breeze through Masdar's streets. The site is raised above the surrounding land to create a slight cooling effect. Buildings are clustered close together to create streets and walkways shielded from the sun. Masdar will use a mix of electric vehicles and other clean energy vehicles for mass transit inside the city. The majority of private vehicles will be restricted to parking lots along the city's perimeter. Masdar is powered by a 22-hectare (54-acre) field of 87,777 solar panels with additional panels on roofs.

INTRODUCTION

Sun is an important renewable source of energy and the middle-east is blessed with lots of it, in fact it has so much excess of the scorching heat that it that has to spend a lot of energy for cooling. In 2006 a message landed on the desk of Gerard Evenden, a senior partner at Norman Foster's (Designer) firm which said Abu Dhabi was looking to build a sustainable city, and would they be interested in participating? "The tender was an indication of a change in thinking from the country's government. That year, His Highness Sheikh Khalifa bin Zayed Al Nahyan -- president of the UAE and ruler of Abu Dhabi -- had an idea. He knew that the main source of Abu Dhabi's wealth -- oil -- would eventually run out. So he asked his advisers to plot a long-term plan that would allow the country to diversify its economy away from hydrocarbons. The answer: renewable energy. "It was basically them saying, look: we produce oil but we'd like to be part of the energy solution. And at the same time, we'd like to make some money. As energy markets change and renewables become a bigger piece of the energy equation, we'd like to have a piece of that too."

The idea was for a fully functional city, the construction of which would inspire better local understanding of, and greater investment in, green energy and technology. Mastery of those industries, the thinking goes, could in the long term, offer Abu Dhabi significant revenue -- and in the short term allow it to sell more of its remaining oil overseas. Second: it was hoped that by housing a green-

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focused university, and providing office space to eco startups, Masdar could act as an incubator for a new generation of Emirati greentech entrepreneurs. In turn, this new workforce could both accelerate the country's reincarnation from an oil economy to one based on renewable energy, and simultaneously help energise a local population long pampered by high state salaries and subsidies. And along the way, the sheikhs hoped their international reputation might receive something of a fillip. The man entrusted with this mammoth task was a young Emirati called Sultan al-Jaber who was an MBA graduate with an economics PhD from Coventry University. Foster's team, led by Evenden, was awarded the contract and, to conceive the world's newest city, Evenden's colleagues first toured some of its oldest. They visited the crowded warrens of Cairo, then the mud towers of Yemen's Shibam, and finally went to Muscat in Oman. They wanted to see how the traditional cities of the Middle East had kept houses cool over the centuries.

What Foster discovered was that these ancient cities often lowered temperatures through simple means: shorter, narrower streets. They calculated that cooler streets tended to be no longer than 70m, and were usually blocked off at the end by a building. "The building at the end was creating just enough turbulence that, as the air hit the building, it would flick the air upwards,"giving a flushing effect with this turbulence which would then reduce the level of heat in the street." Passive designs such as this played a key role in Masdar's realization. And so did technology. The hope was that the city could be powered entirely by onsite renewables -- the world's largest hydrogen plant and an array of photo-voltaic solar panels. The whole city would be raised on a platform, underneath which a squadron of cars would carry residents.

Thus was born the concept of Masdar city. An important point for construction of this city is first to reduce the energy demand: for cooling by constructing a Wind-tower which is able to capture the cooler upper-level winds and direct them to the open-air public square at its base, and LEED Platinum buildings. The next point is to use the sun for generating energy. . The development is an acknowledgement that, one day, the oil will run out.

Masdar city, is a small emerging suburb of Abu-Dhabi, in UAE, which relies mainly on renewable energy. It is about 17 kilometres away from Abu-Dhabi near the Abu-Dhabi International airport. It was initiated in 2006, the city was envisioned to cover 6 square km.. Construction began on Masdar City in 2008 and the first six buildings of the city were completed and occupied in October 2010. The final completion is estimated to be 2030.

ABOUT MASDAR'S VISION, MISSION

Vision

To make Abu Dhabi the prominent source of renewable energy knowledge, development and implementation, and the world's benchmark for sustainable development

Mission

To advance renewable energy and sustainable technologies through education, research and development, investment, commercialisation and adaptation.

The Stakeholders

The Developer of Masdar city is Mubadala Development Company. The Architect is Foster & Partners. Partners in the project through its Clean Tech Fund are Consensus Business Group, Credit Suisse and Siemens Venture Capital. Construction of the first phase of the project is being managed by CH2M Hill. Infrastructure construction for the city will be handled by the Al Jaber Group and design of the central Masdar headquarters building has been awarded to Adrian Smith and Gordon Gill Architecture. The city's wayfinding system was developed by Endpoint and City ID. The headquarters of the International Renewable Energy Agency (IRENA) are in Masdar city. The city is designed to be a hub for cleantech companies. Its first tenant was the Masdar Institute of Science and Technology, which has been operating in the city since it moved into its campus in September 2010.

Design and Vision

As designed, the city would be home to 45,000 to 50,000 people and 1,500 businesses, primarily commercial and manufacturing facilities specializing in environmentally friendly products. In turn, more than 60,000 workers are expected to commute to the city daily. Masdar City will be a highly planned, specialized, research and technology-intensive municipality that incorporate a living environment, similar to KAUST, Saudi Arabia or Tsukuba Science City, Japan. Masdar is a sustainable mixed-use development designed to be very friendly to pedestrians and cyclists. The designers Foster and Partners team started its work by touring ancient cities such as Cairo and Muscat to see how they kept cool. Foster found that these cities coped with hot desert temperatures through shorter, narrower streets usually no longer than 70 meters (230 ft). The buildings at the end of these streets create just enough wind turbulence to push air upwards, creating a flushing effect that cools the street.

Masdar City has terracotta walls decorated with arabesque patterns. From a distance, the city looks like a cube. The temperature in the streets is generally 15 to 20 C (27 to 36 F) cooler than the surrounding desert. The temperature difference is due to Masdar's unique construction. A 45-meter-high (148 ft) wind tower modelled on traditional Arab designs sucks air from above and pushes a cooling breeze through Masdar's streets (Fig.1). The site is raised above the surrounding land to create a slight cooling effect.

The tower, rising well above the rooftops of any neighboring buildings, is not a turbine designed to generate electricity. Rather, it's a simple empty cylinder with adjustable louvres at the top. The primary purpose of the wind-tower is simple: a tall cylinder is capable of provoking a convection current as hot air rises simply by standing there. This creates a natural current of air flowing from the street level of the city and up out the top of the tower – the breeze it creates pulls hot air out of the city and makes life in the plaza below considerably more pleasant. The system can also be extended to work in the other direction. By adjusting the louvres, the tower can be "turned" to catch any prevailing winds and therefore "pull down" flowing air, sending it cascading into the plaza to provide a breeze which lowers the perceived temperatures. It works particularly well because of the deliberately narrow streets of Masdar City – designed that way to minimize the amount of direct sunlight that hits them. Being compact and narrow also means the breeze can be channeled more tightly, making it faster and more effective.

Buildings are clustered close together to create streets and walkways shielded from the sun. The second use of the tower : Signalling : LED lights run up each of the three legs of the tower. When they are green, it means that the the city is running at better than it's daily goal for energy consumption, when the lights are red the city has exceeded it's limits by some amount.

Fig.1 : The Wind Tower of Masdar City

Use of Passive Design in the Masdar Institute

Masdar Institute for Science and Technology employed passive strategies to reduce energy

demand. As the first building to be constructed in Masdar City, The Masdar Institute seeks to provide a local example on how passive design can help reduce energy demand, and thus help achieve the city's zero energy targets.The first phase of the Masdar Institute, which has been fully operational since 2010, features 6 buildings that achieved a 50% reduction in cooling demand compared to an average UAE building.

To achieve this remarkable reduction in cooling demand, its designers incorporated several innovative passive design strategies, most of which were inspired by elements from traditional architecture of the Emirates. The most notable feature of these strategies is a 45m structure that provides cool breezes to the central courtyard . This contemporary reinterpretation of the traditional wind tower operates according to the same principles of the wind towers built in the Bastakia area of Dubai and elsewhere around the region, albeit in a more active manner. While the traditional wind towers opened to all four directions, this wind tower is equipped with sensors that will operate its top louvers to open in the direction of the current prevailing winds, thus ensuring maximum efficiency.

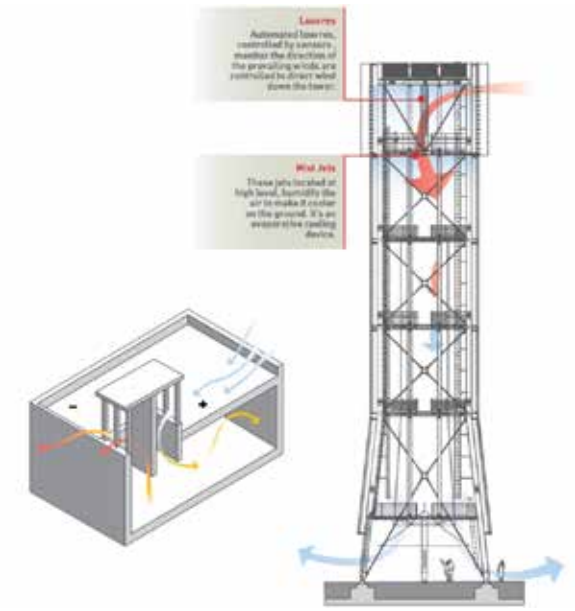

Fig.2: Operation mechanism of modern wind tower (right), compared to traditional wind tower (left).

LEED Platinum Buildings

A regional headquarters for Siemens has been built in Masdar City. This building is the most energy efficient in all of Abu Dhabi. The LEED Platinum building makes use of sustainable and energy efficient materials and building techniques. It was designed to use 45 percent less energy and 50 percent less water than typical office buildings. The Siemens headquarters won an award for best office building at the Mpim Architectural Review Future Projects Awards in 2012. The Middle East Architect Awards named it both the best and most sustainable office building the same year.

The 12,000 m^2 (130,000 sq ft) building is built around the idea of a "box within a box". The structure includes a highly insulated airtight inner façade that insulates from the sun and a lightweight aluminium shading system on the exterior. The plaza beneath the building is funnel-shaped. This shape works to suck prevailing winds underneath the building. Due to the Venturi effect, a breeze flows up to the roof of the building through atria in the buildings structure, cooling public spaces without energy costs. These atria also allow daylight into the centre of the building in order to reduce the need for artificial lighting, further reducing energy consumption. The buildings automation systems are all from Siemens. There are no light switches or water taps in the city; movement sensors control lighting and water to cut electricity and water consumption.

The Alliance to Save Energy honoured Masdar City with a 2012 EE Visionary Award in recognition of the city's contributions to the advancement of energy efficiency.

Solar Energy

Masdar is powered by a 22-hectare (54-acre) field of 87,777 solar panels with additional panels on roofs. It is much more efficient to build a solar field on the ground in the middle of the desert compared to solar panels on the roofs because a man can be sent to brush them

off every day, rather than having to access everyone's buildings individually, and one can make sure that they are running at their absolute peak. Blowing sand has been a problem for its solar panels, so Masdar has been working with other companies to engineer surfaces with pores smaller than sand particles to stop them from sticking on the panels. Scientists at the Masdar Institute are also working on coatings that repel sand and bacteria for use on solar panels and in other applications.

Within the UAE, Masdar Clean Energy projects include:

- The 100-megawatt Shams 1 solar power project that stretches over more than 2.5 square kilometres in western Abu Dhabi;
- Masdar City's 10-megawatt solar photovoltaic plant in Abu Dhabi;
- Masdar City's 1-megawatt solar rooftop installations;

Fig. 3: Solar power station consists of 768 solar collector assembly units and 27,648 absorber pipes

Shams 1, the largest solar plant (Fig.3) in the Middle East, and it works differently. There are no panels here, just gleaming, curved five-metre-wide mirrored blades shimmering in the heat. Each one reflects the Sun's rays on to a pipe of liquid at its centre. Under the glare of such concentrated heat, the temperature of the liquid is heated to several hundred degrees Celsius. It is then pumped through a station on-site -- its heat creating electricity that will save 175,000 tonnes of CO2 a year. Completed at the start of 2013, it will take 20,000 Abu Dhabi homes off-grid.

Impact of the Concept of Masdar City

Since the year 2000 energy demand among the Middle Eastern oil producers has grown at 5% a year, outstripping China and India. Inspired by the concept from Masdar, the UAE is also building what has been billed as the world's biggest solar farm in Dubai, and to install rooftop solar on every home in the emirate by 2030. Similarly other oil-exporting companies are also trying to tap solar power. The main motive is not reducing greenhouse gas emissions, but cutting back on domestic energy demand that is taking up a rising share of production. Oil exporters would rather sell their fossil fuels abroad than burn them at home, especially if solar energy is abundantly available. Kuwait set a target of sourcing 15% of its electricity from wind and solar by 2030, and making buildings 10% more energy efficient. Qatar planned to get 20% of its electricity from renewables and reduce water consumption by 35%. Egypt set a renewables target of 30% by 2030. The writing is clearly on the wall for oil-exporting countries that they are facing the end of the fossil fuel era, and if the economy depends on that it would be prudent in the extreme to plan for that transition while you still have respectable revenue.

Present Status of Masdar City

The progress of the development has been slow, at about 5 % of the total development planned. The reasons are financial : In 2008 the global financial crisis came . A two-hour drive away, Dubai's vast state-owned investment company, Dubai World, ran up unserviceable debts of $59 billion (£39 billion). Its sister city, Abu Dhabi, had no choice but to bail out Dubai. As a result, Abu Dhabi had less to spend on its own projects -- such as Masdar. Later due to drop in oil prices UAE did not have enough money to spare for Masdar.

CONCLUSION

The concept of Masdar City to become sustainable using renewable energy was imaginative and ambitious. However due to financial problems, it did not achieve the development in the time frame that was envisaged. If the things improve such as

rise in oil prices, the UAE may have surplus funds to invest in further development of the Masdar city and make its a concept reality. In fact, the city has a long way to go before it achieves what its founders hoped to achieve long back. More cities on the region can be planned through lessions learnt in planning and development of Masdar City.

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ENERGY AUDIT IN BUILDINGS

VINAYAK KOUNDANYA*

Abstract

Energy Audit means examination or inspection of various electrical fittings including appliances, equipment, instruments followed by physical checking of inventory, their efficiency and reasonable use in the buildings. Today over 50 Million public, commercial and residential buildings consumes half of the world's energy produced. The single largest challenge lies to enhance efficiency, improved air quality and streamlining management of buildings to consume accurate needed energy/power for safe environment.

WAPCOS Corporate office building at Gurgaon was selected under the India BEE/ Sweden STEM Cooperation Project WPIa " 50% Energy Reductions in Buildings" as a demonstration buildings for developing BELOK Total Concept (BTC) protocol for India. This is a working method of improving Energy Efficiency by decreasing the energy use up to 50 % by careful analysis of energy requirement, identification of energy saving measures and other remedial measures.

Dr. Per-Erec Nilsson CEO and Associate Professor and Dr Mari-Lisa Maripuu Project Manager elaborated the method of audit, requirement of exhaustive building data, electrical lighting and equipment like Computers, A Cs etc. All the measures in the action package are planned, designed for implementation. The energy use is measured after the action package has been prepared and energy saving measures were identified at each location. The net energy requirement on the proposed measures/result was compared with baseline energy used for checking the profitability results.

The paper discuss the case study which will be helpful for others to save the energy, recurring expenditure, reduction in carbon emission and at large climate change.

INTRODUCTION

All the companies have to undertake various activities/projects to fulfill the social responsibilities under "corporate social responsibility and sustainability. During the financial year 2012-13, author was responsible to achieve the goal set up by the Government and subsequently identified projects were submitted to the Ministry of Water Resources. Conducting energy audit was also under consideration and a search for the reputed energy auditor was initiated. The Bureau of Energy Efficiency (BEE) India was contacted who were in process for selecting some corporate house buildings for undertaking reduction upto 50 % by conducting energy audit. WAPCOS Corporate Office Complex at Gurgram and Siri Fort Auditorium, New Delhi were selected under on-going India BEE/Sweden STEM Cooperation Project "WP1-Buildings" PROJECT 1a "50 %" .

NEED FOR ENERGY AUDIT

Over 50 million public, commercial and residential buildings consume half of the world's energy produced. There is a lot of scope to study and analyse the data to save the energy so that more areas, localities, villages can be supplied

**Former Executive Director, WAPCOS Ltd.*

electricity. Saving of energy itself is generation as well as addition of supply to the grid. The required and accurate lumens of light in the rooms/working places/tables, roads and other places are to be provided by actual measurement. This will help to reduce the stress on eyes due to less or excessive intensity of light of the employees, maintaining needed cooling effect of air conditioner, create good working environment to improve efficiency / out-- put in a days work, etc.

ENERGY CONSERVATION BUILDING CODES (ECBC)

The Code Indicates

- Minimum energy efficiency standards for design and construction
- Encourages energy efficient design or retrofit of buildings so that, it does not constrain the building function, comfort, health or the productivity of the occupants as well as lifecycle cost (construction + energy costs) are minimized
- Applicable to commercial buildings with connected load of 100 kW or contract demand of 120 kVA or more
- It covers the components like building envelope (walls, roofs, doors and windows), lighting (indoor and outdoor), heating, ventilation and air conditioning (HVAC) system, solar hot water heating and electrical systems

WAPCOS OFFICE COMPLEX AT GURUGRAM

Office is located at Plot No.76-C, Institutional Areas, Sector -18, Gurugram having built-up area of 6470 sqm. which covers G+2 story building having 4 wings interconnected by 1.5 m wide and 15 m long open passage from center of the building. The building is having good ventilation as well as light from exposed surface and transparent dome on each block. In addition to this it covers library, CMD's office, administration and finance wing. There are several closed cabins for senior officer's at all blocks and at all floors. The building is made up as load bearing walls of bricks with 20 mm thick cement mortar plaster inside and outside.

Power supply is given by the distribution company having connected load of 413 kW through11kV feeder with transformer situated at ground floor and all other needed electrical panels etc. are at basement. In addition to this, power through diesel operated generator set is supplied at break down and power cut timing having capacity of 100 kVA. Most of the rooms have air conditioner either window or split as required by the individual officer in an un-planned manner. Percentage of air conditioning is 2/3rd of total built up area.

There are about 500 employees and office is following 5 days week with office hours from 9:00 am to 5:30 pm. However few officers (about 10 to 15%) are attending office on Saturday and Holidays depending on the work priority.

DATA COLLECTION, METHODOLOGY AND ANALYSIS

Data Acquisitions

- Exhaustive data was collected for building, its plan, elevation, height of each floor, thickness of plaster, nos. of doors and windows, type of door material, window glass panel, thickness of glass, thickness of slab at each level/floor, flooring material and thickness of top slab, type of ballast , drainage system, ceiling and ceiling material etc.
- Electrical data in respect of no. of lights, fans, computers and printers ,air conditioners, other machinery, electrical bells, other points, wiring, switches,decoration boards, compound wall street light system etc.
- Occupancy activity such as no. of entry and exit from the officers chamber, temperature

of rooms and cabins, light intensity, hours of operation of air conditioners and their period of operation and months and hours in a day) during summer months, servicing of air conditioners.roomheaters/ blowers in winter months with their capacity, etc.

- Last 5 years of electricity bills, no. of hours of operation of generator set, (log book) quantum of diesel used and expenditure as well as repairing charges.
- Rate for all needed materials and labor charges were collected from market.

Measurement

- A detailed measurements of supply of power and its consumption, intensity of light in lumens at each table, room temperature was monitored for 24 hours at selected locations by the experts.
- One to one discussions regarding use of power with various level of officers to understand and confirm the ground truth.
- Audit were carried out on site by CIT Energy Management AB Sweden experts (Fig.1) and Indian team experts empaneled by BEE India and energy saving measures were identified.

ASSESSMENT AND ANALYSIS

With the available data and actual measurements at site during 2012-13,(4 visits of 1 week duration by experts) BELOK Total Concept (BTC) Method was used at office premises keeping in view to provide sufficient lights, cooling effects so as to feel comfortable while working. Some of energy saving measures were identified for the premises within the profitability frames set by the building owner. The good environment in the office increases the efficiency and effectiveness of work. Complete energy audit in terms of energy saving, capital cost for investment to achieve the suggested modifications and energy bills etc. was analyzed and considered for implementation.

Fig.1: Energy Audit by BEE/STEM Sweden

IDENTIFICATION OF ENERGY SAVING MEASURES AND THEIR IMPACT

Adjust the Temperature Set-Point for Cooling (Air Conditioned)

- According to National Building Code of India, the inside design room temperature/condition for offices is 23-24 C during Summer season and 21-23 C during winter season. Accordingly, the temperature set-point for all cooling units (air conditioners) is to be maintained at 23 C.
- There is energy saving of 60MWh/year without any cost involved for implementation
- Total Annual cost saving (2012 -13) will be Rs. 4,55,000

Adding Daylight Control to the Lighting System in the Atriums.

- In the atriums in each building block, there are in total 77 CFL light fixtures with the nominal power of 2x11 W. The lighting is manually controlled. The atriums have a lot of daylight coming from the transparent hemispheric roof, however the lights often are switched on during the daytime. The energy saving potential is calculated based on the following estimation/changes in the system:

(i) The estimated current annual operating time of

the system is ca.2600 hour /year

(ii) The estimated decrease in the operating time of the lighting is ca 40% , to about 1600hour/year when daylight control is added.

- The total capital investment is Rs. 10,000/- , however total annual cost saving will be Rs. 25,000/-

Add Occupancy Control to the Lighting in the Office Areas.

- In the office areas everywhere, lights are manually operated, which means that there is a great risk for the lights to be continuously switched on during the working hours even if there are no persons present in the room/hall. According to this measure, occupancy sensor is added to the lighting system in the office areas with the possibility to switching on manually and switching off by the sensor. This measures are for approximately 55 rooms in the office areas. In some big rooms and halls, multiple sensors are proposed. It is also recommended to consider sectioning the lighting in the bigger office room so that only working areas occupied by the people are lit. The energy saving potential is calculated based on the following estimations /changes in the system with energy saving of 21 MWh/year.

(i) The operating time of the existing lighting system in the office rooms are estimated to be 10 hours. The estimated decrease in operating time in the office areas with the occupancy control is about 30 %

(ii) The estimated saving potential is on total power input for the new lighting fixtures.

- The total investment cost will by Rs 93,000/- with annual cost saving is Rs 1,59,000

Add Occupancy Control to the Lighting in the Restrooms

- In the Restrooms (Toilets) the lights are also manually operated as elsewhere, which means that there is a risk for the lights to remain switched on during the working hours even if there is no need of light. By implementing the occupancy control measure in approximately 50 restrooms, the energy saving potential is calculated based on the following estimation/changes in the system:

(i) The operating times of existing lighting system in the restrooms are 12 hours per day. The estimated decrease in operating time with the occupancy control is about 60 %

(ii) The estimated saving potential is based on the estimated total power input for the new lighting fixtures, measure 3 is carried out . With old lighting fixtures the saving potential is ca 20-25 % higher due to higher base power input of the lighting systems. There is energy saving of 2 MWh/year.

- The total capital investment will be Rs 84,000/- with annual total cost saving of Rs 18,000 /- per year.

Change Existing Lighting in the Office Areas and Restrooms to Energy Efficient Lighting

- There are both fluorescent tube lamps (FTL) and compact fluorescent lamps (CFL) installed in the buildings. However, there are number of FTL lights with T tubes that use the traditional electrical copper ballast. In total there are about 390 FTL lighting fixtures in the bi-areas. These fixtures are 2x36W, 2x40W and 1x36w. and all are manually controlled and remained switched on during the office hours from 9:00 am until 5:30 pm.

- According to switching over to this system, FTL lighting fixtures to be changed to energy efficient T-5 lighting with HF-ballast.

- The energy saving measures/ potential is calculated based on the following estimations / changes in the system :

(i) In total there are about 390 FTL lighting fixtures with electrical copper ballast in the office areas and 45 fixtures in the bi-areas with the total estimated power input of 90W for the FTL lighting fixture 2x36W; 100W, 2x40W, and 45W for FTL lighting fixture 1x36W. There is energy saving of 31MWh/year.

- The total capital investment will be Rs.45,000/- and annual cost saving is Rs. 2,40,000/-

Other Measures which are Suggested as Follows:

(i) Switch off the office machines whenever not in use.

(ii) Maintenance and surveillance should be done time to time.

Table No. 1 is prepared considering the investments and priorities is attached.

Table 1: Calculated Measures in the Action Package Report and Priorities

Description Rs/Y	Energy Saving Electricity	Total Savings (Rs./ Years)	Investment (Rs.)	Economic Calculation Period
Adjust the Set Point for cooling units	60	4,55,,000	.000	10 Years
Install daylight control for lighting in the atrium	3	25,000	10,000	10 Years
Install occupancy control for lighting in the office	21	1,59,000	93,000	10 Years
Install occupancy Control for lighting in rest rooms	2	18,000	84,000	10 Years
Change to more energy efficient lighting Indoor	31	2,40,000	45,000	15 Years
TOTAL	8,97,000	2,32000	19 Years	

STAR RATING OF BUILDING BY BEE

The status of building was evaluated by filing a separate prescribed application to BEE before implementation of above suggestions. After examination of physical assessment, data analysis, Bureau of Energy Efficiency awarded the status of 4**** (star).

CONCLUSION

The audit indicates very simple energy measures with an investment cost of Rs.2,32,000/- (one time) which will fetch annual saving of Rs.8,97,000 for a period of minimum 10 years or more apart from saving of energy and climate change.

In view of high cost of power generation and unabated increase of demand due to enhancement of life-style, conservation of energy and its optimal use is one of the most important task for the administrators, managers and also for the stakeholders. Continued efforts need to be made by all concerned to save energy and use it judiciously. The suggested energy saving measures are to be taken up by one and all for their buildings, office premises, malls, multiplex, hospitals, schools, institutions and industry.

It is recommended that similar audit is carried out for each complex to achieve more benefits in terms of energy saving, carbon production, saving in expenditure, covering remote areas by extending power connections and overall climate mitigation.

ACKNOWLEDGEMENTS

The author place his special thanks to Shri Nelson, Ms. (Dr.) Mari Paua CIT Energy Management AB, Sweden and Sh. Girjashankar, Energy Economist, Bureau of Energy Efficiency, India for carrying out the detailed study. I also thank Dr. R. K. Gupta CMD, WAPCOS, for conducting the study under Corporate Social Responsibility. Thanks also to my officers and engineers who have participated in the process.

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ENVIRONMENTAL LEGISLATIONS IN INDIA - A BRIEF OVERVIEW

Dr. Rajender Singh* And Satender Singh**

Abstract

"Modern Environmental Law in India is a recent and evolving branch of law. With the kind of environmental issues that our society faces today, a better under understanding of this field of law has become of vital importance. Two crucial instruments for environmental governance in India are the Environmental Impact Assessment regulation of 2006 and the National Green Tribunal (NGT) which was established in 2010.

Environmental Impact Assessment is a process to anticipate, measure and weigh the socio-economic and bio-physical changes that may result from a proposed project. It assists the decision makers in concluding whether the proposed project is justified to be carried out by considering its environmental costs and benefits. The National Green Tribunal is one of the first courts in the world dedicated to environmental matters. In a short span of seven years of existence, it has succeeded in delivering landmark judgments and in putting the environmental dimension of development at the forefront.

With particular reference to the EIA and NGT regimes, this paper overviews the major environmental legislations in India.

INTRODUCTION

The history of environmentalism in India is very rich. The importance of protecting the environment can be found in our ancient texts under which it was considered ones "dharma" to protect Nature. Previously and even today in some parts of the country, people particularly in many tribals areas worship symbols of nature such as trees, rivers, mountains, animals, etc. Water from the river Ganges has been considered holy from time immemorial and holds great cultural significance in Hinduism. As far as legal regulation of environment is concerned, various ancient texts made reference to environment related obligations and punishments. For instance, "Manusmriti" prescribed different punishments for causing injury to plants while Kautilya in his "Arthashatra" determined punishments on the basis of the importance of a particular part of a tree.

The development of modern Environmental Law in India can be traced from the 1970s onwards.

CONSTITUTIONAL PROVISIONS

It is to be noted that the original Constitution that came into force in 1950 did not have any express provision relating to environment; presumably the drafters of the Constitution at that time did not envisage that the exploitation of environment in India would reach such an extent that specific provisions would need to be provided in the constitution for its protection. It was only in 1976, through the 42nd amendment to the constitution, that Article 48A ("The State shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country.") was added as a Directive

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Principle of State Policy, and Article 51A(g) ("It shall be the duty of every citizen of India— to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures") was added as a Fundamental Duty. Even though both Directive Principles (which are mere guidelines to be followed by governments while drafting laws and policies) and Fundamental Duties (which are more in the nature of moral obligations to be followed by each citizens) are not enforceable by courts, nevertheless the inclusion of these provisions has given a fresh impetus to the development of Environmental Law in India.

Significantly, the Supreme Court in a number of judgments has interpreted the 'right to a clean environment' within the meaning of 'right to life' under Article 21 of the Constitution, thereby giving it a status of a Fundamental Right. The implication of this is that any citizen deprived of a clean environment can directly approach the Supreme Court or the High Court under their writ jurisdiction to get this right enforced. Further, besides the generic 'right to a clean environment', the courts have also included specific environmental rights within the scope of Article 21, such as right to access to clean drinking water and to clean air.

OVERVIEW OF ENVIRONMENTAL LEGISLATIONS

The first dedicated environment related legislation was the Water (Prevention and Control of Pollution) Act of 1974, which provided for the setting up of the Central and State Pollution Control Boards, and provided them with powers to prevent the pollution of water, including the power to take samples, prescribe penalties, and even shutting down of units. An analogous act with regard to air pollution was enacted in the form of the Air (Prevention and Control of Pollution) Act of 1981. Another important legislation for regulating the use of forests was the Forest (Conservation) Act enacted in 1980 which provides for mandatory Forest Clearances for activities on designated forest areas.

Thereafter in 1986, an important overarching legislation, the Environment (Protection) Act came into being, which apart from providing a coordination framework for the existing authorities, also authorised the central government to formulate rules and take all necessary measures required from time to time for the protection of environment. Various Rules dealing with diverse aspects of environment protection have been laid down by the central government in exercise of the powers granted by the Environment (Protection) Act; for instance, Noise Pollution Rules 2000, Wetlands (Conservation and Management) Rules 2010, E-Waste (Management) Rules 2016, etc.

Besides these major legislations, a number of other legislations also exist which deal with significant aspects of environment. These include, amongst others, the following: The Wildlife (Protection) Act of 1972, The Biological Diversity Act of 2002, The Indian Forest Act of 1927.

The National Green Tribunal

The Supreme Court of India had in numerous judgments cited the need for establishment of specialised courts for the adjudication of environmental matters. Further the Law Commission of India in its 186th Report in 2003 had also recommended the constitution of special environment courts. This demand from various quarters was primarily raised as a consequence of the following factors: (i) the higher courts of India had often realised that while dealing with environmental matters, the lack of technical knowledge amongst the judges with regard to the interdisciplinary fields of environment was becoming a hindrance in delivering justice. (ii) the courts in our country are immensely overburdened with pending litigations which greatly affects the quality of justice delivery, even more so in the cases related to environment and pollution, where at times the relief to be granted must be expedited.

In furtherance of the above discussion, the National Green Tribunal Act was enacted by the Parliament in 2010, establishing a specialised environmental court with the objective of "effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental

thereto."

The Tribunal has a presence of both Judicial Members (who are retired or sitting judges of the Supreme Court or High Courts) and Expert Members (who are technically qualified persons in the field of environment related fields or experienced administrators), who hear cases together. Besides the Principal Bench located in Delhi, the Tribunal also has regional benches located in four other locations in the country thereby ensuring that the access to the Tribunal reaches people from a wide geographical area. Other salient features of the Tribunal include that the Act requires the Tribunal to endeavour to dispose off cases within a time frame of six months; the Act expressly puts an obligation on the Tribunal to apply the established principles of environmental jurisprudence such as the 'polluter pays principle', 'precautionary principle', 'sustainable development' and 'no fault liability'; the Act does not bind the Tribunal to follow the procedure as laid down in the provisions of the Code of Civil Procedure of 1908 or the Indian Evidence Act of 1872, but rather gives it the power to regulate its own procedure, subject however to the 'principles of natural justice'.

It is to be noted that the National Green Tribunal is not the first environmental adjudicatory body in the country. Two former bodies, the National Environment Tribunal (established in 1995) and National Environmental Appellate Authority (established in 1997), were formed earlier with objectives similar to that of the National Green Tribunal, but they were both widely considered to be non-functional and defunct and therefore a new institution was sought to be established replacing the earlier two authorities. In contrast, the National Green Tribunal, in its short span of existence of seven years, has turned out to be extremely forthcoming in addressing environmental issues and has garnered widespread acclaim.

ENVIRONMENT IMPACT ASSESSMENT

In order to carry out a nation's economic progress and it's development plans, certain activities are needed to be carried out which are bound to have a certain footprint on the environment. Large developmental projects such as dams, ports, railway lines, nuclear power stations involve major alterations to the natural environment which in turn may lead to potential adverse impacts on the environment as well as the human populations living around these projects. It is enshrined in the well established principle of Sustainable Development that only such development activities ought to be allowed the effects of which are within the assimilative capabilities of the environment, in other words, the environment ought not be irreversibly damaged as a consequence of those activity.

One of the means of establishing whether such a project is environmentally justified or not is the instrument of 'Environment Impact Assessment (EIA)'. It is a process to anticipate, measure and weigh the socio-economic and bio-physical changes that may result from a proposed project. Where the benefits accruing from the project sufficiently exceed the costs resulting therefrom, the project can be allowed to be carried out.

In India this process is carried out through the provisions of the Environment Impact Assessment Notification, 2006 which was introduced under section 5(3) of the Environment (Protection) Act of 1986 (This 2006 Notification was introduced while replacing the earlier EIA Notification of 1994).

Under this Notification, certain developmental activities have been notified which could be taken up only after obtaining prior and proper 'Environmental Clearance (EC)' from therequired authority. For the purpose of assigning the authority, the activities have been classified into two categories: activities which fall under category 'A' are considered to be having a more severe impact on the environment and the EC for such activities is granted by the Ministry of Environment, Forests and Climate Change, while activities falling under category 'B' are the ones which have a milder environmental footprint and for which the EC is issued by a state level authority known as the State Environment Impact Assessment Authority (SEIAA).

A list of some activities within both these categories is given in Table 1 (note that this list is not exhaustive):

Table 1: Activities and the Category

CATEGORY 'A' (EC by MOEF)	CATEGORY 'B' (EC by SEIAA)
Mineral Mining in area greater than 50ha	Mineral Mining in area less than 50ha
Hydroelectric projects with power generation capacity of greater than 50MW	Hydroelectric projects with power generation capacity of less than 50MW
All Nuclear Power projects	-
Cement Plants with production capacity greater than 1 million tonnes per annum	Cement Plants with production capacity less than 1 million tonnes per annum
All Chemical fertiliser projects	-
Rayon fibre manufacturing	All other manmade fibres manufacturing
-	All integrated paint industry
All Airport projects	-
All new National Highways	All new State Highways

Over the years, the EIA regulation has turned out to be very crucial in governing the field of environment in India, by ensuring that the proponents of large scale projects are held accountable for the impact that their activities have on the environment.

A grant (or refusal of grant) of an Environment Clearance under the EIA Notification can be challenged before the National Green Tribunal. This ensures an effective environmental law system with a two stages of check mechanism, firstly before the regulatory authorities when they apply their minds on the merit of the proposal for EC, and secondly before the National Green Tribunal when a person aggrieved by a decision of EC can challenge the same before the Tribunal. Through all of this, the writ jurisdiction of the Supreme Court and the High Courts, being constitutionally guaranteed can always be invoked.

The National Green Tribunal has on a number of occasions has accepted the challenge to a malafide grant of Environment Clearance (EC). The most famous case was the 2012 case [PrafullaSamantaray v. Union of India and Ors., dt. 30th March, 2012] involving South Korea's Pohtang Iron and Steel Company (POSCO) which had proposed a mega steel project in Odisha, and for which it had received the EC. However, when it was challenged before the NGT it was held that the process of grant of EC was malafide on various grounds. Therefore, EC was stayed and the Ministry of Environment and Forests was asked to relook again into the grant thereof.

It is through such decisions that the National Green Tribunal has turned out to be a sentinel for environmental protection in our country.

CONCLUSION

Over the years, the EIA regulation has turned out to be very crucial in governing the field of environment in India, by ensuring that the proponents of large scale projects are held accountable for the impact that their activities have on the environment.

A grant (or refusal of grant) of an Environment Clearance under the EIA Notification can be challenged before the National Green Tribunal. This ensures an effective environmental law system with a two stages of check mechanism, firstly before the regulatory authorities when they apply their minds on the merit of the proposal for EC, and secondly before the National Green Tribunal when a person aggrieved by a decision of EC can challenge the same before the Tribunal. Through all of this, the writ jurisdiction of the Supreme Court and the High Courts, being constitutionally guaranteed can always be invoked.

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SOLAR ROADWAYS FOR SUSTAINABLE DEVELOPMENT

O.P. GUPTA vsm*, VIJAY GUPTA, CHANDAN GUPTA*** VAIBHAV GUPTA****AND ABHISHEK GUPTA*****

Abstract

Technological innovations are leading the way in new lighting and paving systems to make up for these economic and environmental constraints.

Many new paving methods equipped with smart technologies are popping up throughout the world.

The purpose of Solar Roadways is not only to collect solar energy and rain water but to also make smart roads. Roads that illuminate themselves at night, heat themselves in the winter and are easily programmable to direct drivers. Further the potentials of the technology allow to further contribute to some more green concepts as smart city, the connected things, smart gird applications, hybrid, electric cars and other. Put the normal solar panel to a better and much more practical use, there can be derived many new benefits.

INTRODUCTION

The Solar Roadways consists of structurally engineered solar panels that we drive on. Each Solar Road panel (roughly 12' by 12') interlinks with neighbouring panels to form the Solar Roadways system. The Solar Roadway generates electrical power from the sun and becomes a nation's decentralized, intelligent, self-healing power grid, replacing existing deteriorating power distribution infrastructure.

The Earth's climate has changed throughout history. Just in the last 650,000 years there havebeen seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era and of human civilization. Climate change is changing our economy, health and communities in diverseways. In case no efforts are made to curb climate change the results will be disastrous. Carbon dioxide and other global warming pollutants would be causing the planet to warm up. The average global temperature has increased and increasing at the fastest rate. Unless the emission is controlled global temperature is bound to increase considerably by the end of the century.

GLOBAL WARMING

Global warming has become one of the most complicated issues faced by the world in the present century. It has resulted in a drastic change in the climate all over the world in recent years. The undesirable changes have been attributed to the large amount of carbon dioxide released into the earth's atmosphere. The industrially developed nations are responsible for these changes as they are emitting the greenhouse gases.

Increase in the use of renewable energy resources is considered as one of the primary solutions to reduce the global warming. Among all the renewable energy resources, solar energy is the only resource available all over the world abundantly and distributed more evenly.

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Based on the NAOA statistics, the combined average temperature over global land and ocean surfaces for September 2015 was the highest for September in the 136-year period of record, at 0.90 C (1.62 F) above the 20th century average of 15.0 C (59.0 F), surpassing the previous record set last year in 2014 by 0.12 C (0.19 F). The September temperature is currently increasing at an average rateof 0.06 C (0.11 F) per decade (Fig.1).

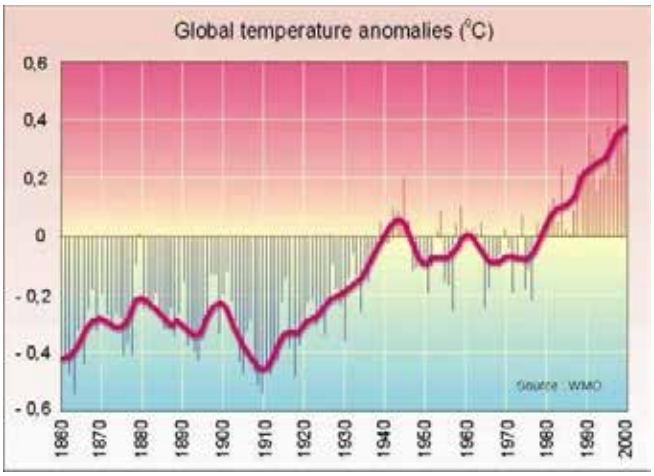


Fig.1: Global Temperature Anomalies (^{0}C)

One of the key issues for global warming is the increased levels of CO_2. There are two main industries largely influencing the production of CO_2 transport and energy production. There is a need that the technologies are developed reducing pollution from vehicles and power plants. Existing technologies be utilised for manufacturing of emission free cars and more modern electricity generators. More reliance on renewable energy sources such as wind, sun and geothermal be given. Further efficient appliances and conserve energy is considered one of the best alternate for power energy.

SOLAR ROADWAYS

Solar Roadways technology combines a transparent driving surface with underlying solar cells, electronics and sensors to act as a solar array with programmable capability. It replaces asphalt surfaces with structurally-engineered solar panels capable of withstanding vehicular traffic. The proposed system would require the development of strong, transparent, and self-cleaning glass that has the necessary traction and impact-resistance properties.

The concept of solar roadways provides plenty of technical challenges that will need to be hurdled, but the promise of unlimited clean energy, along with safer, smarter roads is already driving the cells into production.

Functions of Solar Roadways can drastically change our lives for better. Smart Solar roads combine different solutions in one – it can help to improve energy production from solar panels, to collect and distribute rain water, to provide a digital platform for Smart city, to facilitate emerging electric cars and driver-less cars and much more. Further it can offer many additional benefits to citizens, to the environment and will contribute for sustainable development as a whole.

While most people think of walkways as only having one use (i.e., enhancing pedestrian mobility), the Solar Walk is also a power source and a light source when paved with solar panel tiles.

Further the walkways are paved with "special minerals that absorb UV light during the day, and emit a soft glow during hours of darkness." According to the manufacturers of these paths, the luminosity of the pathway adjusts to compensate for the atmospheric light levels – brighter on pitch black nights, and dimmer on lighter evenings. With an array of LED bulbs integrated into each solar road panel sidewalks and parks paved with the cells would generate electricity by day and illuminate roadway at night. The same LED's could also be used to display messages that warn drivers of weather conditions, road obstructions and accidents. These solar panels promise an entire infrastructure that can think and communicate with drivers in real time, providing live traffic intelligence that has never been in the past. The road could send signals to cars that inform drivers of traffic conditions and suggest alternate routes; commuting would be faster and safer than ever before.

Features of solar panels (Fig.2) are that they are slip-resistant, semi-transparent walkable tiles. The tiles contain photovoltaic technology to convert sunlight into electricity. The purpose of Solar Roadways is not only to collect solar energy and rain water but to also make smart roads. Roads that illuminate themselves at night, heat themselves in the winter and are easily programmable to direct drivers. Further the potentials of the technology allow to further contribute to some more green concepts as smart city, the connected things, smart gird applications, hybrid, electric cars and other. Put the normal solar panel to a better and much more practical use, there can be derived many new benefits.

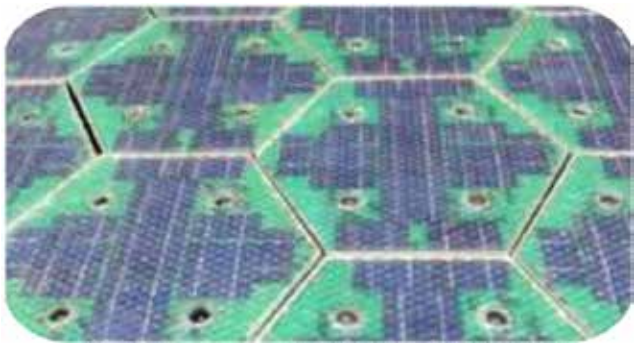
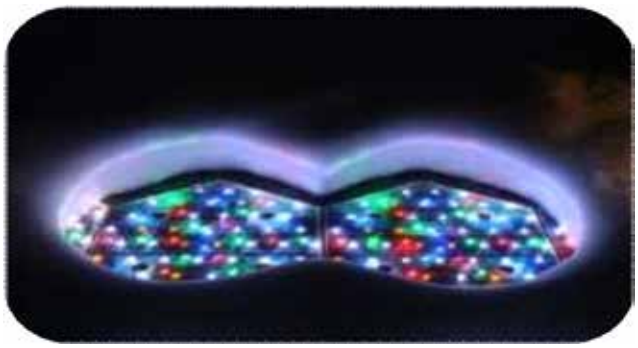


Fig. 2: Solar Road Panel



Panels melting snow

Star Path Ways

The 'Star-path' is a treatment that can be directly applied to an existing surface without the need to take up the original path and re-lay it. In a time when local authorities are reducing electricity consumption to save money, a new surface that acts as a light source and

The solar energy collected by the smart surface could be used to feed the grid during the day time or even power things such as heating elements under the surface to clear ice and snow from the roads in the winter.

Photovoltaic is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductor that exhibit photovoltaic effect.

STRUCTURE OF SOLAR ROADWAYS

Structure of Solar Roadways (Figs.3&4) Comprises of

Road Surface Layer:

- The road surface layer is semi-transparent and is of high strength.
- The sunlight can still pass through it to the solar cells where solar energy is collected.
- It is rough enough to provide sufficient traction, yet still passes sunlight through to the solar collector cells embedded within, along with LED's and a heating element.

Electronics Layer:

- A number of ultra-capacitors are also fitted in this layer to store energy for future use.
- It contains photovoltaic cells which absorbs solar energy. It also contains a microprocessor board with support circuitry for sensing loads on the surface and controlling a heating element with a view to reducing or eliminating snow.

Base Plate Layer:

- It has the responsibility of distributing the power as well as data signals (Phone, T.V, Internet etc.) being collected from the electronic layer.
- The energy thus collected is transmitted to homes linked to the Solar Roadway.

- It needs to be weather proof to protect the electronic layer above it.

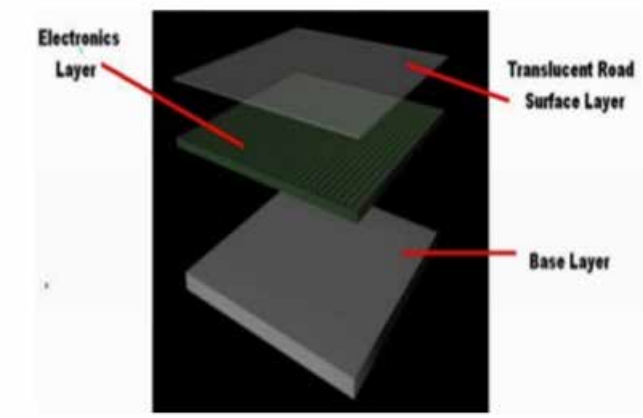


Fig. 3: Structure of Solar Roadways

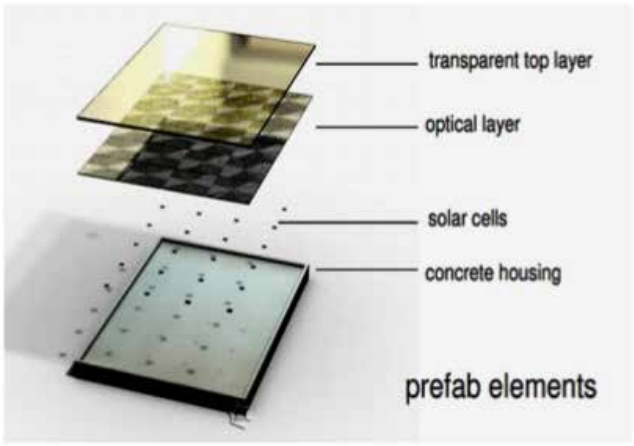


Fig.4: Components of Solar Roadway

Solar Panel Roads Are Smart Roads, because

- It gives Instructions
- They can also warns drivers of obstacles on the road.
- The panels are Power independent, meaning they recharge themselves.

Solar Panel can be used to charge electric cars. They can be recharged at any conveniently located rest stop, or at any business places that incorporates Solar Roadways Panels in their parking lots for. Owners can plug-in their cars in and recharge while they're eating or shopping. Engineers are even investigating ways to use mutual induction to charge EVs while they are driving down the Solar Roadway. By the way, using electric cars would eliminate most of the other half of the cause of global warming and could virtually wean the world off oil entirely.

SMART GRID

With the Solar Roadway, the road can become the power grid, eliminating the need for unsightly utility poles and relay stations. Power is generated everywhere - every road, parking lot and driveway. No more power outages, roaming or otherwise. The Solar Roadways generates "secure" energy; it can't be deliberately shut down. Not by terrorists, not by power companies, it simply can't be shut down.A smart grid would be more automated and more "self-healing," and so less prone to failures. It would be more tolerant of small-scale, variable power sources such as solar panels and wind turbines, in part because it would even out fluctuations by storing energy.

Solar Panel Roads Are Source of Income

Source of Income to be generated apart from the Road tax are,

- Through the generation of electricity
- By transporting cleaned storm water to municipalities or agricultural centers
- By leasing the roadside conduit (Cable Corridor) to entities such as utility companies, telephone, high-speed internet, cable TV, etc.
- By selling advertising in parking lots with the configurable LEDs
- By charging people or companies to recharge their electric vehicles

Suitability of Solar Panel for Roads

It is considered that Glass is softer than asphalt, hence it would not be suitable, but it is not so. When tested for its hardness as compared to

Asphalt. According to Moh's Scale of Hardness, the test results on various objects are shown in the Table 1.

Table 1: Hardness of various Materials

Hardness	Object
0,7	Graphite
1,3	Asphalt
3,0	Copper Penny
5,5-6	Knife Blade
5,5-6	Plate Glass

Perusal of the test result reveals that the Asphalt is softer than Glass.

Moreover, Solar Road panels are made of tempered glass and tempered glass is 4-5 times stronger than non-tempered glass. Further testing has revealed that the surface of the panel road is less slippery than a normal road.

SOLAR ROAD PANEL CITIES

Solar road panel cities could be entirely powered by the sun. Parking lots become solar farms. India's vast network of national highway, state highways and rural roads would serve as India's new and improved electric grid. These panels have the potential to power cities cutting carbon footprint significantly while upgrading antiquated infrastructure.

Energy intensive industries and buildings would all become emission free, leaving the air clean even in the heart of downtown.

BENEFITS OF SOLAR PANEL ROADWAYS

Avoid Accidents

- The Solar Roadways can protect wildlife and motorists.
- Load cells in the Solar Road Panels can detect if something is on the surface of the panel.
- Load cells work like weight machines.
- In the event that an animal does get onto the Solar Roadway, oncoming drivers will be warned via embedded LED's of the danger ahead and will be given plenty of time to slow down.
- Illuminated Roads unlike the dark roads we drive on by night today, the Solar Roadways will have LED's which will "paint" the lanes.
- There is no need to spend energy when no cars are travelling, so the intelligent roadway will tell the LED's to light up only when it senses cars on its surface.
- This way, drivers will know an oncoming car is ahead when they see the lights on the other side of the road begin to light up ahead.
- Each Solar Road Panel contains a microprocessor that monitors and controls the panel, while communicating with neighbouring panels and the vehicles travelling.
- Electric vehicles (EVs) are on their way'.
- More and more car manufactiureres are offering electric vehicle options.
- EVs can be recharged at any conveniently located rest stop, or at any business that incorporates Solar Road Panels in their parking lots.
- Owners can plug their cars in and recharge while not driving.
- It might be possible to power electric cars as they drive along. There would be a huge development for electric vehicles, because with current road surfaces and charging systems, they have a limited range that precludes long-distance journeys.
- By replacing deteriorating highway infrastructure with the Solar Roadways, a new system is created that will support the recharging of all-electric vehicles.

- Using of all-electric vehicles will eliminate the need for fuel.
- By the removal of internal combustion engine, vehicles are easy to drive.
- The Solar Roadways will distributes its electrical power to all business and homes connected to the system via their parking lots and driveways (made up of Solar Rod Panels).
- In addition to electrical power, data signals (cable TV, high-speed internet, telephone, etc.) also travel through the Solar Roadways, which acts as a conduit for these signals (cables).
- This feature eliminates the unsightly power lines, utility poles, and relay stations we see all over the countryside.
- In the event of an environmental disaster or National emergency, Solar Roadways would provide power when it is needed most.
- As solar power is renewable, it obviously requires no external connection to an artificial power source.

Disadvantages

- Initially, the start-up and maintenance costs of building such roadways and parking lots is extremely high.
- The average efficiency is currently 20%.
- Driving or walking on a textured glass surface is completely different than asphalt. Solar Roadways when tested, its wet textured glass surface at a university lab has shown that it can not stop a vehicle going 80 miles per hour within the required distance, which can be very serious and can lead to major and fatal accidents.
- Durability is also not fully proven and tested on practice.
- There is a great need for research work for material and equipment. During the prototype phase, there are some problems with materials and specific equipment delivery, which are difficult to procure.
- Solar Roadways have no developed business at this stage. This business cannot be developed on its own till there is a Govt. policy, incentive and support for the manufactures and service providers.

STATUS OF SOLAR ROADWAYS IN OTHER COUNTRIES

Work undertaken in some of the Countries is given here under: -

Europe : The use of solar panels for road surfacing may be new to the United States, but Europe is farther down the solar road.

Netherlands : In 2015, Netherlands made headlines with the installation of the world's first solar road, a bike path that captured energy through glass-coated solar panels. After the first six months, the 230foot test bike path generated 3,000 kWh, or enough electricity to power a small household for a year.

France : In France, the government recently announced plans to resurface 621 miles of roads with solar panels, using Wattway panels that were developed by road-building company Colas in partnership with the French National Solar Energy Institute.

America : America's iconic Route 66 is about to become part of a new solar system.

MAINTENANCE AND OPERATION OF SOLAR PANEL ROADS

Cleaning of Snow fall from Road Surface: During winter, they melt the snow off them, making it safe for driving but also possible to collect sunlight.

Water collection and treatment: The rain or snow water can flow off of the road and through the grates to a filtration area. The water is gravity

fed through filtration socks (or other treatment options as desired.) and into a storage tank below the frost line. The water can be discharged into an existing drainage system or it can be pumped from the storage tank in either direction along the road. Destinations may include a bigger filtration facility, an aquifer, or an agricultural center.

Easy to Detect Damaged Panel: In a case of malfunction or any sort of damage on one or more panels, the other panels can report the problem. Each of the panels contain their own microprocessor, which communicates wirelessly with surrounding panels.

Easy to Replace Damaged Panel: A single operator could load a good panel into his/her truck and respond to the scene. The panel could be swapped out and reprogrammed in a few minutes. The damaged panel would then be returned to a repair center.

Quick and Easy to Repair Panel : Repair is much quicker and easier than maintenance system for asphalt roads.

CONCLUSION

"Everyone has power. No more power shortages, no more roaming power outages". No more need to burn coal (50% of greenhouse gases). Less need for fossil fuels and less dependency upon foreign oil. Much less pollution. An electric road allows all-electric vehicles to recharge anywhere: rest stops, parking lots, etc. They would then have the same range as a gasoline-powered vehicle. Internal combustion engines would become obsolete. Our dependency on oil would come to an abrupt end. It is time to upgrade our infrastructure roads and power grid to the 21st Century. For roughly the same cost of the current systems (asphalt roads and fossil fuel burning electricity generation plants), the Solar Roadways can be implemented. No more Global Warming. Safer driving conditions Far less pollution. A new secure highway infrastructure that pays for itself. A decentralized, self-healing, secure power grid. No more dependency on foreign oil.

COOL ROOFS AND PLANTING TREES: MITIGATING URBAN HEAT ISLAND AND PRESERVING ENVIRONMENT

MANOJ PANWAR* AND KAVITA RATHI**

Abstract

Urban settlements are considered as growth engines of development, as they serve centre of economy, human resources, culture, entertainment, political power, innovations and knowledge. Cities have rendered uncountable benefits to human life. In current state, 32% of India is residing in urban areas. The share of urbanized India is projected to be 50% in 2040. More urbanization also means inflow of impervious surfaces, loss of vegetation cover, increase in surface areas and 3D structures, increase in energy consumption, degradation of environment, and increase in transportation and activity subsystem on urban space. One of the problems as identified and described by various researchers across world is the increase in temperature of urban settlements which has been identified as major predicament posted to urban ecology. The phenomenon of temperature rise in settlements with higher human intervention "termed as urban settlements" as compared to neighbouring areas is known as urban heat island (UHI). Average UHI intensity observed across different urban settlements ranges from 3^0C to 5^0C. Electricity demand in cities increases by 2–4% for each 1^0C increase in temperature.

Adoption of energy efficient architectural strategies leads to energy conservation. Cool roofs and planting trees are promising mitigation measure to UHI, and have various direct and indirect environmental benefits associated. Authors have provided conceptual framework for inclusion of these strategies at urban scale. System dynamic modelling technique has been used to quantify the costs and benefits. Pollution and heat emitted by coal based thermal power plants have shown significant reduction. The study concludes with quantitative benefit for mitigating UHI for Delhi using best farming method incorporating these measures.

INTRODUCTION

Energy consumption is basic need for this development. Per capita power consumption is an indicator of economic development. Energy is the basic element for development of any system. The per capita energy consumption is much higher in developed countries, whereas it is much less in less developed and developing countries. Urban settlements are considered as growth engines of development, as they serve centre of economy, human resources, culture, entertainment, political power, innovations and knowledge. Cities have rendered uncountable benefits to human life. In current state, 32% of India is residing in urban areas. The share of urbanized India is projected to be 50% in 2040 by UNDP. The study area, Delhi state, has achieved 100% connectivity and is pioneer in unbundling power distribution. The over consumption of land resource can be observed in availability of urbanisable land in NCT-Delhi for 2021 in Master Plan 2021 for Delhi. The increasing GDP is still promising Delhi as magnet for population immigration. More urbanization means inflow of more impervious surfaces, loss of vegetation cover, increase in surface areas and 3D structures, increase in energy consumption, degradation of environment,

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and increase in transportation and activity subsystem on urban space. All these intertwined, interlinked phenomenon, are going to increase the temperature of settlement. The rise in temperature of urban settlement as compared to temperature of its counterpart suburban and rural settlement is called Urban Heat Island (UHI). The phenomenon gained importance because of the its backwash effects on urban system specifically on environment and its surroundings, electricity demand etc. The review on backwash effects of UHI has been presented in Panwar et al., (2017). Average UHI intensity observed across globe in different urban settlements ranges from 3°C to 5°C. In Delhi, UHI observed ranges from 4°C to 12°C. The UHI developed using remote sensing imagery of Landsat dated March 02nd 2016, has validated the UHI range of previous studies (Fig. 1).

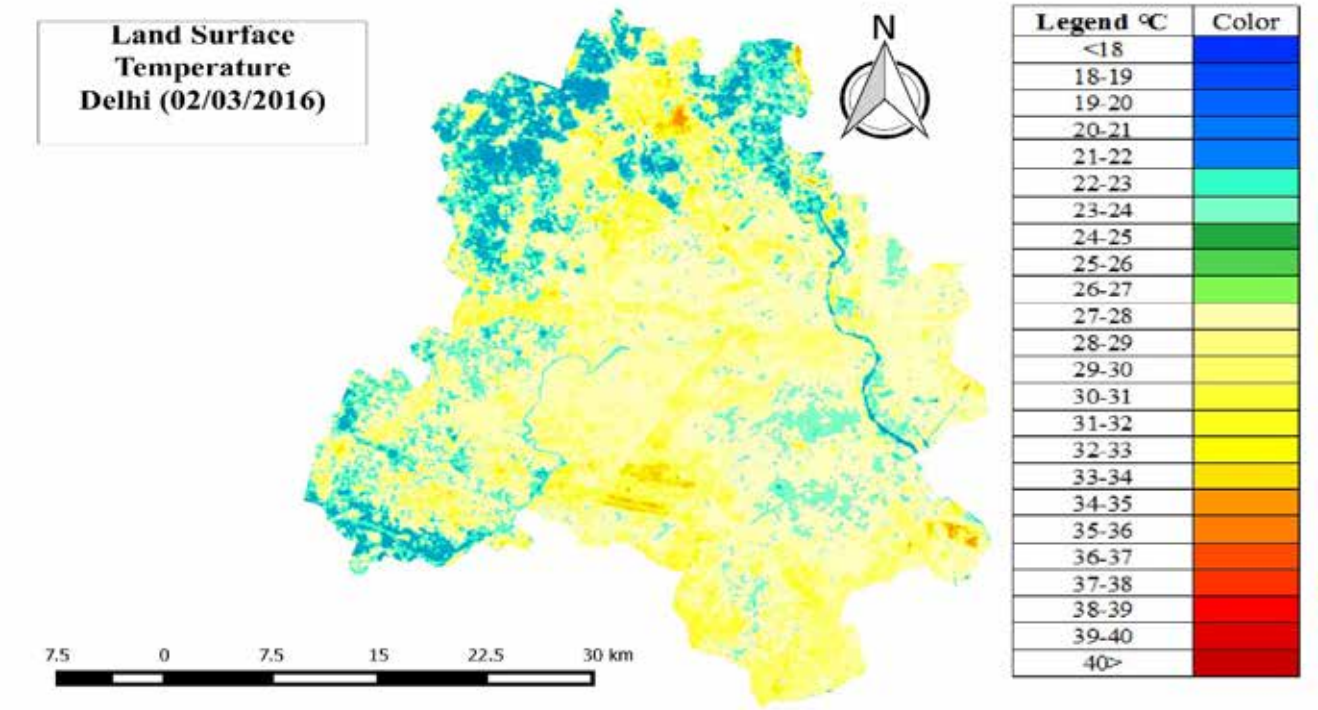

Fig.1: Land Surface Temperature Delhi
(Source: Adopted from Kumar & Panwar (2017)

Electricity demand in cities increases by 2–4% for each 1^0C increase in temperature (Akbari et al. 2001; Mirzaei and Haghighat 2010; Mirzaei 2015). So, assuming an average UHI intensity of 8°C, the impact on cooling energy demand in summers is going to be 16-32% increase. In Delhi, the domestic sector is consuming more than 50% of total energy consumption. Due to dominant share of domestic load and extreme weather conditions, it has its unique load pattern and peak load problems in summer (Mescon 2016). As the electricity supplied in Delhi is generated using coal power plants, consumption of more quantity of fossil energy leads to more carbon emission, which further lead to climate change and other associated problems. Solar radiations and anthropogenic activities are considered as the major contributor to UHI (Panwar et al., 2017). A large number of strategies have been proposed across globe for mitigating UHI, cool roof and urban greening has been considered as very promising solution. The paper concludes

with the results of modelled house in Delhi using base case, and case with cool roof and greening strategy.

COOL ROOF AND PLANTING TREES

A part of the solar radiations falling on the building envelope are absorbed by the buildings. These absorbed radiations increase thermal discomfort during day and increase UHI intensity by re-radiating the absorbed energy during night (Flor and Domınguez 2004; Chen et al. 2014; Kleerekoper et al. 2012; Chun and Guldmann 2014). This absorption can be reduced by either through reduction in absorption of solar radiation or reducing the surfaces having direct solar radiation. Individual building have been simulated and tested to see the impact on UHI reduction through energy savings (Prado and Ferreira, 2005; Radhi et al., 2014; Susca, Gaffin, and Dell'Osso, 2011). A cool roof is a roofing system that delivers higher solar reflectance (the ability to reflect the visible, infrared and ultraviolet wavelengths of the sun, reducing heat transfer to the building) and higher thermal emittance (the ability to radiate absorbed, or non-reflected solar energy) than standard designed roofing products . This can be achieved for short duration by painting roof surfaces with light colour paints (short term, seasonal solution), using ceramic tiles or using specially designed reflecting materials in roof (long term, permanent solution). The reflected solar radiations will heat up the atmosphere during day. So, reducing the building envelope in direct contact with solar radiation is incorporated in cool roof. It can be achieved by adding a building component e.g. double roof, for shading. Authors in this research, have used solar panels as shading component for roof and electricity source as an additional benefit by absorbing the solar radiations without harming the environment during day also.

The reflected solar radiations being harmful to environment is proposed to be utilised by vegetation. Vegetation reduces the heat available in atmosphere through evapotranspiration and strengthen the water cycle, oxygen cycle and carbon cycle in environment. It will increase and enrich the live species in urban environment apart from the direct benefits of trees. So, cool roofs integrating solar panels for roof shading and planting trees in synchronised integration have been proposed as strategy to mitigate UHI and environment preservation and tested in the present research.

MODEL HOUSE IN DELHI

The affordability of air-conditioning has been considered for selecting the house design. The average house size with air-conditioning appliance varies from 60 SQM to 200 SQM. Authors have modelled 3 BHK house (Area 1320 SQM) in Delhi, using trail version of Design Builder Software and analysed electricity consumption for cooling under normal construction and using cool roof and vegetation (Fig. 2). The cooling energy demand and total energy consumption for model house is simulated for typical summer week using, case 1 as simple framed structure with normal roof and case 2 using cool roof strategies having shading from solar panel on 50% of the roof. Electricity consumption of modelled house in Delhi under both the cases is presented in table 1. Household size is considered as 5 for ease of modelling.

Fig. 2: 3 BHK House Model

The model house has shown benefit in form of not only reduction in energy consumption and but also solar radiation absorption by the materials which the buildings

re-radiate during night in form night UHI. Delhi has mix of buildings with varying heights available in different wards. Authors are in process of developing 3D Model for a part of city to analyse the benefits at urban scale. For simplification, all the buildings are assumed to be three storey. So, the benefits of the saving in electricity consumption and energy generation has been converted to one third for analysing the benefits in all residential buildings. The proposal of planting a tree with house has shown reduction in the outdoor temperature. The reduction is temperature varies with the tree species which is yet to be analysed.

Table 1: Electricity Consumption for the Modelled House

Case	Base case without any specific strategy	Design case with cool roof, tree in south and 50% roof shading through solar panels
Recorded Temperature range	28o C – 41oC	28o C – 41oC
Comfort temperature range*	21o C – 28oC	21o C – 28oC
Total Energy consumed	436 Units	342 Units
Energy consumed for cooling	368 Units	272 Units
Energy generated	nil	230 Units
Net Energy consumption	436 Units	112 Units

*This comfort range has been derived using climate consultant 6.0 software for location Delhi ISHRAE 421820 WMO station number.

SYSTEM DYNAMIC MODEL

In this study, Delhi, the capital of India, is considered as a system. System dynamic model for population, buildings, energy consumption and carbon emission is developed (Fig. 2). Cool roof and tree plantation strategy as mentioned above has been proposed to be implementing following fig. 3. By year 2031 A.D. all the buildings are proposed with cool roof with solar panel and tree abutting. Forecasting is made for all the above mentioned sub-systems under business as usual and using the modelled 3 BHK house as best farm case for interpolation at city scale for 2031 A.D. The results of the model are presented in table 2.

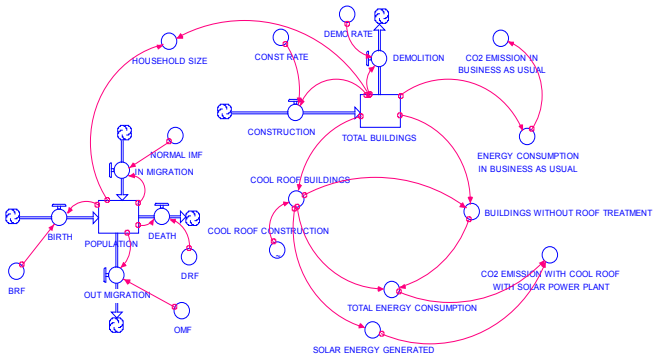

Fig. 2: System Dynamic Model for Population, Residential Buildings, Energy Consumption and CO¬2 Emissions

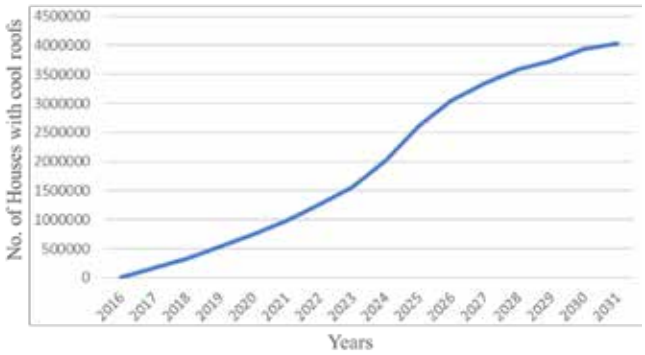

Fig. 3: Cool Roof and Tree Plantation Strategy Implementation Timeline

The model has been validated through population, electricity consumption by residential sector and number of residential buildings. Although, the results are for summer design week, so the results are on very optimistic side, but once validated for full year the results are proposed to be promising.

Table 2: Results of Proposed Model under Business as Usual (BAU) and Best Form Scenario

Year	Projected Population	Projected No. of Residential Buildings	Electricity consumption (EC) (BAU)	Proposed Cool Roof Buildings	EC after implementing Cool Roof + Tree Plantation	CO2 emission (BAU)	CO2 emission after Cool Roof + Tree Plantation
2016	16,850,000	3,370,000	(in Million Units)	0	(in Million Units)	(in tons)	(in tons)
2021	20,998,166	3,577,111	1,258.13	983,706	1,258.13	1,132,320	1,132,320
2026	26,167,535	3,796,951	1,335.46	3,056,546	1,229.21	1,201,909	902,666
2031	32,609,509	4,030,302	1,417.53	4,030,302	1,087.42	1,275,776	345,974
			1,504.65		1,069.37	1,354,182	128,163

CONCLUSION

The phase-wise implementation of cool roof and tree plantation strategy in residential buildings, make it a pragmatic policy as the projected savings will motivate public through actual savings. The environmental preservation will be achieved not only through reduction in CO2 emission but also through reduction in excessive heat released by thermal power plants due to electrical energy from roof-top solar system. The research is in primitive stage with lack of data about building heights, actual design and size of residential unit. The socio-economic data synchronised integration will lead to development of more pragmatic policy development.

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MAKING OF A SOLAR CITY- CASE STUDY OF DELHI

VISHV RATAN BANSAL* AND KANIKA BANSAL GOYAL**

Abstract

The "Development of Solar cities/ Green cities" programme has been launched by the Ministry of New and Renewable Energy (MNRE) with the aim to achieve minimum 10% reduction in projected demand of conventional energy at the end of five years through a combination of energy efficiency measures and enhancing supply from renewable energy sources.

"Development of Solar Cities" programme is designed to support/encourage Urban Local Bodies to prepare a road map to guide their cities in becoming 'renewable energy cities' or 'solar cities'. It motivates the local bodies for adopting renewable energy technologies and energy efficiency measures.

The paper deals with the case study of Delhi for making it a solar city.

INTRODUCTION

Energy has been universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption. On one hand, growth of an economy, with its global competitiveness, hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development has been observed to be reliant on the energy demand.

Energy intensity is an indicator to show how efficiently energy is used in the economy. The energy intensity of India is over twice that of the matured economies. India's energy intensity is also much higher than the emerging economies the Asian countries. However, since 1999, India's energy intensity has been decreasing and is expected to continue to decrease.

Energy independence has to be the nation's first and highest priority, and India must be determined to achieve this within the next few years.

DEMAND AND SUPPLY SCENARIO

In the recent years, India's energy consumption Fig. 1 has been increasing at one of the fastest rates in the world due to population growth and economic development. India ranks fifth in the world in terms of primary energy consumption,

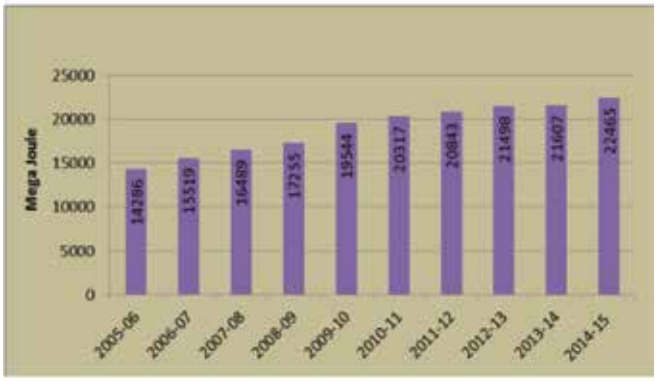

Fig. 1: Per Capita Energy Consumption

Despite the overall increase in energy demand, per capita energy consumption in India is still very low compared to other developing countries.

India is well endowed with both exhaustible and renewable energy resources. Coal, oil, and natural gas are the three primary commercial energy sources. India's energy policy, till the end of the 1980s, was mainly based on availability of indigenous resources. Coal was by far the largest source of energy. However, India's primary energy mix has been changing over a period of time.

Renewable energy sources offer viable option to address the energy security concerns of a country. Today, India has one of the highest potentials for the effective use of renewable energy. India is the world's

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fifth largest producer of wind power after Denmark, Germany, Spain, and the USA. There is a significant potential in India for generation of power from renewable energy sources, small hydro, biomass, and solar

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Renewable energy sources offer viable option to address the energy security concerns of a country. Today, India has one of the highest potentials for the effective use of renewable energy. India is the world's fifth largest producer of wind power after Denmark, Germany, Spain, and the USA. There is a significant potential in India for generation of power from renewable energy sources, small hydro, biomass, and solar energy.

SOLAR ENERGY

Solar energy can be defined as the energy derived from Sun's radiations and its use is becoming increasingly common as an alternate to fossil fuel.

Solar energy can be harnessed either directly using photovoltaics (PV), (Fig.2) or indirectly using concentrated solar power, also called Solar thermals. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect. Mostly, solar power is harnessed with solar panels that use semi-conductors to convert the collected energy into electricity.

Fig. 2: Solar Energy Using Photovoltaic Cells

DEVELOPMENT OF SOLAR ENERGY

The early development of solar energy technologies started in the 1860s by an expectation that coal would soon become scarce. The world's first roof-top photovoltaic solar panel, was set up New York in as early as 1884. However, development of solar technologies stagnated in the early 20th century in the face of the increasing availability, economy, and utility of coal and petroleum. In the mid-1990s, development of both, residential and commercial rooftop solar as well as utility-scale photovoltaic power stations, began to accelerate again due to supply issues with oil and natural gas, global warming concerns, and the improving economic position of PV relative to other energy technologies. The use of solar energy accelerated in the late 1990s with the technological advancements in solar energy equipments. International Energy Agency in 2014, has projected that, under its "high renewables" scenario, solar power could supply 27% of global electricity generation by 2050.

Advantages of Solar Energy

- The best benefit of solar energy is the fact that it is entirely renewable and unlimited.
- Environmentally friendly source of energy as it comes directly from the Sun and does not

involve burning of fossil fuel.

- Produces low emissions, is economical and provides jobs
- Solar energy plants have low maintenance expenditure and near silent operation
- Solar plants have low impact on eco-system
- Has ability to power homes even in far-flung areas
- Unlike wind or hydro power, solar energy can be used even at household level. In fact, roof top solar systems are increasingly becoming popular in various cities in India.

Disadvantages

- Solar energy does not work at night and becomes less potent on cloudy days.
- The initial cost of setting up a solar plant is high, even though the electricity produced through solar energy costs significantly less.

SOLAR POWER IN INDIA

India has substantial solar potential at around 750 gigawatts (GW) (based on the assumption that 3% of wasteland in each state can be used for solar power projects, plus an assessment of the potential for rooftop solar). This represents almost three-times India's total installed power capacity today. The solar resource is strongest in the north and northwest of the country (Rajasthan, Jammu and Kashmir), but it is also considerable in a number of other states, including Maharashtra, Madhya Pradesh, and Andhra Pradesh. Installed capacity has been growing quickly. Utility-scale solar photovoltaic (PV) projects have made the fastest in-roads, with about 4 GW of capacity in place as of mid-2015 (up from 3 GW in 2014). Rooftop solar installations have been slower to take off, with around 450 megawatts (MW) of capacity installed as of 2014. Concentrating solar power (CSP) has only just started to gain ground, with around 200 MW in operation. Solar power is at the heart of India's push towards low-carbon energy sources. The overall national target is to reach 100 GW of installed capacity by 2022, a huge task given the starting point. This total is split between 60 GW of utility-scale projects (both solar PV and CSP), including a series of large solar parks, with capacity generally above 500 MW each, and a further 40 GW of rooftop solar applications for commercial users and households, together with some small-scale schemes and off-grid capacity. A range of national and state-level initiatives have been announced in support of these objectives. Since electricity is a shared responsibility between federal and state authorities, the political commitment of individual states to solar power is critical to the prospects for growth.

Government Initiatives

Government of India also considers Solar energy as the most viable form of green energy with the potential of lowering government's expenditure on energy as also reduction in its dependence on fast depleting fossil fuel, thereby ensuring energy security and therefore, it has also initiated a number of measures to promote the use of Solar energy in India, including enactment of legislations and policy of incentives on use of Solar energy.

SOLAR CITY INITIATIVE

The "Development of Solar cities/ Green cities" programme has been launched by the Ministry of New and Renewable Energy (MNRE) with the aim to achieve minimum 10% reduction in projected demand of conventional energy at the end of five years through a combination of energy efficiency measures and enhancing supply from renewable energy sources.

"Development of Solar Cities" programme is designed to support/encourage Urban Local Bodies to prepare a road map to guide their cities in becoming 'renewable energy cities' or 'solar cities'. It motivates the local bodies for adopting renewable energy technologies and energy efficiency measures.

The Ministry has already initiated various programmes in the Urban Sector for promoting

solar water heating systems in homes, hotels, hostels, hospitals and industry; deployment of SPV systems/devices in urban areas for demonstration and awareness creation; establishment of 'Akshya Urja Shops'; design of Solar Buildings and promoting urban and industrial waste/ biomass to energy projects.

The solar city programme helps to consolidate all the efforts of the Ministry in the Urban Sector and address the energy problem of the urban areas in a holistic manner. In a Solar City all types of renewable energy based projects like solar, wind, biomass, small hydro, waste to energy etc. may be installed along with possible energy efficiency measures depending on the need and resource availability in the city.

The program assists Urban Local Governments in:

- Preparation of a master plan for increasing energy efficiency and renewable energy supply in the city
- Setting-up institutional arrangements for the implementation of the master plan
- Awareness generation and capacity building activities

The criterion for Identification of solar cities includes:

- City population (ideally between 0.50 lakh to 50 lakh with relaxation could be considered for special category States including North-Eastern States and hilly States, Islands and Union Territories) ,
- Potential and commitment for adoption of renewable energy and energy conservation in the city activities,
- Initiatives already taken by City Council/ Administration/ Private Developers/ Industry/General Public in promoting renewable energy and energy conservation,
- Regulatory measures taken on deployment of renewable energy technologies and their willingness to provide resources and sustenance of activities initiated under the programme.

A total of 60 cities/towns are proposed to be supported for development as Solar Cities during the 11th Plan period with at least one city in each State to a maximum of five cities. List of Selected Solar Cities is as below:

Andhra Pradesh	1. Vijayawada*
	2. Narsapur Town
	3. Kakinada
Assam	4. Guwahati
	5. Jorhat
Arunachal Pradesh	6. Itanagar
Bihar	7. Gaya
Chandigarh	8. Chandigarh
Chhattisgarh	9. Bilaspur
	10. Raipur
Gujarat	11. Rajkot
	12. Gandhinagar
	13. Surat
Goa	14. Panaji
Haryana	15. Gurgaon
	16. Faridabad
Himachal Pradesh	17. Shimla
	18. Hamirpur
Karnataka	19. Mysore
	20. Hubli-Dharwad
Kerala	21. Thiruvananthapuram
	22. Kochi
Maharashtra	23. Nagpur
	24. Thane
	25. Kalyan-Dombivli
	26. Aurangabad
	27. Nanded
	28. Shirdi
	29. Pune

Madhya Pradesh	30. Indore Prepared 31. Gwalior 32. Bhopal 33. Rewa 34. Jabalpur
Manipur	35. Imphal
Mizoram	36. Aizawl
Nagaland	37. Kohima 38. Dimapur
Delhi	39. New Delhi (NDMC area)
Orissa	40. Bhubaneswar
Punjab	41. Amritsar 42. Ludhiana 43. SAS Nagar (Mohali)
Rajasthan	44. Ajmer 45. Jaipur 46. Jodhpur
Tamil Nadu	47. Coimbatore
Telangana	48. Mahbubnagar
Tripura	49. Agartala
Uttarakhand	50. Dehradun 51. Haridwar & Rishikesh 52. Chamoli –Gopeshwar
Uttar Pradesh	53. Agra 54. Moradabad 55. Allahabad
West Bengal	56. Howrah 57. Madhyamgram 58. New Town Kolkata
Jammu & Kashmir	59. Leh
Puducherry	60. Puducherry

PREPARATION OF MASTER PLAN

It consists of following steps:

- Preparing energy base-line(a detailed documentation of the existing energy demand and supply scenario for the city) for base year. The base line report is developed through sector-wise energy consumption matrix and energy supply-mix for the base year, surveys for understanding energy use patterns and efficiency of use.

- Forecasting the Demand for 5 year and 10 year periods. The forecast is based on estimated growth of energy demand (considering the past time-series data and information on growth plans and proposed developmental plans and policies).

- Preparation of Sector wise strategies after taking up the techno-economic feasibility of different renewable energy and energy efficiency options for each sector and making a priority listing of the options.

- Assessment of Renewable energy (including assessment of solar radiation, wind power density and availability, biomass resources and municipal/industrial wastes) to identify the potential renewable energy sources for the city followed by listing of all potential renewable energy technology options.

- Energy Efficiency (EE) and Demand side management (DSM) to reduce the energy demand.

- Stakeholders Consultations (participants can include elected representatives, local research and academic institutions, resident welfare associations, industries and corporate organizations, NGOs, SNA, etc.)

- Implementable Project Proposals/DPRs would be highlighted in the master plan. These projects will be called the pilot projects.

- Preparation of master plan in prescribed format.

Action to be taken by the Government for developing a Solar City

- To create a “Solar City Cell”

- To constitute a "Solar City Stake Holders Committee"
- To promote National Rating System for construction of energy efficient Green Buildings in particular to commercial and institutional buildings
- To amend building bye-laws for making the use of solar water heating systems mandatory in certain category of buildings.
- To provide rebate in property tax through Municipal Corporations/ Municipalities and in electricity tariff though Utilities/ Electricity Boards to the users of solar water heaters especially in domestic sector.
- To comply with MSW Rules 2016 notified by the Ministry of Environment.
- To organize rigorous publicity, and also the training programmes/ business meets for various stake holders e.g. architects, engineers, builders and developers, financial institutions, NGOs, technical institutions, manufactures/suppliers, RWAs etc. so as to involve them actively in meeting the objective of solar city.
- To generate necessary funds from State Govt. and other funding organizations for achieving the objective of making the city as "Solar City".

IS DELHI A SOLAR CITY?

Delhi has land-locked position, the high cost and paucity of barren land within its borders, and low potential for wind or hydro power, reducing its renewable energy potential substantially. Still Delhi is one of the leading cities in the solar city program. A few of the initiatives are as listed:

Solar Policy of Delhi

Delhi is blessed with almost 300 sunny days which brings a huge potential for solar energy harvesting. The rooftop space available for solar panels is estimated to be 31 Sqkm, giving Delhi a solar energy potential of 2.5 GW (annually approx. 3,500 million kWh). Of this potential, 26% is in the government/public sector, 25% in commercial/ industrial sector, and 49% in domestic sector.

In 2015, the peak power demand in Delhi was almost 6 GW (annually approx. 28,000 million kWh). Power demand can vary considerably across a 24-hour window, especially in summer and owing to the increasing use of air conditioning. In general, energy utilities (DISCOMS) pay more to meet short-term demand surges, raising the average cost of power. Delhi's peak demand curve broadly matches the generation curve of solar systems, which can therefore help reduce peak demands. Moreover, energy produced by rooftop solar systems is mostly consumed at, or near, the point of generation, minimizing transmission and distribution losses. Self-consumption of rooftop solar energy also reduces the need for, and the challenge of, provisioning new distribution infrastructure, such as transformers, in congested localities.

As Delhi is well positioned to lead India's rooftop solar revolution and has consequently established solar generation targets of 1 GW by 2020 (4.2% of energy consumed) and 2.0 GW by 2025 (6.6% of energy consumed), Delhi government has come up with Delhi Solar Energy Policy, 2015 to achieve the national target of generating 40 GW is from rooftops by 2022. The policy is applicable for any solar energy generating system with a capacity of 1 KWp or more. This will also help in increasing consumer awareness of solar energy, promote capacity building, and generate healthy competition among solar developers, so that solar power is adopted on a mass scale and Delhi becomes the premier solar city in India.

Salient features of the Solar Policy of Delhi are as below:

- GNCTD promotes the development of grid-connected solar plants on rooftops for meeting own electricity needs and injecting surplus electricity into the distribution grid.

- Group Net Metering has been facilitated whereby surplus energy exported to the grid from a solar plant in excess of 100 percent of imported energy at the location of the solar plant can be adjusted in any other (one or more) electricity service connection(s) of the consumer.
- Solar plants have been made mandatory for all proposed and existing government buildings.
- The State would explore the feasibility of floating solar power plants on top of some of the perennial water bodies in Delhi as well as on the rooftop of moving buses and eRickshaws.
- encourages the operation of solar plants with net metering on all commercial and industrial buildings with available rooftop areas
- encourages the installation of solar plants with net metering on all residential buildings, colonies, townships, housing societies, private bungalows, farm houses, etc.
- All development agencies and the local bodies of Delhi shall facilitate the deployment of solar project installations.
- Generation Based Incentives are given by the state. Electricity Tax will be exempted for solar energy units generated, whether for self-consumption or supplied to the grid and there are no operative charges.
- CDM (Clean Development Mechanism) benefit

ROLE OF LOCAL BODIES

Local bodies, on their part, have also taken a series of measures and the new building bye-laws (UBBL 2016) mandates all the buildings to comply with green norms and confirm to the requirements specified therein, depending upon the plot size and use. Chapter 10 of the UBBL deals extensively with the green norms mandated for a building and annexure 10 thereof further details the mandatory requirements of a building with respect to green norms, including Solar energy.

The UBBL mandates all building above 105 sqm to have solar assisted water heating system and all buildings above 3000 sqm to have Solar Photovoltaic panels for its lighting, heating, cooling and ventilation needs.

To further incentives the use of solar energy, UBBL 2016 exempts the solar panels on mount at a clear height of 2m maximum from the terrace level to the springing point and subject to the max. height as permissible by AAI, free from covered area for FAR and ground coverage calculations.

New Delhi Municipal Council Initiatives:

To implement the Solar City project in posh Central Delhi, the area's civic body-cum-discom New Delhi Municipal Council (NDMC) has worked out a detailed proposal to increase the region's proposed solar power generation by an additional 5 MW. For the first phase, the civic agency has already identified around 28 government buildings where solar power systems shall be installed.

As of now, the NDMC generates 110 kW of solar power through two systems set up in its schools. While one is a 60-kW plant at N.P. Bengali Girls' School, Gole Market, the other is a 50-kW solar plant at Navyug Senior Secondary School, Mandir Marg.

In 2014, the NDMC had signed an MOU with Solar Energy Corporation of India (SECI) for development of solar rooftop on all its buildings.

The NDMC already generates 110 kW of solar power through two systems set up in its schools. While one is a 60-kW plant at N.P. Bengali Girls' School, Gole Market, the other is a 50-kW solar plant at Navyug Senior Secondary School, Mandir Marg

CONCLUSION

With the above initiatives and the framework being put in place, it is expected that Delhi will be able to achieve its target of achieving the Solar city tag.

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UNDERSTANDING GREEN RATING SYSTEMS: A COMPARATIVE STUDY ON PREVALENT RATING SYSTEMS IN THE WORLD

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Abstract

Green movement has been around for a couple of decades. Over a period of time a lot of rating systems have been developed the world over, giving elaborate guidelines on "what constitutes a green building". Certain nations have more than one prevalent rating systems. For example USA, UKand India have two rating systems each. Present paper attempts a comparative study of popular rating systems in the world.

INTRODUCTION

Green Building Concept is an offshoot of Sustainable Development Initiative which traces its history to the energy (especially fossil oil) crisis and environmental pollution concerns of the 1960s and 1970s (Mao et al. 2009). The United Nations World Commission on Environment and Development -Brundtland Commission- Report (WCED 1987) defines sustainable development as: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The terms "sustainability" and "green" that are often used interchangeably, have gained recognition in the architecture, engineering, and construction (AEC) industry within the past decade, as the world has become more sensitive to the issues of the environment and global climate change.

Globally, buildings contribute to substantial resource and energy consumption, ecosystem changes and global warming. As an example, in the United States, buildings consume approximately 40% of all energy, 72% of all electricity and produce 39% of primary greenhouse gas emissions (DOE 2007). Moreover, buildings are responsible for over 10% of the world's freshwater withdrawals, 25% of its wood harvest, and 40% of material and energy flows, globally (Kibert 2013). These findings justify the importance and timeliness of more aggressively engaging the AEC industry in efforts toward sustainability. Sustainable construction is a vital agent in the preservation of world's resources and promoting quality life across the globe.

Over a period of time a number of standards have been developed worldwide to measure sustainability or greenness with reference to AEC industry. The leading standards which concern World community in General and India in particular have been dwelled upon in the present discussion.

A BRIEF ABOUT SUSTAINABLE OR GREEN CONSTRUCTION

In the global context, sustainable construction is defined as "a holistic process starting with the extraction of raw materials, continuing with the planning, design, and construction of buildings, and ending with their demolition and management of the resultant waste" (CIB 1999). Sustainable construction requires a different conception of thinking about cost, quality, and time that traditional construction industry lacks (Vanegas et al. 1995). It adopts additional criteria which prioritizes minimal resource

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consumption and environmental procedures to achieve a healthy built environment (Kibert 1994). This paradigm shift in the AEC industry has social, cultural, and environmental implication in the global context (CIB 1999).

The paradigm shift in the AEC industry generated the need to develop guidelines for green building design and construction. The term green building guidelines refers to "the guidelines which evaluates the environmental performance from the 'whole building' perspective over the building's service life" (Augenbro 1998). Many countries including the U.S., U.K., Australia, Canada, Japan, Korea and India have either already developed the green building guidelines or are in the process of developing them. The U.S. Green Building Council (USGBC) became one of the front runners when it launched the Leadership in Energy and Environmental Design (LEED) guidelines in 2000. Today, LEED has more than 12,659 certified or registered projects in all 50 states in the U.S. and more than 85 registered projects in 69 different countries (USGBC 2008). Many developing countries, especially the rapidly developing ones such as India, have also started taking initiatives in this area.

As per an IMF report the developing nations are the partially industrialized countries that usually lack sufficient national income or domestic private capital to finance the investment required to reach modern industrial statehood (IMF 2008).

AN OVERVIEW OF LEADING GREEN BUILDING RATING SYSTEMS

Table 1 gives an overview of the popular Green Building Rating Systems. It is interesting to note that certain countries have more than 1 rating systems thus giving rise to confusion as to which system is to be followed in a particular country by the AEC professionals. While certain standards have a global reach, the others are localised to the nation(s) concerned. Some standards are Govt Initiatives while the others, particularly the global ones have been institutionalised by the private bodies. Each of these standards have some common criteria such as sustainable sites, water efficiency, materials and resources, indoor environment and innovation. Some standards are very comprehensive covering all possible types of infrastructures with tailor made rating criteria while the others are more generic, covering only broad categories of new buildings and existing buildings. All these standards emphasise on certain prerequisites as a must as well as certain optional criteria to improve upon the green performance of the buildings. A detailed comparison of all the covered standards is given in table 2. A brief discussion on all these standards is covered in ensuing paragraphs.

Table1: Green Rating Systems at a Glance

S. No.	Country	Rating System(s)	Agency	Notes
1.	USA	LEED (USA)	US Green Building Council	International Standards
		Energy Star	USEPA	National Standards
2.	UK	BREEAM	BRE Group UK	International Standards
		The Green Globe Rating System	Green Globe Ltd UK	International Standards
3.	India	IGBC Rating Systems	Indian Green Building Council	National Standards
		GRIHA Rating Systems	The Energy and Resources Institute (TERI)	National Standards
4.	Japan	CASBEE	Japan Sustainable Building Consortium (JSBC)	National Standards
5.	Australia	Green Star	Green Building Council Australia	National Standards
6.	Canada	LEEDS CANADA	Canada Green Building Council	National Standards

Leadership in Energy and Environmental Design (Leed) USA

LEED has been developed by United States Green Building Council (USGBC). LEED has a provision to assess and certify both existing buildings as well as new construction. In new construction, buildings can be assessed from 16 to 24 months after occupancy. The assessment is done over 6 criteria namely (a) Sustainable sites, (b) Water efficiency, (c) Energy and atmosphere, (d) Materials and resources,

(e) Indoor environment quality, (f) Innovation and design process.

In existing buildings the assessment is done over 3 criteria namely (a) Sustainable sites, (b) Water efficiency, (c) Energy and atmosphere.

Leadership in Energy and Environmental Design — Canada (LEED)

In LEEDS Canada the assessment is done over 6 criteria and buildings are categorised in four categories as in the case of LEED USA. The 6 criteria for assessment are (a) Sustainable sites, (b) Water efficiency, (c) Energy and atmosphere, (d) Materials and resources, (e) Indoor environment quality, (f) Innovation and design process.

Green Star (Australia)

Green Star rating system has been developed by Green Building Council Australia (GBC). Its focus is on office design and office interiors. In office design it focuses on 9 criteria namely (a) Management, (b) Indoor environment quality, (c) Energy, (d) Transport, (e) Water, (f) Materials, (g) Land use and ecology, (h) Emission and (i) Innovation.

In the case of office interiors also the scores are awarded over 9 broad categories as above with little difference in sub criteria. These categories are (a) Management, (b) Indoor environment quality, (c) Energy, (d) Transport, (e) Water, (f) Materials, (g) Land use and ecology, (h) Emission, (i) Innovation.

Building Research Environment Assessment Method Consultancy (BREEAM) United Kingdom

BREEAM is a detailed and comprehensive rating system developed by United Kingdom. Its main highlights are:-

- Applicable to different situation: industrial; multi-residential; office and retail etc
- Two pre-assessment estimators: Design Stage and Management and Operation
- Points system
- Design Stage checklist calculates (i) Core section and (ii) Design and Procurement section and Design Stage assessment can be applied on 12-month occupancy
- Management and Operation checklist calculates (i) Core Building Performance and (ii) Management and Operation

Comprehensive Assessment System for Building Environment Efficiency (CASBEE) Japan

Like BREEAM CASBEE is also a very comprehensive rating system comprising of two assessment areas, i.e., internal and external. Assessment is done by two leading factors namely Quality and Loading. Salient features of this rating system are:-

- Two assessment area: Internal and External
- Internal: improving living amenity for the building users
- External: negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)
- Assessment by two factors: Quality (Q) and Loading (L)
- Quality: evaluates 'improvement in living amenity for the building users, within the private property'
- Loading: evaluates 'negative aspects of environmental impact which go beyond to outside or the public property'
- Four assessment aspects: (1) Energy Efficiency; (2) Resource Efficiency; (3) Loading Environment and (4) Indoor Environment
- Building Environment Efficiency (BEE) = Q (building environmental quality and performance) / L (building environmental loadings)

S. No.	Rating System	No. of criteria	Criteria covered New	Grading	Notes
1.	LEED (USA)	6	•Sustainable sites (1 prerequisite + 14 credits) •Water efficiency (5 credits) •Energy and atmosphere (3 prerequisites + 6 credits) •Materials and resources (1 prerequisite + 14 credits) •Indoor environment quality (2 prerequisite + 15 credits) •Innovation and design process (5 credits)	Four categories: •Certified (26-32 points) •Silver (33-38 points) •Gold (39-51 points) •Platinum (52-69 points)	•US Green Building Council •Provision for judging existing buildings exists •In new construction buildings can be assessed from 16 to 24 months after occupancy •Judging consists of : ✓ Prerequisites (Compulsory) ✓ Credits (For extra efforts)
2.	LEEDS - CANADA	6	•Sustainable sites (1 prerequisite + 14 credits) •Water efficiency (5 credits) •Energy and atmosphere (3 prerequisite + 17 credits) •Materials and resources (1 prerequisite + 14 credits) •Indoor environment quality (2 prerequisite + 15 credits) •Innovation and design process (5 credits)	Four categories: •Certified (26-32 points) •Silver (33-38 points) •Gold (39-51 points) •Platinum (52-70 points)	•Canada Green Building Council •Provision for judging existing buildings exists •Judging consists of : ✓ Prerequisites (Compulsory) ✓ Credits (For extra efforts)
3.	Green Star (Australia)	9	•Management (7 clarifications) •Indoor environment quality (16	Three categories: ✓ 4-star Green star (score 45-	•Developed by Green Building Council Australia (GBC) •Focuses on office

			clarifications) •Energy (7 clarifications) •Transport (4 clarifications) •Water (5 clarifications) •Materials (8 clarifications) •Land use and ecology (5 clarifications) •Emission(9 clarifications) •Innovation (3 clarifications)	59) [Best practice] ✓ 5-star Green star (score 60-74) [Australian excellence] ✓ 6-star Green star (score 75-100) [World leadership]	design and office interiors •After 31 October 2016, all the new projects to register under LEED v4 rating systems, developed by the USGBC as per the information available on website.
4.	BREEAM (United Kingdom)	•8 (Design stage) •7 (O and M)	Design Stage •Management: 4 criteria •Health: 13 criteria •Energy: 4 criteria •Transport: 4 criteria •Water: 4 criteria •Materials: 7 criteria •Land use: 6 criteria •Pollution: 8 criteria O and M •Management: 4 criteria •Health wellbeing: 15 criteria •Energy: 8 criteria •Transport: 5 criteria •Water: 6 criteria •Materials: 3 criteria •Pollution: 7 criteria	Design Stage 4 categories •Pass (Points 25) •Good (Points 40) •Very Good (Points 55) •Excellent (Points 70) O and M 4 categories •Pass (Points 20) •Good (Points 35) •Very Good (Points 50) •Excellent •(Points 65)	•Applicable to different situation: industrial; multi-residential; office and retail etc •Two pre-assessment estimators: Design Stage and Management and Operation •Points system •Design Stage checklist calculates (i) Core section and (ii) Design and Procurement section and Design Stage assessment can be applied on 12-month occupancy •Management and Operation checklist calculates (i) Core Building Performance and (ii) Management and Operation
5.	CASBEE (Japan)	4	Four efficiency aspects •Energy Efficiency •Resource Efficiency •Loading Environment •Indoor	Building Environmental Efficiency in 4 categories •0.5: Class B- •1.0: Class B+ •1.5: Class A	•Two assessment area: Internal and External •Internal: improving living amenity for the building users •External: negative aspects of

			Environment	•3.0: Class S	environmental impact which go beyond the hypothetical enclosed space to the outside (the public property) •Assessment by two factors: Quality (Q) and Loading (L)
6.	The Green Globe Rating System (United Kingdom)	7	•Project Management (Policies and Practices): 50 points •Site: 115 points •Energy: 360 points •Water: 100 points •Resource, building materials and solid wastes: 100 points •Emission and other impacts: 75 points •Indoor environment: 200 points	Four categories •1-globe (35%-54%) •2-globe (55%-69%) •3-globe (70%- 84%) •4-globe (85%-100%)	•Another rating system by UK •Green Globe operates under a twenty year license with a renewal option from Green Globe Ltd UK the owner of the brand worldwide.
7.	Energy Star (USA)	Multiple (Live rating system based on a country wide data system)	Energy star certified building must •Save energy •Save money •Help protect the environment by generating fewer greenhouse gas emissions than typical buildings	Two categories •Median energy performance (50-74 points) •Top performer (75-100 points)	•Rating system by United States Environment Protection Agency (USEPA) •A very comprehensive system based on a live comparison with the building database of entire country •Certification is given on an annual basis, so a building must maintain its high performance to be certified year to year
8.	India Green Building Council (IGBC) Rating	•7 (New Buildings) •5 (Existing Buildings	New Buildings •Sustainable Architecture and Design •Site Selection and Planning	New Buildings (4 Certifications) •Certified: 40-49 points •Silver: 50-59	•IGBC awards certifications in the 9 categories ✓ IGBC Green New Buildings ✓ IGBC Green Existing

	Systems	)	•Water Conservation •Energy Efficiency •Building Materials and Resources •Indoor Environmental Quality •Innovation and Development Existing Buildings •Site and Facility Management •Water Efficiency •Energy Efficiency •Health and Comfort •Innovation	points •Gold: 60-74 points •Platinum: 75-100 points Existing Buildings (4 Certifications) •Certified: 50-59 points •Silver: 60-69 points •Gold: 70-79 points •Platinum: 80-100 points Other 7 categories also have 4 certification levels with a little difference in scoring ranges	Buildings ✓ IGBC Green Homes ✓ IGBC Green Schools ✓ IGBC Green Factory Building ✓ IGBC Green Townships ✓ IGBC Green SEZs ✓ IGBC Green Landscapes ✓ IGBC Green Mass Rapid Transit System •All 9 rating systems are based on the five elements of the nature (Panchabhutas) and are a perfect blend of ancient architectural practices and modern technological innovations •The ratings systems are applicable to all five climatic zones of the country
9.	GRIHA (India)	34 Criteria (7 Broad Categories)	7 Broad Categories are •Conservation and efficient utilization of resources. •Health and wellbeing. •Conservation and efficient utilization of resources. •Recycle, recharge, and reuse of water. •Waste management •Building operation and maintenance •Innovation	5 Certification Levels •1 Star (50-60 points) •2 Stars (61-70 points) •3 Stars (71-80 points) •4 Stars (81-90 points) •5 stars (91-100 points)	•GRIHA stands for Green Rating for Integrated Habitat Assessment •GRIHA is founded by TERI (The Energy and Resources Institute, New Delhi) with support from MNRE (Ministry of New and Renewable Energy, Government of India) along with a handful of experts in the sustainability of built environment from across the country

The Green Globe Rating System (United States)

This is yet another Green Building Rating System from United States. Here assessment is done over 7 broad criteria such as (a) Project Management, (b) Site, (c) Energy, (d) Water, (e) Resource, building materials and solid wastes, (f) Emission and other impacts, (g) Indoor environment.

Table 2: A comparison of Green Rating Systems

Energy Star (United States Environment Protection Agency)

Energy Star is a comprehensive greenness awareness, promotion and certification program by United States Environmental Protection Agency (USEPA). Energy Star encompasses awareness programs for going green, product certification, facility certification, building certification as well as awards for recognition. The motto of Energy Star Certification is to select an energy-efficient top performer that saves money without sacrificing performance.

Specifically, to be eligible for energy star certification, a building must earn an energy star score of 75 or higher, indicating that it performs better than at least 75 percent of similar buildings nationwide. Through Portfolio Manager, EPA delivers 1 – 100 energy star scores for many types of buildings. The energy star score accounts for differences in operating conditions, regional weather data, and other important considerations. Thus Green Star is a very elaborate and comprehensive green certification system.

Certification is given on an annual basis, so a building must maintain its high performance to be certified year to year. And the information submitted in the certification application must be verified by a licensed Professional Engineer (PE) or Registered Architect (RA) to be eligible for approval.

Certification is based on a comparison based on a national database of similar kind of buildings in the United States. This database is updated every year by a nationwide survey of buildings and facilities conducted by U.S. Department of Energy's Energy Information Administration.

India Green Building Council (IGBC) Rating Systems

IGBC is an independent organisation created under the umbrella of Confederation of Indian Industry (CII) which is a 120 year old non-government, not-for-profit, industry-led and industry-managed organization. CII was founded in 1895, it has over 7,400 members, from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 100,000 enterprises from around 250 national and regional sectoral industry bodies. IGBC has developed a comprehensive rating system to promote and judge the green initiatives in India.

IGBC awards certifications in the following 9 categories:-

- IGBC Green New Buildings
- IGBC Green Existing Buildings
- IGBC Green Homes
- IGBC Green Schools
- IGBC Green Factory Building
- IGBC Green Townships
- IGBC Green SEZs
- IGBC Green Landscapes
- IGBC Green Mass Rapid Transit System

IGBC has created these rating systems under the vision, "to enable a sustainable built environment for all and facilitate India to be one of the global leaders in sustainable built environment by 2025".

As per the information contained on IGBC website all the above rating systems are based on

the five elements of the nature (Panchabhutas) and are a perfect blend of ancient architectural practices and modern technological innovations. The ratings systems are applicable to all five climatic zones of the country. IGBC rating programmes have become National by Choice and Global in Performance.

Green Rating for Integrated Habitat Assessment (GRIHA)

As per the information provide on GRIHA website GRIHA Council is an independent platform for the interaction on scientific and administrative issues related to sustainable habitats in the Indian subcontinent. It was founded by TERI (The Energy and Resources Institute, New Delhi) with support from MNRE (Ministry of New and Renewable Energy, Government of India) along with a handful of experts in the sustainability of built environment from across the country. TERI-GRIHA framework was initially developed by TERI for new commercial, institutional and residential buildings. The rating was further modified when it was adopted by MNRE as GRIHA. Over 330 projects across India of varying scale and function are being built based on GRIHA guidelines.

GRIHA is a rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.

The system has been developed to help 'design and evaluate' new buildings (buildings that are still at the inception stages). A building is assessed based on its predicted performance over its entire life cycle – inception through operation. The stages of the life cycle that have been identified for evaluation are:-

- Pre-construction stage: (intra- and inter-site issues like proximity to public transport, type of soil, kind of land, where the property is located, the flora and fauna on the land before construction activity starts, the natural landscape and land features).
- Building planning and construction stages: (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well-being). The prime resources that are considered in this section are land, water, energy, air, and green cover.
- Building operation and maintenance stage: (issues of operation and maintenance of building systems and processes, monitoring and recording of energy consumption, and occupant health and well-being, and also issues that affect the global and local environment).

CONCLUSION

Present paper gives an overview of leading green building rating systems in the world. Paper highlights that although all the rating systems categorise the scoring criteria in similar pattern, there is a variation in grading and ratings awarded. Paper also highlights that there is a lack of uniformity when it comes to rating systems with respect to particular countries. For example USA, UK and India, all havetwo rating systems each, independent of each other. Thus there is a need for standardisation and a single point rating system in respect of particular countries. Most of these systems play an advisory rather than statutory role and thus implementation is totally dependent on incentives rather than compliances. This in the view of authors leaves a lacunae with respect to holistic implementations of green philosophies, particularly when compared to the root philosophy of sustainable development which states that it is a development which looks after the needs of present generations without compromising the needs of future generations. This goal can only be achieved when green compliance is given a statutory status. Overall, past decades have seen a seriousness about the way people think about green and quantify it. There is still a need for consensus on uniformity of rating parameters across the world.

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