



**BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL** Ministry of Housing & Urban Poverty Alleviation, Government of India

"Creating Enabling Environment for Affordable Housing for All"





### CONTENTS

From the Desk of Executive Director	2
Concept of Public Spaces for All in Sustainable and Smart Cities	8
Swachh Bharat Abhiyan: The Sulabh Perspective	12
Innovative Design Solutions for Affordable Housing – Housing for All with Public Spaces for All	15
Agent for Change: Urban Public Spaces	19
Space Planning for Thermal Comfort House	23
Bamboo Toilets for Swatch Bharat (Clean India): Any takers??	27
Public Spaces for All	31
Facilitating Sustainable Housing Technologies	34
, frgffl d Lefjd <b>legrqikta</b> h L <b>j</b> glkigyga	36
Benchmarking and Objective Selection of Technologies for Housing in India	40
Embodied Energy – a future way to quantify Sustainability	46
Glimpses of Great Indian Public Spaces	49
Development of Advanced Cement Free Fly Ash based Geopolymer Green Concrete	56
Demonstration Housing Projects using Emerging Technologies	60
Performance Appraisal Certification Scheme (PACS)	66
Decentralized Waste Water Treatment System (DEWATS)	70
Publications of BMTPC	79

#### in the state of utter neglect and not given priority in the development of a city. It is time that public spaces are made integral part of master plan of the city and we need to draw development plan for these places as they project the image of the city.

From the Desk of

**Executive Director** 

Public spaces embrace a wide array of spaces, from old city centres to new suburbs. Their form, uses and maintenance raise a host of imperative questions regarding urban planning from the local urban to metropolis scale. They shall be considered as assets for urban renewal, new developments, public health & wellbeing, mobility & happiness. The proposed sustainable development goals put Public spaces as a key and important topic and it is targeted to provide universal access to safe, inclusive and accessible green & public spaces, in particular for woman and children, older persons and persons with disabilities by 2030.

MTPC is releasing its special newsletter Nirman Sarika on the theme Public Spaces for all designated by United Nations for World Habitat Day 2015. World habitat day reminds us of our collective responsibility to lead our cities towards sustainable & resilient path by taking all together especially poorest of the poor. The theme of Public Spaces for All is a welcome step by UN as most of the time, these open spaces are taken for granted on as & where basis. These social places which are generally open & accessible to people are

BMTPC is part of the celebrations held on World Habitat Day by Ministry of Housing & Urban Poverty Alleviation, Govt. of India. We work hand in hand with Ministry to realise its goals towards urban renewal. Recently Housing for All (Urban) Mission is launched by the Ministry and we are given an important task to create a favourable eco-system for states which will facilitate use of new housing technologies which are sustainable, safe & quick. The conventional construction practices make use of materials & systems which are based on natural resources, energy & labour intensive and, therefore, world over industrialized housing technologies which are not only energy efficient but also based on renewal resources are being practiced. BMTPC is studying these and trying to bring them for Indian construction industry. The target of building 20 million houses by 2022 is stiff one and cannot be accomplished unless fast track sustainable construction practices are introduced into our conventional construction system.

As regards, our newsletter, it is a quarterly magazine with a special publication on this day. Through our newsletter, we constantly sensitize the masses regarding the latest know how in the field of housing construction. It is our constant endeavour to educate at the grass root level regarding good construction practices which are safe & sustainable so that the housing stock being added put less pressure on our mother earth and we have clean, green & safe habitat.

Any suggestion to improve our newsletter is welcome.

dutyramal

(Dr. Shailesh Kr. Agrawal)

Cover Photos: Courtesy World Wide Web and UN-Habitat.





M. VENKAIAH NAIDU Minister of Housing and Urban Poverty Alleviation, Urban Development and Parliamentary Affairs Government of India



#### MESSAGE

he first Monday of October is marked as World Habitat Day and celebrated world over by United Nations and other Habitat related institutions to highlight the issues related with our towns and cities and basic rights to all of adequate shelter.

Each year a new theme is chosen based on the current issues relevant to Habitat Agenda. This year's theme "Public Spaces for All" is intended to have a fresh look and stock of existing public spaces, particularly in developing countries. A public space is social space which is accessible and enjoyable by one and all without prejudice and includes roads, pavements, public squares, parks, beaches, etc. Public spaces play vital role in social, cultural and intellectual progression of cities.

It is high time that public spaces need to be made integral part of city's development plan and due care to be taken so that they become model places for community development, environmental sustainability and promotion of health, happiness and wellbeing of citizens. The Housing for All (Urban) Mission recently launched by my Ministry also lays emphasis on creation of green, open spaces in slum rehabilitation projects. It is need of the hour that we take bold and transformative steps to develop a society which is sustainable, resilient and inclusive.

Building Materials & Technology Promotion Council (BMTPC) has been entrusted with the task of bringing new housing technologies and alternate materials which can help in creating superior, sustainable and safe housing stock. Off late, BMTPC has played a proactive role in identifying a few emerging technologies for mass housing.

I congratulate BMTPC for bringing a Special Issue of its Newsletter "Nirman Sarika" on the occasion of "World Habitat Day" and wish success in its future endeavours.

(M. Venkaiah Naidu





**BABUL SUPRIYO** *Minister of State for Housing & Urban Poverty Alleviation and Urban Development Government of India* 



#### MESSAGE

he World Habitat Day is an yearly event being celebrated on first Monday of each October on the theme chosen by United Nations with the purpose to remind the world regarding their responsibility to shape the future of our cities and towns so as to have sustainable, safe resilient and inclusive growth.

The United Nations need to be congratulated for bringing out "Public Spaces for All" as a theme for this year's World Habitat Day, as public spaces encompass a wide array of spaces from old historical centres to streets and can play a pivotal role in urban renewal schemes. Often public spaces are found to be well below the expected level and have become places for unauthorised encroachments, settlements and business. It is high time that we revisit these places and bring them to a level so that they become a key asset for city's growth and well-being.

Quality public spaces not only enhance community cohesion but also promote health, happiness and well-being of all citizens. These spaces can also foster investment, economic development and environmental sustainability. Therefore, public spaces need to be given due importance while considering city's development plan and key stakeholders in the urban areas need to be sensitized about this. I hope the World Habitat Day celebrations will play a role of catalyst in drawing attention of urban planners towards public spaces.

I understand that Building Materials & Technology Promotion Council (BMTPC) is involved in promotion of cost-effective, environment-friendly, energy-efficient building materials and disaster resistant construction technologies under the Ministry. The Special Issue of Newsletter "Nirman Sarika" being published by BMTPC on the occasion of World Habitat Day will give its readers an opportunity to understand some of the important issues related with Public Spaces for All and other housing related matters.

I commend the efforts put up by BMTPC and wish them success in their future efforts.

My Bertest of Wishes to BM/PC

(Babul Supriyo)





**DR. NANDITA CHATTERJEE** Secretary Ministry of Housing & Urban Poverty Alleviation Government of India



#### MESSAGE

inistry of Housing & Urban Poverty Alleviation celebrates United Nation's designated World Habitat Day on first Monday of October each year on the theme selected according to its annual relevance. This Year's theme "Public Spaces for All" adds new dimension to urban renewal. Public spaces are open spaces where communities gather for community education, energy and growth. Hence, they need to be considered as assets for the city as they help in various aspects of life such as well-being, public health, mobility and a sense of community among the residents of the city.

This theme provides us the opportunity to attend to the need of public spaces for all and to include them into city's economic development plan. The Sustainable Development Goals envisage that the public spaces should be inclusive, accessible, green and safe for women and children, older persons and persons with special needs. It is, therefore, our collective responsibility to create quality urban public spaces. It is also important to upgrade the existing public spaces and to make them part of inclusive growth of the city so that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature.

The Housing for All (Urban) Mission, recently launched by our Ministry, seeks to address the housing requirement of urban poor including slum dwellers through slum rehabilitation, affordable housing and other verticals. The Mission encourages people friendly inclusive layouts, designs and habitat planning with more green and open areas so as to make urban renewal more participative, community driven, resilient and sustainable.

Building Materials and Technology Promotion Council (BMTPC) is the nodal organization for promotion of appropriate building materials and construction technologies which are sustainable, safe and affordable. BMTPC is envisaged to play an all important role of dissemination of housing technologies under Housing for All (Urban) Mission. I congratulate BMTPC for publication of Special Issue of their Newsletter "Nirman Sarika" on the occasion of World Habitat Day.

(N. Chatterjee)





**RAJIV RANJAN MISHRA** Joint Secretary (Housing) Ministry of Housing & Urban Poverty Alleviation Government of India



#### MESSAGE

his year's theme of "Public Spaces for All" of World Habitat Day provides us opportunity to raise awareness about the need for quality urban public spaces which can play an important role in shaping the future prospects of a city. In developing countries, like ours, housing and other related infrastructure is given more importance, which is a priority in a sense, but creating sustainable public spaces while contemplating the developmental projects can help in building image of the city which can help community cohesion and inclusive growth.

The Ministry of Housing & Urban Poverty Alleviation is celebrating World Habitat Day on 5<sup>th</sup> October, 2015 and would dwell upon the issues related with public spaces. The attached organisations with the Ministry are bringing out special publications related to the theme on the occasion, which shows that Government of India is committed to the global resolve of providing sustainable development policies that ensure adequate housing for all with improved and inclusive urban planning.

Building Materials & Technology Promotion Council (BMTPC) is a technical organisation under the Ministry providing sustainable habitat solutions with regard to appropriate materials and construction systems. BMTPC has also been front runner in the area of disaster mitigation and management, playing a pro-active role in ensuring safe habitat.

I am happy that BMTPC is coming out with a Special Issue of its Newsletter "Nirman Sarika" on the occasion of World Habitat Day. I am sure the issue will highlight the theme of World Habitat Day.

I extend my best wishes to BMTPC.

(Rajiv Ranjan Mishra)





**SANJEEV KUMAR** Joint Secretary & Mission Director (Housing for All) Ministry of Housing & Urban Poverty Alleviation Government of India



#### MESSAGE

Inited Nations celebrates first Monday of October as World Habitat Day each year on a chosen theme world over. This year's theme is Public Spaces for All. Public spaces are social open spaces being accessed by one and all and are assets to any city. However, these spaces some how do not get adequate importance because of competing demands of growing cities, need of resources etc. Through this year's theme let us revisit the state of existing urban public spaces and make a pledge that the existing urban public spaces are converted into spaces which are more inclusive, safe, sustainable and resilient. Also efforts should be made to create more public spaces which can help in improving city's environment, social cohesion and equality.

In the previous schemes of our Ministry on housing and the recently launched Housing for All (Urban) Mission, the due importance is being given for creating green open spaces whenever slum renewal projects are undertaken. It is being Ministry's endeavour that housing is created with adequate social & physical infrastructure and open spaces so as to nurture inclusive growth with better community participation. Also our effort has been to create spaces in harmony with nature. Better habitat planning encompassing effective and efficient public spaces is the call of the day and will help in providing safe and healthy living environment.

Building Materials & Technology Promotion Council (BMTPC) has been striving to mainstream emerging sustainable technological solutions to States which can help in quick sustainable construction without compromising structural and functional performance. I am pleased to learn that Special Issue of BMTPC's Newsletter "Nirman Sarika" is being released on the occasion of World Habitat Day. I sincerely hope that the publication will provide better insight to the chosen theme of the World Habitat Day.

I wish BMTPC all the best in their future initiatives.

(Sanjeev Kumar)



## Concept of Public Spaces for All in Sustainable and Smart Cities



Ashok Kumar\* Vija

Vijay Raj Deopa\*\*

#### ntroduction

Public spaces have a central role, both physically and functionally in urban planning and development. Access to, and utilization of, the public spaces are among issues that are negatively affected by rapid urban growth. Public spaces such as public squares, market places, gardens, neighbourhood parks, are one of the major elements that define the city's unique attraction points that play an important role of building civic pride, public communication, economic investment that contribute to health and quality of life [Nil Pasaogullari and Naciye Doratli].

Physical and psychological access to public spaces is a basic consideration for all open space planning. Public spaces must be seen and treated as an essential part of the planning process for urban development. Public spaces may be able to provide a variety of accessible opportunities' to people and become a means of enhancing the quality of living in the urban development. Public spaces in the form of parks and community centers also serve as symbols of civic pride and sense of place which promote the notion of community. Access to public spaces is considered as one of the key issues in terms of the physical dimension of the public realm, which might be both facilitated and constrained by the social environment [Duany and Platter – Zyberck]. Accessibility is defined as "the freedom or ability of people to achieve their basic needs in order to sustain their quality of life" [Lau and Chiu].

Location and design of public spaces can play a significant role in bringing people together [Calthorpe, 1993], whereas a compact city structure promotes physical accessibility, which reduces the travel distance to public spaces. According to Whyte, (2000), the public spaces can be judged by its connection to its surroundings, both visual and physical. For instance; streets are preferred to major arterials, and the sidewalks are seen as a way to encourage links between private and public spaces [Talen, 2000]. A public space should be accessible to everyone regardless of the residential developments, physical abilities or financial resources.

#### Planning and Development of Public Places

All the public spaces should be designed and developed so that they are sustainable, affordable, livable, and resilient to climate change. These public spaces should overlook green and should be located within easy walking distance from public transport. The primary and secondary attributes are as follows:

- a) The people at large in public space are safe, healthy, accessible and inclusive.
- b) There is a quality infrastructure and services including health.
- c) The public has access to a range of quality open spaces and recreational opportunities.
- d) To create built forms and buildings that are using passive cooling techniques to conserve energy and thereby reducing reliance on fossil fuels and decreasing green house gas

Principal Scientist and Head, Architecture & Planning and Efficiency of Building,

CSIR- Central Building Research Institute (CBRI), Roorkee; Email: ashokkumar@cbri.res.in

<sup>\*\*</sup> Project Fellow, CSIR- CBRI, Roorkee.



emissions.

- e) Design for appropriate climate responsive orientation, providing shade and allowing cut-outs for the penetration of sunlight, breeze, and getting close to natural environment.
- f) Create a contemporary cutting edge design as a showcase for public awareness where there is an appropriate use of building materials and technology developed by R&D institutes.
- g) Develop incubation –cum- technology demonstration centers for public use.
- h) Develop outdoor meeting points, entertainment hubs, recreational areas which have easy access to public transport and have shaded pedestrian walkways.
- Water harvesting techniques should be used to conserve water and limited use of portable water should be done.

 Getting integrated with nature and providing maximum open spaces or parks as they are a key element of public behavior.

The above-listed attributes are integrated in a conceptual layout of a city or a town of five lakh population showing different facilities and amenities to be provided in public spaces for sustainable and smart cities as shown in Fig.1 and 2. The salient features are as follows:

- a) Open Spaces: Open spaces are located in distinctive part of the landscape along living and public spaces. They include parks, small parks and streetscapes. These are linked to form a network and a permeable structure of the town / city plan.
- b) Street Layout and Movement Network: Street layout has been done to have East-West routes for public transport and major vehicles so that majority of buildings have a Northern Orientation for optimum solar

access. North-South streets extend a metaphysical or ideal orientation for shady pedestrian linkages for walkways.

- c) Streetscape: The avenue planting contributes to the creation of lower on temperature. Hence the space for trees between buildings and between buildings and streets is essential.
- All the new and existing buildings must be rated for the environmental and green attributes in five key areas i.e.: i) Energy efficiency, ii) Water efficiency, iii) Sustainable operation and management, iv) Indoor environment quality, and Green innovation.

The Fig.1 indicates that the public spaces should be developed centrally with equitable accessibility in north – south orientations.

The Fig.2 indicates a skyline of Public Spaces with central metro rail system connectivity.







Fig.2: Conceptual Cross – section of the Public Spaces

The Fig.3 indicates that the public spaces may be designed to act as a model or showcase depicting modern technologies and smart features.

To conclude, planning for a future to make our communities more livable, prosperous and vibrant is a challenge before planners, architects, engineers, experts and the Government. Smart infrastructure planning brings a holistic approach to infrastructure through the analysis of geospatial, physical and temporal data, along with seeking out economic, environmental and social impacts, which are directly or indirectly related to sustainability. Similarly, smart cities representing as a 'knowledge', 'digital', 'cyber' or 'eco' city; a concept open to a variety of interpretations, may be viewed as cities and towns of the future, but considering today's rate of innovation, it is highly likely that smart city models will become more feasible and certainly very popular strategies for cities' development over the coming decade.

Hence, the public spaces in towns and cities must be designed and developed to have significance in showcasing all the innovations being done by scientists to general public and with all the features of



Fig.3: Three dimensional view of the Buildings in Public Spaces



smart infrastructure and the use of smart technologies and mobile based web applications including Wi-Fi, systems including electronic connectivity and the Information and Communication Technologies (ICTs). Since, the rapid urbanization will exert more pressure on cities' traditional infrastructures; these technologies will present a very viable means of upgrading the infrastructures to replicate the demands of the future generations and the public spaces must be created as a precondition for smart and sustainable city functionality. These concepts will not only dem-

onstrate the new technologies to the public at large but also contribute in building a confidence to accepting the newer technologies by the people.

#### References

- 1. Nil Pasaogullari and Naciye Doratli (2004). Measuring accessibility and utilization of public spaces in Famagusta. Doi:1016/j.cities.2004.03.003.
- 2. Duany and Platter Zyberck (1991). Towns and Town- making Principles, Rizolli Publications, New York.
- 3. Lau, C. Y. and Chiu, C. C. H.

(2003). Accessibility of low income workers in Hong – Kong, Cities 20(3), 197-204.

- 4. Calthorpe, P (1993). The Next American Metropolis. Princeton Architectural Press. New York.
- 5. Talen, E (2000). Measuring the public realm: a preliminary assessment of the link between public space and sense of community. Journal of Architectural and Planning Research 17(4), 344-359.
- 6. Whyte, H.W. (2000). How to Turn a Place Around. Projects for Public Space Inc. \*\*\*\*

### Students create designer urban spaces

BANGALORE: The next time you pass by Anand Rao Circle flyover, don't miss the urban landscaping underneath: with patches of green and benches to perch on, it's a space to stop awhile.

This project by nine students pursuing masters in architecture, Columbia University, aims to redesign public spaces, turning them into bright urban spots and meaningful, sustainable infrastructure.

The students, along with interns from Sustainable Urbanism International (SUI), an NGO, and students of Srishti School of Art, Design and Technology, worked on this idea. They used recyclable wood, plastic bottles compacted to bales, bamboo and metal scrap from flea markets like Jolly Mohalla and Bamboo Bazaar near Shivajinagar.

The project is inspired by 'Folly for a Flyover' - an amphitheatre made of recycled material under a motorway in London, besides a community hall made of beer bottle craters under a flyover in Slovakia, greening concretization in Ohio, Singapore, Hong Kong and King's Cross in Mumbai, which looks at sustainability by redefining engineering.

Says Chelsea Hytuk, one of the members from the design team: "The idea is to allow people to slow down in life in such places. People who work around these areas can come here for lunch; parents taking their children to and from school can make use of the play areas. We are dividing and demarcating pedestrian and vehicular ways."

The students felt the city has the potential for many such designer public spaces. In fact, they proposed a similar project for Richmond Road flyover, and also a waste management kiosk at Madiwala market.



#### **BBMP TO REPLICATE IDEA**

Dungeon-like places beneath flyovers could soon become a thing of the past. Taking a leaf out of this novel project. BBMP commissioner M Lakshminarayana announced that the idea will be replicated at all junctions and flyovers in the city adding that Rs 50 crore has been allocated for it in the budget. On Friday, Lakshminarayana directed his officials to appoint one consultant for each flyover, and undertake improvement of junctions, including the spare land undertake inprovers. "We must refering encineering and leaping of flyovers. We must

redefine engineering and planning of flyovers. We have to work with the BDA," he said.

the BJA, he said. Srisht School of Art and design will partner the BBMP to redesign such junctions and spaces. Lakshminarayana also said the Palike will book criminal case against people who stick posters on pillars and flyvoers walls. The BBMP has undertaken drives to pull down illegal billboards, hoardings and flex boards, and booked 400 criminal case against the offenders

#### The aim: To create meaningful public spaces

<sup>44</sup>The project encompasses solutions for three main problems the city faces-heavy urbanization and concretization, reduced sustain-ability and solid waste crisis in municipal areas. The freeways and crosswalks can be redesigned such that the cement structures are greened by creepers. Spaces used to trash waste can be trans formed into public areas. The project aimed at making meaningful public areas. It's better to work in collaboration with urban planners from the time an infrastructure true project is planned.

Jvoti Hosagrahar | PROFE SERVATION, AND DIRECTOR OF SUI

SOURCE: THE TIMES OF INDIA, JANUARY 18, 2014



### Swachh Bharat Abhiyan: The Sulabh Perspective



Dr. Bindeshwar Pathak\* Ph.D., D.Litt.

t is commendable that our national leaders have finally realized that without freedom from filth we cannot become a great nation. Civilization begins from sanitation, as it provides the basic condition for human well-being. Mahatma Gandhi vividly made this point when he said during the freedom struggle that cleanliness was more important than independence. The proclamation of Hon'ble Mr. Narendra Modi after becoming Prime Minister that building toilets was a priority over temples was in sync with Gandhi's dream of making India clean. Following this, he kicked off Swachh Bharat Abhiyan, which is a national mission to make India's streets. roads, and infrastructure clean by 2019. Apart from the ensuring general cleanliness and scientific disposal or recycling of solid waste alongside bringing a behavioural change in people regarding healthy sanitary practices and generation of public consciousness about the linkages of health and hygiene, the crucial-almost central-component of the mission is construction

of toilets. Besides constructing toilets in every school immediately, it plans to construct 12 crore toilets in rural India by October 2019. The aim is to provide every household a toilet and thus eliminate open defection. Conversion of insanitary toilets to pour flush toilets and eradication of manual scavenging are an integral part of the mission's objective. No doubt it is a truly national and noble mission, and if India says goodbye to open defecation by 2019, which is the promise of the Prime Minister, it will indeed be a splendid achievement.

The Prime Minister's plan of cleanliness has generated a nationwide enthusiasm. But the litmus test of leadership is not noble intentions or utterances but the actual results produced. Everyone knows that the success of the Clean India Mission hinges on the elimination of open defecation. It is not impossible, but the scale of the challenge—constructing 12 crore household toilets and thousands of public ones in schools and slums—is staggering. It will require not just the synergy between the political leadership, the state and the corporate sector, but also people's participation and a brilliantly thought out plan that can work on the ground. As an expert in the arena, I would like to share my vision about how we can construct 12 crore toilets by 2019, but before that I would like to briefly state Sulabh's track-record from which we can derive valuable insights for making India clean.

### Sulabh's experience and success

In 1970, I founded Sulabh that focused on two primary goals: to prevent environmental and water pollution by promoting costeffective sanitation facilities, and to liberate the manual scavengers, traditionally engaged in manual cleaning of human excreta. During four decades of our work, we have constructed 1.3 million household toilets and 8,000 community toilet complexes being used by 15 million people every day. We have also liberated and rehabilitated thousands of manual scavengers. But the environmental pollution

 \* Sociologist & Social Reformer, Founder, Sulabh Social & Sanitation Movement Sulabh Gram, Mahavir Enclave, Palam-Dabri Road, New Delhi-110 045 Tel.: (011) 25031518, 25031519, Fax: (011) 25034014, 25055952
Email:info@sulabhinternational.org/contact@sulabhinternational.org/ sulabhinfo@gmail.com /sulabhinfo1@gmail.com Website: http://www.sulabhinternational.org / www.sulabhtoiletmusem.org



remains a huge challenge, and an estimated 700 million Indians still lack toilets. Sulabh, however, has shown the way to overcome the problem.

Sulabh not merely constructed toilets but its Founder, Dr. Bindeshwar Pathak, invented an environmentally safe and cost-effective two pit, pour flush, on-site compost toilet (which could easily be constructed from locally available materials and thus with minimum cost), which has been recognized as one of the best global technologies for safe disposal of human waste. Also, the Sulabh model of pay-and-use community toilets in urban centres and an effective mechanism of maintenance have proved successful all over India. The following set of suggestions is not only based on our long and deep experience of work in the sanitation sector, but also takes into account why various government sanitation programmes initiated from time to time have not succeeded till now (though due to the space constraints, I will not be able to explain them directly here).

### India needs 2,50,000 sanitation motivators

Our basic challenge is to build 12 crore household toilets by 2019, besides constructing toilets in all schools and public toilets in urban centres. We should begin with a vigorous cultural campaign for sanitation through all means of communications, in which the lead should come from the government agencies and the mass media. But my special proposal is to create and train a nationwide cadre of roughly 250,000 sanitation motivators who will create mass awareness about the need for construction

of toilets and tell the people how to maintain them properly. The trained motivators will also monitor and supervise construction of individual household toilets. These motivators will work as a link between the beneficiary, Panchayat members and the financial institutions so that the programme is properly planned, implemented and the toilet utilization progresses smoothly. India has a huge pool of unemployed educated youth; many of them are also eager to do something socially meaningful. It should be no problem to recruit the required trainee motivators. For this a productive partnership with the business houses and NGOs must be forged.

India has 690 districts, 5924 blocks, 2.5 lakh Panchayats and 6,40,867 villages. To convince and bring along the masses for toilet construction, we need one motivator for each panchayat. This means we need roughly 250,000 motivators and should be given Rs. 2000/- to each of them for motivation, education, communication, implementation, maintenance and follow-up. These motivators will have to be properly trained for carrying out their assigned task.

Selected NGO should be given Rs. 1000/- for coordination, monitoring and supervision.

Alongside the motivators, we will need to employ 500,000 masons to build the toilets.

To recruit and train 250,000 motivators and 500,000 masons will take time. But this must be accomplished by March 2016.

Thus, we have just three years to do all the work. We have 2016-17, 2017-18 and 2018-19. To meet the target, 250,000 motivators will have to build fifty lakh (50,00,000) toilets in a month, six crore (6,00,00,000) toilets in a year and eighteen crore (18,00,00,000) toilets in three years.

The money required to accomplish this mammoth task will be approximately Rs. 3,27,388 crore or to put it in rounded figure Rs. 3,30,000 crore.

In view of the sensitive Centre-State relations, I would suggest that this amount should be entrusted to the various banks situated in or around the Panchayats, so that the money should reach the beneficiary swiftly and without any hitch.

Besides the subsidy, the beneficiary should be provided loan from the banks on the least interest.

Presently, as per Government of India's guidelines, the estimated cost of Individual Household Latrine (IHHL) is Rs. 12,000/- with contribution from Government of India, State Government and beneficiary. As per the present cost of material, it is rather impossible to construct a good toilet functioning for at least 10 years at this cost. This needs to be enhanced in view of the current inflation to Rs. 25,000/-. The cost of construction of each of these individual toilets can vary and will be borne by individuals with cost being met through subsidy supplemented by bank loan. With numerous designs available to the beneficiary, he can choose one which suits his means. It is envisaged that a beneficiary will construct the toilet on loancum-subsidy basis.

#### Role of Bank will be crucial

Subsidy to the beneficiary should be passed on through a



bank that gives the loan and the bank before doing so will satisfy itself that the loan given to the beneficiary has been utilized properly. The point is, if the banks are directly involved then the financial burden on the government is limited to subsidy amount. The bank will ensure that there is physical achievement: only after the bank's certification, the beneficiary will get the release of subsidy. Thus the banks too will become a stakeholder.

The role of bank is important because the usual financing pattern of funds being passed on to the state government and then to local bodies is very time-consuming and the progress is tardy as has often been witnessed. The government passing on the subsidy to the bank will not only mean its proper utilization but will also reach the right person and in addition will be an incentive to the bank to readily disburse the loan to a beneficiary. The Panchayat need not be involved in the release of subsidy. If the loan-cum-subsidy involves only the beneficiary and the bank, the

physical achievement is ensured and the red tape is cut.

#### Partnership with NGOs

In this mission the role of NGOs and the motivators will be critical. The NGOs working in tandem with the motivators will ensure that tangible achievement takes place according to the expenditure shown. Their role will also be to take the technology to the beneficiary, and to ensure that dry latrines are replaced wherever they exist and new toilets constructed where there are none. In the verification of physical target being achieved, the system of reply paid postcard can be introduced whereby the beneficiary informs that the toilet has been constructed, also mentioning the defect, if any, so that the construction agency (that is, the NGO) can set right the defect. The NGO can also give guarantee for a given period of time to effect cost-free defect removal. Sulabh has practiced this system successfully over the years. Recently, nearly 12,000 toilets in rural areas of Punjab have been built on this basis.

Alongside the construction of household toilets, there will be construction of toilets in schools. the cost of which will vary depending upon the size and location of the school. The public toilets can vary from five seats to 35 seats. They will be built in public places and will be self-sustaining when run on pay-and-use basis. This will be valid for urban areas. The key to running a public toilet efficiently is its maintenance. This can be handled by NGOs in urban centres but in rural area the responsibility can be discharged by the Panchayat.

Summing up, if the above plan is implemented and a synergy is generated for the sanitation movement, it will ensure a combination of skill development, speedy implementation, and desired result produced. It will make India not only free from open defecation, but also generate employment for a large number of people in the form of sanitation motivators, masons, and artisans engaged in production of materials for toilet construction.







## Innovative Design Solutions for Affordable Housing – Housing for All with Public Spaces for All



Dr. Anil Sawhney\* Ph.D. FRICS

ood design plays a pivotal role in affordable housing; this idea has received significant attention that it deserves in the Housing for All (Urban) Scheme Guidelines in the form of a Technology Sub-mission that was launched in June of 2015. This Sub-Mission particularly encourages the utilization of efficient designing and planning for superior housing solutions that will fall within the parameters of this scheme. While the design and construction processes are important, it is the function, performance, end-user acceptance and satisfaction that is of even greater importance. However, this, in turn, makes the task of designing and constructing affordable housing even more challenging. While designing affordable housing, housing providers often have to address several important,



Fig.1: Role of Design in Construction and Use Phases

constraining and sometimes even conflicting requirements. Design must be viewed as a catalyst that can substantially improve the construction and use- phase of the building as shown in Fig.1.

A good affordable housing solution, in addition to addressing basis issues of design, must address the following parameters:

- Social and cultural acceptance plays an important role in affordable housing. Current solutions sometimes carry the stigma that 'low-cost means low-quality'. Appropriate design can eradicate this stereotype. It is also mandatory that while designing affordable housing the providers acknowledge local cultural preferences.
- 'Liveability' and end-user comfort must be addressed in a much more holistic manner. From the design of indoor spaces to the design of community areas, the interests of end-user must always be held in high regard. Community spaces and areas for social interaction must be interwoven carefully into the design solution. So-

cial cohesion and interaction are fostered when designing takes place while maintaining a perfect balance between human needs, environment and nature.

- Affordable housing units must be adaptable and amenable to the idea of incremental housing. This is a must for the wholehearted acceptance of such housing by urban poor – especially the younger population of the country.
- 4. Energy efficiency and sustainability are an integral part of the design process. Passive and bio-climatic design can help in producing an optimal solution to the housing needs of the urban poor. Locally sourced materials and vernacular solutions must also be used. Sensitive adaptations of traditional vernacular building designs with an appropriate mix of modernistic solutions must also be explored.
- Design must be such that it is easy to construct and with minimal waste. The end product must be easy to operate and maintain. Quite often, the

Associate Dean, Director & Professor of Construction, RICS School of Built Environment, AMITY University, Noida



design, construction and operation phases of a building are fragmented leading to a suboptimal solution. Integration of these functions is a must as we move forward.

- Long-term sustainability and viability of the housing and the community is an important consideration for design. This has to be managed at the individual unit level as well at the level of the whole neighbourhood. Open space and community spaces must form the fabric of a sustainable and viable affordable housing development.
- Resilience has to be built-in at the unit level and at the community level as well. Ability to adapt to economic downturns, natural hazards, and other problems must be considered in the design process. This will make affordable housing developments child friendly, safe and secure.
- Technology driven solutions, community and end-user participation are becoming increasingly important in today's context and cannot be ignored by the affordable housing providers.

Incorporating the parameters listed above is both important and challenging. A shift in mindset and the process of design itself is imperative. For those working in the affordable housing sector it is crucial to embrace the following paradigms in a true and holistic fashion:

#### **Design Thinking:**

Tim Brown, president and CEO of IDEO defines design thinking as a "human-centred approach to innovation that draws from the designer's toolkit to integrate the

needs of people, the possibilities of technology, and the requirements for business success". Design thinking will allow designer to more intelligently and creatively think about design of affordable housing projects. While embracing this paradigm it is useful for designers to think about constructability and constructors to understand the design intent. Sometimes designers develop creative and innovative solutions but ignore the constructability aspects. Construction experts adopt construction means, methods and materials that defeat the design intent. The end result is a product that the user or consumer does not like or want. There is a need to intermingle design thinking with construction thinking as shown in the Fig.2.



Construction Thinking

### Building Information Modelling (BIM):

Housing projects need to be designed with the assistance of modern design technologies that are generative and parametric in nature. Building Information Modelling (BIM), also known as Virtual Design and Construction, can play a significant role in making our designs sustainable, end-user friendly, efficient and mistake-proof. BIM allows project team members to visualize the design (see Fig.3), collaboratively work on the project, efficiently share project information and create better design solutions. BIM must be available in the designers' toolbox when designing affordable housing projects.

#### **Big Data:**

Today data is strewn everywhere in and around the designer's office, on a project site, in a product manufacturer's factory, in the control system of an operating building or bridge, in a vendor's database or a census database, with a public agency or utility and at different levels - project, neighbourhood, city, state and nation. We are now able to collect massive volumes of data about the built environment and the users that inhabit it. Can affordable housing providers have real-time access to this data during the design, execution and operation processes to make critical decisions? Big data technology can be tapped to enhance the design, construction, operation and maintenance of our affordable housing developments. Data can provide evidence and context that can enhance the design process and the outcome of the design will be more acceptable.

#### **Digital Fabrication:**

In 2014, a small company in China used 3D printing technology to print a housing unit of 2,200 square feet in a few hours at the cost of USD 5,000. More recently, in 2015, another Chinese company printed a 5-storey building with 10 housing units in 24 hours. Moving forward digital fabrication will play a crucial part in the delivery of affordable housing. It is crucial that designers and providers of affordable housing consider design and digital fabrication as an innovation driver.

To produce the kind of affordable housing that our citizens





Fig.3: Building Information Modelling based Visualization

demand we need to embrace the above mentioned paradigms in an integrated and holistic fashion. This will work to our advantage as we can spend effort and time on the drawing board in search of solutions that will be more sustainable, affordable and pleasing to the end user. With the aid of these tools, techniques and models we can conduct tremendous amount of analysis and develop a better understanding of the design solutions for affordable housing. For example, at the concept level the designer will have access to analysis tools that show for a large affordable housing community how to optimize the internal and external spaces that will enhance the quality of life of the end users. Similarly the designer now has access to tools that allow sun path analysis helping optimize massing, orientation, and public spaces for the end users. These models and their analysis are shown in the graphics provided in Fig.4, 5 & 6.



Fig.4: Mass Housing Wind Analysis





Fig.5: Mass Housing Wind Analysis



Fig.6: Mass Housing with Sun Path Analysis

## Training of Trainers (TOT) Programme on Earthquake Resistant Design & Construction for State Engineers and Architects in Bihar

The Bihar Institute of Public Administration and Rural Development (BIPARD), Government of Bihar at the behest of the Bihar State Disaster Management Authority requested BMTPC's assistance in conducting Training of Trainers (TOTs) on Earthquake Resistant Design and Construction. Two batches of TOTs were organised from 8-11 June, 2015 and another two batches from 15-18 June, 2015 at BIPARD Campus, Patna. So far fifteen batches of Training of Trainers (TOT) programme for engineers have been organised at Patna. The resource persons are from IIT Roorkee, IIT Mumbai, NIT Patna, BMTPC including other experts in the field. At the end of training of each batch, evaluation of trainees has also been conducted through examination.





### Agent for Change: Urban Public Spaces



Dr. Mahua Mukherjee\* Ph.D.

ublic spaces are meant for public use, and they are accessible by all for free or nominal charges for maintenance without profit motive. These include streets, open spaces and public facilities. Degree of interactions, visibility, interconnectedness, place-making, visual information are few measures to characterize these places analytically. Traditionally people enjoyed, utilized and celebrated successful public places. Urban India is transforming at rapid rate; drivers are population and aspiration of economically well-off younger generation; and this is facing the real-time conflict of interest between economy and environmental concern i.e. sustainable development paradigm. The more purist approach of 'sustainability' focuses on the ability of humans to continue to live within concept of carrying capacity of ambient environment. Urban development attracts growth beyond this carrying capacity. Overcrowding, pollution (air, soil, water, noise), congestion, encroachment or severe lack of accessibility, safety, amenities, inclusivity, cleanliness, maintenance present alarming de-

terioration of urban environment today. So transformation of urban public areas are required to accommodate the growth future which is attractive to the users. Essentially it shall create significant impression on public mind and becomes the place for social and cultural cohesion. Can public space be the agent of change? If so then how to change? What shall be the qualities of such place?

Concept of compact city, future city and recent buzz of smart city allow future smart growth promises; yet the fact is large-lump or cataclysmic growth achieved within shorter time has long-term implications on public spaces. City of Chandigarh of 1960s is apt example of such grand scale alien intervention. The public spaces develop physical, intellectual, emotional and psychological bonds with citizens and the city with time. As association provides comfort of familiarity and de-stressing, re/development with sudden large-scale interventions require critical scrutiny. Indian urban public spaces have contextual characteristics and past fabrics of history like Meena Bazzar or Chandni Chowk of Delhi, and they shall not vanish when the smart development takes place. Large-scale investmentoriented development like Gurgaon presents an opportunity to understand inevitable realities of rapid inorganic growth. In absence of interactive dialogues, streets may become monotonous, unattractive and vulnerable; and if not checked, they lose opportunity to be a place for socio-economic and cultural exchange which allows desirable changes. Fragmented, incremental growth takes care of mistakes in organic fashion and allows periodic repair of faults with enlightened experience of past failures. This enables continuity of past while accommodating future aspirations.

The new age public spaces of existing or new urban setup, need to balance between large-scale re/development and bottom-up incremental projects as filler. These spaces shall display efficiency without snapping connect with the nature. Design intervention, community participation and deployment of integrated advanced technologies can make next-gen public places an agent of change.

Associate Professor, Department of Architecture and Planning, Indian Institute of Technology Roorkee, Roorkee



Exchange of clues for change is traditional strategy for public space design. Designers or city managers leave indications of potential opportunity and constraints of development and change. Users pick up clues, use space, discover the existence or absence of catalyst, and redefine the use pattern. Rejuvenation or renewal process follows the thread and regenerates the space through in/formal interventions. Adaptability to change, both in terms of resiliency and robustness, is driven by visions of positive urban actors.

Thermo-physical character, accessibility, safety, green-infrastructure and networking are selected to elaborate sustainability traits of public space in this article. Thermophysical environment is dependent of urban elements of buildings, open spaces and vegetation. Mean radiant temperature (MRT), wind, humidity and air quality are modifying factors for urban outdoor climate. Urban design and outdoor thermal comfort share common context, yet dialogue between the two is quite limited till date. Organically grown public spaces maintain closer relation between design and climate considerations in comparison to formal public space design. MRT depends on ambient air and ground surface temperature which, in turn, depend on albedo (surface area and material property of built and open structures); urban canyon geometry and urban morphology (building height, density; orientation and width of road) and sky-view factor; built- open-vegetated space ratio; and shading provided by tree or building. Wind flow direction and speed are important for pollution dispersion and control of moisture islands' creation, and get influ-

enced by canyon geometry, orientation of street and arrangement of buildings and open spaces. Urban landscape, soil, vegetation cover and rainfall influence humidity. Additionally, anthropogenic and other pollution contribute to the thermal regime of Indian urban public spaces. It will be a smart move to look at traditional towns like Jaiselmir of Rajasthan, Coochbihar of West Bengal, Udaipur in Tripura, and Thiruvananthapuram from Kerala for deriving at intelligent climate responsive public space design strategies.

Accessibility is assessed through walkability, ease of access, interchangeability, shorter travel time, clean travel mode and safety. Walkability and Public transport can bring multitude impact on societal problems in addition to accessibility. Walkability represents the extent of friendliness of any neighbourhood to walk; this creates an opportunity for less pollution, better social cohesion, local small scale business, improved neighbourhood vigilance, elderly safety etc. Street connectivity, land-use mix, presence of trees, vegetation and other natural commons, building density, active street frontages, local pollution level etc. influence walkability. Copenhagen, back in 1990s, started to work towards pedestrianized and cycle-friendly public space. City core with time has changed the city car-owners' attitude and gradual expansion of no-motor zone establishes that fact only; outdoor café seats are increasing in the city core and so the seasonal outdoor sitting time span despite harsher outdoor climate. In India, analytical studies are carried out on walkability for few cities. Absence of continuous and easy to negotiate footpath is the basic constraint to it. Delhi Nullah Project proposed, way back in 2010, transformation of sewage drains into urban canals keeping walkability in the focus. Probably we need to walk few more additional miles to ensure implementability of such proposals need to be reinforced. Local participation potential can be improved further if livelihood and safety options become integral part of such proposals.

Public transport is advocated and practiced in most of the important world cities, as it can tackle mass transportation with least stress, can curb pollution and energy demand and can nurture frequent citizenry interaction. In Masdar City design, Sir Norman Foster restated the importance of public transportation. Underground metro train is perceived as safe smart public transportation in India. Exemplary successful alternative initiatives from Curitiba, Brazil which relies on express bus services or Suburban train services of Mumbai emphasize the very fact of importance of management as key to succeed. In India, we have metro to small tiers of cities and towns; appropriate eco-environmental solution for one shall not be employed in others without due diligence check. Number of non-motorized or less-polluting vehicles are rising in urban areas globally. On the contrary, China banned cycles from major roads of Beijing in 1998 and of Shanghai in 2004. It drew global critical attention as equivalent car space for bicycle varies around the world within 0.1 to 0.2. Again it is quite logical to aspire for Tokyo bullet train services which showcase technology prowess of Japan.

Safety most importantly de-

pend on law enactment practices of any society. Governance in India, be it at any level, have to accept their failure in numerous occasions. In-built vigilance, eyes on the street are good qualities of any public space; yet enforced vigilance only can deter miscreants for any wrongdoing. Merely knowing that the area is under camera surveillance is reason for reduction of crimes in wired public spaces. Safety shall be holistic and include elderly, women and children's safety in public space. Advanced gadgets can help to curb nuisances at public spaces. Traffic signals at road intersection, smartphone deployment, outdoor illumination and extensive signage for public amenities can improve safety of public space. Design singularly can improve functional safety in a space by integrating right detailing.

Green infrastructure, strategically planned and managed natural ecosystem networks i.e. urban commons, are employed for benefits of people. Natural elements like forests, lake, rivers, marshy lands, fisheries or grazing land within the urban precinct or at fringe areas are urban commons and are shared, used and enjoyed by all. Man-made ecosystems like park, permeable parking, pavement, cascades, bio-swales, retention and detention ponds are also part of green infrastructure. Advantages of green infrastructure are many: health and wellbeing of community, preservation of biodiversity, better water percolation, bio-retention of heavy metals like lead, mercury, etc. Today, the urban commons are in focus for their role as eco-service providers. They extend perpetual services of reduction of pollutions, managing

complex natural recycling systems even from a distance. Example of adjacency of effective green infrastructure can be seen in suburban green reserve of Tokyo. This helps attenuation of the CO2 emission from core Tokyo city area which has alarmingly low rate of vegetation cover. In India, eastern part of Kolkata Metropolitan Region enjoyed presence of large chunk of marshy wetland which manages sewage and solid-waste disposal of the city on daily basis. Encroachment, shoddy deals for development are some of the problem common to the East Kolkata Wetland today. If strong community and political will prevail, options to resolve this land use land cover (LULC) change can be well resolved. The Economics of Ecosystems and Biodiversity (TEEB) initiative for valuation of ecosystem services includes both tangible and intangible benefits. Process of recognition, demonstration and capturing of sustainability value of these unique natural ecosystems are worthy to refer while doing cost-benefit analysis for any upcoming real estate project. Future generations' future is too worthy to compromise.

Intervention like "Slum networking project in Indore" is relevant example of successful public place. The high point of the project is successful networking: be it a networking of sewers, drainage and rivers of the city; of slumdwellers and their aspirations; of river, culture, heritage and city dwellers; or networking of support from community, local body, state, and even international funding agency. Efficient design, detailing and management of system of utilities guided by principle of natural and engineering science is the underlying principle of the project. Credit for implementation of the project goes to planner, community and local government alike as every entity took active part into the project's deliverables. Traits of climate-responsiveness, contextuality, accessibility, safety, value capturing of eco-services and smart networking made the project successful and it received its due recognition through receiving the Aga Khan Award way back in late 1990s.

Government's role to design and develop conducive public place is important. Instead of planning or designing, authority need to play more effective role of enabler for public spaces in upcoming future or smart cities and as law enforcement agency to manage them. Smart city concept accommodates interchangeability and interoperability of compatible urban systems. The evolution of smart city concept is similar to intelligent buildings; in both the cases, individual dedicated intelligent system evolved at initial phase. As and when support from society and technology evolved, further level of integration provided it the strength of efficiency and convenience in resource management. Preparatory meetings for HABITAT II conference also emphasized on the role of governance in public space management.

Planners' and designers' role is too critical at this juncture of time. Integration of state of the art tools and techniques in the process of planning and designing of urban public spaces will be the prerequisite. Infrastructure like transportation, energy, water, health, etc. need to be decoupled from emission, pollution, resource scarcity and damage due to disas-





Capacity Building Programme for Engineers & Architects on Earthquake Resistant Structures and Retrofitting of Buildings for NCR Region at New Delhi

Under the Chairmanship of Secretary, Ministry of Home Affairs, a meeting was held on Earthquake Risk Reduction in National Capital Region. Wherein it was desired that BMTPC and NIDM may jointly organise capacity building programmes for engineers & architects of NCR region (UP, Haryana & Delhi) on Earthquake Resistant Structures and Seismic Retrofitting of Buildings. Accordingly, a Two-days programme was organized from 12-13 February, 2015 at New Delhi. The programme was attended by around 80 engineers, architects and town planners from various parts of the country. Dr. Nandita Chatterjee, Secretary, Ministry of Housing & Urban Poverty Alleviation, Govt. of India inaugurated the programme. Shri Sanjeev Kumar, Joint Secretary (HFA), Ministry of Housing & Urban Poverty Alleviation and Shri Anil Kumar Sanghi, Joint Secretary (Mitigation), National Disaster Management Authority (NDMA) addressed the participants. The faculty from IIT Roorkee, NIDM and other experts covered various topics on Earthquake Resistant Structures and Retrofitting of Buildings for NCR Region.



ter. Landuse planning with due consideration to livelihood and disaster risk reduction are integral part of tomorrow's successful public space.

It is the people who shall shoulder due responsibility for use and maintenance by display of civic sense. The community shall take part in project formulation, planning and execution. Inclusive design does not stop at universal accessibility; inclusion of important stakeholders in decision making, planning and implementation process is very important for next gen public space.

#### **Suggested Readings:**

- The Oregon Experiment, Alexander, C. (1975), Oxford University Press, Oxford
- Walkability in Indian Cities, Clean Air Initiative for Asian Cities (CAI-Asia) Center (2011), Philippines
- The Death and Life of Great American Cities: The failure of modern town planning, Jacobs, J. (1961, 1984 edition), Peregrine Books, London
- What Time Is This Place? Lynch, K. (1972), MIT Press, Cambridge, Mass.
- Squaring the circle? Some thoughts on the idea of sustainable development, Robinson J., Ecological Economics, 48 (2004), pp- 369– 384
- Public places-urban spaces: the dimensions of urban design, Carmona M., Heath T., Oc T. and Tiesdell S. (2003), Architectural Press, London
- The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB, TEEB (2010), UNEP
- Slum Networking of Indore City- Indore, India, Aga Khan Development Network
- UNCHS, http://unhabitat.org/habitat iii
- UNISDR, http://www.unisdr.org/sendai framework/

\*\*\*\*



## Space Planning for Thermal Comfort House



Dr. J.S. Chauhan\*

efore one begins to design and construct a building, one should carefully consider the implications of its proposed physical context, the building site. Its geographical location, topography, climate, orientation, and peripheral conditions should influence the overall design & layout. These factors affect the choice of a building's structural system, and its materials and construction. The correct orientation of a building can also help to control natural light, heat, view, noise, and other environmental elements by providing the building and its occupants with access to desirable elements and absorbing or shielding the building from those elements which may be undesirable.

Bhopal region of Madhya Pradsh falls in what is termed the composite climate zone. The composite climate is one in which no single season predominates and at least three seasons are experienced the hot dry summer, the warm humid mansoon, and the cold but largely dry winter. Each of the seasons is sufficiently extreme so as to justify consideration when designing buildings, though short spells of moderate weather are possible. For the building designer, the composite climate poses a challenge because elements of a building that have been installed for one season may harm in another season. This thesis overviews same of the most important techniques for provision of better thermal comfort for buildings of this region.

#### Orientation, Openings and Shading Devices

With few exceptions, it can be said that the primary aim of buildings in our climate should be to maximise heat gain in the winter and minimise it in the summer, while maintaining the best cross ventilation in the monsoon. The maximum radiation incident on any face of a building in hot region in the winter is due solar south (more than the roof). Therefore, it would seem desirable to orient buildings such that one long face is towards the south. In fact, if buildings are not very deep and have well glazed south faces, the entire winter heating requirement can be eliminated in the region with one stroke. This is due to the

sunny and not too extreme Nature of the winter. Of course, one or two weeks of heating may still be required on overcast or rainy winter days. But is this orientation good for excluding summer heat? With a few variations and care in the opening design, yes. In the summer, it is no longer the south wall which receives the most solar radiation but the roof. Therefore it is the roof which requires to be

opaque, reflective, massive or insulated. Whatever little direct sun streams in from the windows can be effectively cut off by a simple chajja (balcony). If the south orientation with some sun protection for summer seems to work best for winter and summer, is it also appropriate for the monsoon? This is a lot more difficult to say for the composite zone in general, but for hot region. the prevailing southeasterly and north-westerly breezes can be comfortably tapped in the building.

The requirement for cross ventilation does not predominate over other considerations for a due south orientation because air movement is ephemeral, tending

\* Vice Principal and Incharge Director, S.A.T.I. Vidisha, Email: jsccivil@rediffmail.com, Mob.: 9826244840



to be unreliable in direction and speed, changing from site to site, and can be tapped with a variety of other breeze catching methods anyway. Openings should be avoided or at least reduced in the west and east faces. The openings in general should be based on considerations of light and glare on all faces except the south, where heating considerations may predominate. Shading devices over openings can regulate the disadvantages of some faces to some extent. The south facing chajja is of course the simplest and most successful. Shading devices shield a building's surfaces and interior spaces from solar radiation. Their effectiveness depends on their location, orientation and form. Exterior shading devices are more efficient than those located within a building's walls since they intercept the sun's radiation before it can reach the building's surface.

#### **Insulation and Thermal Mass**

The primary purpose of a building's thermal insulation is to control heat transfer and thereby protect a building from excessive heat loss during cold seasons and heat gain during hot seasons. This control can effectively reduce the amount of energy required by a building heating and cooling equipment to maintain conditions for human comfort. Heat may be transferred by convection, conduction or by radiation.

- Convection : It means air currents from warm to cold air zones and controlled by blocking flue action in wall cavities and continuity between floor, roof and wall spaces.
- 2. **Conduction** : It means transmission through the man of a

material, and it is controlled by using materials with high heat resistivity.

3. **Radiation** : It means emission of radiant heat energy from warm surfaces through air to cooler surfaces. It is controlled by the proper placement of reflective surfaces & by providing required air space (minimum 19 mm) between layers.

Materials which resist heat flow are called insulating (still air, rock-wool, earth, to name a few in decreasing order of insulation per unit thickness). These are used in buildings to resist the flow of heat in either direction.

Materials that have a capacity to store large amounts of heat (and cool) are considered thermal mass (water, earth, brick work and concrete, to name a few in decreasing order of thermal mass per unit volume). These are used in buildings to store heat (or cool). The use of insulation and mass can be very important to utilise the benefits of all other effects. Insulation (especially of low thermal mass) is generally desirable in buildings which have a significant cooling source within, but is of lesser value in buildings which are not conditioned in any way. Thermal mass can be generally thought of as a damping device which evens out the extreme fluctuations of diurnal conditions, and is generally useful in unconditioned buildings. It is the primary traditional technique for thermal comfort.

But it must be remembered that a well insulated roof shall impede the flow of summer daytime heat, but also resist the outflow of heat in the night. Likewise, massive walls can create comfortable days in the summer, but overheat in the evenings and early part of the night.

#### Surface

Just as smaller windows and shaded openings can reduce unwanted solar gain, reflective surfaces can do the same. A fully reflective surface can be said to be as effective as putting the building in shade all the time. Generally in this region, bright or white external surfaces are to be recommended, since the summer takes precedence over the winter in this regard. But more important than the walls is the roof. As far as possible, roofs should be either shaded (for example, with a pergola or verandah like space on top, or even some creepers) or painted white.

A reflective metallic surface, despite its better reflective properties, is not as suitable as a matt white finish due to its emission properties being low. It will not be as efficient as the matt white surface would be in terms of shedding heat when required.

#### **Movable Devices**

The composite climate zone is one where it would be ideal to change the properties of some of the materials of the external skin of a building over the course of the day. It would be good, for instance, if one could stay in a massive and insulated room in the day, and have a very lightweight room in the night. The barsati is just one example of such a device which provides a thermally unacceptable space during the day, when one can stay downstairs in the heavier rooms with few windows, while providing a very pleasant night space, when the spaces below are



unbearably hot. They also work very well all through the day and night for monsoons.

Wooden shuttered windows are another technique which is successfully employed by traditional buildings. The only requirement is that the user be in a position to open the shutters when outside conditions are better than inside and vice-versa.

#### Ventilation

Whenever there is a source of air which is cooler than the indoor air in the summer, it is desirable to ventilate. This shall definitely happen in summer nights for unconditioned buildings, as also in the days if there is sufficient green area or water bodies around. Ventilation is even more desirable in the monsoon to create comfort conditions by air flow across the skin alone, even if the breeze has the same temperature as the room. The term selective ventilation is used to refer to systems which ventilate when conditions are favourable and do not when they are not. The simplest traditional example is the shuttered window when operated by an intelligent user. Selective ventilation can actually reduce indoor temperature on the whole, though rarely by more than 300C. Traditionally, the courtyard acts an important means of reducing external surface area of buildings by tight clustering while allowing just sufficient light into the interior. Its major advantage, however, is considered to be ventilation. It is possible to design courtyards that heat or ones that cool.

#### **Evaporative Cooling**

The use of the phenomenon of cooling produced by evaporation

can potentially provide temperatures as low as 22°C in the summer, though it would rarely go below 25°C in the monsoon due to the highly heat prevailing at that time. The commonest traditional form of this cooling used to be khas mats which were kept wet around the house. The development of the desert cooler which included a tank, re-circulating pump, and a fan allowed the use of smaller pad areas at the expense of a small amount of energy. The technology is a viable option provided it is not used in the wet mode during the monsoon when better crossventilation of ambient air only may suffice for reasonable comfort. It is also possible to duct the air to various rooms much like an airconditioning system.

In recent years, studies have been undertaken of the traditional wind towers and wind scoops of the middle east. The thermal mass of the tower cools the air before entry to the house. However, many designs incorporated water in some form to make the air cool and heavier in order to sink into the house. Another interesting recent development, largely derived from the original khas concept, is roof top evaporation. The idea is to keep a moist surface above the roof which is the source of the maximum heat in the summer, thereby converting the room from a heating element to a cooling element. The concept has the potential to be applied with a direct head of water available, or with pumps and sprinklers. The idea should only be to discover a combination which provides effective cooling with minimum water use. Naturally it must be ensured that the roof is moisture resistant.

It is also desirable with this method working that the roof be thin. Since humidity is not added directly in the space, the method has certain advantages over desert cooling otherwise. One method to keep the roof top cool is by providing a layer of sand - 20- 25 mm thick over the roof and keeping it moist throughout the day by allowing a 20-25 mm thick layer of water over it. Experience has shown that in the capital city of M.P. this method has brought down the inside room temperature by around 10°C. The presence of water bodies and vegetation in the landscape or even within the house has also been used traditionally and can be thought of as a form of evaporative cooling.

#### The Role of the Landscape

Suburban and rural buildings can gain tremendously from proper vegetation and environmental treatment around them. The first advantage of good vegetation would be a general tempering of the micro-climate.

#### Aspects of Daylighting

Closing up a building too much in order to reduce heat gain may work only upto a point. If there is too little light, there will be a tendency to switch on electric light during the day to work. Daylight is the coolest source of light known to man. In the summer and monsoon, artificial lights add both to the electricity cost as well as to the heat gain. This can be avoided by providing a just adequately lit interior. However, care must be taken to avoid glare by providing a good distribution of this light, other wise curtains shall be drawn and artificial lights shall be used.



However, people in the area do not use too much energy (compared with international standards) to heat or cool the house. The techniques described in this thesis may have only a minimal effect on energy consumption, but they can help in providing better thermal comfort in buildings which do not have any conditioning systems or those with only fans. They can also help retard the increasing and often unnecessary demand for full air-conditioning in buildings.

#### **Summary**

The requirement for designing thermally comfortable building's is minimum flow of solar heat into the building in summer and increase in heat flow in winter. The above requirements are achieved by using cost effective methods & it will be a great contribution to the construction industry.

The cost of the roof and walls in the total cost of house construction are approximately 25% and 30% respectively. Savings can be achieved in the roof and in the walls to the extent of 20 to 25% by using R.C.C. filler slab roof & hollow concrete block walls. These methods not only reduce the cost of construction but also provide thermal comfort due to the cavities provided in them. As housing shortage is a national problem and mass housing involves huge expenditure a reduction in the cost with thermal comfort for the inmates of the dwelling is of vital importance in the present day context. Therefore, it is presumed that, this study will further contribute to the existing knowledge of house construction and will help the builders in construction activity.

\*\*\*\*

Capacity Building Programme for Engineers & Architects on Earthquake Resistant Structures and Retrofitting of Buildings at Panchkula, Haryana

A Capacity Building Programme on Earthquake Resistant Structures and Retrofitting of Buildings for the State of Haryana was organized on May 22-23, 2015 at Haryana Regional Chapter (ITPI), Panchkula, Haryana. The Programme was inaugurated by Shri P. Raghavendra Rao, IAS, Additional Chief Secretary to Govt. of Haryana, Town & Country Planning Department and addressed by Shri J. S. Redhu, Chief Co-ordinator Planner (NCR), Directorate of Town & Country Planning, Haryana and Dr. Shailesh Kr.Agrawal, Executive Director, BMTPC. The programme was attended by more than 70 participants mainly State Engineers & Architects of Government of Haryana. The faculty from IIT roorkee and other Institutions include Prof. D. K. Paul, Professor Emeritus, Prof. Y. Singh, Prof. R. N. Dubey from Department of Earthquake Engineering, IIT Roorkee; covered various topics on Earthquake Resistant Structures and Retrofitting of Buildings.





## **Bamboo Toilets for Swatch** Bharat (Clean India): Any takers??



Kamesh Salam\*

overnment of India is laying emphasis on: a) Construction of individual sanitary latrines for households below the poverty line with subsidy (80%) where demand exists.

- b) Conversion of dry latrines into low-cost sanitary latrines.
- c) Construction of exclusive village sanitary complexes for women providing facilities for hand pumping, bathing, sanitation and washing on a selective basis where there is not adequate land or space within houses and where village panchayats are willing to maintain the facilities.
- d) Setting up of sanitary marts.
- e) Total sanitation of villages through the construction of drains, soakage pits, solid and liquid waste disposal.
- f) Intensive campaign for awareness generation and health education to create a felt need for personal, household and environmental sanitation.

According to recent UN statistics, half of India's population does green gold as it qualifies under not have access to toilets, with the condition even more dismal in rural areas where around 60% of the population still defecates in the open. Poor and inadequate sanitation accounts for various healthrelated issues causing economic and social losses. It is estimated that 1.01 lakh government schools do not have toilets for girls, 1.52 lakh schools do not have toilets for boys and a 1.64 lakh schools have dysfunctional toilets. Poor sanitation facilities lead to drop out from schools, especially among girls in the 5-14 age brackets. Retention of the girl child in schools has increased by 30% in schools with access to proper sanitation facilities.

Therefore, adequate and appropriate sanitation facilities are a pre-requisite for the socio-economic development of the country. Today's school children will be tomorrow's leaders, employers and resources and it is imperative to provide basic amenities to them in order to have a healthy, productive workforce.

Bamboo is rightly called the many of the categories listed for green building materials. Globally, there is a resurgence of interest in Bamboo in this age of information revolution and environmental consciousness. Bamboo is being currently looked upon as an alternate low cost material for the enormous housing problem faced by several developing countries. Bamboo is has always been popular as a building material, especially in house-building and is now widely regarded as the super material of the 21st century. It is one of the fastest growing and highest yielding renewable natural resource making it a good substitute to wood in mitigating pressure on natural forests. Bamboo is a family of grass; it matures in as little as 4 to 6 years much faster than hardwood trees which can take 20 years and above to reach maturity. It sends out new shoots after each harvest and has unrivalled capacity to capture carbon. Bamboo has big income generating for people living in rural areas through bamboo cultivation. Its usage needs to be

Founder and Executive Director, South Asia Bamboo Foundation (SABF) Former President World Bamboo Organisation (WBO), Founder, World Bamboo Day



promoted - leveraging this super material as a sustainable solution to sanitation challenges in areas that still do not have access to proper toilets will not only help in 'Clean India Mission' but also help the cause of leveraging bamboo as an economic tool to drive socio economic development of India, which incidentally also has the second largest bamboo reserves in the world. Bamboo walls & partitions panels, bamboo floors and corrugated bamboo roofing sheets, including Bamboo toilet seats can all be part of such toilets. Bamboo indeed has tremendous potential not only to transform India's rural economy, but also to contribute to the sustainable development efforts. The BMPTC has supported IPIRTI; Bangalore which has developed technologies for manufacture of several bamboo composites such as bamboo mat board, bamboo mat corrugated roofing sheets, bamboo mat ridge caps, bamboo floor tiles and laminates. Engineering and material properties were studied exhaustively to utilize the full potential of bamboo as an engineering material in housing. Bamboo housing technology clearly demonstrates the engineering application of bamboo in housing. All load bearing and semi load bearing elements have been made either of round or split bamboo in the form of slivers in combination with bamboo based composites like BMB and BMCS for roofing with minimal use of timber and high energy consuming materials like iron, steel and cement. Having successfully developed the technology for construction of bamboo based housing system; the challenge was to develop the technology which is equally viable for other structures, community



centres and utility products like toilets. Supported by BMPTC the South Asia Bamboo Foundation (SABF) has conducted one International and three Regional training programs on Building with Bamboo and construction of Bamboo Toilets for community and public in Kochi, Kerala, Haflong and Dimapur in Assam and Nagaland to enhance local capacity and skills. These were done in jointly with BMPTC, Auroville Bamboo Centre, Pondicherry, Kerala State Bamboo Mission (KBSM), Nagaland Bamboo Development Agency (NBDA), and Forest Department of Dima Haso Autonomous Council, Assam. During the training two types of Toilet modules were constructed using local bamboo. The models are Single toilet for household usages and twin model for community usages like schools and other public places. The Details layouts are attached.

The Bamboo Toilet in Dimapur constructed at the Nagaland Bamboo Resource Centre, was launched by the Governor of Nagaland and Assam Shri PB Acharya on 14th July. Governor PB Acharya who was nominated one of the third group of nine members to form the National Committee on Swachh Bharat Mission (SBM) by



Prime Minister Narendra Modi on December 25, 2014. Also during the event other Swatch Bharat "Ambassadors from Nagaland State attended the function along with high officials of Nagaland Governments.

This is where bamboo can play a lending itself as a cost effective and eco-friendly material to build toilets and thereby play a very important role in 'Clean India' mission. The abysmal state of sanitation in India is that only 32% of rural households have their own toilets and that less than half of Indian households have a toilet at home. There were more households with a mobile phone than with a toilet. Of the estimated billion people in the world who defecate in the open, more than half reside in India. Poor sanitation impairs the health leading to high rates of malnutrition and productivity losses. India's sanitation deficit leads to losses worth roughly 6% of its gross domestic product (GDP) according to World Bank estimates by raising the disease burden in the country. Children are affected more than adults as the rampant spread of diseases inhibits children's ability to absorb nutrients thereby stunting their growth. A large part of India's malnutrition burden is owing to the unhygienic environment in which children grow up. Poor sanitation and high population density act as a double whammy on Indian children half of whom grow up stunted. The absence of an effective public health network in a densely populated country has resulted in an extraordinarily high disease burden. The initiatives of Government of India's effort to build toilets under Government funded and CSR funded should be extended to bamboo based toilets for public and community. But issue is "ANY TAKERS". Ideas are great for bamboo has few takers... in reality.





## 

### Indo-Norwegian Training Programme on Seismic Design of Multi-storey Buildings: IS 1893 vs. Eurocode 8 at New Delhi



As per its mandate, BMTPC has always been in the forefront in educating and creating mass awareness amongst common men and professionals through training courses, symposia, conferences and publishing manuals, Guidelines, brochures, etc. for improving Earthquake and Cyclone/Wind Resistance of Housing in collaboration with various technical and academic institutions.

In line with above, BMTPC has been organising Training Courses jointly with IIT Roorkee since 2006 on regular basis. IIT Roorkee is one of the premier organization having excelled in the area of earthquake resistant design and construction and one of the first School of Earthquake Engineering in India.

In 2014, NORSAR, Norway under Indo-Norwegian Collaboration Project "EQRisk" supported by the Norwegian Embassy to India, New Delhi collaborated with IIT Roorkee for the project. NORSAR, Norway is an independent research foundation specialized in seismological research and engineering services relevant for the society and their efforts have over the past years included seismic hazard and risk projects in many earthquake exposed countries. They are also instrumental in imparting training to professionals in India on design and earthquake resistant structures.

BMTPC, IIT Roorkee and NORSAR, Norway conceptualised the three-days Indo-Norwegian Training Programme on Seismic Design of Multi-storey Buildings: IS 1893 vs. Eurocode 8. The two programmes conducted so far have been very successful.

The third programme in the series was organised from May 27 to 29, 2015 at New Delhi. The three days Training Programme was inaugurated by Dr. Nandita Chatterjee, Secretary, Ministry of Housing & Urban Poverty Alleviation, Government of India. The programme was attended by around 100 participants from various parts of the country The course was specifically targeted to Structural & Geotechnical Engineers and Designers in public and private sectors with emphasis on real-life problems and tackling them through hands-on training.



### Public Spaces for All



Ar. Anupam Mittal\*

ublic and Spaces, two words spoken together and almost instantly an image of large open space, parks, railway stations, hospitals and such may come to our minds but only being larger. Is larger sufficient to address the subject "Public Spaces for All ?" No, not for sure because there will be many factors, which will govern the design of such Public spaces and unless the Public Space is designed in lieu with the proposed use, kind of user, public load, rate of inflow etc, it can never be integrated within the system and will remain an isolated place only.

Rate of urbanization, socioeconomy status of the users, literacy level of the area, core business of the suburbs and the available resources shall remain the main guiding factors while designing Public Spaces. An efficient thought process, within a defined span of time, will not only create a suitable space for all but also form a sustainable balance for years to come.

Visitors of all kinds, coming to such business places, have an agenda and they might be spend-





\* Director, ARINEM Consultancy Services Pvt. Ltd., New Delhi





ing good number of hours around the place. It is important to understand that everyone needs a comfort zone and if such places are not been upgraded to meet the demands, a forced and organic development of amenities will lead to an unorganized growth of the same place, that will not only create unhealthy environment but also invite encroachment and lead to a situation, when the place will lead its own death.

#### Can we find a Solution?

Every time we need to move ahead on an unknown path, we always get the best lessons from the past so it would be better to undertake studies of such live examples (both successful and failure) and taking up one such case shall be more appropriate. Connaught Place, New Delhi, which got operational way back in the year 1933, taking four years of execution, stands good even today in 2015

From low rise structures around to the densely populated high rise office buildings of Barakhamba road, from railway stations around to the Metro inside, from the regular traffic to the intense inflow of visitors, it is still managing itself and seemingly not reaching critical stage in the near future. The factors responsible for this are several, most important of them are design factors like central green size, road widths, off street parking spaces



and well designed public spaces along with the amenities developed. Also, the up gradation of details and designs at micro level have done a wonderful job of keeping it sustainable. This was one example but there are number of locations in many cities and towns, badly hit by the unstoppable urbanization and needing attention to develop or redevelop public spaces to cater to today's demand and to be ready for the future.

#### An attempt must be made...

A human behavior and the demands are very simple and easy to be met, we just need to address the basics of human nature by implementing small details while creating Public Spaces in every building. The user may be an infant in a stroller, a child, an old man, may be someone blind, and physically challenged person, a handicapped one or a healthy human being, everyone has a right to walk or move at ease. A ramp, comfortable stairs, wide walkways, suitable signage, shaded pathways, well lit corridors, safe railing and environment friendly atmosphere should be provided in and around public places for a smooth and barrier free movement. Appropriate number of toilets at suitable distance and easily approachable





locations will not only be beneficial for the user but also help is keeping the place clean and healthy. The general toilets at parking spaces, in hospitals, in institutional buildings, malls, railway stations, bus stands are neither available nor usable due to bad maintenance.

Street vendors will be there but an effective garbage disposal must be planned with designated dustbins for plastics, food waste and other wastes. The placement is very important, preferably to be kept after examining the probable areas and human tendencies. The collection by municipal corporations in a defined timeline has to be ensured, keeping load factor, peak timings and the number of collection points with in the area. Designated platforms for vendors will help in the above system and a token of appreciation for the smart shopkeeper and vendors may also be worked out through the local associations. Once they gather for receiving the appreciation, few words on cleanliness may be delivered for others, to follow in the future.

Benches and informal seating at every few meters, preferably all across the shopping area and food stalls will help in keeping the area

live throughout the active hours and it will extend a great support to the families with children and older generation. The seating area can be partly shaded and should be well connected to the parking and shopping areas for all weather utilization. Parking will always remain the top priority for any every public place due to our tendency of taking short cuts and a mindset of finishing the task in just two minutes. Basement parking will always be better due to convenience and connectivity but some percentage of surface parking is also required for different practical reasons.

All amenities such as drinking water, mother and baby care room, worship space, first aid with ambulance, entry, exit and other signage, landscaped walkways etc. need to be planned at every public place. This will start improving the work culture, shopping culture and even work out well at hospitals, railway stations, bus stands, public parks and every other public place. Lets come forward and initiate working on Public Spaces for all and start creating a smart culture to move ahead towards smart cities.

\*\*\*\*





## Facilitating Sustainable Housing Technologies

### through Technology Sub-Mission of Pradhan Mantri Awas Yojana (Urban)

C.N.Jha \* Pankaj Gupta \*\* Dr. Shailesh Kr.Agrawal \*\*\*

**B ackground** The Government of India has launched "Housing for All (Urban)" under Pradhan Mantri Awas Yojana with the objective of providing every family a pucca house with water connection, toilet facilities, 24x7 electricity supply and access by the time the Nation completes 75 years of its Independence i.e. 2022.

During the past years, there has been tremendous growth in housing and infrastructure sector which is adversely resulting in depletion of natural resources, rising cost of traditional building materials, environmental concerns of producing and using such materials; scarcity of coarse and fine sand / aggregates in different parts of the country, use of energy intensive building materials; high Green House Gas emissions; vulnerability to natural hazards. There is shortage of skilled/unskilled labour and need is to bring efficiency, speed & quality in construction and use of new emerging and proven building materials and technologies. With these impediments, achieving the goal of housing for all will be a challenging task.

Therefore, it was felt to have an integrated approach for com-

prehensive technical & financial evaluation of emerging and proven building materials & technologies, their standardisation, developing specifications and code of practices, evolving necessary tendering process, capacity building and creating appropriate delivery mechanism. With this background, Ministry of Housing & Poverty Alleviation, Government of India has decided to set up a Technology Sub-Mission under "Housing for All" (Urban) with the Mission statement as "Sustainable Technological Solutions for Faster & Cost Effective Construction of Houses suiting to Geo-Climatic and Hazard Conditions of the Country".

The Technology Sub-mission under the Mission would facilitate adoption of modern, innovative and green technologies and building material for faster and quality construction of houses. Technology Sub-Mission will also facilitate preparation and adoption of layout designs and building plans suitable for various geo-climatic zones. It will also assist States/Cities in deploying disaster resistant and environment friendly technologies.

The Sub-mission will coordinate with various regulatory and administrative bodies for main-streaming and up scaling the deployment of modern construction technologies and material in place of conventional construction. Technology sub-mission will also coordinate with other agencies working in green and energy efficient technologies, climate changes etc.

The Sub-Mission will work on following aspects: (i) Design & Planning, (ii) Innovative technologies & materials, (iii) Green buildings using natural resources, and (iv) Earthquake and other disaster resistant technologies and designs. Simple concept of designs ensuring adequate sunlight and air should be adopted. Centre and State would also partner with willing IITs, NITs and Planning & Architecture institutes for developing technical solutions, capacity building and handholding of States and Cities. State or region specific needs of technologies and designs would also be supported under this Sub-Mission.

### Technology Sub-Mission: Objectives

 To identify, evaluate and adaptation of emerging technologies for facilitating their speedy introduction in the states taking into consideration the diverse geo-climatic and hazard condi-

<sup>\*</sup> Dy Chief (S&PD), \*\* Dy Chief (I&D), \*\*\* Executive Director, Building Materials & Technology Promotion Council (BMTPC), New Delhi



tions in the country.

- Extending technical support, capacity building & handholding to state Government by creating pool of professionals and skilled manpower.
- Providing support in planning and designing of affordable housing projects including technical documentation such as specifications, standards, manuals etc.
- To facilitate enabling policy framework for use of emerging and green technologies in the states.
- Online portal for technologies and best practices.

#### Technology Sub-Mission: Scope

The Sub Mission will cover following:

- Emerging Technologies
- Green Technologies
- Good Construction practices
- Disaster Resistant construction
- Better Habitat planning & design
- Area specific design & technologies suiting to different geoclimatic zones
- Innovative technologies and design for on-site & decentralized infrastructure

### Technology Sub-Mission: Strategy

 Constitution of technology submission comprising of experts, academicians, practitioners for resolving impending issues related with technologies right from planning to execution of projects.



Shri Narendra Modi, Hon'ble Prime Minister of India launching the Housing for All (Urban) Mission

- Involving R&D institutions, IITs/ NITs by harnessing their strength in identification, review, testing, design & consultancy in the Housing Technology.
- Handholding & technical support to the states for preparation of DPR, planning & design, quality control, preparation of Schedules of Rates (SoRs),
- Analysis of Rates, Standards & Specifications, Code of Practice, manuals & guidelines etc.
- Capacity Building & training for state engineers, municipal engineers, architects, planners and artisans etc.
- To carry out long term & short term R&D for smooth adoption of technologies in Indian Context.
- Collaboration with Bureau of Indian Standard (BIS) for resolving issues related with Standards and Specifications of Emerging Technologies.
- Inclusion of appropriate clauses regarding use of Alternate Emerging Technologies in National Building Code (NBC).
- Advocacy for Policy & Fiscal

interventions to bring level playing field between new technologies and conventional construction system.

 Advocacy for Safer and Quality construction on continual basis.

#### Technology Sub-Mission: Outcome

- Mass scale adoption of different emerging and proven technologies.
- Framework at state level for use of emerging and proven technologies.
- Enhancing availability of skilled professionals / artisans for construction of houses.
- Documentation of success stories.
- Availability of Standards & Specifications, Code of Practices, Schedule of Rates, Analysis of Rates on different emerging and proven technologies.
- Confidence in the mind of stake holders on emerging and proven technologies.
- Reduction in construction Time & Cost.

\*\*\*\*



# ऐतिहासिक स्मारकों हेतु भूकंपीय सुरक्षा पहलुएं

डॉ. शैलेश कु. अग्रवाल \*

इस लेख में ऐतिहासिक रमारकों के स्थापत्य कला संबंधी एवं सांस्कृतिक मूल्यों के संरक्षण के क्रम में भूकंपीय क्रिया के कारण उनकी विघात के विभिन्न महत्वपूर्ण विधा पर चर्चा की गई है। ऐतिहासिक भवनों की सुरक्षा के स्तर के मात्रात्मक मूल्यांकन हेतु यह एक प्रयास है। यह लेख गतिशील गुणों और संरचना की गिरावट / क्षति के अध्ययन हेतु ऐतिहासिक संरचनाओं के यंत्र विन्यास, प्रयोग और निगरानी की जरूरत को प्रकाशित करता है।

#### विहंगावलोकन

ऐतिहासिक स्मारकों के सुरक्षा मूल्यांकन हेतु मानदंड के बारे में और उनकी संरचनात्मक सुरक्षा के संरक्षण हेतु तकनीकों के बारे में काफी विवाद मौजूद है। प्रचलित धारणा यह है कि ऐतिहासिक स्मारक खुद को परिष्कृत संरचनात्मक विश्लेषण हेतु प्रदान नहीं करता और ये निर्णय भूकंप सहित अन्य कारकों के द्वारा मूल क्षमता कितनी प्रभावित हुई, इसके संबंध में मात्रात्मक विवेचनाओं के आधार पर होना चाहिए। यही धारणा यह भी कहती है कि कोई भी संरचनात्मक सुधार प्रारंभिक तौर पर उस संरचना की जो विशेषताएं थी उसे पाने तक ही सीमित होना चाहिए। यह समझा जाना चाहिए कि संरचनात्मक विश्लेषण हेतु आधुनिक तकनीकों की वैधता और खासतौर पर जो भूकंपीय डिजाइन से संबंधित है, के बारे में अविश्वास ऐतिहासिक स्मारकों के विभिन्न प्रकृति पर उपयुक्त विचार किए बिना आधुनिक संरचनाओं हेतु विकसित बहिर्वेशन प्रक्रियाओं के प्रायः उन पर किए गए दुरुपयोग के कारण उत्पन्न हुआ। हालांकि पिछले कुछ दशकों में रमारकों के संरचनात्मक व्यवहार को समझने एवं उनके व्यवहार हेतु उपयुक्त विश्लेषणात्मक विधियों के विकास में काफी उन्नति हुई है।

यह लेख भूकंपीय दृष्टि से खतरनाक क्षेत्रों में ऐतिहासिक स्मारकों के संरचनात्मक सुरक्षा के प्रासंगिक पहलुओं पर प्रकाश डालता है।

### ऐतिहासिक स्मारकों के भूकंपीय व्यवहार के संरचनात्मक पहलू

ऐतिहासिक स्मारकों हेतु मूल संरचनात्मक सामग्री कई अलग–अलग प्रकार की चिनाई है जिसमें चूने के गारा से जुड़े कच्चे, ईंट, खुरदुरे पत्थरों से लेकर अच्छी गुणवत्ता के सीमेंट के गुण वाले सामग्री से जुड़े पत्थर–समूह आते हैं। चिनाई अपने काफी वजन और कम तनन क्षमता जो आगे मौसमी प्रभावों के कारण बढ़ता जाता है, के कारण भूकंपों में बहुत खराब प्रदर्शन करता है। इसके अतिरिक्त, चिनाई विषम होती है और विभिन्न संरचनात्मंक सदस्यों के बीच इसकी गुणवत्ता में विविधता होती है। चिनाई संरचना का एक महत्वपूर्ण पहलू है उनके संरचनात्मक सदस्यों अर्थात अनुप्रस्थ (आड़ा) दीवार, फर्शों और नीवों वाले दीवार को निरंतरता देने में कठिनाई और इसी के साथ–साथ अत्यधिक सख्त एवं मजबूत दीवारों को जड़ता बल प्रदान करने की क्षमता वाले सख्त क्षैतिज मध्य पट को तैयार करने में कठिनाई।

आमतौर पर होने वाली विघात के विविध प्रकारों के बारे में आगे चर्चा की गई है।

#### दीवारों का पलटना

विघात का सबसे आम प्रकार है समतल जड़ता बल के नहीं होने के कारण, जिसके कारण छत पर बाहरी धक्का पैदा होता है, भूकंपों के दौरान लंबी दीवारों का बाहर की ओर झुकना और पलट जाना। विघात दीवारों के अलगाव के साथ शुरु होता है जिसके बाद इसके कंपन से दीवारें ऊपर की ओर उठने लगती हैं।

यह ज्ञात तथ्य है कि भूकंप के दौरान स्मारक झुकने लगते हैं जिसका विश्लेषणात्मक मूल्यांकन मुश्किल है। इसलिए दीवारों की सुरक्षा आमतौर पर समान संरचना के पूर्व प्रदर्शन के साक्ष्य के आधार पर सामान्य नियमों के द्वारा जांचा जाता है। इन नियमों को आमतौर पर दीवारों की






fp= 1%yFchnloljladkclgjdhvlj >qlukvljjiyVuk

# r lfydl&1%dPph bW dsedluladh n loljiadh n plbZvl\$y albZdh 1 lek a

छत का प्रकार	अधिकतम जोखिम का क्षेत्र		काफी क्षति जोखिम का क्षेत्र	
(किग्रा ⁄ वर्गमी में भार)	कमजोर	कॉलर बीम वाले	कमजोर	कॉलर बीम वाले
हल्का (50)	2.9	6.5	4.1	9.2
मध्यम (250)	2.4	5.5	3.4	7.7
भारी (500)	2.0	4.7	2.9	6.6

लेखक सुझाव देता है कि तालिका–1 भारतीय हालातों में इस्तेमाल किया जा सकता है जहां जोन III एवं I∨ को अधिकतम जोखिम का क्षेत्र'' निर्धारित किया जा सकता है और जोन–∨ को 'काफी क्षति जोखिम' के तहत वर्गीकृत किया जा सकता है।

# इमारत के मोहरो (फसाड) का खंडन एवं नष्ट होना

विफलता का आम कारण विधा चर्चों या महलों के अग्र भागों के गिरने के कारण हैं जो स्मारकों के बाकी हिंस्सों के साथ अच्छे तरीके से बंधे हुए नहीं थे। चित्र-2 एक आम स्थिति को दर्शाता है जहां उनका सतह जड़ता बल अनुप्रस्थ होने के कारण एक भारी और लंबा मोहरा अस्थिर हो सकता है। छत या मध्यस्थ फर्श मोहरा के बाहरी विस्थापन के लिए उपयुक्त रोक प्रदान नहीं करता है। भूकंपीय पुनः संयोजन के सबसे आम उपायों में से एक है विभिन्न प्रक्रियाओं के द्वारा मुख्य दीवारों से बाकी संरचनाओं को सहारा देना।

#### दीवारों की अपरूपण विफलता

तिरछी दरार के माध्यम से दीवारों में अपरुपण बलों के कारण विफलता एक ऐसा मामला है जो स्मारकीय भवनों में बहुत अधिक नहीं होता है क्योंकि स्मारक के आमतौर पर काफी मोटाई दीवार को अपरूपण बलों से सामना करने के लिए महत्वपूर्ण क्षमता प्रदान करती है चाहे यदि उनकी इकाई मजबूती कम भी हो तो भी। आमतौर पर अपरूपण विफलता बड़े मुंहाने वाले दीवारों से जुड़ी होती है जैसे कि घंटाघरों की दीवारें। (चित्र 3)

# संरचनाओं की तनन विफलता

अधिकतर स्मारकों में जिसमें उपयुक्त मंजिल और छत मध्यपट की कमी होती है छत के स्तरों पर काफी मात्रा में जड़ता बल पैदा होते हैं वे सीधे प्रतिरोध सदस्यों के संबंधित पार्श्विक कठोरता की परवाह किए बिना छत के हरेक भाग से दीवारों में स्थानांतरित हो जाते हैं। पार्श्विक बलों की बहुलता कुछ दीवारों में उठ सकती है। इसके अलावा, यह भी ध्यान में रखना चाहिए कि संरचना के कंपन के दौरान छत में तनन तनाव उठते है जिससे बड़ी दरारें पैदा हो सकती हैं, असल में संरचना को हिस्सों में विखंडित कर सकती है जिसके स्थायित्व की खासतौर पर मूल्यांकन की जानी चाहिए। इस हालात का एक उदाहरण चित्र 4 में दर्शाया गया है। जब विशाल गुंबददार संरचना अपुनप्रस्थ् दिशा में कांपती है तो तनन तनाव गुंबद पर लंबवत दरार पैदा करता है इसलिए.



fp= 3%Hita es(lfrxir eljci) xqjir dk?likij (1 i %www.nicee.org)





संरचना का बांया भाग, जो कम सख्त और मजबूत होता है, को छत के सबसे बड़े भाग में उत्पन्न जड़ता बलों का सामना करना चाहिए। इसी प्रकार, इमारत का मोहरा शेष संरचना से लंबवत कंपन के कारण अपने टावरों और पूश्ताओं के साथ अलग हो सकता है जिसे उनपर पैदा होने वाले जड़ता बलों का सामना करना चाहिए और उनके पूश्ते बाकी संरचना के अपरूपण मजबूती में योगदान नहीं देता है।

# ऐतिहासिक स्मारकों पर भूकंपीय बलों का मूल्यांकन

जब बलों और खिसकने के विश्लेषणात्मक अनुमान हेतु भूकंपीय क्रिया को कैसे परिभाषित किया जाए इस पर विचार किया जा रहा हो तो आधुनिक संरचनाओं के साथ इनमें कई भिन्नताएं है इसको ध्यान में रखना चाहिए।

भूकंपीय बलों पर भारतीय मानक के संबंध

में निर्दिष्ट संहिता भूकंपीय गुणांक और कई कारकों सहित प्रतिक्रिया तरंग जो मुख्य रूप से ऐसे संरचनाओं के निर्माण हेतु मुख्य रूप से परिभाषित किए हैं जो भूकंपों के द्वारा प्रदर्शन करते हैं, हेतु संतोषजनक माने गए हैं। ये मूल्य आधुनिक भवनों हेतु अंशांकित किए गए हैं और सीधे स्मारकीय संरचनाओं हेतु बहिर्वेशन नहीं किए जा सकते हैं।

भूकंपीय सुरक्षा मुल्यांकन हेतु सामान्य पद्ध ति है समतुल्य स्थिर पार्श्व बल के साथ संरचना का विश्लेषण। ये बल उन स्तरों पर लागू होते हैं जहां भार संकेंद्रित होता हैं और संरचना की ऊँचाई के साथ तेजी में रेखीय वृद्धि मानी जाती है। यह आमतौर पर बनाए गए उन मध्यपट वाले संरचना हेतु मान्य होता है जिसमें ऊँचाई के साथ अधिक या कम समान तनन वितरण होता है, जोकि स्मारकीय संरचनाओं के साथ नहीं होता है। ऐतिहासिक स्माारकों के सुरक्षा मूल्यांकन हेतु स्थल निर्दिष्ट प्रतिक्रिया तरंग को ध्यान में रखा जाना चाहिए। ऐसे स्मारक के अध्ययन पर अधिक ध्यान दिया जाना चाहिए जो काफी नरम मिट्टी पर बने हों जहां भूकंपीय तरंगे लंबे लचीले संरचना पर महत्वपूर्ण प्रभावों के साथ प्रवर्धित होती हैं।

अधिकतर स्मारकीय संरचना हल्के भूकंप के दौरान बेहतर प्रदर्शन करते हैं क्योंकि कंपन की मूल अवधि जमीन के कंपन की लंबी अवधि से काफी कम होती है। हालांकि, इन स्मारकों की भूकपीय सुरक्षा भेद्यता विभिन्न स्थापना, लंबवत संरचना सदस्यों के झुकाव, हल्की दरारें और नरम मिही के मामले में क्षेत्रीय घटाव के कारण बढ जाती है। यह इसके बदले भविष्य के भूकंपों के प्रति इन संरचनाओं की सुरक्षा को घटाते हैं। स्मारकों के भूकंपीय प्रतिक्रिया के किसी भी मात्रात्मक मूल्यांकन हेतु इन प्रभावों को ध्यान में रखा जाता है। स्मारकीय संरचना के भूकंपीय सुरक्षा जो उसमें प्रारंभ में था उसे दोबारा लाने का सबसे प्रभावी तरीका है अंतरीय स्थापना और संरचनात्मक सदस्यों के भार को ठीक करने के साथ–साथ संरचना के विभिन्नत हिस्सों के बीच निरंतरता को बनाए रखना।

# र्यत्रीकरण, प्रयोग एवं निगरानी

आधुनिक संरचनाओं हेतु डिजाइन या सुरक्षा मूल्यांकन की पद्धति धारणाओं और यांत्रकीय गुणों पर आधारित होते हैं जो मुख्य रुप से प्रयोगशालाओं में किए गए विस्तृत परीक्षणों से आते हैं। उनकी प्रकृति हेतु स्मारकीय संरचनाओं को प्रयोगशाला परीक्षण के लिए नहीं ले जाया जा सकता है जो साधारणतम रुपों (मेहराब, खंमा, दीवारें) के व्यवहार तक सीमित होते हैं। अधिकतर परीक्षण सीधे मूल भवनों पर किए जाने चाहिए।



जो स्मारकों हेतु भी महत्वपूर्ण जानकारी दे सकता है वह है परिवेश कंपन जांच। परिवहन, हवा या हल्के कंपन के कारण होने वाले कंपन को मापने के लिए संरचना के महत्व पूर्ण बिंदु पर विभिन्न जगहों में उच्च संवेदनशीलता वाले एसीलिरियोग्राफ या सीरमोग्राफ लगाए जाते हैं। आम प्रवृत्ति को पाने के लिए शोर और खास इनपुट के प्रभावों को हटाकर काफी संख्या में मापों के औसतों का इस्तेमाल किया जाता है। संकेतों के तरंगीय विश्लेषण के द्वारा कंपन की प्राकृतिक बारंबारता और औसत आकृतियों को संरचना के विभिन्न हिस्सों के कंपनों के बीच सहसंबंध के साथ निर्धारित किया जा सकता है।

बाहर के कुछ स्मारकों में विस्थापन,

स्थापना, झुकाव और दरार के संबंध में

निगरानी हेतु परिष्कृत तकनीकों को

लागू किया गया है। कुछ मामलों में ये

ऑटोमेटिक डाटा संग्रहण प्रणाली के द्वारा

सराहे गए हैं जिसे चयनित सीमा के बाहर

प्रतिक्रिया बढने पर अर्ल्ट संकेत देने के

भूकंपीय प्रतिक्रिया के निर्धारण हेतु स्मारकों

का यंत्रीकरण और निगरानी बहुत कम हैं।

एक तकनीक जिसका इस्तेमाल लगातार आधुनिक संरचनाओं में बढ़ रहा है और

तथापि ये काफी उपयोगी हो सकते हैं।

लिए लगाया जा सकता है।

रमारकीय संरचनाओं के व्यवहार की

जब कुछ सालों के बाद या एक महत्वपूर्ण

# भूकंप के बाद इन मापों को दोहराया जाता है तो गतिशील गुणों में बदलाव पाया जा सकता है जो संरचना के क्षति या झुकाव का परिणाम हो सकता है।

#### निष्कर्ष

यह लेख भूकंपीय क्रिया के कारण ऐतिहासिक स्मारकों के नष्ट होने के विधाओं का बेहतर तरीके से समीक्षा करता है। इन संरचनाओं का सुरक्षा मूल्यांकन काफी ऐतिहात से किया जाना चाहिए और आधुनिक भवनों के साथ इसे मिलाया नहीं जाना चाहिए। ऐतिहासिक स्मारकों की यंत्रीकरण, प्रयोग और निगरानी इस समय की जरूरत है।





# Benchmarking and Objective Selection of Technologies for Housing in India





Prof. Virendra Kumar Paul\*

Varun Seth\*

# ntroduction

As per the National Housing Bank, the Technical Group on Housing Shortage has estimated housing shortage in urban India at 18.78 million units in 2012. The housing sector faces challenges like demand and supply constraints, land availability and shortage, financial constraints and operational constraints like pressure on land and infrastructure, lack of clear titles of land and encroachment. (National Housing Bank, 2013). However, the most critical issues concerning housing in India are affordability, sustainability and quality of housing. Technology holds great potential to provide solutions to the challenges of sustainability and quality of housing. Hence, benchmarking of technologies for housing in India is imperative for developing a framework for creating Sustainable and Social "Housing for All".

# Suitability of technologies for housing

Technology is one of the key enablers for ensuring the availability of affordable housing. Building professionals need to adapt to new techniques and designs to fasten the process of development of housing units without compromising the strength and quality of the house. Determining their suitability is the foremost requirement.

#### **Functional needs**

A key driver for selecting suitable technologies for housing is to create resilient urban settlements which, when possible, use renewable energy, and proactively take into account climate change and are resilient to natural and human-generated hazards. Functional factors for construction technologies can be derived from various national and international literatures including policies documents, codes and standards, green building guidelines. The focus of housing construction needs to be strictly based on the use of building codes and standards, which promote harmonization of common practices, procedures, products specifications to allow compatibility across state borders and support building safety.

#### Sustainability needs

Apart from functional needs, selection of technologies for hous-

ing construction must take into consideration the needs of social, economic and environmental sustainability. Sustainable buildings benefit the user's health, wellbeing, economic productivity, environmental sustainability and social integration and form a fundamental part of sustainable development. Today, knowledge on sustainable buildings is well developed and rating systems have been developed based on criteria like energy efficiency, use of materials, water efficiency, occupant comfort, sustainable site development etc. United Nations' Sustainable Solutions for Social Housing (2013) too enlists parameters for addressing the environmental aspects of sustainability.

Design and technology must also allow for green spaces around and within housing areas, including areas that provide habitat for wildlife, space for leisure, sport and urban agriculture and importance should be given to creating compact housing settlements with planned growth to prevent urban sprawl. However, most of the guidelines and rating systems on green and sustainable buildings fo-

\* Department of Building Engineering and Management, School of Planning and Architecture, New Delhi



cus on the aspects of requirements related to site planning and management, water efficiency, energy efficiency, materials, resources and indoor environmental quality. This leads to green and sustainable building solutions being driven by new and innovative technologies. However, such guidelines and rating systems often remain silent on the aspect of social sustainability. The production of housing stock needs to be based, as much as possible, on local solutions, labour and local materials for their design, construction, refurbishment and maintenance, thus contributing to local employment. Green infrastructure becomes crucial in creating better societies by creating sustainable and integrated transport systems, encouragement of healthy living through the ease of maintenance and retrofitting, treating waste management as an integral part of housing development, and efficiently distributing and improving social infrastructure and services.

The Sustainable Social Housing Initiative of the United Nations Environment Programme, which aims at supporting decision-makers in selecting appropriate sustainable solutions for social housing development, prescribes consideration of the following socio-cultural aspects for selection of appropriate design and technologies for Sustainable Social Housing-

- Promote social cohesion and contribute to meeting the housing needs of various social groups, including marginalised and vulnerable groups and people.
- Facilitate implementation of universal design principles in order to increase the usability

of homes for all people across generational, gender and disability divides and encourages socially mixed communities.

- Take into account social and territorial peculiarities and support the protection and enhancement of landscapes, historical heritage and cultural heritage.
- Takes into consideration the background and culture of inhabitants.
- Involve local communities.
- Research and exchange of knowledge on all aspects of sustainable housing. (UNEP, 2013).

# **Overview of performance** standards

The challenge of housing is a complicated issue due to several limitations. A major limitation that restricts the supply of appropriate and adequate housing is the technologies implemented for construction, operations and maintenance of housing. Clearly, there is significant room for improvement and this gap needs to be filled by developing and choosing appropriate technologies which are strictly driven by qualitative and quantitative performance standards. Roman architect, engineer and author, Marcus Vitruvius Pollio 2000 years ago defined performance criteria as: Firmitas (firmness, durability); Utilitas (performance, conformity); and Venustas (aesthetics).

Today, national and international codes and standards for performance, some of which include standards like ISO 6240, ISO 6241, European Commission Construction Product Directive and the Performance Appraisal Certification Scheme (PACS) by BMTPC, show the need of certain qualitative characteristics in performance standards, which may be listed as-

- Performance standards need to be based on outcomes and not on individual preferences.
- Performance standards must be so designed that the compliance is observable and represents specific indicators of success.
- These standards should be meaningful, reasonable and attainable. Criteria for evaluation need to be clearly defined.
- These standards should be able to be expressed quantitatively, qualitatively and in terms of time and cost metrics.

Each code and standard has its own area of focus and is applicable in its own peculiar context. For example, the ISO 6240, which specifies the basic contents to be included in performance standards for building components and assemblies, and indicates a standard order for their inclusion, enlists various requirements for performance under four heads- user's requirements, uses of buildings and spaces, sub-systems of the building fabric and agents relevant to building performance. On the other hand, the European Commission Construction Product Directive enlists various requirements under five heads- mechanical resistance and stability, safety in case of fire, hygiene, health and the environment, protection against noise and energy economy and heat retention. Codes in New Zealand specify different performance standards for building elements which have durability up to 5, 15



and 50 years.

In India, for the performance assessment of building technologies, BMTPC operates the Performance Appraisal Certification Scheme (PACS), which is a third party assurance system based on laboratory and field tests of the required performance criteria.

From the overview of national and international performance standards, it is evident that each standard holds good in certain aspects and lacks in some. Thus, there is an imperative need to develop a holistic approach towards performance standards of building technologies and strengthen the focus on functional needs as well as needs of sustainability. This approach can be derived from a framework of objective methodology for selection and implementation of appropriate technology for housing.

# **Objective selection framework** for technologies

The selection and implementation of appropriate technologies is an ongoing challenge for various stakeholders due to the increasing cost and complexity of technology, accelerating demand and competing performance standards. Our present systems of performance standards and evaluation needs to address the requirement of a holistic system which is objective and transparent in its methodology, and places performance as the key criteria for selection of a technology. Further, it may be argued that we have been lacking on objective benchmarking framework for housing technologies. Benchmarking is used to measure performance against specific indicators to get a metric of performance of a

process or technology. Presently, our building codes and standards including the National Building Code, IS codes and green building rating systems provide prescriptive guidelines and requirements for minimum level of performance. However, they remain silent on a methodology for assessing total performance of a system. Further, the current performance standards look at performance of building elements and not the complete system and hence, a holistic picture is missing. Lack of a framework for benchmarking the performance of technologies implies lack of a methodology to derive and understand the metrics of performance of any technology. Hence, there is a pressing need for development of an objective framework for benchmarking, selection and implementation of appropriate technologies which is based on sound quantitative and qualitative parameters and involves a scientific approach for dealing with the metrics.

The emerging technologies proposed, including the ones by BMTPC, do not yet have solutions for an integrated building system. While technologies solely based on concrete and steel address the requirements of structural integration, other technologies rely on composite construction techniques, which may lead to problems associated with the use of two dissimilar materials in one place and the integrity of joints. It is also observed that in some cases, the technologies are suitable to only one application, which may be structure, walls or floors. These technologies address the requirements of specific building elements and do not look at the holistic perspective of the complete building system as yet. Further, the durability characteristics in such cases have been defined only for the sub-system and not, the holistic picture of the system. Thermal properties in some cases correspond to the basic materials and may be addresses by further R&D on the integration of insulation with these technologies to achieve optimal thermal performance. The quality assurance process defined for most technologies is only valid up to the individual element and not for quality assurance of the complete building. Further, many of the proposed technologies do not have any quality assurance process in place as yet. In such a scenario, the performance of these technologies could be evaluated against the levels of performance achieved by well-established techniques to make decisions related to their adoption for construction of housing.

It is believed that the selection of a suitable technology is not possible until and unless they are compared to well established performance standards based on existing technologies. Also a holistic view needs to be adopted to develop and adopt technologies for building systems and not building elements. Hence, it becomes imperative that an objective benchmarking and selection methodology is adopted and new technologies are validated against the established benchmarks.

# Need for benchmarking and validation

Benchmarking is the process of comparing the cost, cycle time, productivity, or quality of a specific process or technology to another that is widely considered to be an industry standard or best practice. It is used to measure performance



against specific indicators to get a metric of performance of a process or technology. This process of benchmarking allows innovators to assess areas of improvement in their technology and adopt standards that are comparable to best practices. The process for selection of technologies proposed above needs to quantitatively assess performance of the technologies with respect to industry best practices in order to develop a holistic approach towards achieving the highest standards of housing in the country. Benchmarks for the selection framework must be established based on the industry best practices and must take into account the local context in terms of the geo-climatic, socio-cultural and hazard conditions. Such an approach will tend to strengthen the focus on functional needs as well as needs of all three spheres of sustainability, i.e. social, economic and environmental.

Validation of the performance of any system through such a benchmarking process is critical for the success of the system. ISO 9000:2000 defines validation as confirmation through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled. From this definition, it becomes evident that an objective system for selection of appropriate technologies based on comparison with performance benchmarks will prove to be instrumental in developing an evidence based methodology for achieving total performance of building systems.

# Parameters for benchmarking and selection

Dependence on conventional

practices results in energy intensive housing developments, which are characterized by low durability, poor quality of housing and slow construction speeds. Selection of technologies for construction, operation and maintenance of housing in a country with diverse geo-climatic, socio-economic and hazard conditions requires a fresh approach to address the needs of quality, durability, environmental concerns as well as socio-economic and cultural concerns. Such an approach may be derived from the functional, environmental and socio-economic needs of housing which have been discussed in this paper. Thus, based on the preceding discussions, holistic criteria which could serve as the inputs for the benchmarking as well as the assessment framework can be listed as-

- Strength and stability
  - o Structural performanceo Fire resistance
- Compliance to codes and standards
  - o Compliance to NBC
  - o Compliance to IS codes
  - o Compliance to Green Building Codes
  - o Compliance to other performance standards
- Functional requirements
  - o Functional appropriateness
  - o Aesthetic aspects
  - Affordability and adaptability
  - o Durability
  - Protection against rain and moisture
  - o Thermal behaviour
  - o Acoustic behaviour
  - o Ease of fixing services
  - o User's satisfaction with space, light, acoustics, design, storage etc.
  - o User's perception of thermal

comfort

- o User's perception of control of their environment
- Realisation of the design intentions of the various stakeholders involved
- Construction management aspects
  - o Industrialization of construction process
  - o Standardisation and modular construction
  - o Cost-effectiveness of materials used
  - o Simplicity and versatility in construction
  - o Construction time and lead time
  - o Supply chain factors
  - o Health and safety
  - o Quality assurance
  - Maintenance
  - o Frequency of requirement of maintenance
  - o Ease of maintenance and replacement of mechanical components
- Environmental sustainability
  - o Use of renewable resources for building materials
  - Efficient use of existing conventional materials by producing factory made (pre-cast) building components
  - o Use of raw materials resources based on waste products
  - o Energy use
  - o CO<sub>2</sub> emissions
  - o Use of sustainable and environment-friendly materials
  - o Water use
  - o Waste water management
  - o Indoor air quality
  - Induction process for the user for his understanding of the operation of the building
- Economic sustainability



- o Economies of scale
- o Construction cost
- o Operation and maintenance cost
- o Salvage value
- Social sustainability
  - o Employment generation potential
  - o Potential for involvement of local communities
  - o Potential of application of universal design principles
  - Potential for protection and enhancement of landscapes, historical and cultural heritage
  - o Cultural appropriateness
  - o Potential for exchange of knowledge

# Metrics of assessment Methodology

The parameters listed for selection of technologies represent a broad range of issues to be considered and takes into account the perspectives of all likely stakeholders. However, for successful translation of these parameters into an effective framework, each of the parameters need to be translated into quantitatively assessable variables and a common weighted credit system needs to be evolved which takes into account the relative importance of these factors. Some inputs for a system for assessment are as follows-

- A tiered approach may be followed, where an initial screening might be done on the basis of broad qualitative parameters.
- Subsequently, detailed quantitative assessment may be done for the technologies which clear the initial screening process.

# Conclusion

The "Housing for All by 2022"

mission has put forward a mammoth task of providing quality housing for those who cannot afford it and this has opened new avenues for large-scale innovation in the field of technology for housing. Large numbers of houses needed, the inadequacies of existing construction technologies and the need for faster and guality construction opens the doors for research and development in the field of development of new and appropriate technologies. At present technologies which are being developed focus on the technical aspects of certain structural and functional requirements. However, the development of a framework for benchmarking performance of these technologies against a broader domain of factors that need to be considered for development of such technologies. The broad areas under which factors need to be considered are presented in this paper. It has been found that the emerging technologies cater to building elements and not holistic building systems. Hence, it is proposed that there is a need to develop an objective framework for the assessment of suitability and performance criteria for such technologies. For successful development of such a framework, development of benchmarking standards for performance of building systems is of utmost importance. It is imperative that the selection of new technologies has to be solely based on this objective methodology against the defined parameters and with reference to the established benchmarks of performance to achieve the target of providing quality housing to all within the specified time constraint.

It may be further discussed that technology itself provides means

to assess the suitability and performance criteria of technologies. BIM is a digital representation of physical and functional characteristics of a facility and involves collaboration by stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information to support and reflect the roles of that stakeholder. BIM application is effective tool for detailed designing, analysis, documentation, construction planning and fabrication, construction logistics, operations, maintenance, renovation and retrofitting of buildings. Hence, BIM is indispensable towards creating and holistic assessment framework for benchmarking and objective selection of technologies.

# "Technology made large populations possible; large populations now make technology indispensable." – Joseph Krutch

# **Bibliography**

- 1. Dulaney Jr, R. (2012). The low-income single-family house and the effectiveness of architects in affecting affordability. ARCC Journal, 24-34.
- Coimbra , J., & Almeida , M. (2013). Achieving Cost Benefits in Sustainable Cooperative Housing. buildings, 1-17.
- 3. Danko, M. R. (2013). Designing Affordable Housing for Adaptability: Principles, Practices, & Application. Pitzer Senior Theses.
- Horne, R., & Hayles, C. (2008). Towards global benchmarking for sustainable homes: an international comparison of energy performance of housing. J Hous and the Built Environ, 119-130.
- 5. Jones Lang LaSalle. (2012). Affordable Housing in India: An Inclusive Approach to Sheltering the Bottom of the Pyramid. JLL.
- KPMG. (2010). Affordable Housing A key growth driver in the real estate sector?
- KPMG. (2013). Key recommendations: sustainable housing for masses. KPMG.
- 8. KPMG. (2014). Decoding housing for all by 2022. KPMG.



- 9. McKinsey Global Institute-I. (2010). India's urban awakening: Building inclusive cities, sustaining economic growth. McKinsey Global Institute.
- McKinsey Global Institute-II. (2014). A blueprint for addressing the global affordable housing challenge. McKinsey Global Institute.
- 11. Ministry of Housing & Urban Poverty Alleviation-I. (2015). Pradhan Mantri Awas Yojana: Housing for All (Urban)-Scheme Guidelines. New Delhi: Government of India.
- 12. Ministry of Housing and Urban Poverty Alleviation-II. (2013). Affordable Housing in Partnership: Scheme Guidelines . New Delhi: Government of India.
- 13. Ministry of Housing and Urban Poverty Alleviation-III. (2015). Compendium of Prospective Emerging Technologies for Mass Housing. Government of India, Ministry of Housing and Urban Poverty Alleviation. Government of India.
- 14. Mukherjee, M. (2015). Inclusive Green Affordable Housing for All. IIT Roorkee.
- National Housing Bank. (2013). Report on Trend and Progress of Housing in India. New Delhi: National Housing Bank.
- 16. Press Information Bureau. (2015, June 17). "Housing for All by 2022"-Mission National Mission for Urban Housing. Retrieved July 8, 2015, from Press Information Bureau Web site: http://pib.nic.in/newsite/PrintRelease. aspx?relid=122576
- Roy, R., Risbud, N., Chen, R., Langer, S., & Lall, N. (2009). Spatial Inclusion and Sustainable Design of Low-income communities. SPA, New Delhi, National Resource Centre.
- Town and Country Planning Department-Haryana. (2013). Affordable Housing Policy 2013. Haryana Government.
- 19. UNEP. (2013). Sustainable Solutions for Social Housing: Guidelines for project developers. United Nations Environment Programme.
- UNEP. (2013). The Sustainable Social Housing Initiative consultation workshop in India. Proceedings of the Sustainable Social Housing Initiative consultation workshop in India Delhi 25 April 2013 (pp. 1-24). New Delhi: United Nations Environment Programme.
- 21. Wadhwa , K. (2009). Affordable Housing for Urban Poor . SPA, New Delhi, National Resource Centre.

# Capacity Building Programme on "Good Construction Practices include Emerging Technologies" at Vadodara, Gujarat

BMTPC has planned to organize capacity building programmes in various states to enhance the capacity of engineers & architects in the area of quality control and good construction practices and also to introduce them with the emerging technologies in housing sector. In line with this, BMTPC organized a two days Capacity Building Programme on "Good Construction Practices including Emerging Technologies" at Vadodara, Gujarat on 29 - 30 July, 2015. Nearly 70 engineers and architects from various state govt. departments participated in the programme.

The programme was inaugurated by Sh. H.S.Patel, Municipal Commissioner, Vadodara Municipal Corporation. In the keynote address, Dr. Shailesh Kr.Agrawal, ED, BMTPC explained the objective of the programme made an elaborate presentation on Cost Effective and Emerging Technologies. The expert faculty made presentations on various subjects such as Planning & Design Aspects for Housing projects, Good Construction Practices and Quality Assurance in construction projects, Earthquake Resistant Design & Construction Practices. Presentations were also made by the Technology Providers on emerging technologies such as Glass Fibre Reinforced Gypsum (GFRG) technology, Light Gauge Steel Frame (LGSF) technology, expanded polystyrene core panel technology for construction of houses, precast RCC waffle panels for walling and roofing, factory made precast RCC panel based technology and Modular transportable Housing system.





# Embodied Energy – a future way to quantify Sustainability



**Dipan Shah\*** 

mbodied Energy is one of the very important yet less known subject. In today's world of advance technologies; when "Green" is the new Buzz word; it is very unfortunate that we have yet not explored the immense potentials of Embodied Energy (EE).

Present market conditions are quite favorable for the promotion of Green and sustainable technology. The market and developers have moved towards exploring the product range of Green and Sustainable technologies. Challenge in last decade was to promote Green technologies but the present day challenge is different. People have started knowing and exploring about green technologies. In fact challenge presently is to identify actually the "Green" technology from the shades of Green. In the present market, each and everyone knows that "green", "sustainable", Environment Friendly, energy efficient etc are the buzz words to sell the product. Now a days, anyone and everyone has come up with green or environment friendly product range. Many of them, fail to deliver in real time. Which in

fact is slowly draining the market faith on such products and technology. EE is one of the few tools, which brings in the solution to this concern and it can help quantify Sustainability.

#### What is EE?

Embodied Energy is the sum total of all the energy used in building material right from its extraction of Raw material to transportation to production to packaging to transportation (site) to installation to maintenance to deconstruction to disposal. That is sum total of all the energy utilized at each stage. Depending on the boundary conditions of energy summation, the EE can be CRADLE to GATE or CRADLE to GRAVE or CRADLE to Site. For eg. Cradle to Gate means sum total of all the energy from extraction of raw material till the Gate of Factory where it is made ready for dispatch. Apart from linear flow of energy as described above, EE calculation will have to also account for all the percentage energy loading on a product with respect to infrastructure, machinery, tools and also ancillary Operation energy which can be accounted for that particular product under consideration. Thus, sum total of EE done on a logical frame work of understanding is EE of that particular product. It will be important to mention that in EE it is never actual EE of a product but always equivalent EE of the product due to logical framework analysis of energy and then percentage loading on the product.

There are also two other terminology used commonly with EE that is PER and GER. Process energy Requirement (PER) is a liner flow of EE with respect to particular product while Gross Energy Requirement (GER); as the name suggest is the Gross energy calculation for that particular product. It is nearly impossible to calculate GER and hence mostly for all practical purpose PER is calculated.

With all this specifics said about EE the important point of understanding will be the practical importance of EE and how it can help solve present crisis of quantifying sustainability of a product or technology.

Lets first try and understand this with a simple example. Generally for affordable technologies

\* Director - Sustainable Habitat Services Pvt. Ltd and Managing Coordinator - Society for Environment Protection, Ahmedabad; E-mail: dipan@sepindia.org



or green technologies we say that they have to be local in nature, low on production energy, should be using local material, will be advantageous if we use high man power etc. How EE will reflect all this. For instance, stone is considered as natural material and considered one of the Green alternative. Now if the same stone is to be used in a region were stone is not locally available, the EE value of same material will go up because the transport component will be added. So at the point of use, one can actually take decisions based on tangible number rather than perception about the product.

EE if evolved in suitable framework it has immense potential to be a rating system for products and technology and go much beyond it. Presently under the aegis of BMTPC, SEP is evolving and hosting a National Network on Embodied Energy (NEE). The project which has various university partners across India is a comprehensive project which explores range of aspects of EE. Working since last two years, NEE is working towards evolving data collection templates of EE specific to various material, working on regional level databank of EE, exploring ways and means to evolve EE as a tool to quantify Sustainability.

Some of the interesting findings from the phase I of the project are as below :

 As a part of network activity, detail studies were done on various products and technology. One of the product taken for study was bricks. Now generally for energy modeling and rating system, the EE of the burnt brick is taken around 4MJ/unit. When we studied various brick manufacturing units the range of EE found was ranging from 3MJ/unit to 5 MJ/unit. This huge variation was accounted to range of factors like location of unit from the source of Raw material, technology used in extraction of raw material, production systems, technology used to fire bricks etc. Like for instance the unit which used efficient kiln and but using labour intensive production process was low on EE against the unit which procured raw material from distance and was using low end mechanization.

- Similar study on Flyash bricks also revealed interesting findings. The flyash brick was further more sensitive on production technology and systems. When studied at Ahmedabad, the Flyash brick unit which was procuring flyash from thermal power plant situated at around 80kms away to the unit to the one which had 25 kms they (clubbed up with their other factors) had about 20% to 25% energy variation. Similarly, contrary to the set belief of lime being a cost effective material and addition of lime as a stabilizer making green product, the EE of lime is nearly same as that of cement (Even as per recent study EE of lime goes nearly double of Cement). This is primarily because of low end, highly in efficient kiln based production of lime against high end, sophisticated production of cement. So the lime based Flyash bricks (FAL-G) was much high on EE against their counter part.
- Similarly for instance steel is very high on EE and hence

use of steel is restricted in many alternate framework. But if a small shed or other elements are to be made, the Steel though high on initial energy, it comes up with huge potential of recycle and reuse. Thus, when EE analysis done on steel with reference to Cradle to Grave boundary conditions, the efficiency of steel increases.

- Contrary to this many hybrid material like FRP are though high on EE, but are light weight so per sq ft EE loading is less. But at the same time, the end of life of this structure provides zero reuse/recycle potential and they end up in Hazardous waste dump site. So if one evaluates them on the backdrop or Sustainability, their use needs to be judicious.
- Studies on construction site, working on EE further gave interesting revelations. One of the material studied was concrete. Concrete EE did vary from site to site based on the procurement source of Raw material. It will be important to mention here that the cost may remain same since market forces will deliver aggregate at the standard prize at site but the procurement distance has its impact on EE of Concrete produced on site. Also, for a small construction upto say 2 storey, transport of concrete is done manually for slab concrete. This brings down the EE of slab against the one which has used mechanized ways to transport concrete. The concrete EE, will increase as the height increases. Thus concrete on first floor slab to the concrete on 10<sup>th</sup> floor slab, the EE variation in the same



material is about 5% to 7%. Similar variation was seen for brickwork too.

An interesting Case study done on a veneer production unit was an eye opening to even all of us involved. It also reflects the strength of EE as a tool to take business decision and how it can help make product green without cost implication. One of the Veneer unit studied used imported wood from Malaysia as the main Veneer material and for backing material local plywood is used. An intense study was done on the unit in partnership with the owner himself. Generally in veneer production, major cost component was of imported wood and local plywood backing account to about just 20 to 25% cost. When EE analysis of done, we expected that same will be reflected in the EE too. But though EE of imported wood was very high, the percentage use of it in final product was limited to facia and thus very less % by weight. And hence its loading on the final product in percentage of EE was less against the loading of the backing material which was local plywood. Now in this case, the Veneer unit, to make its product more Green and low on EE, had to find source of backing ply (which was cheap and indian in nature) which can bring down the EE. Thus, without spending much they had potential to improve their products EE tremendously by changing the source of local backing material.

These are few of the examples of the immense learning we and all associated with the project had in last two years. Now we are gearing up for the Phase II of the project which will expand further and proactively work towards developing backword and forward linkages with product and processes to quantify and authenticate them. The project is also developing portal www.embodiedenergy.in which is under development yet. The portal will host regional level database of EE for various material. This is very important because as mentioned earlier, most of the green building analysis for rating system is done on the theoretical EE number available from net which may be totally wrong with respect to specific location or actual product in use. Like for instance using EE value of concrete block available in Delhi or Bangalore will be totally wrong for a project in Ahmedabad or Baroda where sand is easily available. In Delhi or Bangalore sand transport will have huge implication on the blocks EE. Thus the same product will have different regional value and greenness.

As the pressures which multifold construction sector is putting on environment, it is high time that we evolve tools and frame work which are comprehensive and which can help take us judicious decision on a neutral backdrop of Sustainability. EE is one such tool, which has this potential. Global markets like Australia, New Zealand have explored it quite a lot have come up with comprehensive index of EE coefficient for different materials and technology. We at India are just a beginner in this sector. But if we want to be a global leaders in Environment friendly technology, then EE is one such tool, which provides us with tangible solutions. Way we have **BEE i.e. Bureau of Energy Efficiency** similarly we need to works towards exploring the tremendous potential of NEE (Network on Embodied Energy) and build it in our policy frameworks on Sustainability. It is essential that comprehensive regional level data bases are made on EE of materials and is put in public domain. The work is exhaustive and is all the more complicated with daily advent of new material in the present market. But nevertheless it is utmost important that such data frameworks are available in public domain, so one is able to take up neutral comparison of products and technology range available and takes judicious decision so as to make Sustainability not a premium product but an everyday preference of all.

(Author can be reached at dipan@sepindia.org for any further information).

\*\*\*\*





# Glimpses of Great Indian Public Spaces

J.K.Prasad\*

#### ntroduction

A public space may be a gathering spot or part of neighbourhood, water front, recreation park/ centre, the pathways or other areas within the public realm that help promote social inter action and a sense of community.

Famous Journalist and Urbanist of US, Mr William Whyte said" One can measure the health of a city by the vitality and energy of the streets and public places."

His perspectives are:

**The Social Life of Public Spaces.** Whyte wrote that the social life in public spaces contributes fundamentally to the quality of life of individuals and society as a whole. He believed that we have a moral responsibility to create physical places that facilitate civic engagement and community interaction

**Bottom-Up Place Design**. Whyte advocated for a new way of designing public spaces – one that was bottom-up, not top-down. Using his approach, design should start with a thorough understanding of the way people use spaces, and the way they would like to use spaces. Whyte noted that people vote with their feet – they use spaces that are easy to use, that are comfortable. They don't use the spaces that are not.

The Power of Observation. By observing and by talking to people, Whyte believed, we can learn a great deal about what people want in public spaces and can put this knowledge to work in creating places that shape livable communities. We should therefore enter spaces without theoretical or aesthetic biases, and we should "look hard, with a clean, clear mind, and then look again – and believe what you see."

Cities are undergoing constant change where local municipalities focus on making urban areas more attractive, lively and interesting and where many new housing developments are taken place. This is largely a success which means more people visit, use and live in cities. A common goal in the revitalisation process is for urban space to be welcoming and accessible to everyone. At the same time, urban planners try to create flexible, diverse and multicultural space to meet changes in use, preferences and needs. Urban users have different needs and interests which is a challenge to the concept of 'urban space for everyone'. Another goal in urban development is to avoid mono-functional areas and instead aim for a mix of activities in certain districts. This means placing stores, cafés, restaurants, amusement arcades, movie theatres and other types of businesses and housing side by side. This is attractive to many people because it livens up the street. But it also creates conflicts when families living in the city have to co-exist with others who use the city as an entertainment centre until the early hours of the morning. By using a more traditional strategy of avoiding entertainment and other activities in housing areas and concentrating 'urban functions' in other areas such conflicts can be avoided. However, this kind of concentration can leave some parts of the city deserted. Conceptually, multifunctional urban spaces are designed to meet the need of all users. However, urban planners often have specific users in mind, and some work consciously to design urban space that appeals to selected groups. For although the general goal is to provide flexible,



diverse and multicultural space, creating 'common space' is difficult in a time where individuality is valued and marked by different and changing needs. There are, however, many 'urban successes' around the country and in many ways it has been possible to create diverse urban life. These could fall under the category of Great Urban Places. Characteristics of Great Public Spaces include:

- Promotion of human contact and social activities
- Safe, welcoming and accommodating for all users
- Has design and architectural features that are usually interesting
- Promotes community involvement
- Reflects the total culture or history
- Is well maintained
- Relates well to bordering uses and has a unique or special character

# Effective Public Places in Different Regions of the Country

# INDIA HABITAT CENTRE, NEW DELHI

India Habitat Centre (IHC) was conceived to provide a physical environment, which would serve as a catalyst for a synergetic relationship between individuals and institutions working in diverse habitat related areas and would therefore maximize their total effectiveness. To facilitate this interaction, the Centre provides a superb range of facilities.

Representative of "ecology by design, India Habitat Centre was



Stein's largest project. It is perhaps most successful as a work of urban design, a place that handles transportation and an enormous variety of public and private activities, from housing to banking to entertainment to food. A city within a city, it is an intellectual shopping centre that provides cheap green curry, great theatre, cutting edge art, ...., and wonderful outdoor spaces that are comfortable even in summer. The IHC has made an extraordinary contribution to the city of Delhi ..." (Source: An Innocent Abroad: Joseph Stein in India, by Professor Jeffrey M Chusid. Occasional Publication 18, India International Centre).

Spread over an area of nine acres the IHC campus has been designed and built by Joseph Stein, Doshi and Bhalla who have created an island of architectural excellence in the busy metropolis of India's capital, Delhi. The campus weaves in a unique interplay of institutions, supporting infrastructure and facilities such as conference venues, auditoria, hospitality areas, the library and resource centre, and art galleries. Elegantly designed, the campus is a hub of activity while simultaneously being serene. The architectural and design elements that Stein has built in enable this paradoxical blend. The landscaping, horticulture and fountains add to the pleasing ambience of the campus. The campus is wi-fi enabled.

#### DILLI HAAT, NEW DELHI

It is an open-air food plaza and cradia, and from a variety of cultural traditions of India. Unlike the traditional weekly market, the village Haat, Dilli Haat is permanent. It is located in the commercial centers of South Delhi, opposite INA market. The 6 acres of land on which this complex is situated was salvaged as part of a reclamation project and transformed into a plaza. Extensive foundation work, small thatched roof cottages and kiosks give the plaza a village atmosphere. Some shops are permanent but other sellers are rotated, usually for fifteen days. A number of shows promoting handicrafts and handlooms are held at the exhibition hall in the complex. To sell wares, there is an application process and spaces are allocated according to the state the seller is from. It is easily approachable and





an excellent place where 62 stalls allotted on a rotational basis to craftsmen a payment of INR 100 per day for a maximum period of 15 Days. Public get taste of cuisines of different states at one place. Different cultural events organized give opportunity to know the culture of different states from time to time.

#### SABARMATI RIVER FRONT, AHMEDABAD

Sabarmati river has been an integral part in the life of Ahmedabad since the time the city was founded in 1411 along the river banks. Besides being an important source of water, it provided a backdrop to cultural and recreational activities. During the dry seasons, the river bed became a place for farming. With time it also offered place for various informal economic activities, and the river banks were used by informal squatter settlements.

Gradually, however, the intensive uses took their toll on the river. Untreated sewage flowed into the river through storm water outfalls and dumping of industrial waste posed a major health and environmental hazard. The river bank settlements were disastrously prone to floods and lacked basic infrastructure facilities. Lacklustre development took shape along the riverfront. Such conditions made the river inaccessible and it became a virtual divide between the two parts of the city. Slowly, the city turned its back towards the river.

There had been a long-standing acknowledgement that the riverfront could be turned into a major urban asset from its undesirable state. Proposals to achieve the same have been made since the 1960s and it was finally in 1998 that this multi-dimensional project was envisioned and undertaken by the city.

It has long been acknowledged that appropriate development of Ahmedabad's riverfront and the building of adequate infrastructure can turn the Sabarmati River into a major asset for the city and significantly improve the quality of life for all sections of its citizens. The Sabarmati Riverfront has the potential to create a singular identity for the city, bring people closer to water, bring back focus to the city center, and create city level social infrastructure and recreation facilities.

It was with this aim that the the river front project was initiated. The Sabarmati Riverfront Development has been envisaged as a comprehensive development of approximately 11 kilometres of length on both the banks of the Sabarmati River encompassing all its potentials as primary goals. The project approach is to bring about an overall environmental improvement, social upliftment and sustainable development along the Riverfront.

The Riverfront project presents a great opportunity to create a public edge to the river on the eastern and western sides of Ahmedabad. By channelling the river to a constant width of 263m, riverbed land has been reclaimed to create 11.25 kms of public riverfront on both the banks. The total land reclamation is 202.79 hectares.

The main considerations in allocating land uses for the reclaimed portions were: existing land uses along the river; extent, location and configuration of reclaimed land available; potential for development; the structural road network and form of the city; bridges proposed in the Ahmedabad Development Plan, and the possibility of providing adequate infrastructure.

To provide new and improved amenities for the city and to include sections with particular needs, provision of markets and vending areas to include street vendors, laundry facilities for the washing community, trade and fair facilities for the business community have been made in the project. The project replaces a largely private riverfront with an expansive public realm with a network of parks, waterside promenades, markets, cultural institutions, recreational facilities and commercial developments for the city's five





million residents.

#### **VRINDAVAN GARDEN, MYSORE**

The Brindavan Gardens, a celebrated beauty spot in this part of India is world famous for its symmetric design. It is one of the most beautifully laid out terrace gardens in the world. The creation of this garden in the Krishnaraja Sagar Dam site has been the achievement of Sir Mirza Ismail, the then Dewan of the princely State of Mysore. The beautification of the whole dam complex was conceived by Sir Mirza Ismail. Modeled on the design of the Shalimar Gardens of Kashmir in the Mughal style, the garden is enriched with a number of terraces, parterres, fountains, running and cascading waterchannels, water chutes, lush green lawns, flower beds, shrubs and trees. Today, the Brindavan Gardens is world famous for its ethereal beauty, grandeur and illumination/ musical fountain.

Located in the Krishnaraja Sagar dam site in Srirangapatna taluk of Mandya district, the Brindavan Gardens is at a distance of 24 Km.



from the famous cultural heritage centre of Karnataka - the city of Mysore, and 143 Km. from Bangalore, the capital city of Karnataka. The Krishnaraja Sagar dam is built across the river Cauvery, one of the principal rivers in South India. The garden extends over an area of 60 acres and it is laid out in the three terraces, which ends in a horseshoe shape. The slopes are planted with colourful Bougainvilleas and ornamental plants. This garden is a public park and it is one of the important tourist spots of India. The garden is enriched with innumerable fountains decorated with coloured lighting. The illuminated running waters and fountains with changing colours of lights is an event that the tourists can look forward to in the evenings. The garden has many open spaces, lawns, illuminated flower beds and ornamental plants. It also has well laid out roads and pathways. The Brindavan Gardens is the bestilluminated terrace garden in India. The boating pond in the midst of the garden is a location where the visitors can enjoy a boat ride. The whole garden when illuminated is an enchanting site to see. In addition the musical and dancing fountain keeps the gathering enchanting before leaving the place.

#### SUKHNA LAKE, CHANDIGARH

The lake was created by Le Corbusier and the Chief Engineer P L Verma. To preserve its tranquility Corbusier insisted that it be forbidden to motor boats and the top of the dam (promenade) prohibited to vehicular traffic. The lake is fringed by a golf course to the south, and Nek Chand's famous Rock Garden of Chandigarh to its west.

Sukhna is an inseparable part of the city of Chandigarh. Le Corbusier





had foreseen that the residents of the city would be drawn it for the 'care of the body and spirit'. The city planners were deeply attached to the lake. So much so that Pierre Jeanneret's ashes were immersed in the lake in 1970 as per his wishes by his niece.

The roof of the 'bandh' or dam has become a favorite promenade. Serious walkers pursue an exercise regime, families enjoy an evening stroll and nature lovers mingle with children on roller skates. Photographers and painters love to capture its scenic beauty of the setting sun, or the heavily clouded monsoon sky, or the early morning mist in winter set amidst the tranquility of the lake. Even anglers do not leave unrewarded.

Sukhna has a membershipbased Lake Club with lawns, a gym, indoor games, swimming pool and tennis courts with both synthetic and grass courts. Boating, rowing, sculling, sailing, kayaking and water skiing can be enjoyed throughout the year.

The lake, which was the venue for the Asian Rowing Championships, has the longest channel for rowing and yachting events in Asia. It also has facilities for other water sports like water surfing, skiing and sculling.

Sukhna is a sanctuary for many exotic migratory birds like the

Siberian duck, Storks and Cranes, during the winter months. The lake has been declared as a protected national wetland by the Government of India.

During summers, there are streams of men, women and children from all walks of life offering voluntary service to desilt the lake bed for about three months. This annual ritual has been a regular feature since long ago.

Sukhna Lake is the venue for many festive celebrations too. The most popular is the Mango Festival held during the monsoons when scores of varieties of mangoes are on display. From time-to-time other food festivals, featuring specialities from different Indian States, are also held here, along with cultural performances.

#### SCIENCE CITY, KOLKATA

Science City, Kolkata the largest science centre in the Indian subcontinent under National Council of Science Museums (NCSM), Ministry of Culture, Government of India, is at the crossing of Eastern Metropolitan Bypass and J B S Haldane avenue, Kolkata. It is considered by some people as the most distinguished landmark in post-independence Kolkata. Saroj Ghose, was the first Director General of NCSM, who is credited with having conceptualized this centre in 1997. This centre was inaugurated by two parts: the 'Convention Centre Complex' was unveiled on 21 December 1996 by Paul Jozef Crutzen in presence of the then Hon'ble chief minister Shri Jyoti Basu and the whole centre was opened by the then Hon'ble prime minister Shri Inder Kumar Gujral on 1 July 1997.

In a tropical country like India, the outdoor is sunny and more inviting than the indoors for most part of the year. In the Science Park, people come closer to plants, animals and other objects in their natural surroundings and also learn about the basic principles of science in an open air learning environment. The park interactive exhibits are engineered so as to tolerate all the weather. Science Park has become the integral part in all the centres of NCSM. It comprises Caterpillar Ride, Gravity Coaster, Musical Fountain, Road Train, Cable Cars, Monorail Cycle, butterfly nursery and several exhibits on physical and life sciences and a maze set up in a lush green ambience. there are many people who come from different states

There is an Earth Exploration





Hall -A permanent exhibition on earth is housed in a two storied hemispherical building that displays the details of the southern hemisphere in the ground floor and northern hemisphere in the first floor. Slicing a huge earth globe at the centre of the hall into 12 segments vertically in each hemisphere, important features of each segment such as physical geography, lands and people, flora and fauna and other dynamic natural phenomenon on earth have been highlighted around the central globe with the modern display technologies such as attractive visuals, interactive multimedia, video walls, panoramic videos, tilting tables, computer kiosks and 3-D effects theatre wearing a special Polaroid spectacle.

A theme tour of 1300 square meter covering 7 large walk through dioramas with 71 robotic pre-historic animals, 26 dinosaurs and 140 early plant model set to their periods. It portrays the story of evolution of animal life, specially the extinct species.

#### MARINE DRIVE, MUMBAI

Marine Drive is a 4.3-kilometrelong boulevard in South Mumbai in the city of Mumbai. It is a 'C'shaped six-lane concrete road along the coast, which is a natural bay. The road links Nariman Point to Babulnath and Malabar Hill. Marine Drive is situated over reclaimed land facing west-southwest. A promenade lies parallel to this road. Marine Drive is also known as the Queen's Necklace because, if viewed at night from an elevated point anywhere along the drive, the street lights resemble a string of pearls in a necklace. In 2012, the Municipal Corporation of Greater Mumbai announced



that the entire road would be resurfaced, 72 years after it was originally laid.

The official name for this road, though rarely used, is Netaji Subhash Chandra Bose Road. The promenade is lined with palm trees. At the northern end of Marine Drive is Chowpatty Beach. This is a popular beach famed for its Bhel puri (local fast food). Many restaurants also line this stretch of the road. Further down this road lies Walkeshwar, a wealthy neighbourhood of the city, also home to the Governor of Maharashtra.

Marine Drive is the preferred connecting road between the central business district located at Nariman Point and the rest of the city.It is a live wire for local residents , who are seen jogging and doing exercise every morning. It also protects the building along the road from the fury of ocean during high tide time.

Marine Drive is also used successfully for important events like republic day parade , Bombay Marathon, French festival etc

#### Conclusion

With positive thinking, good governance and planning; creating Great Public Places for All is not difficult. These are only some of the examples in the country. There are many other good examples of effective public places in the different states/region of the country. Taking clue from these examples other states could also develop, based on the local need and culture, such types of effective places to give public the opportunity to socialize and relax.

#### **References:**

- 1. Eleven Principles for creating Great community Places-Project for Public spaces, www.pps.org/reference/11steps
- Urban Space: for Everyone Challenges, Conflicts and Measures, Helle Nergaadd & Solvi Borrener, The Danish Building Research Insttute, Alalborg University
- 3. Websites:

https://en.wikipedia.org/wiki/Sukhna\_ Lake

https://en.wikipedia.org/wiki/Science\_City\_ Kolkata

https://en.wikipedia.org/wiki/Brindavan\_Gardens

https://en.wikipedia.org/wiki/Marine\_ Drive,\_Mumbai

www.sabarmatiriverfront.com/ https://en.wikipedia.org/wiki/Dilli\_Haat www.indiahabitat.ora/

\*\*\*\*



# Conference on Emerging Technologies in Housing and Building Construction at New Delhi

BMTPC organised a Conference on 'Emerging Technologies in Housing and Building Construction' jointly with NAREDCO on 24 July, 2015 at India Habitat Centre, New Delhi. Nearly 100 delegates primarily from housing development companies, State Govt. agencies and technology providers participated in a day long deliberations.

In the welcome address, Shri Navin M.Raheja, Chairman, NAREDCO referred to the challenge posed by the Pradhan Mantri Awas Yojana to housing construction industry for construction of 20 million houses by 2022 and called upon developers to become partners in the Housing for All Mission of the Government of India, which offers a game changer opportunity in housing sector. He emphasised on the need for modern prefab technology to reduce cost & time to complete the projects.

Inaugurating the Conference, Dr Nandita Chatterjee, Secretary, Ministry of Housing & Urban Poverty Alleviation emphasised on the role of new technologies and alternate building materials in order to come out of 'Housing Poverty'. She elaborated the four verticals of Housing for All (Urban) Mission under Pradhan Mantri Awas Yojana. The Secretary, MoHUPA referred to the Technology Sub-Mission which shall focus on design and planning of habitats, adopting green building techniques, minimizing the cost etc. She expressed the need to adopt alternate technologies with a view to conserve the depleting natural resources, safeguard environment, use local materials and minimize the use of scarce skilled manpower.

In his Theme presentation, Dr. Shailesh Kr.Agrawal, Executive Director, BMTPC emphasised that tapping the huge housing demand shall not be possible with conventional technologies alone, therefore in future, buying of housing shall be linked to factory, assembling in-situ, use of smart materials leading to zero energy buildings. Industrialization of housing sector is the need of the hour. Speaking on the occasion Mr Sunil Mantri, President, NAREDCO emphasis the need for lowering the cost of new technology for high rise buildings.

Sh. Sanjeev Kumar, Joint Secretary (Housing for All), Ministry of HUPA, chaired the Panel Discussion. He informed about the initiatives being taken by the Ministry of Housing and Urban Poverty Alleviation for facilitating the adoption of alternate technologies for mass housing.





Development of Advanced Cement Free Fly Ash based Geopolymer Green Concrete







Manish Mudgal\*

R.K. Chouhan\* S.S.

S.S. Amritphale\*

bstract In recent decades, the industrialization and urbanization are the two phenomena that are going unabated all over the world. Most important ill effect of these global processes has been the generation of large quantities of industrial wastes. Thermal power industry generates huge amount of fly ash, which is rich in silica and alumino-silicates and has been widely researched for making geopolymers by reacting with alkali. The quality of fly ash which content amorphous and free silica, etc. has strong influence on the engineering properties of the produced geopolymers. Accordingly Advanced Cement Free Geopolymer Concrete Mix design has been developed by taking various compositions of alkali-fly ash mixtures, with fine and coarse aggregates. The standard cubes of dimensions 15cm x15cm x15 cm (for compression strength) and standard beam of dimensions 15 cm x 15cm x 70 cm (for flexural strength) were casted and ambient cured for 28 days and evaluated for engineering properties. The optimized composition possessed a compressive strength

of 20-35 MPA and flexural strength of 2-4 MPA, when tested as per IS 516 : 1959 (Reaffirmed:2004).

Keywords: Fly Ash, Geopolymer Concrete, Compressive Strength, Flexural Strength

#### Introduction

In recent decades, the industrialization and urbanization are the two phenomena that are going unabated all over the world. Apart from the need for these phenomena, one has to look into their negative impacts on the global environment and social life. Most important ill effect of these global processes has been the generation of large quantities of industrial wastes. Therefore, the problems related with their safe management and disposal has become a major challenge to environmentalists and scientists. Second related problem is the pressure on land, materials and resources to support the developmental activities, including infrastructure.

Fly ash can be disposed-off in a dry or wet state. Studies show that wet disposal of this waste does not protect the environment from migration of metal into the soil1. Heavy metals cannot be degraded biologically into harmless products like other organic waste. Studies also show that coal ash satisfies the criteria for landfill disposals. In most of the countries fly ash is considered as non-hazardous. With the present practice of fly-ash disposal in ash ponds (generally in the form of slurry), estimated land required would be about 0.6 ha per MW.

Fly ash, being treated as waste and a source of air and water pollution till recent past, is in fact a resource material and has also proven its worth over a period of time. Fly ash is one such example, which has been treated as waste materials, in India, till a decade back, and has now emerged not only as a resource material but also as an environment saviour

Energy requirements for the developing countries in particular are met from coal-based thermal power plants. The disposal of the increasing amounts of solid waste from coal-fired thermal power plants is becoming a serious concern to the environmentalists. Coal ash, 80% of which is very fine in nature and is thus known as fly ash

\* CSIR- Advanced Materials and Processes Research Institute (AMPRI), Near Habibganj Naka, Bhopal 462026 (M.P.), India Email : mmudgal1969@rediffmail.com Fax :0755-2457042



is collected by electrostatic precipitators in stacks. Fly ash generated at present is largely responsible for environmental pollution.

During the last 30 years, extensive research has been carried out to utilize the fly ash in various sectors, as this is not considered as hazardous waste. Broadly, fly ash utilization programmes can be viewed from two angles, i.e. mitigating environmental effects and addressing disposal problems (low value—high volume utilization).

Fly ash is now recognized as valuable substances which confers certain desirable characteristics in its many applications.

# Indian Scenario of Fly Ash Generation and Utilization

COAL-based thermal power plants have been a major source of power generation in India, where 75% of the total power obtained is from coal-based thermal power plants. The coal reserve of India is about 200 billion tones (bt) and its annual production reaches 250 million tones (mt) approximately. About 70% of this is used in the power sector. In India, unlike in most of the developed countries, ash content in the coal used for power generation is 30-40%. High ash coal means, generation of a large amount of fly ash. India ranks fourth in the world in the production of coal ash as by-product waste after USSR, USA and China, in that order.

At present in India about 130 coal based thermal power plants are producing about 170 million tons of fly ash every year. With the increase in demand of power energy and coal being the major source of energy, more and more thermal power plants are expected to be commissioned in near future. As per the estimates, fly ash generation is expected to increase to about 225 million tons by 2017.

Initiatives taken by the government, several non governmental and research and development organizations for fly ash utilization, the level of fly ash utilization in the country was estimated to be less than 10% prior to 1996–97.

The problem of fly ash disposal has assumed such an enormous scale in the country that the Ministry of Environment and Forests (MoEF) issued a regulation on 14 September 1999 specifying normative levels for progressive utilization of fly ash. According to the regulation, it is mandatory for the existing (old) and new coal based thermal power plants to utilize 100% of the fly ash produced in a stipulated time horizon. The new coal thermal power plants are required to use 100% of the fly ash produced within nine years of commencing operation. The old power plants, however, are required to achieve 100% fly ash utilization goal within 15 years from the date of issue of the regulation.

Central Electricity Authority is monitoring fly ash generation and its utilization in the country since 1996.The present status of Fly ash generation and its utilization in the country based on data being received from Central Electricity Authority is described in Table 1.0

A large number of technologies have been developed for gainful utilization and safe management of fly ash under the concerted efforts of Fly Ash Mission of the Government of India since 1994. As a result, the utilization of fly ash has increased to over 72.52 mil-

Table 1 : Status of F	y Ash Generation &	its Utilization in India
-----------------------	--------------------	--------------------------

S.No.	Year	Fly-ash Generation (Million Tons per Annum )	Fly-ash utilization (Million Tons per Annum )	%Utilization
1	1996-97	68.88	6.64	9.63
2	1997-98	78.06	8.43	10.80
3	1998-99	78.99	9.22	11.68
4	1999-2000	74.03	8.91	12.03
5	2000-01	86.29	13.54	15.70
6	2001-02	82.81	15.57	18.80
7	2002-03	91.65	20.79	22.68
8	2003-04	96.28	28.29	29.3
9	2004-05	98.57	37.49	38.04
10	2005-06	98.97	45.22	45.69
11	2006-07	108.15	55.01	50.86
12	2007-08	116.94	61.98	53.00
13	2008-09	116.69	66.64	57.11
14	2009-10	123.54	77.33	62.60
15	2010-11	131.09	73.13	55.79
16	2011-12	132.98	72.52	54.53

Source : Report on "Fly ash generation at coal / lignite based thermal power stations and its utilization in the country for first half of the year 2011-12", Central Electricity Authority, New Delhi.



lion tones in 2011-12. Fly ash was moved from "hazardous industrial waste" to "waste material" category during the year 2000 and during November 2009, it became a saleable commodity. Fly ash utilization has started gaining acceptance, it being 54.53% during 2011-12.

Fly ash has acquired the status of a "useful commodity" which opens up plenty of opportunities in terms of laying & fine tuning policies, conducting gainful businesses and R&D efforts, and addressing the concerns of environment at the same time. We achieved the highest level of fly ash utilization of 63% in 2009-10. However, it would require a lot of efforts to reach the target of 100% ash utilization.

#### **Geopolymer Concrete**

The name geopolymer was named by a French Professor Davidovits in 1978 to represent a broad range of materials characterized by networks of inorganic molecules (Geopolymer Institute 2010).<sup>[1],[2],[3]</sup>.

The geopolymers depend on thermally activated natural materials like Meta kaolinite or industrial byproducts like fly ash or slag to provide a source of silicon (Si) and aluminum (Al). These Silicon and Aluminium is dissolved in an alkaline activating solution and subsequently polymerizes into molecular chains and become the binder. The polymerization process involves a substantially fast chemical reaction under alkaline conditions on silicon-aluminum minerals that results in a threedimensional polymeric chain and ring structure <sup>[4]</sup>.

The reaction of Fly Ash with an aqueous solution containing

Sodium Hydroxide and Sodium Silicate in their mass ratio, results in a material with three dimensional polymeric chain and ring structure consisting of Si-O-Al-O bonds.<sup>[5]</sup>

Water is not involved in the chemical reaction of Geopolymer concrete and instead water is expelled during curing and subsequent drying. This is in contrast to the hydration reactions that occur when Portland cement is mixed with water, which produce the primary hydration products calcium silicate hydrate and calcium hydroxide. This difference has a significant impact on the mechanical and chemical properties of the resulting geopolymer concrete, and also renders it more resistant to heat, water ingress, alkali-aggregate reactivity, and other types of chemical attack. [3] & [5]

The temperature during curing is very important, and depending upon the source materials and activating solution, heat often must be applied to facilitate polymerization, although some systems have been developed that are designed to be cured at room temperature. <sup>[2] & [3]</sup>

### **Materials and Methods :**

#### Materials used :

The materials used in the investigation is industrial waste generated from thermal power plant ,Fly ash confirming to IS 3812 (Part-I) and alkali activator of optimized composition of Sodium Hydroxide ,Sodium Silicate and other additives. The conventional sand and coarse aggregate was used for the preparation of geopolymer concrete. The Physical properties and chemical composition of Fly Ash used for the investigation are

# Table 2: Physical Properties of Fly Ash

рН	8.4-8.6
Moisture content	0.088 %
Specific Gravity	2.1
Blaine fineness	330-390 m²/kg

# Table 3: Chemical Composition of Fly Ash

S.No.	Constituents	wt. %
1	SiO	64.2
2	Al <sub>2</sub> O <sub>3</sub>	28.27
3	Fe <sub>2</sub> O <sub>3</sub>	3.70
4	CaO	0.062
5	Na <sub>2</sub> O	0.174
6	К,О	1.34
7	MgO	0.46
8	*LOI	1.39
*IOI Less an invition		

\*LOI- Loss on ignition



Fig.1: SEM Image of Fly Ash Sample

summarized in Table 2 and Table 3 respectively. The SEM image of Fly Ash sample is shown in Fig.1.

# Mixing Procedure & Preparation of Test Specimen:

Advanced Cement Free Geopolymer Concrete Mix design has been developed with various compositions of alkali-fly ash mixtures, with fine and coarse aggregates. The standard cubes of dimensions 15cm x15cm x15 cm (for compression strength) and standard beam of dimensions 15 cm x 15cm x 70 cm (for flexural strength) were casted and left for 24 hours and then removed from the moulds. The samples were air cured at room temperature until the testing at the age of 28 days.





Mix Design and Preparation of Advanced Cement Free Fly Ash based Geopolymer Concrete



Advanced Cement Free Fly Ash based Geopolymer Concrete Cubes



Slump Test of Advanced Cement Free Fly Ash based Geopolymer Concrete



Ambient Air Drying of Advanced Cement Free Fly Ash based Geopolymer Concrete Cubes



Compressive Strength Testing of Advanced Cement Free Fly Ash based Concrete Cubes



Flexural Strength Testing of Advanced Cement Free Fly Ash based Concrete Beams

#### **Results** :

# Compressive strength and Flexural Strength :

The compressive and Flexural strength tests were performed in accordance with IS: 516-1959. Method of Tests for strength of concrete. The Engineering Properties of Advanced Cement Free Geopolymer Concrete is reported in Table 4.

#### **Conclusions:**

- From the results obtained for optimized composition, the compressive strength of fly ashbased geopolymer concrete after 28 days, almost comply to that of OPC concrete of M30grade.
- The geopolymer concrete is more environmental friendly and has potential to replace ordinary Portland Cement Concrete.
- The developed advanced ce-

Table 4 : Engineering Properties of Advanced Cement Free GeopolymerConcrete

S. No.	Properties	Results
1	Slump of Fresh Fly Ash based concrete	30-40mm
2	Compressive Strength	20-35 MPa
3	Flexural Strength	2-4 MPa
4	Density	2300-2500 Kg/m <sup>3</sup>

ment free fly ash based geopolymer green concrete may be the road pavement material for the future.

#### References

- [1] Davidovits, J. 1984. "Pyramids of Egypt Made of Man- Made Stone, Myth or Fact?" Symposium on Archaeometry 1984. Smithsonian Institution, Washington, DC.
- [2] Davidovits, J. 2008. Geopolymer Chemistry and Applications. Institut Géopolymère, Saint-Quentin, France.
- [3] Geopolymer Institute. 2010. What Is a Geopolymer? Intro-

duction. Institut Géopolymère, Saint- Quentin, France. Accessed on January 29, 2010, at http://www.geopolymer.org/ science/introduction.

- [4]. Hardjito, D., S. Wallah, D. M. J. Sumajouw, and B. V. Rangan. 2004. "On the Development of Fly Ash– Based Geopolymer Concrete." ACI Materials Journal, vol. 101, no. 6.
- [5] Recent Research Geopolymer Concrete- Nguyen Van Chanh Bui Dang Trung, Dang Van Tuan during the 3rd ACF International Conference-ACF/VCA 2008.

\*\*\*\*



# Demonstration Housing Projects using Emerging Technologies by BMTPC

ousing for All (Urban) under Pradhan Mantri Awas Yojna is one of the important agenda of Government of India. The Government is planning to adopt an approach to act as a 'facilitator' and 'enabler' by developing suitable instruments to be used by the State Government for promotion of housing for the Economically Weaker Section (EWS) and Low Income Group (LIG) serviced with basic amenities.

In the context of the massive housing initiatives by the Government of India and various State/ UT Governments under various schemes and programmes, there is an urgent need to propagate and popularize the proven, green and emerging technologies vigorously and to introduce appropriate interventions to bridge the gap between availability of these technology options and application of the same increasingly in large scale Housing initiatives.

BMTPC has been promoting proven and emerging building materials & technologies in different regions of the country through identification, evaluation, standardization, certification, capacity building, training and field level application of such technologies. In the recent past, the Council has constructed a number of demonstration houses in various parts of the country. The efforts of BMTPC have helped in building up confidence and acceptability of proven and emerging technologies among public and private construction agencies, professionals and others.

After streamlining the methodology for construction of demonstration housing projects in different parts of the country, the Ministry of Housing & Urban Poverty Alleviation, Govt. of India requested the Chief Secretary of State Government of Maharashtra, Kerala, Andhra Pradesh, Telengana, Karnataka, Rajasthan, Haryana, West Bengal, Odisha, Sikkim, Gujarat, Uttar Pradesh, Uttarakhand, Tamil Nadu, Bihar and Chhattisgarh for participation in the "Demonstration Housing Project" of BMTPC to further popularize and mainstream the proven and Emerging Technologies in construction. BMTPC has so far received requests from the State Government of Andhra Pradesh, Telengana, Odisha, Haryana, Maharashtra, Uttar Pradesh, Bihar and Karnataka for construction of Demonstration Houses and Community Buildings using emerging building technologies. The Council has initiated the process for undertaking the projects in these states.

# Demonstration Housing Project at Nellore, Andhra Pradesh

The District Magistrate and Collector, SPS Nellore, Government of Andhra Pradesh has allotted land admeasuring 1.85 acres for construction of Demonstration Houses and a Demonstration Community Building at Saraswathi Nagar, Chowtapalem Village, Venkatachalam Mandal, SPS Nellore District. The foundation stone of the project was laid by Shri M. Venkaiah Naidu, Hon'ble Minister of Housing and Poverty Alleviation, Urban Development and Parliamentary Affairs on 31<sup>st</sup> May, 2015.

It has been decided to construct demonstration houses using one of the Emerging Technologies i.e. Glass Fibre Reinforced Gypsum (GFRG) Panel System - a technology approved by BMTPC under PACS and evaluated by IIT Madras. The structural design of the houses has been undertaken by IIT Madras. The community building will be constructed using alternate technologies like flyash blocks and filler slabs. The layout plan, designs and estimates of the demonstration houses and community building have been finalised in consultation with IIT Madras and Andhra Pradesh State Housing Corporation Ltd. (APSHCL). The work for construction of demonstration









houses has been entrusted to FACT-RCF Building Products Ltd. (FRBL), Cochin, a Government of India Enterprise and manufacturer of GFRG panels and work for construction of community building and onsite infrastructure work has been entrusted to APSHCL, Govt. of Andhra Pradesh.

The Demonstration Housing Project will comprise 36 houses in cluster in G+1 having minimum carpet area of 30 Sq.mts. consisting of Living room, Bedroom, Kitchen, Bath, WC and Balcony including on site infrastructure development like internal roads, pathways, boundary wall, UG tank, electrification etc. Apart from this, a Community Building having an area of 6900 sq.ft. is being constructed using green technologies like flyash bricks, filler slabs, etc. The Community Building will have a multipurpose hall, kitchen/pantry area, office space and utility area. While designing the layout and the housing units, provision of adequate natural lighting and ventilation to each area have been planned with Vastu friendly unit design.

# Proposed Technologies / Specifications for Houses

#### Foundation

• RCC Column footing with grade beams using M-25 concrete

### Walling

• GFRG Panel filled with M20 concrete

#### **Roof/Floor**

 GFRG Panel Slab for floor& roof

#### **Doors/Windows**

- Aluminum Door & Window Frames
- Flush door Shutter









### **TYPICAL FLOOR PLANS FOR HOUSING UNITS**









A Perspective View of Housing Units



# Layout Plan of Community Building





- PVC door and frames in toilet
- Glazed aluminum windows

### **Flooring & Finishing**

- Polished cuddapa stone flooring
- Ceramic tile flooring in Kitchen and Toilets
- Interlocking pavers block at entrance lobby
- Oil bound distemper on internal surface
- Exterior walls with weather proof paint

#### Staircase

• GFRG Panel with polished cuddapa stone as tread and riser

# Proposed Technologies / Specifications for Community Building

#### Foundation

• RCC Column footing with grade beams using M-25 concrete

# A Perspective View of Community Building

### Walling

• 200 mm thick walls using Fly ash blocks

# **Roof/Floor**

- Filler slab using earthen pots / Mangalore tiles
- RCC Sloping roof over the courtyard and entrance lobby using Mangalore tiles as cladding

#### Doors/Windows

- Aluminum Door & Window Frames
- Aluminum door shutter with pre laminated particle board
- PVC door and frames in toilet
- Glazed aluminum windows

# **Flooring & Finishing**

- Polished cuddapah stone flooring
- Ceramic tile flooring in Pantry and Toilets
- Interlocking pavers block in entrance lobby

- Oil bound distemper on internal plastered surface
- Exterior walls with water proofing cement paint

#### Infrastructure:

- Boundary wall of Fly-ash brick Masonry in Rat Trap Bond
- Interlocking paver tiles on pathways and internal roads
- Underground Water Tank
- Septic tank for solid waste management
- Landscaped inner court
- Rain Water Harvesting

The construction of the demonstration housing project with community building is likely to start very shortly. During the construction of Demonstration Housing Project, training programmes will be organised at three levels (i) engineers, (ii) supervisors, and (iii) construction workers to acquaint them with the use of technology.

# Performance Appraisal Certification Scheme (PACS)

Barbon MTPC is implementing Performance Appraisal Certification Scheme (PACS) giving independent opinion of the fitness of new building materials, components, products, elements, construction system and assemblies for intended use, not yet covered by Indian Standards. The scheme provides for a third party certifying the performance of the product and in the process it generates sufficient data needed for formulation of Indian Standard at a later date.

The activities carried out under Performance Appraisal Certification Scheme (PACS) during the period from April to September 2015 are include:

Issuance of Performance Appraisal Certificates for the products/systems namely Roof Insulation Tiles-Insulla, Bamboowood Flooring, QuickBuild 3D Panels and Modular Tunnelform approved by the Technical Assessment Committee in the 8th Meeting to the respective manufacturers. Brief details of these products/systems are given below:

# **Roof Insulation Tiles**

Roof Insulation Tiles are made using Phase Change Material (PCM) technology. PCM is an application of geo-inorganic products that are used for the effective storage of

heat or cold and to mitigate the extremes of temperature. While PCMS store the heat. the surface of the roof remains cool. These tiles are made with cold grit granules. These granules absorb and store within them, the humidity from the air, cooling the tile and surface below it. As the temperature rises, these granules release the water vapour, ensuring that the heat is not transferred below. This process absorbs carbon oxide and neutralizes nitrogen oxide present in the air. These tiles reduce room temperature by about 5°C - 8°C. Insulla tiles are of white colour and these are good insulators. These tiles replace the conventional lime terracing laid over the concrete slab. These tiles also provide smooth surface finish and acts as a heat resistant, water resistant and antifungal on the roof surface.

Roof insulation tile is shown in Fig. 1.



### **Bamboowood Flooring**

Bamboowood Flooring is made from Strand woven bamboo. It is a conversion of bamboo to wood. Bamboowood flooring is an eco-friendly product made from bamboo, the fastest growing plant on earth. Bamboo travel through boiling process or burn it under high pressure stream to remove starch and sugar content to make it termite resistant. Further, voc compliant phenolic resin is used as binder and 9 layers of UV coating is applied on it. Bamboo is one of the natural materials available for flooring and is an alternative to hard wood flooring. Bamboo has a higher fibre rating than any other hard wood which gives it exceptional hard wearing qualities. Flooring and wall paneling are coated with UV coat while decking shall be coated with oil.

Flooring suitable for indoor area is shown in Fig. 2.



Fig.2



#### QuikBuild 3D Panel System

QuikBuild 3D Panel System consists of a welded wire space frame integrated with a polystyrene insulation core. The wall panel is placed in position and a wythe of concrete is applied to both sides. The wall panel receives its strength and rigidity from the diagonal cross wires welded to the welded-wire fabric on each side. This combination produces a truss behavior, which provides rigidity and shear terms for a full composite behavior.

Steel trusses are pierced through the polystyrene core and welded to the outer layer sheets of galvanized steel mesh to form a rigid panel. The shell of the structure is built by manually erecting the panels directly onto the slab with reinforcement rods. Desired utilities like doors, windows and ventilators may be pre-built while plumbing, electrical conduits may be added onsite. The wall is then finished by plastering with cement using the traditional method or by shotcreting machine to create a monolithic structure.

These panels are used in the construction of exterior and interior load-bearing and non-load bearing walls and floors of buildings of all types of construction. Description of the Panel is shown in Fig. 3.

#### **Tunnel Formwork**

Tunnel Formwork is a mechanized system for cellular structures. It is based on two half shells which are placed together to form a room or cell. Several cells make an apartment. With tunnel forms, walls and slab are cast in a single day. The structure is divided into phases. Each phase consists of a section of the structure that will cast in one day. The phasing is determined by the programme and the amount of floor area that can be poured in one day. The formwork is set up for the day's pour in the morning. The reinforcement and services are positioned and concrete is poured in the afternoon. Once reinforcement is placed, concrete for walls and slabs shall be poured in one single operation. The formwork is stripped the early morning and positioned for the subsequent phase. The standard Tunnelform is shown in Fig. 4.





# Products under Evaluation Process

Inspection of works of the following new products/systems has been carried out by BMTPC and TAC members:

#### 1. Ultra Sound Pipes & Fittings

These soundproof pipes and fittings made of Polypropylene and mineral field polypropylene compounds (PP-MD) are suitable for drainage, soil and waste water discharge and low & high temperature. These pipes are having triple layers– external layer, middle layer and internal layer as shown in the Fig. 5.

#### 2. SRPL Building System (Waffle-Crete)

SRPL (Waffle-Crete) Building system shall consist of large, structural, ribbed panels of reinforced precast concrete, bolted together and the joints between the panels shall be caulked to form the walls, floor and pitched or flat roofs of buildings. The surface of each panel shall consist of 51mm thick slab or skin, stiffened with the ribs around the perimeter and across the panel, giving an overall panel thickness of 152mm or 203mm.

For single storey buildings, the external walls shall normally be supported on ribbed, suspended floor panels of reinforced precast concrete, that span between grade-beams of reinforced precast concrete laid parallel to each other on well-compacted earth. The design of buildings including the foundations shall be the responsibility of a professional engineer. A concrete apron shall be laid around the perimeter of buildings where there is a danger of water or wind erosion of the ground adjacent to the building. Where the engineer





considers the building site to be unsuitable for suspended floors and grade beams, the walls shall be supported on conventional cast-insitu concrete strip footings.

For buildings of more than one storey, the walls shall be supported on foundations designed by the engineer.

Metal or timber window and door frames shall be incorporated into the wall panels during casting or fitted after erection into openings that are formed in the panels during casting.

Internal walls shall consist of reinforced precast concrete ribbed panels as described above, conventional masonry walls or concrete walls. Where precast concrete panel or masonry internal walls are used in single storey buildings, these shall normally be erected on a concrete surface bed or on concrete strip footings and not on suspended floor.

Services like water supply and electricity shall be normally accommodated in preformed slots in the ribs of panels, before the walls are lined.

The casting can be done in casting yard while foundation is done, which reduces the construction time. Curing time is reduced by trapping the moisture generated from the concrete.

The building after construction can be shifted from one place to another as the structure is joined using bolt connections. The mould and cover forming part of the panel is shown in Fig. 6.



Fig.6

### 3. Expanded Polystryrene (EPS) Core Panel System

Expanded Polystyrene Core Panel System is a factory produced panel system for the construction of low rise buildings upto G+3 and as filler walls in high rise RCC and steel frame buildings. In this technique a core of undulated polystyrene is covered with interconnected zinc coated welded wire mesh on both sided reinforcement and shortcrete concrete.

The panels are finished on site by pouring concrete (double panel, floors, stairs) and spraying concrete to realise the following different elements of the system:

- Vertical Structural Walls
- Horizontal Structural elements
- Cladding elements

The building details of a single panel is shown in Fig. 7.



Fig.7

# 4. Walltec Concrete Hollowcore Wall Panels

Walltec wall panels are extruded non-load bearing concrete hollowcore wall panels manufactured in fully automated machines. Walltec wall panels are factory produced using light weight concrete



made of river sand, crushed stone aggregate, light weight aggregate and Ordinary Portland cement. The concrete are extruded and cut while still wet to the requisite length. Curing and sealing are followed for 24 to 48 hours by stacking and palletizing after which the walls are watered and cured for a further period of 7 to 8 days. After 15 days the panels are ready for transportation to site.

Walls have cylindrical hollow cores incorporated with 7 No 53mm dia voids in the 92mm thickness and 6 No 74mm dia voids for the 120mm thickness panels. The corresponding nominal weight shall be 140 kg/m<sup>2</sup> and 170 kg/ m<sup>2</sup> for 92mm and 120mm thick panels respectively. Hollows are incorporated in Walltec walls to reduce weight, facilitate mechanical, electrical and plumbing services through hollows, thereby increasing sound and thermal insulative properties. The sides of all panels are tongued and grooved to facilitate positive jointing.

Walltec walls do not require stone or wood sills/frames to level surfaces for windows and openings. Lintels need not be cast as panels may be placed horizontally as lintels wherever required. Wash basins, cup-boards, mirrors, paintings etc. may be hanged with regular plug screws. Detail of the panels is shown in the Fig. 8.



Fig.8

#### 5. Plastic Honeycomb Panels – Toiletz

Lightweight thermoplastic honeycomb structures are produced using polypropylene. The honeycomb panels are thermo formed into shape in combination with fibre reinforced polymer composite skins to create structural parts. As these pre-fabricated components are ready made and self-supporting, shuttering and scaffolding is eliminated and can be installed immediately.

Walls made out of these panels shall be designed to withstand all kinds of weathers. Paint is generally not required on the walls. However, if required, different finishes like teak wood, checker board and marble etc. can be provided. The roof of the honeycomb panels shall be either self-supportive tapered or flat.

These panels are suitable for clean room, walls, ceilings & roofs for office and cabins, security booth, vending kiosks and toilets etc.

A typical toilet using plastic honeycomb panels is shown in Fig.9.



Fig.9

#### **Surveillance Inspection**

Surveillance Inspection of Works of the following products/ systems for renewal of the following PACs has been carried out:

- i) Underground Water Storage Tank (Sump)
- ii) Insulated Roof Panel
- iii) Plastocrete Panel
- iv) PVC Profile Door
- v) Formwork for Monolithic Concrete Construction

#### **New Applications**

Applications received for issue of PACs are in the pipe line as per the details given below:

- Light Gauge Steel Framed Structure with Infill Concrete Panel Technology
- ii) Precast Concrete Panels
- iii) Composite Plumbing Pipes
- iv) Polystyrene based lost formwork Building Technology

Many agencies involved in manufacturing/ developing/marketing of new materials/systems to be used in construction have been approached to apply for PAC for their new emerging product/ system.

Feedback for reviewing the whole process of PACS was sought from the PAC holders. Most of the PAC holders have submitted the feedback about their products/ systems stating that the PAC has helped them a lot in convincing their clients as a third party assurance from a Govt. body like BMTPC.

\*\*\*\*



# Decentralized Waste Water Treatment System (DEWATS) - A Sustainable Approach to Sanitation

C.N.Jha \*

he safe sewage disposal & treatment is one of the most essential infrastructure requirements for every citizen in the country. Government of India has recognized the importance of this & in it's recently launched Swacch Bharat Mission made elimination of open defecation & eradication of manual excavenging as important objectives.

The task is huge and challenging. If we look at the scenario of sanitation coverage based on 2011 census, in rural areas 32.7% of households have access to toilet and households going for open defecation are 67.3%, while this figure is 87.4% & 12.6% respectively in urban areas. The national average for households going for open defecation is 49.8%. Understandably, the most deprived sections are households living in slums & other poor households.

The urban scenario though looks better than rural area, however is not at all encouraging if we include the treatment aspect and the adverse impact of untreated sewage has on the environment. As per Central Pollution Control Board status report on waste water generation & treatment (2009-10), estimated sewage generation by

Class I cities including metropolitan cities are 35,558 MLD (based on 80% of the water supply) & installed sewage treatment capacity is 32% of the total generation. The estimated sewage generation by Class II cities is about 2,697 MLD & sewage treatment capacity is only 8% of the total generation. Thus about 70% of the sewage from class I cities & 92% of the sewage from class II cities contaminates surface and ground water on daily basis. In the report, the Class I (498 Nos.) & Class II (410 nos.) cities are based on census data 2001, with projected population of 25.76 crore in year 2008. The discharge of untreated sewage is the most critical water polluting source for surface and ground water in India.

The conventional sewage disposal & treatment system in vogue are highly capital intensive. It involves electro-mechanical equipments, requires high energy input for operation, dosage of chemicals/ polymers & skilled manpower, making operation & maintenance cost very high. Moreover, the conventional system is generally centralized system, wherein pumping of sewage to the treatment unit contributes to high operation cost. Thus, the coverage of all the households both in terms of sewage disposal facility & it's treatment would require huge resources with conventional system. The lower capacity version of conventional systems for decentralized applications also have similar high initial and maintenance cost.

It is now the time to look for alternate and cost effective decentralized options for safe sewage disposal & treatment. The Decentralized Waste Water Treatment System (DEWATSTM) as promoted by Consortium of DEWATSTM Dissemination (CDD) Society appears one such good option. It's applications are based on the principle of low-maintenance since major parts of the system are designed to work without energy inputs (following gravity). It comes at affordable prices as the materials available locally can be used for construction of it's components. The structure being civil structure in nature, it's designed life is of about 30 years. It's applications can be designed and dimensioned in such a way that treated water meets requirements stipulated in environmental laws and regulations.

The advantages of DEWATS are:

• Low primary investment costs as no imports are needed

\* Dy Chief (S&PD), Building Materials & Technology Promotion Council (BMTPC)



- Efficient treatment for daily wastewater flows up to 1000m<sup>3</sup>
- Modular design of all components
- Tolerant towards inflow fluctuations
- Reliable and long-lasting construction design
- Low maintenance costs & no requirement of expensive and sophisticated components

There are five major modules of this system for both anaerobic & aerobic treatment of waste water;

### i) Settler

- Settler tanks are underground or closed tanks with two or three compartments, which are designed to retain wastewater for a required period of time (retention period) and allow heavy solids to settle at the bottom.
- The settled solids are partially decomposed due to anaerobic condition and forms sludge and get collected at the bottom.
- The first compartment occupies more than half of the total volume as it retains most of the scum and sludge, whereas the following compartment(s) ensures smooth undisturbed flow (avoiding turbulence) in to the next treatment module.
- Partition or baffle wall is provided to avoid scum and solids entering in to the next treatment module.
- Required number of manhole openings is provided for easy access into the treatment system.

• Efficiently designed and operated primary sedimentation tanks (settler) should remove from 50-70% of the suspended solids and from 25 to 40% of the BOD, depending on the retention time.

### ii) Baffle Reactor

- Baffle reactor tanks are underground or closed tanks with four to eight chambers in series
- Each of the chambers is designed to take care of required hydraulic and organic loadings. The tanks put in series helps to digest difficult degradable substances
- The anaerobic bacteria, which are responsible for removal of pollutants (suspended and dissolved) from the wastewater live in the sludge at the bottom of the tank.
- During the flow of wastewater through the sludge, the bacteria's will consume the pollutants (degradation of pollutants) and convert it in to sludge.
- The length and width (area) required for each of the chambers is derived from the peak hour flow and defined velocity of wastewater within the chamber.
- The baffle walls or pipes (down shaft pipes) ensure the direction of wastewater flow within the tank.
- These pipes/walls ensure the wastewater to flow through the activated sludge accumulated at the bottom of each chamber.
- Baffled reactor is one of the most efficient anaerobic treatment modules under DEWATS

principals.

 The efficiency increases with higher organic load. The treatment performance is in the range of 65-90% COD removal and 70-95% of BOD removal.

# iii) Anaerobic Filter

- Anaerobic filter tanks are underground or closed tanks with two to four chambers in series
- The anaerobic filter, also known as fixed bed or fixed film reactor, includes the treatment of both non-settleable and dissolved solids by bringing them in close contact with a surplus of active bacterial mass.
- The larger the surface provided for bacterial growth, the quicker the digestion.
- Anaerobic filters may be operated as down flow or up flow system. The up flow system is normally preferred and used as the risk of washing out active bacteria is less in this case.
- An important design criterion is that of equal distribution of wastewater upon the filter area. The baffle walls or pipes (down shaft pipes) ensure the direction of wastewater flow within the tank. It forces the wastewater to flow through the filter media in each of the chamber.
- The quality of treatment in well-operated anaerobic filters is in the range of 70%-90% BOD removal
- It is suitable for domestic wastewater and all industrial wastewater which have a lower content of suspended solids. However, pre-treatment in settlers or septic tanks may be



necessary to eliminate solids of larger size before they are allowed to enter the filter.

# iv) Planted Gravel Filter (PGF)

- Planted gravel filter tanks (also referred to as wetlands) are over ground shallow open tanks filled with graded filter material (substrate).
- The wastewater introduced into the tanks flows through the substrate and is discharged out of the tank through the structure which controls the depth of wastewater in the filter tank.
- Usually river pebbles or construction gravel are used as filter materials and planted with vegetation.
- During the water flow through the filter media wastewater will come in contact with a network of aerobic, anoxic and anaerobic zones.
- Attached and suspended microbial growth is responsible for the removal of soluble organic compounds, which are degraded biologically both aerobically as well as anaerobically.
- The oxygen required for aerobic

degradation is supplied directly from the atmosphere by diffusion or oxygenation from the vegetation roots.

- The vegetation planted in the PGF should fulfill the criteria of efficient oxygen transport into root zone to facilitate oxidation of reduced toxic substances, should be fibrous in nature and locally available species and have aesthetic look
- The quality of treatment in well-operated planted gravel filters is in the range of 50-60% BOD removal. Enrichment of dissolved oxygen occurs to a large extent.
- PGF is suitable for domestic wastewater which has a lower content of suspended solids.
- Pre-treatment in settlers or baffle reactors is necessary to eliminate solids of larger size before they are allowed to enter the filter.
- In case of DEWATS, PGF is used for removal of odour, colour and for hygenisation rather than the removal of organic pollutants as the HPGF is fed

with wastewater with very low organic loading.

### v) Polishing Pond

- Polishing pond is a shallow aerobic pond. This pond is mainly used for enriching the oxygen in the wastewater and elimination of pathogens by exposing water to UV radiation of sun rather than removal of organic pollution like BOD.
- The oxygen intake into the system is through water surface & through photosynthesis process of aquatic plants
- Depth of the pond is kept as minimum (to avoid anaerobic conditions) as possible and surface area as high as possible.
- Under DEWATS, polishing ponds are used only when there is reuse requirement of treated wastewater for toilet flushing or for other non-potable uses
- The increase in dissolved oxygen in the well designed polishing pond may be in the range of 5 to 10mg/l & elimination of pathogens is possible to the extent of 70-90%.
- In addition to the above pro-



The modules as above are designed to work under gravity and thus avoiding energy input.


cess, also some quantities of BOD solids and nutrient removal takes place.

 Some specific species of fishes are used in the pond to help control the mosquito larvae.
Gambusia is one such specie used in the polishing pond.

The DEWATS modules have been installed at Arvind Eye Hospital, Pondicherry. The details w.r.t capacities of it's various modules & performance of the system is given in the form of fact sheet as below:

# DEWATS FOR ARAVIND EYE HOSPITAL

(No. 68, Abhishekapakkam, Thavalakuppam Junction, Pondicherry)

#### Project background

Aravind Eye Hospital located on the east coast highway between Pondicherry and Cuddalore, serves the eye care needs of the people of Pondicherry and neighboring districts of Tamil Nadu. The ratio of free beds to paying beds being 4:1, there are 600 beds for free patients and 150 beds for Paying patients. The hospital outpatient department can handle 1500 patients per day.

Kind of Project : DEWATS for domestic wastewater

Implementing Agency : Aravind Eye Hospital

Supporting Organization : CSR, PAS & FDCO (presently CDD)

**Construction Period : 8 months** 

Construction Cost: Rs. 91.83 lakh

Start of Operation : February 2003

#### Salient Features

Source	: Toilets, bath- rooms, urinals, laundry, Kitchen
Design Capacity	: 307 m³/d
No of users	: 750
Peak Flow	:8h
Influent quality	: COD 1053 mg/l
	BOD 320mg/l
Effluent quality	: COD 18 mg/l
	BOD 7 mg/l

#### Purpose

Compliance to State Pollution Control Board standards

Accommodating the installing a low maintenance wastewater treatment plant in the space available.

Huge requirement of water for landscaping

#### System in brief

Black and grey water streams are separated and treated in the following modules: Settler, Baffled reactor, Anaerobic filter, Planted gravel filter and Polishing pond.

The treatment takes place by sedimentation, anaerobic degradation, sludge stabilization and facultative degradation of organic matter followed by pathogen removal by ultra-violet radiation in the polishing pond.

#### **Operation and maintenance**

The wastewater treatment plant is operated and maintained by the O&M team and the trained gardener of the hospital. A regular schedule is followed for maintenance, like periodical check of sewer line system, removal of sludge in settler, baffle reactor and anaerobic filter. In the planted gravel filter regular harvesting of plants is done. The filter media of both planted gravel filter and anaerobic filter is washed once in five years.

Operating charges are exclusively electricity charges that cost Rs.2,19000/- annually. (There are 4 motors of 7.5 hp that run 8 hours a day). The maintenance is

. .

wodules adopted				
Settler				
Volume	: 163 m³			
Area of construction	: 107 m³			
Baffle reactor				
Volume	: 440 m <sup>3</sup>			
Area of construction	: 392 m <sup>2</sup>			
Anaerobic filter				
Volume	: 365 m³			
Area of construction	: 375 m²			
Filter material used	: Cinder			
Planted gravel filter				
Volume	: 634 m³			
Area of construction	: 1210 m <sup>2</sup>			
Filter material used	: Pebbles			
Plants used	: Canas Indica			
Polished Pond				
Volume	: 300 m³			
Area of construction	: 600 m <sup>2</sup>			
Built up Area	: 2690 m <sup>2</sup>			





carried out once in 3 years costing approximately Rs. 30,000/-. The annual O&M charges are therefore Rs. 2,19,000/-.

### **Reuse options**

- Reuse of treated water for gardening.
- Sludge is transformed into good manure through composting.

## **Monitoring results**

Monitoring of wastewater is carried out regularly.

Sample Points	COD	BOD	TSS	
	ppm	ppm	ppm	
Date of sampling 17.10.2004				
Outlet to drain	48	13	26	
Date of sampling 17.10.2006				
Outlet to drain	99	28	22	
Date of sampling 12.11.2008				
Inlet of plant	1053	320	286	
Inlet AF	130	34	121	
Inlet PGF	52	24	34	
Final Effluent	18	7	14	

The system were explained in Training programme DEWATS<sup>™</sup> organized by CDD at Bangalore during September 07-11, 2015 & details of DEWATSTM modules installed at Arvind Eye Hospital & it's functioning were circulated during the training programme. The system being low-maintenance in nature & requiring nil/low energy input, the prospective users are advised to study the system for application at their end.

## References

- i) Census of India 2011
- ii) Status of water supply, wastewater generation and treatment in class-I cities & class-II towns of India, Report by Central Pollution Control Board (2009).
- iii) Proceedings of the Training programme on DEWATS<sup>™</sup> organized by CDD at Bangalore during September 07-11, 2015.

\*\*\*\*

## **Project Photos**





# Preparation of Earthquake Hazard Maps

BMTPC has undertaken a project for preparation of updated Earthquake Hazard Zoning Maps based on the earlier published Vulnerability Atlas of India entrusted by National Disaster Management Authority (NDMA). The updated Maps for the whole country upto district level based on the Survey of India administrative boundary data has been completed. These maps include latest data from India Meteorological Department, Geological Survey of India, Bureau of Indian Standards, Survey of India and Census of India. The State and District level maps also include data of sub-divisions level from Census of India. Earthquake Hazard Maps consists of Seismic zones as per IS 1893 (Part1) – 2002; Boundaries as per 2012 Survey of India data; Epicentres of earthquakes of 5.0 and above as per IMD data; Seismo Tectonic details as per Seismotectonic Atlas of India of GSI and Housing & Population data as per Census 2011 from Census of India. The State specific atlases have also been prepared under the project.





## SPIHER-MSME BUSINESS INCUBATOR (Approved by Ministry of Micro, Small & Medium Enterprises, Government of India) St. PETER'S UNIVERSITY

## GEOPOLYMER CONCRETE BRICKS AND HOLLOW BLOCKS FOR BUILDING CONSTRUCTION

Technology developed under the Scheme Support for Entrepreneurial and Managerial Development of SMEs Through Incubators



GPC brick

Geopolymer is an inorganic alumino-silicate polymer synthesized from predominantly silicon (Si) and aluminium (AI) materials of geological origin or by-product materials such as fly ash. Geopolymer concrete can be produced with good compressive strength and is suitable for structural applications. Due to their ceramic-like properties, geopolymers possess good fire resistance.

Geopolymer concrete has great potential for use in civil engineering applications. Geopolymer concrete bricks produced on an industrial scale are found to meet the minimum compressive strength requirement with low water absorption and resistance to temperature. The method of mixing and compaction are the same as that for conventional cement concrete. Curing with water is not required for Geopolymer concrete.

## **Geopolymer Concrete (GPC) Bricks**

The basic raw materials used for GPC bricks are: Fly ash, Quarry dust and Alkaline solution consisting of sodium hydroxide and sodium silicate.GPC bricks can be produced using the same technology / machine as that for normal concrete or fly ash bricks/blocks.

Compressive strength of 5.7 MPa has been obtained for GPC bricks in the tests conducted at St. Peter's University. Water absorption was 5.2%. The compressive strength is found to increase by 38% after heating to 200° C. Comparitive properties of fire clay bricks and fly ash bricks is shown in the table. GPC bricks are found to meet the minimum strength requirement of National Building Code.



GPC Hollow blocks



Compression test on OPC bricks

Load test conducted on GPC brick walls showed no damage to the wall when loaded with live load as per IS code.



Heating in oven



## **Properties of GPC bricks**

Specimen	Compres- sive Strength at 28 days (MPa)	Water absorption (%)	Compressive strength after heating to 200ºC (MPa)
GPC brick (M3)	5.7	5.2	7.9
Burnt clay brick	4.1	6.8	6.7
Fly ash brick	4.0	8.6	9.9



A view of the semi-automatic manufacturing plant consisting of pan mixer, concrete conveyor, and the pressing and demoulding operations at incubatee's plant.



Load test on GPC brick wall

### **Hollow Blocks using Geopolymer concrete**

Closed cavity hollow blocks can be produced using Geopolymer Concrete. The basic raw materials used are: Fly ash, Quarry dust, sand and Alkaline solution consisting of sodium hydroxide and sodium silicate. Ground Granulated Blast Furnace Slag (GGBS - waste material from steel plants) can also be used. 400x200x100 mm size hollow blocks were produced and tested. Average compressive strength of 3 MPa was obtained. Water absorption was 10%. This meets the min imum requirement for non-load bearing walls as per IS 2185 (Part 1).



GPC hollow blocks produced using hollow block machine.

#### **Advantages**

- Effective utilisation of fly ash which is an industrial waste from thermal power plants.
- Cement is completely eliminated. Hence reduction in CO<sub>2</sub> emission.
- Can also use GGBS which is an industrial waste from steel plants.
- Raw materials easily available.
- Sand which is becoming scarce can be eliminated for GPC bricks.
- Compressive strength comparable to presently available technologies and meets standards. Strength increases with heat curing.
- Compressive strength found to increase with ageing and temperature.
- Less water absorption for GPC bricks compared to burnt clay bricks and fly ash bricks.
- Water curing not required. Can be cured in open area under sunlight.
- Good fire and acid resistance property.
- High durability .
- Technology easy to adopt. Machines/equipment available in market. Existing plant can be easily modified.
- Environment friendly.

Incubatee : Mr.G.Maragathamani, Flashbricks Mentors: Dr.D.S.Ramachandra Murthy Dr.P.Partheeban

Contact: SPIHER-MSME BUSINESS INCUBATOR St. PETER'S UNIVERSITY, AVADI, CHENNAI-600054 www.stpetersuniversity.org





## **International Seminar on**

# **Emerging Building Materials and Construction Technologies**

March 2 – 3, 2016, Silver Oak Hall, India Habitat Centre, Lodhi Road, New Delhi

BMTPC is organising a two days International Seminar on *Emerging Building Materials and Construction Technologies* to bring engineers, architects, technology providers, plant & machinery manufacturers, users, govt. agencies and other stakeholders, looking for emerging building materials and technologies and construction practices, on one platform to bring awareness and share the knowledge and experience on new emerging building materials & practices.

## **Topics for Paper Presentations**

- Innovations in the following areas:
  - Agro Industrial & Construction Waste Utilization in Building Industry.
  - Bricks, Blocks & Masonry
  - Wood Substitute in Building Industry
  - Concrete, Cement & Supplementary Cementitious Material
  - Plumbing & Sanitary Services
  - Water Proofing Material & Techniques and Chemical Admixture
  - New Renewable Energy Services for application in housing
  - Disaster resistant construction
  - Finishes Paints, Tiles, Plaster, Cladding
  - Insulation materials

- Emerging Housing Technologies such as
  - Formwork System for monolithic construction
  - Prefabricated System
  - Steel / Structures based technologies
  - EPS Based Structure system
  - Wall Form System
  - Others
- Standardization & Certification
- Green Initiative
- Any other related topic

Abstract of Papers may be submitted by 30<sup>th</sup> October, 2015. Researchers, Engineers, Architects, Academicians, Technology Providers, manufacturers are invited to participate in the Seminar.

## Fees and Sponsorships:

The registration fee for the seminar is Rs.3,000.00 or US\$ 50 per participant, inclusive of the seminar registration fee, training material, lunches and refreshments, etc. In case of students, the fee is Rs.1000.00. The participants have to make their own arrangements for stay in Delhi. The Sponsorship Fee for the seminar is as given below:

	0		1 1		0
S.	Category	Amount in	Amount in	Free	Free Advt. in Seminar Proceed-
No.		Rs.	US\$	Delegate	ing
1	Principal sponsorship	5,00,000	8000	10	Back cover
2	Gold sponsorship	3,00,000	5000	6	Inside Cover
3	Silver sponsorship	2,00,000	3300	4	Full page
4	Sponsor	1,00,000	1650	3	Half page
		4 4 -	1 - ( /-	<b>A 1 1 1</b>	

All the payments shall be made in the form of Demand Draft/Pay Order in favour of BMTPC, New Delhi payable at New Delhi or through NEFT/RTGS.



## Priced Publications of BMTPC



DIRECTORY OF INDIAN BUILDING MATERIALS & PRODUCTS (with information on Nepal, Bhutan & Pakistan) 2009 550 pages, Rs. 1000 + 200 postage



BUILDING MATERIALS IN INDIA: 50 YEARS - 560 pages, Rs.1500 + 200 postage



HOUSING AND KEY BUILDING MATERIALS IN INDIA - A LONG TERM PERSPECTIVE - 98 pages, Rs. 700 + 75 postage



INSTRUCTION MANUAL FOR APPROPRIATE **BUILDING SYSTEMS** 64 pages, Rs. 150 + 75 postage



BUILDING WITH COMPRESSED EARTH BLOCKS 28 pages, Rs. 60 + 30 postage

STANDARDS AND SPECIFICATIONS FOR COST EFFECTIVE INNOVATIVE BUILDING MATERIALS AND TECHNIQUES INCLUDING RATE ANALYSIS (SECOND EDITION) 200 pages, Rs. 250 + 75 postage



Darthe Details

DIRECTORY OF CONSTRUCTION EQUIPMENT AND MACHINERY MANUFACTURED IN INDIA - 684 pages, Rs. 1500 + 200 postage

USER'S MANUAL on Production of Cost-Effective, Environment-Friendly and Energy-Efficient Building Components -116 Pages, Rs. 250 + 50 postage





MANUAL ON BASICS OF DUCTILE 27 pages, Rs. 100+50







ATLAS OF INDIA - Landslide Hazard Maps and Cases Studies -125 pages, Rs.2500 + 200 postage

LANDSLIDE HAZARD ZONATION

VULNERABILITY ATLAS OF INDIA

(First Revision – 2006) - Earthquake, Windstorm and Flood Hazard Maps and Damage Risk to Housing - 900

pages, Rs. 5000 + 200 postage

BUILDING A HAZARD- RESISTANT HOUSE: A COMMON MAN'S GUIDE-88pages, Rs. 350+75 postage

MANUAL FOR RESTORATION AND RETROFITTING OF BUILDINGS IN UTTRAKHAND AND HIMACHAL PRADESH -134 pages, Rs.250+ 75 postage

GUIDELINES FOR IMPROVING EARTHQUAKE RESISTANCE OF HOUSING -84 pages, Rs. 350 + 75 postage

> GUIDELINES FOR IMPROVING FLOOD RESISTANCE OF HOUSING 36 pages, Rs. 200 + 50 postage

GUIDELINES FOR IMPROVING WIND/CYCLONE RESISTANCE OF HOUSING - 50 pages, Rs. 350 + 75 postage

EARTHQUAKE TIPS – LEARNING EARTHQUAKE DESIGN & CONSTRUCTION 58 pages, Rs.200 + 50 postage

Publications/Video Films may be obtained by sending Demand Draft, drawn in favour of BMTPC payable at New Delhi

10

Disclaimer: The views expressed in various articles are those of the authors. They do not necessarily represent those of the BMTPC.

## Promotional Publications of BMTPC

- Corporate Brochure in English and Hindi 1. **BMTPC** Newsletters 2.
- **Environment Friendly Building Materials &** 3. Construction Technologies
- 4. Grah Nirman Mein Vishesh Savdhaniyan **Reconstruction of Earthquake Resistant Houses** 5.
- in Garhwal Region Guidelines in Hindi
- Retrofitting of Stone Houses in Marathwada 6. Area of Maharashtra
- 7. Saste Makan: Vibhinn Vikalp Avam Suvidhain - in Hindi
- 8. Useful tips for House Builders
- 9 Local Vegetable Fibres + Industrial & Mineral Waste for Composite materials
- Machines developed by BMTPC 10.
- Performance Appraisal Certification Scheme 11.
- Green Houses for ITBP at Leh 12.
- 13. Bamboo - A Material for cost-effective and disaster resistant housing
- 14. Retrofitting of Hospital in Kupwara, Kashmir, J&K for Safety Against Earthquakes
- Simple Ways to Earthquake Safety for Jammu 15. & Kashmir - in English and Urdu
- Bamboo in Housing & Building Construction -Initiatives of BMTPC
- 17. Aam Aadmi Series - House Building Digest (Series 1 to 12)
- 18. Seismic Retrofitting of MCD School Buildings in New Delhi
- Guidelines for Multi-Hazard Resistant 19 **Construction for EWS Housing Projects**
- Guidelines on "Aapda Pratirodhi Bhawan Nirman 20. : Sampurn Bharat ke liye Margdarshika
- 21. Design & Construction of Earthquake Resistant Structures : A Practical Treatise for Engineers & Architects
- 22 Design Packages using Alternate Building Materials & Technologies for Western and Souther Regions.
- 23. Major Activities in Pursuit
- Criteria for Production Control of Ready Mix 24. Concrete for RMC Capability Certification
- 25. Explanatory Handbook on Performance Appraisal Certification Scheme (PACS)
- Prospective Construction Systems for Mass 26 Housing - Technology Profiles
- 27. **Building Artisan Certification System**
- Guidelines on "Rapid Visual Screening of 28. Buildings of Masonry and Reinforced Concrete as Prevalent in India".













The Building Materials & Technology Promotion Council (BMTPC) was setup in 1990 as an inter-ministerial organisation under the Ministry of Housing & Urban Poverty Alleviation to bridge the gap between laboratory research and field level application.

## Vision

"BMTPC to be world class knowledge and demonstration hub for providing solutions to all with special focus on common man in the area of sustainable building materials, appropriate construction technologies & systems including disaster resistant construction."

## Mission

"To work towards a comprehensive and integrated approach for promotion and transfer of potential, costeffective, environment-friendly, disaster resistant building materials and technologies including locally available materials from lab to land for sustainable development of housing."

