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Portfolio

IBC Journal
January 2020
FOCUS ON
BUILT ENVIRONMENT -
SUSTAINABILITY IN CONSTRUCTION INCLUDING EXTERNAL DEVELOPMENT IN BUILDING PROJECTS

From

Editor-in-Chief's Desk

Sustainability, in the context of our planet, became a very important issue during last three decades. It is considered very important to maintain balance between our resources, environment and liability. The uncontrolled utilization of resources and degradation in the level of liveability 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. Sustainability can be defined based on energy, minimize resources, land use and bio-diversity. 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.

For our country the sustainability in building construction including external development and facility development, is a very critical issue and needs attention. Therefore, experts in this field were requested to give their papers, to cover different aspects of sustainability. It is heartening to note that in all eleven papers have been received.

(i) Shri A K Jain an eminent town planner with the credit for drafting master plan of Delhi and author of several books, in his paper has analysed and brought out that buildings in India account for 40% of energy use , 30% of raw material use, 20% of water use and 20% of land. They generate 30% of solid waste, 20% of liquid waste and 24% of CO_2 emissions. This clearly indicates that concept of sustainability should be applied to reduce use of resources as also waste and emissions.

(ii) Shri Jit Kumar Gupta an eminent tower planner, and academician has brought out that for sustainability, planned development, compact city planning, proper infrastructure as per master plan and state of art technology are necessary.

(iii) Dr. KM Soni, an eminent civil engineer, has noted that there is continuous improvement in the foot print of green buildings. He has observed that due importance has not been given to building services. Details given by him show that there are several issues, which should be resolved.

(iv) Shri Deepak Narayana, past President IBC, an eminent civil engineer with more than fifty years experience, has given his findings about sustainability of landscape development. This field is generally not attended and he has examined it from sustainability angle.

(v) Shri Rajendera Kumar Mehra, top level civil engineer from Madhya Pradesh, has analysed different dimensions of external development, from environmental consideration. He has deep knowledge and practical experience and issues brought out by him are important.

(vi) Ms. Usha Batra is holding top position in the Government and presently heading the engineering and architectural units, responsible for construction and Maintenance of buildings. She has dealt the subject of sustainability by bringing out six important dimensions. These are (a) minimize resources consumption (b) maximise resource reuse (c) use renewable/recyclable resources (d) protect the natural environment (e) create a healthy non-toxic environment and (f) pursue quality.

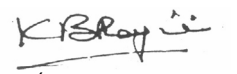
(vii) Shri Deepak Gupta, a young professional is working in the field of quality management in construction. He has deep knowledge of ISO standards. He has explained sustain ability principles of ISO 9000:2015, as applicable to construction. He has advocated for additive building construction, similar to additive manufacturing techniques. It will be possible to construct small commercial buildings and private habitats in 20 hours, with built-in plumbing and electrical facilities, in one continuous operation, by using large 3D printers. Our country has to take initiatives in this direction.

(viii) Dr. J Bhattarcharjee is an eminent civil engineer. He worked in the Government and after superannuation, worked for consultancy services. Thereafter, he joined teaching profession and is presently working in a university. He has covered different aspects of sustainability. He has observed that sustainability is achieved by efficiently using energy, water and other resources, protecting health and improving productivity. He has also observed that reducing waste, pollution and environmental degradation are also to be considered.

(ix) Shri P. S. Chadha is an eminent engineer. He was holding top position in Government and is having about fifty years of experiences. He has been associated with IBC for number of years. Shri Chadha has brought out an important aspect for sustainability related to major flood affected areas of the country. He has given a case study about work done in Japan to solve the flooding problem as also developing replenishing system for rivers during dry season.

(x) Shri D. S. Sachdeva, was holding highest position in Government. He has been working with Indian Buildings Congress for imparting training to professionals. He has explained causes for inadequate sustainability. His paper deals with planning, design, construction, up- gradation, rehabilitation and preservation aspects.

(xi) Shri V. Suresh is an eminent professional and superannuated form highest position in the Government. For last more than fifty years he has been consistently working for profession. He is presently working for developing and propagating green building concept. His co-authors, Shri S. Srinivas, Shri M. Anand and Saurav Choudhary are also working for green buildings. They have described the Green building rating system and other related issues. The concepts of green city have been brought out in a perfect manner.



(
K. B. Rajoria)
Editor-in-Chief

Sustainable Built Environment and Green Construction

A.K. Jain

Former Commissioner (Planning), DDA, New Delhi

Prologue

Almost every sector of development involves construction of buildings, human settlements, social and physical infrastructure, railways, roads, highways, bridges, dams and canals, etc. In India, construction contributes 8.2% of the GDP and 11.52% of jobs. According to Intergovernmental Panel on Climate Change, urban areas account for 67 to 76% of global energy use and 71 to 76% CO_2 emissions. The buildings in India account for 40 % of energy use, 30% of raw material use, 20% of water use and 20% of land. They generate 30% of solid waste, 20% of liquid waste and 24% of CO_2 emissions, contributing to climate change and poor air quality.

Therefore there is acute need of sustainable buildings and services which can resolve these issues.

-Editor-

Introduction

The basic idea is to reduce the use of natural resources and ecological footprint by decoupling economic growth and environmental sustainability. Technology's role ought to change given recent advances in building and urban services, materials, construction systems and operations that help mitigate climate change. For adaptation to the climate change, the stress should be on least consumption of resources by following dictum of doing more with less.

Sustainable Development Goals

In view of imminent threats of climate change, pollution and disasters, the Sustainable Development Goals (SDGs) have been adopted by 193 countries of the United Nations in September 2015. The concept of Sustainable Development integrates three aspects of sustainability-social, environmental and economic.

Sustainability is all embracing- the ecology, landscape and cultural processes, the physical context, i.e. geography, geology, hydrology, vegetation and climate. It emphasizes that the urban process, construction, consumption, food production, water, energy and waste management should be based on the principle of circulating metabolism and recycling.

Goal 11 of the SDGs focuses on making cities and communities inclusive, safe, resilient and sustainable. Sustainable Development Goal 7 aims at sustainable and clean energy, while goal 9 deals with infrastructure. Goal 13 of SDGs calls for combating climate change and its impacts. There is a clear shift in the paradigm of development, which is not just economic but aligns with its humane, environmental, cultural and socio-economic aspects.

Urban Policies and Strategies

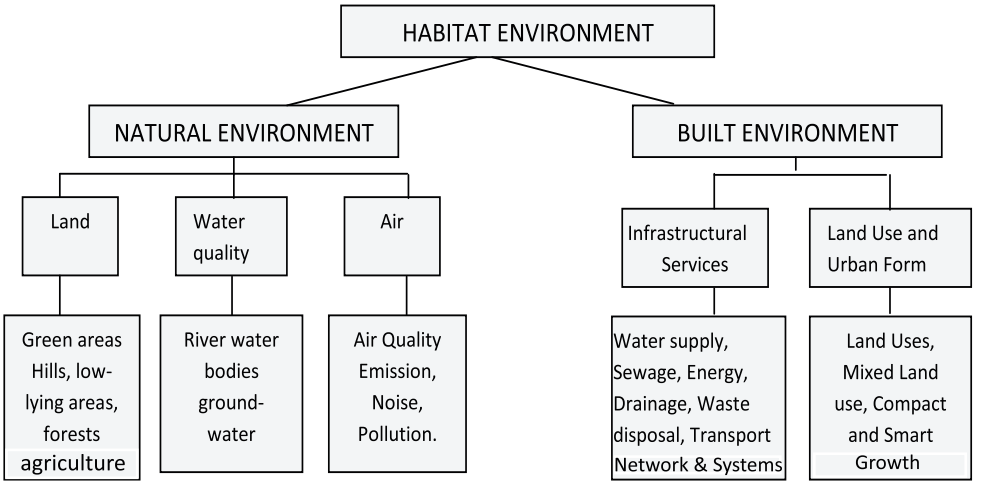
India is poised to have 600 million urban population by 2031, which is a big challenge. This is to be seen in a larger policy perspective and in the context of differential geographies and demographics. This involves a series of steps, which include the following:

- Urbanisation as a fulcrum of growth of jobs integrating economic, social and ecological sustainability
- Linking urbanisation with climate and disaster resilience
- Planning at regional/district, city and local levelsand with the participation of civil society.
- Setting up the benchmarks and standards and review of development norms for optimising use of land and to reduce urban footprint
- Preparation of action plans for implementation of different goals
- Strategic coalition and capacity building
- Legal and procedural reforms
- Financial planning, outcome budgeting and harnessing the resources of government, private and community sectors.
- The strategies of decentralization, localization, partnerships and equity.

All these converge into a comprehensive and sustainable vision

The Built Environment

The built environment exists in an ecological sphere comprising air, soil, water, urban matrix, energy, services, etc. It manifests a close interaction between natural and the built environment. As such, the buildings and cities need to be designed and built on the principles of sustainable resources, water and energy efficiency with green materials and infrastructure services.



Components of Urban Environment

The urban service networks integrate the built and natural environment. The circulating metabolism can give as much to the environment as it takes out, thus reducing the ecological impact. An ecological city and the buildings respect the nature and protect the environment by passive design with the sun, wind, water, earth and space. The sustainable built environment synthesises both the traditional forms, as well as modern technology.

Every building is a part of urban system and has a foot print. It is, therefore, necessary that a wide angle view of the urban space is taken in the context of ecology and environment, mobility, bio-diversity and natural resources, including water bodies, open space and parks, social and physical infrastructure, housing, informal settlements, local culture and heritage. This involves planning and building construction in its ecological context comprising air, water, energy, services, lighting, building envelope, openings, façade, roof, construction materials and technical installations.

Reducing the Urban Footprint

In order to reduce the urban footprint, it is necessary to optimise the density and Floor Area Ratio (FAR) for compact and dense development, while enhancing the open

spaces, infrastructure services and transportation networks. This involves mainstreaming sustainability of land, services and construction in following ways:

- Dense, compact and mixed use development, upgradation of services and facilitating redevelopment of low-density , dilapidated brownfields
- Maximising greens, trees, vegetation and public areas
- Minimising roads, service lines (water, sewer, electricity, drainage, etc.), parking and paved area
- Minimising envelope surface area by compact urban form
- Reducing costs of land development by optimizing densities and FAR
- Reducing energy consumption and construction cost
- Enhancing creation of jobs, conservation of heritage and local culture.

By compact, dense development and mixed land use the cost of development, land required and need to travel can be curtailed.

Planning for Clean Air

Low-carbon and sustainable development involves reducing emissions from transport, power and industries, wastes, dust, etc. Such a city is planned on the principles of compact and mixed land use, intelligent traffic management, transport demand management, non-polluting public transport, bicycles and non-motorised transport (NMT) and walk to work. As a policy, only zero polluting industries must be allowed, besides converting coal based thermal power plants and industries to be powered by CNG and renewal energy. Preparation of pollution control plans at district, municipal, and local levels should incorporate low carbon transit system, zero net energy buildings, black hole technology of waste management and smart utilities. Intelligent and smart systems viz, Big Data Analytics, Supervising Control Data Acquisition Systems (SCADA), ERP solutions, GIS, Integrated Digital Control/ Command Centres and Satellite Surveillance are necessary for air pollution control.

Infrastructure and urban form are interlinked and shape the land use, transport choice, housing and affect the sustainability and efficiency of city. This needs adopting a low carbon (thus low emissions) urban form and structure. According to the IPCC

(Climate Change Report, 2014, WG III) the critical aspects of spatial planning for clean air comprise:

- Density, FAR optimisation
- Land use (mix of activities, population)
- Connectivity, walkability and traffic density
- Accessibility for all by public transit, cycle and by walking.

Bundling these strategies can reduce emission by reduced transport, and increasing density, jobs, dwellings, shops, informal trade, etc.

Corridors and Transport

As urban transport contributes nearly two-thirds of the total suspended particulate matter and 18 per cent of carbon emissions, it is time to think of sustainable modes of transit and provide Integrated Transit Corridors (ITC) for BRT, Metro and trains linked with pedestrian and cycle lanes. These can be flanked by public, semi-public, high density, high rise development. Metro, trains and primary roads run underground for easy bike and pedestrian traffic on the grade.

Besides regulating growth of private vehicles, it is necessary to explore parking space in stilts, multi-level puzzle/skeleton structures, on roofs and in underground spaces. Seamless multimodal public transport system comprising bus rapid transit, rail-based mass transport system would work only by adoption of single ticketing and restructuring of land uses by transit-oriented development.

The concepts of walk to work, transit-oriented development, travel demand management. Intelligent transport Systems (ITS), promoting NMTs, electric vehicles, multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. River/water transport can be explored which is almost pollution free and most cost-effective. The concepts of cordon pricing, minimum occupancy vehicles, ceiling on new registration of private vehicles and establishment of a Unified Metropolitan Transport Authority can contribute in sustainable urban transport.

Infrastructure Services

In urban areas, particularly in the slums and unplanned settlements, there is a serious lack of sanitation, drinking water facility and a clean place to urinate and defecate. The public and individual toilet facility, particularly for women and children, is a critical area of concern.

Drinking water, sanitation, solid waste treatment and drainage are important aspects of the human environment. The performance of present sanitation systems needs to be reassessed with reference to environment, hygiene and their accessibility, Intelligent, alternative and innovative ways to provide services, i.e. water, power, drainage and solid waste management have to be introduced. The urban services have to be low carbon, low energy, smart, sustainable and resilient. The use of IT, simulation, automation and robotics can make them smart and intelligent. In place of the emphasis on end of pipe pollution control measures, what most urban centres need is an environmental planning approach that integrates urban services and healthcare, gender equity, schools, transport, etc.

Sensors and digital systems can make the city energy efficient, smart and reduce emissions. Common Utility Ducts carrying electricity, water, cable television and a 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 showerheads save water. Satellite controlled micro-irrigation system cuts water and power consumption.

Solid waste and 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 drainage, conserve water and save human settlements from floods. Rooftop solar panels generate electricity instead of power plants and reduce city’s heat build-up. Vertical vegetation, insulation and super-insulated glazing quadruple the building’s thermal performance. Smart glass technology and cool air draughts in clay pipes, save on air-conditioning and high energy costs. These help in obviating the ecological footprints, formation of heat islands and outdoor and indoor pollution.

Energy

The buildings are major energy- consumers. These emit heat, dust, carbon dioxide and greenhouse gases due to air-conditioning, lighting, equipment and glazed facades. The embodied energy in the building materials and construction is a significant issue. With steel and concrete as the predominant materials, it is necessary to consider their embodied energy, reusability, and thermal mass effect. By Building Energy Management System, the sensors can monitor these factors.

The energy guzzling air-conditioning can be avoided by methods like Net Zero Energy Design, variable refrigerant volume (VRV) system, earth air tunnel (EAT) and electricity storage. By EAT system inside temperature of building can be maintained within 27^0celsius during summer and 19 to 24^0celsius during winter. Lower ambient

lighting with LED bulbs and bionic controls, and integration of natural light with high performance glazing with light sensors can save energy use in a building. Synchronized lighting and HVAC systems can be designed to match building loads and segmented into multiple zones to allow more controllability. Green roof, light coloured finishes and vertical gardens help to insulate the structure.

The use of a heat exchanger for recovering energy between the inlet and outlet flows can reduce the heating and cooling load by as much as 70%. Controlled natural ventilation, rather than mechanical ventilation, can save energy. Internal air motion is important for uniformity of thermal comfort. Although not yet a mature technology, phase-change materials such as paraffin waxes, fatty acids, and hydrated salts are being employed for night cooling. Use of porous materials for dynamic insulation for lowering heat gain and smart glazing are becoming common.

Some measures for lowering carbon retrofit include the insulation of roof, wall and floor, improving ventilation, insulating hot water tanks, switching to LED lighting, usage of high efficiency condensing boilers and renewable energy, installing double or triple glazing, and employing zoned energy with time sensors for energy savings.

Green Buildings

As the environment has become a major issue, the engineers, architects and building industry have developed the concept of green building and green construction.

The idea of green building is to link built environment with the human health and comfort, water, energy, biodiversity and other natural resources. The endeavor is to use less energy and water, generate less greenhouse gases and wastes over the life cycle. A green building responds to the changing micro-climate and varying conditions of natural ventilation and light. It obviates outdoor and indoor pollution, and avoids use of materials with high energy demand. It provides for water conservation, rainwater harvesting, recycling of wastes, renewable energy, and the use of smart, intelligent systems. All these factors are integrated and accounted for in the mandatory Environment Impact Assessment (EIA) for buildings above 5000sqm floor area (MOEFCC notification of 2006 and 2016).

Innovative building resources and practices based on sustainability are being developed by the building industry. For example, traditional cement production emits greenhouse gases, using fossil fuels to heat calcium carbonate to high temperatures, which releases CO_2. Cement production currently accounts for around 2% of CO_2 emissions. In this light, carbon-negative cements have emerged which absorb CO_2 during their production and use. Super-heat steam is used to make cement from calcium magnesium carbonates particles that takes up large quantities of CO_2 as it hardens. By using magnesium oxide, carbonates and silicates, low-temperature process absorb carbon dioxide during cement production.

In conventional RCC, steel is used which needs huge kinetic energy in its production and emits large amounts of greenhouse gasses. Innovative alternatives are being developed incorporating space-age technology, such as Basalt fiber composites as alternatives to steel reinforcement for bridges and buildings that could reduce the carbon emission and steel consumption.

Some New Green Resources and Technologies

- Swales, bio-drainage, porous paving, rainwater harvesting, waste water recycling, dual piping
- Aerators for water fixtures
- Waterless urinals and other water saving systems
- Micro irrigation systems, xeriscaping
- Building Integrated Solar Photovoltaic, wind energy, parabolic solar cookers
- Green roof, vertical garden, urban farms
- High Co-efficient of Performance (CoP) chillers
- Wind towers /tunnels/chimney/ High Albedo materials
- Geothermal systems
- LED, CO2 Sensors, Intelligent, Bionic Sensors and Controls
- Building Information systems
- Rapid walls, precast, prefabricated component
- Low emitting adhesives and sealants

- Insulation products
- High Solar Refractive Index (SRI) coatings
- High performance glass, intelligent, insulating windows
- Certified wood, engineered timber product
- Nano-technology, nano-adhesives
- Carbon – negative cement and concrete

Translucent concrete allows daylight to pass through thousands of optical fibres between the surfaces of the blocks. Tiny glass fibers only constitute 4% of the blocks' overall volume and therefore do not affect their strength. Another innovation has been the self-healing concrete that fills up the cracks and cavities by a tiny calcium carbonate 'sear'. A genetically modified bacterium knits together cracks in concrete structures by producing special glue, which prolongs its life.

Most of the money, time and labour in a building is spent in erecting a wall .It also has thousands of joints, vulnerable to leakage, seepage and cracks. To tackle these problems Rapid Wall provides a logical solution, which is earthquake tested, is cyclone, fire and water resistant, load bearing, sound proof and 100% recyclable. Rapid Wall can be erected within minimum time and cost. In India millions of tons of Sulphur-Gypsum wastes are produced by coal fired power stations and chemical fertilizer industries, disposal of which is a huge environmental problem. The sulphur gypsum wastes can be recycled into rapid wall panels that can be manually erected, energy efficient and save time and costs.

Conclusion

The construction sector in India encompasses buildings, human settlements, infrastructure, railways, roads and highways. While it contributes to the economy, it is also responsible for bulk of global energy use and CO_2 emissions, which result into climate change, poor air quality and the environment. There is a need for a paradigm shift in the processes of development and construction which reduces the ecological footprints and use of natural resources.

It is estimated that 60 per cent of buildings which will exist in India in the year 2030 are yet to be built. This provides a unique opportunity to reinvent the construction processes, which are resource efficient, green, smart and sustainable.

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Promoting Sustainable Infrastructure in Urban India

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Prologue

Infrastructure is known for its critical role and importance in ensuring rational growth and development of urban settlements. Despite distinct advantages, infrastructure is conspicuous by its absence in large majority of urban settlements in India, adversely impacting quality of life, capacity and capabilities of cities and towns to act as engines of economic growth. Inadequate infrastructure has genesis in prevailing pattern of urban growth; low priority accorded to provision of infrastructure; non-availability of adequate financial resources; ever expanding dimensions of urban centers etc. In search for appropriate solutions to promote sustainable infrastructure, the author looks at the options of: promoting planned development; making cities compact; creating infrastructure master plan; involving state of art technologies.

-Editor-

Introduction

Rapid growth of the urban population and its concentration in few large urban centres has obvious implications in terms of infrastructure and services because all human beings, for their living, sustenance, growth, effective working and quality living, need basic services both in quantity and quality. In fact infrastructure is a foundation on which entire super-structure of human living and settlements is built. As promoter of economy, generator of employment, determinant of quality of life and operational efficiency of urban settlements, infrastructure as a sector is known to play critical role in ensuring rational growth and sustainable development of urban settlements.

Despite distinct role and importance in leveraging the economy and human living, majority of urban centres are found to be deficient in providing basic infrastructure to its inhabitants., New economic policies of the government emerging from liberalization and globalization have placed heavy demand on infrastructure and services in urban areas putting the available infrastructure under heavy stress The emerging infrastructure bottlenecks in urban areas pose serious impediments in enhancing operational efficiency and productivity. Failure to expand water supplies, improve sanitation system, expand

housing supply and improve transportation to match the growth of population has emerged as major causes of poverty and misery in urban areas. Accordingly, it becomes critical that provision of urban infrastructure, on prescribed norms and standards to urban residents, should be taken on priority for making urban centres as engines of economic growth and provider of quality living.

Issues

Recent estimates made reveal that no Indian city provides water 24 hours a day and 7 days a week, only 64 percent of urban households are covered by individual connections and stand-posts for water supply. Only one half have toilet facilities. More than two third population is left uncovered by sanitation facilities. Coverage of organized sewerage system ranges from 35 percent in Class-IV to 75 percent in Class-I cities. Number of cities/towns do not have even partial sewerage network. The drainage system for rainwater disposal covers only 66 percent of urban population. The city roads are inadequate, leading to congestion and their fast deterioration, due to excessive load and traffic. Apart from deficiencies in terms of access to facilities, the operation and maintenance of infrastructures leaves much to be desired.

Provision of infrastructure has primarily remained within the domain of public sector. Government has traditionally been providers of the services because of monopolistic nature of these services involving high up-front costs and long payback periods besides requiring huge amount of resources and investments. These services are also characterized by existence of externalities making it difficult for agencies to recoup investment costs and operational expenses through levy of user charges. The very fact that infrastructure services do not pay for themselves and the government does not have resources and financial capacity to subsidize the beneficiaries, has led to low availability of funds. With increasing fiscal implications, this has led to the deficiency in both volumes as well as quality of services.

Assessment of existing status and investment has been made by different groups from time to time, including the working group constituted by Planning Commission for Infrastructure Development, based on norms laid down by the Task Force on Housing and Urban Development. High Powered Expert Committee Report (March ,2011) on 'Indian Urban Infrastructure and Services', set up by Ministry of Urban Development, GOI, has estimated that the investment for urban infrastructure over the next 20 year period (2011-2031) to be of the order of Rs 59.1 lakh crores at 2009-10 prices which include Rs 39.2 lakh crores as capital cost and Rs 19.9 lakh crores as O&M cost for eight identified new and old services including water supply, solid waste management ,storm water drains, urban roads, urban transport, street lighting and traffic support infrastructure. Bridging the financial gaps for creating adequate infrastructures is surely beyond the capacity of public sector and accordingly alternative strategies have to be evolved to generate resources besides tapping additional avenues for funding the urban infrastructures.

Promoting Planned Development

Considering the role and importance of Infrastructures in accelerating the pace of socio-economic development and promoting quality of life, it becomes critical that provision of infrastructure in urban areas is accorded highest priority. Appropriate strategies, accordingly will have to be put in place to remove all roadblocks which hamper the provision of such urban services with innovative techniques adopted to improve their availability. In order to achieve the goal of 'Basic Infrastructure for All', following suggestions are considered appropriate:

Promoting planned development of urban areas offers the best option to provide basic infrastructure on a sustainable basis. Provision of basic amenities, as mandated in the legal framework, has to be provided as part of planning process which makes available not only land required but also the resources to develop the infrastructure. In colonies developed in the states of Punjab/ Haryana, 55% area of colony is kept as saleable area whereas remaining 45% is to be used for roads, open spaces and amenities to be provided. The cost of providing and developing the infrastructure/amenities of water supply/sewerage/sanitation, roads, open spaces, electricity, communication etc, is loaded as development cost charged from allottees of plots. Thus it becomes critical that efforts are made to promote planned development of urban areas and all haphazard and unplanned development strictly controlled.

Infrastructure Master Plan

Preparing Infrastructure Master Plan for urban settlements would be critical in order to ensure the provision of all basic infrastructure on pan-city basis to all the inhabitants in an integrated manner. Most of the urban residents are facing deprivation in the provision of basic services because of absence of any statutory framework guiding their future growth and development. Gaps and overlapping of services and infrastructure are the outcome of absence of a pre-defined growth pattern for the cities. Preparing infrastructure master plan should be made integral part of the master planning process which would help in not only promoting orderly growth and development of the city but would also help in making provision and ensuring the availability of the critical physical and social infrastructure in the urban settlements on the prescribed norms and standards.

Making Cities Compact

Providing infrastructure network and service nodes are both cost and resource intensive. Accordingly, it is important they must be made both cost- effective and resource efficient. This would call for minimizing the size, length, breadth and depth of infrastructure network. Making cities compact offers best option to cut down the cost of infrastructure. Compact cities are the outcome of planning/development based on; high rise and high density development; promoting flatted rather than plotted development; promoting public transport; planning inside and not outside; and rationalizing city shape and size.

Thus new approach to urban planning has to be based on minimizing the size and cost of service network so as to make city development cost- effective. Compact city also helps in minimizing travel, reducing the road network required for vehicular traffic. Cities become walkable which leads to reduced cost of road infrastructure. Accordingly, making city compact will help in reducing cost of urban development and make infrastructure available to all in urban residents at minimum cost.

Rationalising Norms and Standards

Provision of appropriate infrastructure has suffered in the past in the urban centres due to the adoptions of variable and unrealistic norms by pararstatal agencies. In many cases precious resources have been wasted due to adoption of unrealistic standards of services provided, making them un-economical and un-sustainable over a period of time. Accordingly, it becomes critical that realistic infrastructure norms and standards are evolved for urban areas so that fair assessment could be made of such infrastructure and its provision made on a time bound basis.

Adopting New Technologies

For making available cost-effective and efficient infrastructures in urban areas, technology identified and used would need considerable modernization. Outdated technologies used in creating services have led to wastage of precious resources. Accordingly, state of art technologies, which are cost-effective over entire life span of infrastructure and services need to be adopted so that optimum use of available resources is made.

Promoting Sustainable and Green Buildings

Built environment/buildings are known to have significant impact on infrastructure, sustainability, environment and consumption of resources, accounting for; 16% of world's fresh water withdrawal; 25% of wood harvested; 30% of consumption of raw material.; 50% of global energy consumption; 35% of world's CO_2 emission; 40% of Municipal solid waste; 50% of Ozone depleting CFC's ; 30% of the residents having sick building syndrome and 40-45 % of global warming. Accordingly, buildings are known to be large consumer of resources, energy and generators of waste. Buildings require lot of infrastructure and resources during their construction, operation and maintenance. Considering the fact that India is on the cusp of rapid urbanization, addition to urban population is going to be both rapid and massive. As per Mckinsey Global Institute Report (April, 2010), 'India Urban Awakening :Building Inclusive Cities', India would be required to create, on annual basis, buildings to the tune of 700-900 million sq.mt to meet the emerging needs of urban India. Green buildings offer the best option to promote sustainability in the built environment because these buildings make optimum use of natural resources for meeting the needs of heating, cooling and lighting of buildings in a passive manner. Mandating new buildings to be constructed in urban areas and retro-fitting the existing buildings as Green buildings

can help in ushering a new era of providing cost-effective infrastructure. Green buildings are known to cut down energy consumption by 24-50%, water consumption by 40% and generation of solid waste by 70%. This would make cities more sustainable due to less consumption of resources and generation of waste. Smaller electricity and water/sewer network due to reduced consumption would minimize the cost of infrastructure besides making cities more clean, since waste to be transported will be reduced enormously, bringing economy in such services. Green Buildings make cities environmentally more sustainable due to reduced carbon footprints. Planning and designing green buildings is also based on the principles of, 'Refuse, Reduce, Recycle and Reuse' to optimize use of resources and minimize generation of waste.

Making Higher Financial Provisioning

Infrastructure sector in the past has been monopolized by the public sector. Low priority has been attached to the sector, as indicated by the budgetary outlay made by the public sector in the past. In the second five year plan the funds earmarked for this sector was merely 0.65% which rose to 1.38% in the Eighth Five Year Plan. If productivity of urban areas is to be leveraged, then investment in the public sector has to be of higher order/increased. India Infrastructure Report, 2011 has recommended increasing investment in urban infrastructure from 0.7 per cent of GDP in 2011-12 to 1.1 per cent by 2031-32 to provide adequate resources to provide appropriate infrastructure in urban areas.

Involving Private Sector

Private sector needs to be involved in a big way in the creation of urban infrastructure. Technological innovations have permitted low-cost supply options and increasing range and quality of services. In addition, new technologies have considerably reduced the cost of providing these services making the infrastructure commercially viable for the private sector. Thus private sector should be given appropriate role by making them co-parceners in the planning/ creation /provision/ operation/ maintenance of local level services and amenities. Involvement of private sector in urban development through granting permissions/licenses to develop colonies/SEZ/Mega Projects/Industrial Estates etc, offer immense opportunities for creating local and city level facilities. These services can be funded by the internal development carried out by colonizers/ promoters whereas city level infrastructure can be created through the levying of External Development Charges (EDC). States of Haryana/Punjab have been able to generate enormous resources from the private colonizers on account of EDC charged on the area developed by them. Haryana/Punjab model needs to be leveraged by other states with certain modifications for providing adequate/quality urban infrastructure.

Creating Unified Agency

Multiplicity of agencies operating in urban areas in the domain of infrastructure development has done more damage than good in providing services at local level.

Absence of any single agency looking after the entire gamut of infrastructure has been the root cause of majority of urban ills. Accordingly, ensuring co-ordination among various agencies responsible for providing urban infrastructures and services is another area which requires focused action on priority. It would be important that laying of services should be planned and coordinated in such a manner that all services should be laid as per a pre-drawn program so that no damage is done to already laid infrastructure. In case of connectivity of services at the household level, prior connections should be laid for each house for water and sullage so that frequent road cuts are avoided. Damage, if any, caused to any infrastructure should be rectified at the risk and cost of the department doing such damage. It would also require that a nodal agency for each city must be identified and given the task and responsibility to ensure effective coordination between various agencies. Nodal agency must be equipped with necessary expertise and manpower resources to deal with all issues of infrastructure.

Adopting Tunneling Technology

At present all services are laid independently and separately. This pattern causes lot of developmental problems while laying services besides posing considerable problems in their maintenance /upkeep. In order to avoid this, system of providing services in a trench can be used. This helps in providing large number of services in a single trench which is put in place along the road. It also helps in providing additional services, as and when required, without resorting to digging. Maintenance and upkeep of services besides detecting faults also becomes easy and speedier.

Using Information Technology

Information technology can be effectively leveraged in planning, mapping, monitoring and managing services. Supervisory control and data acquisition (SCADA) has been extensively used for managing water supply distribution system and operation of tube wells in the urban areas. Many countries have used IT for detecting leakage and damage to the services resulting in minimizing loss and early repairs. Solid waste management has also been effectively monitored by putting chips on the garbage bins communicating their status about garbage for their disposal. Road damage has also been detected automatically whereas traffic and transportation system have been regulated effectively by the use of appropriate technologies.

Conclusion

Habitat-II-1996 mandates that sustainability of urban areas and making cities smart cannot be attained without providing adequate infrastructure and services besides ensuring availability of the services at an affordable price. Considering role and importance of urban infrastructure, India has already launched Smart City Mission and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) to provide basic services to every household in order to improve the quality of life, while promoting equitable access to

city services. Smart City Mission/AMRUT targets100/500 out of 4,040 urban centres to improve service delivery, resource mobilization and bringing greater transparency in municipal functioning and capacity building to increase their operational efficiency. Considering the magnitude of infrastructure to be provided in all urban settlements, innovative and state of art technologies would have to be evolved and made operational. This would not only help in rationalizing the urban growth but also go a long way in generating adequate resources for creating basic infrastructures. Approach has to be people-centric involving all the stakeholders in the task. Promoting planned development and making cities compact should lead the agenda for providing infrastructure on self-sustaining basis. Norms and standards for infrastructure would need rationalization, considering the local conditions to make them cost- effective, more realistic and least consumers of resources and land. Preparing Infrastructure Master Plan for each city should be considered as a priority to plan and provide infrastructure at pan-city level on a time bound basis. Efforts have to be made to rationalize construction sector to create Green and intelligent infrastructure in order to make it more sustainable and operationally efficient. Role of private sector would be critical in infrastructure development. For achieving the goal of infrastructure for all, providing infrastructure in urban areas has to be declared as a priority area with higher allocation made in the national, state and local budgets. Adequate infrastructure can launch Urban India on the fast trajectory of growth and development besides making people and the cities more healthy, happy and productive.

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Sustainability and Services in Building Construction

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Prologue

Infrastructure development without consideration of sustainability is against the nature and objective of sustainable development. Therefore, sustainability has to be incorporated in terms of design, materials, resources, processes and durability.

Green building ratings have been adopted in the country now for a long time and many buildings have been constructed with the same concept. There has been continuous improvement in the footprints of green buildings showing clearly the awareness of such construction. Government organizations have also taken lead in this direction. But building services have not been given due importance in the country which are backbone of comforts for the users. Many services are even designed for a considerable lesser life compared to buildings which are difficult to be replaced in an occupied building hence criterion has to be changed.

Concepts of sustainability, sustainable development, ecological balance, green buildings, and sustainable buildings are discussed along with internal and external services which need special care during planning and execution.

-Editor-

Introduction

At the Sustainable Development Summit on 25 September 2015, UN Member States adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. These SDGs are no poverty, zero hunger, good health and well being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, sustainable consumption and production, climate action, life below water, life on land, peace, justice and strong institutions, and partnerships for the goals. These goals can only be achieved through sustainable development which is not practically feasible without protecting environment.

Main objective of such sustainable development is to end poverty, inequality and injustice which in itself is difficult to define as the same are relative terms and depend upon

various aspects including religion, culture, traditions, education, growth of population and economic conditions. But every infrastructure development generates employment of large unskilled and semi skilled workforce and is guided through government and social guidelines. Sustainability, sustainable development, ecological balance, and green and sustainable buildings are closely associated hence any infrastructure development has to consider them for future generations.

Sustainability, Sustainable Development, Ecological Balance and Sustainable Buildings

- **Sustainability**

  Sustainability is the ability to exist constantly and refers generally to the capacity for the biosphere and human civilization to coexist. It is also defined as the process of people maintaining change in a homeostasis (i.e. the tendency towards a relatively stable equilibrium between interdependent elements) balanced environment in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. Thus, sustainability is through interconnected environment, economic and social domains.

  Though, originally sustainability was meant making only such use of natural, renewable resources, now sustainability encompasses broad meaning and includes conservation of natural resources, environment and climate change, direction of investments, orientation of technological development and institutional changes to meet human needs and aspirations to meet the goal of human-ecosystem equilibrium.

- **Sustainable Development**

  Sustainable development is the organizing principle for human development to continue to meet human needs without undermining the integrity and stability of the natural system and can be defined as development that meets the needs of the present without compromising the ability of future generations.

  Sustainable development may be the organizing principle of sustainability though emphasis of sustainable development has now shifted more towards economic and social development with environmental protection. Main objective of such sustainable development is to end poverty, inequality and injustice protecting natural resources for future.

- **Ecological Balance**

  Different species in the ecosystem have their own role in keeping the ecosystem running smoothly and balanced and role of each species is important to keep the ecosystem balanced. Ecological balance is a term describing how ecosystems are organized in a state of stability where species coexist with other species and within their environment. Development with which ecological balance can be achieved indicates sustainability and sustainable development.

- **Green and Sustainable Buildings**

  Green buildings or sustainable buildings refer to a structure constructed through and by environment friendly materials and processes providing comforts and better indoor air quality simultaneously using less non renewable resources.

  Green buildings often include measures to reduce energy consumption both the embodied energy required to extract, process, transport and install building materials and operating energy to provide services such as heating and power for equipment and buildings. Thus, green buildings are based on energy efficiency, water efficiency, materials efficiency, indoor air quality, waste reduction, conservation of natural resources and well being of occupants and public. Sustainable buildings may include concept of green buildings and safety and quality aspects for a durable structure.

Sustainability in Building Projects

A building project includes construction of buildings, internal services and external development. A typical building may require many materials and processes but major materials required are;

i. Cement

ii. Steel

iii. Bricks

iv. Sand

v. Aggregates

vi. Timber/Aluminium/PVC/Steel/Glass doors, windows, partitions etc

vii. Flooring items like tiles/stones

viii. Paints

ix. Electrical & Mechanical items/accessories

Materials like cement, steel, bricks, aluminium, glass possess high embodied energy while timber, sand and aggregates are natural materials whereas tiles are manufactured from soil. PVC and paints are manufactured from polymer materials hence affect the environment. Hence, building construction contributes largely to environmental degradation and consumes large natural resources and thus theoretically cannot be said to be part of sustainability. But building construction has to be taken up for human shelter hence engineers and architects are to ensure that use of waste but durable materials is maximized in building construction. This is termed as material efficiency in green building concept.

A building requires considerable energy in its construction through materials used, installed and during its operation and maintenance. If the energy is produced from non renewable sources, it is not environment friendly. Thus, energy has to be conserved during building construction and building has to be constructed in a way that energy consumption during its operation and maintenance is minimized so that the building is energy efficient. This is done through better orientation, architectural design, and by providing energy efficient fixtures, equipment and operation practices. Additionally, energy is generated through renewable sources meeting the requirement of the building and users occupying it to the maximum extent. Such a building is considered energy efficient.

Water is another commodity which needs to be conserved. Water is required to produce the materials, building components and the building. Water is also required during its operation being the basic need of the human being hence use of water has to be minimized and waste water to be reused. Such provisions in a building mean the building being water efficient. Waste disposal requires considerable resources in its disposal hence waste generation has to be minimized and thereafter to be reused through recycling and resource generation.

A building is constructed for comforts and well being of the users and must not pose ill effects during its construction and thereafter. Hence, wellbeing of workers and indoor air quality are also part of green building concept. Landscape and horticulture helps in ecological balance hence is a part of green and sustainable buildings.

Green Building Rating

Green rating has been started in many countries for the buildings. In India also, three agencies have their own rating systems as given below;

Indian Green Building Council (IGBC), a part of confederation of Indian Industry has its green building rating system vide which it awards the ratings as “Platinum”, “Gold”,

"Silver" and "Certified" to various buildings mainly based on sustainable architecture and design, site selection and planning, water conservation, energy efficiency, building materials and resources, indoor environmental quality and innovation and development.

Green Rating for Integrated Habitat Assessment (GRIHA) council which is an independent platform registered as a society awards the ratings as one star to five stars. The rating is mainly based on similar concept of the site selection, architectural design, water quality and conservation, energy efficiency, workers welfare, indoor air quality, energy efficiency and innovation.

Central Public Works Department (CPWD) which is a Government of India agency engaged in construction and maintenance has come out recently with its own rating system. Details of rating system proposed by CPWD are presented here in details.

CPWD Green Rating System

The buildings will be rated as "Green", "Green Plus" and "Super Green" on the scale of 100 marks. A building scoring marks between 55 and 70 will be awarded rating as "Green", between 71 and 85 as "Green Plus" and between 86 and 100 as "Super Green". A building scoring less than 55 marks will not qualify for green certification and as such no rating will be accorded to it.

Same criteria will be adopted for all types of buildings i.e. residential, office or institutional. The buildings will be rated by a committee of CPWD officers drawn from Architecture, Civil, Electrical and Horticulture cadres. Approvals from local bodies like municipal corporations, fire and environment or as applicable are prerequisite for award of green rating. Marks are to be given in whole numbers and not in decimals.

The criteria for ratings of buildings have 9 subhead as given below:

1. Architectural planning and design
2. Quality and safety
3. Sustainable building materials
4. Green construction measures
5. Water conservation measures
6. Energy efficiency and conservation
7. Waste management
8. Welfare measures
9. Landscape and horticulture

It is observed that CPWD rating criteria includes sustainable concept rather than only green building concept as it is based on architectural efficiency, structural safety, energy efficiency, water efficiency, material efficiency, waste management, green construction processes and trees protection and efficient irrigation system. It also includes use of local and domestically manufactured materials which are sustainable materials. Welfare measures required during construction and for differently abled persons are also included. Apart from building components, emphasis has also been given on services. Thus, it is hoped that such rating system will lead to sustainable development.

Services for Buildings

Services play a very important role in indoor air quality, comforts of occupants and durability of building affecting its life. In case of leakage, seepage, inadequate natural light and frequent repairs, no building can be called as sustainable. Services are designed for a lesser period compared to building life. It was due to non availability of durable materials at affordable cost. Now, the materials and technologies are available by which services can be designed for comparable life of the buildings hence durable services should be designed and adopted for sustainable construction.

Internal Services

Some of the internal services which lead to inconvenience and discomforts are discussed in the following;

- **Shafts for Services**

  Shaft in any building is required for taking the service pipes and accordingly designed. Services may include water supply pipes, sanitary pipes, rain water pipes and even AC pipes and smoke exhaust due to fire requirements. Three important factors that need to be kept in mind while deciding the size of shaft are:

  - Space requirements should be decided based on the pipes/services required and space required for repair and maintenance including replacement. Accessibility to the maintenance staff for repair of replacement should also be considered.

  From the experience, it is seen that many a times shaft size is designed only to accommodate total number of pipes. It becomes so narrow that the pipes are laid one over the other and sometimes the space is so tight that it is not feasible to open the joints of pipes by the maintenance staff. It is also very common scene that pipes are placed in front of window, making it non operational. In one of the case, it was observed that door/eye of the sewage pipes was broken and sewage started accumulating over potable water supply lines which were laid closely due to space constraints and then due to leakage at one place

in the water supply lines, it was getting mixed. Many a times, pipes are then segregated and provided on wall surface.

➢ In many multistoried flats, proper entry to the shaft is not provided as the size of the shaft is kept very tight and sometimes even one person cannot enter into it. Therefore, shaft needs to be well ventilated having arrangement of illumination with proper entry and staging platform for repairing the services.

➢ Sometimes platforms for maintaining the services are either not provided or provided without any protection. Due to continuous flow of water on such platforms, corrosion starts in the reinforcement and the platforms become dangerous from safety point of view. It is therefore desirable to provide platforms of sufficient width, properly approachable and covered from rains so that maintenance staff can work safely. It must be understood that sometimes two persons may be required to maintain the services at a time and use such staging platforms.

- **Flat Rooftop with waterproofing**

Flat rooftop is very common in the country. Flat roof means RCC work is carried out through uniform thickness of slab, over which slope is prepared by various other methods, most commonly by laying brickbat coba treatment or plain cement concrete. Waterproofing is then laid over the same as slope cannot be prepared in water proofing. In case, material used in preparation of slope treatment is not laid properly, seepage starts and even after various layers of waterproofing, seepage continues due to failure of base treatment.

Sometimes APP membrane is provided over existing coba treatment or similar waterproofing. APP membrane if inserted into rain water pipe reduces area of pipe and raises level which is not desired and if provided short, water enters from the bottom and damages roof treatment.

- **Service Pipes through Floor**

Service pipes like rain water, sewage and water supply pipes are taken from the shaft which is generally located on outer face of the buildings and is the best way of taking out pipes. In some of the buildings, shafts are provided inside the building and the pipes are horizontally brought out through floor. Such a system sometimes creates considerable maintenance problems.

- **Covered Rain Water Pipes**

Sometimes rain water pipes are covered due to aesthetic requirements. In

such cases, bottom length of rain water pipes is exposed sometimes 600mm to 900mm only and even the same is covered by grill or temporary sheets. Such pipes if get blocked pose problems. Services should always be approachable for better maintenance.

- **Drainage in Balconies**

  In India, balconies are used for many purposes whatever may be the design consideration. Normally, water proofing is not provided in the balconies and sometimes even spout is not provided. If spout is provided, water falls on the ground or in the balconies of other occupants leading to unhygienic conditions. Sometimes occupants use balconies for keeping the washing machines and discharge waste water through spout of the balconies. Therefore, there is need to provide water proofing and proper pipes to take out rain water/waste water to the manhole chambers.

- **Low Plinth Level**

  Low plinth level is a major problem which leads to backflow of rain water during rains from the adjoining areas which go on rising due to road level rising every time on account of re-carpeting and even backflow in the toilets due to rain water entering into sewers. Minimum plinth level should now be adopted as 600mm in place of 450mm.

- **Plinth Protection in Black Cotton Soil Areas**

  Plinth protection is normally provided as 900mm to 1200mm wide with brick bats or lean concrete. In the areas where black cotton soil exists, such plinth protection fails due to swelling pressure exerted by soil on account of water entering through the junction of the building and plinth protection. Therefore, in the areas of black cotton soils, RCC plinth protection should be provided having width 2000- 3000mm as per the space availability below which lime concrete should be used in place of cement concrete. It is also recommended that either horizontal plinth protection should be connected through RCC plinth beams for monolithic construction to avoid joint formation at the junction of horizontal plinth protection and the structure or vertical plinth should be provided covering the joint through stone cladding in addition to RCC horizontal plinth protection.

- **Tree Plantation and Grassing in Black Cotton Soil Areas in Courtyards and near Foundation**

  Trees and grass are normally planted near the buildings but in case trees are

too close to the foundation, they are likely to damage the foundation due to water required by the plants. In case of black cotton soil areas, such plantation is very damaging to the structure as the soil expands due to its expansive properties and damage the structure on perennial basis hence no plantation or grass is recommended near the foundation. In case of courtyards, RCC floor should be provided over which good soil can be filled up if grassing is required.

- **Stone Window Frames or Linings**

  If granite is provided in the window openings as sub frame and aluminium/PVC windows provided without gasket between granite and window frame, there is likelihood of water entering through the gap/fine cracks between two different materials. Similarly, there is likelihood of gap between brickwork/blockwork and granite if proper sealant is not provided. During rains, if rain is likely to come on such surfaces, there is likelihood of rain water getting inside. Therefore window frame must be provided with rubber gasket and joint between granite stone and wall must be sealed properly

- **Location of Electric Points**

  Electric points are generally not planned according to architectural drawings and furniture layout. This creates inconvenience to the users. Therefore, electric points and furniture layout should be the part of the architectural designs issued by the architect.

- **Ventilation**

  Fresh air inside the office buildings and even in residential buildings is not being considered in new and existing buildings when renovated. With new technologies and materials, there is hardly any gap for air entry through closed doors and windows. Due to air-conditioning adopted, doors and windows are kept closed and frequent opening of doors is also not there. In such cases, particularly in residential flats where there is no central air-conditioning, fresh air is not available inside the flats.

External Services

External services include roads, paths, external water supply, fire services, external lights/ compound lighting, air conditioning ducts, sewer lines, tree plantation etc. When such services get disrupted, large number of users are affected hence such services should be provided which are durable and can be repaired quickly with ease of maintenance.

- **Trenches for Services**

  Providing trenches for integrated services in campuses and towns makes operation and maintenance easy and workable, simultaneously cutting down cost of maintenance. It also saves deconstruction and reconstruction time as easy access is available in the form of trenches with openings.

  Traditionally, external water supply is laid by excavating the trenches and after laying the water supply lines covered with soil. During leakage, it becomes difficult to find out the leakage immediately and also maintenance becomes difficult leading to considerable wastage of water. It is therefore essential that smart system of laying water supply lines is adopted and preferable water supply lines are laid in accessible trenches.

- **Electrical and Communication Lines in Disaster Prone Areas**

  During cyclones, major hurdles are uprooted trees, disrupted overhead power lines, hoardings, poles and similar structures which are not being designed for wind pressure. If power lines are overhead, they get wrapped around them. It takes considerable time and cost for bringing the power and communication services to normal. It is high time that the all services are designed underground in such areas.

  Sufficient care is also not being taken while laying external services in earthquake prone areas as such these likely to get damaged during earthquakes. It must be understood that extra cost involved is very less compared to rehabilitation cost of the damages after earthquakes.

- **Exposed RCC Members in Water Tanks**

  Due to continuous drying and wetting, corrosion starts in the exposed members of the staging of water tanks. It is recommended that such beams should be treated with materials avoiding water ingress to avoid corrosion like tile cladding/water proofing or special kind of reinforcement be provided which doesn't corrode easily.

- **External Roads**

  Road level is normally kept below plinth level of adjoining area but during each recarpetting, road level is increased and after few years, road level may become higher than building floor level. Sometimes, over the road surface, interlocking blocks are laid resulting into building level further going down. It is therefore essential that road level is not increased and recycling of existing

bituminous material is made mandatory for sustainability. When road level is increased, footpaths, central verge levels, manhole covers and drains are also altered which cannot be termed as sustainable development.

- **Plantation**

  Tree plantation is not carried out scientifically resulting into damage of property and sometimes to disasters. Plantation near foundation and courtyards in black cotton soil areas, trees which get uprooted due to wind easily in cyclone prone areas, trees of single species unfriendly to ecological balance, and plantation which need removal due to road widening or infrastructure development are against the principle of sustainability. Therefore, planned plantation should be carried out scientifically including transplantation for better rate of survival.

Conclusion

Sustainability and ecological balance are basic requirements of human survival. If natural resources are utilized in sustainable manner, resources will get regenerated for ages. Construction industry uses large number of resources and in large amount hence architects, engineers and builders are to make their sustainable use by adoption of green and sustainable building concept.

Services play very important role in comforts of the occupants of the buildings hence to make buildings sustainable from construction and maintenance points, internal and external services are to be made durable and maintenance friendly.

Architects, engineers and horticulturists/landscape designers have to come together during preparation of design and drawings to make the buildings user friendly. Necessary guidelines for the services are also required so that the services are well planned and designed according to requirements of sustainability.

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Sustainable Landscape Development in Built Environment

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Prologue

Landscape design typically involves artistic composition and artisanship, finesse and enterprise and emphasises on detailed site configuration from conceptual stages to the final planning of the area. Design factors include aspects such as climate and microclimate, topography, orientation, site drainage, ground water recharge, municipal bye laws and national codes.

Landscaping is the design of outdoor areas, landmarks and structures to achieve environmental and social behaviour and aesthetic outcomes. It involves a systematic investigation of existing social, ecological and soil conditions and processes in the landscape and the design of interventions that will produce the desired outcome. Its scope includes landscape design, site planning, storm water management, erosion control, environmental restoration, parks and recreational planning, green infrastructure planning and landscape master planning. This paper gives an insight into landscape planning and design of the adjoining land areas keeping in view aesthetic, horticultural, environmental sustainability aspects.

-Editor-

Introduction

Landscape design and planning of the land areas keeping in view aesthetic, horticultural and environmental sustainability is of utmost importance. Micro climatic conditions play an important role in landscape design as it accounts for the environmental conditions specific to the landscape, including temperature, wind and humidity. Landscaping helps in maintaining natural capacity of site for storm water management thereby contributing to soil organic matter and preventing erosion. It also involves maintaining natural configuration of site with necessary modifications and caters for storm water management, groundwater drainage and maintenance of soil structure. It helps in maintaining proper microclimatic conditions through evaporation uptake and effect of trees and other vegetation. It plays an important role in landscape design and helps in control of temperature, wind and humidity. A water body can increase evaporation and humidity. Higher microclimatic factor conditions occur where evaporation potential gets modified due to landscape surrounded by heat absorbing and reflective surfaces and existing untidy conditions. Examples of high micro climatic factor areas include parking

lots, west sides of buildings and slopes and areas experiencing wind funnel effects. Low micro climatic-factor areas include shaded areas and areas protected from wind, north side of buildings, slopes and areas under overhangs and north side of slopes.

Vegetation provides green areas leading to climatic benefits. Buildings shade certain parts of the external area during part of the day. Northern side external areas of buildings tend to be shaded while southern side has access to sunlight for most times of the day. Vegetation should be planted on solar exposed side depending on requirement of sunlight for the species of vegetation. Vegetation helps to reduce energy consumption of buildings by providing shading and cool microclimate.

Landscape Design

Pervious paving existing at site helps to hold rainwater, reducing the rate of storm water flow and helps the water to percolate into the ground. For sustainable site planning, preciousness in the paved areas of the site needs to be maximised. The open parking areas of concrete or asphalt absorb heat and contribute to heat island effect. Shading of such areas or use of light coloured materials over paving can be helpful in reducing such effect.

Landscape design for controlling solar gain is also important. Vegetation placed at suitable locations around buildings helps to reduce energy consumption and cost of measures for indoor climate control. Trees, shaded trellises, green roofs, green facades and green walls can be used to increase shading both on the ground and in conserving energy in buildings. Roof garden, green walls or vertical landscaping are extremely useful for the purpose. Further to above, urban agricultural practices and social forestry contribute significantly to urban greening, heat reduction and preservation of excess water.

Rain water harvesting is another important measure which helps at harvesting surface and groundwater, arrests groundwater decline, augments groundwater table and benefits water quality in aquifers. It also inculcates a culture of water conservation and helps in storing rainwater for the storage and recharge tanks. Recharging groundwater aquifers involves various kind of recharge structures, which collect water and promote water percolation through soil strata to recharge the depleting aquifers.

The building envelope should be designed to conserve energy and maximize day light and natural ventilation with access to fresh air. The building envelope may also be designed to integrate systems for renewable energy. The design strategies evolved out of long experience in various climatic zones may be suitably utilised. Building envelope components and their configuration can be considered to determine the amount of heat gain or loss resulting in natural ventilation in the habitat.

Landscaping maintenance specifications and management plan are key to aesthetic environment and surroundings. A site maintenance plan should be developed

which outlines long term strategies and short term actions for achieving sustainable maintenance. It should cater for plant maintenance, integrated pest management, soil management, fertilizer use and rain water harvesting. Healthy soils allow rain water to penetrate thus preventing excessive run off, sedimentation and erosion of soil. By storing water and slowing the delivery of water to plants, good soils play an important role in vegetation health. Protection and use of existing vegetation in soft landscape design helps in minimum disruption to existing habitat. Trees are significant community resources and need to be preserved. Where vegetation clearing is necessary for planning of buildings, transplantation of other suitable trees to the existing site or in neighbourhood should be explored. Conservation of native plants and endangered species of trees is important and should be suitably catered for.

Water Conservation and Irrigation Practices

Efficient irrigation systems, planting vegetation appropriate for site conditions and climatically suitable, and using captured rainwater or gray water can reduce water waste. To restrict the waste irrigation water through evaporation, wind, and unsuitable system design, necessary steps should be taken. Low water demand vegetation should be used along with grasses regionally appropriate. The turf area should not exceed thirty percent of the total landscape area. Reuse of gray water, captured rain water or condensate water is recommended. A sub surface drainage system should be planned in areas covered with turf.

External Access Design

Open parking and paved areas including roads and paths should not exceed twenty five percent of the site areas with a view to control the imperviousness. The safety and comfort of cycle lanes and pedestrians is important and construction of segregated right of way for bicycles and pedestrians needs to be encouraged. Providing suitable off street parking and loading facilities are needed to protect neighbourhoods and surrounding lands from parking, loading and traffic congestion. Neighbourhood connectivity, workability and safety are important to ensure that the neighbourhood is safe walking place. Planting of trees is an essential component for all streets to provide shade to pedestrians. Increasing greening in the area is recommended.

External Lighting Design

The landscape lighting should be designed so that light fixtures emit light as per norms and standards and ensure that lighting in the area is adequate from the point of safety and comfort. Proper use of outdoor lighting restores the ambience of dark night skies. Whether outdoor lighting is directly adjacent to a species in habitat or located at some distance is an important consideration which should be kept in view, so that combined effect of artificial lighting on different species is not adverse. The landscape lighting should be designed such that light fixtures emit minimum light as per norms of total fixed lumens.

External signage design can be classified as externally lit or internally lit consistent with the functional requirement and aesthetics. The requirements of different signage's should be suitably evaluated. Illuminated signage forms a substantial part of upward direct lighting. Fabrication of signage should preferably use locally available materials.

Maintenance of Landscaping

Landscape maintenance and management plan is key to pleasant and aesthetic environment and surroundings. Well maintained green areas enhance the value of the asset and provide relief and comfort to the users. The objective is to provide maintenance services as per landscape maintenance specifications. This covers hardscapes such as walkways paving, water features, fountains, driveways etc. Also included are the softscape elements such as soil, plants, shrubs, trees, flowers, grass turf etc. Maintenance of walkways, roads and paths should ensure accessibility features provided to facilitate movement of people. Weekly and monthly checklists should be maintained.

It is necessary to have right plant at the right place. Indigenous plants or other well adapted plants to local conditions should be used wherever possible. Plant growth rate, size of maturity, life span, requirements of light, water and soil are important factors in selecting plants along with their colour, texture and seasonal characteristics. Trees should be maintained in healthy, vigorous growing conditions free from disease and large concentration of pests. Pruning of trees should be done at appropriate time and intervals. Shrubs and vines should be pruned weekly or as required. Weeds in planted areas, side walls, or pavement should be removed as necessary. Hand watering should be done to supplement natural rainfall and permanent irrigation system to ensure that plants receive adequate water irrespective of weather conditions. While it is essential to maintain all landscapes and soft capes properly, it is also necessary to ensure general cleaning of the areas to enhance the appeal of the surroundings.

Conclusion

Landscape design involves gathering ideas and setting up plan of external areas of built environment keeping in view the factors such as climate and microclimates, topography and orientation site drainage and groundwater recharge, human and vehicular access and circulation, lighting and native plant habitat. Design factors include special site requisites, client's needs and preferences for plants and elements at site. Natural and cultural landscapes play a critical role in enhancing our social, cultural and ecological well being. The presence of accessible natural landscapes provides the opportunity for people to escape the pressure of modern living and to get in touch with nature. Accessible landscapes significantly increase the quality of life in urban habitat. Landscapes are touchstone for what we have come for, who we are and how we relate to

the surroundings around us. They are a critical exponent of our well being as individuals and as a nation. The unique landscapes provide people with physical and spiritual respite and links with our cultural heritage.

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Importance of External Development in Building Projects

Rajendra Kumar Mehra

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Prologue

The services of any individual building, colony and cities behave like network of arteries, communication system and excreta disposal system in living beings. The internal as well as external development are synonymous to construction of any building Project and are integral part of the project Without the internal and external development services, the buildings will be simply mass of Brick and cement without serving any useful purpose and which can not be made habitable. There are different types of services like internal water supply and sanitary installations, Internal electrical installations, Mechanical, electrical and plumbing services, HVAC, communication network, Sewerage and drainage system, Horticulture plantation, Energy generation on rooftops, facades, and compounds through renewable sources of energy, waste to energy, Rain Water Harvesting, care taking etc. All the services are equally important.

Here in this paper the author has discussed about various external development services for individual building, at Colony level and at city level development which is very interesting- A must read.

-Editor-

Introduction

For every building the internal and external services are equally important as the structure itself. For a new building its connection to the existing system of services act like the pressure valve of a pressure cooker which if not provided to release the pressure will burst the pressure cooker. Hence without the external development the existence of building is fatal. For any building, there are mainly three types of external developments. a) The immediate external developments within the plot boundaries called individual external developments. b) The external developments of the neighborhood, colony or the city. These are the development works of the project, neighborhood or the colony of which the building is a part. c) The trunk development works at the city level, which ultimately carries or holds the external development at the city level.

External development of any individual building, comprises of all kinds of services required for the running of the building and the surrounding civil developments, approach and connectivity including electrical services. These aspects have been elaborated in this paper.

Individual External Development

Individual external developments are the bridge between the internal building service and the project level external services. And the project level developments are a bridge between the project and the city level developments.

The plinth protection, external pathways, porch, entry-exit gates, the gardens, the site level rainwater harvesting system, inspection chambers, electrical connection from the project to the building, the boundary wall, the surface drains inside the plot are the components of individual external development works, which is the continuation of the internal building service. This external development supports the basic building life and helps in the running of the building. The basic issues of water logging, corrosion of plinth beam, water seepage from plinth, termite, water seepage from the ground floor, return of sewerage during rainy season and many other kinds of issues are addressed by the proper execution of individual external development work. For example; the plinth protection addresses the issues of water logging near the building and eventually protecting water seepage from floors. The proper execution of curtain wall helps in protecting water seepage in floors and settlement of ground floor. Adequate plinth height and proper level of inter-connections of inlet-outlet prevents the return of sewerage during rainy season. The gardens with re-charge pit takes care of roof rainwater harvesting. Proper slope inside the plot takes care of required surface drainage inside the plot.

The Project Level External Development

- **Road Top Level**

  The project level external development takes care of the abutting road level, the external street light and electrification, the surface drainage of the road, the manholes which has inlet from individual plots and outlet to the other manhole of the project, which ultimately leads to the treatment plant or the trunk sewerage line of the city. Hence, the most important thing is to fix the levels of road level keeping in view the adjoining city and level of adjoining sewerage lines as the road levels are the spine of any development work. They decide the plinth of each building and also the location of treatment plant and rainwater catch-basin traps. The slope of road in both directions lateral and horizontal both are equally important.

- **Road Section**

  The design of road section is the basis of every site development. It decides the kind of traffic and also the kind of street ambiance the project is going to give. An ideal street section defines almost everything about the character of the street and the project. The position of street light poles, the manholes, surface

drains, footpaths, street furniture, road divider, avenue trees, junction design, RW catch basins, drive way design, pavement designs everything is reflected through the road section design. All the wet services, electrical services are governed by the road section design. Roads contribute the major part of project level external development work. Hence a good project is judged by its designing of street sections and pavement design.

- **Wet Services**

Wet services coming under the project level development work are the deciding factors of the life of the project. A project can be lively only when the services are functional. These services join the individual plot level services to the treatment plant or city level trunk lines. Efficient design of sewer-line affects the life of any project. More efficient the sewer-line system, more efficient is the life of the project or the colony.

Water supply services are also part of this project level development work, responsible for the supply of water from the source to individual plot. This again is one of the life-giving works without which there is no possibility of habitation in any project. The design of water supply lines involves design of loops, junctions, position of valves, diameter of supply line pipes, quality of pipes etc. With proper designing of water supply lines, we can achieve economic and efficient water supply system. Water supply system with re-utilization of treated water is the need of the hour. Proper drip system supported with the reuse mechanism of treated water, keeps the whole project or colony green and healthy. Water supply systems shall be designed keeping in view the number of gardens and rainwater harvesting system design. Treated water can be used back to individual level for flushing and car wash. Today utilization of water for non-drinking/cooking/bathing use is more. Hence, for non-drinking/ cooking/bathing we shall design water supply system using the treated water. In the long run, this system reduces the raw water consumption and helps in reduction of less usage of groundwater.

- **Electrical Work**

Efficient design of electrical development work supplements to the overall day-night ambiance. Location of power supply grid, transformers, and poles of street light all are decided by the electrical design work. Project level electrical work is a bridge between the city level electric supply and the individual user at plot level. Hence the electrical development work is an important element in the functioning of the project.

- **Urban Design**

  The urban design of any project is defined by the design of its project level external development work. Design of plaza, walkways, street lights, street furniture, fountains, gardens, crossroad design, signage design, the color and texture of the pavement design, everything is part of project level external development work and is covered under the urban designer scope of work.

- **Landscaping**

  The landscape of the project is another major part of external development. The health of the landscape tells us the health of the project or the society it caters to. When the gardens are healthy and well maintained, they create an environment of health and happiness. Landscape design takes care of surface drainage also. The design of the sections between the road and the gardens or the open area, are very important for avoiding water logging and improving surface drainage. Landscaping also takes care of the treatment of the base of tree trunks. This helps in improving the life of the tree and helps the water to percolate into the roots of the trees. Landscaping takes care of the art and aesthetics of the external ambiance of any project. The statues, sculptures, paintings-art work, design of water fountain etc. add to the liveliness of the project.

The City Level Development

The city level external development is the ultimate receiving end of sewerage system and the source of generation of water and electricity services. The sewer line system of the city takes the project level sewerage to its ultimate destination. The over head tank or water body at city level becomes the source of water to all the residents of the locality. Likewise, the HT line or high level transformers become source of electricity to everyone. Hence, external development at city level, project level and plot level is one of the major works in the development of the whole city!!

Conclusion

External development is the most important work in the development of the individual building, colony and city. It acts like a medium which gels all the different entities of the built-form. Without the external development, no development of building, colony and city is complete. External development is the connecting bond between the buildings and the infrastructure. Without external development one cannot imagine a complete ideal city.

Sustainability in Construction Sector

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Prologue

The climate change, air pollution and reduction of the quantity of Earth`s natural resources are the biggest worldwide problems nowadays. Every year scientists are working on projects for decreasing the carbon dioxide emissions. The Earth has finite number of resources, an ever growing population, and a need for sustainable construction. Sustainability is reducing the depletion rate of natural resources to maintain the ecological balance. Though construction deteriorates air quality, but with the growing population there is a greater need for construction. Therefore, only alternate available is to make construction sustainable.

It is estimated that the buildings consume 40% of the energy and creation of the built environment leads to resource depletion, destruction of plants and wildlife, water and air pollution. Green construction is a step towards sustainability and determines how we can minimize our environmental impact in the construction process and to offset the impact that we already have. New technologies like prefabrication and BIM can improve the sustainability through savings in material wastages, improvement in overall construction quality of the built environment and reduction in consumption of resources.

-Editor-

Introduction

Sustainability in terms of sustainable development can be defined as meeting the needs of the present without compromising the ability of future generations to meet their needs. It has the ability to exist constantly. The construction sector is capable of making a significant contribution to it, particularly considering the vast amount of materials and energy resources required to produce and maintain the built environment, not to mention the sum of emissions and waste generated throughout the life-cycle. Considering the global extent of urbanization today and taking into account the pace at which the planet is being further urbanized, it is even more imperative that whatever is built must perform environmentally, economically, and socially consistent with sustainability.

The construction sector is considered as a key polluter to our urban environment, however it can be addressed through sustainable construction in which clean energy is going to play a major role.

Sustainable Construction

Construction activity contributes to environmental degradation due to pollution and consumption of natural resources. Therefore, sustainable construction needs to be resource efficient, environment friendly and user friendly. In brief, sustainable construction should enhance living, working and leisure environments for individuals and communities, consume minimum energy over its life cycle, generate minimum waste over its life cycle, integrate with the natural environment, and use renewable resources where possible. Further, sustainable construction should not cause permanent damage to the natural environment or consume large amount of resources during construction or demolition. It should not unnecessarily waste energy, water or materials due to short life, poor design, inefficiency or low standard construction techniques.

A In brief, sustainable construction can be accomplished by eliminating resource depletion, and environmental degradation through;

- Minimize resource consumption (Reduce)
- Maximize resource reuse (Reuse)
- Use renewable or recyclable resources (Renew/Recycle)
- Protect the natural environment (Protect Nature)
- Create a healthy, non-toxic environment (Non-Toxics)
- Pursue quality in creating the built environment (Quality)

Resources to create the built environment are; water, materials, land and energy. The above principles apply to most of the resources but they apply to energy resource differently, therefore energy is discussed differently. Importance and impact caused by above aspects are as follows:

Reduce: Minimising resource consumption is the first principle to address sustainability. Green / energy efficient buildings save energy to the extent of 40-50%. The first step to promote their use is use of passive measures to provide heating, cooling, ventilation, and lighting for structures to minimise energy consumption which is absolutely essential. The next step is to consider high efficiency systems, high levels of insulation, and high performance windows and the last step is to use the renewable energy and create net zero or energy plus built environment.

Use of durable materials that have long life and require low maintenance will reduce resource consumption. There are many ways to conserve water e.g. low flow fixtures, dual flushing cisterns, waterless urinals, shorter lengths of piping to hot water taps ,Permeable landscaping materials to absorb and retain rainwater, landscape that requires less watering etc. To reduce demand of land, options are to go high rise, mixed use and multiple use of built environment.

Reuse: After resource consumption is reduced to the minimum, we need to consider to reuse resources we have already extracted. Reuse in contrast to recycling reuses items simply with minimal reprocessing whereas recycled items are in essence reduced to raw materials and used in new products. Windows, doors, electrical appliances and bricks etc. are the items that can be reused in new construction and renovation. Water can also be reused through rain water harvesting. Grey water can be reused (greywater is wastewater from wash basins, showers, washing machines) for watering the garden or washing the car. Land can be reused by replanning, vertical addition, redevelopment and adding flyovers or under passes etc. Reuse of energy is through energy efficiency like regenerative lifts and waste heat recovery systems.

Recycle/Renew: Resources that are recyclable or have recycled content, or that are from renewable resources must be given priority over others. The principle applies to energy also where renewable sources such as solar and wind power are available for use. It applies to materials as well that can be recycled to use them in new form e.g glass, concrete, aluminium, steel, C & D waste etc. Water from STP can be treated and recycled for use in landscaping and cooling towers. Land can be recycled by redevelopment and using higher density on the same land.

Protect Nature: Creating the built environment will impact the natural environment and its ecological systems. Considering the past negative effects on the natural environment, perhaps it is time to do better than just sustain by restoring wherever possible. Grey zones can be remediated, detoxified and returned nearly to their original state. The abuses of river straightening, marsh draining, and deforestation can be remedied by intelligent intervention in creating the future built environment. The impacts of materials acquisition practices must be studied in detail with respect to mining, or consuming energy, to minimize environmental effects.

Non-Toxics: The products constituting the built environment are accompanied by a wide variety of hazardous and toxic substances that ultimately threaten human health and well-being. Toxic materials must be handled with care and eliminated to the greatest extent possible with main objective to achieve good indoor air quality and environment.

Quality: It includes planning of habitat in such a way so as to reduce automobile trips, increase interpersonal activity, and provide a good quality of life. It includes excellence in design of buildings as an absolutely essential component of sustainable construction including selection of materials, energy systems, design of passive energy and lighting systems etc.

B Energy

Production of energy from non renewable resources is not sustainable hence gradually one has to switch over to non conventional resources till it becomes sustainable. Simultaneously energy conservation habit needs to be inculcated at all levels by way of use of minimum energy, good engineering practices and adoption of good habits. Energy efficiency measures need to be adopted in all construction activities. Smart energy pyramid as shown in Fig. 1 shows the way to reduce demand through energy conservation, energy efficiency and lastly through renewable energy which serves the dual purpose of fulfilling the demand and simultaneously reducing the global warming.

As the world is slowly embracing green initiatives and moving towards renewable energy, India has also revised it's target of renewable power capacitv from 175GW by 2022 to 450GW by 31.03.2030.

Fig. 1 Smart Energy Pyramid

Energy Conservation

Energy conservation is to be given more importance than production. December 14th is celebrated as World Energy Conservation day globally to highlight the importance of energy consumption and its use in our day-to-day life. It is the most economical solution to energy shortages, which reduces strain on the environment and brings down electricity expenses. We use energy faster than it can be produced. Energy saved is energy generated - saving one unit of energy is equal to 2 units of energy produced as it not only saves money but also reduces the demand. It mitigates numerous adverse environmental and social impacts associated with energy production and consumption e.g. air pollution, acid rain and global warming, oil spills and water pollution, loss of wilderness areas, construction of new power plants, extends the lifetime of equipment, and reduces the maintenance cost by operating for fewer hours at less than maximum capacity.

"Energy conservation" and "Energy efficiency" are often used interchangeably, but there are some differences. At the most basic level, energy conservation means using less energy and is usually a behavioural change, like turning off lights or setting thermostat at lower temperature. Energy efficiency, however, means using energy more efficiently, and is often a technological change.

Energy Efficiency

It is estimated that 40-60 % consumption can be reduced by adopting energy efficiency measures. Distribution of sector wise consumption in India during 2016 given below in Fig. 2 shows that maximum consumption is in Industrial sector, which is 45%, followed by building sector which includes residential/ domestic and commercial -30%. Green buildings attempt to minimize resource consumption and wastage thereby reducing the environmental impact during the entire lifecycle of a building from construction to operation, consuming various resources like energy, water, materials. Bureau of Energy Efficiency (BEE) and Energy Conservation Building Code (ECBC) promote energy efficiency in building sector to bring down the energy consumption by 40-60%. This can further be enhanced by construction of net zero buildings and energy plus buildings. CPWD has constructed net zero building as Indira Paryavaran Bhawan and Dandi Memorial as energy plus campus with 41 solar trees and each tree generating 3.51Kwp with total power generation of 144Kwp.

Renewable Energy

Apart from energy efficiency and conservation, there is a need to switch over to generation of renewable energy in place of non renewable sources. Renewable energy sources have the potential to provide 3,078 times the current global energy needs of which solar energy 2,850 times, wind energy 200 times, biomass 20 times, geothermal 5 times, wave-tidal energy 2 times, and hydropower 1 time. In order to promote renewable energy and energy security, it is decided by the Government of India that 8% of total consumption of electricity, excluding hydro power, shall be from solar energy by March 2022.

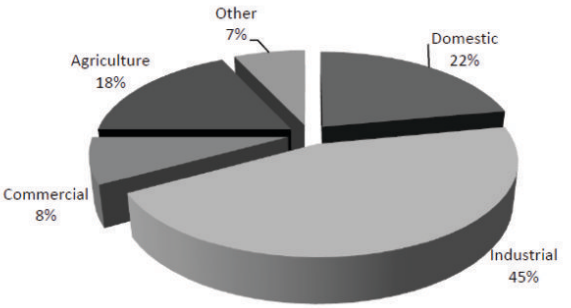

Fig. 2 Distribution of Sector Wise Consumption

India is one of the countries with the largest production of energy from renewable sources. In the Paris Agreement, India had committed to achieving 40% of its total electricity generation from non-fossil fuel sources by 2030 but now country is aiming for even more ambitious target of 57% of the total electricity capacity from renewable sources by 2027 in Central Electricity Authority's strategy blueprint. According to 2027 blueprint, India aims to have 275 GW from renewable energy.

Recently, at UN climate summit, India has announced to increase its renewable energy target from 175GW by 2022 to 450GW by 31 March 2030. As of 2019, India's total electricity generation mix is 35% from renewable energy, 55% from coal, 2% from nuclear power, and the remaining 8% from small hydro and other sources. As of October 2019, of the 175 GW (100 GW of solar, 60 GW of wind, 10 GW of bio mass and 5 GW of small hydro) interim target, 83 GW is already operational, 29 is under installation, 30 GW is under bidding, and remaining is under planning.

Some Other Experimental Initiatives

As part of reducing environmental pollution and consumption of non renewable resources, country has already started use of solar panels on car, train, bus, truck and aircraft on experimental basis which may be implemented later on large scale. Solar roof tiles and solar panels on vertical surface are also being experimented.

To save on land, solar paneled roads and floating solar plants are also being experimented. To cater to the needs of cleaning and to maintain the efficiency of solar panels, Israel has been using robots and microfibers instead of water. Each minute a robot cleans about 100 sq feet panel area. Also manufacturing unit of robotic cleaning is being set up at Chennai. To create sustainable environment, we need to integrate all these isolated areas of interest.

Conclusion

- Construction sector, although is a key pollutant, is capable of making a significant contribution to sustainability.
- Sustainable construction enhances living, working and leisure environments for individuals and communities.
- India has revised its renewable energy target from 175GW by 2022 to 450GW by 31 March 2030 and is one of the countries with the largest production of energy from renewable sources.
- Sustainability principal of 3Rs i.e. reduce, reuse and recycle in respect of all resources of built environment must be respected and adhered to.
- We use energy faster than it can be produced.
- One unit of energy saved is equal to 2 units of energy produced as it not only saves money but also reduces the demand.

- Robotic solar cleaning shall prove to be much more useful with increase in use of solar panels on roof and walls.

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Sustainable Quality Management in Buildings

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Prologue

In our country, building construction sector is currently flourishing in various parts of the country, especially in major cities and towns. The ambitious economic development and obligations are coming in the way of preserving natural resources and ecosystems. There is the need of the hour to shift the focus to holistic approach in building development comprising economic development, social development and environmental protection for future generations. The term 'sustainability' should be viewed as humanity's target goal of human-ecosystem equilibrium.

The author Shri Deepak Gupta is a Civil Engineering graduate with PGDM in Advanced Construction Management and MBA in Quality Management, having more than 20 years of experience in the field of quality management. The paper gives an insight into sustainable quality management in buildings. The fundamental concepts and principles of ISO9000:2015 as applicable to construction work have also been explained.

-Editor-

Introduction

Sustainable building construction is one of the prerequisites of the society for the future. It requires a great deal of effort on the part of various stakeholders involved in construction. Sustainable construction is designed to have a lower environmental impact on the habitat while providing a normal level of comfort, durability and functionality for the occupants. Developing sustainable buildings minimizes the use of water, raw materials, energy and land. It also reduces emissions, waste and pollution in the environment and protects health of the people.

Sustainable buildings are the future requirement of the habitat. These buildings are comparatively costlier than conventional buildings. Therefore, the initiative for constructing sustainable building has not yet gained momentum. Concepts of sustainable

quality management are generic and equally applicable for external services. The continuous savings on water, electricity, heating and maintenance costs amortize price difference of sustainable building over a period of time. A customer can choose to invest in upfront high quality sustainable buildings and external development to reduce or prevent failures in future and avoid need for additional costs in future.

Sustainable Buildings

Some essential elements of a sustainable buildings are as follows:

- **Water** - In sustainable buildings it is essential to plan a sustainable use of water by reusing wastewater with the correct treatment systems and collecting rainwater.

- **Raw Materials** - Instead of depleting natural resources, developers of sustainable construction use less raw materials and more environmentally-sustainable products, such as recycled or renewable resources. Tiles made from glass bottles, impeccable parquet floors made with reused wood from other buildings, patio flooring made with old crushed and compacted tiles are extremely useful. They also look for a durable option to delay the need for replacements and repairs for as long as possible. Lastly they help to recycle construction debris to reduce the amount of waste going to landfills.

- **Energy** -Sustainable buildings include energy-saving appliances that lower carbon emissions. The buildings are designed and positioned to take full advantage of sunlight. Investing in solar panels for electricity, heating and hot water is a good choice. This reduces electricity and heating consumption.

- **Land-** Even the choice of land plays an important role in sustainable construction. Properties need to be built in areas where construction will lead to the least possible land degradation and deforestation while promoting healthy landscaping and preventing erosion.

Sustainable Quality Management in Buildings and external development

Much of what we call sustainability has deep roots in quality. Quality is based on a set of values and beliefs at its center, such as “do no harm,” “zero-waste”, “driving out fear” between management and employees. Quality is the symbol of human civilization and many issues such as innovation, ethics, trust and reputation could be regarded as parameters within Quality Management System (QMS).

While these sound like the latest ambitious mantras of Corporate Social

Responsibility (CSR), they are core principles and definitions of the quality movement, defined by the quality gurus decades ago. Quality also has a very strong focus on people—not just customer satisfaction, but also quality of working life and employee satisfaction. The ISO 26000 standard related to social responsibility makes a more deliberate connection between people and quality management systems with guidance provided for human rights, labour practices, fair operating practices, consumer issues, community involvement and development. The intersections between CSR and quality in shared core values and issues provide a strong foundation for more strategic alignment between the two functions.

The context in which an organization works today is characterised by accelerated change, globalization of market and the emergence of knowledge as principle resource. Society has become better educated and more demanding making interested parties increasingly more influential. The impact of quality extends beyond customer satisfaction, it can also have direct impact on organization's reputation.

Construction projects are an extremely complex process, involving a wide range of issues. There are plenty of factors affecting the quality of construction, such as design, materials, machinery, topography, geology, hydrology, meteorology, and construction technology, methods of operation, technical measures, and management systems and so on. In construction general perception for quality remains limited to quality control and quality assurance only and other important aspects of quality management are generally perceived non essential. ISO:9001:2015 QMS is truly a management tool for improvement in construction business performance. It is the time to position quality as internal consultants and advocates, rather than "cops".

Some aspects of ISO:9001:2015 Standard related to Sustainable Quality Management and beneficial for sustainable buildings are as follows:

i) International Standards Organization (ISO) Annex SL

(a) The ISO has developed Annex SL ("Annex SL – Proposals for management systems standards") Directive. This annex states that all management system standards will use "High level structure (HLS), identical core text, common terms and core definitions".The Annex-SL framework has been developed based on Risk-based Thinking approach, which is a step towards sustainability in quality management.

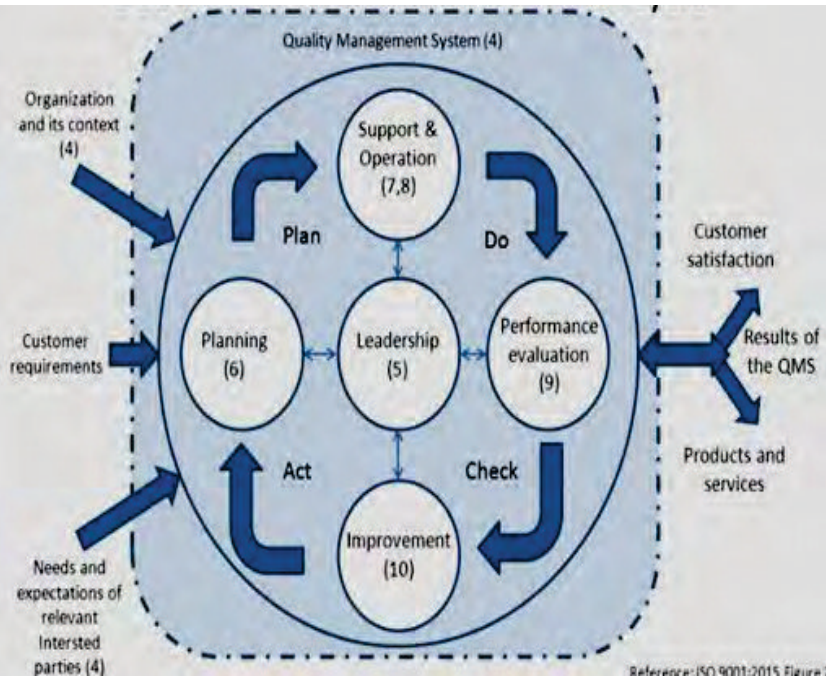
(b) ISO 9001:2015 – Quality Management System, ISO 14001:2015 - Environmental Management System and ISO 45001:2018 – Occupational Health and Safety Management Standard have followed Annex SL framework.

ii) Change in ISO 9001 QMS Process Model

(a)The process-based quality management system model was introduced in

ISO 9001:2000 edition which replaced the 1994 standards ISO 9001, ISO 9002 and ISO 9003 by unifying them. The model illustrates the process linkages present in the clauses 4 to 8 of ISO 9001 Standard and remains applicable up to end of ISO 9001:2008 standard validity.

(b)The process-based quality management system model is revised in currently applicable ISO 9001:2015 Standard edition. The model illustrates the process linkages present in the clauses 4 to 10 of ISO 9001 Standard. Its components are:-



- **Plan**: establish the objectives of the system and its processes and the resources needed to deliver results in accordance with customers' requirements and the organization's policies and identify and address risks and opportunities;

- **Do**: implement what was planned;

- **Check** : monitor and (where applicable) measure processes and the resulting products and services against policies, objectives, requirements and planned activities and report the results;

- **Act**: take actions to improve performance, as necessary.

iii) Quality Management Fundamental Concepts and Principles

The quality management fundamental concepts and principles described in ISO 9000:2015 standard give the organization the capacity to meet the challenges by an environment as detailed below:

a) Quality Management Fundamental Concepts

Quality

An organisation focused on quality promotes a culture that result in the behaviour, attitude, activities, processes that deliver value through fulfilling the needs and expectations of customers and other relevant interested parties. The quality of an organization's products and services is determined by ability to satisfy customer and unintended impact on relevant interested parties.

Quality Management System

A QMS comprises activities by which the organization identifies its objectives and determines the processes and resources required to achieve desired results. The QMS manages the interacting processes and resources required to provide the value and realize results for the relevant interested parties. The QMS enables top management to optimize the use of resources considering the long and short term consequences of their decision.

Context of an Organization

Understanding the context of the organization is a process. This process determines factors which influence the organization's purpose, objectives and sustainability. It considers internal factors such as values, culture, knowledge and performance of an organization. It also considers external factors such as legal, technological, competitive, market, cultural, social and economic environments.

Interested Parties

The concept of interested parties extends beyond a focus solely on the customer. It is important to consider all relevant interested parties. The relevant interested parties are those that provide significant risk to organizational sustainability if their needs and expectations are not met. Organizations define what results are necessary to deliver to those relevant interested parties to reduce the risk.

Support

- General

  Top management support of the QMS and engagement of people enables provision of adequate human and other resources; monitoring processes and results; determining and evaluating of risks and opportunities and implementing appropriate actions.

- People

  People are essential resources within the organization. The performance of the organization is dependent upon how people behave within the system in which they work. Within an organization people become engaged and aligned through a common understanding of the quality policies and the organization's desired results.

- Competence

  A QMS is most effective when all employees understand and apply the skills, training, education and experience needed to perform their roles and responsibility. It is the responsibility of top management to provide opportunities for people to develop these necessary competences.

- Awareness

  Awareness is attained when people understand their responsibilities and how their actions contribute to the achievement of the organization's objectives.

- Communication

  Planned and effective internal and external communication enhances people's engagement and increased understanding of the context of the organization; the needs and expectations of customers and other relevant interested parties.

b) Quality Management Principles

Elements of Quality Management Principles are as follows:

- Customer Focus

  The primary focus of quality management is to meet customer requirements and to strive to exceed customer expectations.

- Leadership

  Leaders at all levels establish unity of purpose and direction and create conditions in which people are engaged in achieving the organization's quality objectives.

- Engagement of People

  Competent, empowered and engaged people at all levels throughout the organization are essential to enhance its capability to create and deliver value.

- Process Approach

  Consistent and predictable results are achieved more effectively and efficiently when activities are understood and managed as interrelated processes that function as a coherent system.

- Improvement

  Successful organizations have an ongoing focus on improvement.

- Evidence-based Decision Making

  Decisions based on the analysis and evaluation of data and information are more likely to produce desired results.

- Relationship Management

  For sustained success, organizations manage their relationships with interested parties, such as suppliers.

Conclusion

All concepts, principles and their relationships pertaining to Quality Management should be seen as a whole and not in isolation to each other. No individual concept or principle is more important than the other. At any point of time finding the right balance in application is critical.

The management teams generally want increase in efficiency, customer satisfaction, and profitability, but rarely tap into the real power of ISO 9001. To achieve sustainable quality management in buildings, ISO 9001 must be valued more than a standard. It should be part of a company's strategic plan. The guidelines and quality principles in ISO 9001 are just good business practices. The implementation of new process model of ISO 9001, its related fundamental concepts and principles can facilitate achievement of sustainable quality management in buildings.

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Green Building Concept for Sustainable Infrastructure in India

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Prologue

The civil engineering infrastructure is growing at a rapid pace in India. The paper brings out the advantages of Green Materials and Green Building practices and measures required for saving energy by using green materials for construction to reduce overall impact of the built environment on human health and natural environment. This is achieved by efficiently using energy, water and other resources; protecting occupant health and improving employee productivity and reducing waste, pollution and environmental degradation. It is observed that in many cases, environmental aspects are ignored leading to uncomfortable habitat and increased maintenance and energy requirement, causing threat to the environment.

How can we meet the today's needs without diminishing the capacity of future generations to meet their own, a challenge we have to address in construction industry? In fact, our survival in this planet will mainly depend on how in an innovative way and efficiently we can use more and more green materials in our various infrastructure projects for sustainable development.

In this paper the author has highlighted that by using green materials we can take advantage of renewable resources, reduced energy use and reduced waste etc.

-Editor-

Introduction

Sustainable development has become the challenge for humanity particularly with rapid growth of urbanization. Critical issue is to provide food, shelter and other basic needs to rapidly growing world population and save natural resources on which the very existence of population depends. We have got wide variation in the Perception of responsibility to future generations and ethical issue. There is an urgent need of us the professional to understand and implement cleaner production and sustainable development objectives at all level of responsibility.

The buildings in which we live, work, and play protect us from Nature's extremes. Yet they also affect our health and environment in countless ways. The design, construction, operation, maintenance, and removal of buildings takes enormous amounts of energy, water and materials, and generates large quantities of waste, air and water pollution. As the environmental impact of buildings becomes more apparent, a concept called green

building is gaining momentum. Green or sustainable building is the practice of creating healthier and more resource efficient models of construction, renovation, operation, maintenance, and demolition. Research and Experience increasingly demonstrates that when buildings are designed and operated with their lifecycle impacts in mind, they can provide great environmental, economic, and social benefits. It is worth noticing that most of us talk about energy consumption and pollution because of industry and transport, when about 40% of the total energy produced is consumed by buildings only. Based on this concept Smart City is being created in India in number of places. In this concept we are trying to develop Green field project, where complete planning/designing/construction is being done on virgin land. However, number of existing Cities/Township is also being modified/retrofitted to as brown field smart city/towns.

Advantage of Green Building Concept

It is estimated that about 40 percent of energy consumption in a building is on account of heating, ventilating, and air-conditioning, or HVAC. Green buildings have provision for solar protection to prevent heat gain in the premises during the day. This helps in putting less of load on air-conditioning system to maintain ambient temperature within the premises. Weather sensors help in optimizing the benefits offered by automated solar protection system. In winters, the natural heat can be allowed in the premises using the same solar shades and for controlling those, depending on the sun effect and heat coming inside the building, thereby helping the heating system perform better. The downsizing of active temperature management systems (air-conditioning and heating) in the green buildings reduces the overall building costs.

As per estimates, 76 percent of the electricity generated by all power plants is consumed by buildings and 35 per cent of the energy consumed in a building is because of use of light in the day time. So the big question is how to reduce the consumption of this energy? The simple answer to this question is the solar protection mechanism in green building. It ensures the usage of natural light to the maximum and that results in the reduction in the consumption of electricity used for lighting. It helps in curbing the recurring energy consumption costs like lightning by the use of natural lights. Indian climate provides us natural light for quite a longer duration and if the luminosity coming in can be controlled, then this will be huge source for energy. The mechanism also protects the premises from the glare and heat of harsh Sun in the summers and maintains the warmth of Sun during the winters. This helps in the increase in the comfort level of users, as it enables natural ventilation, natural light and also climate control in a natural way. So, the overall experience in such buildings is quite soothing.

Green Building Practices

Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees

through green roofs, rain gardens, and for reduction of rainwater run-off. Many other techniques, such as using packed gravel for parking lots instead of concrete or asphalt to enhance replenishment of ground water, are used as well. Effective green buildings are more than just a random collection of environmental friendly technologies. However, they require careful, systemic attention to the full life cycle impacts of the resources embodied in the building and to the resource consumption and pollution emissions over the building's complete life cycle.

On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable building: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy. Building materials typically considered to be 'green' include rapidly renewable plant materials like bamboo and straw, lumber from forests certified to be sustainable managed, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and / or recyclable (egg Tress, Linoleum, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, sea grass, cork, expanded clay, vermiculite, flax linen, sisal, sea grass, cork, expanded clay grains, coconut, wood fiber plates calcium sand stone. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects. Building materials should be extracted and manufactured locally to the building site to minimize the energy embedded in their transportation.

Every year grain farmers battle with the remains of their harvest, straw. Straw does not decompose very rapidly and becomes burden for the farmers, and the burning of straw produces CO, which has an impact on the environment. Thus the use of straw bale in building will not only solve the problem of straw as waste but also will help in building houses having significantly low impact on the environment without sacrificing most of comforts having accustomed to. Straw is a renewable material offering good thermal insulation properties and a much lower environmental impact than many current mainstream construction materials. It can be promising building alternative that meets housing needs and energy efficient goals of India. So choosing straw bale construction has many advantages for people and the planet.

Bamboo is basically like a grass. India has second largest bamboo reserves in the world. It is fastest growing species on the planet. It takes only 7 to 8 years for a seedling to grow into a mature clump. Considerable environmental degradation is taking place in India through declining forest cover and carbon emissions. It is possible to cultivate bamboo on degraded land also. Bamboo can lower light intensity and protect against ultraviolet rays. Bamboo conserves the moisture in the soil and protects against drought. Bamboo stands release 35% more oxygen than equivalent stands of other trees, thus helps in reducing carbon dioxide gasses, blamed for global warming. Thus utilization of bamboo is multifold and has great potential in developing economy, but in India, so

far not much attention is paid in these lines. In India, NBM (National Bamboo Mission) has been set up under the Ministry of Food and Agriculture in 2005, with the following objectives:-

- Use bamboo development as an instrument of poverty alleviation and employment generation particularly in the rural sector.
- Diversify, modernize and expand bamboo based industries through the application of modern technology and financial support and;
- Use of bamboo as a means to achieve ecological security through plantation of quality species needed by the industry and the handicrafts sector.

The progress on ground is slow. The utilization of bamboo has great potential in developing economy. However with the involvement of traditional bamboo crafts sector, it is expected that the Mission will be able to fulfill its objectives.

Reduced Energy Use

Green building often includes measures to reduce energy use. To increase the efficiency of the building envelope, (barrier between conditioned and unconditioned space), they may use high-efficiency windows and insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy loads. Finally, on site generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building. Power generation is generally the most expensive feature to add to a building.

Reduced Waste

Green architecture also seeks to reduce waste of energy, water and materials used during construction. For example, in California nearly 60% of the state's waste comes from commercial buildings. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills. To reduce the impact on wells or water treatment plants, several options exist. "Grey water" wastewater from sources such as dishwashing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, e.g., to flush toilets and wash cars. Rainwater collectors are used for similar purposes.

Centralized waste water treatment systems can be costly and use a lot of energy. An alternative to this process is converting waste and wastewater into fertilizer, which avoids these costs and shows other benefits. By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced. This concept was demonstrated by a settlement in LubeckGermany in the late 1990s. Practices like these provide soil with organic nutrients and create carbon sinks that remove carbon dioxide from the atmosphere, offsetting greenhouse gas emission. Producing artificial fertilizer is also more costly in energy than this process.

Energy Saving Measures in Homes

Energy can be saved in homes by adopting the following measures:

- Using renewable energy devices / system such as solar water heaters, solar cookers, solar lanterns, solar home systems, solar generators, and other devices.

- Retrofitting some components of solar passive architecture, for example, sunshades, double glazed windows, smart glazing, window overhangs, roof treatments, ventilation, evaporative cooling, and day lighting, depending on the climatic zone where the house is constructed.

- Adopting energy conservation devices, for example, LEDs (light-emitting diodes) CFLs (compact fluorescent lights) instead of incandescent bulbs, electronics chokes and fan regulators, sensors for automatically switching lights on or off, automatic speed regulating fans / motors, energy – efficient electrical appliances such as fans, refrigerators, air conditioners, coolers, room heaters, and water pumps among others.

Green Building Materials

Eco – Friendly Building Materials and Resources

- Select materials such that a major portion of the building is recyclable during renovation and re-construction.

- Use materials having longer life which ultimately can reduce environmental impact in materials manufacturing and transporting (woods, flooring, paneling, cabinet, doors, frames, brick, light, fixtures etc.).

- Use locally available materials for construction, thereby reducing environmental impact resulting from transportation and supporting to the site area.

- After construction of the building, recycle or salvage at least 50 to 75% (by weight) of construction, demolition and land clearing waste.
- Allocate separate space for sorting and storing waste disposals (e.g. Newspaper, organic substances, dry waste etc.)
- Design waste bin, which allows for easy cleaning and thereby avoid health hazards.

Properties of Eco-friendly Materials

- It is biodegradable and can be reused / recycled.
- It aids energy efficiency in buildings.
- It is durable and life span more.
- It helps in reduction in air, land and water pollution.
- Normally locally available.
- Reuse of waste product is possible.
- It is generated from renewable source.

The Source of Material is given below

- Renewable Source
  - ➢ Rapidly renewable sources e.g. wood from certified forests.
- Reuse of Waste
  - ➢ Salvaged products – e.g. old plumbing, door frames.
- Recycled contents
  - ➢ Agriculture / industrial waste

Conventional Eco-friendly Materials

The major eco-friendly materials are listed below:

- Bamboo, bamboo based particle board and ply board, bamboo matting.

- Brick sun dried, precast cement concrete blocks, hollow concrete block.
- Calcined phosphor gypsum wall panels, calcium silicate boards and tiles, clay roofing tiles, marble mosaic tiles.
- Cellular light weight concrete blocks, insulated blocks.
- Cement paint.
- Water polyurethane and acrylic based chemical admixtures for corrosion removal, rust prevention, water proofing.
- Epoxy resin system, flooring, sealants, adhesives and admixtures.
- Ferro-cement boards for door and window shutters, ferro cement roofing channels.
- Fly-ash sand lime bricks and paver blocks, stone dust.
- Gypsum board, tiles, plaster, blocks, gypsum plaster fiber jute / sisal and glass fiber composites.
- Laminated wood plastic components.
- MDF Boards and mouldings, particle boards.
- Micro concrete roofing tiles,
- Polymerized water proof compound.
- Portlandpozzolona cement, Portland slag cement.
- RCC door frames.
- Ready mix cements concrete.
- Rubber wood finger joint board.
- Water proof compound, adhesive, polymer, powder.

Technical Attributes and Specifications of Bamboo buildings

- Durable (30 years life) and weather resistant.

- Designed for withstanding high winds and earthquake resistant.
- Aesthetically pleasing, functional and fire resistant.
- Good thermal and acoustic properties.
- Eco-friendly, energy saving in manufacture and in usage.
- Light weight, modular and interchangeable.
- Quick and easy to erect and re-erect and transported with minimum effort.
- Cost effective.

Advantages over competing choices:

- Cheaper compared to cement / RCC structures.
- Easily the best “green” alternative.
- Is better compared to other portable alternatives (mainly plastic and wood ply based) both in terms of cost and environmental benefits.
- Easy to maintain and repair.
- Easy and cheap to relocate the structures.
- Bamboo is grass, not timber and best green building material.
- Foremost and fastest in biomass production. Highly renewable: regenerates in 2-3 years (timber takes 25 years or more).
- Most efficient in carbon sequestration.
- Excellent remedy for soil erosion.
- The best natural engineering material.
- Energy efficient: requires 1/3rd of energy compared to timber, 1 /8th of energy compared to cement and 1/50th of energy for processing equivalent mild steel.

Conclusion

As brought out in the paper, it has become imperative to produce innovative building materials for various elements of construction and take recourse to alternative technology, considering the short supply, increasing cost and energy and considering environment consideration for traditional and conventional materials. The production and application of appropriate materials and technology in re-cycling of industrial and agricultural waste has to receive substantial emphasis for Sustainable development. The use of cost effective environment friendly materials and technology will not only reduce the cost of construction and provide durable structures, but will also lead to sustainable development. Green Buildings is the practice of increasing the efficiency with which buildings use resources – energy, water, and materials while reducing building impacts on human health and the environment during the building's life cycle, through better siting, design, construction, operation, maintenance, and removal. Green buildings are designed to reduce the overall adverse impact of the built environment on human health and the natural environment by efficiently using energy, water, and other resources, protecting occupant health and improving employee productivity and reducing waste, pollution and environmental degradation; thus leading to sustainable development.

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Sustainable External Drainage System-Case Study

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Prologue

As India's cities have expanded, their drainage systems have not kept pace with building growth nor with the provision of water supply. Encroachment on floodplains as well as inadequate drainage/sewerage systems flowing into storm drains mean that these drains cannot cope with monsoon runoff.

During the monsoon in 2019, many States across India were affected due to floods. The major affected States include Bihar, Kerala, Karnataka, Maharashtra and Assam. Patna, the capital of Bihar, was affected worst by the deadly rains, with much of the city of 2 million people submerged under knee-deep water and the city resembling a huge lake. As per an estimate, there were at least 800 deaths due to rain-related causes.

-Editor-

A very interesting Article - A must read

Introduction

Blocked drains are the primary cause for the floods in urban areas, especially in metros. For instance, failure of the drainage system is believed to be one of the primary causes behind the Chennai floods in December 2015 that led to the death of more than 400 people.

Recurrent floods cause severe damage to infrastructure like transportation networks, electricity generation and distribution equipment, etc. in addition to outbreak of diseases. Lack of proper drinking water facilities, contamination of water (well, ground water, piped water supply) leads to outbreak of epidemics like diarrhoea, viral infection, malaria and many other infectious diseases. The probability of outbreak of diseases in highly dense areas of India is high.

When the water level cross the normal limits in residential areas, the drainage system miserably fails to pass the water. The drainage systems get blocked due to excessive dumping of garbage as well as the administration's failure to ensure timely desilting. Hence water cannot find a way to flow. The failure of drainage system recently in Patna was such a case

Conventional Drainage Systems

Drainage systems have been found in ancient cities over 5,000 years old, including Indus and Persian civilizations. These drainage systems focused mostly on reducing nuisances from localized flooding and waste water. Drainage systems made from brick or stone channels constituted the extent of urban drainage technologies for centuries. Rome also employed drainage systems to protect low-lying areas from excess rainfall. When builders began constructing aqueducts to import fresh water into cities, urban drainage systems became integrated into water supply infrastructure for the first time as a unified urban water cycle.

Modern drainage systems did not appear until the 19th century in Western Europe, although most of these systems were primarily built to deal with sewage issues arising from rapid urbanization. One such example is that of the London sewerage system, which was constructed to combat massive contamination of the River Thames. At the time, the River Thames was the primary component of London's drainage system, with human waste concentrating in the waters adjacent to the densely populated urban center. As a result, several epidemics plagued London's residents and even members of Parliament, the events known as the 1854 Broad Street cholera outbreak and the Great Stink of 1858. The concern for public health and quality of life launched several initiatives, which ultimately led to the creation of London's modern sewerage system as shown in Fig 1. This system aimed to ensure waste water was redirected as far away from water supply sources as possible in order to reduce the threat of waterborne diseases. Since then, most urban drainage systems have aimed for similar goals of preventing public health crises.

Fig.1 London Sewage System being built in 1860

The conventional way is to improve the drainage paths downstream, by dredging and widening the streams, canals, culverts and other structures, so that they can accommodate the peak flow without inundating the ground. If canals are not feasible, we design the drainage system to take the rainwater through underground pipe systems, for example by micro-tunneling, as fast as possible, to the sea, to prevent the flooding of urban areas. In all these interventions, the main objective is to get rid of the water, and discharge it to the sea as soon as possible.

- **Evolving Sustainable Drainage System**

  Canal system is not the correct way we should be managing the situation. People in many countries are exposed to water stress, and the situation is

getting worse as the years go by. Climate change impacts are likely to aggravate the issues. Fresh water is such a precious resource, can we afford to 'get rid' of it in order to protect ourselves and our properties from flooding? This brings to mind a popular statement. "Not one drop of rain water shall reach the sea without putting it to good use". Isn't this statement more relevant now than it was nine centuries ago?

It seems that we are not doing the right thing now. When flooding takes place, our solution is to dispose of the water as fast as possible, unconcerned about the fact that it is the very same rainwater that maintains life, provides food and amenity value for us, and nurtures the biodiversity that enriches the environment. So isn't it the sensible thing to make use of the water as much as possible before discharging it into the sea., what is advocated in the above statement is, in fact, 'Sustainable Drainage'.

In brief, 'Sustainable Drainage' is the management of surface water for maximum benefit. The main design philosophy for Sustainable Drainage Systems (SuDS) is "Use surface water runoff as a resource". SuDS design concepts include

- Manage rainwater close to where it falls
- Allow rainwater to soak into the ground
- Promote evapotranspiration
- Slowing and storing runoff to mimic natural runoff characteristics
- Reduce contamination of runoff through pollution prevention and controlling the runoff at source

Treat runoff to reduce risk of urban contaminants causing environmental pollution

Examples of Sustainable Drainage Systems:

- A bioswale is a shallow depression in a piece of land meant to gather and filter storm water runoff by directing polluted rainwater through soil and vegetation. Besides the environmental benefits bioswales provide, they are commonly used in public spaces due to their aesthetic qualities and generally low difficulty of installation and maintenance. Bioswales are designed linearly as shown in Fig. 2 and slightly sloped in order to drain water throughout its components and into the soil as opposed to simply collecting it in a standing location. Although bioswales provide passive means to filter runoff indefinitely, they are limited by their momentary capacity for runoff volume. As such, they can be easily

flooded over if rainfall events, adjacent surfaces, and soil characteristics are not adequately considered.

- Permeable pavement systems aim to provide a manner for water that falls on hardscaping to seep through to the soil below. This is accomplished by either dividing traditional pavement materials into sections, or using a porous pavement material.

  In China, paved urban areas have grown rapidly since the 2000s, with dozens of cities supporting populations over one million. In response, the Chinese government has commissioned the design of several "Sponge Cities" which employ SuDS at urban scales throughout the country. One such example is Nanhui, a Shanghai suburb designed to combat rising sea levels on China's eastern coast. Nanhui, previously known as Lingang, uses permeable pavement for roads and public right-of-ways to reduce the effects large urban infrastructure has on the natural water cycle. It is the organic combination of modern green new technology and society, environment, human culture for social progress.

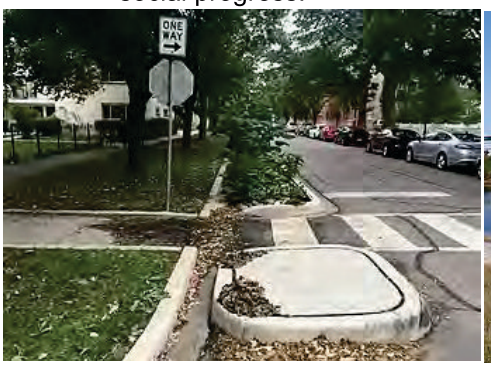

Fig. 2 Roadside Bioswale designed to filter Storm Water runoff from Street Surfaces

Fig.3 Trounce Pond in Saskatoon, Canada serves as a storm water detention basin within the local drainage system

- Artificial wetlands can be constructed in areas that see large volumes of storm water surges or runoff. Built to replicate shallow marshes, wetlands gather and filter water at scales larger than bioswales or rain gardens. Unlike bioswales, artificial wetlands are designed to replicate natural wetlands processes as opposed to having an engineered mechanism within the artificial wetland. Because of this, the ecology of the wetland (soil components, water, vegetation, microbes, sunlight processes, etc.) becomes the primary system to remove pollutants. Water in an artificial wetland tends to be filtered slowly in comparison to systems with mechanized or explicitly engineered components.

  Wetlands can be used to concentrate large volumes of runoff from urban

areas and neighborhoods. In 2012, the South Los Angeles Wetlands Park was constructed in a densely populated inner-city district as a renovation for a former Metro bus yard. The park is designed to capture runoff from surrounding surfaces as well as storm water overflow from the city's current drainage system.

- Detention basins (or retention basins) are storm water detention areas meant to offset excess water that could overrun the capacity of the current filtration or drainage systems. Detention basins as shown in Fig.3 reduce peak discharge into drainage systems by methods including slowing runoff velocity, holding excess volume, and trapping sediment that could disrupt drainage systems downstream. Basins can be either wet or dry, depending on whether the default state of the basin is filled with water or only anticipates it during storm surges.

- Green roofs are landscaped or vegetated areas on the roofs of buildings, usually built to mimic natural landscaping or ground-level parks. Green roofs help drainage systems by offsetting peak discharge from otherwise hardscape surfaces, and filtering rainwater directly as it falls. They also have the added advantage of reducing energy consumption for buildings that would otherwise be receiving direct sunlight onto their roofs throughout the day. As part of the 2015 United Nations Climate Change Conference, Argentina agreed to reduce greenhouse gas emissions as part of a global effort to combat climate change. Consequentially, many of Argentina's cities have passed resolutions requiring or encouraging new developments to implement green roofs. In Buenos Aires, the city government provides tax reductions to developments that incorporate green roofs along with other LEED criteria.

Case Study- G Cans Project of Tokyo

Japan is a long ribbon of islands stretching north to south, divided by a spine of steep mountains occupying 75% of the land. Steep rivers flowing into the ocean easily overflow when heavy rain falls. So, Japan's effort to develop flood-control technology dates back to the ancient past. The Metropolitan Area Outer Underground Discharge Channel, an underground discharge channel constructed in Saitama Prefecture adjacent to Tokyo, represents technological innovations accumulated over many centuries.

The discharge channel is a mechanism to drain water from flooded residential areas into five gigantic vertical shafts built below ground and then discharge it into rivers through an underground tunnel connecting the shafts.

The G-Cans project, or the Metropolitan Area Outer Underground Discharge Channel) is a massive underground waterway and water storage area built by the Japanese government to protect Tokyo from flooding during the monsoon seasons. Begun in 1992, the two-billion-dollar project was completed in 2009.

A world-class underground discharge channel has been constructed on the outskirts of Tokyo, the capital of Japan. The tunnel, dug about 50 meters below ground, extends 6.3 km in total. The underground construction, comprising vertical shafts to store floodwater – which look more like gigantic tanks – and a mammoth water tank supported by towering pillars weighing 500 tons each as shown in Fig.4 is far beyond anyone's wildest imagination. It was planned as an anti-flood scheme for local residents and completed in 2006. The underground discharge channel, having employed a variety of new technologies, is the very best of Japan's state-of-the-art civil engineering technology.

Gigantic underground shaft are about 70 meters tall. The large shafts measure about 30 meters in diameter, spacious enough to park a space shuttle.

The connecting tunnel 50 meters below ground measures about 10 meters in diameter. The tunnel stretches for 6.3 km, including a sharp curved line with a minimum radius of 250 meters. Fig. 5 shows the schematic diagram of the entire project.

Fig. 4 A Huge Pressure-Controlled Tank

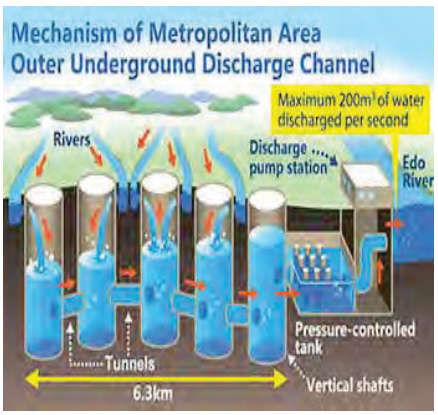

Fig. 5 A Schematic Diagram

Before being discharged into rivers, the drained water is stored in a huge pressure-controlled tank. The tank is designed to perform multiple functions, including abating the force of running water and adjusting water pressure that could change sharply if a water pump breaks down. Measuring 177 meters long and 78 meters wide, and lying about 22 meters below ground, the water tank is larger than a soccer pitch. The ceiling of the water tank is supported by 59 pillars which are 18 meters tall and weigh 500 tons each. An inside look at the tank structure conjures up the image of a "Temple" below ground.

The underground tunnel for drainage, dug with a gigantic shield tunneling machine, employed an improved segment technology. Segments, which are concrete plates, used to be bolted together to form the outer wall of a tunnel. It consumed a lot of time to bolt them.

In constructing the underground channel, however, segments were joined together with a wedge method developed on the principle of wedging instead of bolting. Unlike bolted walls with an uneven surface, joined walls have a smooth surface and are instrumental in greatly reducing construction time. The segment-joining method was jointly developed by six Japanese companies, including general contractors, and it became possible to reduce the time to build walls so much so that it has emerged as a standard method for large tunnel construction work and which was lately used by Delhi Metro also for constructing underground Metro tunnels.

Flood water stored in the channel can be discharged into rivers at a maximum rate of 200 cubic meters per second. In other words, a 25-meter swimming pool full of water is drained in a second. Under this mechanism, each drainage pump has a high-speed impeller that gives flowing energy to water, discharging it rapidly.

The impeller is powered by a gas turbine engine, a modified version of the high-performance engine used in jetliners. Hot, strong wind generated by burning fuel revolves the impeller, which in turn makes the water flow. The impeller is compact and generates less vibration and noise, saving much needed space below ground.

After the underground discharge channel was completed, a torrential rain hit the area in August 2008. The facility was able to discharge into rivers about 12 million cubic meters of water, a record high, or the equivalent of 25,000 numbers, 25-meter swimming pools.

Flood control using an underground discharge channel has attracted worldwide attention and draws visits by flood control experts from many countries, including China and South Korea. Japan has a small land area and cities are densely populated, making it difficult to build large water discharge channels on the surface. Japan has solved this dilemma with its civil engineering and flood-control technologies.

Conclusion

It is a proven fact that housing/commercial units in projects/cities with good connectivity, wide roads, better amenities, sustainable drainage system etc sell better than those in projects without them. This would be true even if the former projects were costlier than the latter. This is why external development work becomes a must for those active in real estate building constructions.

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Sustainability in Construction and Development of Built Environment

D. S. Sachdev

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Prologue

Sustainable development in general parlance is termed as 'Development that meets the need of the present without compromising the ability of future generations to meet their own needs'. In India, unfortunately, because of lack of sufficient resources on one hand and immediate need to bring India on the path of progress while dealing with the rehabilitation of millions of displaced persons as an aftermath of partition of the country after independence in 1947 on the other hand, there was no other alternative but to create basic infrastructure at a most economical cost. This, however, resulted in inadequate sustainability of the infrastructure in the face of rapid growth of population. Further, setback to the sustainable development has been because of migration of large population from rural areas to cities in search of livelihood and better quality of life. The paper deals with planning design and construction, upgradation, rehabilitation and preservation of old and new infrastructure.

-Editor-

Intoduction

The building construction activity has undergone fast changes due to improved construction techniques, innovation of new materials and requirement of improved environment and comfort levels. The concept of sustainability in building construction has been evolving over many years with initial focus on how to deal with the issue of limited resources, especially energy, and on how to reduce impacts on the natural environment. However, with the beginning of 21st century the public focus is shifting in favour of an era of sustainable development. This means that, in the future it will not be possible to pursue techno-economic goals without giving equal importance to the goal of preservation of the ecological balance on the planet Earth .It has now been recognized that besides technical and design related issues, economic and social sustainability and the cultural heritage aspects of the built environment are equally important. These have to be examined and integrated right from the stage of conceptualization through design to execution and post construction housekeeping and maintenance.

Presently, the construction industry both in Government and private sector is

deeply engaged in adding new infrastructure and upgrading the existing infrastructure to improve the physical connectivity and providing functionally efficient and resource efficient buildings. In so far as built environment s concerned, it comprises of both building and civic infrastructure and following needs to be addressed while adding new infrastructure or upgrading the existing ones:- a) Planning, design and execution stage, b) Up-gradation, retrofitting & rehabilitation of existing infrastructure and c) Preservation of old and new infrastructure.

Planning, Design and Construction of New Infrastructure

To ensure sustainability of structures, all issues related to site selection, planning, design, construction and use of materials and equipments are to be addressed to right from the stage of conceptualization. These are discussed below:-

Site Selection (Land Use and Site Issues):

- Creation of cohesive, integrated communities should be a high priority.
- Encourage in-fill and mixed use development
- Locate buildings to provide access to public transportation, bicycle paths, and walking access to basic services by working from home wherever feasible.
- Evaluate site resources such as solar access, soils, vegetation, water resources, important natural areas, etc.
- Plan buildings to preserve open space.
- Provide responsible on-site water management.
- Situate buildings to benefit from existing vegetation.
- Protect trees and topsoil during site work.
- Protect heritage - both natural and man-made.

Planning:

Planning parameters for both building and civic infrastructure are to be duly identified and adhered to as under:

Buildings:

- Optimize use of interior space through careful design so that the overall building

size and resources used in constructing and operating it are kept to a minimum.

- Space for service areas viz. toilets, kitchens and the disposal shafts must be standardized with dry and wet areas duly planned. Rooms & other area are built around to create efficient design.
- Design buildings to use renewable energy.
- Select location specific materials and optimize their use and minimize waste by standardizing all building elements and making provisions for future additions / alterations.
- Design water efficient, low maintenance landscaping. Make it easy for occupants to recycle waste.
- Recycle and reuse waste water efficiently.
- Design structures for durability.
- Design for future reuse and adaptability e.g. Schools and community centers should be so designed to be available for accommodating the affected population in the event of National Disasters.

Civic Infrastructure:

The most critical space between the buildings and the source of supply of a service or the disposal point of any service in a city/town is the foot path on either side of the city roads. Incidentally this is also the space available for the pedestrians to move on safely away from the vehicular traffic. The planning of this space is therefore most critical from sustainability point. For this it is essential to identify all the elements required in an efficiently planned street. These are:

- Kerb Stones
- Kerb channels
- Bell Mouth
- Bell Mouth Cover Slab
- Silt Chambers with cover
- Drain Cover Slabs

- Drain Manhole covers
- Services pipes
- Manhole covers for electrical services.
- Manhole covers for Telecom services
- Cycle Tracks (NMV)
- Bollards across pedestrian paths
- Tree gratings
- Lighting poles on main roads and service roads
- Table Tops on free left turns
- Pedestrian paths at intersections/ T-junctions
- Pedestrian paths on traffic islands.
- Pedestrian paths across Central verge
- Pedestrian paths near Rotaries (un-signaled)
- Pedestrian paths below flyovers
- Signages
- Traffic signals
- Cable ducting by Distcoms.
- Central verge irrigation system
- Central verge, footpath & Traffic Islands plantation
- Street furniture
- Bus Queue shelters.
- Public art.

All the above elements are to be planned and integrated in the entre scheme while planning city roads and footpaths.

Design:

Firm up the Design methodology based on the location of buildings in seismic zone, coastal areas, hilly terrains and the types of building viz. normal load bearing structures or high rise ones. In both cases seismic resistivity provisions have to be made as per latest codal provisions to take care of such eventualities during the course of life of the structure.

Execution:

- Use building construction techniques that are resource efficient. Mechanization is the order of the day for speedier construction. A proper balance between machine and man has to be struck to ensure reduction in environmental pollution.

- Use of pre-finished elements in building should be encouraged. To enumerate, all kota stones, granite and marble slabs etc. should be brought to site in pre-finished condition as per the design. All cupboards & modular kitchens are brought to site in finished conditions and installed. Standardised doors and windows shutters in wood, aluminium, UPVC or steel should be fabricated in workshops and fixed in position at site in the pre-finished openings. Reduce wet work to the minimum.

- Provide method statement of execution of finishing items in detail to achieve the desired finish.

Materials:

- Choose building materials with low embodied energy without sacrificing durability and performance. Materials that require little maintenance and which have little impact on environment should be preferred

- Buy locally produced building materials as transportation is costly in both energy use and pollution generation.

- Use salvaged building materials from demolition waste by recycling in an engineered manner.

- The use of flyash in cement concrete will take care of its effective disposal on one hand and reduction in emission of GHG in the process of manufacture of cement.

Equipment:

- Avoid ozone-depleting chemicals in mechanical equipment and insulation: CFCs have been phased out, but their primary replacement, HCFCs', also damage the ozone layer and should be avoided where possible. Reclaim CFCs when servicing or disposing of equipment.

- Install high efficiency lights and appliances: High efficiency appliances conforming to ECBC standards offer both economic and environmental advantages over their conventional counterparts. Select LED lighting to reduce the life cycle cost.

- Install water efficient equipment: Water conserving toilets, showerheads and faucet aerators reduce water use as well as the loading to septic systems and sewage treatment plants. Reducing hot water use also saves energy.

- Solar water heating systems should be used in mass housing and office buildings for canteen and kitchen use.

Up-gradation, Retrofitting & Rehabilitation of Existing Building Stocks

Most of the structures have been distressed because of lack of regular optimum housekeeping & maintenance. It is well known that different elements of the building do not last that long along with the building while as a whole has a life of 60-70 years or even more. In fact, the life of plumbing lines & fixtures and electric wiring have a life around 20 years and need replacement. Water proofing needs replacement in almost 10-15 years. Old plumbing lines do lead to leakages at the roof top and along the plumbing lines & shafts. Aluminum wiring needs to be replaced by copper wiring to improve its serviceability. Corrosion caused due to leakage in the building causes distress in the structure which needs rehabilitation. The latest seismic codes provide more stringent norms & existing structures, both R.C.C. and load bearing ones need retrofitting. Following needs to be addressed while upgrading the existing building stocks:

- Replacement of plumbing lines & fixtures in the old buildings;

- Check for water leakages & take steps to plug the same and make the structures waterproof. Deficiencies causing ingress of water in to buildings be removed & adequate protection in terms of chajjas etc. be provided.

- Provide permanent fixtures wherever possible;

- Replace aluminium wiring with copper wirings;

- Retrofit the buildings distressed on various accounts.

Preservation of Buildings

It is true that Architects and Engineers can produce world class state of the art buildings but to ensure the sustainability of such structures, it is extremely essential that these are duly serviced during the intended period of its life. The building structure with an array of services and facilities therein is like a human body. Just as a human being needs continuous upkeep and maintenance during its life period, a building structure also needs similar or rather more exhaustive systems to lead its full life. The present day buildings both residential and non-residential are equipped with multifarious high end services viz. Security surveillance and access control, Fire alarm and fire protection system, communication network, communication network, Central heating & cooling controlled through IBMS apart from conventional water supply & sewerage system and internal & external electric installations.

Effective Housekeeping and maintenance is a pre-requisite for efficient functioning of buildings particularly those provided with large number of services. The earlier method of maintenance and housekeeping through engagement of set of skilled and unskilled workers only cannot take care of the effective functioning of the building because of the large number of services being provided these days. The maintenance and housekeeping in fact have become complementary to each other and cannot be looked in isolation. The regular housekeeping leads to reduced maintenance effort and the constant maintenance involving the preventive one also reduces the burden on the housekeeping staff.

Conclusion

It is high time that all stake holders be it the Government, the builder, the owner and the users put their heads together to focus on all aspects of Sustainable

Development of Built Environment and infrastructure so that we the present generation are able to provide the best to our future generation which we certainly owe to them.

Indian Green Building Council (IGBC) Facilitating Greening of Cities

V. Suresh, Chairman, IGBC; **S. Srinivas,** Principal Advisor, IGBC;

M. Anand, Principal Counsellor, IGBC, **Saurav Choudhury,** Associate Counsellor, IGBC

Prologue

Of late, India is witnessing tremendous spurt in the construction sector and facilitating rapid urbanisation across the Country. This in turn is also offering new growth opportunities to various National and international stakeholders.

It is estimated that country's building stock is all set to grow 100 Billion Sq. ft by 2030 and here lies great opportunity for India to construct all the upcoming projects as Green Cities by design and set new global standards in design, construction and operation.Broadly, a GreenCity will facilitate the following (not limited to)

- Efficient use of resources
- Efficient land use planning
- Efficient mobility management
- Enhanced quality of life

-Editor-

Intoduction

Playing a catalytic role in the spread and growth of green building movement in India, since the year 2001 is Indian Green Building Council (IGBC), part of CII. The vision of the Council is to facilitate India emerge one of the global leaders in green buildings and green built environment by 2025.

IGBC understanding the imperative that each building type is a species has designed and developed 25 green building ratings to address various building typologies. All the rating systems of IGBC are designed to address National priorities and are playing a catalytic role in building a greener and healthier India.

All IGBC Rating System have been developed based on the holistic approach of Panchabhutas and are a perfect blend of ancient architectural practices and modern technological innovations.

As a result of concerted efforts, today over 5,400 green building projects, amounting to over 7 billion sq.ft of registered green building footprint are adopting IGBCs green building rating systems. IGBC has facilitated India to become one of the top 3 countries in the world in terms of largest registered green building footprint.

IGBC- Moving from Green Buildings to Green Built Environment

Having gained rich and varied experience in facilitating greening of buildings, IGBC as part of its multi-pronged and visionary approach progressively expanded its focus from “Green Buildings” to “Green Built Environment” over the last five years, for larger area development and finally leading to Green Cities. This was done to start with for Greenfield projects, with new land and new cities.

Moving ahead, keeping in view India’s specific development needs for sustainable city development needs, IGBC also evolved a green city rating for Brownfield development for existing cities. This has become a necessary with 100 Smart cities development, 500 AMRUT cities development and many DMIC and other growth corridor city development needs. This will cover the pan city development and new Area Based Development [ABD] as well.

IGBC Green Cities Rating for Greenfield Cities

IGBC Green Cities

Following are some of the focus areas of Green Cities

- Employment opportunities: Cities due to the economic prospects they offer attract population from rural areas. Hence all the upcoming Green Cities will be an important source for job creation and offer new growth opportunities for various vocations.

- Walk to Work: In a Green city, concept of mixed used development will be a way of life and will significantly improve productivity of the citizens by minimizing travel time. Streets will be designed for 'All' and should accommodate pedestrians, hawkers, cyclists, public transport and private vehicles. Vehicular movement will come down significantly and, in the process, improve the air quality and make the city 'breathe'.

- Waste Water Treatment & Reuse: Green cities would facilitate 100% onsite waste water treatment and its reuse. Onsite treatment of waste water should be encouraged, and the treated water can be used for non-potable purposes, thereby reducing dependence on potable water. Use of dedicated Purple lines to convey treated water will become a reality. Biological process of treating waste through Phytoremediation should be adopted across the cities.

- Open spaces & Green Cover: Green cities should dedicate 10 % of city area for open spaces and should be designed for 33% Green Cover, which does not call for significant investment and mitigates urban heat island effect. It should provide world-class recreation facilities and biodiversity parks. Today, Singapore has demonstrated that 46 % of green spaces can be achieved.

- India has all the potential to surpass the feat of Singapore and set new global benchmarks. This gives us an opportunity to develop and incorporate out-of-the box models.

- Stakeholders participation: In order to facilitate, Green cities, private sector will have to play a key role. The key to implement green city projects is to develop a clear business model. Public-private-community partnerships (PPCP) should also be forged to ensure success of the project.

The key benefits of cities going the green way include the following:

- Air Quality Improvement (PM2.5, PM10, CO2, Nox, Sox)

- Increased Urban Green Cover (Atleast 9 sqm per capita meeting WHO Standard)

- Reduced Energy Demand by 20-30% (2 – 2.5 MW per million sq.ft of Green Buildings)
- Enhanced Water Efficiency by 30-40% (45 litres to 30 litres per person per day in Commercial, 135 litres to 100 litres per person per day in Residential)
- Waste Segregation & Recycling (Develop Recycling industry)
- e-Governance (Ease of Transactions)
- Citizen's participation

Cities going Green in India with IGBC

- Greenfield Cities

S.no	City	State
1	Dholera	Gujarat
2	Sri City	Andhra Pradesh
3	New Town Kolkata	West Bengal
4	Mahindra Industrial Park	Tamil Nadu
5	Mahindra Industrial Park	Gujarat
6	GIFT City	Gujarat
7	Shendra-Bidkin	Maharashtra

- Existing Cities

S.no	City	State
8	Bhopal	Madhya Pradesh
9	Visakhapatnam	Andhra Pradesh
10	Panchkula	Haryana
11	Rajkot	Gujarat

Some of the green building features in some of the IGBC green cities projects

Sri City: Vision to create a World Class Business Destination, with a perfect harmony between Industrial Growth & Sustainability

- Sustainable Mobility

- Reliable Power
- Water Resource Management
- Dedicated Storm-water & Sewer network

Dholera SIR: Gujarat: Sustainable Approach towards Evolution of a Low Carbon City

- Compact City Development
- Urban Mobility
- Social Infrastructure & City Landscape
- Physical Infrastructure
- Information & Communication Technology

New Town: Future ready global services hub attracting the best talent with a fine work-life balance

- 30% Areaallocatedfor Green& Socialfacilities
- 480 Acres manmade Eco Park developed around the lake
- Pedestrian Friendly Streets
- Barrierfree design for All

GIFT City: City's vision to have 100% Green BuildingsState of the art Green City Infrastructure already in place. Green Waste Management Systems

Smart Cities are also Green Cities

Hon'ble Prime Minister's initiative of developing 100 Smart Cities will soon be a game changer and usher in a paradigm shift in the way cities are conceived and designed. Green cities and smart cities go together, and the former is an integral part of the latter. IGBC is partnering with the Government in this excellent path-breaking initiative. Core infrastructure elements in a Smart City include the following:

- Adequate water supply
- Assured electricity supply

- Sanitation
- Solid waste management
- Efficient urban mobility and public transport
- Affordable housing
- Robust IT connectivity
- e-Governance
- Citizen participation
- Sustainable environment
- Safety and security of citizens
- Health and education

IGBC Green Cities Rating System are Aligned with SDGs:

Green buildings and green cities contribute significantly towards meeting the Sustainable Development Goals (SDGs). The adjoining infographic illustrates the role of green buildings in meeting SDGs.

Greening ofcities will mean significant progress in decoupling economic growth

from climate change, poverty and inequality, helping to achieve the goals and creating a greener world that we can all be proud to call home.

Market Potential for Green Building Products & Technologies

In terms of market potential for green products, materials and technologies, it is estimated that by the year 2025, it will be about USD 300 Billion. This offers excellent growth opportunities for the manufacturers of green products, materials and technologies.

Today, Indian industry has taken up activities & initiatives to ensure that growth is not at the cost of environment and has clearly realized that pursuing ecological sustainability ultimately results in making Indian industry more competitive. IGBC would continue to work more closely with the stakeholders in building a greener and healthier India.

Conclusion

In days to come, all the upcoming and existing cities should be designed as Green Cities. This will holistically address national priorities which include conservation of natural resources, water efficiency, energy efficiency, handling of municipal waste and health & well-being of the citizens. Green Cities present an excellent opportunity to redesign and transform cities by solving critical infrastructure issues, thereby encouraging people to live more sustainably.

With the thrust being given for integrated sustainable development approach, IGBC will achieve 10 billion sq. ft of green foot print by 2022 and emerge as world leader in green sustainable built environment development.