Azadi Ka Amrit Mahotsav

ISSN 2349-7475

Indian Buildings Congress

Volume Thirtieth
Number One
2022

Seminar on

"SUSTAINABLE BUILT ENVIRONMENT FOR FUTURE"

April 28-29, 2022
New Delhi

आधुनिक तकनीक सुरक्षित निर्माण

INDIAN BUILDINGS CONGRESS

PRELIMINARY PUBLICATION

Indian Buildings Congress

Vol. Thirtieth
Number One
2022

25th Annual Convention and National Seminar on

"SUSTAINABLE BUILT ENVIRONMENT FOR FUTURE"

April 28-29, 2022
New Delhi

आधुनिक तकनीक सुरक्षित निर्माण
INDIAN BUILDINGS CONGRESS

PRELIMINARY PUBLICATION

ISSN 2349-7475

Published by

H.P. Gupta
Honorary Secretary,

Indian Buildings Congress
Kama Koti Marg, Sector-VI, R.K. Puram,
New Delhi – 110022
Phone No: 011- 26169531, 26170197
E-mail: indianbldgscongress@gmail.com, info@ibc.org.in
Website: www.ibc.org.in

FOREWORD

Climate change due to green house effect has become an important, current and ongoing issue not only locally but globally. The climate change is a global or regional change in weather patterns that lasts for a long period of time. We started to realize and correct the problem in the late 1970s due to the effect of industrialisation on account of increased level of harmful gases and pollution in the environment.

Humans using fossil fuels is one of the biggest causes of climate change, fossil fuel combustion releases harmful chemicals into the atmosphere, negatively affecting it, leading to problems in the atmosphere such as, the hole in the ozone layer. Pollution is also a huge factor of climate change, air pollutants affect the amount of sunlight coming into the atmosphere, some pollutants warm the Earth, while others cool it down. The most common pollutants are methane, black carbon, ground-level ozone, and sulphate aerosols. Deforestation is another huge leading cause to climate change by reversing the effects of carbon insulation and releasing greenhouse gases into the atmosphere.

Various processes in construction industry use fossil fuel which in turn produces tonnes of waste and harmful chemicals leading to pollution of the land and air affecting the environment. Mining to extract the raw construction material damages the eco system and pollutes the environment. The factories manufacturing construction materials also generate lot of waste and harmful gases which pollutes the atmosphere. The transportation needed to move supplies and the waste from the building site also has a very negative impact on the environment.

Huge amount of energy used in building sector is also largely responsible for the Global warming, Climate change, Green house gases, pollution of the environment and natural resources and ultimately the health of the living being on the earth including human race. Reducing energy demand is therefore major aspect of reducing emissions

In the construction industry, key to restrict the climate change is to go for construction of net zero or energy surplus buildings, mass scale generation of green energy from renewable resources like Sun, Wind, Sea waves etc, conserving the energy, use of energy efficient gadgets and various processes in construction industry, conservation of water and natural resources, recycling and reuse of waste water and waste material to minimise the waste besides adopting the principles of orientation, passive Architecture, climate responsive design, use of locally available materials etc.

The Indian Buildings Congress has selected "Sustainable Built Environment for Future" as theme of this Annual Convention and National Seminar to draw attention of all the stakeholders engaged in Built Environment. It is expected the useful recommendations shall emerge out of the deliberations, which will be of immense value to the society as a whole.

(Pradeep Mittal)
President, IBC

PREFACE

On account of massive urbanization, propelled by large population base, high natural growth rate and ever increasing rural-urban migration, built area requirements of Urban India are rising sharply coupled with climate change due to rise in temperature. As per, McKinsey Global Institute Report, 'India would be required to create buildings to the tune of 700-900 million sqm, on annual basis, to meet the needs of housing and business, for additional population in urban India'.

In transportation, India also needs to build 350 to 400 kilometers of metros and subways every year, more than 20 times the capacity-building of this type that India has achieved in the past decade. In addition, between 19,000 and 25,000 kilometers of road lanes would need to be built every year (including lanes for bus-based rapid transit systems), nearly equal to the road lanes constructed over the past decade.

Requirements of energy, materials and resources for construction and operation of such a huge volume of buildings and infrastructure will be enormous. Generation of energy to meet the demand by using fossil fuels is one of the biggest causes of climate change. Whole world is fighting under the '2015 Paris Agreement Resolution' against climate change where nations collectively agreed to keep warming "well under 2°C" through mitigation efforts. Accordingly, building sector, which is large consumer of energy, would require close scrutiny and monitoring for effecting and achieving overall economy in energy consumption, use of resources and generation of waste, for making buildings green and sustainable.

Sustainability, in the context of our planet, has become a very important issue to maintain balance between our resources, environment and liability. The uncontrolled utilization of resources and degradation in the level of livability in the environment are creating such condition, that it is the threat to existence of human race. Therefore, sustainability is to be reviewed, considered and remedial measures taken to stop or reduce the degradation.

In the context of built environment, the sustainable construction is the practice of creating structures and using processes that are environmentally responsive and resource efficient throughout building's life cycle from planning to design, construction, operation and maintenance. In the context of sustainability in construction, concepts include the protection of natural environment, choice of non-toxic materials, reduction and reuse of resources, waste minimization and the use of life cycle cost analysis.

A sustainable construction aims at reducing health and environmental impacts caused by construction processes. The related issues are energy conservation, using minimum water and to have harmony with nature. New techniques of building construction are being researched and concept of green buildings has been developed. In western countries, there are advances in 3D printing technology which is very important, and it should be used for construction, keeping in view, aesthetic, horticulture and environmental sustainability aspects.

Considering the importance of Built Environment, the development of infrastructure in the country, maintaining balance between our resources, environment and responsibility to contain the climate change the topic of "Sustainability Built Environment for Future" is very much relevant to the present day demand. The topic has evoked a keen response from the authors, and accordingly 17 number of papers have been selected for publication and deliberation at the National Seminar. The authors have come up with many time tested workable solutions in the direction of Sustainable Construction of Built Environment as discussed in their papers. All the relevant issues shall be deliberated at length in the National Seminar to evolve workable solutions towards creation of Sustainable Built Environment.

I hope the deliberation in the National Seminar will bring out practical recommendations which will be gainfully utilized by all the stakeholders in the 'Built Environment Industry' for benefit of all the living being as a whole to maintain the balance in eco system while creating built environment.

I express my sincere thanks to my colleagues in the Technical Committee, for their valuable support in screening and selection of the papers. I also acknowledge the untiring efforts of Shri M.C. Bansal, Advisor (Tech.), IBC in bringing out this publication.

(Krishna Kant)
Chairman
Technical Committee, IBC &
Former UN Expert & CE, CPWD

TECHNICAL COMMITTEE

CONVENOR

Krishna Kant
Former UN Expert & C.E., CPWD

MEMBERS

Dr. Mahesh Kumar
Past President, IBC &
Former E-in-C,
Haryana PWD

R.N. Gupta
Vice President, IBC & CMD,
Ramacivil India Const. Pvt. Ltd.

V.R. Bansal
Former C.E., North DMC

H.P. Gupta,
Hony. Secretary, IBC
Hitech Engg. Consultants

M.C. Bansal
Advisor (Tech.), IBC &
Former Special D.G., CPWD

CONTENTS

"SUSTAINABLE BUILT ENVIRONMENT FOR FUTURE"

CONTENTS

DECARBONISING CITIES THROUGH GREEN AND ENERGY EFFICIENT BUILDINGS

Jit Kumar Gupta*

Abstract

Cities, globally have been recognised as the major promoters of global warming, climate change and increasing carbon footprints. Within cities, it is the built environment and transportation, which are primarily responsible for making them unsustainable. Majority of problems related to urban sustainability are the outcome of the manner in which buildings are planned, designed, constructed and operated. Buildings, as definers of character and fabric of any city, are known for their positivity, negativities, dualities and contradictions. Consuming nearly half of the global energy, majority of resources and generating large carbon emissions, buildings are largely responsible for making cities unsustainable. This call for making buildings energy efficient and least consumers of resources. Sustainable Development Goals also mandate the critical role of buildings in promoting global sustainability. However, majority of buildings are designed and constructed, without any concern for energy, resources and environment. Making buildings minimum consumers of energy and resources would require changing the traditional approach to designing the buildings; making building green; considering relevance of climate, site and orientation; life-cycle assessment; energy, water efficiency and building materials.

INTRODUCTION

Historically, cities are valued for the contributions they make to promote economic development, generate employment, promote innovations and provide options for state of art infrastructure and facilities. Housing large human numbers, cities also remain preferred location for operation and concentration of activities. Cities not only create, generate and provide supportive environment for businesses to thrive and flourish, but also enable residents to have gainful employment and quality of life. Cities invariably drive competitiveness and investments.

Studies made by UN indicate that, cities globally housed 4.2 billion people, or 55 percent of the world's population in 2018. By 2050, the urban population is expected to reach 6.5 billion. Accordingly, cities will script the future of communities and nations. Despite showcasing distinct advantages, cities are known for their dualities and contradictions; positivities and negativities. Occupying merely 3% of the area of planet earth and generating 60% of the global wealth, cities are known to consume 70% of the energy, generate 75% of the carbon footprints and produce 70% waste; indicating that if cities are usherers of the global/nation's prosperity, they are also responsible for promoting global crisis and growing vulnerability in terms of rising temperature, ozone depletion and increasing carbon footprints. Reckoned to be prime cause and major victims of disasters striking the planet earth, cities are fast becoming vulnerable and unsafe. Two major factors considered largely responsible for making cities hot beds of global warming and ever-increasing carbon footprints include; irrational manners in which built environment is being created and the manner in which people, goods and services are transported.

*Former Director, College of Architecture, IET Bhaddal

Buildings are known to be primarily responsible for consuming large proportion of energy, electricity, water and materials. Studies made and analysis carried out by International Energy Agency, has estimated that existing buildings are responsible for more than 40% of the world's total primary energy consumption and 24% of global carbon dioxide emissions. Accordingly, in order to decarbonize the cities, there is an urgent need for not only designing and constructing our buildings, more rationally and thoughtfully; but also minimizing the travel and traffic, to make cities sustainable and carbon neutral.

BUILDINGS/BUILT ENVIRONMENT

Human growth and built environment have close connectivity and high degree of inter-dependence; because historically, built environment has scripted and showcased the footprints and achievements of humanity, right from its inception. All human activities of living and working, require built environment for optimisation. Buildings also remain relevant and valuable for saving, protecting and providing shelter to human beings from the vagaries of nature; including extreme heat, extreme cold, precipitation, snow, wind, thunderstorm, cyclone etc. With 80% of human life spent within four walls of buildings, built environment remains major determinant of quality of human living. In addition, buildings significantly impact environment, ecology, bio-diversity; consumption of resources. Known for dualities and contradictions, buildings not only provide space for productive human living, but also considered anti-thesis to the environment and ecology. Buildings constitute a complex system of designing, construction, materials, resources and environment.

According to, 'World Energy Council Report, 2016', Buildings consume over 40% global energy, 30% raw materials, 25% timber harvested, 16% fresh water withdrawal, generate 35% of world's CO_2 emission, 40% municipal solid waste and 50% ozone depleting Chloro Fluoro Carbons (CFC) besides promoting 'Sick Building Syndrome'. Looking at the entire context that buildings are the largest consumers of energy and resources, they also offer greatest opportunity to minimize energy consumption, by simply changing the options used for planning, construction and operation of the buildings. If sustainability is not embedded into planning, designing and construction practices, building related emissions could double by 2050 (UNEP).

GREEN BUILDINGS

Looking at the entire gamut of built environment, Green Buildings emerge as the best option to make buildings sustainable and least consumers of energy and resources. Green Buildings minimize use of water, optimize energy efficiency, conserve natural resources, generate less waste and provide healthier space for occupants as compared to conventional buildings. Green Buildings, as a concept, approach and strategy to decarbonize the cities, has been gaining acceptance among professionals and users for its distinct advantages.

Considering the multiplicity of components involved, Green Buildings have been defined differently and distinctly, by different experts, institutions and agencies involved in planning, designing and constructing such buildings.

- World Green Building Council has defined Green Building as a, building that, in its design, construction or operation, reduces or eliminates negative impacts, can create positive impacts, on our climate and natural environment. Green Building preserve precious natural resources, improve quality of life.
- Jerry Yudelson**,** describes, Green Building, as a high-performance construction that reduces its impact on the environment and human health. (Yudelson, Jerry, 2008).
- As per the Indian Green Building Council (IGBC), 'A Green Building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building'.
- USGBC says, 'Green Building is a holistic concept that starts with the understanding that the built environment can have profound effects, both positive and negative, on the natural environment, as well as the people who inhabit buildings every day. Green building is

an effort to amplify the positive and mitigate the negative of these effects throughout the entire life cycle of a building.

Looking at the entire context, Green Buildings are characterized by distinct features involving;

- Efficient use of energy, water and other resources.
- Using renewable energy including solar energy.
- Minimizing pollution and waste through re-use and recycling.
- Promoting healthier spaces, good indoor environment and air quality.
- Using non-toxic, sustainable and waste based, local materials.
- Involving environment in design, construction and operation.
- Designing with nature using natural elements.
- Valuing and including user's quality of life in design, construction and operation.

BENEFITS OF GREEN BUILDINGS

Globally, Green Buildings are being recognized and valued, for bringing multiple benefits and providing best option for achieving Sustainable Development Goals, addressing climate change, reducing global warming, creating sustainable & thriving communities, and driving economic growth. Using less water, energy or natural resources, Green buildings not only reduce/eliminate negative impacts of buildings, but also positively impact environment by generating their own energy and increased bio-diversity. Globally, Green Buildings have capacity to reduce greenhouse gas emissions by 35%; energy savings by 50%, water consumption by 40% and limiting global temperature rises to 2°C by 2050 (UNEP). Green Buildings can also discount CO_2 by 8000-12000 tons and 3 MW of connected electric load for every million sft. of built space; besides reducing 70% waste. Green buildings not only reduce consumption of non-renewable resources but also offer numerous economic/financial benefits such as, lowering construction and operating costs, increasing property values; increased occupancy rates; and generating more employment opportunities. Social benefits of green buildings include; better health and wellbeing of people; increase in cognitive scores; sleeping about 46 minutes more per night and improving performance upto 8 %. (Dodge Data & Analytics, 2016). Studies made have also revealed that, 'Green Schools make learning easy and more meaningful'; 'Green Houses makes people happy and healthy', and 'Green Hospitals cure patients quickly'. Green Buildings may cost more up-front, but save through lower operating costs over useful life of building. Cost saving is optimised, when buildings are designed as Green Buildings at the conceptual design phase. Green Building practices expand/complement building design concerns of economy, utility, durability and comfort.

DESIGNING GREEN BUILDINGS

On the threshold of massive urbanisation, propelled by large population base, high natural growth rate and ever increasing rural-urban migration, built area requirements of Urban India are rising sharply. As per, McKinsey Global Institute Report, 2010, 'India would be required to create buildings to the tune of 700-900 million sqm, on annual basis, to meet the needs of Housing and Business, for additional population in urban India'. Requirements of energy, materials and resources for construction and operation of such a huge volume of buildings will be enormous. Accordingly, building, as a sector, would require close scrutiny and monitoring for effecting and achieving overall economy in energy consumption, use of resources and generation of waste, for making buildings green and sustainable.

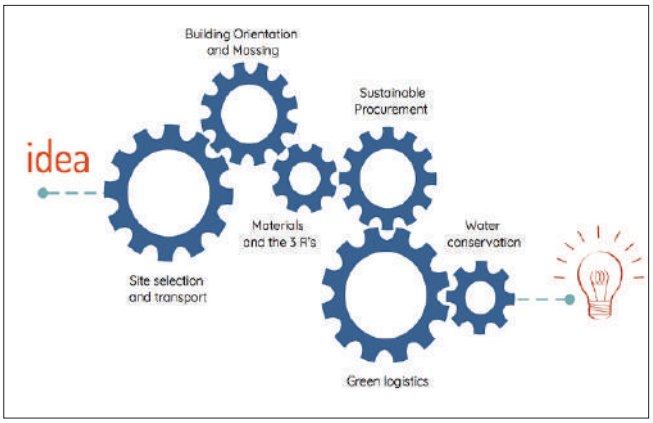
DESIGNING WITH CLIMATE

Architectural designs are known for their capacity and hold the key to promote sustainability in the built environment. Accordingly, sustainability needs to be made intrinsic and integral part of all Architectural designs for making buildings sustainable and green. Any building can be designed as a green building, whether it's a home, office, school or a hospital. However, all green building designs don't follow uniformity and similarity. While principles for building green remain universal but designing green buildings will vary from region to region and

within regions, depending upon prevailing climate, site conditions, building typology and prevailing wide-ranging environmental, economic and social priorities. Green Buildings shall invariably be designed based on the climatic conditions prevailing at the regional/city/local levels. Based on the climatic conditions, India has been divided into five instinct climatic zones including, Hot and Dry; Warm and Humid; Composite; Temperate and Cold & Sunny. Since climatic conditions of temperature and humidity varies in all these zones, accordingly, building design shall vary in each zone. If in the Hot zone, green buildings will try to eliminate all options of heat gained by the building and in case heat is gained, building is designed to promote heat loss in the minimum time frame, in order to maintain the indoor temperature at comfort level. However, in the case of Cold climate, building designs are oriented to capture maximum sun so that solar heat can be optimized to keep the indoor spaces warn and comfortable, without resorting to mechanical heating.

ADOPTING INTEGRATED APPROACH

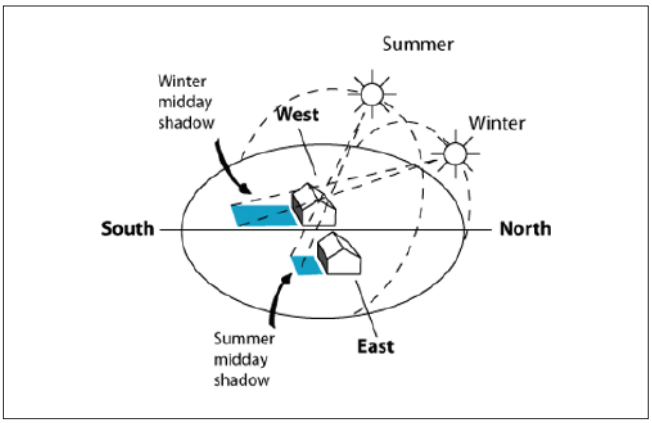
Experience has shown that buildings can be



designed to meet the occupant's needs for thermal comfort at reduced level of energy consumption by adopting an integrated approach to building design. The integrated approach would include rational site planning; determining optimum shape and size of the building; minimising floor to volume ratio; promoting building efficiency; rationalising ratio between length and depth of the building; using simple structural form; promoting high degree of energy efficiency; optimising water efficiency and minimising use of water; using low embodied energy local materials and material made from industrial/ agricultural waste; using principles of solar passive building design; using energy efficient equipment for lighting, heating, ventilation; using solar energy for meeting the energy/lighting/heating of building and generating energy from non-conventional sources.

DESIGNING WITH ORIENTATION

Orientation is the most critical factor which needs to be effectively leveraged in all building design to evolve energy efficient building envelop, by



making use of solar light/heat/radiation and the wind energy. However, requirements of building design would vary, from region to region, based on prevailing climatic conditions. Accordingly, buildings with regard to sun and wind will have to be oriented differently in different regions. In order to ensure that building design makes best use of solar and wind energy, it would be essential that majority of building sites should have the advantage of best orientation. Accordingly, role of town planning assumes importance, for ensuring that highest consideration in planning is given to orientation so that maximum number of plots has the advantage of best orientation. In addition, ratio of plot width and depth needs to be fixed so that the entire depth of built-up area should have access to natural light during the day, minimizing the requirement of artificial lighting. This would be particularly important, in case of row housing where plots have the option to draw light only from front and rear.

DESIGNING WITH NATURE

Genesis of green buildings shall always remain nature centric. Accordingly, planning and designing of green buildings shall invariably be based on using design options which remain nature centric and make optimum use of available natural elements/ sources and vegetation, for meeting entire needs of heating, lighting and ventilation of the buildings. Planning with nature would essentially involve, making optimum use of *Panchbhutas*- Prithvi (site), Agni(energy), Jal (water), Vayu (air) and Aakash (Space), for meeting the basic needs of energy and resources for buildings. Any building designed with nature shall always remain a sustainable and green building. Ignoring and excluding nature from designing, shall never make any building green. Nature based design helps in making buildings not only sustainable but also promoter of wellbeing of the users besides making value addition to the place and environment, where such buildings are placed and positioned.

Space Planning

Space planning is another mechanism to promote green buildings and making them sustainable because each site has positivities and negativities. In the hot regions, western side remain the most unsustainable, whereas south and south- east direction are considered better for human living. Accordingly, positive and negative directions need to be mapped considering the movement of sun and wind. While planning the buildings, all spaces used for human habitations should be placed in good orientation and all spaces requiring minimum human habitation, can be placed on orientation not conducive to human living. This approach can help in minimising the energy consumption and making available habitable spaces in the best.

Planning for Life Cycle Cost

With only 10% cost going into initial construction and 90% cost going into operation and maintenance, planning and designing buildings based on lifecycle cost will be the best option for making buildings sustainable. Green buildings, accordingly focus on minimizing life-cycle cost of buildings by reducing and optimising energy, water and resource consumption for creating win-win situation for both owners, builders and occupants over the entire life span of building.

Energy Efficiency: Green buildings are designed to achieve highest degree of energy efficiency through thermal insulation, installing high performance windows, using passive heating, ventilating and air conditioning, geo-thermal options besides using day lighting as integral part of designing process.

Water Efficiency: Green buildings optimise water efficiency by using water efficiently and reducing water consumption by; slowing the flow; multiple use of water; recycling and reuse of water; mixing air with water; using water-efficient fixtures; rain water harvesting; and minimize storm water runoff.

Design Efficiency: It is achieved by making Green buildings compact with smaller footprints, using space more efficiently, achieving highest carpet area, minimising circulation /area under walls, adopting efficient structure and structural system, minimizing construction waste.

Promoting High Indoor Air Quality: By choosing environmentally responsive non-toxic/low VOC based materials and finishes, for construction/ interior finishes, produced by clean manufacturing processes that do not pollute and produce unhealthy interior environments.

Using Materials: Materials in natural form which are available locally, cost-effective, having low embodied energy, produced from industrial/ agricultural waste and are easy/inexpensive to repair and maintain.

RETRO-FITTING OF EXISTING BUILDINGS

In addition, to making new buildings green and energy efficient, it will also be critical that concerted efforts should also be made to make existing buildings energy/resource efficient and carbon neutral. Retrofitting the existing buildings has been used as the mechanism to make building green and cities sustainable. Singapore has drawn a master plan to make all the existing buildings green through a collaborative policy framework involving residents, property owners and the government.

Retrofitting of Empire State Building of New York has led to achieving reduction of electricity load for the building to the tune of 3.5 MW and green house gas emissions by 1,00,000 tonnes over a 15 years period. The payback/recovery period for the $13.1 million spent on retrofitting of building, has been placed at 3.5 years due to saving in energy, lighting, air conditioning etc. Retrofitting needs to be promoted on large scale to make cities sustainable.

CONCLUSION

Green Buildings, as a concept and strategy, is now being increasingly adopted globally and locally, to make built environment affordable, sustainable and resource efficient. Considering the enormous amount of built environment yet to be created, urban India will have no option but to tread the path of sustainability and sustainable development in the built environment to promote economy, generate employment, banish poverty and restoring balance in environment and ecology. Sustainable built environment would go a long way in achieving, majority of the 17 Sustainable Development Goals for the reason, built environment is known to be the largest consumer of energy, resources and generators of waste. Urban sustainability will be largely contingent upon how effectively and efficiently buildings are made green using renewable/waste materials and involving state of the art options for designing, construction and operation. Green building design practices, reduce the environmental impact; minimize building footprints; promote energy conservation, sustainability and resource efficiency by focusing on environmentally sound methods of design and construction.

Employing more than 35 million people (1/6 of total workforce of country), India's construction industry is projected to expand, both horizontally and vertically, with investments in residential, infrastructure and energy projects continuing to drive growth. Various government flagship programs; including 100 Smart Cities Mission, Housing for All, Atal Mission for Urban Rejuvenation and Transformation (AMRUT), Make in India; Power/ water for All; Making India $ 5 trillion economy, Carbon neutral by 2070 and Putting 500GW of non-conventional resource-based energy by 2030; will be the major growth drivers for the construction/building industry. Growth agenda of the Government of India offers both a challenge and an opportunity, for the professionals and building industry. Considering the major implications of buildings, it will be important that construction industry must innovate and evolve, so that built environment created in future is more affordable and sustainable. Failure to make built environment sustainable will have huge environmental, financial, economic, physical and social implications for people, community and nation, which will bedifficult to resolve and rationalise subsequently.

BIBLIOGRAPHY

1. The Future of Construction Sector in India, Build Tech Magazine India - September 9, 2016
2. Walker Wells, Ed, Blueprint for Greening Affordable House, Washington: Island Press, 2007, pp 2
3. http://www.sanctuarymagazine.org.au/ideas-advice/more-affordable-and-more-sustainable/
4. Alpana Sivam and Sadasivam Karuppannan; The Sustainability of Affordable Housing, University of South Australia
5. McKinsey Global Institute: "India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth", April 2010
6. World Green Building Council;https://www.worldgbc.org/what-green-building
7. Wikipedia; Green Buildings; sustainable construction principles.

EVALUATION OF SUSTAINABILITY DEVELOPMENT OF A TERTIARY CARE CAMPUS OF INDIA

P. S. Saini*, Dr. Parampreet Ahuja And Shivank Sharma*****

Abstract

The technological advances made in the field of medicine in the recent past have added many new dimensions to the functions of health care systems worldwide. While creating new infrastructure and upgrading the existing one, the engineering services department has to take a call on management and control of the environment and natural resources systems in such a way so as to ensure the sustainability of development efforts over a long-term basis. Implementation of decisions leading to saving of electricity and water, safe disposal of waste water, odor control, infection free environment, avoidance of contamination of water & air and adequate ventilation take hospital, a step closer in promoting eco-friendly and sustainable development. With the objective to tackle these environmental issues and to provide a platform for continual improvement in environmental, social and economic performance leading towards sustainable development in Higher Education Institutions (HEIs), University Grants Commission had launched 'SATAT' frame work in November 2019.

The paper focuses on the quasi-independent hi-tech centres established/coming up with state of art facilities at 'Post graduate Institute of Medical Education & Research' (PGIMER), Chandigarh, India, a referral hospital for several northern states and one of the institutes of national importance. Most of the sustainable development strategies provided in 'SATAT' viz; project planning, designing and development, resource optimization, landscapes & biodiversity, campus building design, energy and water management, transportation, procurement, waste management are being practiced. Green and Energy efficiency has been part of the PGIMER culture for last more than fifteen years. The paper also discusses the challenges and practical difficulties faced in sustainability transition of a tertiary care hospital campus.

INTRODUCTION

The technological advances made in the field of medicine in the recent past have added many new dimensions to the functions of health care systems worldwide. The accompanying increase in the sophistication and complexity of healthcare and hospital administration becoming complex has escalated the technical performance required of the staff in successfully meeting the environmental health requirements and sustainability goals of the modern hospital. While creating new infrastructure and upgrading the existing one, the engineering services department has to take a call on management and control of the environment and natural resources systems in such a way so as to ensure the sustainability of development efforts over a long-term basis.

With the aim to tackle the environmental management issues, UGC released its document 'SATAT'- A Framework for Eco-friendly and Sustainable Campus Development in November 2019 to guide Higher Educational Institutions (HEIs) to incorporate sustainability in day to day campus management. SATAT also calls for HEIs to create unique environment and resources and therefore, HEIs need to develop their guidelines for campus sustainable development by adopting the proposed framework in a locally appropriate way aimed to enable a sustainability transition with an aim to transform them into a "living laboratory" for sustainable development.

**Superintending Hospital Engineer, Department of Hospital Engineering & Planning, PGIMER, Chandigarh.*
***Civil Engineer, Department of Hospital Engineering & Planning, PGIMER, Chandigarh*
****Consultant Architect, Department of Hospital Engineering & Planning, PGIMER, Chandigarh.*

'SATAT' framework is a process of continual improvement in environmental, social and economic performance leading towards sustainable development. The framework also suggests implementation strategies for gaining the goal of sustainable camp development. With immense pride it is brought out that at PGIMER Chandigarh, Engineering Department has already incorporated Green and Sustainable features in all its ongoing and upcoming projects and is already contributing its bid toward achieving sustainable development goals.

Through this article, we have tried to analyse the development of the campus on SATAT Framework.

CAMPUS MASTER PLAN

"Develop and refine the Campus Master Plan(s) to enhance the environmental quality of the campus and to adopt sustainable green and sustainable methods in its future development……"

- The Institute has a sprawling campus of 277 acres. By incorporating vision of next 20 years PGIMER Master Plan was prepared and got approved from UT Chandigarh Administration during 2017.
- The Master Plan has Institutional and Residential Zones clearly demarcated for purposes of future expansion and development.
- Building plans of all upcoming buildings have been approved by Local authority as per Chandigarh Building Rules, 2017.
- Environment clearance has been taken from State Environment Impact Assessment Committee.
- The entire campus especially the Institutional Zone has already been remodelled and upgraded to meet the requirements of Barrier-Free accessibility.
- More than 33% of the Campus area has been reserved as "Green". Lawns and plantation are in line with the principles of the city planning and maintaining a healthy open, vegetated, and build area ratio.
- Adequate buffer has been provided between various buildings to ensure adequate light, ventilation and isolation.
- All the buildings of the Campus have been well connected through walkways. The maximum time it takes from one building to another is around 11 minutes (850 metres).

RESOURCE OPTIMIZATION

"Minimize consumption and depletion of material resources. Reduce the consumption of resources by using materials that have long service duration……"

- Buildings are being constructed using concrete and steel having long life of more than 75 years.
- All the excavated earth from the building site is being used for refilling the low-lying areas of the Campus.
- The Waste segregation and disposal mechanism has been developed in such a way that all the plastic, glass and e-waste are sold to authorised recyclers.
- Condemned medical items viz trolley wheels, IV stands, wheelchairs, stools etc are reutilised as railing, planters, topiaries, etc.
- The Horticulture waste is reduced by treating in composting machine.
- Most of the operation theatre tools / surgical articles are sterilized and reused.
- The adhesives and sealants being used are low VOC.

- CFC free refrigerant in all central Air-Conditioning plants of the Institute (>8000 TR).
- Use of halon free gases in Fire extinguishers.

LANDSCAPES & BIODIVERSITY

"Develop strategies to alleviate the adverse impacts of severe weather conditions in the summer and winter protect and enhance the natural biodiversity of local areas and aim to conserve locally endangered flora and fauna…."

- Chandigarh lies in the northern region of the country in sub-tropical climate zone. The spaces have to be planned according to hot summer, monsoon and chilly winters. Building orientation and planning is arranged as per the sun-path of city. Even the old buildings (since 1963) are oriented in appropriate direction with the longer face facing the North-South direction.
- Nearly one-third area of the campus has been retained as green cover to help preserve the nature and has around 4500 number of matured trees spread through-out the campus.
- Along the Boundary wall of the Campus, scientific plantation of two rows of selected trees is being carried out which would act as sound and dust barrier for the Campus.
- With proper upkeep and maintenance of green areas and vegetation we are able to retain trees as old as 200 years.

- Natural / Local tree and plant species have been planted and maintained by a dedicated wing of the Engineering Department.
- Five trees have been planted for every single tree which was required to be uprooted to take up new construction.

CAMPUS BUILDING DESIGN

"Integrate sustainable features into new building design by adopting appropriate green building rating system as the minimum starting point and aim to achieve the highest rating possible……"

- Emphasis has been given on integrated design approach towards green buildings. All new construction is Green rated.
- Layout of the buildings is based on Geo technical and hydrological surveys inputs so as to ensure that the development does not impact negatively the recharge and discharge zones of water.

- Regularly occupied spaces receive optimum day light.
- The buildings are optimally oriented and facade is designed such that the heat gain is minimised and day light is maximised.
- Building features such as recessed windows and chajjas have been provided on the buildings in the campus since long back and these features also highlight the traditional knowledge passed onto the city by the city planners like – Le Corbusier, Jeanneret and M. N. Sharma.

- Since 1996 the buildings are being designed and monitored by using energy efficient design.
- The buildings are modular repetitive units and building in the shapes such as 'H' and 'X' have been thoroughly utilised all across the campus.
- The latest building projects have been constructed by utilising Fly-ash bricks and Autoclaved Aerated Concrete blocks, Double Insulated Glazing units (DIGU), rockwool, etc. all in line with the latest construction and green-building techniques.
- Through planning it has been ensured in all buildings that more than 25% of regularly occupied spaces and 50% of patient areas achieve daylight illumination levels of minimum 110 Lux.
- 25% of regularly occupied spaces achieve direct line of sight to vision glazing i.e. between 0.9 meters (3 feet) and 2.1 meters (7 feet).
- Smart Metering, Energy Management systems and Building Management System has been integrated into the building construction to carry out monitoring compliance of green measures during operation phase.
- Healthcare spaces have been designed considering the positive effects of colours on patients & staff. Having color in spaces reduces the stress levels and anxiety.
- Care has also been taken to reduce the sound pollution within the buildings and to meet the acoustic level of 30-50 dBA by acoustically treating the vital areas.

ENERGY SUSTAINABILITY

"Set energy-saving target with a timeline and implement energy efficiency actions in buildings and infrastructure systems to reduce the energy use intensity. Utilize smart energy modelling for new buildings to optimize energy performance by building orientation to take advantage of natural light (day-lighting), natural ventilation (e.g. operable windows), use of shading devices, occupancy sensors, etc……"

250 BEDDED NHE IS FIRST IGBC PLATINUM HOSPITAL IN GOVERNMENT SECTOR

- During 2019, PGIMER became the first Government Hospital to receive Indian Green Building Council (IGBC) Green Healthcare Facilities Platinum Rating for the project – Expansion of Nehru Hospital. Concept of green and energy efficiency is not new and it has already been inculcated into the work culture of the Institute.
- During 2014, two hospital buildings of PGIMER were conferred with Energy Star Rating by the Bureau of Energy Efficiency, Govt. of India. PGIMER was among the seven hospitals of the country and the only Government Hospital to be conferred the Star Rating. EPI of Advanced Eye Centre was evaluated to be 183 kWh/m^2 whereas for Advanced Cardiac Centre it was 166 kWh/m^2.
- The latest projects of Advanced Neurosciences Centre and Advanced Mother & Childcare Centre are targeted to be 5 Star GRIHA rated.
- Their construction is being monitored by online Dashboards using latest project monitoring software (Primavera).
- Building Management System (BMS) and SCADA are being installed to monitor and control environment and energy parameters of the buildings.
- The Campus street lighting have been replaced by LED lights (695 points) in a systematic manner with lamp efficacy of more than 115 lumens/Watt.

- Energy Consultants are deputed for all the major projects with an endeavour to achieve GRIHA – 5 star rating and / or IGBC Platinum rating for the upcoming projects both on campus and off-campus.

WATER MANAGEMENT

"Manage storm water to prevent it from leaving the campus, wherever sustainable. Reduce water consumption by using low flow faucets and toilets, waterless urinals, sensors and electronic controls on sinks and lavatories, wherever practical. Install a black water recycling system to treat sewage for non-potable uses. Re-use non-potable water resources to the extent possible……"

- The campus is fed by the municipal supply and the water-works is located within the campus. The main storage tanks for the campus are old and the proposal to de-centralise the water supply system is at advanced stages. Once completed the water-supply would be de-centralised into smaller-efficient circuits each meeting the up-to-date requirements of codal provisions.
- Efficient water conserving faucets and low-flow sanitary ware are being installed. Nehru Hospital Extension (NHE) Block buildings is able to achieve 54% water saving as compared to IGBC base case. This has been achieved by use of flow restrictor of 1.3 LPM in Faucets, flow restrictor of 3.8 LPM in showers and flow rate 2.0 / 4.0 LPF in WCs.
- The Institute is already in the process of installation of STP-ETP. The long term aim is to make a zero-discharge campus.
- The landscapes water demand has been reduced by minimising turf area and planting only indigenous species
- The campus has utilised hardy native species of trees and plants thus saving water resource.
- The new campuses of Sangrur, Una, Ferozepur, Sarangpur etc. are being planned with drip-irrigation systems thereby further reducing the water requirement.

TRANSPORTATION

- Institute intends to go green in terms of vehicular movement and reduce pollution within the campus.
- The Academic, Research and Administrative activities have been clustered together within

walking distance of 5 minutes.

- For pooling of Staff to reach the Campus number of buses have been deployed.
- End to end Campus Transportation in the form of battery vehicles and buses has also been taken up.
- The Nehru Hospital Extension Block is already equipped with 06 number e-vehicle charging stations.
- Even for transportation of waste to the central collection centre from various buildings – battery operated vehicles are being utilised since 2019 (same as used in airports).
- Medical Oxygen is being procured in liquid form and stored in LMO tanks to avoid repeated transportation and nuisance created by gas cylinders.
- Parking available in campus fulfils the city byelaw requirements, however, the same proves to be inadequate as the campus is visited by huge number of patients and attendants every day. Therefore we are working on provision of additional multilevel car-parking spaces which are envisaged to be smart parking

spaces. Further, low lying areas are also being developed as surface parking by utilising the earth excavated from various ongoing projects.

- The hospital is well equipped with tele-medicine and tele-consultation services are being provided to large number of patients each day. This entire system is managed by the Doctors and the IT department.

WASTE MANAGEMENT

- Waste is segregated at source.
- Centralised Waste facility has been provided from where the recyclable waste is sold to authorised vendors and rest is disposed off as per the byelaws.
- The Waste segregation and disposal mechanism has been developed in such a way that all the plastic, glass and e-waste are sold to authorised recyclers.

As regard to the 'Green Catering' and 'Event Organisation' the Institute is in the process of implementing various measures as suggested by SATAT Framework

CHALLENGES

- It is very difficult to redevelop the existing Institute Campus to fully comply with the requirements of framework as it involves enormous cost and time implications.
- It is difficult to take up measures through upgradation / renovation in the existing hospital buildings as it risks the safety of the patients in the vicinity.
- Lack of adequate awareness and training of the officers responsible for taking up these green and sustainable measures also impede the implementation.
- As most of the Higher Education Institutions work on Government funding, implementation is difficult unless additional funds are provided for the purpose.
- There is dearth of trained professionals, even the builders and developers are also not well acquainted with green technologies in the field to guide development of such projects.
- Projects are funded on the basis of initial capital cost and not life-cycle costing.
- A regulatory framework is required to be in place for success of such projects.

CONCLUSION

By an efficient Master planning of the Campus / redevelopment of the Campus incorporating Green rating system in infrastructure development of the Campus, the objectives of SATAT can be accomplished.

By adoption of SATAT Framework the Institutions would not only achieve savings on account of Energy and Water cost but also would generate less waste thereby conserving natural resources. The green and sustainable development would also enhance employee productivity by providing health promoting environment and ecology. Above all it would help the Nation move towards achieving Sustainable Development Goals.

MINIMIZATION OF CARBON MODEL FOR SUSTAINABLE BUILT ENVIRONMENT OF TALL AND LOW HEIGHT BUILDINGS

Dr. Mutyala R. Prakash*

Abstract

"No More Carbon"

The World is edging towards major reforms with regard to minimization of atmospheric pollution. After a century or more humans have realized that 'atmospheric pollution' is a man-made hazard and finding extremely difficult to work out corrective measures at least to down scale the existing menace. One of the major impacts of atmospheric pollution continues to be on built environment and other living objects such as vegetation, water, air, and non-human entity on our globe besides humans. An attempt is being made to identify target areas for universal action to minimize the destructive single element and its manifestation, known as CO, and CO_2. Some analytical and theoretical models were borrowed in, to analyse , theoretise and change the facts to fit in to global corrective mechanism with special emphasis on the built environment. A Benefit Cost Analysis is incorporated at relevant places to control the actions those recommended by the author. A critical action programme charter is being prepared for policy formulation and implementation by Global and Indian Governments.

INTRODUCTION

"This is World of action, not for droning in"
- Dickens

"No more carbon" be the slogan of year 2022". The world is experiencing unprecedented threat from the alarming increase in carbon in our atmosphere; if unchecked at right time the dooms day of the World is certain to happen early. No matter who they might be; rich or poor nations, developed countries or developing countries, the atmospheric pollution is pervasive and not chunks of islands those may remain at one place. It affects all, globally. In this paper an attempt is being made to examine the impact of pollution at a micro level and derive the possible measures to counter the increasing waves of pollution on our planet. In the short run there seem to be no quick fix to the existing pollution problems, however the awareness in people at large both country level and World level is imperative. This paper is a continuation of the previous core themes of Indian Buildings Congress on Green and Energy Efficient Buildings seminar dated August 18, 2021; focuses on Tall and Low height buildings. Further it brings out the share of construction sector in producing Carbon Dioxde (CO_2). CO_2 is the main consideration in deciding Green Buildings accreditation[10].

*Director, Institute of Development Planners and Researchers India

CONCEPT OF POLLUTION, DEFINITION, AND MEASUREMENT

Our planet is blessed with clean air, water, and food. However they have been contaminated progressively since first industrial revolution (1760) through our time and it is bound to sprawl for another decade or more. The measurement of pollutants reaching the atmosphere is highly technical task which are generally measured in the form PPM. PPM is unit scale of measurement in the atmosphere. It shows the number of greenhouse gas molecules present in one Million molecules of air, technically termed as PPM (Parts per Million). Based on the quantum of Carbon production in Million Metric Tons at Annexure A, Table 1, four countries were assigned with factor 5 which produced highest PPM. These countries are USA, Rassia, China and India. Germany is assigned with the factor 4 meaning less

Annexure A

Table 1. Data Base Analysis of Top 10 Polluting Countries in World Contibuting to PPM

1	2	3	4	5	6	7	8	9
1	Carbon	World's Share	World's Share	Steel	Cement	PPM	Population	Per capita
Country	Production	Oil Consumption	Coal Production	Production	Production	Factor	(Millions)	GDP (USD)
	(MMT) [1]	[2]	[3]	(MMT) [4]	(MMT) [5]	Score		
Australia	4.33	0.1	0.055	5.5	8.6	1	25	52825
Brazil	4.78	0.02	Negligible	33.25	72	2	212	6783
Canada	1.54	0.044	0.005	11	12.5	2	37	43278
China	**29.51**	**0.188**	**0.464**	**803.83**	**2500**	**5**	**1439**	**10484**
European Union	9.62	0.15	0.02	169.3	7	1	742	35800
Germany	**2.16**	**0.5**	**0.025**	**42.68**	**3.2**	**4**	**83**	**45733**
India	**6.81**	**0.064**	**0.077**	**89.58**	**280**	**5**	**1380**	**1965**
Indonesia	6.25	0.016	0.49	9.3	60	2	273	3922
Iran	1.76	0.02	Negligble	29	75	2	84	7555
Japan	3.47	0.089	0.002	105.15	8.6	3	126	40146
Kazakhstan	2.77	0.002	0.015	3.9	1.96	1	18	1146
Mexico	4.83	0.041	0.001	16.8	0.466	1	128	8421
Poland	3.18	0.007	0.018	7.9	9.1	1	37	15654
Russia	**4.88**	**0.044**	**0.045**	**71.11**	**69**	**5**	**146**	**10037**
Saudi Arabia	6.15	0.052	0.033	7.8	63	3	34	20178
Sourth Korea	1.71	0.044	Negligible	69.73	71.4	3	51	31497
Turkey	4.16	0.008	0.009	31.52	75	2	84	8548
U.S.A	**14.34**	**0.383**	**0.117**	**78.92**	**83**	**5**	**331**	**63416**
Ukraine	1.96	0.022	0.003	22.93	20.8	1	43	3653
Vietnam	3.05	0.005	0.006	19.5	60	1	97	3499
Total	117.26	1.799	1.385	1628.7	3480.63	50	5370	414540

Sources:
[1] www.toteny.com
[2] CIA World Factbook-2018
[3] www.basic Planet.com
[4] ww.worldatlas.com
[5] ww.worldatlas.com

in generating CO_2 and the remaining countries in the Annexure A, Table 1 were assigned with factor 3, 2, and 1. The classification of factor grouping is to indicate where exactly the CO_2 is being generated that travels all over the World along with wind and rotation of earth.

THE WORLD SCENARIO

On broad spectrum the pollutants emanate from Oil Consumption, Coal Production/ Consumption, Steel Production, and Cement production. Based on the Tabe 1 at Annexure A, a correlation analysis is carried out and reported at Table A considering a sample of 20 countries.

Table A: Correlation Analysis of GDP and CO_2 Generation by 20 top Nations.[9]

Varibles	Percapita GDP	Carbon Production
Carbon Production	0.053	1.000
Oil Consumption	0.658	0.342
Coal Production	0.182	0.681
Steel Producion	0.045	0.906
Cement Production	-0.198	0.886

The Per capita Gross Domestic Product is positively correlated to Oil Consumption, followed by Coal Production, Carbon Production, and Steel Production. Interestingly, though the Percapita GDP is negatively correlated to Cement Production, the correlation coefficient due to CO_2 is significantat 0.886. This may be due to the fact that the developed nations are tending towads new construction materials, such as glass, or construction of sky scrappers which require less cement as compared to the Low Height Building units.

The Carbon production is significantly and positively correlated to the Steel Production followed by Cement Preduction, Coal Production, and oil consumption. Our task is now well defined to argue about the role of steel and cement production which are back bone of any construction activity and both contribute to PPM and CO_2. The focus now is whether the Tall Buildings would minimize the usage of steel and cement in construction as compared to the low height buildings. In considering the benefit cost analysis keeping in view the CO_2 as an important issue, the paper attempts further the various aspects of CO_2 with relevance to the production of Steel and Cement production and skips the discussion on Coal Production and Oil Consumption due to the limitation and scope of the present topic.

A systems model is built to enumerate, how strongly the important productive sectors of nations are dependent on factors of CO_2 production. These sectors of the nations such as industry, agriculture, transport, services sectors and construction sector form 80% of a nation's activity. Therefore the

Table B: Estimation of CO_2 Emission Based on Partial Global Systems Model for CO_2

Endogenous Variables	Abbreviations	Unit	Exogenous Variables	Abrevia -tions	Unit
Indutrial Sector	IND	GDP	Oil	OIL	MMT
Agriculture	AG	GDP	Coal	COL	MMT
Transport Sector	TR	GDP	Cement	CMT	MMT
Services Sector	SS	GDP	Steel	STL	MMT
Construction Sector	CS	GDP	Urban Population	UPOP	Numbers
			Urban Heat	UHT	Surface Area
			PPM	PPM	Micrograms Per metre

Specification of Model

IND = f (OIL, COL, CMT, STL, μ1) (1)
TR = f (OIL, COL,CMT,STL,UPOP, μ2) (2)
AG = f (COL,STL,CMT,OIL, μ3) (3)
SS = f (OIL,STL,CMT,UPOP, μ4) (4)
CS = f (CMT, STL,UPOP, μ5) (5)
GDP = (IND+TR+AG+SS+CS,) (6)
CO_2 = f (GDP, μ7) (7)

specification of model at Table B is termed as "Partial Global Systems Model for CO_2". The model might consider the data as given at Annexure –A, Table 1. And other published sources

The paper could not demonstrate the empirical analysis with application of the above model for want of space in the paper. There is significant correlation between GDP of the nations associated with production of CO_2 and contributing to the PPM share in Greenhouse effect due to construction activity, no matter , whether they are Tall Buildings or Low height buildings.

SCOPE OF STEEL IN CONSTRUCTION ACTIVITY TOWARDS PRODUCING CO_2 OR PPM

One is aware that 'no coal, no steel' is a famous saying. Coal has been the major input in producing steel which is being used for various process of steel production. Steel accounted for 8% of the World's total greenhouse gas emission as of 2021[(1)].

China ranks number 1, out of top 20 nations' in production of steel followed by Japan, India, US, and Russia as 2,3,4,5 . China produces 49% of steel of the total production of 20 top nations in World producing steel . With regard to coal production China produces 46% of World production of coal. Undoubtedly China contributes to CO_2 to the order of 50% above of PPM standards from production of steel. Mini steel plants produce steel with electric furnaces thereby avoiding burning of coal. In the case of the Integrated Steel Plants which involve in steel making, rolling and shaping, operates through feeding Iron Ore, coke, and flux in to the blast furace require oil or coal burnings as source of energy. Attempts were made by some nations to substitute the use of coke in blast furnace by electric furnaces. However there is hardly much effect of the substitution as the electric power required for the electric furnace is produced by thermal device which consumes coal. In construction industry, the steel is being used to the order of 50% of total production. The innovation of steel usage in buildings were elaborately analysed by Prakash[(2)]. The steel is an important component in construction of High Rise/ Tall Buildings and steel being used right from the excavation stage to the façade stage of buildings. The usage of steel reduces the inputs of concrete and cement requirement in High Rise buildings as these buildings are structured by sturdy columns and beams. Carbon steel, aluminium, copper and stainless steel are durable, strong and corrosion resistant for the construction of buidings. There is no substitution for steel in High Rise buildings construction as these structures are prone to the stresses of weather, earthquakes, wind, gravity,… ,etc. The steel can provide vertical and horizontal strength to the buildings.

Steel production, types and uses are unlimited in the arena of concepts, technique of production and end use benefits. In this paper our focus is towards CO_2 produced by the steel manufacturing industry which is vital in construction industry at the receiving end. On an average 1.8 tonnes of CO_2 is produced and emanated in to atmosphere for 'every tonne' of steel produced. While utilization of steel can not be set aside by the building industry, one might be equally concerned to find various strategies to reduce CO_2. One of the ways to reduce CO_2 appears to be through aggressive development of recycles of steel, the subject hethero was not paid much attention.

RECYCLING OF STEEL & ITS ALLOY FROM SCRAP METALS AND STEEL

It is estimated that 1 tonne of steel scrap recycles save, 1.1 tonnes of iron ore, 630 Kg of cooking coal and 55 Kg of lime stone which are directly responsible in producing CO_2. India being labour surplus nation, the steel scrap recycling is much suited proposition. However, our attention was not paid so far towards this segment of industry. The steel scrap is generated from demolished buildings & bridges, crushing of old vehicles, steel made super structures, electric poles, wires, and so on so forth. Besides these major steel scrap can be obtained from the dismantled Ships and Oil Containers.

SHIP BREAKING YARDS IN INDIA

The large ships/sailing vessels, of both civilian use and military use are the sources of high quality steel, wood, glass andceramic wares. These items apart from reusability, they help in reducing CO_2, as most

Table C: The World's Largest Ship Breaking Yards

Rank	Location	Dismantling Capacity
1	Bay of Nouadhibou- Mauritiania	300 vessels at a time
2	Aral Sea- Eurasian Country of Uzbekistan	N.A
3	Alang- Bhavnagar Gujarat, India	*50% World Capacity *6900 and 415 in 2011-12 *450 per annum * In 2020 longest ship of the World was dismantled. *Advanced infra-facilities/Social Infrastructure
4	Chuuk Lagoon within the federation of States of Mocronesia	*Under water constructed
5	Landevennes-Franc	Located at Cove Created by Aulie River
6	Gadeni in Pakistan	*130 Plots, 10 Km strife *100 ships/year dismantled
7	Sketuton Coast in Nambia	N.A
8	Staten Island-USA i. Witte Maritime ii. Tugboat Graveyard iii. Arthur Kill iv. Donjon	N.A
9	Bikini Atoll -USA	N.A
10	Olenyabay- Russia	N.A
11	Aliaga- Turkey	N.A
12	Chittagong-Bangladesh	N.A

Source: www.marineinsight.com

of them are finished products to large exent. The main activity of these ship breaking yards are to salvage the value of ships by dismantling the age old ship whch are unworthy on the sea. Table C shows the list of Ship Breaking yards in the World.

Though the ship breaking yards are good source of steel, wood, curtains, crockery, plumbing items which are reusable, however they are under criticism as their existence at coastal area are responsible in destruction of mangroes, marine life and soild waste due to toxic contents. Attempts were made to set up dry dock to mitigate this problem. However the same could not be successful as the moving of large ships from see shore to dry docks is not an easy task as they are too heavy and voluminous. India being the leading ship breaking activity centre in the Word, it is imperative to set up a few more ship breaking yards in the country as India has longest coastal belt which can be put in to use.

CO_2 AND PRODUCTON OF CEMENT & CONCRETE

The cement and concrete are two important elements and inputs in any construction activity no matter; they are High Rise Buildings or Low Height Buildings. The cement industry is the main producer of carbon dioxide , and a major contributor to the greenhouse gas[3]. The Cement and Concrete production and use in buildings were proved to be more environmentally hazardous as compared to the the usage of steel in building construction. The usage of cent percent steel is not feasible alternative in buidings construction, Prakash,…,etel,[2] advocates, construction of builidngs by using the steel as cent percent supplement or alternative use. However the less usage of steel and metals in bulding construction is viable for Low Height Buildings, however one has to resort to the maximum utilization of Cement & Concrete in Hgh Rise Buildings and Sky Scrappers

apart from Cement & Concrete being essential input for the construction of buildings. Cement & Concrete offer lot of flexibility in designing and stability of the buildings.

A considerable experiments are on the way to reduce the effect of Carbon Dioxide generated by the Cement & Concrete, by indentifying the supplements and usage of fly ash, bottom ash, and slag, and similar ingredients to the exetent of 80% combination in production of Cement. Photocatalysis methods are being used to reduce smog due to iced concrete in winter[4]. Owing to rapid concrete surface expansion all over the World, the technique of Embedded solar cells and Dye-sensitized solar cells embedded in concrete has been experimented to reduce the carbon and energy footprints of budiligs[5]. Experiments are under way to use Clay as alternative construction material. Prakash[6] in an unpublished paper carried out a detailed analysis of alternative construction material focusing on the clay as major input for building homes and their advantages to the countries similar to India where 50% or more live in mud homes. An advanced innovation is being carried out to use natural building materials replacing cement and concrete by Canadians[7].

MAJOR CONCERN OF PRODUCTION OF CEMENT, CONCRETE AND GROWING CONSTRUCTION ACTIVITY

Surface Run Off: Most of the urban cities in World are constructing the pavements, and surfaces other than buidlings, causing the Urban Surface Runoff due to impervious surfaces. The water runs off may collect many types of pollution in the process, and then flows in to the storm drain or nearby body of water. This is typically experienced in India as many builders constructed impervious surfaces around their buidings, amounted to the flooding and water logging in Indian Cities. Besides this the run off water tends to pick up gasoline, motor oil, heavy metals, trash, and plastic package materieals, which might cause accidents, floods, and contamination of water tables under the soil.

URBAN HEAT ISLAND AND ITS DEFINITION

An Urban Heat Island (UHI) is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities. The temperature difference is usually larger at night than during the day, and is most apparent when winds are weak. UHI is most noticeable during the summer and winter[8].

Table D :The top 20 worst urban heat Cities and their respective rankings in U.S.A

1. New Orleans	11. Sacramento
2. Newark	12. Salinas, California
3. New York City	13.Burlington,Vermont
4. Houston	14. Bend, Oregon
5. San Francisco	15. Cleveland
6. Boston	16. Detroit
7.Chicago	17. Erie, Pennsylvania
8. Miami	18. Fresno, California
9. Baltimore	19. Lafayette,Louisiana
10 Providence	20. McAllen, Texas

Source : www.cnn.com

CONCRETE DUST AROUND CONSTRUCTION ACTIVITY

Concrere dust exists at the areas of building demolition and natural disaters such as earth quakes, collapse of buildings and bridges. The cement plants produce concrete dust which might travel along with wind to the radius of 2 to 3 Km. Beside dust, the concrete production might produce the toxic and radio activity. Human contact with the wet concrete can cause skin chemical burns due to the chemical properties of the concrete.

INNOVATIVE WAY TO REDUCE THE URBAN HEAT AND CO_2

The urban heat is generated from the concrete surfaces of both the constructed areas and open concrete areas normally exist around the buidlings, uncovered tenement roof tops, pavements, vehicle parking areas, and all those which are constructed by the cement and concrete. These areas reflect the sun rays, partly absorb and retain them for longer

hour and release them into atomosphere causing abnormal temperature variation. They can be identiefied thorugh Albado and Sequestering effect. 'Albedo' is the proportion of the incident light or radiation that is reflected by a surface, typically that of a planet (Sun) or moon. 'Sequestering' means segregation, integration, insulation, isolation, separation, reclusion, retirement and seclusion. Urban heat is caused by Albedo and Sequestering. The following are some of the methods where one can minimize the effects of Albedo and Sequestering.

1. Cover the open terrace of buidlings with plants, water storage, and use the trendy fibre, Hippo Polysester, Upvc, Mild steel, Durashine, Fibre glass, PPGI /Mangalore tile, thatched shed, so on so forth.
2. The parking concrete surface area or open concrete areas around the buildings be protected by trees, or mild steel roofing.
3. The Tall and Hgh Rise buildings be covered with the Solar Panelling at outside walls of the building or fasten with reflectors to reduce the Albedo effect.
4. One may cover the open terrace with mild metal sheets and install solar panels . This might reduce the Albedo effect and avail the benefit of solar energy.

All the measures as per 1 to 4 would reduce the CO_2 effect to a greater extent. Only USA has collected and reported the open concrete surface area as 10% of the total constructed areas in the urban cities. Rest of the nations do not have data on this account. One may make use of the Solar and metallic shed to prevent the Albedo effect due to open terrace concrete surfaces. The example can be seen from the Fig.1.

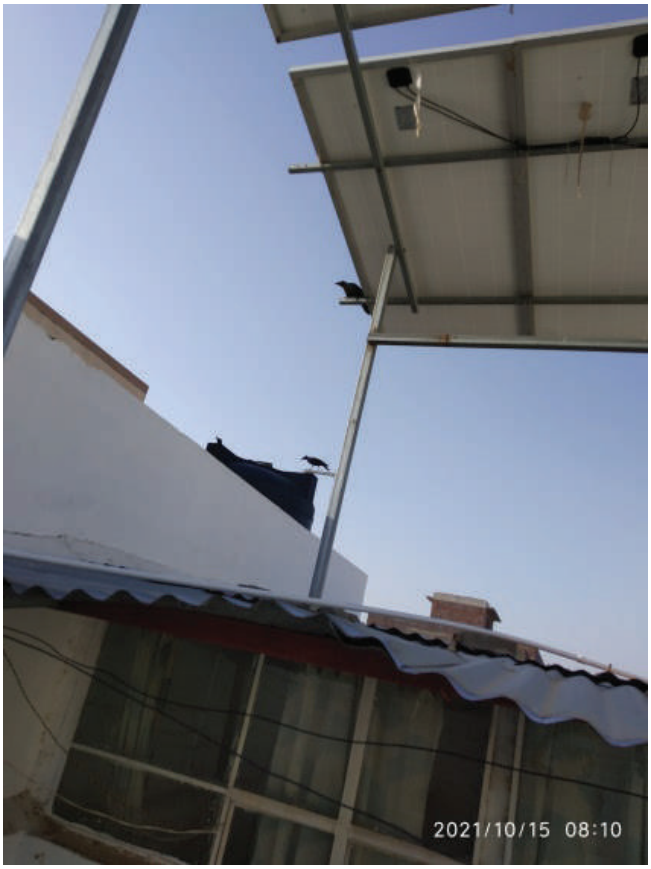


Fig. 1: Example of Solar and thin metallic shed to prevent Albedo Effect

CONCLUSIONS CRITICAL ACTION CHARTER

1. It is long way to go to reduce CO_2 due to steel, cement and concrete production.
2. People may restrict creating using concrete surface areas as much as possible
3. Install solar and metallic sheds to prevent Albedo Effect
4. An open concrete surface tax for concrete surfaces be levied to prevent uncessary and lavish covering of natural earth surface, by concrete surface.
5. The Tall Buildings have less scope in Albedo Effect as they have only top floor being exposed to direct sun light . The Low Heigh Buildings are to be restricted in building single floors; instead atleaset 4 to 5 storey buildings be encouraged to minimize UHI.
6. More experiments to reduce CO_2 in producing steel and cement are to be sponsored.

REFERENCES

1. One order of Steel: Hold the Greenhouse Gases (http:/nut.e du/2013/steek-without-greenhouse-gs-emmissions-0508)

2. Mutyala R Prakash, A Review and Status of Metal Houses in India and in Other Countries. The Indian Buidings Congress 2018.

3. The Cement Sustainability Initiative: Our agenda for action , World Business Council for Sustainable Development, page 20, published 1 June 2002.

4. The Smog Eating Chruch of Roma(http:/ abcnews.go.com/Technology/ Print?id=2687898).

5. Dyescrete(http:/www.klussmann.org). Experiments are under way to use Clay as alternative construction material.

6. Mutyala R Prakash, Unpublished paper: Innovative Construction Material Towards Housing for all in 2020 and beyond.

7. www.mudgirls.ca.

8. (www.NationalGeographic.org) August 10, 2019

9. Mutyala R Prakash, Disparities in Global South and Global North Nations (page 45 to 58), North- South Imbalances in Global Arena (Perspectives and Chalenges), Andhra Law Times (2020)

10. Modern Technolgies and Construction Management Tools of Tall Buildings of the World.

IBC Objectives

To promote and encourage the science and practice of conceptualizing, planning, designing, constructing, caretaking and maintaining built environment, by adopting the latest standards, State of the Art practices, use of innovative and new materials. To review and make suggestions to the Government for improving the built environment, working conditions and general welfare of construction workers and to provide a channel for expression of collective opinion of members on the matters relating to built environment, achieving the following aims:

1. To promote interface between various disciplines related to built environment on one hand, the Construction Industry and the Government on the other.
2. To promote improved system of administration, planning, design, construction, operation, use and maintenance of built environment.
3. To promote conservation and upgradation of eco-environment.
4. To promote the use of appropriate technology and building materials to enhance quality, productivity and affordability.
5. To disseminate the knowledge of built environment to others.
6. To promote safety, health, wages, working conditions and welfare of construction workers and supervisors.

TOWARDS A NET ZERO BUILDING COMPLEX BASED ON MINIMISATION OF ENERGY CONSUMPTION AND MAXIMISATION OF RENEWABLE ENERGY GENERATION

J. K. Choudhury*

INTRODUCTION

Modern buildings are mostly centrally air-conditioned and are fitted with a large number of electricity consuming devices. A typical building with 100,000 sq meter built-up area with conventional loading will consume 3000 KVA towards AC and 3000 KVA towards other Electrical loads. This translates to about Rs9.0crore electricity bill per year @ 10 per unit, considering 250 working days and 10 working hours a day. In 30 years, electricity bill will amount to Rs 475 crores, with energy cost compounded at 5 % per year.

With passive architectural measures as described in this article, the heat load and AC energy requirement can be reduced by 50 % and with modern energy saving measures on E&M Systems, electrical power consumption can be reduced by 50%. This results in reducing the Substation capacity by 50 % and Central AC TR Capacity by about 50 % resulting in 50 % reduction in capital cost and energy cost. The approximate capital cost of substation and power distribution is about 3 crores per MVA and Rs 80,000 per TR of Central AC Plant.

Provision of solar power generation requires about 7000 sq meter roof top area to generate 1 MVA of power, at a cost of Rs 6 crores. This cost can be recovered in about 6 years' time with reduced power billing. Most buildings can be made net zero buildings with passive architecture and coordinated efforts of the architects, civil/electrical engineers and the Client.

This means, we have to generate solar power which equals to or is more than our power requirement.

A typical new IIT campus will require 5 MVA power with all energy saving measures incorporated. It is generally built on land area of about 200-400 acres. If about 5-acre land is earmarked for solar system, the campus will become net zero, by generating 5 MVA solar power. This looks quite achievable. This amounts to energy cost saving of more than 300 crores over 30 years.

This article details the measures taken to make this building Net Zero.

*Former Chief Engineer, Electrical, CPWD

SUMMARY OF MEASURES TO BE TAKEN

Architectural Measures

- Building layout and orientation (to reduce heat ingress and ensure natural ventilation).
- Surrounding greenery and landscaping to ensure lower ambient temp.
- Day lighting to reduce need of artificial lighting.
- Building envelope insulation: Reducing U values for roof/wall/fenestration: to reduce heat ingress.
- Deciding on optimum value of WWR –window to wall ratio.
- Geothermal exchange system- to take advantage of lower underground temperature for reducing cooling tower capacity.
- Provide for adequate roof area and land area for solar power generation.

Measures to reduce AC Energy requirement

- Energy efficient Chillers, pumps, AHUs, Cooling Towers backed by VF Drive and total AC system management by IBMS. System design to reduce IKW to 0.5 KW/TR.

Measures for Energy Savings on Electrical Loads

- Use maximum day lighting to reduce artificial lighting.
- Use most energy efficient lighting like LED.
- Use occupancy sensors so that in room with no occupation, lights and AC are OFF.
- User timer switches for switching off desired loads.
- Use lighting automation to meet desired user requirements.
- Use task lighting in place of general lighting of the areas.
- Hot water supply with individual geysers require huge power supply. Gofor solar water heating which saves substantial power.
- Use all appliances like fans, lights, computers with highest star rating.

SALIENT FEATURES OF INDIRA PARYAVARAN BHAWAN,(IPB)NEW DELHI, CONSTRUCTED BY CPWD IN 2013, WHICH IS A NET ZERO BUILDING

Reduces power requirement by more than 50 %.

- Plinth area 32000 sq meter.
- Maximum electrical demand including AC: 830 kW
- Installed Solar Power Capacity: It generates 14 lakh units of power worth 1.2 crores a year.
- Central AC capacity is 400 ton which comes to 1 ton for 45 sq meters of air-conditioned area. AC power load is 400 KW.
- The power consumption of IPB comes to 26 watt per sq meter compared to 60 watt as per conventional loading.

U Value of Fenestration

- U value: 1.43 against 3.3 as per ECBC requirement with provision of double glazed hermetically sealed 6-12-6 mm glass with U value 1.5
- SHGC Value: (Solar Heat Gain Coefficient) 0.25- against 0.25 allowed as per ECBC. Glass with SHGC 0.32 and shading devices.

U Value of Wall Assembly : U value achieved 0.36 against 0.44 allowed as per ECBC. Achieved with outer walls made with 300 mm Aerated Autoclaved Concrete Blocks (AAC) with density one third that of clay bricks.

U Value of Roof Assembly :

- Shaded. Roof insulation with PUF. Reflective tiles.
- U value achieved 0.34 against ECBC requirement of 0.41

Day Lighting Area : 75.1 %.

Surrounding Areas : With trees and green landscaping.

Geothermal Heat Exchange Systems: Provided with UG pipes to reduce 160 TR load on cooling tower

Roof Top Area provided for Solar Power Generation: 6000 sq meter to generate 930 KWp solar power more than the total power requirement of the building.

Building Orientation and Layout with Atrium: Building longer sides facing North and South. Provides for reduced heat ingress and natural ventilation.

REDUCING POWER REQUIREMENT OF CENTRAL AC PLANT

In a modern AC Building, AC consumes about 50% of the total power requirement which can be reduced substantially.

Steps to reduce A.C. load and achieve 0.5 kw/TR.

- Maglev chillers, completely lubrication free.
- Chilled and condenser pumps with Variable Frequency Drive, (VFD) to optimise pumping energy.
- Best efficiency cooling tower to ensure Cooling tower approach to 3 Deg C.
- Reduce lift in the chillers
- Reduce fouling factor in condenser by applying automatic tube cleaning.
- Chillers in series counter arrangement to reduce lift.
- High efficient AHUs.
- Efficient operation of the entire plant with BMS
- Selection of capacity and number of chillers to ensure efficient combination to take care of day and night loads.
- VFD for chillers, pumps, Cooling Towers, AHUs.

BMS for the entire AC system to control, monitor and schedule the entire AC System to run it with optimum efficiency.

For example, with VF Drive, the power consumption of AHUs reduces cube times the reduced speed. When the speed is reduced1/2, the power consumption is reduced 1/8th. Similarly, the BMS will control the speed of chillers and pumps by changing the speed to send the exact quantity of chilled water for ensuring economy. The operating parameters of the entire AC system like inside temp, humidity, cfm of AHUs can be monitored, controlled and operated by BMS to ensure most efficient and economical operation. BMS will reduce energy requirement by as much as 25 %. Manual control of the Central AC is a very poor substitute to BMS.

The Provision of IBMS is mandatory as per ECBC. But 95 % of our AC installations are not having BMS or VFD system.

ADDITIONAL COST ON ACCOUNT OF NET ZERO BUILDING VERSUS PROJECTED ENERGY SAVING OVER 30 YEARS

Additional cost on account of following provisions

i. Passive architecture to include periphery insulation, outer wall with AAC Blocks, Double glazed windows etc: About 7.5% of building cost.

ii. Additional cost on account of providing AC Energy Savings: VFD drives, IBMS, maglev chillers, auto condenser cleaning etc. about 2.5% of building cost.

iii. Additional cost for Electrical fixtures/devices: Occupancy sensors, lighting automation, IBMS, 5 star rated appliances etc. 2.5 % of building cost.

iv. Total 12. 5 % on approximate basis.

v. Cost of a 1,00,000 sq meter AC building, complete with all services @ 40,000 per sq meter: 400 crores.

vi. Additional cost of provisions as above: @12.5%: 50 crores.

vii. Additional cost for 3000 KVA solar power generation system @ 6cr/1000 KVA: 18 crores. (Power requirement reduced from 6000 KVA to 3000 KVA on account of reduced heat ingress and energy saving equipments and measures.)

viii. Saving in capital cost on account of reduction in capacity of substation from 6000 KVA to 3000 KVA and AC TR from 3000 TR to 1500 TR: @ 30,000/KVA and 80,000/TR: 21 crores.

ix. Net saving on account of Net Zero Building, saving electricity billing charges on 6000 KVA @ 1. 3crores/year/1000 KVA: 7.8 crores per year

x. For 30 years, projected power saving assuming 5 % power rate increase per year: 450 crores.

xi. So Net saving for 30 years: 50 cr+18 crore-21 crore-450 crores=403 crores.

Summary

Additional cost for architectural /structural and E&M provisions for energy savings, amounts to approximately 12.5 % of building cost. This additional cost is recovered in about 6 years on account of reduced energy cost. In 30 years, the full cost of the building is recovered on account of savings in billed energy cost.

CONCLUSION

A modern building is centrally air-conditioned to ensure proper indoor air quality and comfort conditions for the personnel and equipments working inside to ensure efficient working environment round the year. An IIM Ahmedabad study indicated that providing proper indoor environment improves working productivity by more than 25 %. Power requirement of such buildings is quite substantial. As per conventional loading, this comes to about 1 TR for 20 sq meter of AC area and 1 TR requires 1 KW power. Electrical loads other than AC require 30 watts per sq. meter. In case of Indira Paryavaran Bhawan building, this requirement has been reduced by more than 50 % because of architectural inbuilt measures like envelope insulation, building orientation etc. Similarly, with inbuilt energy saving measures for AC equipments and electrical equipments, the power consumption has been reduced by 50 %.

With further energy saving innovation for AC like 0.5 kW/TR in place of 1 kW/TR, which already has been implemented, AC load can be further reduced by 50 %. Similarly load on Electrical side can be easily reduced by 40 % with innovative measures like lighting automation, occupancy sensors, solar water heating, IBMS, task lighting etc.

All the above measures are commercially available at economical cost and hence entirely implementable. Therefore, the future well designed buildings may require power @ 20 watt per sq meter in place of present 60 watt per sq meter. AC requirement may come down to 1 TR for 45sq meter area in place of present 1 TR for 25 sq meter.

With the above, the power requirement of a 100,000 sq mt. built up area will be reduced to 3MVA in place of present 6 MVA. This 3 MVA power can be easily generated with a roof area of about 21 000 sq meter. With this, the building will be net zero with no electric bills to pay. In fact, we can generate power supply surplus to our requirement.

With conventional power consumption, the electrical bill for 30 years is more than the cost of the building. In reverse, if we can make the building net zero, which is quite feasible, we can save the cost of the building in 30 years out of energy bill savings.

LIFE CYCLE COST ANALYSIS OF PIPE MATERIALS USED IN WATER SUPPLY

Sabarna Roy* And Rajat Chowdhury**

Abstract

Life Cycle is the period (normally in a number of years) of the useful life of a capital asset. In other words, it is the period for which the capital asset can operate within acceptable limits with normal repairs and maintenance. This period is also called Design Useful Service Life (DUSL). DUSL is the period number of years for which the analysis is done. This should be taken equal to the longest DUSL, amongst the competing materials. Life Cycle Cost is the total cost to be incurred for acquiring, maintaining and operating the asset during the 'Life Cycle'. In the context of water conveyance system, these costs shall be as follows:

a) *As laid cost of the system (pumping stations, reservoirs, pipes, fittings, specialties etc.)*
b) *Operating cost of the system (power charges, fuel charges etc.)*
c) *Maintenance cost of the system.*

Life Cycle Cost Analysis (LCCA) is an analytical tool that evaluates the cost of a product over its entire life cycle. LCCA is used internationally by governments and industries to obtain a complete understanding of a product or process life cycle and provide decision-makers a tool for appropriate decisions.

LCCA is commonly referred to as a "cradle-to-grave" analysis. LCCA is well suited to compare alternative products with differing cost expenditures over the useful service life.

This study was conducted by the authors to study the Scenario of Life Cycle Cost with Different Pipe lines based on Life Cycle Cost Analysis detailed-out in clause no. 5.4 of the CWC PIN Manual and to find out the factors affecting the life cycle cost of a project. This kind of similar study can be carried out during the preparation of DPR of various kinds of water supply projects to find out the right kind of pipe products to be adopted in that scheme.

INTRODUCTION

Water is supplied through pipes over centuries. With various technologies invented over the period of time, various types of pipe materials are developed and are in use in different parts of the world. With so many years of practice, the authorities have experienced the direct and indirect cost implications that are necessary to be considered while the design of piped irrigation systems. It is very essential that we shall account for the life cycle cost of the pipe supply system while arriving at the most suitable and economical pipe diameters and proper selection of pipe material.

Life Cycle Cost shall be expressed as **CLCC = CC + CO + CRL + CM + CR + CD**

Where, CLCC is Life Cycle Cost, CC is Construction Cost, CO is Operation Cost, CRL is Revenue loss due to leakages, CM is Maintenances and repairs cost, CR is Pipe replacement costs for short-lived pipe material, CD is Disposal Cost.

**Senior Vice President*
(Business Development), Electrosteel Castings Limited
***Sr. Executive*
(Business Development), Electrosteel Castings Limited

PRESENT WORTH ESTIMATION WITH ESCALATION

Present value is an economic technique to discount costs occurring in future years to their equivalent current value and sum them taking into consideration the effects of inflation or deflation as well as the earning potential of money over a given period.

Project life is the common point in time against which all costs or benefits from investment opportunities are measured; this is usually the commissioning date, also referred to as the base date. For a water supply project with a life of many years (say 50 to 100 yrs), consideration of inflation is inevitable. Hence calculation of present worth with appropriate values of inflation and rate of interest is necessary.

Capitalization of Annual Cost Expenditure: The financial flow diagram considers a flat rate of annual charges like leakage loss or maintenance cost. The present worth, in this case, is calculated as

$P = A[\{(1+i_r)^n - 1\}/\{ i_r(1+ i_r)\}]$,

Where P = Present Worth, A = Annual Cost

The present worth, in case of inflation, is calculated as $P_{inf} = A.\ CF$

CF is Capitalization Factor, i.e., $[\{(1+w)^n - 1\}/\{w(1 + w)^m\}].[1/(1+ if)]$,

where, w, is calculated as $w = (1+ ir)/(1 + if) - 1$

Considering, the Rate of interest on capital investment, Ir = 12 % per annum, and Rate of inflation for replacement cost, if = 5 % per annum, w will be 1.067 and CF will be 13.72, for a Project Life of 50 years.

Construction Cost: Construction cost (CC) includes the cost of pipe material and associated laying costs CC = CP + CL, where, CP is the Cost of Pipe material CL is the Cost of Laying.

For a Pipe of 100 mm		
CP	326.00	Rs./m
CL	77.44	Rs./m
CC	403.00	Rs./m

Operation Cost: Operation costs (CO) are calculated considering the electric power usages that are required for pump operations over the project period.

D=internal diameter of pipe in mm	97.5	mm
V= velocity of flow in m/s	1.2	m/s
CR=Pipe Roughness coefficient	1	
L=length of pipe in m	10000	m
Q=flow in pipe in m^3 /s	0.009	m^3/s
The Cost of Operation for Gravity Schemes is NIL. In present case it is assumed that external energy equivalent to head loss has to be provided.		
From Modified Hazen William Formula, Head Loss (h)	145.3	m
Add 10 % for Minor Losses, H	159.8	m
Power Required for Pumping	18.82	KW
Annual Power Requirement, for 365 days working	6,869	KW
	1,64,863	Units
Cost of Operation @ Rs 6/unit	9,89,179	Rs./ annum
Cost of Operation per m	98.92	Rs./m/ annum
Project Life,n	50	Years
i_r = Rate of Interest	12	%
i_f = Rate of Inflation	5	%
Capitalization Factor (CF), (as per CWC PIN guideline)	13.72	
Capitalized of annual CO over 50 Years	1,357	Rs./m

Revenue Loss due to Water Leakages: Loss of revenue due to leakages (CRL) should be considered in Life Cycle Cost Analysis. Appropriate Water tariff shall be considered for computation of the revenue losses due to water leakages.

Volume of water Supply for 365 days	2,83,824	Cum
Loss of Water @ 1%	2,838	Cum
Revenue Loss by Leakages @ Rs 5 / Cum	14,191	Rs./ annum
Revenue Loss by Leakages per m	1.42	Rs./m/ annum
Capitalized of annual CRL over 50 Years	19	Rs./m

Present Worth Replacement Cost:

$(CR1)/[1+(Ir/100)^{n}] + (CR2)/[1+(Ir/100)^{2n}] + (CR3)/[1+(Ir/100)^{3n}] + ...$

Where, Ir = Rate of Interest

CR1, CR2, CR3 = Replacement cost at the end of the n^{th} year, $2n^{th}$ year, $3n^{th}$ year respectively.

n = Replacement interval

Maintenances and Repair Cost: The Maintenance and Repair cost (CM) can be worked out on per meter basis as a fraction of construction cost and then capitalized over the project period.

Annual R&M cost is assumed as 1% of Construction Cost (CC)	4.03	Rs./m/ annum
Capitalized of annual CM over 50 Years	55	Rs./m

Replacement Cost: Consideration of replacement cost (CR) is essential for pipes having a shorter life in comparison with the project life.

Capitalization of Replacement Cost: The replacement costs are worked out with respect to the above formulation and individually present worth are calculated with respect to prevailing interest rate, ir, as follows, $Pn1=[\{C(1+if)^{n1}\}/(1+ir)^{n1}]$.

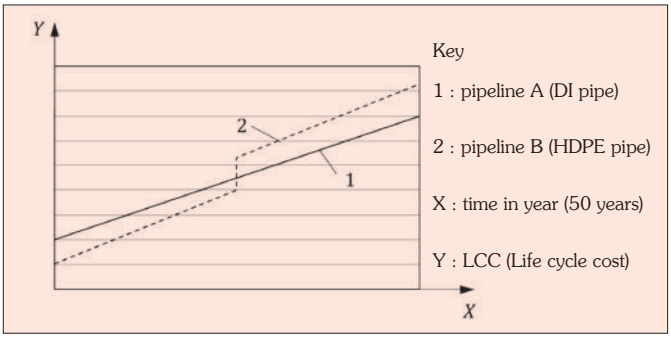
Project Life	50	years
Life of Pipe Material	18	years
Replacement interval	18	years
Nos. of replacement in the period of Project life	2.00	0.78
i) As laid Cost Rs/m from (a)	403	Rs/m
ii) Replacement cost at the end of 18^{th} year(CR1)	971	Rs/m
iii) Replacement cost at the end of 36^{th} year(CR2)	2,337	Rs/m
Present worth replacement cost	166	Rs./m

10% of Replacement Cost	17	Rs./m
Original cost of Pipeline	326	Rs./m
Salvage Value (50% for HDPE pipe)	-6	Rs./m
Disposal Cost is taken as 10% of Replacement Cost with Salvage	11	Rs./m

Disposal Cost: Disposal cost (CD) accounts for the total cost incurred in the removal of the pipeline, waste disposal, and salvage value, in case the pipe material is recyclable.

LIFE CYCLE COST ANALYSIS WITH DIFFERENT PIPELINES

Below figure shows scenarios of LCC with two different pipelines:



Although the initial cost of pipeline A (for example a DI pipeline) is higher, its LCC can become lower than that for pipeline B (HDPE pipeline, as an example) because of the low operation/maintenance cost and long service life.

SCENARIO OF LCC WITH DIFFERENT PIPELINES

Comparison of the two pipelines:

Pipeline	A	B
Pipe material cost	High	Low
Operation cost and Maintenance cost	Low	High
Service life	Long	Short
Cost of recycling	Low	High

A Life Cycle Cost Analysis between Metallic pipes DI, Steel, and Thermoplastic pipes HDPE has been carried out in the similar manner described above for a Project Life of 50 years with the following considerations:

Notes:

1. The Supply, Lowering, Laying, Jointing and Testing rates of all the pipes are taken from Maharashtra Jeevan Pradhikaran Schedule of Rates, 2021-2022.
2. The leakage losses are considered as 1% for DI pipe and Steel pipe; although ISO 21053:2019 (E)- (Life Cycle analysis and recycling of ductile iron pipes for water applications) the leakage rate for DI pipes is

0.004% as per clause C.2.3, the average rate for France.

3. The Repairs & Maintenance Cost as a percentage of construction cost is considered same as the Leakage Loss rate as given in CWC PIN Manual.
4. The Rate of Interest on Capital Investment is considered as 12%.
5. The Rate of Inflation for Replacement cost is considered as 5%.
6. The Unit Rate of Power is considered as Rs 6/unit.
7. The Water Charges are considered as Rs 5/m^3.
8. The service Life of PVC-O pipe has to be increased by 20% from the life of uPVC pipes, due to its improved property on account of molecular orientation. So, in the new scenario Maximum Life of PVC-O pipe will be 24 years (from 20 years), and the Minimum life will be 18 years (from 15 years), and so the average life will be 21 years.

JUSTIFICATION FOR LIFE CYCLE COST OF 50 YEARS

The timeline of 30 years for evaluating the cost viability of the project is governed by an underlying assumption that 30 years is a moratorium period for refunding a loan = project cost by the Project Authority. 30 years per se is not the life of the whole project or its parts. For example, rotating equipment has a lower life cycle because of wear and tear; whereas permanent structures, like, buildings and underground assets, like, pipes have a higher life cycle. This matter is also partially covered in the CPHEEO Manual under Clause No. 6.14.4, titled: Pipeline Cost under Different Alternatives, which states as follows:

"There are three independent factors bearing on the problem viz., the design period usually limited to a maximum of 30 years, the loan repayment period of 30 – 40 years and the life of the pipeline which may be anything from 50 to 100 years. There is one particular pipe size for which cost should be minimum, considering its capital and maintenance charge, for the loan repayment period. The size of the pipe will be larger if the period considered is the life of the pipeline and this larger size would appear to be less economical if the period is restricted to the loan repayment period.

The issue, therefore, hinges on which size to choose out of the two in a particular project. Whichever size is adopted, the loan, therefore, has to be repaid, within the specified period, long before the pipeline ceases to be of use. For the investor, the pipe size which will cost him the minimum is the criterion,

Sl. No.	Pipe material	Diameter Range	Brief Specification	Design useful service life as per NEERI Manual			Salvage value	Leakage rate	Repair and maintenance Rate
Metallic Pipe									
1	Ductile Iron	Class K7 – DN 100 to DN 1000 Class K9 – DN 100 to DN 1200	Class K7, K9 - Outside Coating Zinc + Bitumen, Inside Lining Cement Mortar	70	90	80	100%	1%	1%
2	Steel Pipe	OD 219 to OD 1219	Spirally welded/ ERW/SAW/Fabricated Steel Pipes - Internal 400 micron epoxy lining and external 3000 micron composite coating	25	40	32.5	90%	1%	1%
Thermoplastic Pipes									
3	HDPE	DN 63 to DN 1000	PE 100 grade - PN 6 and PN 10	10	25	17.5	45%	3%	3%

pipe costs and maintenance being considered over the loan repayment period. The other size based on the life of the pipe material would cost him an additional financial burden although it may be the cheapest when considered over the life period of the pipeline.

The sale price for the water will have to be based on the financial obligations on the repayment of the loan and the maintenance costs. The period of repayment of the loan thus enters into the question and the consumer will have to pay a higher price if the comparison is based on the lifetime of the pipe and not on the loan repayment period or the design period, as the case may be.

The life period of the pipeline as also other components would become a more rational factor when the project is financed entirely from perpetual public debts to be incurred by the promoters and the community pays back in perpetuity against loans raised from time to time for additions, alternations and expansions needed.

Whether the pipe size is based on the loan repayment period or the lifetime of the pipe its utility to the community will be there even after repayments of the loan. Since the incidence of the financial burden on the consumer will be less in the former case, the method is to be preferred."

RESULTS

The results obtained with these are as below: Summarized Life Cycle Cost (50 Years, 365 days water supply and Low-pressure pipeline) of HDPE, Steel, and DI Pipes as per CWC PIN Manual.

Sl. No.	HDPE (PN 6)			Steel			DI (K7)		
	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost
1	63	56.6	1,168						
2	75	67.3	2,228						
3	90	80.9	3,069						
4	110	97.5	2,161				118	102	2,474
5	125	112.3	2,573						
6	140	125.8	2,998						
7	160	143.7	3,551						
8	180	161.8	4,115				170	154	3,458
9	200	179.7	4,643						
10	225	202.2	5,558	219	209.5	8,354	222	206	4,506
11	250	224.7	6,441						
12	280	251.8	7,638	273	263.4	10,313	274	257.4	5,625
13	315	283.4	9,128						
14	355	319.4	10,948	324	312.7	12,698	326	308.8	6,714
15	400	359.8	13,432	356	344.4	13,853	378	356	7,966
16	450	404.7	16,742	406	395.2	15,673	429	406.4	9,245
17	500	449.7	20,082	457	445.8	17,532	480	456.8	10,591

Sl. No.	HDPE (PN 6)			Steel			DI (K7)		
	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost
18	560	503.8	24,308	508	496.8	19,373	532	508	12,011
19	630	566.9	29,695						
20				610	598.8	24,458	635	609.6	15,118
21	710	638.7	36,978						
22	800	719.9	43,954	711	696.8	29,642	738	708	19,194
23							790	758.6	21,450
24	900	809.8	54,413	813	797.2	35,562	842	809.2	23,856
25	1000	899.7	65,770	914	896.6	43,970	945	910.6	28,189
26				1,016	996	50,183	1,048	1012	32,956
27				1,118	1098	55,336			
28				1,219	1195	66,612			

Summarized Life Cycle Cost (50 Years, 365 days water supply and High-pressure pipeline) of HDPE, Steel, and DI Pipes as per CWC PIN Manual.

Sl. No.	HDPE (PN 10)			Steel			DI (K9)		
	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost
1	63	53	1,212						
2	75	63.1	3,312						
3	90	75.8	4,715						
4	110	92.9	2,442						
5	125	105.6	2,905				118	100	2,676
6	140	118.3	3,438						
7	160	135.1	4,121						
8	180	152	4,872				170	152	3,692
9	200	169	5,538						
10	225	190	6,709						
11	250	211.3	7,942	219.1	209.5	8,354	222	203.4	4,842
12	280	236.6	9,452						

Sl. No.	HDPE (PN 10)			Steel			DI (K9)		
	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost	OD	ID	Life Cycle Cost
13	315	266.2	11,556	273	263.4	10,313	274	254.4	6,176
14									
15	355	300.1	13,962	323.9	312.7	12,698	326	305.6	7,418
16	400	336.9	17,610	355.7	344.4	13,853	378	352.6	8,784
17	450	380.4	22,463						
18	500	422.6	27,184	406.4	395.2	15,673	429	402.8	10,246
19	560	473.4	32,242	457	445.8	17,532	480	452.8	11,934
20				508	496.8	19,373	532	504	13,565
21	630	532.5	41,060						
22	710	600.3	51,133	610	598.8	24,458	635	605.2	17,064
23	800	676.2	61,007						
24				711	696.8	29,642	738	704.4	21,222
25							790	755.4	23,432
26				813	797.2	35,562	842	806.6	25,424
27				914	896.6	43,970	945	907.8	30,179
28				1016	996	50,183	1048	1009	35,579
29				1118	1098	55,336	1152	1111.2	41,609
30				1219	1195	66,612	1255	1212.4	47,378

KEY DRIVERS FOR LIFE CYCLE COST REDUCTION

The following key drivers can be highlighted:

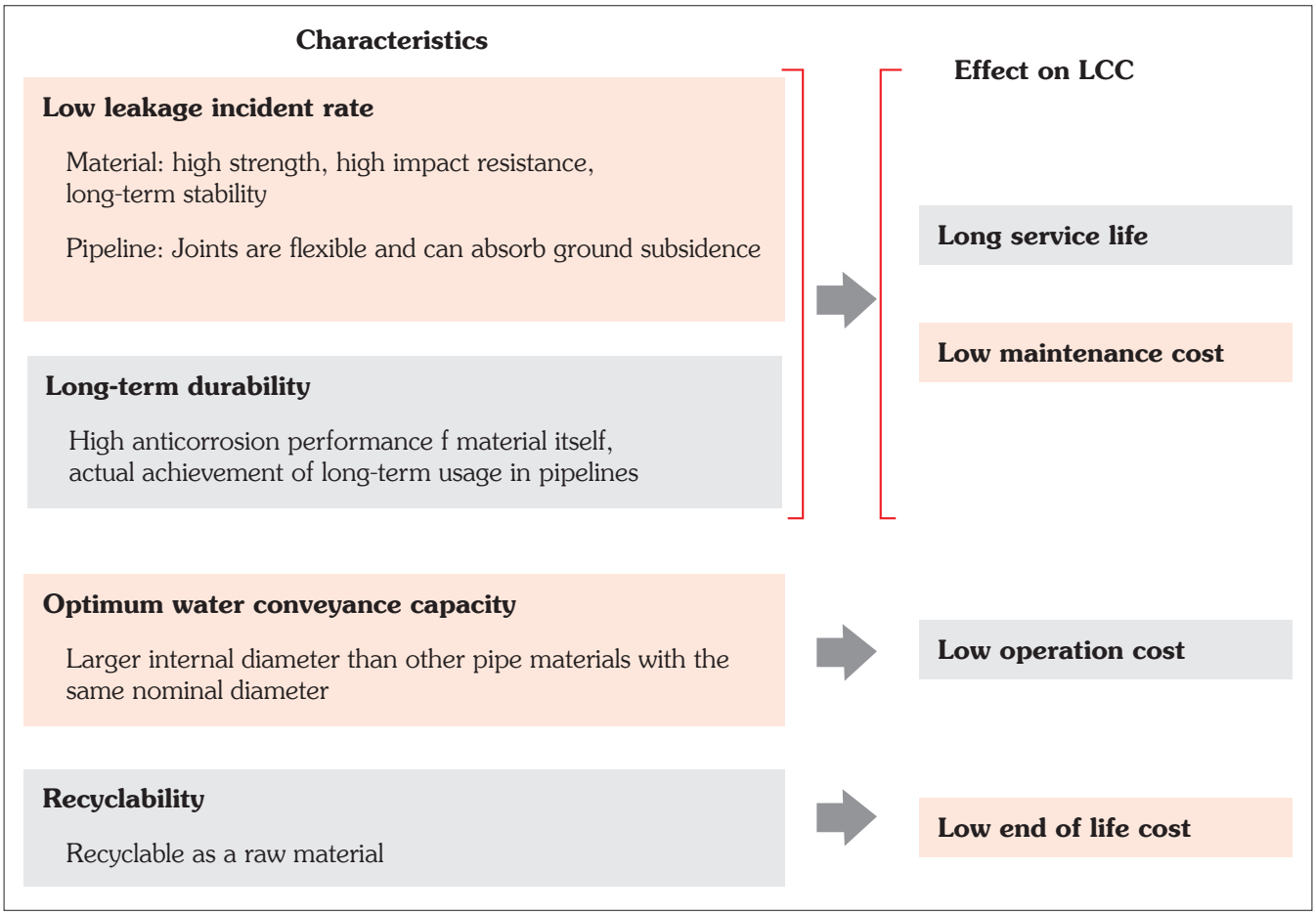
Leakage: Strong material properties and flexibility of joints contribute to prevent the leakage incident on buried ductile iron pipes.

Durability: A service life can be reduced or increased considering the nature of the pipe coating and the local soil conditions.

Conveyance Capacity: Pipes should be designed for a larger internal diameter in order to reduce the head loss on energy pumping and the operation cost such as the electric power usage cost.

Recyclability: In some cases, excavated iron pipes can be reused as a raw material to manufacture new pipes. Benefits of lower-cost production can be expected in a case where natural resources are used, allowing the disposal cost to be reduced.

The development of new methods of laying (re-use of excavated soils for back filling, narrow trench, etc.) can also contribute to reducing the construction cost.



CONCLUSION

Every pipe has merits and demerits. It will be useful to keep in mind that pipelines pass through a whole length of roads inhabitation and varying soil conditions, bedding conditions, locations, etc., will be encountered at various places. Hence, a particular pipe material may be suitable in a particular location but may require some other material at some other locations. In the same line, every project has its different aspects, pumping or gravity, pumping hours, project life, length of the pipeline, usage of the pipeline, etc. So, the Life Cycle Cost Analysis is required to be adapted project to project basis, as per the Schedule of Rates of respective Governments.

REFERENCES

1. Guidelines for Planning and Design of Piped Irrigation Network (Part – I & II), published in July 2017 by Ministry of Water Resources, River Development & Ganga Rejuvenation, Central Water Commission, Government of India.
2. ISO21053 – Life cycle analysis and recycling of ductile iron pipes for water applications.

VISIONING A NEW INDIA THROUGH ARCHITECTURE THE GREEN WAY

Charanjit Singh Shah*

Abstract

Taking notes from our heritage and culture, as architects and planners, Creative Group, with over four decades of architectural and engineering consultancy practice, tries to highlight the typical urban issues that present challenges in our designing process, simultaneously articulating the interference that designers face from other sectors involved in the construction and building practice. Moving forward with the philosophy that

"A built form should not be treated as a dead mass of brick and concrete, but as a living organism, allowing it to breathe with nature,"

Creative Group has demonstrated sustainable smart developments like Airports, Intermodal Hubs, Educational Campuses, Shopping Complexes, Railway Stations and have conceived the vision plans for some of the upcoming cities like Jamshedpur and Erode.

INTRODUCTION

The fast paced growth of the Indian economy, particularly its cities has produced an urban crisis, one that is marked by the lack of adequate infrastructure and growth management as well as by sharp social divisions that are bluntly stamped in a landscape of materialistic enclaves. In this context, there are numerous calls for a more decisive and vital type of planning that can 'future-proof' the cities. Though, many experiments are being executed in aspirations of providing a better infrastructure which gave counter productive results and therefore such piecemeal interpretations shift the focus from the main issue and do not provide any permanent solutions. It has been observed and also been debated at most of the professional platforms that an integrated approach towards city infrastructure development needs to be addressed in a holistic manner, rather than unraveling issues with a segmented and fragmented approach which ultimately results in temporary shifting of the issues and perhaps, we are unable to solve and understand the complexity of the matter of city development which chokes the cities and leaves no breathable human spaces.

*Founding Principal, Creative Group, New Delhi

HISTORY SPEAKS VOLUMES

Taking examples from our own past and how Indian cities have developed over the years, our modern settlements owe a great deal to the ancient civilizations like Indus Valley or Mesopotamia among others that considered the various factors that translate into a healthy human settlement. Creating planned cities according to human requirements is a trend that started with these civilizations. A well-planned street grid at the time when there were no vehicles and an elaborate drainage system hint that the system hint that the occupants of the ancient Indus civilization city of Mohenjo Daro were skilled urban planners with adequate knowledge of city services, drainage etc.

Fig. 1: Grid Street Planning as evident in the Indus Civilization

Interestingly, the "Great Bath" at Mohenjodaro is called "the earliest public water tank of the ancient world" wherein the water was discharged by a huge drain, making it one of the best known structures of the civilization.

VARIOUS REDEFINITIONS OF CAPITAL CITY OF INDIA - DELHI

Subsequently, with the changing mindset of the people, the city planning changes. Talking about the new cities of India, we see an emerging trend of emphasis on the social understanding of its inhabitants. Built on the banks of River Yamuna, Shahjahanabad, the walled city of Delhi envisioned by Shahjahan still exhibits the romance of Old Delhi's bazaars in the lanes of Chandni Chowk. Similarly, Edwin Lutyens is a one-man brand for New Delhi's heritage, prominently known as "Lutyens' Delhi" which still ranks as one of most elegant urban landscapes anywhere in the world. Lutyen's Delhi became the symbol of British Imperial power and dominance; a monumental, grand and larger than life city space. Connaught Place designed by Sir Robert Russell became the central business district of Lutyens' Delhi.

CONNAUGHT PLACE - REDEFINED PHYSICAL PLANNING WITH ADD ON LAYERS OF FACILITIES

A distinguished attempt to makeover Connaught Place has been proposed by the author showcasing a transformation and redefinition of landscape spaces with multiple and multifunctional underground developments. Therefore, it has been recommended that a smart blend of user integrated facilities with the Central Park of Connaught Place as the hub without interfering with the Lutyen heritage shall be made. Blurring the line between art and architecture and delivering both to the user is the consideration for redefining the heart of Delhi by adding layers beneath the Connaught Place radius in the form of combining street landscaping, retail and commercial hub, bus access, multilevel car parking and the metro train access on all different levels whilst blending into the old culture by retracting features of the famous Connaught Place colonnades.

VIBRANT PINK CITY OF JAIPUR

In a similar background, Jaipur or the "Pink City", a socially and culturally artistic city, can be traced

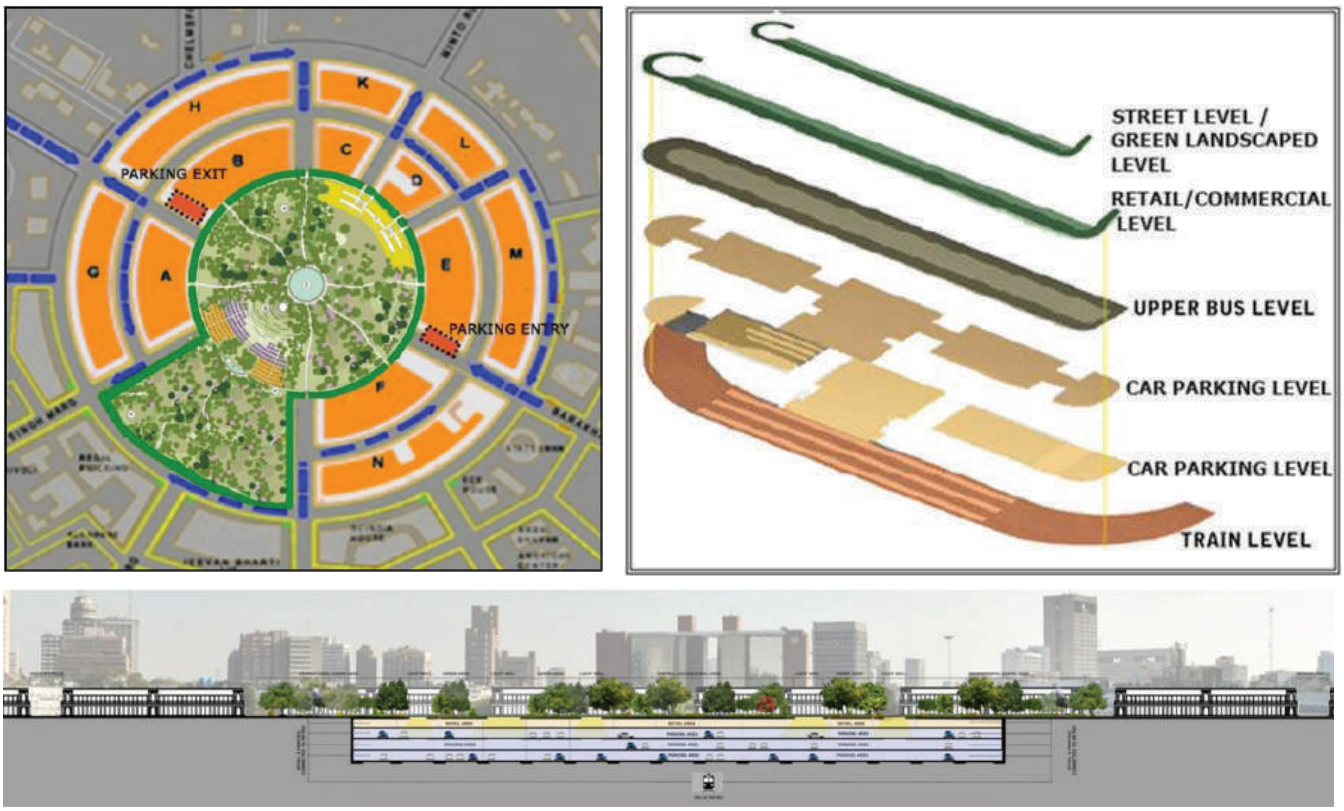


Fig. 2: Proposed Section of the Central Park Multimodal Hub

in an assortment of chronological and artistic destinations that dwell in the city. The credit solely goes to Vidyadhar Bhattacharya, planner appointed by Maharaja Sawai Jai Singh. Bhattacharya created plans of the city in line with the prehistoric Hindu dissertation on architecture known as "Shilpa Shastra," the science of Indian structural design. Therefore, Jaipur has been divided into nine wards developed within a "corridor planning" and has a city wall running along with seven entrance gates (Fig.3). The Pink colour, distinctive of the terracotta coloured lime plastered walls of all the buildings, adds an alluring character to the city.

Fig. 3: Seven Gates of Jaipur

LE CORBUSIER'S GREEN CITY OF CHANDIGARH

Chandigarh, the dream city of independent India's first Prime Minister, Sh. Jawahar Lal Nehru, is known as one of the best experiments in urban planning and modern architecture in the twentieth century in India. The city, whose sole contributor is Le Corbusier, became symbolic of the newly independent Indian. The city plan was conceived as post independence "Garden City" wherein using a grid iron pattern, the metaphor of a human being was employed, keeping in view the socio-economic conditions and living habits of the people.

ARCHITECTS'/PLANNERS' INTERVENTION

Grasping from the above, it is evident that the role of an architect in urban development need to be redefined. In the present scenario, most of the visualization of detailed project feasibility and

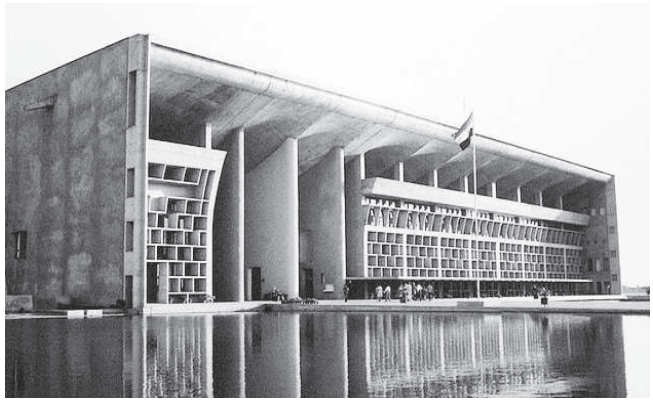


Fig.4: Palace Assembly alongside a water body in Chandigarh

analysis of the urban issues are being hindered due to inferences which act as counterproductive and thus dilute the contribution of the planner. A professional architectural intervention is critical, especially at this sensitive stage of our cities. The prevailing social and demographic changes are leading to a greater demand for housing in urban areas. According to a United Nations report, India will witness the largest increase in urban population in the next four decades, which in turn will increase the depravity of urban issues. How we choose to solve them is going to decide the future of our nation and make sure that we leave behind a flourishing India for our coming generations.

ISSUES OF EXISTING INDIAN CITIES

India's plan for coming up with 100 new cities can only be supported with the initiative of upgrading the efficiency of our existing Indian cities. The new cities are proposed to be developed as satellite towns around the existing cities that would need to be linked with modal transport systems. Before the Government goes down the roadmap for the Smart Cities initiative, the bedlam that exists due to the expanding urban growth needs to be addressed so that India can develop as an ingenious nation.

ILL TREATMENT OF EXISTING WATER BODIES IN THE COUNTRY

In the current scenario where India is facing the challenges of unplanned urbanization, the water bodies play a vital role in the sustainable functioning of a country. The current statistics prove that the

state of water bodies is deteriorating rapidly despite plenty policies and regulations for protection of lakes, baolis, rivers and other such sources of water. For instance, in the early 1960s Bangalore reported 262 lakes and currently only a small number of 10 still hold water. Similarly, in the year 2001, a total of 137 lakes were listed in Ahmedabad and by the year 2012, more than 65 lakes were reported to have been built over. The Capital of the Country, New Delhi recorded that 21 lakes out of 44 had gone dry in a span of 10 years due to accelerated urbanization and falling water tables.

The concern is not only related to drying up of our water sources but their maintenance as well. The state of water pollution is an alarming issue which is responsible for taking human lives as well. An eminent politician of the country once stated that the Pollution in the River Ganga claims more lives than bomb blasts every year. Baolis and step wells, which were heritage sites and major sources of water in the country at one time, are now mere garbage dumps.

Encroachment is another major threat to water bodies particularly in the urban areas as a result of rural to urban migration. As the availability of land is getting scarce, the urban lakes and rivers are considered as real estate properties rather than efficient sources of water. The Pillakaranai marshland in Bangalore was encroached upon by the Government itself and is now one of Karnataka's largest dumping sites. Due to such neglect towards the existing water bodies, the country now faces a disturbing scarcity of water. Almost 54% of India faces high to extremely high water stress, a percentage that shames the development that we have so far achieved.

MANAGEMENT OF TRAFFIC AND ROAD INFRASTRUCTURE

Traffic Congestion is an issue that thrives in the urban and metropolitan cities of India depicting the failure of transport infrastructure in keeping pace with the increasing population. With the growth in population, there is also a growth in shifting from rural to urban which leads to more transportation users on a daily basis. Statistics show that 1400 cars are added to the Capital's roads every day and evidently, the road infrastructure is not condign to deal with such an escalation. Moreover, one needs to understand that each city has different issues that need to be solved in a particular manner. The insertion of the Bus Rapid Transit System (BRTS) in Delhi has led to choking of the roads and more traffic as opposed to its success in Ahmedabad.

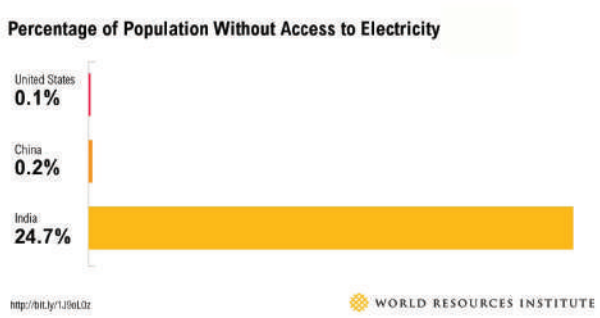
Fig. 5 : Traffic Congestion Scenario on roads in the Capital

LACK OF ELECTRICITY

Approximately 300 million Indians which constitute a quarter of the population are living without a regular supply of electricity. Although India has less than fifth of the world's population, it has an estimated 40 percent of the world's population that lives without electricity. This shortage in electricity directly affects the economic growth of the country and its fight for poverty. While the Government plans a number of smart cities with a probable 24 hours power supply, there are still a thousand of villages that crave a well lit night, an issue that needs

to be addresses at the earliest.

Table 1: A survey by World Resources Institute on Lack of Electricity in India



LACK OF HOUSING FOR ECONOMICALLY WEAKER SECTIONS

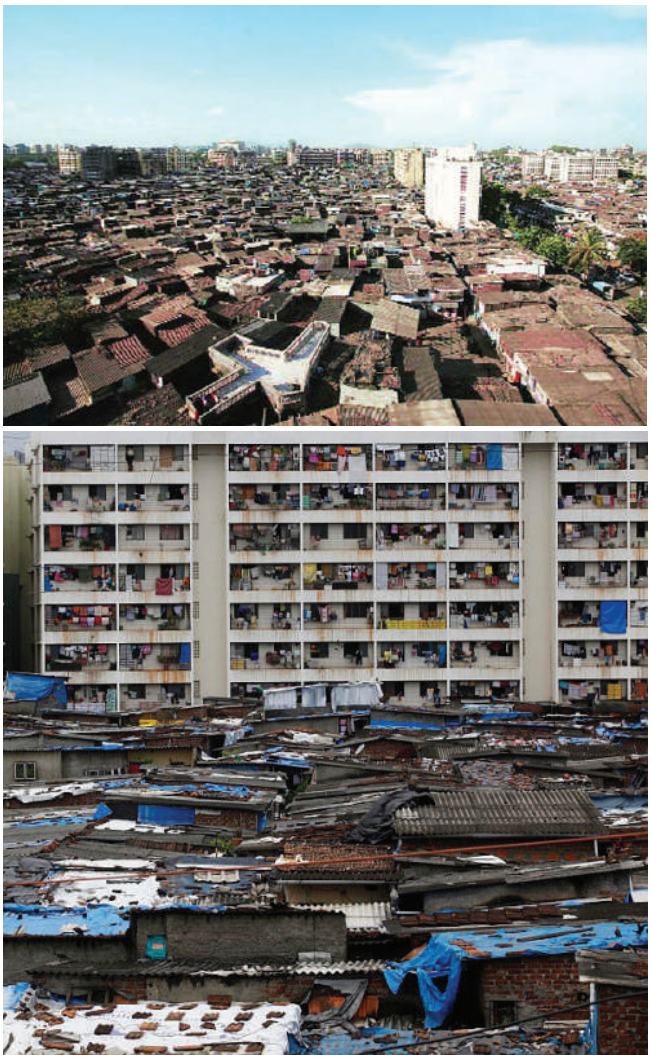
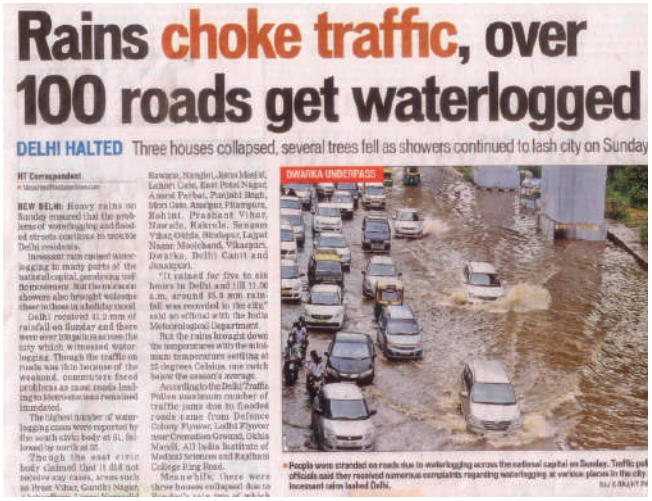


Fig. 6 : Slums in Metropolitan Cities

According to a recent Government Census, India has the largest urban slums with 68 million citizens living in slum settlements. The lack of housing for the Weaker Sections leads to unplanned slum settlements in various parts of the metropolitan cities thus hindering a planned development system. Undoubtedly, one of the major concerns to accelerate the infrastructure growth is development of affordable housing for the poor by the use of alternative technology and materials while keeping in view the socio cultural aspect of community living.

STORM WATER MANAGEMENT


Rains choke traffic, over 100 roads get waterlogged

DELHI HALTED Three houses collapsed, several trees fell as showers continued to lash city on Sunday

DWARKA UNDERPASS

Fig. 7 : Water Logging in Capital during Rains

Issues of water logging and flooding of roads due to heavy rains continue to trouble citizens on a daily basis. The root of the problem lies in inefficient storm water management on a city level which causes massive suffering for local communities.

The construction of roads or buildings significantly changes the hydraulic properties of an area is a lesser known fact and needs to be taken into consideration to plan drainage runoff systems and storm water management systems. A more sustainable approach in this matter would be an Integrated Urban Water Management System which refers to the practice of managing fresh water, waste water and storm water simultaneously and design infrastructure with the urban planner in lead.

LACK OF SOCIAL AWARENESS

It was recently in the news that how the Capital of our country is near the bottom of the 'Cleanest cities of India' list due to rampant open defecation and poor waste management facilities. The major concern here would be the lack of social awareness among the citizens of a city or nation who need to feel responsible for the maintenance of infrastructure of their habitat.

It is, therefore, indisputable that before all of us think of making smart cities with first class technology and upgraded infrastructure, we must upgrade our existing cities into smart and sustainable cities. Learning from our mistakes, it is necessary to build a foundation of sustainability while planning an upcoming smart city. Moreover, the concept of a "smart city" is still one which stands debatable and needs to be understood with utmost thoroughness.

SMART CITY

It is the great vision of our honourable Prime Minister to develop 100 new smart cities in India. Its a city which uses technology to run itself and manage resources efficiently. Everything from a smart city's governance to its public transport network, water distribution and waste-disposal systems would use technology to provide better services to residents and make efficient use of resources. The currently on going GIFT City in Gujarat proposes a modern town boasting of high rise buildings and skyscrapers. But, what we need to think about is whether it really is feasible to convert Modern Day India into the down towns of the West? Should we not focus more on adapting passive strategies of sustainable development rather than only on technology implementation and creating glass buildings and skyscrapers?

As we know, Indian cities have their unique and specific issues, related to cultural, social, climatic and economic aspects that perhaps are different from the western world. Due to the unplanned mushroom growth in Indian cities post independence, our cities are choking. These issues need to be addressed particularly in a wholesome manner presenting a pragmatic solution rather than taking a piecemeal approach which eventually eliminates into shifting stands without offering a perpetual resolution. Therefore, imitating the West in terms of gathering a 'smart city approach' would only leave us with limited advantages and many more problems. Moving away from the typical cogitation that use of technology is enough to build a smart city, we should consider a simple historical fact: The previously built Indian cities were simple yet intelligent without an abstract use of technology. Then we can ask ourselves, what if we can envision a smart city with minimal use of energy and technology?

Understanding cities is vital to understanding our civilization. Therefore, redefining a smart city, the author proposes a city which is embedded with nature and enrolls the passive strategies of sustainability whilst gaining from the historically successful planning approach.

"As our rapidly globalizing Indian Cities move further into the 21st century, a long term solution needs to be matured that employs our existing assets and sustainability strategies in the most beneficial way to focus on turning 'ordinary to extraordinary"

RESTORATION OF WATER RESOURCES

Revival of our water resources such as of baolis, kunds, lakes and stepped wells, an entire category of architecture that is slipping off history's grid, would be the first step towards improving living conditions in a smart city. "Baoli" was much more than just a water reservoir in its golden days; it was a candid retreat for the locals from blazing summers and a gathering place for recreation. Restoring our natural water resources can help us in dealing with hot temperatures and fluctuating water availability.

MUTUAL SHADING AS A DESIGN PRINCIPLE

Another factor that can be picked up from history, would be the application of "mutual shading" in our buildings. Cities like Jaisalmer, Jodhpur and Jaipur, being case examples of this design principle, prove that when we mutually shade buildings, an immense amount of energy application can be avoided due to intelligent and abundant use of daylight and heat.

Fig. 8 : Mutual Shading of Buildings

BUILDING ORIENTATION

This basic design strategy is given less importance than it deserves. Rather than adding intelligent facades to avoid the harsh sunlight, placing a building along its N-S direction can result in maximizing daylight and minimizing heat gains, letting the structure breathe and thus reducing the need for energy consumption in the hot and dry climatic conditions.

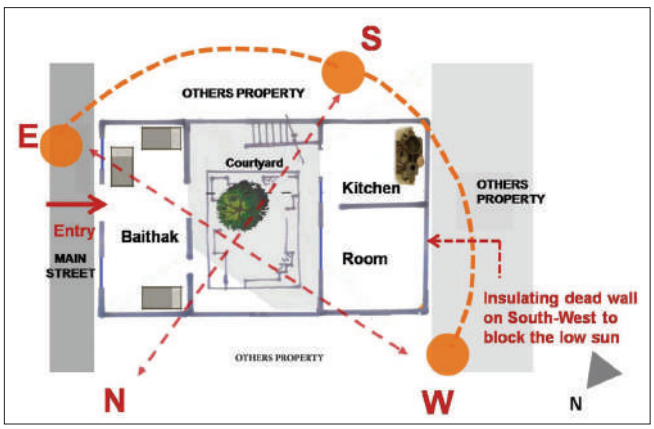
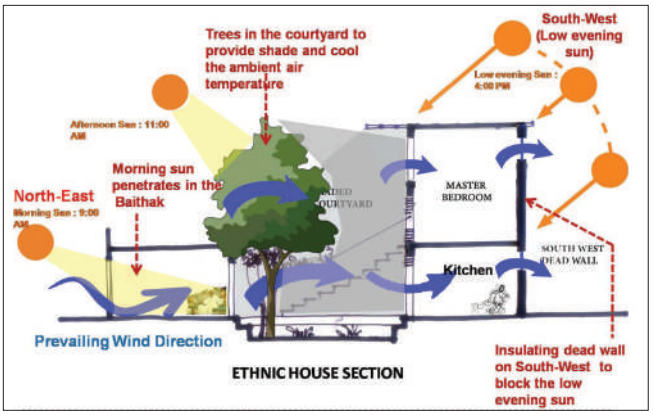


Fig. 9: Orientation of the building as per solar movement



SMART VILLAGES, NOT JUST SMART CITIES

Apart from indulging in sustainable design principles to build smart cities, one should think, what about our villages? As Anna Hazare rightly said, 'India needs smart villages and not just smart cities.' As architects who play a strategically important role in this matter, our intent should be to provide urban facilities in rural areas to prevent migration from under developed villages to ever-growing cities. Rural development, in turn, would create job opportunities through agro-based centres and such, for all the classes and masses.

CONCLUSION

Some Indian states are already experimenting with creating new cities with "smart" elements. These include the Gujarat International Finance Tec-City (GIFT), or Smart City Kochi, in the southern Indian state of Kerala. While reading several articulations pertaining to Smart Cities and their development, the author wonders if it is all a technological humdrum or will planners and architects realize that a lot more than just availing the best of technologies is required. Still grappling with the nuts and bolts of building a smart city, our country is on the lines of fully understanding what an 'Indian Smart City' should be. We ask ourselves, how is architecture so central to our experience of becoming a human? How do architects and planners provide a comfortable life to the occupants? The GIFT city revolving around gleaming high rise glass towers and skyscrapers is one of the many answers.

Dholera, another 'smart city in progress' also welcomes top notch technology and modern living. The current situation calls for a more economical solution in terms of land use, having many social advantages in terms of services and at the same time provide for very close contact with the ground and with nature, i.e. Low Rise, High Density Structures. These structures bring together the best of both worlds: they are dense enough to achieve urban benefits namely access to public transportation and civic amenities while accommodating an integration of open spaces whilst providing a sense of individual identity.

Only one thing needs to be made sure of: Motivating Tradition through Modernity. India has a very strong heritage which cannot be ignored. Attributing simple yet the most effective ways of urban and rural planning, we need to focus on strategies like neighbourhood planning, inter phase between accessibility, efficiency and people's movement. But, is the architecture network around us capable enough to withstand the functioning of such technology? Are we just adding layers and layers of new innovations rather than upgrading the existing infrastructure? These questions raise an alarming situation. Therefore, the cynosure should be on building cities that enhance its residents' lives by utilizing the underlying passive strategies of sustainable architecture and not just relying on technology to solve all our problems. Would we want the people to believe that the only way a city can be 'smart' is when it never gets built? Or does a 'smart and sustainable city' with open spaces, connected neighbourhoods, intermodal hubs and minimalistic energy utilization sound like the way to go? "Therefore, a planning and architectural intervention is very important to be realized and merge the strong Indian Ethnic architecture and the modern trends of planning and with advanced use of technology in terms of services, infrastructure and city development, thus creating sustainable and futuristic Indian Smart Cities.

CIRCULAR ECONOMY FOR SUSTAINABLE CONSTRUCTION INDUSTRY: AN INDIAN PERSPECTIVE

Saurabh Gupta* And Vaishali Jain**

Abstract

Present day construction industry generates more than 25% of solid waste with the exploitation of 30% of natural and scarce resources across the world. The construction business mainly uses the conventional linear economic approach with three pillars (i)take (ii)make, and (iii)dispose. The infrastructure is constructed with primary and secondary resources and disposed once the construction and life of that structure completed. In the recent trends the construction industry shows an inclination towards the "Circular Economy (CE)" approach which is widely acceptable in manufacturing sector. The motive is to keep using the material in a closed loop to gain the maximum values with sustainability, therefore with a greater potential of reducing the waste generation and resources extraction for the Construction Industry. This article aims at finding the recent developments of CE in construction perspective. The paper presents systematic literature review with various key factor involved in CE. The analysis made to find the knowledge gaps and applicability in Indian scenario.

INTRODUCTION

Every year, billions of tonnes of construction and demolition waste (CDW) materials are buried in landfills around the world, inflicting significant social, economic, and environmental impact. In China, around 2.36 billion tonnes of CDW were generated in 2018, with barely 5–10% of this amount recycled. In the same year, the European Union (excluding the United Kingdom) produced 835 million tonnes, with landfilling rates in Cyprus, France, Slovakia, and Sweden of 43 percent, 29 percent, 47 percent, and 39 percent, respectively. In 2018, more than 600 million tonnes of CDW materials were generated in the United States, with around 30% ending up in landfills. Landfilling rates are also substantially higher in smaller CDW-producing countries, such as India, Brazil, and Australia, at 70–90%, 92 percent, and 27 percent, respectively[3].

Given that up to 95% of non-hazardous CDW materials are recyclable and reusable, the impact to the circular economy is enormous. Despite the enormity of the problem, CDW materials are not efficiently handled globally. Anomalies in CDW stream specifications and categories add to this issue. CDW materials have indeed been described using a variety of terminology over the years, including "by-product," "surplus," "excess," "wastage," "difference," "substance," "unwanted material," "loss," and "inefficiency." Variations in definitions may result in ambiguous classifications for the same sorts of CDW items, resulting in variances in waste analytics. This issue is critical since recyclable CDW products may end up in landfills inadvertently, harming the environment and thus promoting the linear economy.

DEFINITION OF CIRCULAR ECONOMY FOR THE BUILT ENVIRONMENT

Circular Economy (CE) is defiened as "restorative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (EMF, 2015). Other available definition "circular approach keep resources in productive

**Research Scholar;Department of Civil Engineering, Indian Institute of Technology*
***Research Scholar;Department of Civil Engineering, Indian Institute of Technology*

use in the economy for as long as possible"[4]. CE for the Construction Industry as a "building that is designed, planned, built, operated, maintained, and deconstructed in a manner consistent with CE principles"[10]. The consideration of these five phases takes into account the European standard EN 15978:2011, that specifies the calculation method for Life Cycle Assessment (LCA) of a building and considers four main life cycle stages: (1) Product manufacture; (2) Construction; (3) Operation; and (4) End-of-life. Fig. 1 shows the value chain of CE in construction industry.

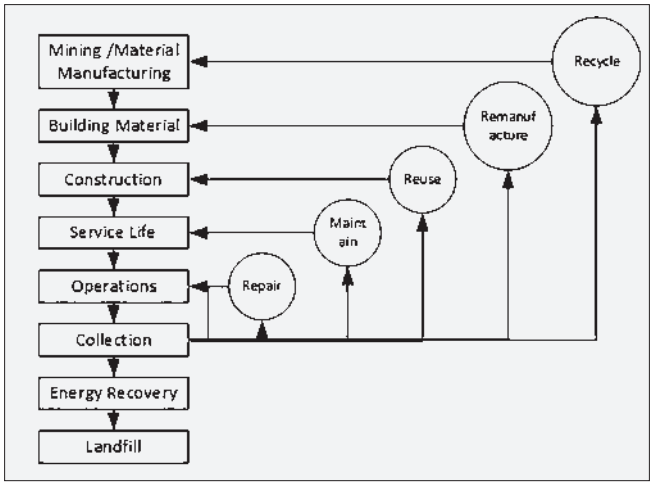


Fig. 1: Circular Economy principles in the life cycle of construction chain

Circular economy, is an economic system based on economic models that substitute the "end-of-life" notion phase of any product which does not obtain ongoing support, because either existing processes are ended or it has reached the end of its lifespan lowering or alternatively reusing, recycling, and restoring materials in the production and utilization. The various approaches when followed in China for restoring CDW waste is shown in Fig. 2.

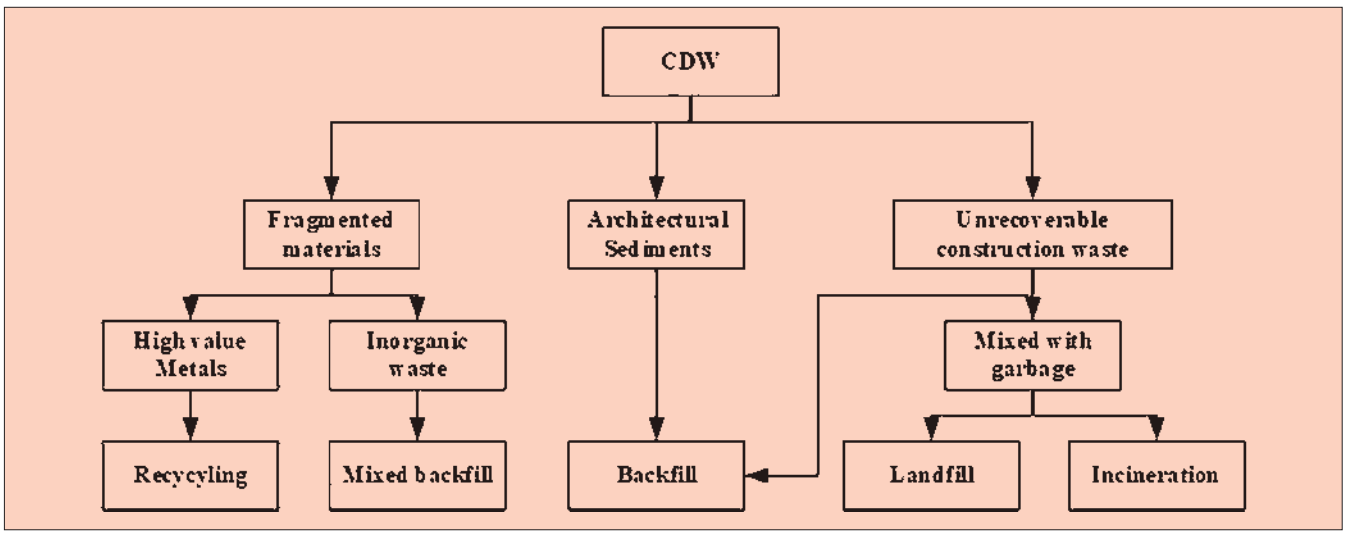
CIRCULAR ECONOMY (CE) FRAMEWORK FOR CDW

In a broader sense, Fig. 1 depicts the basic process through which CDW is manufactured, processed, and disposed of in landfills, or reused and repurposed. Excessive ordering or unskilled labour handling results in the production of CDW in construction projects, while materials left after demolition that are not designed for deconstruction are also converted to CDW. Landfill disposal and incineration are the normal endpoint of this CDW. A CE's purpose is to minimise, if not eliminate, the amount of CDW deposited into landfills and cremated, but it also focuses on increasing the scale and quality of CDW recycling and reuse, as well as its capacity to construct new buildings.

An effective framework in the CE requires three strategies:

i. Narrowing resource loops—using fewer materials in manufacturing to produce less wastage at the end - of - life.

ii. Slowing loops—this refers to the extending of the material's use stage.



Fig, 2: Presesent CDW flow process

Table 1: Literature review of reuse and recycling CDW in new construction applications

Ref	Country	Year	Reuse	Recycling	Type	Observations
[5]	Spain	2019		*	RA	Replacing 25 wt. % with recycled aggregate induces no significant effect.
[4]	China	2019		*		Current research focuses on adopting recycled aggregates in new concrete production.
[10]	Spain	2017		*		In the production of non structural dry-mixed concrete hollow blocks, proper behavior was shown.
[11]	Italy	2018		*		Using RCA into stabilized rammed earth material can be utilized.
[12]	Spain	2018		*		Concrete workability was not affected by use of 100% mixed recycled aggregate. Neither compressive nor flexural strength varied significantly at replacement ratios.
[13]	Spain	2016		*		Use of RA in production of lightweight mortars is a viable alternative.
[17]	France	2017		*		16% additional cement was needed to compensate the drop in compressive strength of RAC.
[19]	Italy	2000		*		Strict relationship between mix design is important and dosages correlate to the strength of the resulting material.
[1]	Spain	2016		*	RCA	Physical, mechanical, and acoustic properties were the same as control material.
[8]	China	2020		*		Compressive strength of concrete blocks made with 100% RCA is within code requirements.
[2]	China	2019		*		Recycling of CDW is economically feasible.
[14]	Italy	2017		*		Production of self-compacting concrete with coarse and fine RCA up to 40% involume.
[15]	Spain	2018		*		RCA from precast elements shows mechanical properties are slightly lower.
[16]	Iran	2019		*		Slight decrease in flexural strength can be observed.
[3]	India	2019		*	Brick dust and Concrete dust	Mechanical properties of resulting asphalt achieved equal or greater amounts.
[2]	U.S.	2019	*		Exterior wall frame systems	Reuse of exterior wall framing systems is feasible as long as transport distance is less than 3000km.
[5]	Poland	2016		*	Sewages ludge ash	Material can be used as substitute in various construction materials production.
[6]	Spain	2018		*	Ceramic aggregates	Material can be used in non structural functions.
[7]	Spain	2019		*	Polystyrene from C&D	Expanded polyterene and extruded polysterene waste from construction and demolition can substitute currently used aggregates perlite and vermiculite.
[9]	Italy	2019		*	Concrete fibers	Recycled plastics and metal fibers in reinforced concrete can be used.
[3]	Spain	2016		*	CDW	Recycling CDW can be attractive when there cycled product is competitive with the virgin material in terms of cost and quality.
[18]	Italy	2017		*	Fillers	Physical properties and mechanical performances are similar or even better compared to standard mixes.

iii. Closing resource loops—this can also be equated to the process of material recycling.

Closing resource loops is the fundamental method used for an effective framework in the reuse and recycling of CDW in material recovery and production, specifically in the reuse and recycling of materials. The recirculation of recovered resources throughout their life cycle enables their usage in new construction applications while minimising the use of virgin raw materials[6]. Material reuse is the technique of reusing appropriate building resources, whereas recycling necessitates the dismantling of discarded goods in order to create new materials and objects[2].

RESEARCH GAPS & OPPURNUTIES

The research gap and oppurnituies is analysed using various literature across the country. These literature review is illustrated in Table 1. Recycling and reusing CDW in new construction applications has been investigated since the late twentieth century. However, research needs remain, such as the incorporation of reuse into new construction applications. Furthermore, research into reuse are limited or fewer in number; nonetheless, studies into recycling outweigh studies into reuse by a large margin. Despite a number of initiatives to harness the potentials of reuse, a lack of quantitative data limits the benefits that can be achieved[11]. The majority of the research and studies conducted in the last 30 years have focused on the successful recycling of CDW in new construction applications.

CE and recycling are growing themes, as seen by the trend of published studies which has seen a lot of potential in not only lowering CDW but also giving the construction and demolition sector the ability to maintain a sustainable development. Further more, the included publications are likely to contain CE and recycling-related issues. Several frameworks have already been established, and CE has received international recognition[6]. A significant number of studies on the reprocessing of CDW in new construction applications have previously been conducted in the field of recycling.

CONCLUSION

Frameworks in CE, CDW, and reusing materials and manufacturing focusing on reuse and recycling demonstrate a coherent drive toward promoting CE in the construction and demolition industry to reduce, if not completely eliminate, the production potential of CDW that endangers the environment and raises issues synonymous. These frameworks serve as guidelines for future research and encourage development toward a more effective CE in which, instead of a linear approach to the design, construction, demolition, and disposal of CDW that produces vast amounts of CDW, a circular model or approach that allows materials to be reprocessed or remanufactured, thereby delaying the life-cycle of the material and alleviating the rising number of CDW disposed of is used. Because of the various applications of CDW when reprocessed and remanufactured into new construction materials, CE on material recovery and processing, specifically on recycling CDW into new construction applications, is viewed as a possible method to be taken. Construction materials with recycled components have nearly the same physical and mechanical qualities as their virgin equivalents, according to numerous research, tests, and outcomes in recycling materials. When the mechanical qualities of recycled CDW are slightly lower than those of natural counterparts, small amounts of other materials are added to compensate for the tiny drop, which is negligible when weighed against the environmental and sustainability benefits of recycling CDW.

Because the goal of this study is to provide recommendations for future work in CE, CDW, and material recovery and production with an emphasis on recycling and reuse, additional research and studies should be focused on metrics for effective reuse of construction materials. The amount of research done on recycling much outnumbers that on reuse. Experimentation on appropriate proportioning of recycled materials, natural materials, and other materials should be explored in terms of material recycling and reprocessing to maximise the usage of recycled CDW. Further research into waste-free recycling systems is also encouraged, as this is completely consistent with CE

concept and encourages sustainable development and environmental preservation. In terms of experimentation and research on the physical and mechanical qualities of recycled materials, it is already possible to use 40 percent or less recycled CDW in new construction applications. Additives can also be investigated so that the usage of recycled CDW with a content of 41% or higher can be optimised. Further research should be conducted in cases where 100 percent substitution was determined to be viable to decrease any risk that could result from the use of CDW instead of their natural counterparts, particularly in structural/load-bearing applications. It is possible to use recycled materials in non structural applications.

REFERENCES

1. Arenas, C.; Galiano, Y.; Leiva, C.; Vilches, L.F.; Arroyo, F.; Villegas, R.; Pereira, C. Development of a flyash-based geopolymeric concrete with construction and demolition wastes as aggregates in acoustic barriers. Constr. Build. Mater. 2017, 134, 433–442.
2. Rios, F.; Grau, D.; Chong, W. Reusing exterior wall framing systems: A cradle-to-cradle comparative lifecycle assessment. Waste Manag. 2019, 94, 120–135. [CrossRef]
3. Choudhary, J.; Kumar, B.; Gupta, A. Utilization of solid waste materials as alternative fillers in asphalt mixes:A review. Constr. Build. Mater. 2020, 234, 117271–117289.
4. Smol, M.; Kulczycka, J.; Henclik, A.; Gorazda, K.; Wzorek, Z. The possible use of sewage sludgeash (SSA) inthe construction industry as a way towards a circular economy. J. Clean. Prod. 2014, 95, 45–54. [CrossRef]
5. del Bosque, I.S.; Van den Heede, P.; De Belie, N.; de Rojas, M.S.; Medina, C. Carbonation of concrete with construction and demolition based recycled aggregates and cement with recycled content. Constr. Build.Mater. 2020, 234, 117336–117352.
6. Valdes, A.; Robles, D.; Gonzalez, J.; Romero, M.; Pozo, J. Mechanical and microstructural characterization of non-structural precast concrete made with recycled mixed ceramic aggregates from construction and demolition waste. J. Clean. Prod. 2018, 180, 482–493.
7. 7. Merino, M.; Saez, P.; Longobardi, I.; Astorqui, J.; Porras-Amores, C. Redesigning light weight gypsum with mixes of polysterene waste from construction and demolition waste. J. Clean. Prod. 2019, 220, 144–151.
8. Zhao, Z.; Courard, L.; Groslambert, S.; Jehin, T.; Leonard, A.; Xiao, J. Use of recycled concrete aggregates from precast block for the production of new building blocks: An insdustrial scale study. Resour. Conserv. Recycl. 2020, 157, 104786.
9. Merli, R.; Preziosi, M.; Acampora, A.; Lucchetti, M.; Petrucci, E. Recycled fibers in reinforced concrete:A systematic literature review. J. Clean. Prod. 2020, 248, 119207. [CrossRef]
10. Morales, M.; Moyano, G.; Espinosa, I.; Palacios, I. Effect of recycled aggregate on physical-mechanical properties and durability of vibro-compacted dry-mixed concrete hollow blocks. Constr. Build. Mater. 2017,145, 303–310. [CrossRef]
11. Arrigoni, A.; Beckett, C.; Ciancio, D.; Pelosato, R.; Dotelli, G.; Grillet, A. Rammed earth incorporating recycled concrete aggregate: A sustainable, resistant and breath able construction solution. Resour. Conserv.Recycl. 2018, 137, 11–20.
12. Cantero, B.; Saez del Bosque, I.F.; Matias, A.; Medina, C. Statistically significant effects of mixed recycled aggregate on the physical-mechanical properties of structural concretes. Constr. Build. Mater. 2018, 185,93–101.
13. Ruiperez, C.; Rodriguez, A.; Gonzales, S.; Calderon, V. Lightweight masonry mortars made with expandedclay and recycled aggregates. Constr. Build. Mater. 2016, 118, 139–145.
14. Manzi, S.; Mazzotti, C.; Bignozzi, M.C. Self-compacting concrete with recycled aggregate: Study of thelong-term properties. Constr.

Build. Mater. 2017, 157, 582–590. [CrossRef]

15. Fiol, F.; Thomas, C.; Munoz, C.; Lopez, V.; Manso, J.M. The influence of recycled aggregates from precastelements on the mechanical properties of structural self-compacting concrete. Constr. Build. Mater. 2018, 182,309–323. [CrossRef]
16. Kazemian, F.; Rooholamini, H.; Hassani, A. Mechanical and fracture properties of concrete containing treated and untreated recycled concrete aggregates. Constr. Build. Mater. 2019, 209, 690–700. [CrossRef]
17. Fraj, A.; Idir, R. Concrete based on recycled aggregates—Recycling and environmental analysis: A case study of paris' region. Constr. Build. Mater. 2017, 157, 952–964.
18. Topini, D.; Toraldo, E.; Andena, L.; Mariani, E. Use of recycled fillers in bituminous mixtures for road pavements. Constr. Build. Mater. 2018, 159, 189–197.
19. Pasetto, M. The re-utilization of discarded building materials in cement-stabilized layers of road and air field pavements. Waste Materials in Construction. 2000, 548–566.

DRAINAGE TO BE INFRASTRUCTURE OF INFRASTRUCTURES FOR SUSTAINABLE DEVELOPMENT

Usha Batra* And Dr. K. M. Soni**

Abstract

Drainage is very important in any infrastructure development for sustainable development as flooding in urban areas has resulted into loss of lives, property, economy, disruption of working and heavy environment cost. Coastal cities are also facing submergence problems and in future some of the low lying areas may get submerged and as such construction of dykes having multiple functions needs to be taken up.

Urban drainage infrastructure needs to be taken up on mission mode among all infrastructure development by Government of India with the participation of state governments through Special Purpose Vehicles so that it is implemented within a time limit to save loss of life, property and economy.

A separate specialized programme should also be developed for flood protection and drainage system considering the importance of the subject.

INTRODUCTION

Drainage is the natural or artificial removal of a surface and sub surface water from a designated area. Drainage is essential every where but more so in metropolitan cities due to adoption of large impervious areas without giving adequate attention on drainage. Population growth and its density in urban areas have further aggravated the drainage problem and existing drainage system has become inefficient to carry required discharge hence needs to be overhauled with latest technology and integrated solution to make it efficient.

Normally drainage system is designed based on parameters like discharge, gradient, soil characteristics, surface characteristics of the drains considering level of the final source of the disposal, catchment area, rainfall etc. and discharged to available river, stream or sea. With the development of cities, these parameters are changed by addition of infrastructure both by private and public authorities. Unauthorized construction, poor maintenance of drainage system, allowing higher FAR/FSI in existing cities and encroachment of natural drainage system like lakes, rivers and streams have chocked the cities as such flooding is observed in most of the old cities during monsoon. The development becomes unsustainable every year in some of the urban areas due to floods for the years to come.

Even, road drainage is not being given adequate attention leading to failure of roads more often. Mixing of sewerage into surface runoff, encroachment on drainage system, poor maintenance, and construction agencies allowed to join drainage system without even capacity assessment of the drainage system have further led to flooding in the cities. This has not only resulted into heavy monitory loss, unsustainable development, loss of lives and heavy environmental cost to the governments and public in addition to the inconveniences.

SURFACE RUNOFF

Surface runoff is the flow of water over the ground surface. The quantity not getting infiltrated into the ground owing to saturated soil or the soil being unable to absorb water, saturation during heavy continuous rains, or water stagnation joins and become part of the surface runoff leading to flooding in case drainage system is unable to take the

**Former SDG, CPWD & **Former ADG, CPWD*

discharge. Such situation may also arise due to high rain intensity, particularly due to low permeability of the soil, silting or blockage of drainage system, soil erosion blocking the drainage, excessive paving of areas, reduction of storage sources like lakes, tanks, reservoirs, rain water harvesting tanks, ground recharging system, rivers and streams, change of characteristics of catchment area due to deforestation, special conditions like melting of snow, cloud burst, landslides, sudden release of water through dams, high tide water, mixing of sewerage into drainage, mixing of sub soil water, and combination of above reasons.

In the recent past, floods have been witnessed in different parts of the country, showing concern of inadequate design and planning by the authorities involved in it. Drainage of the buildings, roads, flyovers and open areas has shown complete failure in some cases. There may be back flow as well, due to the rise in river, sea or lake water levels where the drainages are connected. In Mumbai, when the drain water level is less than water level of sea, flooding occurs.

Municipal drains are designed according to the expected development/master plans. When, FAR/FSI is enhanced or land use changed or unauthorized construction comes up, there is stress on the drainage system and it fails. Increase of FAR/FSI leads to more paved area in building and services like roads/footpath. Additional infrastructure like schools, hospitals, offices, parks, commercial centres etc are then planned in those places. Though development is claimed to be sustainable, it becomes highly unsustainable due to poor drainage system during heavy rains as the most of the city comes to complete halt. Surprisingly, flooding has become common phenomenon during rainy season in many cities including Delhi, Kolkata, Patna, Surat, Mumbai, Kochi and Chennai.

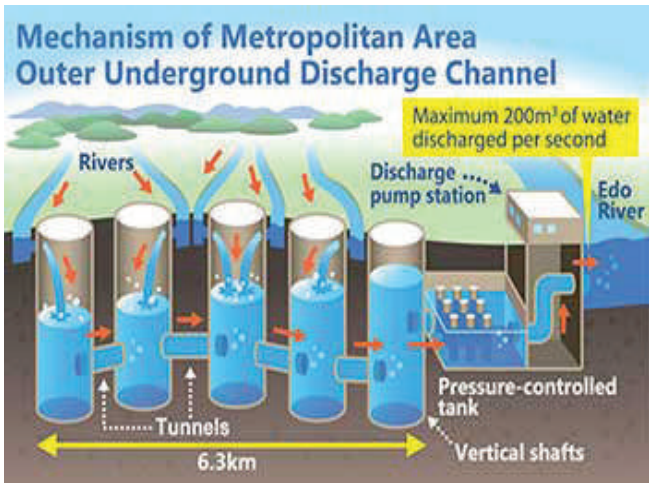
DRAINAGE IN NETHERLANDS

About 60 % of the Netherlands is located behind dykes below sea level and they do not have a natural drainage. Excess water is pumped into a higher elevated network of larger primary canals. The elevation of the primary canals is higher than the surrounding land surface, but still below mean sea level. This means that water is pumped at all times and is released through gravity during low tide only. During times of heavy rainfall where time windows are often not long enough, pumping stations are

installed to provide additional discharge capacity. Therefore, flooding is not observed in Netherlands like Indian cities.

FLOOD PROTECTION MEASURES IN TOKYO, JAPAN

The floodwater cathedral of Tokyo is hidden 22 meters underground and 6.3 km long system of tunnels towering cylindrical chambers that protect North Tokyo from flooding. In the past several decades, Tokyo has perfected the art of coping with typhonic rains and moody rivers, and its intricate flood defense system is a global wonder. The channel sucks in water from small- and mid-size rivers in Northern Tokyo and moves it to the bigger Edo River, which can handle the volume with more ease. When one of these rivers overflows, the water falls to one of five 70-meter tall cylindrical tanks spread across the Channel's length, each of them big enough to accommodate such quantity and interconnected through a 6.3km long network of underground tunnels. As the water approaches the Edo River, the 'floodwater cathedral' Tortajada reduces its flow, so the pumps can push it to the river. Some of the projects are now built to withstand between 65 and 75mm of rain per hour.



FLOOD SCENARIO IN SOME INDIAN CITIES

Floods have become a common phenomenon in cities like Mumbai, Patna, Bengaluru, Chennai, and Kochi. Delhi also witnesses water logging almost for few days due to inadequacy of drainage system every year. In most of the existing cities, adequate drainage system is lacking converting even sustainable infrastructure development into unsustainable. Considering the multiple reasons of failure of the drainage system, flood control measures may require integrated planning including construction of flood control facilities, water detention measures, water retardation, engineering community planning, discharge facilities etc. Cases of some of the cities are discussed in the following.

Mumbai

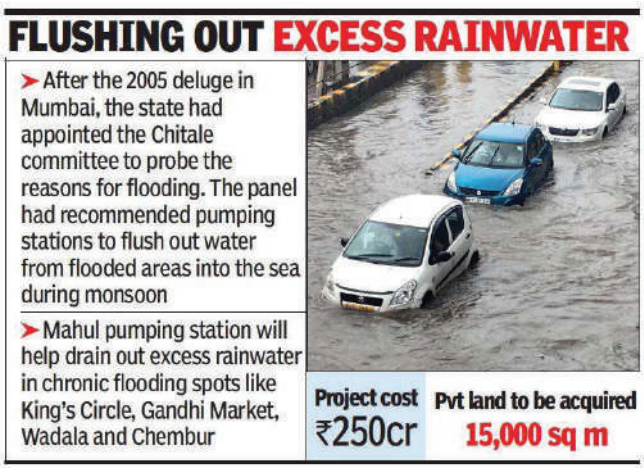


Fig. 1: Flooding situation of Mumbai elevation map

Mumbai has an elevation between 3m to 33m, large area falling between 9m to 33m. During high tides, height of tide may go up by about 5 - 6m. In such situations, it is difficult for the water to drain out through gravity, particularly from the low lying areas of the elevations up to 6m and the option is pumping out the water. Government authorities carry out pumping which is time consuming and expensive. Also, in a gravity system, the gates are

to be closed as a preventive measure (in reverse sea water enter the drains).

This occurs when all the drainage system is through a single system and at a lower level. Let us consider separate drainage systems for different elevation areas. Consider elevation of 9m or more where high tide has little effect. In such areas even during high tides, water can be drained through gravity. Though practically in a dense habitat area, it is not easy however the authorities should examine the possibility of crating multiple drainage systems including adopted by Netherlands and Japan. Drainage system at higher elevation can be planned over the existing drains to avoid acquiring additional land. Also, considerable discharge is carried out by the rivers but Mumbai rivers like Mithi, Dahisar, Poisar and Oshiwara, Malbhat are to be rejuvenated with full width/section after removal of encroachment on the same. As the rivers have silted and encroached, they are unable to take flood water. In low lying coastal areas, dykes may be required to be constructed or raising height of existing dykes may be required.

Chennai

Chennai city has elevation of around 6.7 meters whereas its highest point is 60 m. The soil of Chennai is clay, sedimentary rocks and sandstone. River banks and coasts have sandy soil hence rainwater percolates quickly. Clay is found in most of the city areas and as such clay holds water and prevents percolation. If lakes or reservoirs are constructed in these areas, water can be stored. Where land availability is an issue, reservoirs maybe planned in the gardens and parks over which greenery can be developed as a policy matter.

Most of the city has an elevation of 7m or more. Few areas have elevation of 2-7m though these areas are surrounded by areas of higher elevation. These areas are away from the sea and are prone to flooding during heavy rains. What is required in these areas are both rain water storage and well constructed drainage systems. In some areas, bunds/dykes may also be required.

Chennai had a series of lakes which worked for water retention as well as for water supply system but many of these have either been encroached or filled up. Authorities may examine whether series of lakes can be constructed in large parks and gardens as a policy measure, simultaneously rejuvenating old lakes on large scale.

Delhi

Delhi does not have coastal area but has low level areas near river Yamuna as may be seen from the map. The main problem of water stagnation in Delhi is because of poor drainage. Delhi has silt, sand and rock hence ground water recharging measures are feasible in most of the areas except in areas near Yamuna during rains where ground water table is at shallow depth.

Delhi should have integrated system of flood water management system. Water has to be retained at large parks and gardens as a policy measure so that water travel is reduced. Apart from this, complete overhauling of the drainage and sewage system is required so that storm water drainage is managed separately for its use and does not get mixed with sewage. A series of lakes and baolies existed traditionally in Delhi as per the topography of the area but these are either filled up or extinct due to mismanagement. Such a system needs to be rejuvenated or reconstructed.

Kolkata

Kolkata has many low lying areas though they are at an elevation of about 6m thereby drainage for low lying areas is required. Kolkata will be facing floods in case of poor drainage, but may not be problematic like Mumbai.

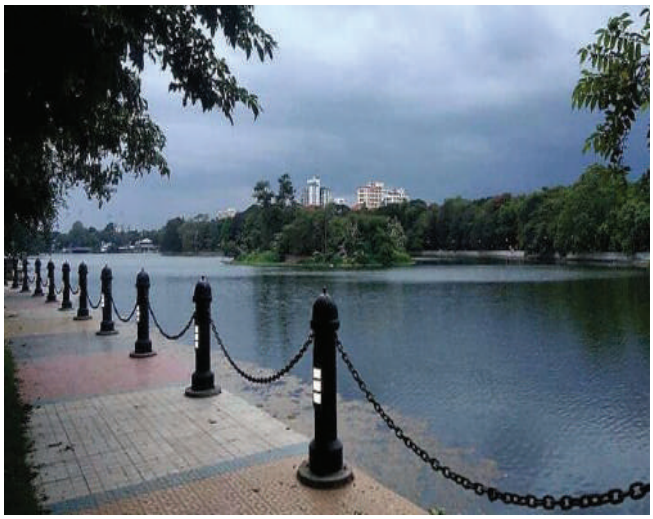


Fig. 2: Flooding situation in Kolkata

Kolkata has no coast line hence sources of natural drainage will be either Hooghly river or the lakes. Pumping arrangements will be required in low lying areas. Traditionally, there were many lakes in Kolkata which worked as rain water reservoirs and need to be protected.

URBAN DRAINAGE SYSTEM

Flooding during rains indicates that the design of the drainage system is not being done, inadequately done or neglected, particularly after original design implemented. Such practice may be followed due to the following reasons;

i. Mismanagement of the approval system

ii. Designing of individual campuses and connecting to existing system without assessing capacity.

iii. Increase of impervious surfaces

iv. Unauthorized construction, encroachment and enhanced FAR/FSI without augmentation of drainage system

v. Misconcept of low cost infrastructure without drainage

vi. Inadequate funds

vii. Difficulties in carrying out augmentation of drainage infrastructure

Sometimes, even properly designed city roads do not have adequate drainage and once water gets stagnated on roads, potholes are formed. Water infiltration weakens the sub-base and potholes reappear in the same place even after the repair. Therefore, it is important that efficacy of drainage system is checked and implemented during construction and repair.

Drainage on bridges and flyovers is also over looked. The water is allowed to flow either through the surface longitudinally or through inadequate drainage system, allowed to fall on the road like a fall damaging the roads.

Many Indian cities lack the capacity to take additional load of the drainage. But the building footprint area increases without much checks. Every municipal corporation should ensure that the existing drainage system is capable of taking additional load for sustainable development. Further, governments tend to increase FAR/FSI from time to time in urban areas even though it may not be feasible to augment drainage system as per requirement. Increase of impervious area with increase in FAR/FSI leads to inadequacy of the drainage system. In some cases, drainage is not included in overall project of the infrastructure cost. The drainage systems in these cases are planned at a later stage resulting into poor conditions of the road.

RECOMMENDATORY REMARKS

The following recommendations are presented:

i. No infrastructure project should be sanctioned without having effective and integrated drainage system.

ii. Without augmentation of drainage system, change in the conditions of infrastructure planning should not be allowed in Master plan.

iii. Concept of drainage infrastructure followed in cities like streams, rivers, lake and baolies should be rejuvenated and reconstructed being time tested.

iv. Planning policy should include minimum impervious surfaces.

v. All rivers and lakes should be desilted and made fully functional.

vi. New lakes, and ponds should be created in open areas, parks and gardens.

vii. Urban drainage infrastructure should be taken up on mission mode among all infrastructure development by Government of India with the participation of state governments through Special Purpose Vehicles.

viii. A separate specialized programme should be developed for flood protection and drainage system and all engineers involved in the work should be trained in the same.

CONCLUSION

Drainage system consists of infrastructure projects, individual and public drains, storage system, soil infiltration, natural water sources and their catchment areas. A well integrated and a high capacity drainage system should be a key element for every infrastructure without which durability of the structure gets affected causing loss to public exchequer.

A policy intervention to ensure construction of adequate drainage should be the part of the infrastructure development and any additional FSI/FRI/change of pervious surfaces should depend on the feasibility of proper and adequate drainage system.

Drainage infrastructure development should be taken up on mission mode by both Central government and State governments and develop as a specialized field. The state governments are already making efforts to rejuvenate extinct lakes and streams though large efforts are still required.

Construction of dykes in low lying areas of the coastal cities should be taken up to avoid their submergence due to high tides and rise of sea water level. Further, feasibility of floating houses should be found out in coastal metropolitan cities to cater for additional housing requirements.

REFERENCES

1. https://en.wikipedia.org/wiki/Sea_level_rise
2. https://en.wikipedia.org/wiki/Geography_of_Chennai
3. https://www.madras.com/v/geography/
4. Soni, K M (2019). Drainage System Most Critical in Urban Areas. Construction Times, December issue, 74-78
5. Soni, K M & Soni, Piyush (2013). Floating and Moving Houses: A Need of Tomorrow. MGS – Modern Green Structure & Architecture, September issue, 51-57.
6. https://www.bbc.com/future/article/20181129-the-underground-cathedral-protecting-tokyo-from-floods
7. https://web-japan.org/trends/11_tech-life/tec130312.html
8. https://www.wearewater.org/en/mithi-river-the-pollution-of-poverty_340931
9. https://www.hindustantimes.com/mumbai/dirty-river-poisar-100-times-more-polluted-than-safe-limit
10. https://www.deccanchronicle.com/gallery/nation/210619/drying-up-before-and-after-satellite-photos-of-chennais-lakes.html
11. https://timesofindia.indiatimes.com/city/mumbai/mumbai-bmc-zeroes-in-on-pvt-land-for-mahul-pumping-station
12. https://timesofindia.indiatimes.com/city/delhi/will-delhi-soon-become-a-city-of-lakes
13. http://www.floodmap.net/Elevation/ElevationMap/?gi=1275339
14. http://www.floodmap.net/Elevation/ElevationMap/?gi=1264527
15. http://www.floodmap.net/Elevation/ElevationMap/?gi=1273294
16. http://www.floodmap.net/Elevation/ElevationMap/?gi=1275004

ANALYZING CRITICAL FACTORS FOR IMPLEMENTATION OF INTEGRATED PROJECT DELIVERY: AN INTERPRETIVE STRUCTURAL MODELING (ISM) APPROACH FOR SUSTAINABLE BUILT ENVIRONMENT FOR FUTURE

Abhishek Shrivas*, Amit Shriwas And Dr. Indrasen Singh*****

Abstract

Globally Architecture, Engineering and Construction (AEC) industry relies on the use of a project delivery method (PDM) for successful execution of a project. The construction industry institute states that there are three basic concepts of project delivery method, which are design-bid build (DBB), Design-build (DB) and construction management at risk (CMR). Besides these approaches, integrated project delivery (IPD) method is one of the latest techniques for project delivery but it is yet to become popular amongst the various stakeholders of AEC industry. The main aim of IPD is to improve project performance in terms of time and cost, proper risk and reward structure, efficient multiparty agreements, increase project value for the owner and reduce fragmentation and frictions amongst stakeholders. Realizing the benefits of IPD, several studies have undertaken research relating to identification of critical factors affecting IPD implementation. However, due to the limited use or implementation of IPD, studies focussing on exploring the interrelationship amongst the identified critical factors are in nascent stage. This research, therefore, aims to identify the critical factors affecting IPD adoption in the AEC industry and establishes the relationships among them. Interpretive structural modelling (ISM) method was used to develop the graphical model of the factors involved and factors were clustered to find their dependence and driving power using Cross-Impact Matrix Multiplication i.e. MICMAC analysis.

INTRODUCTION

Globally for the execution of building projects a number of project delivery systems are being used by Architectural, Engineering and Construction (AEC) industry worldwide such as 1) Design build 2) Design build operate 3) Design bid build 4) Construction management at risk 5) Turnkey project delivery.

Typically, a PDM points out the relationship dynamics of different parties involved in a project (Kensek, 2014). Studies by different researchers show that the availability of all these delivery types does not prevent time and cost overrun in construction industry (Ghassemiet al., 2011). Moreover, the construction projects are becoming more complex due to increased project scale, involvement of building services, tight construction schedule, various number of stakeholders involved at different stages etc. The available delivery contracts at present do not solve the intrinsic problem of the projects like (1) Fragmentation (2) Lack of information and management (3) Lack of project coordination (4) Risk of design error borne by client (5) Conflicts between project stakeholders (6) Multiple culture within AEC industry. In this context a solution needs to be envisaged for finding ways to improve project delivery implementation.

The solution to this problem lies with successful implementation of IPD and it is provided by researcher in this paper. A project manager is when aware about the critical factors for implementation of IPD along with their driving and dependence on each other, he may make a wiser and prompt decisions for success of the project. A model may help him to be clear about the conditions in hand and presentation of implementation barrier in the form of an ISM-based model and the classification into

*Assistant Professor, NICMAR Pune,
**Assistant Professor, NICMAR Goa
***Senior Professor and Dean, (NICMAR) Goa

driver and dependent groups is a new effort in the area of IPD.

LITERATURE REVIEW

Integrated Project Delivery Model

IPD pursues to improve project results through a cooperative method of lining up the incentives and goals of the team (Ghassemi*et al.*, 2011; Kent, 2010). The AIA describes IPD as "A project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harness the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste,and maximize efficiency through all phases of design, fabrication and construction" (AIA CACouncil, 2007). American Institute of Architects and the Associated General Contractors of America (AGC) are evangelist of IPD awareness in terms of forming standards, publishing IPD principles and techniques, facilitating discussions among their members on topics such as successful projects delivered through IPD, barriers to IPD etc.

Industry does not accept a standard definition of IPD and have many different interpretation of the concept derived from various sources and authors. However, the three main common principles tagged with IPD are 1) multi-party agreement 2) early involvement of all parties, and 3) shared risk and reward (Kent 2010). To Implement IPD all the above principles must be incorporated into a project (Sive, 2009).

IPD implementation related numerous challenges/ factors have been recorded by different researchers. These challenges/factors vary in their nature and hence are classified into broad categories such as 1) Technology challenges 2) Legal challenges 3) Financial challenges 4) Cultural challenges (Kent, 2010; Cohen, 2010; Ghassemi, 2011). Another category named "Other" has been introduced by (Malsan*eet al.* 2017) which has factors different than the above mentioned categories.

Categorized into these heads there are various factors affecting implementation of IPD, the researcher in this paper identified the factors and presented the literature review in tabular format shown below in Table 1.

The factors mentioned in the table were chosen broadly from the list of 49 critical factors by the experts who according to them are most important in successful implementation of the IPD. Some of the noteworthy factors were, shorter projects cannot spend time on organizational effort of IPD (Howard, 2010; Cohen, 2010). Setting procedure for problem solving and resolution was also identified as a major factor (Ghassami*et al*, 2011; Lichtig 2006). AIA council pointed out that mutual respect and trust also contributes in proper implementation of IPD (AIA CA Council, 2007; Lichting, 2006).

Table 1: Critical factors in implementation of IPD

S.No.	Critical factors	Authors
1	Poor multiparty agreement	Ghassamiet.al. (2011), Lichtig (2006)
2	No early involvement of parties	Cohen (2010), Ghassamiet.al. (2011), Owen et al.(2010), Hellmundet al. (2008), Howard (2012)
3	Concern regarding shared risk and rewards	Becerik-Gerber et al.(2010), Aki (2011)
4	Differing values and objectives between parties	Becerik-Gerber et al.(2010), Howard (2012),Sieve (2010)
5	Lack of awareness and willingness for IPD	Kent (2010), Sieve (2010), Aki (2011)
6	Inexperience with BIM technology	Owen et al (2010), Hellmundet al.(2008), Kent (2010)
7	Lack of new legal framework for IPD	Becerik-Gerber et al. (2010), Kent (2010), Sieve (2010)
8	Lack of communication between and within group	Aki (2011)
9	Risk appetites of parties involved	Kent (2010), Sieve (2010), Howard (2012), Owen et al (2010)

METHODOLOGY

The methodology in this study adopts ISM suggested by J.Warfield in 1973 (Iyer and Sagheer, 2010). This method is appropriate in an area

when the type of problem is complex and mixed in nature (Jackson 2002,2003). Implementation of IPD also involves similar problem context like difference of opinion amongst key stakeholders and subjective perspectives. Due to its usefulness, ISM has been used in investigation in various fields like: vendor selection (Mandal and Deshmukh, 1994); analyzing risks in projects (Iyer and Sagheer, 2010); understanding barriers of reverse logistics (Ravi and Shankar, 2005); and analysing supply chain risks (Pfohl*et al*., 2011) etc.

ISM facilitates in improving hierarchy and trend of the multifaceted relationships amongst the critical factors of a system (Sage, 1977). In this, a systematic model is developed by taking into consideration a set of variable affecting a particular system. The model derived by using ISM shows the structure of a complex problem, explained both with words as well as graphics (Singh *et al*., 2003; Ravi and Shankar, 2005; Faisal *et al*., 2006). ISM uses opinion of a focus group to find and describe the association among the factors and based on these relationships it creates a structure of element in the form of diagraph (Agarwal *et al*.,2007; Pfohl*et al.,*2011).

Authors identified 16 critical factors based on the literature review and then a panel of experts critically examined each of these (16) critical factors for implementation for IPD. They reduced these 16 factors to 9, identified as the most critical factors. The methodology followed is similar to the one followed by El-Razek et al. (2008). The panel of experts which facilitated the process included two experts from academia having a teaching and research experience of more than 10 years in the field of construction management. Three experts were from construction industry working with construction companies and handling complex projects and had a work experience of more than 15 years in India and abroad.

The ISM technique follows a systematic methodology. In an investigation, with the help of SSIM, reachability and MICMAC analysis, various conclusions were drawn for the critical factors of implementation of total quality management (Talib*et al*., 2011). The different steps in ISM method when implemented to the 9 identified critical factors are as follows:

1. The 9 critical factors are itemized and numbered as 1-9 (Table 1). These factors were selected through extensive literature review and discussion with the subject experts.
2. The Identified factors in the step one are arranged in column and rows; a matrix is than formed for the critical factors by relating each factor with the other one-by-one. An appropriate relationship is thus established among factors with the help of alphabets as explained in next section.
3. The pair-wise relationship between the critical factors of the system derived from step-2 gives rise to structural self-interaction matrix (SSIM) for the given factors (Table 2).
4. We than pick up the cells from SSIM (obtained from step 3) and one by one convert the information into binary numbers i.e. "1" and "0" to get a reachability matrix (Table 3).
5. Based on reach ability and antecedent sets, researchers do a partition of various levels. A series of iterations is required and critical factors of the system falls into different level in each iteration, in present paper 7 iterations were required (Tables 4 & 5).
6. A lower triangular matrix or conical matrix (Table 6) is constructed on basis of level partitions and reachability matrix obtained from step 5 and step 4 simultaneously. A digraph is than drawn based on conical matrix (Fig.1).

RESULTS

The subsequent four alphabets have been used to the connection amongst the factors (i and j):

(1) If factor i "leads to or help achieving" factor j, V is used for the relation from factor i to factor j.

(2) If factor j "leads to or help achieving" factor i, A is used for the relation from factor j to factor i.

(3) If factor i and j "leads to each other or help achieve each other, X is used between I and j.

(4) If factor i and j are not related, O is used for no relation between two factors.

Table 2: SSIM Matrix

Factor Number	9	8	7	6	5	4	3	2	1
1	A	V	A	O	X	A	V	A	V
2	X	V	O	O	A	V	V	V	
3	X	A	A	O	A	X	V		
4	V	V	O	A	A	V			
5	V	X	O	X	V				
6	V	O	O	V					
7	V	O	V						
8	O	V							
9	V								

The reachability matrix below is developed from the SSIM as explained in step 4 of previous section

Table 3: Reachability Matrix

Factor Number	1	2	3	4	5	6	7	8	9
1	1	0	1	0	1	0	0	1	0
2	1	1	1	1	0	0	0	1	1
3	0	0	1	1	0	0	0	0	1
4	1	0	1	1	0	0	0	1	1
5	1	1	1	1	1	1	0	1	1
6	0	0	0	1	1	1	0	0	1
7	1	0	1	0	0	0	1	0	1
8	0	0	1	0	1	0	0	1	0
9	1	1	1	0	0	0	0	0	1

Table 4: Factor Level Iteration I

Factors	Reach ability set R (Bi)	Antecedent set A(Bi)	Intersection set R(Bi) Ω A(Bi)	Level
1	1,3,5,8	1,2,4,5,7,9	1,5	
2	1,2,3,4.8,9	2,5,9	2,9	
3	3,4,9	1,2,3,4,5,7,8,9	3,4,9	I
4	1,3,4,8,9	2,3,4,5,6	3,4	
5	1,2,3,4,5,6,8,9	1,5,6,8	1,5,6,8	
6	4,5,6,9	5,6	5,6	
7	1,3,7,9	7	7	
8	3,5,8	1,2,4,5,8	5,8	
9	1,2,3,9	2,3,4,5,6,7,9	2,3,9	

Table 5 Factor Level Iteration VII

Factors	Reach ability set R (Bi)	Antecedent set A (Bi)	Intersection set R(Bi) Ω A(Bi)	Level
1	1,3,5,8	1,2,4,5,7,9	1,5	III
2	1,2,3,4.8,9	2,5,9	2,9	VI
3	3,4,9	1,2,3,4,5,7,8,9	3,4,9	I
4	1,3,4,8,9	2,3,4,5,6	3,4	V
5	1,2,3,4,5,6,8,9	1,5,6,8	1,5,6,8	VII
6	4,5,6,9	5,6	5,6	VI
7	1,3,7,9	7	7	V
8	3,5,8	1,2,4,5,8	5,8	II
9	1,2,3,9	2,3,4,5,6,7,9	2,3,9	IV

Table 6: Conical Matrix

Ranked Factors	3	8	1	9	4	7	2	6	5
3	1	0	0	1	1	0	0	0	0
8	1	1	0	0	0	0	0	0	1
1	1	1	1	0	0	0	0	0	1
9	1	0	1	1	0	0	1	0	0
4	1	1	1	1	1	0	0	0	0
7	1	0	1	1	0	1	0	0	0
2	1	1	1	1	1	0	1	0	0
6	0	0	0	1	1	0	0	1	1
5	1	1	1	1	1	0	1	1	1

CONCLUSION

The main objective of this research is to study the interaction between the several critical factors of IPD which impedes in the successful implementation of IPD and to develop a hierarchy of those critical factors. Therefore, an ISM model on IPD factors (figure 1) have been developed which depicts that "Lack of awareness and willingness for IPD" (factor 5) is a very significant factor to IPD implementation especially in construction organization as it comes at the base of ISM hierarchy. "Concern regarding shared risk and rewards" (factor 3) and "Lack of communication between and within group" (factor 8) holds the top positions and indicates that they are the IPD factors on which the effectiveness of IPD program overall depend. It is evident from the model that "lack of awareness and willingness for IPD" leads to factor 2 i.e. no early involvement of parties and "Inexperience with BIM technology" (factor 6) which both in turn results in "Differing values and objectives between parties" (factor 4) it shows that an experience in new technology and early involvement of party in the process may leads to common values and objectives amongst the parties for a particular project. While "Lack of new legal framework of IPD" is not influenced by any other factor but affects "risk appetites of parties involved" (factor 9) together with factor 4. "Poor multiparty agreement" is influenced by factor 9 but leads to "Lack of communication between and within group" (factor 8). The problem of poor multiparty agreement is faced by a well-known client in Kutch region during construction of a container terminal in their port based SEZ which resulted in poor communication between and within parties involved which finally resulted in project delay.

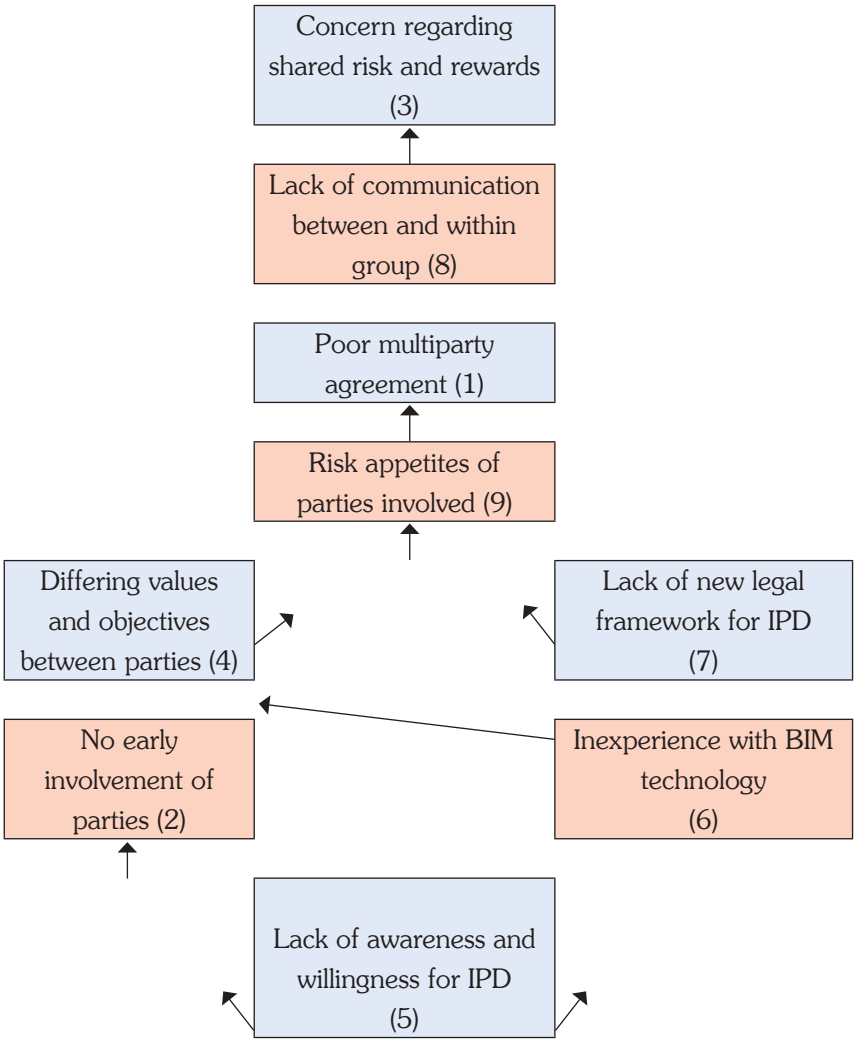


Fig. 1: ISM-based model of critical factors in implementation of IPD for Indian Construction Industry

From the MICMAC analysis in figure 2, it is evident that the factor 6 and 7 are autonomous in nature these factors are relatively disconnected from the system with few strong links. Factor 4 (Differing values and objectives between parties) is in linkage quadrant showing strong driving and dependence power making it unstable in the fact that any disturbance on this factor will affect others. Factors 3, 8, 1 and 9 are falling in dependent quadrant that shows they have weak driving but a very strong dependence which is clear from our ISM model. Factor 5 and 2 finally rests in IV quadrant which shows there strong driving but weak dependent power hence managers should take special care to handle these factors as they have capabilities to influence other factors. They may be treated as "most critical" to IPD implementation.

This paper can provide realistic representation of the problem in the course of implementation of IPD in any organization in India. A prominent contribution of this research paper is in the development of contextual relationship among various identified factors impeding IPD implementation, through an orderly framework. This knowledge will help the practitioners to better utilize their available resources for minimizing the barriers in implementation of IPD in construction organization.

Finally, for future work this model can be validated and tested by statistical methods, one of them being "Structural equation modelling" SEM. Statistical software like SPSS AMOS 25.0 or STATA 15.0 can be used to do confirmatory factor analysis and correlation matrix to validate the results.

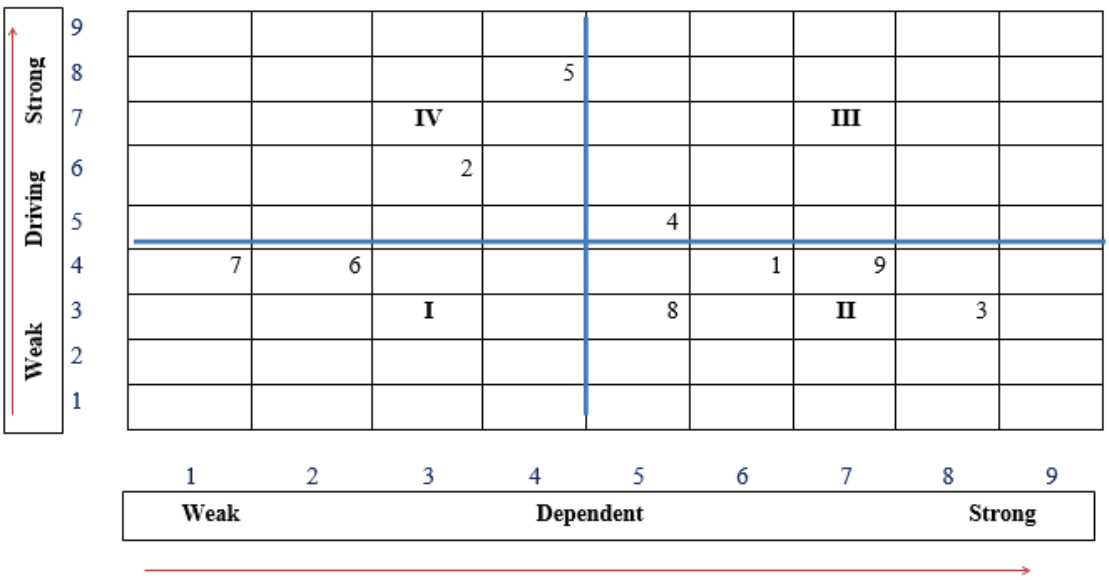


Fig. 2: I autonomous factors; II dependent factors; III linkage factors; IV independent (driver) factors

REFERENCES

1. Agarwal, A., Shankar, R. and Tiwari, M.K. (2007) 'Modeling agility of supply chain', Industrial Marketing Management, Vol. 36, No. 4, pp.443–457.
2. Aki, A. M. H. and Aki, P. H. H., "The Characteristics of and Cornerstones for Creating Integrated Teams." International Journal of Managing Projects in Business, 6 (4), (2013). pp. 695 – 713.
3. Becerik-Gerber, Burcin& David C. Kent (2010) Implementation of Integrated Project Delivery and Building Information Modeling on a Small Commercial Project. Associated Schools of Construction Annual International, and CIB Workgroup 89, at the Wentworth institute of Technology Boston, Massachusetts.
4. AIA California Council. (2007). "Integrated Project Delivery: A Working Definition"<http://aiacc.org/wp-content/uploads/2010/07/A-Working-Definition-V2-final.pdf>.
5. Faisal, M.N., Banwet, D.K. and Shankar, R., "Supply chain risk mitigation: modeling the enablers", Business Process Management Journal, Vol. 12 No. 4, (2006), pp. 535-52.
6. Ghassemi, R., Becerik-Gerber B.,Transitioning to Integrated Project Delivery: Potential Barriers and Lessons Learned. Lean Construction Journal,(2011), pp 32-52
7. Hellmund, A. J., Kevin, G. Van Den W. & Kenneth Baker, "Facing the Challenges ofIntegrated Design and Project Delivery." Strategic Planning for Energy and the Environment, 28:1, (2008), 69-80.
8. Howard W. Ashcraft. (2010) "Negotiating an Integrated Project Delivery Agreement." Hanson Bridgett LLP.
9. Iyer, K.C. and Sagheer, M. (2010) 'Hierarchical structuring of PPP risks using interpretative structural modeling', Journal of Construction Engineering and Management, Vol. 136, No. 2, pp.151–159.
10. Jackson, M. (2002) Systems approaches to Management, Kluwer Academic Publishers, New York.
11. Jackson, M. (2003) Systems thinking: Creative Holism for Managers, Wiley, Chichester.
12. Kensek, K. (2014) "Building Information Modelling." Pocket Architecture Technical DesignSeries, Routledge, New York 10017.

13. Kent, D. and Becerik-Gerber, B., "Understanding Construction Industry Experienceand Attitudes toward Integrated Project Delivery" Journal of Construction Engineering and Management, (2010), pp. 815-825.

14. Lichtig, W., "The Integrated Agreement for Lean Project Delivery". The ConstructionLawyer, HEINONLINE, (2006).

15. Mandal, A. and Deshmukh, S.G. (1994) 'Vendor selection using interpretive structural modeling (ISM)', International Journal of Operations and Production Management, Vol. 14, No. 6, pp.52–59.

16. Pfohl, H.C., Gallus, P. and Thomas, D. (2011) 'Interpretive structural modeling of supply chain risks', International Journal of Physical Distribution and Logistics Management, Vol. 41, No. 9, pp.839–859.

17. Ravi, V. and Shankar, R. (2005) 'Analysis of interactions among the barriers of reverse logistics', Technological Forecasting and Social Change, Vol. 72, No. 8, pp.1011–1029.

18. Roy, D, Malsane, S. and Samanta P.K. (2018) Identification of Critical Challenges for Adoption of IPD, Lean Construction Journal 2018 pp. 01-15

19. Owen, R., Amor, R. et al. (2010) "Challenges for Integrated Design and Delivery Solutions."Architectural Engineering and Design Management, Vol.6.

20. Ravi, V. and Shankar, R., "Analysis of interactions among the barriers of reverse logistics", Technological Forecasting and Social Change, Vol. 72 No. 8, (2005), pp. 1011-29.

21. Sage, A.P., Interpretive Structural Modeling: Methodology for Large-scale Systems, McGraw-Hill, New York, NY, (1977) pp. 91-164.

22. Singh, M.D., Shankar, R., Narain, R. and Agarwal, A., "An interpretive structural modeling of knowledge management in engineering industries", Journal of Advances in Management Research, Vol. 1 No. 1, (2003), pp. 28-40.

23. Talib, F., Rahman Z. and Qureshi, M.N., "Analysis of interaction among the barriers to total quality management implementation using interpretive structural modelling approach", Benchmarking: An International Journal, Vol. 18 No. 4,(2011) pp,563-587

7Cs OF SUSTAINABLE BUILT ENVIRONMENT

A.K. JAIN*

Abstract

Sustainable built environment comprises places and buildings for of living, work and recreation, connected and served by urban transport, facilities and services viz. energy, water, sanitation, drainage, greenery and open spaces. All these should be sustainable, renewable,low carbon and healthy. The paper dwells upon a new paradigm of planning and design of built environment comprising 7 Cs- circular metabolism, climate and disaster resilience, clean air, clean water, clean transport, clean energy and cultural heritage.

INTRODUCTION

According to the Intergovernmental Panel on Climate Change (2014 WG III), urban areas account for 67 to 76% of global energy use and 71 to 76% CO_2 emissions. With the emerging issues of sustainability, climate change, air and water pollution, disasters and pandemics, it is necessary to rethink the approaches of planning and urban development.

The Sustainable Development Goals (2030 Agenda) cover 17 goals and 169 targets. Goal 11 of the SDGs focuses on making cities and communities inclusive, safe, resilient and sustainable. Goal number 13 of SDGs calls for combating climate change and its impacts. The paradigm of development has not to be just economic but align with humane, environmental, cultural and socio-economic inclusion. This implies that the city provides housing, water, sanitation, electricity and jobs to all in a sustainable environment that resonates with the local culture, climate and ecology. These challenges need a new framework and process of planning, design and development of the built environment, which is low carbon and climate resilient. It can be conceptualised in terms of the following 7Cs:

1. Circular Metabolism
2. Climate and Disaster Resilience
3. Clean Air
4. Clean Water
5. Clean Transport and Connectivity
6. Clean Energy
7. Cultural and Natural Heritage Conservation

*Former Commissioner (Planning), DDA

CIRCULAR METABOLISM

Urban India comprising 7933 towns/cities having a population of about 400 million, is passing through rapid economic and social transformation, massive construction of mega projects, leading to increasing carbon footprints, climate change and disasters. It is urgent to relook the repertoire and processes of urban planning and development which should shift to circular systems and recycling so as to conserve the natural resources.

According to the Indian Network for Climate Change Assessment, 58 per cent of the total emissions are caused by the energy sector, followed by the industrial sector at 22 per cent, and remaining 20 per cent by solid and liquid wastes, agriculture and forestry. Linked with it is the phenomenon of climate change and disasters, which impact infrastructure services, housing and livelihoods.

Urbanism with circular metabolism can give as much to the environment as it takes out, thus reducing the ecological impact. An ecological city and buildings are planned as a circular system so as to minimize the use of land, energy, water and carbon emissions (Fig.1).

It protects the natural environment using the minimum of mechanical systems and by passive design with the sun, wind, water, earth and space. Carbon neutral services and passive buildings can make the city energy efficient, smart and reduce

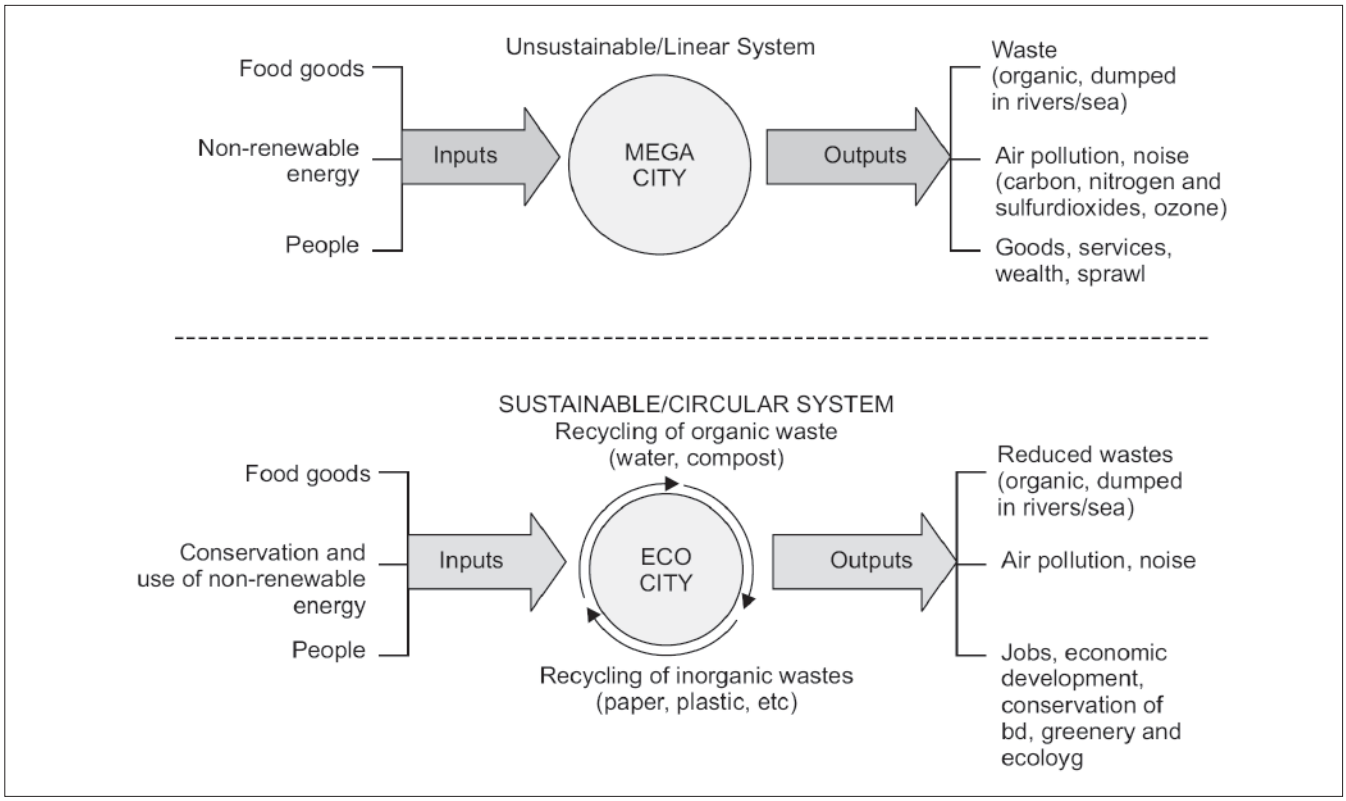


Fig. 1: City as a System

Source: Rogers, Cities for a Small Planet (1997) in UNESCO & MGIEP (2017) Textbook for Sustainable Development, A Guide to Embedding, UNESCO and Mahatma Gandhi Institute of Education, Peace and Sustainability, New Delhi

greenhouse gas (GHG) emissions. Rooftop solar panels generate electricity and reduce city's heat build-up. Rooftop vegetation, insulation and super-insulated glazing quadruple the building's thermal performance. Smart glass technology and cool air draughts in clay pipes, 4 meters below ground save on air-conditioning and high energy costs. These help in obviating the ecological footprints, formation of heat islands and outdoor and indoor pollution, while addressing to a wide range of sustainability issues.

Common Utility Ducts carrying electricity, water, cable television and broadband internet minimize damage from traffic, road repairs, rains, etc. Trigeneration energy systems combining power, cooling and heating, dual piping for recycled water and automated waste collection/utilization and bundle "green infrastructure" together. Water saving toilets with recycled wastewater cisterns and taps will save water. Satellite controlled just-in-time micro-irrigation cuts water and power consumption. Solid waste extracted from sewage can produce electricity. Three bin recycling with separate bins for trash, recyclable and compost can be transported and processed by an underground pneumatic system. Bio-technology, enzyme based STP, bio-remedial treatment, sludge gas/energy recovery, vermi-culture, fossilization and composting options can be explored for waste treatment. Swales, porous paving, bio-drainage and storm surge gates in river, drains and canals and zero run off and sustainable drainage, conserve water and save human settlements from floods.

With the Covid 19 pandemic, the dimension of public health has assumed an important role in built environment. The health of a city depends upon integrity of land uses and safeguarding adequate open spaces and protect living and working areas from hazardous and polluting activities, such as, industry, heavy traffic, wholesale trade, etc. The land use plan and density pattern should strike a balance between the aspects of crowding, health and traffic generation, besides conserving the greenery and urban ecology. According to the recommendations of the World Health Organization (WHO), 5 hospital beds are required per thousand population, whereas

in 2011 the bed- persons ratio in Delhi was 2.55, which is required to be doubled. According to UN Habitat and World Health Organization for healthy and inclusive housing, the following seven criteria must be met: security of tenure, availability of services, materials, facilities and infrastructure, affordability, habitability, accessibility, location and cultural adequacy. The studies show that the blood pressure, obesity, gastrointestinal and cardiovascular diseases are reduced by half in the areas with parks and pavements, where people walk more, exercise and do regular physical activity outdoor. In terms of urban design, it is necessary to achieve harmonious balance between built and natural environment.

It should also cater specially to women, children and the aged. New forms of work-live integration, mixed land use, 15 minutes as a minimum distance among residence, work, and accessible network of parks/ greens are necessary for a healthy built environment.

The built environment cannot be sustainable without the women, who comprise nearly half of the population. They often face the 'gender service gap' in terms of security and access to energy, water and toilets. A sustainable city has to be gender sensitive with adequate, safe and affordable spaces for living and working. This implies gender equity in the built environment, based on the principles of organicity, non-accumulation and minimalism.

CLIMATE AND DISASTER RESILIENCE

Resilience is defined as "the ability of a city as a socio-ecological infrastructural system and its components to absorb and recover from shocks whilst retaining the essential functions and adjust to stresses to reorganise, develop, and transform in order to adapt to socio-economic and environmental changes, over temporal and spatial scales". According to the United Nations Framework on the Convention on Climate Change (2010), the predicted impacts of climate change in India include a surface air temperature rise up to 4° Celsius by 2100, up to 30% decline in yield in rain-fed areas for some crops and an increase in incidences of extreme events, such as droughts, floods and cyclones. Devastating floods, typhoons and hurricanes are being associated with climate change. According to the IPCC (2021), the global temperature rise should be restricted to 1.5° Celsius.

Models predict an average increase in temperature of 2.3 to 4.8°C in India for the benchmark doubling of carbon dioxide scenario. Although per capita carbon emissions in India at 1.2 metric tons (MT) per year is one of the lowest in the world, it is caught in a vicious cycle of climate change and is predicted to double within next 10 years (Fig.2). Already in the urban areas the people with cars and air conditioners emit 4.5 MT of carbon dioxide/ greenhouse gases per year, while the low-income people without car and air conditioners, emit an average of 1.1 MT of CO_2/GH gases. As per UN Climate Change Panel, a benchmark of 3.0 MT of carbon emission per capita per year should be the upper limit.

The corner stone of making a city resilient is to adopt an integrated approach towards ecology and the conservation of the natural resources. The composite urban environment includes the environmental infrastructure–greenery, water supply, air, sewerage, solid waste management, transportation and energy. It is necessary to strike a balance between conflicting demands-citizen freedom versus safeguarding community interests, economic opportunity versus climate and disaster resilience, public services versus mandatory procedures.

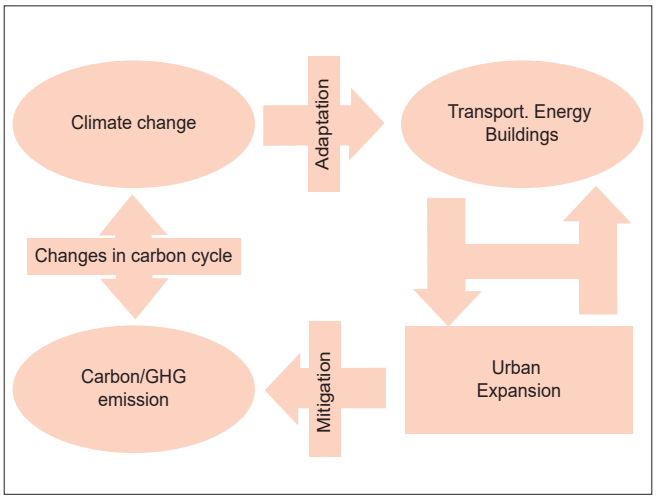


Fig. 2: Vicious Cycle of Climate Change

Source: UN Habitat (2010)

According to the Intergovernmental Panel on Climate Change (Climate Change Report, 2014,

WG III), the critical aspects of sustainable spatial planning comprise:

- Density, FAR optimisation, compact and integrated development
- Land use (mix of activities, population), inclusiveness
- Connectivity, walkability and traffic density
- Accessibility for all by public transit, cycle, walking
- More resilient, healthy environment, buildings and services.

Location is most important for the livelihoods of the informal sector workers who cannot afford to lose time and money in commuting. As a principle, the distance between work and living should be below 15 minutes by public transport, cycle or walk, that is 10 km, 3 km, and 1 km respectively. In view of recent work from home trend due to corona lockdown, it may be mandatory to provide at least half of the built space for work-life integration and mixed land use. This will save the need to commute (Fig.3).

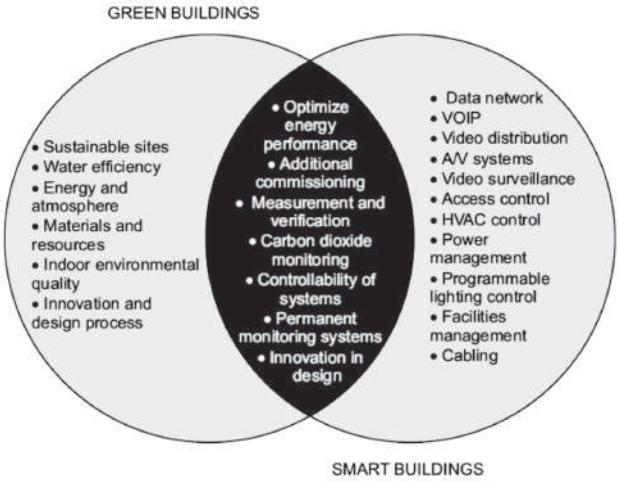


Fig. 4: Interfacing Smart and Green

Source: Jain A.K. (2021) Housing and Community Planning, Discovery Publishing House, New Delhi

CLEAN AIR

Air quality in Indian cities is deteriorating due to indiscriminate use of fossil fuels and vehicular and industrial emissions. According to the surveys conducted by the CPCB ambient air quality in more than 20 Indian cities have reached a very

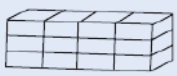
Building form	 *8 separate houses (ground floor plus basement)*	 *2 terraces of 4 house} (ground floor plus basement)*	 *block of 8 flats (2 storeys plus basement)*
Site area	100 %	70 %	34%
Envelope surface area	100%	74 %	35%
Heating energy	100 %	89 %	68 %
Construction costs	100%	87%	58 %

Fig. 3: Comparison of Surface Area, Energy Consumed and Construction Costs for Eight Housing Units in Different Configurations

Source: Presig H.R, et al (1999) Okologische Baukampetenzin Dominique Gauzin -Muller (2002) Sustainable Architecture and Urbanism, Birkhauser, Basel

The aim should be to minimise the greenfield development, rationalise densities and FAR and save building footprint and envelope area by a composite urban form. The strategy of green building need to be interfaced with smart systems and services (Fig.4).

critical situation. Relatively high levels of suspended particulate matter, dust, SPM, SO_2, NO_2, CO_2 and heavy metals, including lead content in the exhaust of automobiles have been observed. The recent changes in the fuel like electric and hydrogen powered vehicles, adoption of clean technologies,

Table 1: Technology, Citizen Engagement and Policy Matrix for Clean Air

	Manufacturing and Industry	Energy	Urban Mobility	Environ-mental Data	Building and Construction	Farming
Technology	• Installing continuous emissions monitoring technology (CEMS) at manufacturing locations, placing more accountability on industrial polluters • Development of low-emission commercial and industrial vehicles processes and logistics • Optimise industrial infrastructure and promote industrial restructuring • Accelerate technological innovations	• Emission and fossil free technology • Trigeneration • Renewable Energy • Zero Net Energy Building • Use of Gaseous Fuels • Elimination of D.G. Sets • Smart Meters • Micro Grids	• Development of low-emission transport, electric cars, e-rickshaws • Transport Demand Management • Transit Oriented Development	• Installing citywide air quality monitoring networks. • Communi-cating air quality data through mobile Apps	• Green building technologies that produce as much energy as a building consumes. • Cool roof • Net Zero Energy Building • Circular Const • Passive design, Natural ventilation • Indoor plants • Green Rating • Dust control • Air filters	• Use of agriculture residue for power generation • Conversion of agri-waste material, bio-char • Satellite surveillance • Gasification technology to convert bio-waste into pellets/ electricity
Citizen Engagement	• Applying public pressure on polluting industries • Promote citizen engagement in industrial environment management • Disclosure of air pollution data	• Renewal energy • Campaigns • Facilitate reduced energy consumption	• Providing N-99 pollution masks to traffic policemen, municipal workers, street vendors, etc. • Initiating campaigns for carpooling and ridesharing	• Vayu App • EIA • Early warning system	• Green building movement • Incentives for GRIHA rating • Promote citizen participation	• Incentives for recycling of agriculture waste & stubble • Vermi-composting • Bio-methane gas • Fuel, Pallets, thermal conversion
Policy	• A cap-and-trade emissions scheme for industries • Ensuring compliance of industrial emissions with the standards • Enforcement • Institutional and legal review • Strengthened environment threshold and industrial layout • Clarify responsibilities of government, enterprises and civil society	• Emission Tracking Systems • Install clean energy production and supply	• Building support for tighter controls on vehicular emissions • Increased use of electric vehicles.	• Actionable use of environ-mental data. • Publicizing and campaigning for action or Pollution Graded Response Plan.	• Facilitating the widespread use of a green rating for a building's energy consumption and emissions	• Schemes for recycling of agro-wastes to Energy, Bidg. matls. • Block chain Tech. • Smart, digital processor

Source: Jain A.K. (2021) Environment, Urbanisation and Development, Discovery Publishing House, New Delhi

new emission norms, development of shared taxis, NMTs and mass rapid transport system can reduce the pollution levels due to vehicular emissions. Bill Gates has stated that the world needs to use green cement and green steel in future to achieve zero emission. 'we must recognise that along with dynamismand growth, we need resilience and security or else the next crisis could be the last'. The public health depends largely on indoor and outdoor environment, which is free from microbial, allergy, toxins, dust and mites. The spaces should be comfortable with proper ventilation, sun and temperature control.

Airshed planning, continuous ventilation, use of cooler and light shaded materials and water spray are some other methods to reduce air pollution. The following table indicates the actions required in various sectors under Technology, Citizen Engagement and Policy Matrix for Clean Air:

CLEAN WATER

Water scarcity has become a persisting problem in Indian cities. The average annual per capita water availability in the country has gone down from 5,236 cubic meters in 1951 to 1,800 cubic meters in 1991. Several cities in India have become water stressed. Only 18% of the renewable water resource is being recycled, while only 10% of the annual rainfall is being harvested in India. The issues of concern are increasing coliform levels and Bio-chemical Oxygen Demand (BOD) in surface waters and increased concentration of nitrates in the groundwater. To overcome these problems, water sources need to be protected by interception, recycling and treatment of wastewater. Water resources can be augmented through recharging of groundwater and by rainwater harvesting (not only for building, but also roads, parks and parking areas)

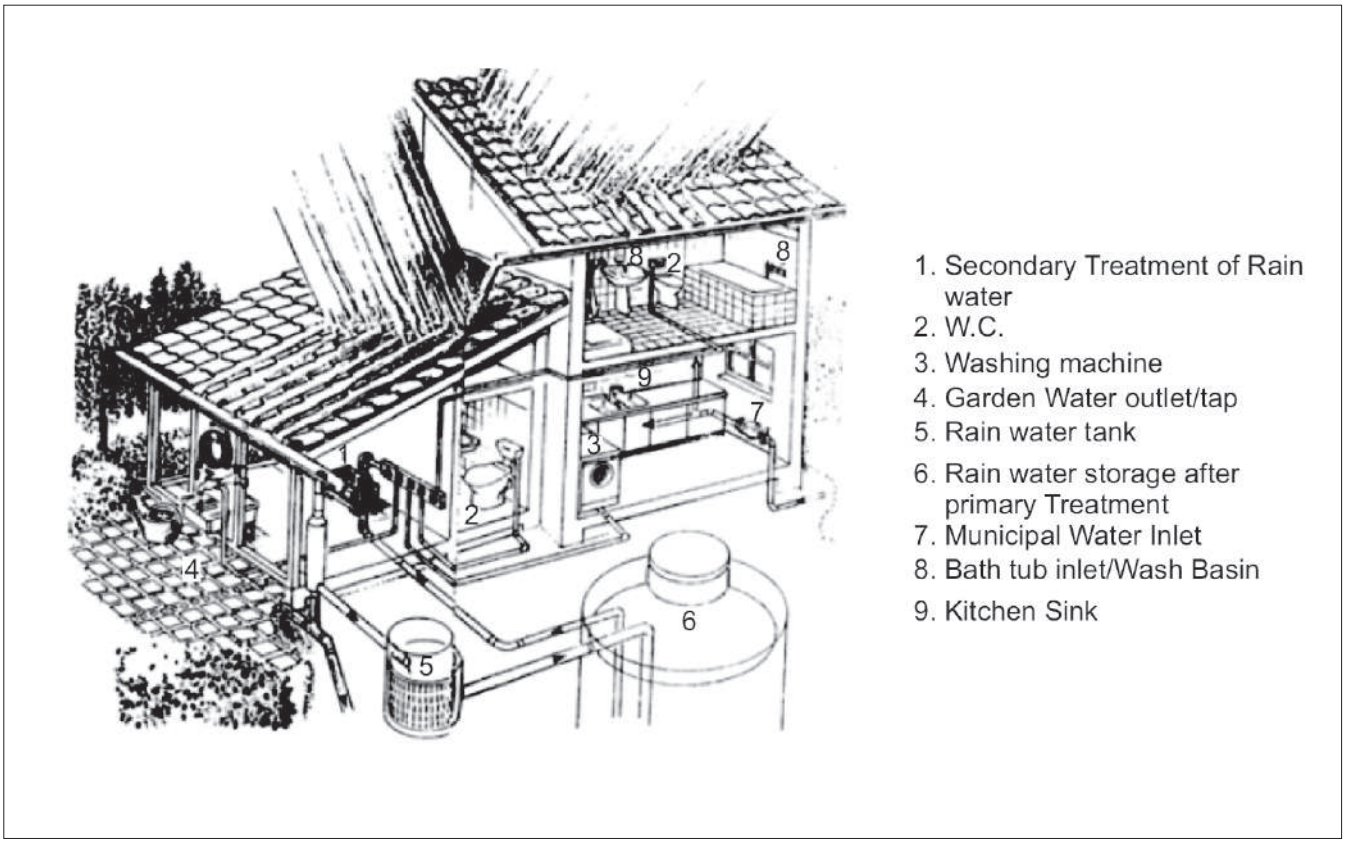


Fig. 5: Rainwater Harvesting and grey water recycling: In most of the regions in India, water is a critical problem. By rainwater harvesting, wastewater recycling, primary treatment and checking of leakages, the problem can be mitigated to a great extent

Source: Jain, A.K, (2009) Low Carbon Cities-Policies, Planning and Practice, Discovery Publishing House, New Delhi.

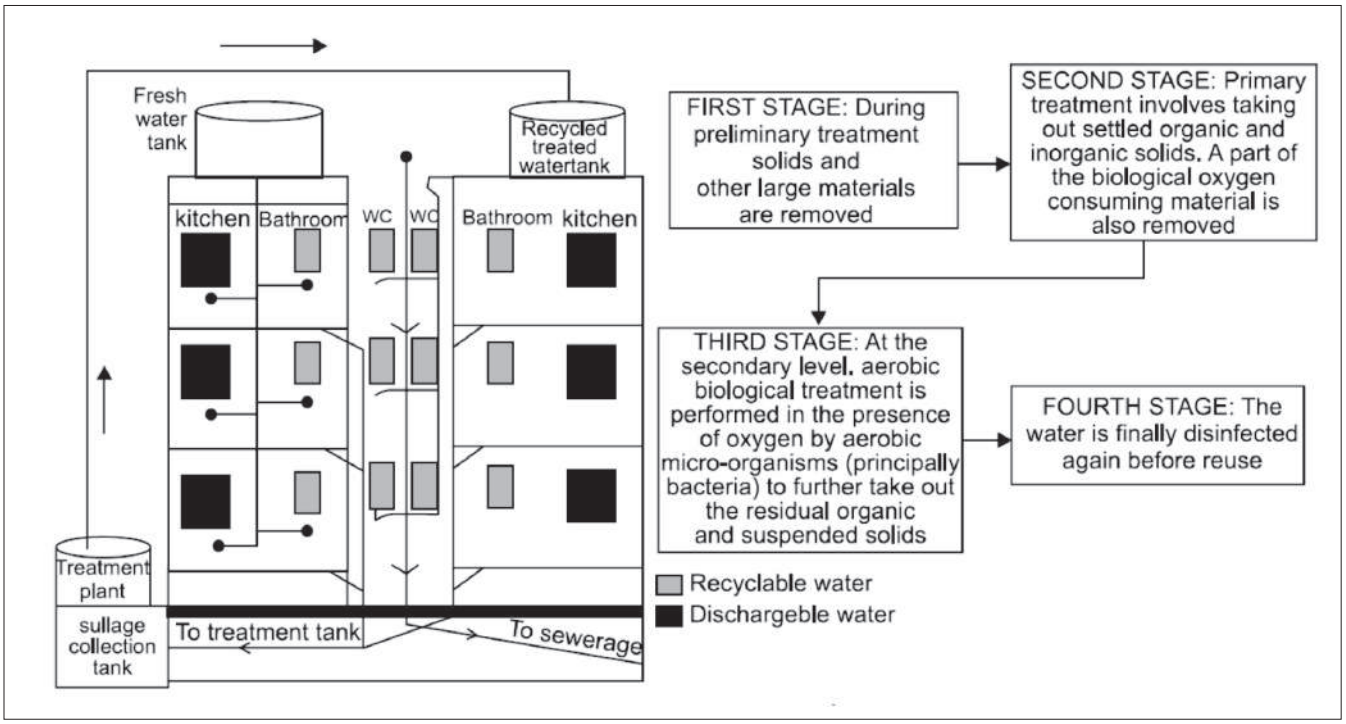


Fig. 6: Dual Plumbing for Wastewater Recycling

Source: Anon (2001) Total Water Management for Communities, Ion Exchange (India) Ltd. Mumbai

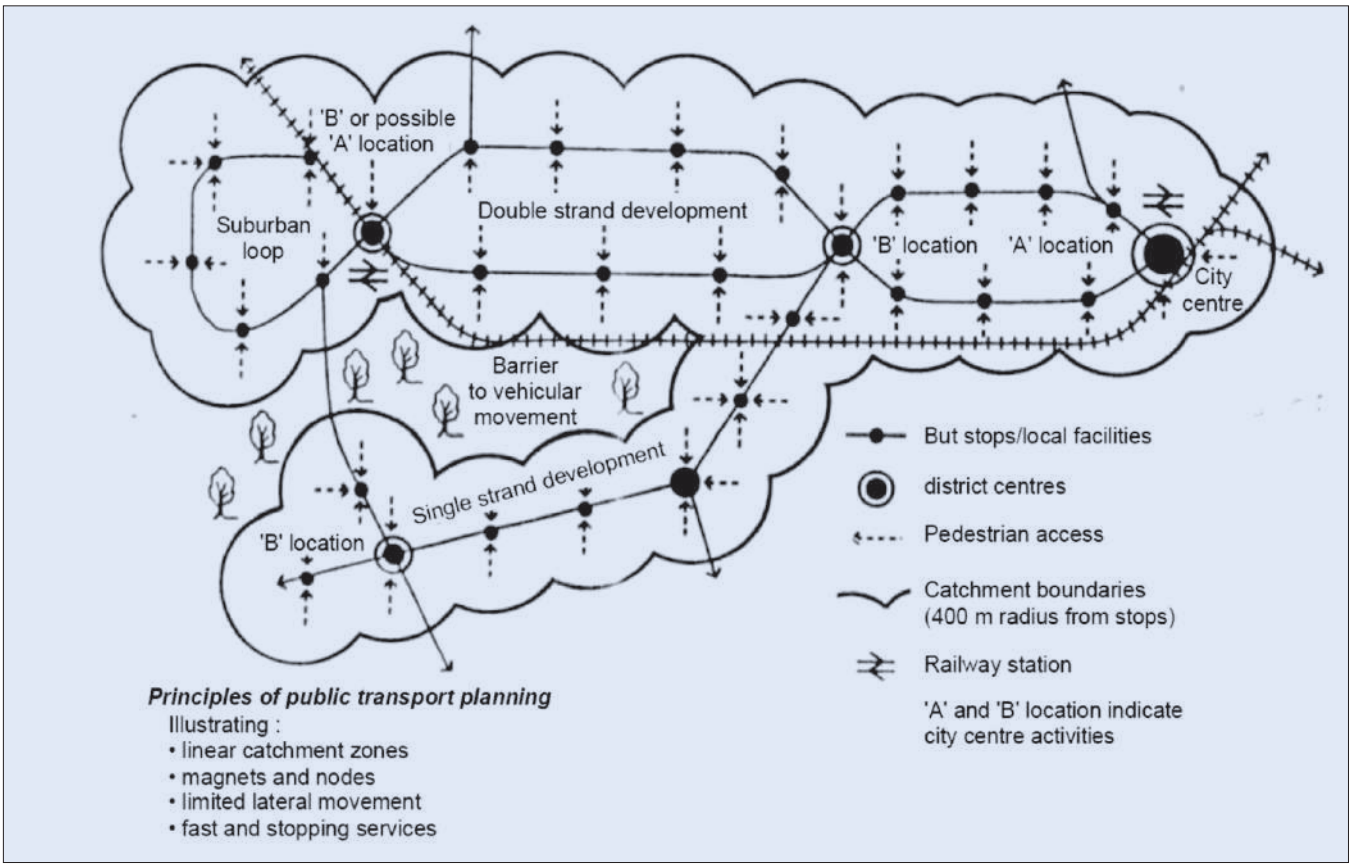


Fig. 7 The organisation of walk able communities along public transit (400 to 500 m distance)

Source**:** Barton H., M Grant and R. Guise (2003) Shaping Neighbourhoods, Spon Press, London

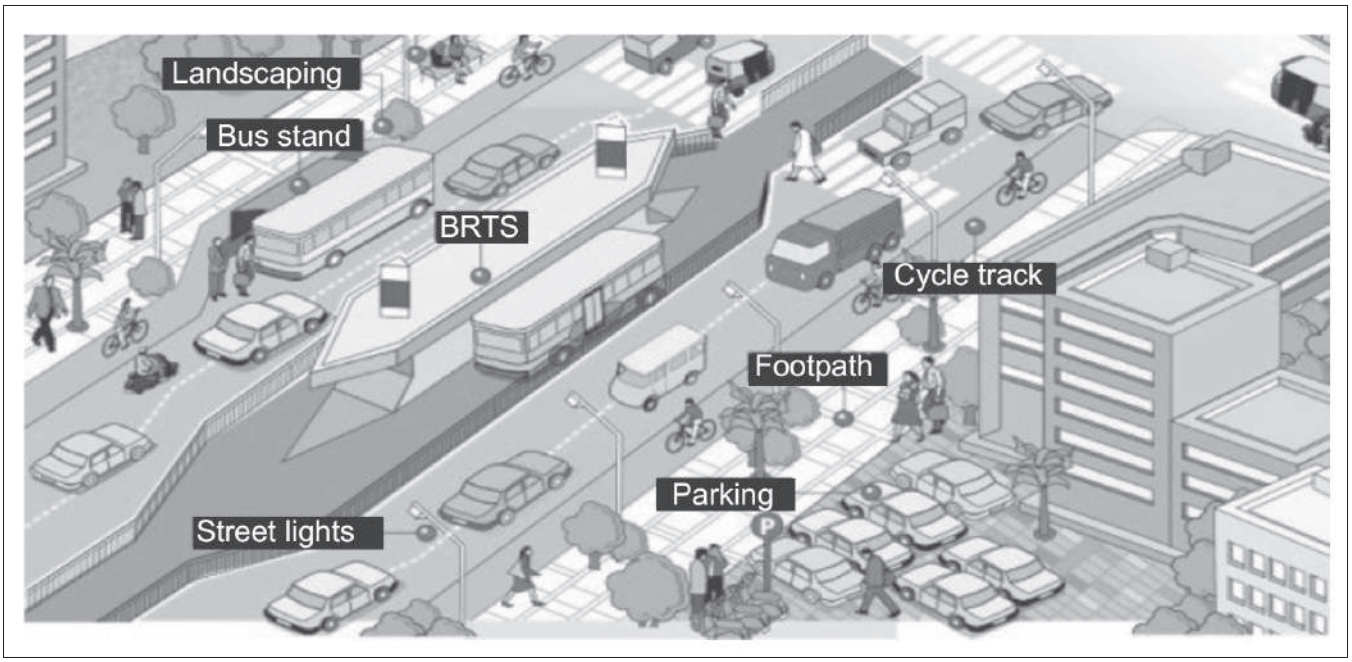


Fig. 8: Elements of Integrated Transit Corridor: Footpaths, cycle tracks, carriageway, storm water drainage, Bus Rapid Transit System, bus stop, street vendor, pedestrian crossing, underground utilities, street furniture, median, service lane, traffic calming, parking, landscaping and streetlights.

Source: DUAC/ Amit Ghosal (2014) Punjabi Bagh Ward No. 103, New Delhi

along with conservation of rivers and water bodies, water efficient taps/fittings, dual plumbing, curbing Non-Revenue Water and recycling of wastewater. Blockchain and SCADA systems can help in 24x7 potable water supply (Figs.5&6).

CLEAN TRANSPORT AND CONNECTIVITY

Urban transport contributes nearly two-thirds of the total suspended particulate matter and 18 per cent of carbon emissions. Prime Minister Narendra Modi, while inaugurating the Global Mobility Summit in September 2018, encapsulated 7 Cs of mobility-common, connected, convenient, congestion free, charged, clean and cutting-edge. He underlined the need to use clean energy for transport as a powerful weapon against climate change, along with pollution-free clean drive. He championed the idea of clean kilometres which could be achieved through bio-fuels, electric charging and hybrid electric vehicles. Clean transport as such underlines the importance of public transit rather than private vehicles.

The MOHUA has recently issued Metro Rail Policy (2017) and Transit Oriented Development Policy (2017), which provide guidelines for preparing comprehensive proposals for promoting urban public transit with private sector participation.The concept of walk to work should be the basis of urban structure and city size (Fig. 7).

For integrated transport system, it may be necessary to provide Integrated Transit Corridors (ITC) integrating BRT, Metro and trains together with pedestrian and cycle lanes (Fig.8).

These can be flanked by public, semi-public, high-density developments. Metro, trains, sub-way and primary roads can run underground for easy bike and pedestrian traffic on the grade.

River/water transport and ropeways can be explored which are almost pollution free and cost-effective. Multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. Besides controlling growth of private vehicles, it is necessary to explore parking space in stilts, multi-level puzzle/skeleton structures, on roofs and underground spaces. Seamless multimodal public transport system would work better by adoption of single ticketing and restructuring of land

uses by transit-oriented development. Subterranean parking garages with charging facilities near commuter destinations 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 concepts of cordon pricing, minimum occupancy vehicles, ceiling on new registration of private vehicles and establishment of a Unified Metropolitan Transport Authority are necessary for sustainable and clean urban transport.

CLEAN ENERGY

Energy scenario in India is characterised by its increasing demand, which is growing at the rate of about three times the population growth rate. At the United Nations Conference of the Parties (COP 26) in Glasgow (November 2021) Indian delegation led by PM Narendra Modi put forward the need to scale up clean technologies and formation of the International Solar Alliance (ISA). The One Sun-One World -One Grid envisions an interconnected trans-national solar energy grid. The COP 26 agreed to reduce the use of fossil fuels and coal by new sources, such as green hydrogen, green metals, carbon capture, solid state batteries, electric fuels, heat pumps and next generation solar PV. PM Modi informed that India's non-fossil fuel energy will be raised to 500 GW by 2030 and 50% of the power requirement will be met by renewable energy. India will achieve net zero emissions by 2070 by clean technologies, like electric batteries, ethanol blending in gasoline, hydrogen, solar photovoltaic and other renewables.

Low carbon energy can be derived from renewable sources, such as bio-fuels, wind, hydrogen, thermal, nuclear, tidal and solar power which needs storage, generation and distribution network, for which various options should be assessed, keeping in view the cost, feasibility and efficiency.

The concept of energy efficiency, renewable energy and Zero-fossil Energy Development (ZED) can reduce the energy demand and consequently pollution. Smart Micro-Grids, Distributed Energy Systems (DES), Micro-Districts and Anchor Microgrids should be linked with renewable energy network and energy efficiency.

The energy guzzling air-conditioning can be avoided by innovative methods like Net Zero Energy Design, variable refrigerant volume (VRV) system, earth air tunnel (EAT) and thermal storage. By HVAC and EAT systems inside temperature of a building can be maintained within 27 degree Celsius during summer and 19 to 24 degree Celsius during winter. Lower ambient lighting with bionic controls and integration of natural light with high performance glazing combined with light sensors can save energy use in a building. Optimum glazing design can also help to reduce glare. Synchronized lighting and bionic climate control systems can be designed to match building loads and schedules, which are segmented into multiple zones to allow intelligent controllability. Green roof, light coloured finishes and insulation also help to reduce energy demand.

CULTURAL AND NATURAL HERITAGE CONSERVATION

The built environment is composed of both natural and cultural elements. The natural environment includes land, air, water, plants and animal life. It is also about continuity of local culture, caring, sharing and living in balance with the natural environment.A clean and varied natural environment is valuable both for self and for its importance to the quality of human life. The cultural environment includes the tangible and non-tangible heritage, housing, historic areas, parks, arts and architecture. These gives identity to built environment and sense of pride to the citizens. As such, it is important to plan and design in a manner that conserves the heritage resources of a city, including its parks, forests, biodiversity, water resources and rivers. The open space systems and parks can be categorized on the basis of pedestrian and vehicular access, which can have a hierarchy of 9 levels from tot-lot/ housing parks to regional parks and national forests (Fig. 9).

CONCLUSION

Urban India is passing through rapid economic and social transformation and massive construction of mega projects, leading to increasing carbon footprints, climate change and disasters. It is faced with increasing pollution, transport, energy and water consumption. It is necessary to relook the repertoire and processes of planning, design

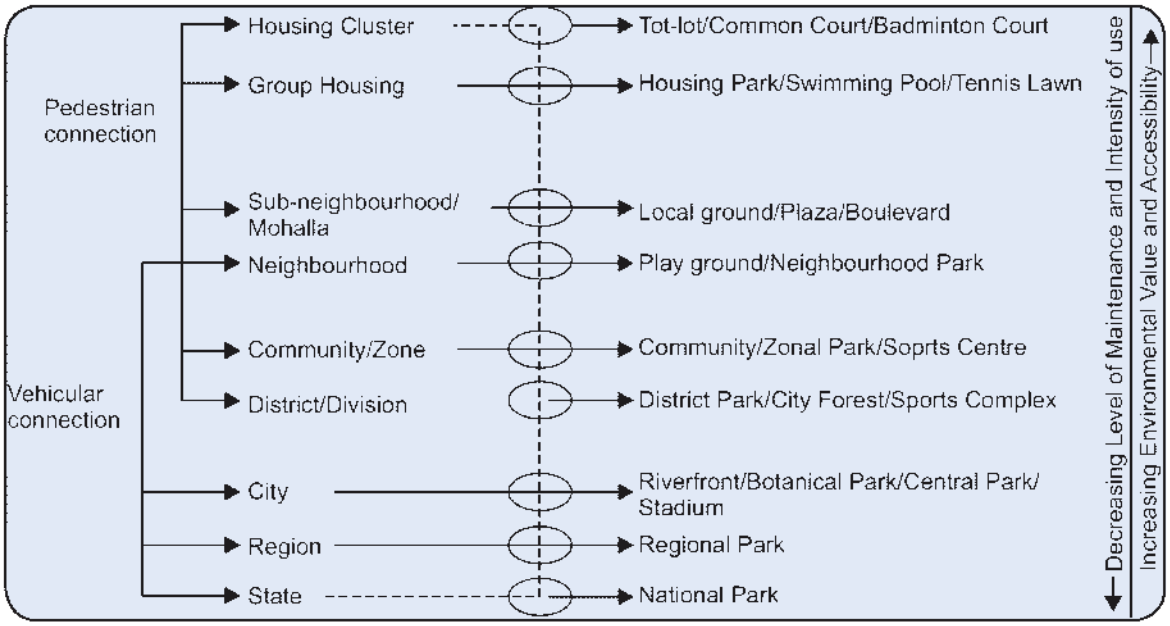


Fig. 9: Hierarchy of Open Space System based on urban access

Source: Jain A.K. (2018) City Planning for a Changing India, Bookwell Publishers, New Delhi

and urban development which should shift to circular concepts of urban renewal, recycling and conservation of natural resource.

REFERENCES

1. Barton H., M Grant and R. Guise (2003) Shaping Neighbourhoods, Spon Press, London
2. Bill Gates (2021) How to Avoid a Climate Disaster, Penguin, Dublin, UK
3. BEE (2017) Energy Conservation Building Code,Bureau of Energy Efficiency, New Delhi
4. CPHEEO (2014) Water Supply and Sanitation Guidelines, New Delhi.
5. DDA (2004) Report of Committee on Making Delhi Slum Free (Madhukar Gupta Committee), Unpublished, New Delhi
6. Delhi Pollution Control Committee (DPCC) Real Time Ambient Air Quality Data of Delhi, India: http://www.dpccairdata.com/dpccairdata/display/index.php.
7. DUAC/ Amit Ghosal (2014) Punjabi Bagh Ward No. 103, New Delhi
8. IEA (2008) India Energy Efficiency Policies and Measures: http:// www.iea.org/textbase/pm?mode=pm&id=4162&action=detail.
9. ICLEI (2007) Preparing for Climate Change: A Guidebook for Local, Regional and State
10. Governments, Washington.
11. Indian Network for Climate Change Assessment (2011) Ministry of Environment and Forests, Lodhi Road, New Delhi,
12. IPCC (2021) Climate Change Working Group, Impacts Adaptation and Vulnerability, IPCC, Cambridge University Press, UK and New York.
13. IPCC (2014) Climate Change Working Group, 6th Assessment Report, Cambridge University Press, UK and New York
14. Jain A.K. (2021) Environment, Urbanisation and Development, Discovery Publishing House, New Delhi
15. Jain A.K. (2021) Housing and Community Planning, Discovery Publishing House, New Delhi
16. Jain A.K. (2017) Urban Transformation, Discovery Publishing House, New Delhi

17. Jain A.K. (2018) City Planning for a Changing India, Bookwell Publishers, New Delhi

18. Jain, A.K, (2009) Low Carbon Cities-Policies, Planning and Practice, Discovery Publishing

19. House, New Delhi.

20. Jain, A.K. (2015) Smart Cities: Vision and Action, Discovery Publishing House, New Delhi,

21. Jain, A.K. (2015) River Regeneration and Water Resources. Discovery Publishing House, New Delhi

22. MOHUA (2015) Urban and Regional Development Plan Formulation and Implementation Guidelines, New Delhi

23. Presig H.R, et al (1999) OkologischeBaukampetenz in Dominique Gauzin -Muller (2002) Sustainable Architecture and Urbanism, Birkhauser, Basel

24. Satterthwaite, D. (2008) Cities' contribution to global warming: Notes on the allocation of greenhouse gas emissions. Environment and Urbanization, 20 (2).

25. UNESCO & MGIEP (2017) Textbook for Sustainable Development, A Guide to Embedding, UNESCO and Mahatma Gandhi Institute of Education, Peace and Sustainability, New Delhi

26. UNFCCC (2010) United Nations Conference on Climate Change, Proceedings, Mexico

27. UN-Habitat (2011) Cities and Climate Change, Global Report on Human Settlements, Earthscan, UK/USA/Nairobi.

28. United Nations General Assembly (2015) Sustainable Development Goals-2030, United Nations, New York

29. WRI, C40 and ICLEI (2015) Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, Washington

30. United Nations COP 26 (2021) Proceedings (Web site) Glasgow

LIFE CYCLE COSTING: A QUESTION OF VALUE

GAURISHANKAR DUBEY*

Abstract

Life Cycle Costing (LCC) is defined in Buildings and Constructed Assets, Service-life Planning as an "economic assessment considering all agreed projected significant and relevant cost flows over a period of analysis expressed in monetary value. The projected costs are those needed to achieve defined levels of performance, including reliability, safety and availability."

In the context of Sustainable Public Procurement (SPP), the use of LCC is essential to demonstrate that procurement processes and decisions -making have to move beyond considering the purchase price of a good or service, for the purchase price does not reflect the financial and non-financial gains that are offered by environmentally and socially preferable assets as they accrue during the operations and use phases of the asset life cycle.

Though many procurers are using Life Cycle Costing (LCC) as a decision-making tool, its use is still far from being systematic and the calculation methodologies are sometimes far from robust system. Moreover, procurers are not using LCC to inform strategically advantageous decisions. It is therefore clear that the current Sustainable Public Procurement model is not delivering the best value for tax payers' money. This needs to change.

INTRODUCTION

Life Cycle Cost (LCC)-Total Cost of Ownership (TCO)-Whole of Life (WOL) to take into account not only the initial acquisition cost but also cost of Operation, Maintenance and Disposal during the lifetime of the external resource procured. Value for Money (VfM) means the effective, efficient and economic use of resources. VfM is achieved by attracting the widest completion by way of optimal description of need; development of value–Engineered Specifications/ Terms of Reference (ToR); appropriate packaging/ slicing of requirement; selection of inappropriate mode of procurement and bidding system.

Value is a management and economic concept. There are three sources of the value of a product.

- The first source of value, known as use value, is from the functional usage of the product.
- The second source comes from the social status associated with the ownership of the product (esteem value).
- The third source of value comes from the price to that one can get by exchanging or scrapping the product at the end of the useful life of the product. This is called the disposal value. Value is the sum total of these three value.

Typical LCC analyses are based on the following:

- Purchasing costs and all associated costs such as delivery, installation, testing, commissioning and insurance
- Operating costs, including utility costs such as energy and water use and maintenance costs
- End-of-life costs such as removal, recycling or refurbishment and decommissioning
- Longevity and warranty time frames of the asset.

PUBLIC PROCUREMENT

Governments, just like private companies, have to buy goods and services for their operational needs. Public procurement refers to the process by which

*Former ED, SAIL & Sr Advisor, JSPL

governments and state-owned enterprises purchase goods and services from the private sector. As public procurement utilises a substantial portion of taxpayers' money, governments are expected to follow strict procedures to ensure that the process is fair, efficient, transparent and minimizes wastage of public resources.

In India, government procurement constitutes about 30% of the GDP. Procurement of goods and services is carried out by various ministries, departments, municipal and other local bodies, statutory corporations and public sector undertakings both at the Centre and at the State level.

Since regulations are defined, they are easy to measure ex-ante. Bureaucracies will naturally tend to substitute supervision with mechanical regulations and will not exercise discretion even when it is available. As per the General Financial Rules (GFRs) guidelines, the Lowest Cost Method, or commonly known as 'L1' principle is the most prevalent bidding method used for Goods/Works and Non-consultancy services.

There is a general agreement that solely relying on 'L1' does not work well and various organisations have advocated the need for reforming the current procurement system over the last few years. Central Vigilance Commission (CVC) in its concept note 'Alternative Procurement Strategy for Award of Works and Goods Contract' noted that although L1 may still hold good for procurement of routine works, goods and non-consulting services; but not for high impact and technologically complex procurements.

Quality Council of India (QCI) conducted a study on highway development sector and found that the vendors who were all awarded contracts on the basis of competitive bidding vary widely in terms of quality of work and performance which was not covered under existing bid evaluation system. The report suggested incorporating Performance Rating in Competitive Bidding to provide a quality premium to superior bidder rather than simply awarding the contract to 'L1' bidder and gave a formula to calculate total score as the summation of financial score and performance rating score.

NITI Aayog in the concept paper 'Indian Public Procurement: Alternative Strategies and Way Forward' argue that 'L1' is not suitable in all the scenarios and came up with a variety of alternatives to use in the procurement process.

In fact, the report also mentions that new procurement frameworks of multilateral banks like World Bank (WB), Asian Development Bank (ADB) and Japan International Cooperation Agency (JICA) have suitable alternative strategies for selecting bidders pointing towards needs for change and reforms in current times. They have moved from 'one size fits all' to 'fit to purpose' approach and incorporated various alternatives such as Value for Money, Rated Criteria to consider non-price attributes etc in the procurement methods.

Despite so many organizations recommending a need for allowing more discretion in the bidding process on account of technical and quality based parameters, we still mostly use L1.The L1 system persists because of the regulatory default problem. No decision maker wants to exercise discretion for the fear of future questioning. These criteria may appear simple and quantifiable, however, in a complex world where it may not be possible to define everything in the pre-procurement process; it is advisable to leave some discretion in the hands of administrators along with maintaining enough transparency and active supervision.

Incorporating performance rating system for contractors into the bid evaluation system will urge the vendors to maintain the quality of the goods and services they provide. Vendors with a better past performance record and fewer disputes and litigations will have a better rating and thus a better chance of getting future contracts. One of the suggestions is to set a threshold rating, and only those vendors above it will be considered in further rounds of evaluation. This will eliminate those contractors who have a poor track record and will help shortlist only those with a proven record of performance.

PREVAILING SITUATION

Governments are waking up to the business case for sustainable public procurement. It is important to integrate (Life Cycle Costing) LCC into these policies, as "green" and socially-preferable assets may carry considerable higher purchasing price

tags than their less sustainable substitutes. It is true that the price premiums paid for sustainable assets may be largely offset through efficiency gains, cost savings and lowered risks during the product/project lifetime. But procurers still face difficult decisions. Whilst they are being required to make purchasing decisions that are better for their environment and their societies, they are also bound by the principle to award the tender to the most economically advantageous bid to ensure the best value for their money.

Incorporating LCC into procurement policies will provide procurers with the opportunity to demonstrate that the best value for money across the asset life cycle can only be assured by purchasing green and socially preferable alternatives in short termed as Environment, Social and Governance (ESG).

But to what extent is LCC integrated into procurement policies? And do procurers and sustainable procurement policy-makers have the expertise to interpret LCC analyses to demonstrate the value for the public purse?

These questions are relevant as governments roll out economic stimulus packages that have a strong focus on sustainable development. Large sums of public funds are being allocated to upgrade infrastructure, buildings and utilities in a manner that reduces energy and material inputs, lowers wastes and improves livelihoods. Governments need to ensure that these funds are put to optimum use and sustainable public procurement, with an inbuilt in LCC requirement, can serve as a cost-effective tool to achieve these ends.

In advocating the use of LCC, it is important that we acknowledge that the science of LCC is far from perfect. Its findings will be skewed based on how future costs are perceived and forecasted, the reliability of the data used, what discounting rates are applied and what stages of asset life cycle are included in the analysis. Additional uncertainties arise when quantifying the lowered risks, avoided environmental damage, avoided clean-up costs, and non-financial benefits such as the contributions to social cohesion through the creation of jobs, livelihoods and new industries. Forecasting such costs and benefits with an acceptable degree of certainty is very challenging.

Procurers will always be under greater pressure to demonstrate that tax payers' money is being well spent. Despite being aware of the benefits of procuring LCC cost-effective assets, procurers will continue to face the high capital outlay dilemma, and give way to selecting "best value for money at the time of purchase" unless there is an express mandate for them to do otherwise.

Understanding LCC, even at its fringes, is essential if the public procurement mindset is to change from "best value for money" to "best value across the project/product life cycle."

Green and more socially equitable alternatives may involve higher capital outlays at the time of purchase. These premiums can often be offset through reduced operating and maintenance cost and avoided environmental risks. But such savings do not alter procurers' concerns that they can be perceived to be too generous or even wasteful with scarce public funds. To address this dilemma, elements of LCC need to be embedded into the main stages of the procurement process. This requires the setting of environmental, social and economic objectives at each stage of the procurement process: establishing the need to procure; setting specifications; developing pre-qualification questionnaires; developing award criteria for the evaluation of tenders and making award decisions; contracting and contract monitoring.

Changing mindsets also requires that procurers appreciate the comparative environmental and social advantage of products and services, which can aptly be assessed by using LCC. Comparative advantage is determined through either product-related or performance-related criteria. Product criteria stipulate the design or composition of a product, whereas performance criteria specify performance aspects such as thresholds of energy efficiency, increased recyclability or longer user life. In targeting outcomes during the user life of assets, performance-based criteria promote innovation and enable bidding companies to develop creative strategies to attain the level of performance being requested.

Product-based criteria, on the other hand, do not spur sustainable design improvements to the same extent, though often they do involve a lesser

degree of uncertainty and risk. Using LCC will help procurers and policy-makers better appreciate the trade-off between these selection criteria and make the best decisions on a case-by-case basis.

Sustainable Public Procurement (SPP) proponents also suggested that embedding LCC into procurement practices is best accompanied by an organization-wide (and even a government-wide) environmental management and social responsibility effort. We believe that the inability of procurers to reconcile capital and revenue budgets is a major reason why LCC lags behind. Indeed, the main motivation to apply LCC in the first place is that budgetary approval procedure requires it. But the typical organization and time frames applied in government budgets work against LCC and related thinking.

For example, multi-year accounting and budget frameworks that allow temporal flexibility to carryover or borrow-against-the-future are important to account for benefits that accrue during user life of assets. This is rarely possible in public sector accounting.

There is also the issue of budget ownership, that is to say, split responsibilities for capital and operating costs. While procurement contracting might be the responsibility of one agency, budgets are controlled by another and the use and maintenance of the product/service/development belongs to yet another.

As the benefits of SPP accrue during the project life and at its end disposal, those bearing the capital costs may not be the first to realize the benefits of sustainable alternatives. Many procurers are of the view that widespread reforms on public expenditure management will be needed to enable LCC to be used as a standard procedure in procurement budgeting.

WAY FORWARD

There is an overwhelming consensus amongst procurers and SPP proponents that whole life costing methodologies are too much focused on financial feasibility to serve as a "licence to operate" for sustainable public procurement SSP.

Procurers are increasingly looking to adopt LCC methodologies to assess costs and benefits well beyond the sphere of discrete assets or services and to showcase how government spending is being directed to support the growth of green businesses, reducing green house gas emissions, providing for skills development and improving work-life balance. To this end, both the social benefits and the avoided social costs enabled by each tender need to be factored into the LCC equation. And this can be extremely challenging to forecast with an acceptable degree of certainty. Accounting for social costs and benefits is particularly challenging. For example, costs such as unemployment benefits that would have been necessary without the procurement of a given asset, or health care costs that would have been necessary if environmentally preferable alternatives would not have been procured, are particularly challenging to forecast. There were more than enough tools and guidance available on LCC (though knowing where to find it all was another matter entirely). Therefore, procurers and sustainable procurement proponents were eager to ensure that the creation of more tools and guidance was avoided. Rather, they wanted to be provided with dedicated training and case studies on different approaches to LCC.

A number of suggestions to ensure that LCC good practice was shared and became a useful learning tool. Suggestions included the following:--

- Large-scale demonstration projects that take into account both local and cross-border economic, social and environmental benefits
- Case studies on interpreting LCC analyses in procurement decisions
- Case studies on how LCC has been applied to frequent areas of public sector spending, such as food; furniture; office equipment like computers, printers and photocopiers; building construction; building retrofits; cleaning materials and vehicles
- Case studies on how avoided pollution control and clean up costs are factored into LCC
- Case studies on how non-financial social benefits, such as improved productivity, better work-life balance and the creation of sustainable livelihoods, can be accounted for.

CONCLUSION

This paper is to begin a local/ global debate on the role of Life Cycle Costing (LCC) in Sustainable Public Procurement (SPP) and indeed, the effectiveness of Sustainable Public Procurement as a cost-effective strategy for Sustainable Development. In the rush to promote "quick wins" and flagship initiatives to promote sustainable public procurement, are governments overlooking the critical importance of demonstrating "value for money" and the business case for sustainable public procurement?

India is accelerating itself to be a five trillion dollar economy by 2025, which means increased public procurement expenditure. We would need to make a consolidated and concerted push to ensure that identified issues are fixed immediately.

Unless LCC is picked up as an integral component in SPP policies, governments will be hard-pressed to demonstrate that the procurement of life cycle-efficient assets is indeed the best way to make the optimum use of tax payers' money. Even if these assets command higher capital or purchasing costs, these can be offset by lower operating costs, lower maintenance costs, low risk premiums, avoided pollution control costs and avoided remediation costs during the use and end-of life disposal of the asset.

Hence, the fundamental sustainable procurement businesses case is the most economically advantageous tender across the asset life cycle. Without LCC methodologies to demonstrate this, SPP policies run the risk of being sidelined or even abandoned on the premise that sustainable goods and services are more expensive.

AN APPROACH TO CONSIDER THE PREMIUM VALUE OF SUSTAINABLE BUILDING COMPARED TO A NORMAL BUILDING AND ITS AFFORDABILITY

K. R. Ramana* And Dr. K. Srinivas**

Abstract

Economic development brought new ways of correlating the efficiency and performance, and development of Sustainable Buildings are spreading at higher levels. This paper discusses specific issues in how valuation methods could be considered when assessing green buildings. The real estate market is one of the most dynamic sectors, and therefore the commercial market increased in size and spreading. As the economy is growing, more office building investment created the framework for companies to operate and to further develop the economy. The objective of the study has been to understand the need of specific correlation between valuation measures and actual financial performance of this type of buildings, relative to value, rent premium, occupancy premium or even increase in productivity. With the growth of Green building foot print increasing in Indian Real Estate Market the issue of incorporating the premium in the final value could be challenging for the Real Estate Valuers, and thus, questions concerning the premium values of sustainability of Built Asset needs justifiable answers. The paper provides suggestions that appraisers should take into consideration the positive effects of sustainable/green buildings in their valuations. This paper focuses on various valuation methods and the points that may be considered in providing premium values to Sustainable Buildings.

INTRODUCTION

Sustainable (Green) building is one of the fastest growing movements in the real estate industry today. More than just a passing trend, the green building movement is a response to the pressing environmental problems prevalent in our society and provides, tangible environmental, community and economic benefits, improving health and public spaces and lowering building and energy costs. Sustainable building (also known as green construction or green building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life cycle: from siting to design, construction, operation, maintenance, renovation and demolition.

Affordability may be defined as the extent to which something is affordable, as measured by its cost relative to the amount that the purchaser is able to pay. In case of tenancy, it is the rent which gives the tenant a comfort of carrying out his business/ livelihood at that premises. In case of a prospective investor, it is the return out of the property that he is expecting. If the investment in the property is highly secured, liquidity is reasonable and most importantly the expected "vacancy" is least, the investment in the property is highly affordable. It is not the "cost" but the "Value" of his money invested in the property.

**Adjunct Professor, National Academy of Construction, Hyd.*
***Asst. Professor, JNAFAU University, Masab Tank, Hyd.*

VALUATION OF ASSETS AS PER INTERNATIONAL VALUATION STANDARDS

The concept of sustainability can be best felt in commercial buildings which includes office buildings also that involve considerable number of foot falls in a day. Generally the investments in these buildings received return in the form of "lease rent" from a number of lessee.

According to "International Valuation Standards, 2017," the basis of value of these sustainable buildings should be "Market Rent". IVS 104.40.1 defines Market Rent as the estimated amount for which an interest in real property should be leased on the valuation date between a willing lesser and a willing lessee on appropriate lease terms in an arm's length transaction, after proper marketing and where each parties had acted knowledgably, prudently and without compulsion. When the market rent is known, the valuer estimated the Market Value of the property by the formula:

C = Y.P. x N
Where, C = Capitalized value
Y.P = Years of Purchase
= 100 / Yield (in %)
N = Net Income

If it is considered the yield of a conventional building and that of a sustainable building is constant, the capital value becomes directly proportional to the net income. If that is so, more the net income, more shall be the value of the property.

But, Net income = Gross Income - Out goings.

As in sustainable buildings, the lessees also receive the benefit of sustainable design and use of materials resulting in less expenditure on electricity bill for lighting, ventilation and air-conditioning, pollution free indoor environment and pride of having space in a star rated sustainable building, they are ready to pay higher rents. Moreover, vacancy rate of the sustainable buildings are also much lower that that of the conventional buildings. So the gross income per annum from the sustainable building will be substantially higher than that of the conventional one. Whereas, outgoings are the expenses incurred by the owner for (1) Maintenance, (2) Repairs, (3) common area lighting, (4) Common area air conditioning. These expenses are very much less than those of conventional buildings.

So, although the cost of construction of sustainable buildings is more or less 10% higher than those of the conventional buildings, in the question of affordability, sustainable buildings are far ahead of the conventional buildings.

VALUATION ISSUES RELATED TO GREEN BUILDINGS

The role of the Valuers is crucial in the adoption of sustainability in commercial property, also because, from a valuation practice perspective, the relationship between sustainability and market value is still inconclusive (Warren-Myers, 2011). The Appraisal

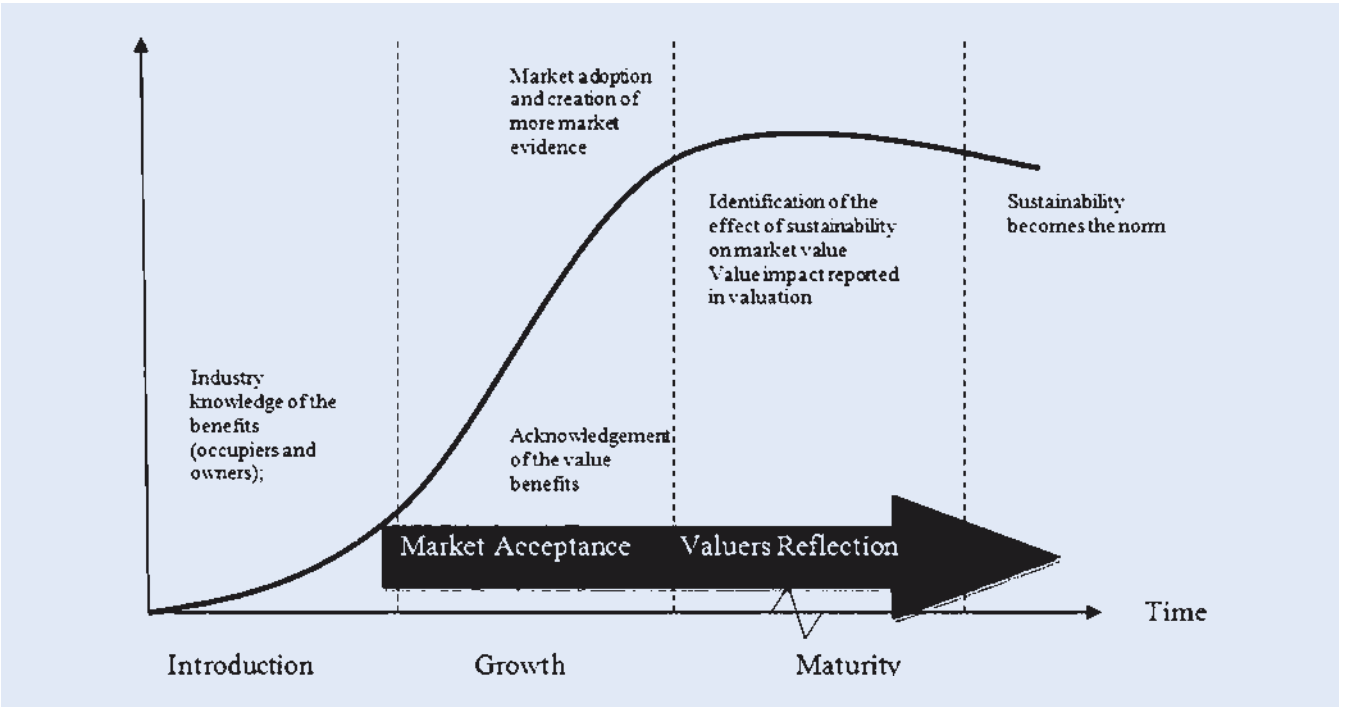


Fig. 1: Market adoption of sustainability and the development of valuers' knowledge

(Source: Warren-Myers, 2011: 497)

institute is just one of the professional bodies that started offering professional development programs in valuation of sustainable buildings.

The amount of knowledge and the steps that will lead to further including of green-building related issues in valuation standardization is represented in Fig.1.

So, what is the role of the appraiser in including in the value of the building all the characteristics that such as: a) rent premium, b) occupancy premium, c) lower vacancy rate, d) higher productivity or e) lower operational cost. Appraisers should reconcile the primary approaches to valuation, as if a recent sale of green building occurred, the sales comparison approach may take on greater significance (Appraisal Institute & Institute for Market Transformation, 2013).

Hence there is a dilemma regarding the inclusion of higher value of green building in current valuation practices. Appraisal Institute presents a way in which the premiums could be included in the methods.

INCOME CAPITALISATION OF GREEN BUILDINGS

As projected in Table 1, income capitalization of green buildings could be included in order to obtain the value of green buildings. In terms of gross revenues, higher rent represents a basis for future growth. Vacancy rate could end up in the effective revenues, as lower vacancy rate create more revenues. The most common understanding of how green buildings are operating is by analyzing operating expenses. Lower operating expenses are represented by lower utility bills, maintenance, reserves but also lower cost for facility management. This will lead to higher net operating income and through a lower capitalization rate, a higher value of the building.

Table 1: Income Capitalization of Green Buildings

Gross Revenue	(higher rents)
-Vacancy	(lower vacancy vs. market)
= Effective Revenue	(revenue up)
- Operating Expenses	(lower utility bills, maintenance, reserves)
= Net Operating Income	(NOI up)
NOI/Cap Rate = Value	(lower cap rate)

(Source: Appraisal Institute & Institute for Market Transformation, 2013: 5)

Table 2: Comparing methods in Green Building Valuation

	Cost approach	**Income approach**	**Market approach**
Lower Operating expenses	X – no mean of reflection	Lower energy bills, maintenance	Increasing number of green building will lead to reflecting lower operating expenses
Higher productivity	Higher productivity can't be included in the cost approach	Lower operating cost through higher efficiency (energy cost reduction), higher revenues	X (t) – could be reflected in time
Lower healthcare cost	X – no mean of reflection	Higher revenues	X (t) – could be reflected in time
Higher reputation	Increased value of brand	V - Reflected in future income	Increasing number of green building will lead to reflecting lower operating expenses
Better workforce	X – no mean of reflection	V - Reflected in future income	X (t) – could be reflected in time

Comparing methods of valuation with potential benefits, could increase the awareness of appraisers related to green building. By also using novel methods to assess the green premium, the further development of green building valuation will be understood. As there is an increased number of new green buildings being built, there will be further data related to higher value of green buildings. One question still will remain to be answered. As the rapid spreading of green label certifications in new buildings, old buildings (uncertified) will receive further feedback from the market as need to engage in a process of retrofitting and green building certification plan, as the decision for tenants to rent office spaces in green buildings will be further influenced by the current studies taking place.

CONCLUSION

The current valuation practices have limited view of the full characteristics of a green building, more precisely on the following points. The cost approach is not covering the premium characteristics of a green building. Appraisers don't have cost catalogs in order to measure "green building" value. This could be further assessed as more constructions are certified as being green. The income approach reflects the rent premium or lower vacancy rate in future income. Moreover, there isn't a relevant and sufficient base for market premium for rents and resale/reverse value or yield rate. One solution to these issues could be further analysis on small data related to the performance of organizations that rent green building. Be correlating the financial performance with the spatial analytic, the appraiser could use the results for the valuation process. The market approach could reflect in the future these characteristic, when the number of green building transactions will increase. Moreover, as green buildings are also developed in areas where location premium is relevant, excluding the location effect and retaining the "green" effect could be made through more data in the sample. Appraisers should include in their valuations the results of studies suggesting benefits of green buildings, as basis for their adjustments.

Moreover, future research questions should answer the actual quantifiable effect of the benefits for tenants and owners of green buildings. Although, the market adoption in order to develop alternatives to the current valuation practices will need more time, there is definite understanding that specific methods are needed to set the norm for this type of buildings.

REFERENCES

1. United Nations Environmental Programme, S. B. and C. I. (2009) Buildings and climate change: a summary for decision-makers. Programme, Sustainable Buildings and Climate, Paris. Report available on-line at http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf

2. Warren-Myers, G. (2011). "Sustainability – the crucial challenge for the valuation profession", Pacific Rim Property Research Journal, vol.17, no. 4: 491–510. Wiley, J. a., Benefield, J. D., & Johnson, K. H. (2008) "Green design and the market for commercial office space", The Journal of Real Estate Finance and Economics, vol. 41, no. 2: 228–24

3. World GBC (2015) Retrieved March 06, 2015, available online at http://www.worldgbc.org/index.php?cID=220

4. Yaron, B. G., Ll, M., Ll, B., & Noel, M. (2013) "Does building green create value?", Report available online at http://www3.cec.org/islandora-gb/islandora/object/islandora:1111/Data Stream/OBJ-EN/view

5. Appraisal Institute and Institute for Market Transformation (2013) "Green building and property value", report available on-line at https://www.appraisalinstitute.org/assets/1/7/Green-Building-and-Property-Value.pdf

ROLE OF PROFESSIONAL ETHICS AND HUMAN VALUES IN SUSTAINABLE DEVELOPMENT

B. P. Suneja*

Abstract

Development is a process that creates growth, progress and positive changes in the built environment and a country experiences a reduction or elimination of poverty, inequality and unemployment so as to bring sustainable happiness. In fact, Development, in its true sense, is Development of people (human development) and NOT the Development of Things and it should be able to provide guarantee of secure future which is full of opportunities, a pleasant world & a healthy planet to live on. Gandhi ji used the term 'Development' as: "The total Development of Society" that includes Mental, Spiritual and Material needs. Basically, ssustainable development is about the future & we can only think of future when, our present is in crisis or society as a whole is not happy.

The unfortunate part of development is that in the process of creating better and comfortable living conditions, man has put himself into the race of adopting the emerging technologies in an unethical & unplanned manner, that too, at the cost of Environment, Natural resources, Health, Harmony, Prosperity of Human Beings & Happiness. Worldwide, the people have come to realise that Science & Technology, without Ethics and Values, can do nothing for the prosperity of human beings. Whenever, wisdom & science are separated from ethics and values, they act against themselves and turn to violence and savagery. The present paper is an effort to address the role of professional ethics and human values in sustainable development and possible ways to inculcate these qualities in the professionals through education and various healthy practices.

INTRODUCTION

Development is vital in today's society as it affects every aspect in everyday life of people. Development is a process of progress by the addition of physical, economic, environmental, social and demographic component using technology or otherwise. According to Amartya Sen, the basic objective of development is "the expansion of human capabilities". The main objectives of the development can be categorized as (i) sustenance, (ii) self- esteem, and (iii) freedom. We know that all people have certain basic needs like, food, shelter, health, and protection, without which life would be impossible. Sustenance is basically the ability to meet these basic needs of people. The ill effects of development have been seen as people started to convert their need into their greed. This brings the ethical attitude or human values in picture. The second aspect of development is implementation of technology to meet the objectives of development. Every new technology has its own advantagesas well as certain adverse consequences of using it. If these adverse consequences are ignored it may lead to disaster and such development looses its sustainability. Here, the professional ethics play an important role in sustainable development.

The present paper describes the ethics, professional ethics and human values and identifies their role for all stake holders of development process so as to achieve the sustainable built environment.

* *Former Dean (Faculty of Engineering & Architecture); Head (Civil), Rajasthan Technical University, Kota*

DEVELOPMENT V/S SUSTAINABLE DEVELOPMENT

Development: Development is a process to achieve growth, progress, positive change or the addition of physical, economic, environmental, social and demographic components so as to experience a reduction or elimination of Poverty, Inequality and

Unemployment. The objective of development is to raise the level and quality of life of the people, and to raise the local regional income and employment opportunities without damaging the resources of the environment. Development is a continuous process to meet the above said objective.

Through the years, professionals and researchers have tried to define the development on different grounds. It was observed that economic growth did not necessarily lead to a rise in the level and quality of life for the people. Amartya Sen, for example, developed the "capability approach," which defined development as a tool enabling people to reach the highest level of their ability, by way of granting freedom of action at economic, social and family fronts. In fact, the development, in true sense, is the development of people and not merely, the development of things. Gandhi ji also used the term development as "the total development of Society, that includes mental, spiritual and material needs". Later, the approach suggested by Amartya Sen laid a basis for the measurement of development index i.e. HDI (Human Development Index), which was developed by the UN Development Program (UNDP) in 1990. Finally, the term sustainable development was evolved. Jeffery Sacks, also emphasizes the promotion of sustainable development in his work.

Sustainable Development: Sustainable development can be referred to as an organizing principle for meeting the goals of human development while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services for future. Hence, sustained development is about the future & we can only think of future when, our present is in crisis or society as a whole is NOT happy. Finally, UN World Commission on Environment and Development in its 1987 report defined the sustainable development as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Also, it should be able to provide guarantee of secure future which is full of opportunities, a pleasant world and a healthy planet. If we talk about our own needs then Gandhi ji explained it nicely by saying that "There's enough in the world to meet the needs of everyone but there's not enough to meet the greed of everyone". It appears that sustainability has taken a back seat in the process of development because people have started converting their needs into their greed. Summarily, the process of sustainable development can be represented as below:

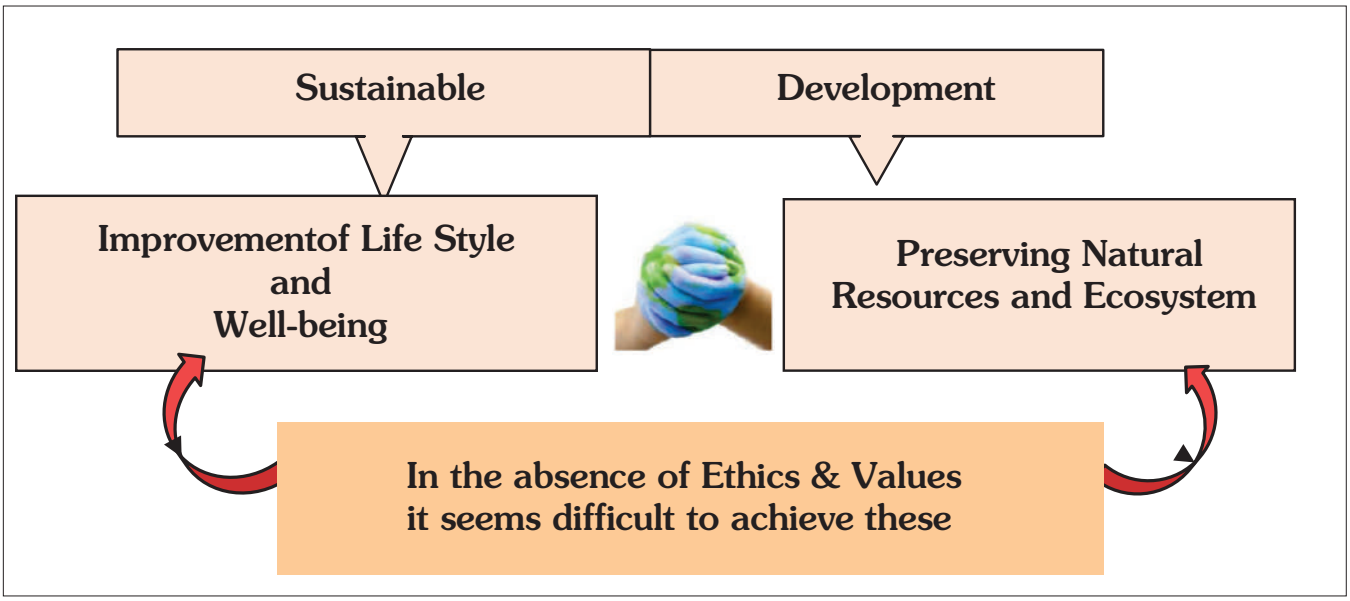


Fig. 1: Requirement of Sustainability

Basically there are three important, independent and mutually reinforced pillars of sustainable development as suggested in United Nations 2005 World summit Outcome Document and are shown in Fig 2.

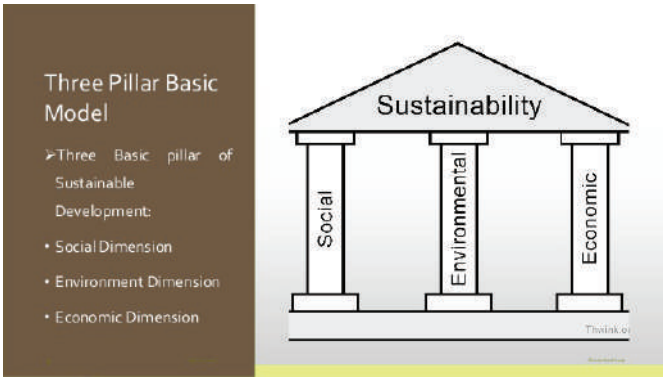


Fig. 2: Three Pillar Basic Model of Sustainability

ROLE OF PROFESSIONAL ETHICS AND HUMAN VALUES

The unfortunate part of development is that in the process of creating better and comfortable living conditions, man has put himself into the race of adopting the emerging technologies in an unethical & unplanned manner, that too, at the cost of Environment, Natural resources, Health, Harmony, Prosperity of Human Beings & Happiness. The major environmental concerns of development are:

- Global Warming (melting of glaciers)
- Green House Effect & Ozone Layer Depletion
- Acid Rains & Desertification
- Pollution (causes 16% deaths globally)
- Technology in warfare (use of chemicals and micro-organism)
- Extinction of Natural Resources & Species

Worldwide, the people have come to realise that Science & Technology, without Ethics and Values, can do nothing for the prosperity of human beings. The generations have witnessed that whenever wisdom & science are separated from ethics, they act against themselves resulting into violence and savagery and has caused pain to both the environment & the people. We all are born to be happy but unfortunately we all have become addicted to short-term happiness. In fact, in the last 100 years, we got very confused about happiness. The way we define happiness decides: what to do, what to sacrifice, and how to spend our money & time. Science & technology can bring us convenience & physical comfort, but inculcating human values in practice, can bring us sustainable happiness. Hence, there is strong need to shift our attention and resource allocation more towards inculcating human values and professional ethics. That can be achieved by emphasising Universal Human Values in our education system. Unfortunately at present, whatever is expected from the education is found missing like Self-reliance, Character building, Values, harmony with all existence etc.

Every discipline of engineering must include the group assignment on case study of major engineering failures which will help in learning the "Professional Responsibility & Ethics" as "man learns better through mistakes". Social Service based Project (in groups) must be encouraged to meet an identified need in a low-income community or to help under-privileged group of society which will enhance the service-learning quality of engineers. [e.g. Columbia University's Fu Foundation of Engineering and Applied Sciences School has successfully included in the UG curriculum]

HUMAN VALUES, MORALITY & PROFESSIONAL ETHICS

Basically, human values are a set of beliefs that a person acquires unconsciously through the personal experiences or learning for promoting wellbeing, happiness and to prevent harms to others. Human values have three components: (i) Morality (ii) Values and (iii) Ethics. These components have been explained briefly in the following paragraphs.

Morality: Morals are the predefined welfare principles that people believe what is right and what is wrong. Personal morality and professional ethics are not always the same rather these are different. The morality can be common morality and personal morality.

Common Morality: Common Morality is a Set of moral beliefs shared by almost every one and is designed to protect individuals from various types of violations of their personhood by others. It has got both positive and negative precepts. For example: the negative precepts are: it is wrong to murder, lie, cheat, steal, break promises, physically harm others etc. and positive precepts are: promote human

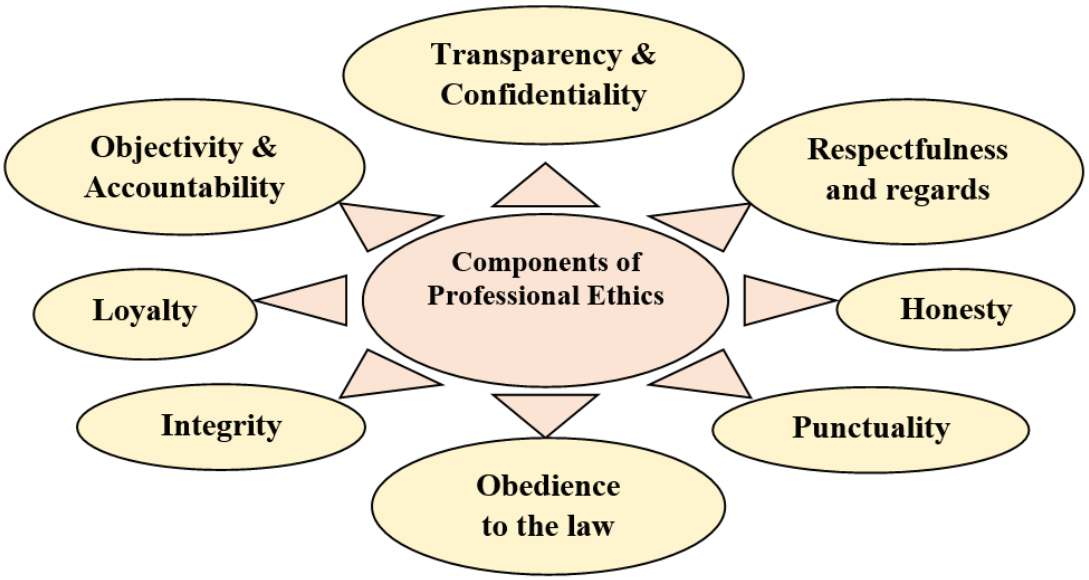


Fig.3: Components of Sustainability

happiness, protect the natural environment, help the needy etc.

Personal Morality: Personal Morality is a set of moral beliefs that a person holds. The precepts of personal morality are very close/ similar to common morality. However, the extent of beliefs may vary from person to person.

Professional Ethics: Personal Morality and Professional Ethics are not always the same. However, these are well connected to each other. Professional ethics has several characteristics that distinguish it from personal ethics and common morality**.** Professional ethics refer to the set of standards/ obligations that should be followed by the people because of their professional status and must be reflected in their conduct/ action and behaviour. Professional Engineering Ethics can be divided into a negative precept (e.g. to prevent disaster, to avoid professional misconduct etc.), and positive precept (e.g. to produce a better life for mankind through technology).

In fact, every profession has its own set of standards for professional ethics like, medicine, law, architecture, pharmacy, and so on. However, irrespective of the profession, professional ethics can have the following components (as shown in Fig. 3).

HOW TO DEVELOP PROFESSIONAL ETHICS

In order to develop the professional ethics, one should work on the following with all sincerity and honesty.

1. Update your knowledge:
   - Develop a reading habit & Learn new things and new skills
   - Go through the orientation/ refresher programme
   - Become the active member of various professional bodies
   - Keep in touch with the latest technological developments
2. Improve your work life balance.
3. Challenge yourself and work on your weaknesses.
4. Get organized and improve your time management.
5. Improve your Communication skill.
6. Develop the habit of active listening with patience
7. Do not mix the professional issues with personal issues.

Working on above will not only develop the professional ethics but also the confidence to face the professional challenges.

ROLE OF ENGINEERS IN SUSTAINABILITY

The growing social consciousness around the world is making it imperative for the Engineers to understand the implications of their work for the human safety, health & welfare and for environmental sustainability. It's unfortunate that law and medical professionals are licensed and therefore have commitment to uphold the profession's formal ethical code whereas, most of the engineers are not licensed and thus not explicitly bound to uphold the profession's codes of ethics. This diverts them from their responsibility in most of the cases.

An Engineer should recognize that he is a member of community and just can't act alone. There are boundary conditions for making money and that as a professional he should not do everything that he is asked to do, he has a responsibility not just to the professional society but towards the society as a whole. We can summarize that the professional ethics will play an important role in achieving the sustainable built environment in true sense.

[Acknowledgement:"Engineering Ethics" by Charles E. Harris et.al.; "The Experiences and Challenges of Science and Ethics", Proceedings of an American–Iranian Workshop (2003), Annexure L by G. Ebrahimidinani,; NEP document and literature available at AICTE portal]

NATURE- THE BIGGEST BUILDER

Ayushi Chandani* And Khush Kumar Kanjani**

Abstract

The Universe has witnessed rise and fall of many civilizations. Such as the Sindhu Valley civilization. In this decade, hundreds of multi-storey buildings have been constructed which could not sustain the after effects of War and Natural Calamities.

The future is promising for Green buildings and roads which use solar and wind energy. Diesel and Petrol Pumps will be replaced by Battery charging stations. Power generation and road Transportation has to minimise carbon emission.

Sustainable development is the need of the hour to protect nature. This can be done by minimising pollution by promoting eco-friendly constructions. It will help for Nature to make it way back.

INTRODUCTION

The history of India starts with Sindhu Valley Civilization, in 2300-1750 BC, about 4400 years ago. The historians say that Sindhu Valley Civilization was the biggest civilization at that time. The structures of this Valley were better than today's cities. Bathrooms and drainage were used at that time. This is called Bronze age civilization because, for the first time, man used tools made of bronze.

Since then, universe has seen rise and fall of many civilizations. In this century, hundreds of such multi storeyed buildings were built which could not sustain the after effects of war and natural calamities.

MODERN ERA

Electricity is the force that made modern world possible. It is the versatile source of energy that has evolved over time into a necessity. Electricity has now reached every home, even the poorest of poor. But generation of electricity from coal has polluted the environment. Mankind is paying a very high price for it. Emissions of poisonous gases from road transport has aggravated it further more. The houses, in which citizens live, emit carbon dioxide causing heavy pollution even without their knowledge. The bitter experience of global warming has alarmed and compelled the mankind the ways they operate on earth. Within the Construction Industry, the green buildings concept has evolved and is gaining momentum rapidly across the world.

POLLUTION

Pollution is the addition of contaminants into natural environment that causes instability and harm to ecosystem. Toxic substances like poisonous gases, chemical wastes, garbage, abuse of natural resources, sewage etc. cause many types of pollution. Pollution can be divided into following categories:

Air Pollution: When unwanted chemicals, gases and toxic particles enter the atmosphere, they cause air Pollution. It causes harm to all living organisms and damages the natural cycle of the earth.

Causes of Air Pollution: Human activities are major cause of air pollution, Harmful gases and smoke enter the atmosphere due to vehicles, factories, power plants etc. Carbon-die-oxide, carbon- monoxide, sulphur etc are some major gases that pollute air:

- Burning of fossil fuels like coal and natural gas also releases many contaminants into air.
- Sometimes natural phenomenon's like forest

**Architect (L&T Mumbai)*
***Student B.Tech., (IIT Prayagraj)*

fire, volcanoes, dust storms etc cause air Pollution.

Effects on Environment:

- Global warming is the most harmful effect of air Pollution caused due to harmful gases
- Ozone layer is getting depleted rapidly because of release of gases like chloroform- carbon, methene gas etc.
- Acid rain is created when high quantity of gases such as sulphur-di-oxide is released into air. It damages forests & buildings and kills fishes.
- Air Pollution has extremely damaging effect on human health. People get disease such as asthma, lung cancer, respiratory infections and heart diseases etc.
- Due to air Pollution, thick smog engulfs the urban areas which makes the life very difficult for people living in metro cities

Land Pollution : Anything that contaminates the land is land pollution.

Causes of Land Pollution :

- The primary cause is garbage. Most of trash that we throw in the form of plastic, polythene wrappers, electrical wastes, is non cyclable and causes land pollution.
- Farming also causes land pollution in the form of fertilizers, pesticides, and insecticides that are added to soil
- Animal wastes and human wastes in the open leads to a large number of bacteria and germs, causing land pollution.

Effects of Land Pollution :

- The addition of chemical waste from factories, toxic waste from mining make the soil harmful and lead their way into our food. It causes a number of soil born diseases.eg. cancer and skin problems.
- Animals and plants die because of contaminated soil and food chain is disrupted.
- Land Pollution makes the surroundings ugly and destroys the beauty of nation.

Water Pollution: When waste chemicals, sewage, harmful substances are added to water bodies, water gets polluted. Water pollution can disrupt the water cycle and can negatively impact health of humans, animals and marine life.

Effects of Water Pollution :

- Non-availability of fresh portable water takes toll on health of billions of people. Dirty polluted water is a host of many diseases like cholera, typhoid, and dysentery which cause millions of deaths every year.
- Water pollution in oceans and rivers causes fishes to suffocate and die
- Oil spills and acid rain cause harm to marine habitats.

Noise Pollution: Sound is the means of communication. A low sound is pleasant whereas loud sound is unpleasant and is generally referred as noise.

Effects of Noise Pollution: Noise pollution can have following physical, mental and behavioural effects on human health:

- It disrupts sound sleep and our ability to work and concentrate.
- It can increase B.P., stress, heart related diseases and fatigue
- Chronic noise can lead to loss of hearing.

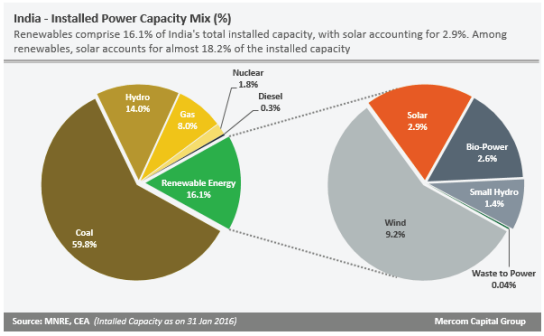
Pollution caused by Coal Fired Power Plants : Coal is the primary fuel for generation of electricity in India and its use is increasing continuously to meet the demands of this country. The main emissions from coal combustion at thermal power stations are CO_2, Nitrogen oxides, sulphur oxides, clorofluido carbides and airborne inorganic pesticides such as fly ash.

A study by IEA (International Energy Agency) has stated that coal burning is responsible for heavy pollution in India. Coal based Thermal power stations contribute over half of sulphur-di-oxide, 30% oxides of nitrogen, and 20% particulate matter.

Burning of coal in thermal Power stations is the major source of pollution in water bodies also. This

results in the formation of fly ash. These ashes contain many harmful metals like arsenic and mercury which are deposited in nearby water bodies with very less utilisation. Bottom ash accumulated in ash ponds can further contaminate ground water through leaching.

RENEWABLE ENERGY GENERATION



Solar sector is ballooning at a rapid pace.

Renewable energy generation in India continues to grow, accounting for ~16.10 percent of India's energy mix, according to Mercom Capital Group. The country's total installed generation capacity is 315,369.08 MW with renewables accounting for 50,745 MW of it. Hydro power makes up 14.01 percent, with 44,189.43 MW of the total power generated in the country. Nuclear power has a total capacity of 5,780 MW and making up 1.83 percent of the energy generation. The solar sector is witnessing installations at a rapid pace. The recent solar auction at the Rewa solar park witnessed record low tariff of Rs.3.30/kWh, closing in on thermal power tariffs. Solar accounts for 9,235.24 MW of the total installed capacity and 2.93 percent of overall power generation, an increase of 0.06 percent over a month.

The wind sector recently successfully implemented competitive bidding process to develop wind power projects of 1,000 MW at record low tariff giving a boost to future wind auctions. Wind currently accounts for 28,871.59 MW of the total installed capacity and 9.15 percent of overall power generation, an increase of 0.01 percent over a month. The installed capacity of small hydro has increased slightly with 4341.85 MW of total installed capacity. Coal-based generation capacity in India stands at 59.77 percent of the total installed capacity of 315,369.08 MW as of January 31, 2016, according to the Central Electricity Authority (CEA). The total thermal power generation stands at 68.07 percent with a capacity of 214,354.89 MW. Thermal power numbers are declining as no new projects are being commissioned and thermal project developers have inhibitions about developing new projects due to the draft electricity plan 2017-2022.

NATURE MEANS GRENERY

Nature has 5 elements namely, sky, air, sunlight, water and earth. Right combination of all the 5 elements of nature is essential for good buildings. Green Building involves a building which incorporates environment consideration into every stage of building from concept to completion. Its objective is to protect occupants health. Green building allows us to preserve most of environment, promote a healthy environment, will not disrupt the environment, water and air, improve employees productivity, use natural resources wisely and reduce environment impact. Green buildings provide better health to occupants due to improved indoor quality, development of more energy efficient materials and use of less natural resources. Some of the advantages of green buildings are:

- Low maintenance and operation costs
- Energy efficiency
- Enhanced indoor environmental Quality
- Water efficiency
- Better Health
- Material efficiency
- Better Environment
- Reduced strain on natural resources

TOP TEN GREEN BUILDINGS OF INDIA

With bleaching coral reefs, rising global temperature and melting ice caps – Mother Earth is dying. Thanks to the concept of green buildings, we are able to save our only source of life – The Earth. India is amongst the few countries spearheading the green building movement worldwide. The Indian Green Building Council (IGBC) is a part of the Confederation of Indian Industry (CII). In the year 2001, the council's vision was to build a feasible environment for India

by 2025. Let's look at some of the benefits of green building and to bring the efforts of some of the top pioneers in limelight, here we are listing the top 10 green buildings in India.

Suzlon One Earth, Pune : This significantly unique office is designed by Christopher Charles, Pune based architect and has received LEED Platinum rating in 2010. To ignite our eyes, he and his partner came up with the concept "Office in the garden". Spread over 10 acres, this magnificent structure is one of the largest green building projects of the country and is also one of the India's first buildings to be LEED (Leadership in Energy and Environmental Design) certified.

Suzlon one earth is 100% powered by onsite and offsite renewable sources. The campus has 18 hybrid wind turbines that fulfil 7% of the total energy consumption, the rest of energy demand is met from offsite wind turbines. The structure is designed in a way to ensure maximum daylight exposure thereby reducing artificial lighting consumption. The infrastructure within the campus is designed to enable water percolation and thereby control storm water runoff thus, contributing towards an increased water table level.

Rajiv Gandhi International Airport (RGIA), Hyderabad : India's 6th busiest airport, which is situated in the downtown of Hyderabad has set a benchmark for the green buildings in India.

The structure of the airport is designed in a way so as to consume less water, electricity and conserves natural resources. Within the campus of the airport, there is a green belt of 273 hectares with numerous plants. In the last couple of years, RGIA has been successful in saving energy for nearly 3.97 million kWh and have reduced the carbon footprint by 3331 tons.

CII-Sohrabji Godrej Green Business Centre, Hyderabad

This architectural masterpiece has set the world's best example of passive architectural design. The CII-Sohrabji Godrej Green Business Center (GBC) was the first building outside of the US to be awarded LEED platinum rating at the time of its inauguration. The building doesn't let out any waste and recycles it all within. It can be said that building is literally made up of only recycled materials.

Infosys Limited, Mysore :

Located in the city of palaces, this green building is an awe-inspiring structure is the third Infosys building to win a Platinum rating, taking the total Platinum certified building area at Infosys to 780,000 sq ft. The 5 storey structure has been built keeping in mind a holistic approach to sustainability in five key areas, including – Sustainable site development, Water savings, Energy efficiency, Materials selection and Indoor environmental quality. The smart mechanism and efficient equipments lead to 40% of less energy consumption.

Infinity Benchmark, Kolkata:

At the time of its inauguration, this 20 storey structure which is spread over 5,60,000sq.feet was 7th building in the world to receive the LEED Platinum rating. The building is furnished with CO_2 monitor sensors, rainwater harvesting, waste water recycling system and humidification controls. The exterior of the building is made of brick wall block while the roof comprises of deck thick polyurethane foam for better insulation.

I-Gate Knowledge Centre, Noida :

Next on the list of green buildings is the Patni Knowledge Centre with the prestigious platinum LEED rating. The building is built over 4,60,000 sq.ft. in Suburban Noida and is designed in a way that it captures 73% of daylight within the office. Nearly 50% of land is covered with grass which doesn't let wastes and sewage water go out.

Bank of India, Goa :

A world of eco-friendly lights and air-conditioning, intelligent glazing, modern capsule lifts, and indoor fountains – this is what sums of this popular bank in Goa. The building uses Nano Misty Blue, softening colour glass manufactured by Saint Gobin Glass, India for producing the cool effect and saving energy. The glass has solar control and thermal insulation properties. The building is a complete package of modern look of today's bank.

Ansal Esencia, 67 Sector, Gurgaon :

This is another masterpiece by Indian architects that wants to be a part of the Green eco Revolution. The features of this building are viable sources of energy; all electronics are made for maximum energy conservation, splendid bicycle tracks, environ benches, bins, poles and bus stops and drought resistant campus.

Biodiversity Conservation India Ltd. (BCIL), Bangalore : In 1994, BCIL was established when green building concept was foreign to all of us and was something one could not locate even with long-range radar. The building was established with an aim of creating eco-friendly living habitats, especially in the urban space. It is a wonderful example of smart homes where one can turn lights off using mobile phones.

That's not all. The building has 44 interconnected rainwater percolation wells that lead to a 400,000 litre water tank. The building makes use of central reverse osmosis system to purify water without the use of chemicals. Grey water is directed to the gardens, toilets and for washing cars.

Olympia Tech Park, Chennai :

Located in technological nerve centre of the city, Olympia Tech Park is one of the largest and most sought after IT parks in Namma Chennai. This majestic structure is worldwide famous for being the first green building of its size (1.8 million sq.ft.) and has some of the best fortune-100 companies operating in it.

Rated as one of the largest LEED Gold rating buildings of the world, this tech park has the lowest energy consumption, high natural lighting systems, 100 per cent water recycling and other environment-friendly practices.

RECENT STUDIES/ DEVELOPMENTS

- A recent research on 148 countries conducted by LEED University, as published in "Nature" magazine with a title "Social shortfall of ecological overshoot of nations" shows that not even a single country is capable of meeting the basic necessities without depleting the Natural Resources.
- Natural Resources are depleting very fast to meet the basic necessities of life. Forests are being cut to meet the needs of wood for fuel and construction of buildings. Number of trees which absorb corbon di oxide from atmosphere, is reducing fast because new trees are not being planted in enough number to replace the trees being cut.
- Ground work is being started on 1500 MW "Solar Parks" at Agar-Shajapur-Neemach belt of Madhya Pradesh. This will save emissions of ahout 30 lakh M.Ton carbon-dioxide which will be equivalent to 5 crore trees in 25 years. The farmers are being encouraged to install solar panels or to give their land on lease for this purpose.
- Green roads are being constructed on National Highways to minimise pollution from vehicles. Battery charging stations will be installed to charge electo vans. Indian Railways are constructing new third rail lines dedicated to goods trains.

CONCLUSION

The pollution of air, land and water in India, and all over the world, is causing sever damage to health of billions of people including deaths of millions every year. Manmade disasters, like emissions of carbon from coal fired thermal power stations and road transport are causing serious damage to eco system. Green buildings, green roads and green energy can improve health and life of people. Let us plant and preserve more trees. Return to Nature is necessary for sustainable development.

CHALLENGES IN SUSTAINABLE DESIGN AND CONSTRUCTION

Dr. Sunil Kumar Chaudhary*

Abstract

The world has experienced unprecedented urban growth in the last and current centuries. In 1800, only 3% of the world's population lived in urban areas. It increased to 14% and 47% in 1900 and 2000, respectively. Since 2008, for the first time in history, more than half of the world population lives in the urban areas. In year 2003, United Nations estimated that by year 2030, up to five billion people will be living in urban areas, accounting for 61% of the world's population. The ongoing migration to urban areas has massive environmental consequences. This condition of unprecedented shift from the countryside to cities has been influencing climate change, where urban areas account for up to 70% of the world greenhouse gas emissions.

As the number of buildings and associated infrastructures increases drastically in order to cope with the increasing population in cities, tremendous resources are required for the construction, and maintenance of these buildings. Design of these buildings become very crucial as the resources required in the subsequent operation and maintenance is highly dependent on the quality of such design. Over the years, there has been tremendous effort put in to design "Green Buildings," with the key objective to make the buildings more sustainable by minimizing the utilization of resources in the construction and maintenance of buildings. Building systems such as air conditioning and lighting are energy guzzlers, which can consume more than 60% of the energy consumption in a typical building. They can also impact the indoor environmental quality. Thus, energy efficiency of the systems is crucial. Selection of materials, which can minimize the embodied energy and construction waste is also important. Challenges in sustainable design and construction have been discussed in detail in this Paper. A case study has also been discussed.

INTRODUCTION

Cities are growing toward megacities with higher density urban planning, narrower urban corridors, and more high-rise urban structures. Increasing urbanization causes the deterioration of the urban environment, as the size of housing plots decreases, thus increasing densities and crowding out greeneries (Santamouris et al., 2001). Cities tend to record higher temperatures than their non-urbanized surroundings, a phenomenon known as urban heat island (UHI) (Oke, 1982; Jusuf et al., 2007). Earlier studies show strong relation between urban morphology and increasing air temperature within city centres. Urban structures absorb solar heat during the day and release it during the night. Densely built area tends to trap heat, which is released from urban structures into the urban environment, increasing urban air temperature compared to surrounding rural areas and causes UHI effect. UHI affects street level thermal comfort, health, environment quality, and may increase the urban energy demand.

As the number of buildings and associated infrastructures increases drastically in order to cope with the increasing population in cities, tremendous resources are required for the construction, and maintenance of these buildings. Design of these buildings become very crucial as the resources required in the subsequent operation and maintenance is highly dependent on the quality of such design (Macmillan, 2005). Over the years, there has been tremendous effort put in to design "Green Buildings," with the key objective to make

*Executive Engineer, Road Construction Department, Vaishali Road Division, Hazipur

the buildings more sustainable by minimizing the utilization of resources in the construction and maintenance of buildings. Selection of materials, which can minimize the embodied energy and construction waste is also important.

ADVANCES IN THE DESIGN, CONSTRUCTION AND MAINTENANCE OF THE BUILT ENVIRONMENT

The multifaceted relationship between microclimate and built environment is the key to promote sustainable theme within design and building practice. There is a vast body of knowledge and research studies about this matter, but to understand fully the microclimate impact on built environment is still a very challenging task. The whole ecology system comprises many systems, which are too complex to be quantified and represented in numbers and models (Yeang, 1995). However, this incomplete and inadequate state of current knowledge about climate–urban relationship should not be the reason to be evasive toward preventive or corrective actions within the design process. Planners and engineers should view design process with a proper understanding on ecological aspects, where the concerns should be laid not just at present time, but also for the future. Over the years, researchers have attempted to develop techniques, models, simulation platforms, etc. for urban planners and architects to understand the impact of their designs on various environmental parameters. One key aspect that has shown tremendous progress is in the study of the urban climate, which deals with issues such as UHI, urban airflow, air pollution, urban noise, daylighting, outdoor thermal comfort, etc. (Kang, 2002; Wong et al., 2003; Compagnon, 2004; Georgakis and Santamouris, 2004; Gulliver and Briggs, 2011; Yang et al., 2013). In recent years, modelling techniques to map out the urban climate (temperature, wind, solar radiation, daylighting) have been developed that help to guide the urban design (Matzarakis et al., 2010; Wong et al., 2011; Tominaga and Stathopoulos, 2013). Various mitigation measures such as the integration of greenery with the urban structures (Wong et al., 2003, 2009; Chen and Wong, 2005), application of cool roof materials (Santamouris et al., 2011; Akbari and Damon Matthews, 2012), improvement of the urban airflow, control of the anthropogenic heat (Sailor, 2010) in urban centers, etc., have been studied to great extent.

At the building level, there has been good progress in the modelling of the performance of buildings and the associate systems such as Energy (Crawley et al., 2008), thermal (Hensen and Lamberts, 2012), lighting (Thanachareonkit et al., 2005), acoustic (Beradi, 2014), indoor air quality (Steeman et al., 2009), etc. with greater precision and certainty. With the advancement of information technology, greater utilization of sensors and control systems have been observed in buildings resulting in better performance and energy efficiency in buildings. At the material level, nano-technology has been employed to develop building materials that can help to improve the performance of buildings such as improving the thermal and acoustical insulation, allowing more daylighting through glazing systems but reducing the entry of heat. The concept of Life Cycle Analysis (Dixit et al., 2010; Ramesh et al., 2010) has also been introduced that monitors the embodied body of resources utilized throughout the entire building life cycle. This has also resulted in better control of resources utilization during the design, planning and construction of buildings.

CURRENT CHALLENGES IN SUSTAINABLE DESIGN AND CONSTRUCTION

Despite the advances in the research and development in the built environment as discussed in the earlier section, there are still major challenges encountered. One key challenge is in the integration of such practices in the design process. Most designers still see such tasks as the responsibilities of the environmental consultants rather than part and parcel of their design tasks. Thus, it is essential that more research should be conducted to seamlessly integrate such modelling approaches with the design process. With the advancement of Building Information Modelling (BIM) (Bynum et al., 2013; Volk et al., 2014), this will serve as an excellent platform for such integration to occur. It also allows a better integration of the different simulation models so that a better understanding of the relationship between these simulation models

could be obtained. Currently, there is also lack of understanding of the inter-relationship between urban and building systems. Such understanding is crucial as studies have shown that the microclimates, which are very much governed by the urban systems could have major impact on the energy, thermal, and lighting performance of buildings. Currently, there are tremendous research works done at the urban level using Geographical Information System (GIS). The study of such inter-relationship between urban and building systems could be facilitated by a better integration between GIS and BIM.

CASE STUDY- GREEN CONSTRUCTION OF DISASTER RESISTANT (EARTHQUAKE RESISTANT, FLOOD RESISTANT & CYCLONE RESISTANT), COST EFFECTIVE AND ECO-FRIENDLY RURAL HOUSES

Client Requirements: In the present case the client was Bihar State Disaster Management Authority, Govt of Bihar. The Client requirement was to construct two types of disaster resistant building – One type having plinth area - 41.28 sqm and the other type having plinth area-20.64 sqm with minimum cost with beautiful appearance. Since it was Earthquake prone, flood prone and Cyclone prone belt of State, expectation was to use such innovative materials which were cost effective and disaster resistant in earthquake prone, flood prone and cyclone prone environment. Material and technology used should be cost effective and eco-friendly in nature. Time for construction was given only 06 month.

Keeping in view the above requirements the building was designed and constructed adopting efficient design and using innovative, cost effective and eco-friendly material within 06 month. Hence satisfies client requirements.

BRIEF DESCRIPTION OF PROJECT

All the 52 houses constructed in Singhwara village of Bihar. One type of Twenty six number of houses have plinth area-41.28 sqm and the other type of Twenty six number of houses have plinth area-41.28 sqm. The rectangular plan is divided in two rooms of unequal surface. The house has an attached veranda on the longer front. This is a traditionally multi-purpose work space used by occupants.

Structure Type-I : The structure is made of bamboo columns and beams, generally tied together with recycled ropes from zippers (an industrial by-product found in plenty in the area). The bamboo structure is supporting the roof cladding made of Banana Fibre–reinforced fly ash cement mortar composite sheets. This material is known to have an extremely poor thermal insulation capacity; therefore it is coupled with an internal layer of straw for better insulation.

The walling system consists of a frame of bamboo (a mesh of horizontal and vertical elements) filled with thatch, split bamboo canes or woven strips. This layer is then covered with 3 inches of mud plaster finished with a layer of cement plaster on the outer face as it is more durable and resistant to the monsoon rains and simple mud plaster on the inner side. Mud plaster is the cheapest and most available solution. The perforated pattern on the upper belt was made to facilitate the air flow and penetration of sunlight in the loft. The bamboo loft also works as an insulating false ceiling for the interiors below.

Salient Features:

- These Single story houses have foundation of FaL-G Block.
- These houses are made of a bamboo structural frame and roofing, bamboo mat walls.
- Houses were plastered with Mud mortar inside and with FaL-G mortar outside.
- High volume fly ash Concrete was used for PCC in foundation.
- Plinth Area single House: 41.28 sqm.
- Cost of the Building: Rs 35000/-.
- CFL Bulb and renewable energy sources like Solar PV and Solar Lights were used

Table 1: Comparison of cost for construction materials for Structure type-I

S. No	Item	Quantity (No)	Unit	Rate (INR)	Cost (INR)	Remark
1.	Clay brick	3500	No	7.0	24500	
2.	Fly ash brick	3500	No	3.5	12250	50% less
3.	OPC	20	Bag	240	4800	
4.	PPC	20	Bag	170	3400	29.0% less

Source: Quantity of construction materials has been worked out and rates are taken from current scheduled rates of PWD-2017.

Table 2: Comparison of energy consumption for electrical appliances/Month

S. No	Item	Quantity (No)	Installation Cost (INR)	Electricity Cost (INR)	Total Cost (INR)	Remark
1.	Tube Light	4	5500	6500	12000	
2.	CFL Light	4	2500	2500	5000	58.30% less

Source: Cost of electricity as per Bihar State Electric Board (BSEB) tariff 2017

Table 3: Comparison of carbon emission for construction materials

S. No	Item	Quantity	Unit	Kg CO_2 /per unit	Total Kg CO_2	Remark
1.	Clay brick	3500	No	0.59	2065.00	
2.	Flyash brick	3500	No	0.11	385.00	81.36% less
3.	OPC	20	Bag	0.89	17.8	
4.	PPC	20	Bag	0.60	12.0	32.6% less

Table 4: Comparison of carbon emission for electrical appliances

S. No	Item	Quantity (No)	Total power Kwh	Tonne CO_2/ Kwh	Total CO_2 Tonnes	Remark
1.	Tube Light	4.0	1507	0.0005883	0.89	
2.	CFL Light	4.0	561	0.0005883	0.33	63.0% less

Source: Department of Energy's Energy Information Administration. Electricity sources emit 1.297 lbs CO_2 per kWh (0.0005883 metric tons CO_2 per Kwh).

Structure Type-II: The structure is made of Flyash Brick Pillars and beams. Reinforcement having L shape at all corners and of Flyash Brick Pillar is inserted in foundation and Beam upto 450 mm ensures proper tie-up of beam and column and maximize the box action of building. The bamboo structure is supporting the roof cladding made of Banana Fibre –reinforced fly ash cement mortar composite sheets. This material is known to have an extremely poor thermal insulation capacity; therefore it is coupled with an internal layer of straw for better insulation.

The walling system consists of Fly ash brick with fly ash mortar 1:4. This wall is then covered with flyash cement plaster on both face as it is more durable and resistant to the monsoon rains. The perforated pattern on the upper belt was made to facilitate the air flow and penetration of sunlight in the loft. The bamboo loft also works as an insulating false ceiling for the interiors below.

Salient Features:

- These Single story houses have foundation of FaL-G Block.
- These houses are made of bamboo roofing, Fly ash Brick walls.
- Houses were plastered with FaL-G mortar.
- High volume fly ash Concrete was used for PCC in foundation and pocket in Fly ash Brick Pillar.
- Plinth Area single House: 41.28 sqm.
- Cost of the Building: Rs 62000/-.
- CFL Bulb and renewable energy sources like Solar PV and Solar Lights were used.

Table 1: Comparison of cost for construction materials for Structure Type-II

S. No	Item	Quantity (No)	Unit	Rate (INR)	Cost (INR)	Remark
1.	Clay brick	10500	No	7.0	73500	
2.	Fly ash brick	10500	No	3.5	36750	50% less
3.	OPC	62	Bag	240	14880	
4.	PPC	62	Bag	170	10540	29.0% less

Source: Quantity of construction materials has been worked out and rates are taken from current scheduled rates of PWD-2017.

Table 2: Comparison of energy consumption for electrical appliances/Month

S.No	Item	Quantity (No)	Installation Cost (INR)	Electricity Cost (INR)	Total Cost (INR)	Remark
1.	Tube Light	4	5500	6500	12000	
2.	CFL Light	4	2500	2500	5000	58.33% less

Source: Cost of electricity as per Bihar State Electric Board (BSEB) tariff 2017

Table 3 : Comparison of carbon emission for construction materials

S. No	Item	Quantity	Unit	$KgCO_2$/ Per unit	Total Kg CO_2	Remark
1.	Clay brick	10500	No	0.59	6195.00	
2.	Fly ash brick	10500	No	0.11	1155.00	81.36% less
3.	OPC	62	Bag	0.89	660.38	
4.	PPC	62	Bag	0.60	445.2	32.58% less
5.	Steel	0.0089	Tonne	1.987	18.00	
6.	Recycled steel	0.0089	Tonne	0.357	4.00	78.0% less

Table 4 : Comparison of carbon emission for electrical appliances

S.No	Item	Quantity (No)	Total Power Kwh	Tonne CO_2/ Kwh	Total CO_2 Tonne	Remark
1.	Tube Light	4.0	1507	0.0005883	0.89	
2.	CFL Light	4.0	561	0.0005883	0.33	63.0% less

Source: Department of Energy's Energy Information Administration. Electricity sources emit 1.297 lbs CO_2 per kWh (0.0005883 metric tons CO_2 per Kwh)

NOVELTY OF THIS PROJECT:

- Made with Simple, Low cost locally available materials, tools and skills material
- Resistant to natural hazards
- Environmentally Sustainable and Energy Efficient
- Socially, aesthetically and culturally appropriate to the context
- Flexible for future upgrading and extensions
- Easy to maintain
- Easy to disconnect, reuse and recycle in its parts

FUTURE DIRECTIONS

It is envisaged that in the near future, there would be a development of a universal and integrated model that could embed the entire urban and building models. As such, it allows the seamless integration between these two scales of models. This will also facilitate the development of the boundary conditions generated by the urban model that could be easily utilized by the building model for the simulations. For example, simulations could be conducted to understand the wind and temperature distribution at the urban level and such data could be seamless utilized by the individual building model for the detail simulations of the wind or

temperature condition inside the building. Another key development would be the integration of the sensors with the urban model for master planning purpose and for creation of smart cities. Such data at the urban level would then be prorogated to the building level for better understanding of the impact on energy, building performance, etc. At the building level, better integration of sensor data and performance simulations could be achieved and thus results in better energy efficiency and performance of buildings. There should also be more integration of user behaviour with the performance simulations.

CONCLUSION

Currently, the research in Sustainable Design and Construction tends to be very fragmented. It is essential that a more holistic approach should be developed to better understand the relationship between urban, building, building systems, and material. It is also essential that such understanding should be propagated throughout the building delivery process from inception to design to construction, operation, and maintenance of the built environment.

REFERENCES

1. Akbari H. and Damon Matthews, H. (2012). Global cooling updates: reflective roofs and pavements. Energy Build. 55, pp 2–6.
2. Beradi, U. (2014). Simulation of acoustical parameters in rectangular churches. J. Build. Perform. Simul. 7, pp1–16.
3. Bynum, P., Issa, R., and Olbina, S. (2013). Building information modeling in support of sustainable design and construction. J. Constr. Eng. Manag. 139, pp24–34.
4. Chen, Y., and Wong, N. H. (2005). Thermal benefits of city parks. Energy Build. 38, pp105–120.
5. Compagnon, R. (2004). Solar and daylight availability in the urban fabric. Energy Build. 36, pp321–328.
6. Crawley, D., Hand, J., Kummert, M., and Griffith, B. (2008). Contrasting the capabilities of building energy performance simulation programs. Build. Environ. 43,pp661–673.
7. Dixit, M. K., Fernández-Solís, J. L., Lavy, S., and Culp, C. H. (2010). Identification of parameters for embodied energy measurement: a literature review. Energy Build. 42, pp1238–1247.
8. Georgakis, C. H., and Santamouris, M. (2004). On the air flow in urban canyons for ventilation purposes. Int. J. Vent. 3, 6.
9. Gulliver, J., and Briggs, D. (2011). STEMS-air: a simple GIS-based air pollution dispersion model for city-wide exposure assessment. Sci. Total Environ. 409,pp2419–2429.
10. Hensen, J., and Lamberts, R. (2012). Building Performance Simulation for Design and Operation. New York: Spon Press.
11. Jusuf, S. K., Wong, N. H., Hagen, E., Anggoro, R., and Yan, H. (2007). The influence of land use on the urban heat island in Singapore. Habitat Int. 31,pp232–242.
12. Kang, J. (2002). Numerical modelling of the sound fields in urban streets with diffusely reflecting boundaries. J. Sound Vib. 258, pp793–813.
13. Laski, L., and Schellekens, S. (2007). "Growing up urban," in The State of World Population 2007 Youth Supplement, eds A. Marshal and A. Singer (New York: United Nations Population Fund (UNFPA)).
14. Macmillan, S. (2005). Designing Better Buildings, Quality and Value in the Built Environment. New York: Taylor and Francis.
15. Matzarakis, A., Rutz, F., and Mayer, H. (2010). Modelling radiation fluxes in simple and complex environments: basics of the RayMan model. Int. J. Biometeorol. 54,pp131–139.
16. Oke, T. R. (1982). The energetic basis of the urban heat island. Q. J. R. Meteorol. Soc. 108, pp1–24.
17. Ramesh, T., Prakash, R., and Shukla, K. K. (2010). Life cycle energy analysis of buildings:

an overview. Energy Build. 42, pp1592–1600.

18. Sailor, D. (2010). A review of methods for estimating anthropogenic heat and moisture emissions in the urban environment. Int. J. Climatol. 31, pp189–199.

19. Santamouris, M., Asimakopoulos, D. N., Assimakopoulos, V. D., Chrisomallidou, N., Klitsikas, N., Mangold, N., et al. (2001). Energy and Climate in the Urban Built Environment, Chap. 1. ed. M. Santamouris (London: James & James), 54.

20. Santamouris, M., Synnefa, A., and Karlessi, T. (2011). Using advanced cool materials in the urban built environment to mitigate heat islands and improve thermal comfort conditions. Sol. Energy 85, pp3085–3102.

21. Steeman, H. J., Janssens, A., Carmeliet, J., and De Paepe, M. (2009). Modelling indoor air and hygrothermal wall interaction in building simulation: comparison between CFD and a well-mixed zonal model. Build. Environ. 44, pp572–583.

22. Thanachareonkit, A., Scartezzini, J., and Andersen, M. (2005). Comparing daylighting performances assessment of buildings in scale models and test modules. Sol. Energy 79, pp168–182.

23. Tominaga, Y., and Stathopoulos, T. (2013). CFD simulation of near-field pollutant dispersion in the urban environment: a review of current modeling techniques. Atmos. Environ. 79, pp716–730.

24. Volk, R., Stengel, J., and Schultmann, F. (2014). Building information modeling (BIM) for existing buildings – literature review and future needs. Autom. Constr. 38,pp109–127.

25. Wong, N. H., and Chen, Y. (2003). Study of green areas and urban heat island in a tropical city. Habitat Int. 29, pp547–558.

26. Wong, N. H., Chen, Y., Ong, C. L., and Sia, A. (2003). Investigation of thermal benefits of rooftop garden in the tropical environment. Buil. Environ. 38, pp261–270.

27. Wong, N. H., Jusuf, S. K., Samsudin, R., Eliza, A., and Ignatius, M. (2011). "A climatic responsive urban planning model for high density city: Singapore's commercial district," in The 5th International Conference of the International Forum on Urbanism (IFoU) (Singapore: National University of Singapore).

28. Wong, N. H., TAN, Y. K. A., Chen, Y., Sekar, K., Tan, P. Y., Chan, D., et al. (2009). Thermal evaluation of vertical greenery systems for building walls. Build. Environ. 45, pp663–672.

29. Yang, W., Wong, N. H., and Jusuf, S. K. (2013). Thermal comfort in outdoor urban spaces in Singapore. Build. Environ. 59, pp426–435.

30. Yeang, K. (1995). Designing With Nature: The Ecological Basis for Architectural Design. New York, NY: McGraw-Hill.

EXPERIMENTAL STUDY ON TILES MADE FROM WASTE PLASTIC AND CONSTRUCTION WASTE

T.R. Dakshayani* And Manoj T. N.**

Abstract

Plastic is a non-biodegradable material, which is widely used in day to-day life. Due to lack of awareness about proper recycling and reusage of plastic it is disposed in an unscientific way. So, it has become major issue to the environmentalists and causing severe impact on environment. Construction industry is regarded as one of the foremost reasons of environment degradation worldwide. Waste is considered an apex issue in the construction sector because of its economic and ecological influences. C & D waste is debris generated due to construction, renovation, and demolition of the buildings. So, this C & D waste is to be managed properly. About 90% of C & D waste can be recycled but most of the C & D waste in India is getting disposed into the landfills. By recycling C & D waste over exploitation of natural resources can be reduced and the pollution caused by it can also be reduced. An attempt is made in our paper to recycle waste LDPE plastic and Construction and demolition (C&D) waste effectively to produce low - cost pavement tiles which can be used in public places like footpaths, parking areas, roof toppings etc. Thus, an attempt made, to help in reducing the plastic waste that is generated enormously worldwide.

INTRODUCTION

India's urban population is expected to grow from nearly 38 crores (2011 census) to 60 crores in 2030. Higher incomes and consumption due to increased urbanization will lead to three times the current waste generation from 62 million tonnes to 165 million tonnes by 2030. High consumption of plastic due to its durability, low cost, flexibility, moisture resistance, superior insulation, low maintenance etc. combined with its resistance to decomposition is causing severe environmental pollution and health problems. India generates 26,000 TPD of plastic waste amounting to 9.4 million TPA (source Google). Even though 60% of collected plastic produced in India is recycled, 9400 TDP of plastic waste is left unattended. This waste can be gainfully utilized through various initiatives. The infrastructure of India is growing rapidly, so that fast growth of construction industry will increase the generation of construction and demolition waste therefore proper management of construction and demolition waste should be needed. Reusing and recycling is one of the measures to reduce the construction and demolition waste. The market demands for the material which is used for the construction purpose is more and the supply of the material is low compared with the demand. So to meet the demand of the market recycling is one of the major aspects. Reusing and recycling is the important term in the market to satisfy the demand of construction material in the market.

**Assistant Prof., Dept. of Civil Engineering, MVJ College of Engineering, Bengaluru, Karnataka*

***Student Department of Civil Engineering, MVJ College of Engineering, Bengaluru, Karnataka*

MATERIALS AND METHODOLOGY

Materials:

(i) Plastic (Low Density Polyethylene)
(ii) Construction and Demolition waste
- Concrete
- Bricks
- Construction debris

(iii) Container for Melting LDPE plastic
(iv) Furnace

Methodology :

Collection and Washing of LDPE Plastic: LDPE Plastic waste is generally collected from local rag pickers and scrap collection enterprises. Collected plastic waste is washed with water just like vegetables and fruits later it is completely dried under sunlight.

Fig. 1: Collection of LDPE Plastic

Fig. 2: Washing process of Plastic

Fig. 3: Shredded LDPE Plastic

Fig. 4: Construction and Demolition

Shredding and Collection of Construction and Demolition Waste: In shredding process the plastic waste is cut into pieces with the help of scissor so the process of melting will be easily done. Construction and Demolition should contain concrete, bricks and construction waste. This consists of concrete cubes which is collected from the concrete lab of our department.

Crushing and Sieving of Construction and Demolition Waste: Crushing of construction and demolition waste is done so that binding with plastic will be easier. The sand passing through 4.75mm sieve is used in concrete. But in the preparation of plastic tiles crushed C & D waste passing through 1.18mm sieve is utilized.

Fig.5: Crushed powder of Concrete Blocks.

Fig. 6: Sieved construction and Demolition Waste

Mould Preparation and Melting: To give the final shape of the tile for molten plastic, a mould is made. This can be manufactured by welding MS plates together or by hard plastic mould. This process is done by adding shredded plastic into the container. Any source of heat can be used for melting. Normally LDPE Plastic converts to molten state at 130°C -150°C. At this point, molten plastic is added with sieved C & D waste and mixed thoroughly. The resultant plastic will act as a binding material.

Fig. 7: Type of Mould.

Fig. 8: Melting Container

RESULTS AND DISCUSSION

Water Absorption Test :

Trail No.	Before Absorption(gms)	After Absorption(gms)
1	3110	3123

Compression Test:

Trail No.	Load(kg)	Load (KN)	Compressive Strength
1	19000	186.27	2.98
2	25000	245	3.92

Results :
Average Load: 218.92 KN
Average compressive strength: 3.5 N/mm^2

Fire Resistance Test:

Trail No.	Temperature
1	130° C for 30 min
2	140° C for 35 min

Final Product :

CONCLUSION

In the current study, plastic and C & D waste were the major materials used in the manufacturing of tiles keeping in view, that both plastic and C & D waste are potentially harmful to the environment. Also, day by day increasing plastic waste is posing a threat to both flora and fauna.

Hence an attempt has been made to utilize the discarded plastic and C & D waste in suitable proportions in the manufacturing of cost effective and eco-friendly tiles which possess longer durability, higher compressive strength, easily available and has good machinability in cutting and finishing than the conventional tiles. Hence it can be definitely considered as an alternative to conventional tiles in the near future.

REFERENCES

1. Comparative Analysis of Tiles Made from Recyclable LDPE Plastic Waste. (Archit Hardikar, Omkar Borhade, Swapneel Wagholikar, Abhishek Shivdeo Rohit Bhikule Dept. Mechanical Engineering, Vishwakarma Institute of Technology, Pune.) (IJERT Vol 8 issue 2 Feb 2019)
2. An Experimental Study on Recycled Plastic Paving Stone. (L Pavan Kumar(Asst Prof), Chinna Suresh Babu(Asst Prof), M Vineetha, S Surya, A Suman, Dept of Civil Engineering, Chaitanya Bharathi Institute of Technology, Proddatur.) (IJRAR Vol 2 issue 1 May 2019)
3. Manufacturing of Pavement Block by Using Waste Plastic and Sea Sand. (Sunil Chavan, Shubham Tamhane, Mukesh Chavan, Prof. Mayur Tampure, Prof. Manoj Deosarkar, Dept of Civil Engineering, DYPSOET Pune.) (IJIRS Vol 8 issue 4 Apr 2019)
4. Reuse of Construction and Demolished Concrete Waste in Producing Strong and Affordable Concrete Blocks. (Mbereyaho Leopold, Ntitanguranwa Jean Paul, Kabano James and Gasingwa Noel) (RJESTE Vol 1 special issue 2018)
5. Strategy for Promoting Processing of Construction and Demolition (C&D) Waste and Utilization of Recycled Products(Ministry of Housing and Urban Affairs Govt of India) (Nov 2018)
6. The Impact of C & D Waste on Indian Environment: A Critical Review. (Sakshi Gupta and Malik) Department of Civil Engineering, Amity University Haryana, India. (Juniper publishers May 2018)
7. Utilization of Waste Plastic in Manufacturing of Plastic Sand Tiles. (Mrs.Manasi V.Ghamande , Mr.Pranay P. Gangele, Mr. Viraj P. Desale, Mr. Ajinkya M. Nande.) (IJARSE Vol 6 issue 11 Nov 2017.

CLIMATE CHANGE: NET ZERO DEMAND AND SUSTAINABLE HABITAT

Dr. R. K. Khitoliya* And Tulsi Puri**

Abstract

In India, climate change has emerged as the primary challenge for economic development. India ratified the Paris agreement on Climate change held in 2015 which required the member counties to make binding commitments to curb CO_2 emissions to keep global average temperatures rise below 2°C. The overall pact was finally adopted when the COP26 presidency accommodated India's concerns. The change from "phase-out" to "phase-down" with respect to coal power use in the final text was agreed to build the consensus. India is known for rich Architectural and cultural heritage. Thermal performance and air quality inside the buildings can be improved substantially and energy can be saved through understanding the ancient design concept. Landscaping was an integral part of Indian palaces and monuments. Jali is the ornamental feature provided in most of the palaces in Rajasthan, Taj Mahal and Agra fort which increase the ventilation and comfort. Courtyard in old residential buildings called Havelis as an element of passive cooling for regular fresh air supply used to be an important feature in hot dry climate. Technique adopted in heritage buildings for energy efficiency can be an incentive for Green Building Design.

The paper discusses the idea of Net Zero Demand due to climate change and need for sustainable habitat. The ancient passive techniques to improve the thermal comfort and ventilation through examples of heritage buildings which may prove an inspiration for energy efficient modern buildings design have also been discussed besides the concept of Green Buildings.

INTRODUCTION

The changed weather patterns, unpredicted rainfalls etc. clearly showcase the impacts of climate change. Recognizing the need to combat the effects of climate change, Government of India had launched the National Action Plan on Climate Change (NAPCC) in the year 2008 having eight national missions. The National Mission for Enhanced Energy Efficiency (NMEEE) under NAPCC consists of programmes having climate change mitigation attributes. The Perform, Achieve & Trade (PAT) scheme under NMEEE has helped in avoiding about 30 million tonnes of CO_2.The COP21 of 2015 in Paris reached a landmark agreement called the "Paris Agreement" to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The aim of the Paris Agreement is to keep the global temperature rise well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Subsequently, the Government of India submitted its Nationally Determined Contributions (NDCs) to UNFCCC.

In addition to the NMEEE programme, the Government of India has also taken various measures for bringing energy efficiency in various sectors of the economy such as Standards & Labelling for appliances, ECBC for buildings etc.

On Paris Agreement Rulebook as adopted in COP26, the new rules represent a new era in scrutiny on government climate pledges. It'll ensure that by 2024 everyone can assess what other countries are doing. It'll have more regular and more robust information on the state of GHG emissions and progress towards Implementing NDCs. Work on having a definite plan to compensate disaster-hit countries will now be shifted to COP27 in Egypt next year.

**Former Director - HBTI, Kanpur, Former Professor and Head, CED & Former Member-BOM, Punjab Engineering College, Chandigarh*
***Auditor, PCDA, Air H/Q, West Block 5, R K Puram, New Delhi*

The pact also moves on finalising the last piece of the unfinished agenda - a mechanism for a carbon market (Article 6) and transparency - of the Paris Agreement rulebook. The declaration also promises to deliver greater amounts of finance to developing countries by deciding to double the quantum for adaptation by 2025 and take steps to help vulnerable countries deal with losses and damages from climate impacts. An official from Indian delegation said, "Singling out coal without talking about other fossil fuels is not the best way forward".

The Federal Republic of Germany and the Government of the Republic of India have, under the Indo-German Technical Cooperation, agreed to jointly promote the "Indo-German Energy Programme" (IGEN) with the aim to foster energy efficiency and energy conservation in consumption in order to use energy more efficiently and in turn improve the protection of the environment.

Indian vernacular architecture reflects the environmental realities. The architectural quality makes a building a heritage building. Hindus & Mughals built magnificent monuments. Traditional architecture is the outcome of centuries of optimization of climate consideration, of material use, construction techniques. Landscaping elements water body and trees provided in monumental buildings, temples improves the micro climate of the place and increase the comfort level in the buildings.

ENERGY EFFICIENCY BUILDING PROGRAMME (EEBP)

Energy Efficiency Building Programme of the Federal Republic of Germany and the Government of the Republic of India: This program supports the Indian Ministry of Power and its Bureau of Energy Efficiency (BEE) in the development of an Energy Conservation Building Code for Multi-Storey Residential Buildings (ECBC-R) and thereafter supporting the implementation in selected states as well as municipalities through a mix of Bottom-Up and Top-Down approaches. During the assignment, capabilities have to be imparted to the stakeholders so that the code shall become implementable with ease.

Present Situation: The ancient India depicts majority of monuments in terms of preservation and sustenance of environment. During earlier times sustainability and sustainable buildings have been the usual way of life in India. These buildings provided comfort to the occupants. They were passive in approach with no external intervention, which in modern times have become quite necessary. Many ancient monuments like Taj Mahal, Hawa Mahal, Forts and the Kanheri Caves are classic examples of sustainable buildings.

Its Objective: Energy efficiency is one of the world's largest energy resource to save energy, and we are only just beginning to tap its potential. India is at a unique crossroads where two-thirds of the commercial and high-rise residential structures that will exist in 2030 are yet to be built. Thus, implementing energy efficiency in buildings that are being constructed in the next ten years presents a singular opportunity to lock in energy and cost savings for the next several decades. India has a tremendous opportunity to turn its building boom into an energy saving boom, simply by considering energy-efficient features and capturing the value of energy savings in its buildings. Energy efficiency through high technology innovations and use of appropriate modern products, materials and designs will lead to sustainability in buildings and energy conservation.

ENERGY EFFICIENCY IN HERITAGE BUILDINGS

Energy is the important component for economic development of the country. The modern equipment and materials used in construction and to maintain indoor thermal environment consumes significant amount of our national energy. In view of the shortage of energy it is very much essential to review the historical origin of Architecture & Technology to restore the comfort inside the building. Climate responsive architecture is the need of the day. Today most building structures are designed to separate man from the outside environment and require application of significant energy quantities to create an acceptable indoor environment. Energy consumption can be reduced in heating & cooling from 50-80% if the buildings are designed and planned considering the microclimate, topography of the place, and other external features. Modern buildings are being built with little consideration of

the climate. Control of the microclimate around the building was always important in indigenous design. This happened not only for the palaces but for simple dwellings as well.

PASSIVE TECHNIQUES OF HERITAGE BUILDINGS DESIGN

Ancient buildings demonstrate the passive architecture of India. Without mechanical means these buildings are better than the newly designed buildings. Natural ventilation and advantages of solar direction was taken in those buildings. Materials are chosen for construction according to the climatic characteristics of the place. The Palaces in Rajasthan also demonstrates the natural ventilation techniques. Water body in temple premises, keeps the environment cool and improve the microclimatic conditions. Havelis of Rajasthan & Gujarat are good examples of passive architecture. The Mughals constructed excellent mausoleums, mosques, forts, gardens and cities. Taj mahal, Agra fort and, Fatehpur Sikri are few monumental buildings near Agra. Mughals laid out many beautiful gardens with water bodies in the centers in the neighborhood of Agra & Lucknow. These buildings are designed in such a way that all people are comfortable inside a building during the hot summer. Mughals also laid out many beautiful gardens with water bodies in the centers in the neighborhood of Agra and Lahore. Some gardens like Shalimar and Nishat gardens in Kashmir have survived to this day.

Landscaping: Mughal gardens are famous for planned landscaping. The general theme of a traditional Islamic garden is water and shade. Unlike English gardens, which are often designed for walking, Islamic gardens are intended for rest and contemplation. These gardens usually include places for sitting with trees. Water greatly influence the microclimate of the place and improve the environment.

Water: Water is an architectural element which is extensively used in our ancient buildings and in garden of the Mughals. Water not only delighted the eye on a hot summer day but also provide the passive cooling. Water improves the physical comfort by the evaporative cooling of the surrounding air. Rate of heat loss from the moving air depends upon the area of water in contact with the air and careful zoning of the sheltered spaces so that strips of the water could be strategically placed around the structure .The beauty of Taj Mahal and Chota Immambada, Lucknow is enhanced by provision of water in front and built environment is comfortable in hot summer. Guru Ramdas, the fourth Guru of the Sikhs first constructed a pool and named it Amritsar or 'Pool of Nectar' on a stretch of land gifted to him by Akbar. The golden temple is built in the water which reduce the outdoor air temperature through evaporation.

Baoli : This method was employed over 1,500 years ago by local Rajasthanis, who built "Baoli" or step wells -- bodies of water surrounded by a descending set of steps, helping to create a microclimate in the surrounding structure. Chand Baoli is a famous step-well situated in the village of Abhaneri near Jaipur. Among the various attractions at the Bada Imambada, the five storied baoli (step well), belonging to the pre-Nawabi era is the most captivating structure. Generally called as the Shahi-Hammam (royal bath), this well is connected with Gomti river. Only the first two-stories of the baoli are above water and the rest being perennially below water. Step wells reduce the temperature of surrounding areas.

Ventilation Techniques in Heritage Buildings

Jali: In monumental buildings, Jali is the ornamental feature provided in most of the palaces In Rajasthan, In Taj Mahal, Agra fort etc. Fresh air enters in the building through jali with speed as well as stone jali protects the enclosure from direct solar radiation. Jali cast the decorative shadow in buildings which is also helpful in reducing the inside temperature.

Ventilator: Natural ventilation is very important for comfort. Ventilation system provided in Bada Imambada Lucknow is the example to improve the natural air circulation.

Courtyard: Courtyard was also an important design element in old residential buildings in hot dry climate including palaces. It was an element of passive cooling for regular fresh air supply and

for day lighting. These interior courts - a common feature of Rajasthani architecture -optimize circulation of air during the 50°C summers.

CONCEPT OF SUSTAINABLE HABITAT

Sustainable Development is the development philosophy which advocates the utilisation of resources without compromising the welfare of future generations. Development is often perceived as 'bigger houses and taller buildings'. However, it is a disconcerting fact that the construction and the waste from the construction sites contribute upto 24 per cent of total carbon dioxide or GHG emissions which are responsible for climate change. So, applying the principles of sustainability to construction is a necessity in today's scenario. Sustainable cities are those which are developed with proper planning for future development, waste management and efficient utilisation of energy. Green Buildings are those which use optimum resources and energy, conserve the natural resources, generate less waste and provide a healthy environment for the occupants. Green building design aims at achieving a balance between sustainability needs and housing requirements. The key features of a green building can be summarized as below:

Proper Site Selection: The selection of the site should take into account the environmental concerns, i.e., whether there is any destruction of forests, wetlands, agricultural land, etc. Proper orientation of a house facilitates natural ventilation, heating or cooling and thus energy consumption for these purposes can be reduced. Also the possibilities for harnessing sunlight must also be utilized in order to use it for natural lighting, heating or electrification.

Structural Design Efficiency: Each building material and its effect on the occupants, resources and the environment must be checked properly. Materials harmful to the environment must be avoided and alternatives must be used creatively. The design of the building should provide natural means of ventilation, maximum natural lighting, utilisation of solar energy, etc.

Energy Efficiency: At the time of construction, building materials and processes must have low energy consumption. During the operation, if windows and ventilators are properly placed, the energy required for Heating, Ventilation and Air Conditioning (HVAC) can be minimised. The utilisation of day light, solar energy for heating, right placement and maintenance of trees for creating shadows, etc. are to achieve energy efficiency in a green building.

Water Efficiency: Reduction in consumption of water and protecting water quality are equally important. In a green building, both these requirements must be addressed. Facilities for water collection, treatment, recycling and reuse are the important factors of green buildings. Water harvesting must be done properly to collect fresh water available from nature. Ultra low flush toilets which use as little as 6 litres of water per flush as opposed to 13-15 litres in conventional flush tanks and low flow shower heads are water conserving devices in green buildings. Sewer dosing units may also be needed for efficient drain use. Usage of waste water for site irrigation will reduce the expenses for both the treatment and the usage of fresh water.

Materials Efficiency: Construction materials for green buildings include lumber, bamboo and straw, recycled stone and recycled metals. It is expected building materials for green buildings are non-toxic, reusable, renewable and recyclable. Industrial wastes like combustion products or foundry sand are also used as building materials.

Indoor Environmental Quality Enhancement: The three important parameters coming under this objective are indoor air quality, thermal quality and lighting quality. In indoor air quality, the main issues include the reduction of volatile organic components and moisture. Volatile organic component will cause bad odour and toxic emissions, whereas moisture helps the presence of bacteria and mould. The HVAC system should mainly depend on passive systems related to the surfaces of the rooms.

Operation and Maintenance Optimisation: Even if the design of a building is sustainable, it is the operation and maintenance that keeps up the tag.

Waste Reduction: Waste reduction is an essential requirement during many phases of the building's life-cycle. During the maintenance or demolishing of a building, it should not have much waste other than those suitable for recycling. Waste water, bio-degradable wastes and others must be effectively treated, and energy must be generated from this.

GREEN BUILDING MATERIALS

The green building materials are materials which are locally produced and sourced and include recycled materials which have low CO_2 emissions, reduced transportation cost, lower environmental impact, thermal efficiency, less embedded energy, and financial viability. Following are the major criteria for selecting the materials:

i. Locally produced and locally available materials

ii. Transportation cost

iii. Environmental impact

iv. Occupant needs and health considerations

v. Thermal efficiency for maintaining comfort depending on the climate

vi. Financial viability

vii. Recycling and re-usability of building materials and demolished buildings

viii. Pollution generated during manufacturing, construction and usage

ix. Treating the wasted part of construction materials

x. Energy required in manufacturing process

xi. Use of alternative and renewable sources of energy in production

xii. Maintenance cost

The use of fly ash, which is a by-product of coal burning power plants, should be used as a substitute for Portland cement in the construction of foundations. For drainage and backfill purposes, concrete and rubble can be used. All foundations can be insulated with polystyrene to minimise heat loss.

Instead of wood, engineered lumber products can be used. This will reduce deforestation. Another strategy is to replace wooden structures as much as possible with steel structures which are 95 per cent reusable. Insulated pipes and heaters will reduce heat losses and thus energy can be saved. Replace toilets with ultra low flush models and fix chlorine filter on shower heads. Brown cellulose insulation is a type of insulation used in green buildings. Instead of incandescent lamps and CFLs, LED lighting is preferred which are more eco-friendly and energy saving.

Rapidly renewable flooring options such as bamboo, cork, sorghum, eucalyptus and palm are used. Wool, sisal, sea grass, etc. are used for the carpets. Recycled ceramic tiles and stone tiles are also used for flooring. Low Volatile Organic Compound (VOC) paints, lime paint, clay paint, milk paint and natural plaster are used for the wall painting to reduce health problems and also for reduction of toxic emissions.

GREEN BUILDING CERTIFICATION AND RATING

Energy efficient green building concept is followed by many construction firms. In order to fix the standards, several criteria are considered important and based on these, ratings are provided for the green buildings. The primary rating systems in India are:

i. GRIHA (Green Rating for Integrated Habitat Assessment)

ii. LEED (Leadership in Energy and Environmental Design)

ENERGY EFFICIENT BUILDING

Energy efficient buildings consume less energy and the costs of operations in such buildings are low. With the development of green buildings and their

ratings based on GRIHA or LEED, methods for energy efficiency are incorporated in different ways. Some of the practices to make a building energy efficient are given here:

Passive Solar Energy Utilisation: The consumption of gas or electricity for heating and lighting can be partly offset by utilising solar energy. Photovoltaic system attached to the roof top of a building produces electricity for different uses. Since low energy LED lights are available, the energy collected during the day time itself will be sufficient for night-time use as well. The proper orientation of rooms for capturing sufficient day light will reduce the use electricity for lighting during day time. Solar heaters can be installed by which heating of water or room heating during the winter can be done without expending coal, fuel oil or electricity.

Thermal Storage: Strategic window placement helps to collect heat and light from the sun during the day time. Glazing of windows with appropriate shading to prevent undesirable heat gain, use of light-coloured materials or paint for building envelopes and roofs, careful siting, orientation and appropriate landscaping help in temperature management. Shading strategies include overhangs and porches, trees and other vegetation, roll down shades or shutters, etc.

Cooling Strategies: The vapour absorption type air conditioners are used for cooling during the summer by connecting it with solar heaters.

Reducing Electricity Usage: Sensors can be used which will switch off lights, fans and other electrical equipment by sensing the absence of occupants. Sensors of this nature are known as occupancy sensors. There are also light sensors which will dim electric lights according to the luminance of other lights available in the room.

High Performance Insulation: Insulating panels made of rigid plastics are used to cover walls. Insulation is done not only for the walls but also for floors and roofs. These panels are generally less expensive compared to wooden panels.

The latest techniques in modern buildings include computerised control of building parts with occupancy sensors, lighting sensors and thermostats. The energy efficient buildings are sustainable by ensuring that only minimum resources are consumed during construction and operation.

CONCLUSION

The paper highlights the ancient passive techniques to improve the thermal comfort and ventilation through examples of heritage buildings which may prove an inspiration for energy efficient modern buildings design. The paper also discusses the idea of Net Zero Demand due to climate change and need for sustainable habitat.

REFERENCES

1. Mittal Neeta, Energy Conservation Ancient Techniques for Effective Planning of Buildings, Seminar on Conservation of Energy in Buildings and Architecture, 15-16 Feb. 2002 Calcutta .

2. Websites of Ministry of Power, Non-Conventional and Environment & Forest, GoI.

3. Introduction To Sustainable Engineering (2016) By Rag R. L. & Remesh Lekshmi Dinachandran, PHI Learning. pp 80-89.

IBC Awards

IBC Awards

(i) **Awards for Best Papers presented during IBC Seminars:** Upto 3 Medals and 3 Commendation Certificates are awarded to the authors of Papers selected out of entries received for each Seminar organised by IBC.

(ii) **Awards for Best Papers presented by Young Professionals (below 35 years of age):** Upto 3 Awards are awarded, out of which one award is reserved for ladies, subject to Papers being of meritorious standard.

(iii) **S.P. Jakhanwal Best Paper Award** for Author(s) of a Paper presented during the year.

(iv) **Awards for Excellence in Built Environment:** Upto two Awards are given in each of the following categories subject to entries being of meritorious quality, depicting excellence in overall design and concept:

(a) Residential Units & Housing Complexes
(b) Commercial and Office Buildings.
(c) Institutional Campuses
(d) Industrial Structures
(e) Rehabilitation / Retrofitting of Buildings
(f) Infrastructure Projects
(g) Monumental Structures
(h) Recreational Schemes

(v) **Smt. Satya Goel Memorial Award** is conferred on an outstanding Woman Building Professional.

(vi) **Life Time Achievement Award** is conferred on distinguished professionals in built environment, of not less than 65 years of age.

(vii) **Outstanding Contribution to IBC Award** is conferred on professionals associated with IBC, who has made an outstanding contribution in the activities of the IBC and has been a Life Member of IBC for at least 5 years.

INDIAN BUILDINGS CONGRESS

PRELIMINARY PUBLICATION

Indian Buildings Congress

IBC Publications Available for Sale

S. No.	Code	Publication Description	Price	Packing/ Postage Extra
01.	IBC:2:2001	Effectiveness of Alternative Models of Land Use Planning	Rs.50/-	30/-
02.	IBC:3:2002	Urban Infrastructure in India – An Overview	Rs.50/-	30/-
03.	IBC:4:2003	Finance for Building Industry	Rs.50/-	30/-
04.	IBC:5:2003	Habitat—Vision 2020	Rs.50/-	30/-
05.	IBC:6:2004	Rural Housing Policy	Rs.50/-	30/-
06.	IBC:7:2004	Housing Policy	Rs.50/-	30/-
07.	IBC:9a:	Making Building Safe Against Earthquakes -A Primer : Simple Overview of Handbook on Seismic Retrofit of Buildings	Rs. 100/-	30/-
08.	IBC:11:2012	Public Toilet Facilities for Women in Indian Cities	Rs. 50/-	30/--
09.	IBC:12: 2012	Manual on Water Proofing of Buildings	Rs.250/-	40/-
10.	IBC:13: 2012	Quality Manual for Civil Works in Building	Rs.400/-	40/-
11.	IBC:14:2012	Review on Jawahar Lal Nehru National Urban Renewal Mission (JnNURM)-A Preliminary Assessment	Rs.50/-	30/-
12.	IBC:15:2012	A Guide to District Planning	Rs.100/-	30/-
13.	IBC:16:2012	Planning & Management Approach Towards Storm Water Drainage for Delhi	Rs.100/-	30/-
14.	IBC:17:2012	Guidelines for Design of Universally Accessible Built Environment	Rs.80/-	30/-
15.	IBC: 18:2013	Guidelines for Electrical and Mechanical Works in Buildings (Including Energy Conservation, Lifts & Escalators, Life Safety and Security, Fire Safety System & HVAC)	Rs.500/-	50/-
16.	IBC:19:2013	Use of Ferrocement in Buildings	Rs.150/-	30/-
17.	IBC:20:2013	New Building Materials & Technologies – Innovations in Concrete (Vol. I)	Rs.400/-	40/-
18.	IBC:21:2013	Concrete Technology	Rs.500/-	40/-
19.	IBC:22:2013	Affordable Housing	Rs.400/-	40/-
20.	IBC:23:2014	Buyer's Guide (Part-I) Purchase of Residential Apartment Glossary & Check List	Rs.75/-	30/-
21.	IBC:24:2016	New Building Materials & Technologies-Vol. II (Manufactured Sand, Fly Ash, Blast Furnace Slag, Geo-synthetics, Geo-polymers, Fibers & Fiber Glass)	Rs.200/-	40/-
22.	IBC:25:2017	New Building Materials & Technologies Vol.III (Formwork, Flooring, uPVC Door-Windows, Hardware, Aluminum Composite Panel & Paints	Rs.200/-	40/-
23.	IBC:26:2017	Manual for Safety in Building Construction	Rs.200/-	40/-
24.	IBC:27:2019	New Building Materials & Technologies (Vol IV.-Compendium of New Building Technologies)	Rs.800/-	100/-

For sending publications through Registered Post please send advance payment including packing/postage charges by DD drawn in favour of "Indian Buildings Congress" payable at New Delhi.

Indian Buildings Congress
Kama Koti Marg,
Sector VI, R. K. Puram, New Delhi - 110022