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Harmonious cities

World Habitat Day

6 OCTOBER, 2008

निर्माण सामग्री एवं प्रोद्यौगिकी संवर्द्धन परिषद्
आवास एवं शहरी गरीबी उपशमन मंत्रालय, भारत सरकार
BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL
Ministry of Housing & Urban Poverty Alleviation, Government of India

"Creating Enabling Environment for Affordable Housing for All"

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From the Desk of Executive Director

To bring out 2nd volume of our newsletter 'Nirman Sarika', in the back drop of World Habitat Day celebrations, makes BMTPC family proud as the theme of this year has been Harmonious Cities. BMTPC's endeavour since its inception has been to bring harmony in almost all sphere of human settlement development. Be it newer building materials or construction technologies or whole set of disaster mitigation measures, we work in harmony with Mother Nature so that its precious natural resources are not depleted. We also work in harmony with the Poorest of the Poor for fulfilling their dream of having an affordable house harmonious to the ambience of the city so that they feel socially included in the fabric of the city.

Our endeavour through cost-effective technological interventions in construction sector has not only been to be sustainable, eco-friendly, energy-efficient but also to provide an equal opportunity for urban poor by generating small enterprises as well as employment avenues. It is BMTPC's sincere effort that we could bring number of technologies from the Research laboratories to the field by evolving simple low energy machines and upscaling the technologies for commercial usage.

The simple to comprehend technologies developed and promoted by BMTPC are mainly based either on local materials or renewable raw materials such as industrial and agricultural waste. We could succeed in identifying a whole range of these wastes and local materials which can suitably be modified to be a sustainable building material/component or technology. However, for the want of dedicated research, a few of them could be transferred to the field with fair amount of success and a few could not see the light of the day. It is an opportune time that our R&D laboratories in the forefront should do some serious thinking and reorient themselves to work towards the technologies for the masses which are in harmony with the global scenario.

Through our newsletter, we constantly aim to make you acquainted with our activities and Government's initiatives. One such initiative taken by Ministry of Housing and Urban Poverty Alleviation has been JNNURM, which dreamt of providing harmonious cities for Urban Poor of India. JNNURM is the only scheme which provides housing to the urban poor with basic services, social inclusion & security and urban infrastructure. It is an innovative and fresh thinking of the Government of India which also leaves enough scope for all the stake-holders especially state agencies to experiment. They can experiment on various technological options in harmony with nature. They can also experiment on water supply, sanitation, education, health, solid waste management, rain water harvesting etc. which are in harmony with our motto of saving the planet earth and at the same time providing social equality to all.

Let us create the cities where everyone has equal opportunity to live, earn and prosper irrespective of their caste, creed and social status.

(Dr. Shailesh Kr. Agrawal)

BAN KI-MOON
Secretary - General
UNITED NATIONS

Many of the world's most pressing challenges – poverty, natural disasters, escalating prices for food and fuel – have important links with rapid urbanization.

Urbanization changes forever the way we use land, water and energy. Done well, it can bring people choices and help them thrive. Done poorly, it reduces safety, despoils the environment and exacerbates the marginalization of those who are already suffering and excluded.

The theme of this year's World Habitat Day is "harmonious cities". Our rapidly urbanizing world cannot claim to be harmonious if slum-dwellers do not enjoy opportunities to find jobs and improve their living conditions. Nor will it be harmonious if the growth and expansion of urban areas comes at the expense of the natural environment.

The Millennium Development Goals call for a significant improvement in the lives of at least 100 million slum dwellers by 2020. As of 2005, slightly more than one third of the urban population in developing regions lived in slum conditions. In sub-Saharan Africa, the proportion was over 60 percent, meaning that large investments will be necessary, for example to provide access to water, sanitation, durable housing or sufficient living space. But even in that region, and in others where deprivation is not as acute, simple, low-cost interventions could go a long way.

Cities have tremendous potential to be places where balanced development prevails, where diverse people live in harmony, and where healthy living conditions coexist with low levels of energy consumption, resource-use and waste. As we observe World Habitat Day, I call on all partners and stakeholders to do our utmost to realize this potential, and to build decent living conditions for all women, men and children in a way that also preserves our natural heritage and promotes greener and smarter growth.

Statement of
Anna Kajumulo Tibaijuka
Executive Director, UN-HABITAT

Today we mark World Habitat Day at a time the majority of the world's people are living in towns and cities. And the process is accelerating. This transfor mation has a direct bearing on the strategies we must adopt to attain the Millennium Development Goals.

The other historic turning point is that the number of urban slum dwellers around the world is moving above the 1 billion mark, making it clear that the urbanisation of poverty is arguably one of the biggest development challenges.

This is why we chose the theme, **Harmonious Cities** for World Habitat Day 2008. We need to raise awareness about the problems of rapid urbanization, its impact on the environment and the consequences and challenges of rising urban poverty.

No longer can we ignore the plight of slum dwellers who live in life-threatening conditions. Nor can we hide from the fact that urban poverty and urban inequalities are rising around the world, in developed and developing countries alike. We have both a moral and ethical responsibility to make our cities more harmonious by making them more inclusive. It is a societal imperative that we fight urban poverty and squalor if we are to secure urban safety and security.

Our experience working with governments, local authorities, communities and the private sector around the world gives us some good insights to meeting these challernges. Even if we do not have all the answers it enables us to ask some of the right questions.

It is also no coincidence that climate change is now emerging at the forefront of international debate at the same time, and virtually at the same pace, as the world becomes urbanized. Cities consume upwards of 75 percent of all energy and contribute to an equally susbtantial amount of green house gas emissions. Cities must therefore be an integral part of any mitigation efforts.

Reducing the contribution of cities to climate change and the vulnerability of cities to the effects of climate change must be viewed as a historical opportunity to improve the living conditions of all women and men, including the most vulnerable segments of our urban populations. Both adpatation and mitigation efforts require improved land use planning, more robust infrastructure and smarter construction. I can think of no better initiative than to combine these efforts to make our cities and towns greener and safer and more equitable. My message to you today is that the challenges of climate change and urban poverty are inextricably linked, they both depend on making our cities more harmonious.

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KUMARI SELJA
Minister of State (Independent Charge) for
Housing & Urban Poverty Alleviation
Government of India

UN Habitat's Theme of ***'Harmonious Cities'*** for the World Habitat Day this year draws the attention of the world community to the important issues of rapid urbanization, the urbanization of poverty as more and more people migrate to towns and cities looking for a better life and its impact on the environment. It puts the focus on one of the most pressing concerns of today - the impact of growing urbanization on communities, cities, economies and policies. United Nations estimates that urban population will account for 55 per cent of the total human population by 2010. It is forecast that 40 per cent of Indian population will be living in urban areas by 2041. The major challenge before us is to minimize poverty in our growing cities, improve access of the urban poor to the basic facilities of shelter, clean water, sanitation and electricity and achieve an environmentally sustainable urban growth.

Accepting fully the affirmation of the Istanbul Declaration on Human Settlements that our cities must be places where human beings lead fulfilling lives in dignity with good health, safety, happiness and hope, my Ministry has formulated the National Urban Housing and Habitat Policy 2007. It aims to promote sustainable development of urban habitats in the country with a view to ensuring equitable supply of land, shelter and services at an affordable price, with an emphasis upon slum dwellers, to all sections of the Society. Government of India has undertaken a major programme, the Jawaharlal Nehru National Urban Renewal Mission, to direct the efforts and finances of State Governments and urban local bodies towards the improvement of urban infrastructure, slums and civic amenities to the urban poor in an integrated manner. This Mission is a fast track, demand driven, community-partnering initiative with emphasis on public-private people participation in planning and financing for development of harmonious cities.

The Building Materials & Technology Promotion Council is playing an important role in providing S&T interventions to strengthen the technological base of the building materials sector. The Council's efforts in the area of demonstration of cost effective and disaster resistant technologies needs to be further propagated in different parts of the country.

I am happy that BMTPC is bringing out the special issue of its newsletter *"Nirman Sarika"* on the theme of this year's World Habitat Day – ***Harmonious Cities***. I extend my best wishes to BMTPC for its efforts and wish the publication all success.

(Kumari Selja)

Management Challenges in Evolving Harmonious Cities through Infrastructure Delivery

*Prof. S. Jeyabalan** *Prof. B. Bhaskara Rao***

Managing Urban Growth Needs

The global population is likely to cross 7 billion by 2012 and 10 billion by 2050. More than half of them live in cities and towns in 2007 and will continue to grow to two-thirds, i.e., 6 billion people, by 2050.Cities and towns have become the hub for much national production and consumption – economic and social processes that generate livelihoods, wealth and opportunity. In a haphazard and unplanned urbanization these areas may become homes for disease, crime, pollution and poverty. In many cities, especially in developing countries like India, economically backward community comprise more than half of the population and have little or no access to decent shelter, safe water, and hygienic sanitation.

As our towns and cities grow at unprecedented rates setting the social, political, cultural and environmental trends of the world, creative urbanization and sustainable urban development will be the most pressing challenges facing the Indian community in the 21st century. Providing jobs and services to the rapidly expanding urban population, and to improve the livelihood and quality of life for those already in the cities, is a management task of a magnitude never before attempted. And, this has to be achieved without over – stretching the earth's critical ecosystems, and responding to impacts of climate change. Although existing institutional structures are adequate for managing stable or slowly growing cities, the level of change required to improve current living conditions is overwhelming, and already many cities cannot cope. Nevertheless planning for development of socially and environmentally sustainable human settlements and achievement of adequate shelter for all is one of the millennium goals set by most of the nations in the world, including India.

Urbanization is an inevitable process in developing economies and "today's rural" is "tomorrow's urban". Formation of cities, towns, as well as deprived community colonies is the fruits of developing economies though tastes bitter. UN-HABITAT believes that "slums have unrealized value and incredible local resources", and that slums exist where they do for sound economic reasons. They provide humble shacks for the low income workers that service a growing city. To maximize the value of slums for those who live in them need to be recognized, upgraded, improved and planned. Further, they should be integrated and dovetailed with the overall city development and macro –economic growth at regional level.

Asian Development Bank of 2005 report on Indian infrastructure estimated that as much as US$200 billion would be needed over the next decade for urban infrastructure. But the available funding for the current economic plan is a mere US$20 billion, meaning that only one-tenth will be available via budgets. So where will be the rest come from? While developed countries invest 4-7% of their GDP on infrastructure, India spends hardly 0.6%. While this is an improvement over the less than 0.5% spent five years ago, it still makes for a major gap. Infrastructure investment in India is

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planned to exceed $450 billion by 2012.[1] With the government failing to bring in the requisite amount of capital to ramp up India's infrastructure, there is a clear need to encourage private investment in this sector.

Cities play a vital role in the social and economic development of regions and countries. About 75% of wealth is generated by urban India. The urban areas provide lead to the country's economic development and acts as search engines for sustainable growth. The efficiency with which the cities are managed can determine the growth rate and quality of life in meeting infrastructure needs of the people. More often the cities expand rapidly into the hinterlands and form into city regions with the least planned infrastructure development, without coordination across agencies and cutting across jurisdictions of multiple agencies. The management of city and especially its infrastructure becomes highly complex and vital services are at casualty. We need to develop a sustainable infrastructure development and effective delivery program by identifying urban issues especially for the urban poor and address them by strengthening the managerial capacity of local authorities in providing basic urban services.

The core capacities required for city management fall into three interdependent groups: (1) planning and policy formulation, (2) infrastructure program and project formulation, (3) management of service delivery and (4) establishing equity in availability and accessibility to "haves" and

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KIRAN DHINGRA
Secretary
Ministry of Housing & Urban Poverty Alleviation
Government of India

The UN-Habitat has chosen the theme "Harmonious Cities" for this year's World Habitat Day, to emphasize the impact of key human settlement issues on national development, and to encourage debate and policy making for an equitable development that can keep pace with the growth of population in urban areas.

A major concern in emerging economies today is the management of the ever widening gap between the demand and supply of urban services especially for the poor. Government of India has responded to the challenge by formulating the National Urban Housing & Habitat Policy, 2007 and launching the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for improvement of basic urban infrastructure and secure housing at affordable prices to all sections of society. BMTPC is playing an active role in this programme by encouraging commercialization of cost effective, environment-friendly, energy-efficient building materials and disaster resistant technologies. I look forward to BMTPC's contribution in promoting affordable housing and harmonious cities.

On World Habitat Day, BMTPC's gesture of solidarity by the special issue of Nirman Sarika should help in creating awareness of the theme.

My best wishes to the Council in its efforts.

Dated: 03.10.2008

(Kiran Dhingra)

"have-nots". We should focus on the involvement and ownership of the community in organising, delivering and maintaining basic urban infrastructure services. This should also create anchoring institutions for support at all levels – citizens, community, neighbourhood, city and region. The harmony in the city structure – between rich and poor, haves and have nots, less developed and posh areas - can be achieved through creating adequate infrastructure development and managing them efficiently. Today the cities and towns suffer with under developed infrastructure, ill or sub-optimal management systems, and inefficient delivery systems.

Infrastructure Development and Investment Planning (IDIP)

Infrastructure Development and Investment Planning (IDIP)[2] as a five year capital investment plan is propagated mainly to fill up the vacuum and bridge the gap between the situation of "no plan and no action programme" at local levels and "non--resource based long-range master plans" of towns proposed by local level town planning authorities. IDIP can act as a tool to meet the challenging urban infrastructure issues by the people and policy decision makers. Besides, the development and capital investment requirements are assessed together to evolve a pragmatic IDIP

The Urban Local Governments (ULGs) of small town to large cities have the twin problems of (a) increasing demand for services, amenities and facilities and (b) inelastic revenue and resources. These local authorities have developed neither, planning and technical capabilities nor evolved any means and techniques. Due to the non-availability of relevant and adequate data base, development and planning decisions are ad hoc, often based on exogenous variables, and lacks internal prioritization of the needs of the town.

With meager internal resources, adequate funds are not available to ULGs to undertake and implement capital works. External borrowing has become a necessity and a favourable option. In order to avail funds from external sources either as a loan or a grant, the assessment of the extent to which a local authority can sustain this investment becomes imperative. A few attempts made at National level in this direction are in the context of:

- Integrated Development of Small and Medium Towns (IDSMT),
- Programme under Municipal Urban Development Fund (MUDF),
- Infrastructure financing window of the Housing and Urban Development Corporation (HUDCO), coupled with the decentralised training programmes **(in Karnataka by the Indian Human Settlement Programme (IHSP) (IHSP-STEM, 1993a and 1993b),** and currently
- Jawaharlal Nehru National Urban Renewable Mission **(JNNURM)**.

Some of these programmes are launched for creating resource generating ventures, for the provision of sufficient supporting infrastructure facilities and the development of these towns and cities as growth centres for the betterment of the rural hinterland, for the reduction of migration to bigger cities. Substantial budgetary allocations by national and state governments have been made to improve the small and medium towns with an integrated approach by improving and/ or creating a mix of urban services and remunerative enterprises. In recent years, access to institutional finances has also created to overcome the financial constraints from budgetary sources.

It is in this context that the studies on investment and Financial Operating Plans (FOPs) for providing municipal services, amenities and facilities have become vital for the decision making process by the funding agencies. IDIP with resource mobilisation at local levels can be considered as an effective tool to establish harmonious cities as envisaged by UN - HABITAT.

Scope of IDIP

Most of the towns and cities have their Master Plan, Outline Development Plan (ODP) or Comprehensive Development Plan (CDP) and these are prepared under Town and Country Planning Acts. They are long-term land use plans ranging from 10 to 25 years. However, the experience indicates that the implementation of these plans is rarely satisfactory due to many reasons, i.e., financial, technical, elaborate but unrealistic, rigid land use and leasing regulations based on traditional concepts of

master plans. The proposed IDIP has in a way not only bridge the long awaited gap between short and medium-term project based plans and long--term master plans, also emphasises the immediate infrastructure needs of the citizens instead of waiting to fulfill the long-term goals and targets of the master plan.

The Purpose and the Process of IDIP

The aim: The two major aims of IDIP as an effective tool and technique are: (a) to generate a sustainable five-year capital investment, plan and programme for ULGs for the management of infrastructure; and (b) to increase the participative role of the community as users and planners.

The objective of the IDIP technique: The objectives of the IDIP technique are:

- To assess physical and financial carrying capabilities of the ULGs.
- To suggest the *modus operandi* for mobilising resources - internal and external.
- To make people and decision-makers aware of the levels of municipal services and the state of urban finance.
- To involve the senior citizens and the officials of development organisations and make them participate in the preparation of IIPP.
- To prioritize developmental needs through a participative process.
- To create a sustainable and adoptable Financial Operating Plan (FOP).

The Process: The major

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S.K.SINGH
Joint Secretary (Housing)
Ministry of Housing & Urban Poverty Alleviation
Government of India

There has been rise in the urban population of late due to more opportunities made available in urban centres all over the globe. But all this creates new challenges for major cities. Faced with the pressures generated by population growth, we must create and manage sufficient public infrastructures to facilitate the full mobility of workers and residents, among other things. Despite all its glories, there is no denial from the fact that the city today, on account of high-density living patterns, faces serious challenges, such as spatial conflicts, cultural collisions, resource shortages and environment degeneration. In view of the fast changing scenario, the theme ***Harmonious Cities*** chosen by United Nations for World Habitat Day-2008 celebrations is the most appropriate one.

The theme in itself defines the various features of well planned and developed cities having special emphasis on the importance of over all planning, better transportation, good health services, social security and better infrastructure & environment for the residents of the city.

I am aware that BMTPC is playing a major role for the development of well planned, socially secure and harmonious cities through its participation in various housing schemes supported by Ministry of Housing and Urban Poverty Alleviation, Govt. of India. Over the years, Council has played an important role realizing the dream enshrined in the National Housing and Habitat Policy 2007 for providing Affordable Housing for All to have harmonious cities in India. BMTPC with Ministry of Housing and Urban Poverty Alleviation, Govt. of India has contributed significantly in appraising, monitoring and implementation of prestigious JNNURM scheme for providing basic services to urban poor including infrastructure facilities.

I am sure that the special publication of News Letter ***NIRMAN SARIKA*** of the Council, brought out on the occasion of World Habitat Day 2008 would go a long way in sharing the experiences and disseminating the knowledge to the common people if India.

I wish all the success to the Council in its future endeavors.

(S K Singh)

components of the IDIP process consists of:

- Analysis of the financial structure of the ULG, given the cash based accounting system.
- Identification of gaps and shortcomings in the delivery process of municipal services systems.
- Identification of options for improving financial status.
- Identification of service and remunerative projects and their appraisal to meet the shortage or gaps of delivery of specific services on priority basis, and to add to or improve financial resources.
- Formulation of a five-year development programme to revive the functions of the ULG to operate on its own, on the strength of realistic assumptions.
- Seeking financial support from funding agencies to undertake developmental activities within an acceptable framework.
- Helping the ULGs to achieve active participation in developmental process at community or local level.

The following should be the thrust areas in their planning, developmental and achievement strategies:

- Broad – based stakeholder involvement in developmental strategies,
- Problem – solving by all participatory stakeholders through inclusive processes and pro- poor governance, and
- A framework for capacity development and support for institutions leading to better implementation.

Key Urban Infrastructure Components

Water Supply and Sanitation

Our highest priority should be to improve access to safe water and provide adequate sanitation to millions of urban dwellers. This can be done by:

- Training water and sanitation sector stakeholders to enable them to develop, provide and manage improved water and sanitation services
- Encourage water and sanitation institutions to guide and promote improved water and sanitation services.
- Form strategic partnerships among key water and sanitation stakeholders, (the development banks, donors, urban centres, utilities, non-governmental organizations, and communities) to promote increasing levels of investment in these programmes.

Urban Housing

Current rates of population growth and urban-rural migration, particularly in India, have serious impacts on living conditions in human settlements. In many cities of India, more than half of the population lives in informal settlements, without security of tenure and in conditions that can be described as life and health threatening. As per the National Urban Housing and Habitat Policy 2007, the Technical Group in the context of formulation of the Eleventh Five Year Plan, has estimated a short supply of 24.7 million housing units for 67.4 million households at the end of the 10th five-year plan. It also pointed out that 99% of this shortage belonged to the EWS (economically weaker section) and LIG (low-income group). The Group estimated that during the 11th Plan, the total **housing requirement** (including backlog) will be around **26.53 million units for 75.01 million households**.[3]

According to data provided by National Buildings Organisation, aggregate housing shortage in the country has increased by 134% since 2001 from 10.56 million units in 2001 to 24.71 million units in 2007. The number of urban households during this period has increased by 11.5 million. Many of them found their ways to slums for shelter.The housing and urban poverty alleviation ministry's data shows that by 2012, the urban housing requirement will be more than 25 million units, 97% for the poor.

While increasing housing production and improving existing housing stock are very important in every society, these activities must run parallel with actions that specifically address and focus on the human rights aspects. A rights-based approach to development in the housing sector can:

- Empower the poor and the homeless;
- Promote security of tenure, particularly for women and vulnerable groups in inadequate housing conditions;
- Strengthen protection against forced evictions and discrimination in the housing sector; and
- The right to adequate housing (as a component of the right to an adequate standard

of living) as enshrined in many international human rights instruments.

Solid Waste Management

Municipal solid waste (MSW) refers to materials discarded in urban areas for which municipalities are usually held responsible for collection, transport and final disposal. MSW includes household refuse, institutional waste, street sweeping etc. In India, the per capita generation of MSW in metropolitan cities is estimated at **0.5 kg per day.** It is much lower (0.2-0.4 kg per capita per day) in non-metro urban centres. Keeping the urban population increase and organised and improved collection of municipal solid waste it is likely to touch **60 million tonnes by 2015**.[4]

Due to rapid and widespread development, not only state capitals but even many cities are already facing the problem of dumping the huge quantum of MSW generated daily. All existing dumpsites have supersaturated and hence scientific disposal has become vital. The MoEF guidelines on MSW, issued in 2000, have become mandatory and this explains the current thrust given to this sector. Rapid urbanisation in India warrants the need for efficient management of municipal solid waste, and MSW-based power plants are a viable solution.

India has yet to record significant achievement in this regard. As of December 2006, the total waste-based installed power capacity stood at 46 mw, which mainly (but not entirely) included MSW-based power capacity.

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DR. P.K.MOHANTY
Joint Secretary (JNNURM)
Ministry of Housing & Urban Poverty Alleviation
Government of India

The United Nations has designated the first Monday of October each year to be celebrated as World Habitat Day. The idea is to reflect on the state of our towns and cities and the basic human right to adequate shelter for all. It is also intended to remind the world of its collective responsibility for the future of the human habitat. This year's theme **Harmonious Cities** for World Habitat Day, 2008 celebrations is very relevant due to the fact that the world is no longer rural and now living in a "world of cities and towns".

The issues of urban poverty, slums and basic amenities to the urban poor are assuming critical importance in the presence of escalating urbanization. The goal of "inclusive growth" set for the 11th Five Year Plan will be realized if inclusive cities are developed with focus on the common man, especially those below poverty line. Harmonious cities will be possible only when inclusion becomes the key theme in urban planning, service delivery and governance. Our flagship programme, Jawaharlal Nehru National Urban Renewal Mission, is aimed at developing inclusive and harmonious cities.

I am happy to learn that BMTPC, under the guidance of the Ministry of Housing & Urban Poverty Alleviation, is also participating in the celebrations of the World Habitat Day by bringing out Newsletter **"Nirman Sarika"**. I am sure the publication would throw light on how technology can be powerful tool for the development of "harmonious" and "inclusive cities". I wish the Council all the best for its programmes and innovative initiatives.

(Dr.P.K.Mohanty)

This capacity represents only 0.5 per cent of the country's total capacity from new and renewable energy sources. In Indian cities and towns on an average, only **60 per cent of solid wastes are collected leaving the balance 40 per cent unattended to**. This gives rise to the insanitary conditions and diseases, especially among the urban poor who constitute 40 per cent of urban population. What is holding better waste management back nationwide? The lack of a resource management plan which embraces zero waste as a vision for the future is holding back progress.[5]

Sustainable Transport Systems

Transport and communication systems are the key to the movement of goods, people, information and ideas. They are also key to access to markets, employment, schools and other facilities and land use, both within cities and between cities, and in rural and other remote areas. Rapid motorization and insufficient investment in urban transport planning, and traffic management in India cause a growing number of road accidents, deaths and injuries, air pollution and lost economic productivity. The transportation sector is a major consumer of non-renewable energy and is a major contributor to pollution, congestion and accidents. People living in poverty, women, children, youth, older persons and people with disabilities are particularly disadvantaged by the lack of accessible, affordable, safe and efficient public transport systems. We have to evolve an Urban Transport Planning Management Program to meet the growing needs as well as the challenges.

The main challenge for Urban Transport Planning Management Programme is to find ways to promote urban productivity and improved living and working conditions for urban populations by appropriately meeting transport needs in an economically efficient and environmentally and socially sustainable manner. Our objective should be in the following areas:

- Improve mobility levels for the urban through promotion of affordable urban transport plans, programmes and technologies;
- Promote public transport and non-motorized transport as a mode for travel,
- Increase the efficiency of existing transport operations through improved planning and management,
- Decentralize urban transport infrastructure investment decision-making, planning and management to the local level.

Managing transport in human settlements should be done in a way that promotes good access for all to places of work, social interaction and leisure and facilitates important economic activities, including obtaining food and other necessities of life. This should be done while reducing the negative effects of transport on the environment.

Environmental Planning and Management

Urban environmental problems are a serious threat to the full realisation of the socio-economic contribution which cities can make. Environmental degradation brings with it enormous costs, resulting in significant inefficiencies in the use of local resources. It also compounds inequities, and threatens the sustainability of development.

Local municipal authorities are able to better address priority local environmental issues and helps to reduce poverty by more efficiently and equitably managing the use of environmental resources and the control of hazards and by promoting employment through improved environmental service delivery.

Price of Neglecting Infrastructure Maintenance

Proper maintenance of infrastructure and other built assets is essential to improving city sustainability. An effective asset management is vital for urban systems. But maintenance gets low priority in India both in funding and attention. Neither regular nor periodic maintenance takes place in a timely manner. Newly constructed assets often deteriorate rapidly. A lack of funds is often quoted as the reason for deferring maintenance, but this leads to unrecognized future funding requirements for many utility agencies and local governments. Asian Development Bank report of 2005, estimates that the annual maintenance requirements for all infrastructure in Asian region from 2006 to 2010 would be 2.3% of gross domestic product (GDP). Not carrying out appropriate maintenance will mean shorter lives for infrastructure assets,

resulting in system failures, safety and health costs, and additional repair and replacement costs later.

Capacity Building

Presently, capacity building on regulatory aspects in the infrastructure sector is drastically lacking. Though independent regulation was introduced in India more than ten years ago, efforts to create necessary facilities to offer training on this subject are lagging behind. Some multilateral donor agencies such as the World Bank facilitate short-term training programmes on an ad hoc basis. Other than that, hardly any effort to create a sustaining facility has been attempted so far.

Importantly, capacity building on regulatory aspects is highly desirable, not just for regulators and their staff but for other stakeholders as well. Given the fact that regulatory decisions are essentially the outcome of stakeholder consultation, capacity building of other stakeholders is equally crucial to attain regulatory efficacy. For instance, government officials need to be adequately trained to negotiate with investors, and meaningful interventions from consumer groups can only be expected once adequate inputs and skills are provided with.

Equally important is incorporating the local context in capacity building and training modules. While learning from other's experiences is desirable, there are certain local peculiarities which demand application of local wisdom to find optimal solutions. Therefore, any efforts to train the stakeholders have to incorporate the local context. Nevertheless, for the government to establish such facilities is not recommended. Instead, the government and industry both should facilitate and support such efforts that can be initiated by professionally managed institutions of repute.

Partners and Funding

Strong urban economies are essential for generating the resources needed for public and private investments in infrastructure, education and health, improved living conditions, and poverty alleviation. At state level, a team should work with local and national partners to carry out the plans. Partners are simply communities, community groups, capital markets and government, both local and at higher levels, who work together to prepare a financially and environmentally viable development proposal for upgrading their homes and living conditions. The proposal can be submitted to local state government, banks and other development banks for financial assistance. With the assessment of all components parts of these plans, financiers will be able to make their own assessment of credit risk and the attractiveness of the plan from a lending perspective.

Cities are the key drivers of India's economic growth. The focus now must be on how to take advantage of the opportunities India's cities offer while addressing the threats to their sustainable development. A new management structures are needed to integrate the economy, environment, and society into the operations, to benefit their hinterlands, to coordinate across agencies, and to reach out to diverse stakeholders, including the private sector and civil society. These structures need to make cities more self – reliant – able to flexibly analyse and solve their problems. Anticipating and planning for future urban growth holds the key to successful development and management of cities, and to protecting their development. Aligning transport and urban land use planning and development control – the maintenance of viable densities – constitute probably the most important requirement for establishing harmonious cities, livable and sustainable.

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Human Waste Management for Better Housing:

A Key to Improve Quality of Life

*Dr.Bindeshwar Pathak**

Provision of housing for all is the major challenge for any government not only in India rather for any developing country. In India there are several programmes run by the concerned authority for sustainable housing system. However, without proper disposal of human wastes or provision of sanitation from such residential areas the concept of good housing can't be met. Health & sanitation has an important bearing on the productivity, sanitation also has a correlation with economic progress of a country. Continued urban migration, congregation of urban poor in slums without safe water supply and sanitation facilities and increasing resource constraints have all led to rapid deterioration in quality of life and community health. There are over 2.4 billion people in the world who either have no organized system of sanitation or have access only to a noxious and unhygienic facility. Globally, 2.2 millions people die every year from diarrhoeal disease (including cholera) associated with contaminated water supply, sanitation, and hygiene. The majority are children under the age of five in developing countries. Epidemiological evidence suggests that sanitation is at least as effective in preventing disease as improved water supply.

Despite the continuous efforts by the International Agencies, different Government Bodies, and Non- Governmental Organizations, sanitation coverage in most of the developing countries is far below levels of satisfaction . In South Asia, Africa and Latin America, demographic and environmental health scenario continues to be a cause of serious concern in most of the developing countries. The traditional problems of water and air-borne infections combine with malnutrition and poor environmental sanitation to form a vicious cycle which is increasing the burden of diseases beyond the capacity of the existing health infrastructure and jeopardizing the productivity of the society.

Low sanitation coverage in developing countries is primarily due to insufficient motivation/ awareness by people coupled with a lack of affordable sanitation technology. Most of these people are from lower socio-economic groups and are not aware of the health and environmental benefits of sanitation. It is still not seen as a high priority, resulting in absence of people's participation. The lack of choice of toilet design, area-specific technologies, inadequate supporting delivery systems, and absence of trained masons; skilled workers and technical manpower are the factors for low coverage. Sanitation is regarded as a matter of individual initiative and not as a collective obligation of the community. In this socio-cultural background, environmental sanitation has not been given required priority. The grossly inadequate progress in the sanitation sector is primarily due to the following factors:

i. Lack of adequate dissemination of appropriate technology
ii. Lack of political will and administrative support for the sanitation programme.
iii. Lack of awareness among the people, particularly those in the rural areas, about the need of sanitation and its health consequences.
iv. Health sector's least involvement and lack of adequate advocacy on its part.

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v. Failure to develop a demand-driven approach with adequate participation of the people at the grassroots level.
vi. Lack of professional marketing strategy.

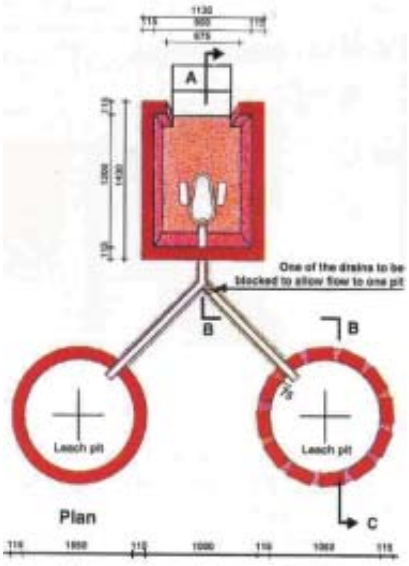
The goal of sustainable development is to conserve nature and ensure sustainable use of natural resources. It is about how environmental, economic, and social systems interact to their mutual advantage or disadvantage at various scales of operation. It is the achievement of continued economic development without detriment to the environmental and natural resources. The primary objective of the Sustainable Development is to reduce the absolute poverty through providing lasting and secure livelihoods that minimize resource depletion, environmental degradation, cultural disruption, and social instability. It implies using renewable natural resources in a manner, which does not eliminate or degrade them or otherwise diminish their usefulness for future generation. It also requires depleting non-renewable energy resources at a slow enough rate so as to ensure the high probability of an orderly society transition to renewable energy sources.

Any sustainable sanitation technology should be viewed in terms of social acceptance, economic viability and environmental impact. For a developing country like India where a society with least sanitation coverage is mostly heterogeneous in terms of socio-economic conditions, social and economic viability is more important. Keeping in view our social, cultural, and economic conditions Sulabh has developed the following sanitation technologies which are being implemented at large scale all over India and in some neighbouring countries.

In many developing countries due to lack of affordable sanitation technology sanitation coverage was far below the level of satisfaction. There was a major breakthrough in the field of sanitation when Sulabh developed and demonstrated the technology of two pit pour flush toilets in 1970, for on site disposal of household human wastes. For providing sanitation in slums (where people generally don't have space and resource to have their own toilets), and at public places Sulabh developed a novel concept of operation and maintenance of public toilets on pay and use basis. Further for the safe and hygienic disposal or use of human wastes, Sulabh developed a new technology for production and utilization of biogas from human wastes for different purposes and convenient method of treatment of effluent of biogas plant to make it pathogen, free, odourless, colourless having Biochemical Oxygen Demand value much lower than the permissible value for using it for different purposes or safe discharge in any water body. It has developed good sanitation marketing system to make the system acceptable to mass. All these technologies are being described in detail below.

Sulabh two-pit pour flush toilet

Sulabh two pit pour flush compost toilet is eco-friendly, technically appropriate, socio-culturally acceptable, and economically affordable. It is an indigenous technology and the toilet can easily be constructed



by local labour and materials. It provides health benefits by on-site safe disposal of human excreta. It consists of a pan with a steep slope of 25°-28° and especially designed trap with 20 mm water-seal requiring only 1.5 to 2 litres of water for flushing

Fig.A Sulabh pan and water seal

and thus conserves water. It does not need scavengers to clean the pits. There are two pits of varying size and capacity depending on the number of users. The capacity of each pit is normally designed for 3 years usage. Both pits are used alternately. When one pit is full, the incoming excreta is diverted to the second pit. In about two years, the sludge in the first pit not in use gets digested and is almost dry and pathogen free, thus safe for handling as manure. Digested sludge is odourless and is a good manure and soil-conditioner. It can be dug out easily and used for agricultural purposes. The cost of emptying the pit can be met partially from the cost of manure made available. Sulabh toilet can also be constructed on the upper floors of a building. It has a high potential for upgradation, and can later be easily connected to sewers when introduced in the area. Sulabh has so far constructed over a million individual household toilets in different parts of the country.

An important aspect of the technology is that it requires only 1.5 litres of water to flush excreta. That is the reason for its adoption in water scarcity areas in different countries. In the conventional system not less than 10 litres of water is required to flush, that is, the two-pit usage saves 8 litres of water per flush. Taking into account number of units constructed by Sulabh used by 5 persons per unit twice a day, 96 million litres of water is saved per day.

Manure from manure excreta:

One of the major difficulties for the use of human excreta as manure is the presence of bacterial and other pathogens. Human excreta contain a full spectrum of pathogens causing various infections. It should be free from pathogens before using it as manure. Another problem is psychological/religious taboos associated with it. The studies carried out by Sulabh have revealed that contents of Sulabh toilet pit is almost free from pathogens when taken out after two years of resting period. Such manure has good percentage of plant nutrients. Besides, it increases humus and water holding capacity of the soil.

Taking out of manure from Sulabh toilet pit.

Recognition of Sulabh technology:

Several national and international organizations like UNICEF, World Bank/ UNDP, WHO, WSSCC, UNCHS/ HABITAT, WEDC, UNEP, Government of India and different developing countries have recognized Sulabh Two Pit Pour Flush Toilet technology for implementation.. The United Nations Centres for Human Settlement (UNCHS) has recognized Sulabh's cost-effective and appropriate sanitation system as a 'Global Urban Best Practice' at the Habitat - Conference held at Istanbul, Turkey in June 1996. UNCHS (Habitat) has also conferred the 2000 Dubai International Award on Sulabh for the "cost-effective and appropriate sanitation has been recommended for adoption by other countries in the UNDP Human Development Reports 2003 and 2006.

Sulabh Public Toilet Complexes

Provision of public toilet complexes at public places and in slums on "pay and use" basis is an important activity of Sulabh in the field of community health & hygiene and environmental sanitation. Sulabh has constructed so far over 6000 such public toilet complexes in different parts of the country, where maintenance is provided round

World's Largest Sulabh Toilet Complex at Shirdi in Maharashtra (having 148 toilets, 108 bathrooms and 5000 lockers)
Sulabh introduced in India the system of maintaining public toilets on 'pay and use' basis.
6000 such toilets have been constructed and are being maintained.

the clock. These complexes are located at public places like bus stands, hospitals, markets etc. and in the slums. For the construction, operation and maintenance of these complexes, the organization plays the role of a catalyst and a partner between the official agencies and the users of the toilet complexes. Our experience has revealed that when facility for bathing is also provided with the community toilets, and above all if they are kept clean, people have no hesitation in paying for the use. For washing hands soap powder is provided to users. User charge is Re. one (2 US Cent) per use. Children are exempted from such charge.

The system of operation and maintenance of community toilets evolved by Sulabh has proved a boon for the local bodies in their endeavour to keep the towns clean and improve the environment. This is a unique example of partnership of local authorities, non-governmental organization, and the community.

Biogas from public toilets

For the disposal of human wastes from high rise buildings, hostels, hospitals, housing colonies, and public toilets Sulabh has developed the technology of biogas generation from human wastes and on-site treatment of effluent of biogas for its safe reuse. Recycling and reuse of human excreta for biogas generation is an important way to get rid of health hazards from human excreta, besides promoting use of biogas for cooking, lighting and electricity generation. Biogas from public toilets has multiple benefits - improve sanitation, community health & hygiene, environment, making available quality liquid manure, in addition to using biogas for different purposes. To overcome the problems Sulabh developed an efficient design of biogas plant linked with public toilets[5] Under the system only human excreta with flush water is allowed to flow into biogas plant for anaerobic digestion. Bathing and cloth washing water is collected separately that is reused after sand filtration or discharged in drain after settlement. For biogas generation no manual handling of excreta at any stage is required. Hydraulic Retention Time (HRT) of feed material is maintained for 30 days. One cft of biogas is produced from the human excreta of one person per day. Human

excreta based biogas contains 65-66% methane, 32-34% carbon oxide about 1% hydrogen sulphide and trace amounts of nitrogen and ammonia.

Produced biogas is used for cooking, lighting though mantle lamps, and electricity generation. Cooking is the most convenient use of biogas. Biogas burner at reasonable price is available in the market that consumes about 25 cft of biogas per hour. Biogas is being supplied at nominal charge to nearby slum dwellers for cooking purpose. Mantle consumes 2-3 cft biogas per hour that gives illumination equivalent to 40 watt bulb at 220 volt. Electricity generation is through dual fuel engine coupled with alternator that runs on 80% biogas and 20% diesel. Consumption of biogas is 15cft/BHP of engine/hr. Electricity from biogas is being used in toilet complexes for operation of water pump and lighting purpose inside the toilet complexes and adjoining areas. Based on 'Sulabh Model' design, 174 number of biogas plants of 35 to 60 cum per day gas production capacity have been constructed by Sulabh in different states of the country so far.

Electricity from biogas

SET (Sulabh Biogas plant Effluent Treatment) System for reuse of effluent

Though during biogas generation there is reduction (up to 85%) of BOD of effluent of biogas plant in comparison to its effluent value in absolute term the BOD of effluent is around 125 mg/l. Similarly, pathogen count too is higher than the permissible limit of discharge in any water body. Such effluent contains good percentage of nitrogen, potash, phosphate and other micronutrients for plants, but its aesthetically bad odour, yellowish colour, high BOD and pathogen contents limit its reuse for agriculture and horticulture; and not safe for discharge in water body.

After a series of experiments Sulabh has developed a simple and convenient technology named as SET (Sulabh Effluent Treatment) to further treat such effluent[6] . The technology is based on sedimentation and filtration of effluent through sand and activated charcoal followed by exposure ultraviolet rays. The treated effluent is colourless, odourless and pathogen free having BOD less than 10mg/l quite safe for aquaculture, agriculture/ horticulture purposes or discharge into any water body without causing pollution. It can also be used for floor cleaning of public toilets in water scarcity areas.

Advantages of the system

- No manual handing of human excreta is required at any stage
- Aesthetically and socially acceptable
- Technically appropriate and financially affordable
- Operation & Maintenance cost almost nil
- Biogas is used for different purposes.
- It provides complete ecological sanitation at community level in addition to biogas for different purposes
- Treated effluent is safe to reuse or discharge into any water body.
- In drought prone areas treated effluent can be used for cleaning of floors of public toilets.

Implementation of public toilet with biogas plants at Kabul, Afghanistan

Sulabh was assigned to implement a few projects on sanitation, in Afghanistan, in collaboration with the Municipality of Kabul, funded by the Ministry of External Affairs, Government of India. Sanitation coverage in Afghanistan is much below the level of satisfaction. Most of the people go for defecation in open. Rest of the people use waste storage tanks. After it is filled up, it is emptied at hilly areas causing severe health and environmental risk. There is no sewer system in Kabul the capital of Afghanistan. The problems for implementation of sustainable technologies appeared initially more challenging due to several local factors like -social, cultural, economical, and environmental. However, we implemented our projects successfully, that attracted local government for its replication at other sites all over the country. In close cooperation with the local government, Sulabh identified 5 Nos. of sites for implementing public toilet linked with biogas plant and on-site device for treatment of human wastes for its safe reuse. All these sites are located either near markets or at other public places where sanitation facility were completely lacking. During construction stage, local people were made involved. Design of public toilet was finalized taking into consideration local socio-cultural aspect and ease to maintain it. For the operation and maintenance of toilet complexes

Fig. A Sulabh public toilet in Kabul (Afghanistan)

and biogas plants, adequate training was provided to local persons, selected by the local government. All these toilet complexes are based on pay and use basis. For initial three months, Sulabh maintained these complexes, thereafter were handed over to the local body for operation and maintenance. However, Sulabh will continue to provide technical support whenever required, for a year. The local body gets monthly surplus amount from users charge after maintaining the toilet blocks. It has encouraged them to replicate the system at other places in the country as it has helped a lot in improving sanitation with opportunity to employment to local people and economic return.

Human waste from public toilets at all the 5 sites is being used for generation of biogas, and for cooking, lighting, electricity generation and body warming. Effluent of biogas plant is on-site treated with a convenient technology developed by Sulabh, and used safely for horticultural purposes. It was encouraging to observe during last winter (December, 2007 to January, 2008) when atmospheric temperature in Kabul dipped to minus 20^0C, biogas production continued and local people used it for heating, lighting etc. This could be due to modification of design of plant to suit such extreme condition.

Sulabh technology reduces Green House effect

In addition to conserving and reusing water the system has additional inbuilt advantage of reducing green house effect arising out of Carbon dioxide and Methane production due to degradation of human wastes. Due to design of leach pit (Sulabh Toilet) produced carbon dioxide is diffused in soil through honey combs. It does not escape in atmosphere as in other cases. During anaerobic digestion of human wastes during biogas production, methane is produced that is used for different purposes. Methane as such is not left to escape in the atmosphere. Thus, both these technologies are helping in reducing green house effect and thus improve environment.

Financial viability of the projects:

Since human excreta were considered as the most hatred object in the society, it was difficult for any one to consider financial viability for the project related to its disposal. However, Sulabh made it financially viable. The cost of construction is met by the local body. The maintenance of toilet blocks and day-to-day expenses is met from the user's charges. Sulabh does not depend on external agencies for finances and meets all the financial obligations through internal resources. All the toilet complexes are not self-sustaining particularly those located in slum and less developed areas. The maintenance of such toilet complexes is cross-subsidized from the income generated from toilet complexes in busy and developed areas.

Elimination of social stigma and psychological taboos: Earlier there was a social stigma and psychological taboo for handling of human excreta. It could also be due to the fact that only people of lowest economic strata were supposed to be associated with this job. Due to the efforts of Sulabh, and financial viability, people from higher social status are competing to join the job without psychological taboo.

Employment opportunity

Altogether there are 50,000 volunteers working with Sulabh that include technocrats, managerial, scientists, engineers, social scientists, doctors, architects, planners and other non-revenue staff. Since Sulabh takes 30 years maintenance guarantee for the toilet complexes constructed by it, all the social workers associated with this work, get almost regular employment. Besides, workers associated with construction job get almost full employment.

A good housing system can be achieved only through providing adequate facility for human waste management. For that purpose there needs a close cooperation between government agencies, NGOs and community concerned. Neither government nor the NGOs or community alone cal solve the problem. Provision of sanitation is more a social problem than the technical. It can be solved only when social aspects are taken into consideration supported by technical inputs. Involvement of community is required to tackle the social issues.

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Foundation Stone Laying Ceremony of Demonstration Housing Project at Amethi

In continuation of its efforts to demonstrate cost effective and disaster resistant technologies, the Council proposes to construct such demonstration houses at Amethi, Distt Sultanpur (U.P.). The land measuring 1484 sqm. (approx) has been allotted by the local administration in Mauza-Raipur Phulwari, Amethi. This demonstration project will pave a way in promoting innovative and disaster resistant technologies in the region.

The Foundation Stone Laying Ceremony of Demonstration Housing Project was organized on 15th July 2008 at Amethi, Sultanpur. The Foundation Stone of the project was laid by Shri Rahul Gandhi, Hon'ble Member of Parliament (Lok Sabha) and ceremony was attended by other Central and State Govt. officials. This demonstration project focus at promoting innovative technologies in the region. The salient features of the project are • No. of houses : 24 (G+1), • Built up area of each unit : 38.22 sq.mt., • Each unit will have one living room, one bedroom, kitchen,one separate bath and WC.

Besides construction of 24 dwelling units, the project also includes onsite infrastructure facilities like pathways, septic tank, electrical works, Boundary wall etc.. The provision of community work centre, rickshaw stand etc. has also been considered in the planning of project. The project will be a live example of field level application of cost effective building materials and disaster resistant technologies. These are:

Structure

- Stepped footing in brick masonry for sub-structure
- Rat Trap Bond in bricks for wall masonry
- RCC lintel band and roof level band for earthquake resistance.

Roof/Floor

- Precast Reinforced Brick Panel for roofing placed over partially precast RCC joists with screed.
- IPS flooring.

Doors/Windows

- Pre-cast RCC door/window frames in place of traditional frames to achieve cost effectiveness.
  Wood substitute door/window shutters.

Understanding the Concept and Selecting a Road to Achieve Harmonious Cities

T. N. Gupta *

Background

Today Humanity Stands at a defining moment in his tory. Each country is confronted with perpetuation of disparities within itself and within the nations. Problems of poverty, ill-health, illiteracy, continuing deterioration of the ecosystems, and fast pace of climate change on one hand and rising urbanization, industrialization, scientific and technological advancements, and concerns of development on the other are the subjects receiving attention of the national planners the world over.

The challenges faced by India, like many other countries in Asia and Pacific due to rapid urbanization, fast pace of industrialization, exponentially rising population, slow decline in poverty, environmental degradation and multiplying factors contributing to climate change are unprecedented. What further adds to the problem is the difference between rural and urban growth in demographic terms is highest in the world-even higher than the African region.

India, according to the new estimates by the World Bank had 456 million people or about 42% of the population living below the new international poverty line of $1.25 per day. The Country had 421 million below the $1.25 a day mark in 1981, but the number has gone up to 456 million by 2005. The new international poverty line of $1.25 PPP per day (taking into account the Purchasing Power Parities - PPPs) has been arrived at as "the average poverty line found in the poorest 10-20 countries". Thus, while there has been a decline in poverty ratio, the numbers of the poor are swelling. In other words, more than four out of 10 Indians live below what the World's poorest countries consider the poverty line.

A UN Study, that examined consequences of global warming in the next 20 to 30 years, has identified India as one of the "hotspots" particularly vulnerable to increase in drought, floods and cyclones in the coming decades. Country like India where considerable Social, demographic and economic conflicts and obstacles already confront the programmes for sustainable development, may find that impact of weather related disasters may further complicate and jeopardize national efforts for healthy and harmonious development of urban settlements. With a total of 285.35 million people residing in urban areas (census 2001) about 27.8% of the country's population, the cities and towns of India account for the World's largest urban system. By the year 2021 it is expected that the country will have the greatest concentration of mega cities in Asia.

In the above backdrop, the theme chosen by UN for World Habitat Day 2008 "Harmonious Cities" no doubt appears to be both timely and relevant. Timely because the a variety of factors already hamphering the harmonious growth are being increasingly analysed under several studies initiated and/or completed by International agencies, and 'relevant' because the demographic growth, social and economic infrastructural base, poverty characteristics, flow of investment and newly emerging dimension of 'urban crime' merit urgent attention in context of fast developing country like India.

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Growth Dynamics of large urban centres

Growth dynamics of cities and towns depend on a large number of variables which cannot be analysed in a tangible way. No doubt the availability and access to social and physical infrastructure are amongst the most important criteria as these attract huge migration from rural areas. Unfortunately speedy migration to cities leads to growth of slums, squatter settlements and urban poverty thereby overstretching the physical infrastructure-which is mostly the starting point for migration.

An Interstate Analysis carried out by Prof. Kundu[1] indicate that there are significant regional variations in the distribution of urban population. A large proportion is concentrated in six most developed states namely Maharashtra, Gujarat, Tamil Nadu, Karnataka, Punjab and West Bengal account for nearly half the country's urban population. The high urban growth entails considerable investment in housing, education, healthcare, transportation, water and sanitation facilities, improving urban governance. But as said in the preceding paragraph these investments while satisfy basic needs of urban dwellers on one hand, simultaneously encourage more and move migrants from hinterland. The impact of this phenomenon is the rising stress on infrastructure, which affect the poor more than other sections of the society. Thus imbalance starts and basic conditions for harmonious urban growth are disturbed.

The above dynamic pattern underscores the point that urban settlements in developing country like India need more raw materials, water, land, energy and economic development to support the changing lifestyle, rising consumption pattern and social aspirations of the population. Besides meeting these physical needs there is another dimension which needs to be studied, analysed and resolved and it relates to number of issues. Foremost of these, pertain to **Equity, Opportunity and Safety.** Unless these are achieved in planning and practice, it may not be possible to evolve a harmonious life in a human settlement. Recent studies reveal that no amount of goods and services that a city may offer will attain the title of Harmonious city, if its citizens (a) do not have equitable access to these goods and services, (b) do not have equal opportunities (depending upon abilities, education, skills etc) to work, educate themselves and live in healthy environment and (c) do not feel socially and physically safe. It may be safety against crime, social discrimination, or from natural and man-made disasters.

Problems and Challenges

For past over two decades statements, and commitments for policies at international fora have been made that urban development has to be inclusive of all sections of the population but what we find is just opposite of it. The most excluded are the urban poor, who are often forced to live in informal settlements which are neither recognized nor serviced by city authorities. Residents of these settlements live in constant fear of forced evictions (in the absence of security of tenure) and most do not have access to formal finance and loan schemes affordable technology and land which could enable them to improve their living conditions. Yet this majority is indispensable to the economy of the cities.

Globalisation of national economies is catapulting the process of restructuring the urban economies. The main guiding activities affecting the restructuring are "**Manufacturing functions**", "**Service activities**" and "**Communication systems**". Pure manufacturing functions in most cities are shifting from their traditional urban locations where wages and land costs are lower, environmental regulations less strict. Service and Information Technology Sectors are spreading as core activity in newly developing locations. The cities are therefore, in need of restructuring their Land-uses to accommodate fast changing "activity mix" of urban economy. This is causing lot of problems as the old Development Control Regulations are unable to match with the new imperatives.

The next important factor which is bothering the urban planners and managers is that traditional "principles of balanced urban growth" are unable to serve newly developing urban

[1] Country Paper at Asia Pacific Ministerial Conference on Housing & Human Settlements by Prof. A. Kundu, Dean School of Social Sciences, JNU, New Delhi.

dynamics, coupled with lack of required types of institutional mechanisms, changing environmental issues, fast rising demand of energy, rising poverty and unemployment, lack of access to affordable housing, acute shortage of water and sanitary facilities and lastly concerns for social security and safety against disasters.

In the context of the present theme, the words of Dr. Wally N' Dow, Former Assistant Secretary General UNCHS (Habitat) appear to be highly relevant, "Imagine a city without fear, a city whose streets can be walked freely by all, young and old, a city where landscapes offer relief from concrete and asphalt, a city with no homeless people, a city where water is available to all, rich and poor alike, a city where creativity and innovation flourish and where every citizen is allowed to exercise his/her rights freely." I feel that there could not be a better description of a HARMONIOUS CITY.

What needs to be done

Given the magnitude and nature of emerging challenges that our fast expanding cities pose and the answers being sought by our policy makers and development managers today make atleast one thing clear that the concepts, which were embraced by the assemblies of nations in past do not hold much promise for future of cities unless we are keen to bring in a paradigm shift in our policies and implementation methodologies. "**Empowerment**" has been tried, "**enabling role**" has been tried, so are the concepts of "**partnerships**", "**decentralization**" and so on. Then what is next that will help in realizing the following,

- Providing a home to every family
- Improving management strategies for settlements
- Promoting sustainable and acceptable land-use planning and regulations
- Promoting integrated environmental infrastructure comprising of water, sanitation, drainage, solid waste management
- Promoting sustainable energy solutions and efficient commuting systems
- Promoting safety in built environment against natural and man made disasters
- Promoting sustainable, affordable, workable construction materials and technologies and other activities relating to construction industry
- Promoting capacity development of institutions, systems, human ware at different levels who are playing – different roles, discharging different responsibilities individually or in groups.

The policies strategies, programmes and methods for implementation are required to be developed at international, national, state and local levels if above actions have to be initiated and implemented effectively. Capacity needs to be built at every level and across all fields of activity that impact the development and management of cities. Organisational development is essentially required for getting things done. In order to achieve this our management practices, procedures, concepts of collective working relationships, team-work, hierarchies, dependencies and supports call for change. The change will have to focus on "flexible and responsive management methods", new relationships and networking between organizations & institutions-that have a role in urban development.

Institutional development will be required to focus on legislative and regulatory changes needed to enable organisations, institutions and agencies at all levels and in all sector to enhance their capacities.

Capacity building is not one time activity but has to be followed continuously, and has to be flexible and responsive to the views and needs of all stakeholders. New institutions and organizations, drawing lessons and benefit of experience of already existing ones would have to be developed for supplying capacity building services. Capacity building should not only mean (as is generally understood) training or human resource development for specific skills or operations. No doubt it is a very major component but if decision-makers, managers, professionals and technicians are to deliver they have to operate at full capacity which has to be more than their own abilities.

Concluding observations

In today's agenda for Harmonious Cities there appear to be few settled issues. The current demographic growth, social and economic aspirations of the people, characteristics of poverty and affluence in our cities,

disparities in access to, land, finance and technology, poor governance, lack of appropriate institutions and organizations managing urban growth, lack of capacities lack of approaches to deal with issue relating to environmental degradation, energy demand and implications of climate change are some of the foremost road blocks which have converted our cities into extremely heterogeneous structures. It is in this context the theme chosen for the World Habitat Day – 2008 is very significant and deserve attention at the highest level both internationally and nationally. Hard decisions will have to be taken to change the profile of our cities, if we are really keen to bring them upto the level of Harmonious Cities. But are we all—who matter prepared to start a march on the long road that lay before us.

BMTPC Foundation Day Celebration 2008

BMTPC celebrated its 18th Foundation Day on 30th June, 2008. The ceremony was presided over by Kumari Selja, Hon'ble Minister of State (Independent Charge) for Housing & Urban Poverty Alleviation. Dr.H.S.Anand, the then Secretary (HUPA) and Shri S.K.Singh, Joint Secretary (HUPA) participated in the event. The ceremony was also attended by various officials from Ministry of HUPA, HUDCO, HPL and other organizations. On this occasion, the first issue of BMTPC's quarterly newsletter "Nirman Sarika" was released by the Hon'ble Minister for HUPA. The Hon'ble Minister for HUPA also launched BMTPC website in a new format.

Creating Harmonious Cities through People's Participation

*Dr.M.L.Khurana**

City has been the subject matter of inquiry for long now. Demographers, sociologists, urban planners, government agencies have time and again looked into different matters of inquiry that have been concerning the cities, be it the planning of the city, housing, transportation, land usage, management of cities, sustainability of cities or be it the social issues that affect a city and its people.

Towns and cities have a long history. In ancient times cities were mainly the centres of trade and economic activity and as such attracted people from far places for better trade thus bringing people together from various religions and different cultures. It can be said that cities evolved when human beings were able to produce more than they consumed and had found ways of storing the surplus to provide for a large number of people, living away from the field. The earliest settlements proliferated in the alluvial plains of the Nile in Egypt, the Tigris and Euphrates in Mesopotamia, the Indus in India and the Chang Jiang (Yangtze) and Huang Ho (Hwang Ho) in China. These cities mainly grew at the intersections of trade routes, at harbours and at the mouths of rivers with easy access to the sea. Athens, Rome and Alexandria were located near the sea. Mecca, Damascus and Samarkand were inland cities located on caravan routes. Varanasi in India is one such ancient and famous city located on the bank of river Ganges.

City was thus formed as a central place of trade for the benefit of members living not only in close proximity but also people living at far places. Such activity not only generated new ideas or sharing of natural resources but got people of different cultures at one place and resulted in interactions which had both positive and negative consequences on people and also on the infrastructure of the city.

Defining City

The Wikipedia encyclopedia defines city 'as an urban area with a large population and a particular administrative, legal or historical status'.

A city literally means a large town. In general usage the term 'city' is applied to any large and relatively dense concentration of population where the inhabitants are engaged primarily in non agricultural occupation. Legal definitions are more specific. In the United States, a city is an incorporated municipality, the city's boundaries and powers of self government are set forth in a charter from the state in which it is located.

Gordon Childe (1950) has attempted to define a city with certain general metrics like:

- Size and density of the population
- Differentiation of the population i.e. for example not all residents grow their own food, some are farmers other may be weavers, artisans, etc.
- Payment of taxes to the government or the king.
- Monumental public buildings.
- System of recording
- Trade and import of raw materials etc.

With the growth of industry came urban revolution which brought with it technological advancement and massive urbanization and thus cities gained more prominence. By the late 18th century, London had become the largest city in the world with a population of over a million.

The Industrial age saw the explosion in city's population,

* **Managing Director**, National Cooperative Housing Federation of India, New Delhi

with urban population enjoying more wealth, more efficient means of production and better health and sanitation conditions. This brought huge number of migrants from rural communities to urban areas in search of better living. The demographic transition which is still continuing has put more pressure on urban areas.

In 1800 only 2% of world's population lived in towns. In 1900, cities were home to 9% of planet's population. In 2008, more than half the world population, 3.3 billion people will be living in urban areas. According to the latest UNFPA Report on State of World Population 2007- Unleashing the potential of Urban Growth, by 2030, the urban population will rise to 5 billion or 60% of the world's population. The Asian, African and Latin American countries are the major regions which would witness a major shift from rural to urban areas. This urbanization process is continuous and inevitable and should be considered as a positive development.

While on one hand the urbanization process has led to 'suffocating cities' i.e. the cities that have reached the limits of their carrying capacity to sustain human life. There is dearth of basic amenities like water, power, land, housing and this is giving rise to fight for basic needs. Crime and violent activities has increased and cities are now becoming miserable due to rising expectations and aspirations beyond the available means.

But on the other hand this urbanization process is part of the development and every developing economy has to go through this phase. Instead of seeing urbanization having negative impacts on the city or urban areas, the process can be made positive by making cities a better place to live, where there is equal distribution of resources and basic amenities, there is no shortage of affordable housing, water and power supply are adequate, education is available to all, and making the legal and judicial system strong and active enough to counter the violent and criminal activities. Though the violent and anti-social activities cannot be totally curbed but to certain extent can be brought down by creating a harmonious environment.

Challenges faced by Cities

The cities world over are facing a variety of social and environmental problems. These include pollution, unemployment, inadequate infrastructure, increased rate of crime and violent activities. These problems pose a great responsibility not only on the government agencies but also on people residing there. The interaction between the government and the people here is the most important factor for the proper functioning of the cities.

In 1990's the concept of 'Sustainable Cities' came into limelight which extended the view that, "improving the quality of life in a city should include ecological, cultural, political, institutional, social and economic components without leaving a burden on the future generations". The concept ensures that sustainable cities would remain healthy over the longer period and would have enough left for future generations. They would not achieve today's growth at tomorrow's expense.

However the vision of attaining a sustainable city needs a volunteer effort on part of the citizens and a joint effort on the part of government and non government agencies. Unlike traditional community development approaches, sustainability strategies emphasize: the whole community; ecosystem protection; meaningful and broad based citizen participation and economic self reliance. The main part of focus should be on people's participation for they better know what is required and how that can be attained. Even the community based organizations and non government organizations have focused on people's participation. UN agencies have time and again talked of people involvement and thus people aiding in their own development. There have been numerous examples where citizen participation has proved fruitful, be it building houses or finding solutions to solve their daily problems, like maintaining hygiene, keeping surroundings green and clean or sanitation facilities, etc.

Creating Harmonious Cities

The UN theme for this year's World Habitat Day 2008 which is to be held at the Angolan capital, Luanda is, 'Harmonious Cities'. The theme highlights, the after effects of rapid urbanization and its impact on the envi-

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Alternate Building Materials and Products

*Dr. N. Lakshmanan**

Introduction

Structural Engineering Research Centre, Chennai a National Laboratory under the Council of Scientific and Industrial Research has contributed significantly to the building sector by its continuing R&D initiatives. The challenges faced by the industry have been dynamic and SERC has responded appropriately to changing times. SERC concentrated on product development and prefabrication in the first fifteen years of its existence, and beyond that period the R&D has centered around material development, particularly with respect to special concretes. The summaries of these developments are given in the next two sections.

Product Development (1965 - 1980)

Cold worked Deformed Bars

Economizing on steel in construction has always been the biggest challenge in construction industry. At a time when mild steel was the only option available, SERC developed cold worked deformed bars which increased the proof stress to 415 MPa from 250 MPa (Fig.1). This, together with the development of ultimate strength design Hand Book in 1966 led to a revolutionary change in reinforced concrete framed construction. SERC also received the prestigious import substitution award for the above invention.

Fig. 1 Cold Worked Deformed Bars

Prefabricated Industrialised Construction

Housing shortage has been a perennial problem in Independent India. Even today the shortage in housing is almost unsurmountable. SERC felt that only prefabricated industrialized construction would be an answer and even built 144 residential flats using large panel prefabrication technique (Fig.2). It is apparent that is SERC was way ahead of times, and when there was constraint on handling equipment even a successful project could not be taken to the society in a large measure.

Fig. 2 Industrialised Building Construction

Precast Products

To economise on use of concrete and steel, and also keeping in view the limitations on availability of handling equipment, SERC developed a number of building products which could be handled manually or by small handling equipment.

Waffle Shell Roof System

Funicular shells of size varying from 0.75m to 1.20m can be cast in square, rectangular and triangular plan shapes to suit the plan shape of a building. These shells cast using masonry moulds have a thickness of 20mm, and are provided with an edge beam having a single 6mm rod as reinforcement, mainly for

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the purpose of handling. Funicular Shells laid over a grid work of beams is known as a waffle system. The grid beams are cast at site using linear form work, and required steel depending on the span of the waffle slab. Waffle shells have been extensively used in India and more than 0.3 million sq.m. of flooring has been constructed using this system. The advantages are savings in concrete, steel, formwork and plastering. (Fig.3)

Fig. 3 Waffle Shell Roof System

Plate floor system

The system consists of thin precast plate elements of 40 to 50 mm thickness including the necessary structural steel reinforcement, used as a lost form work in conjunction with insitu concrete. The in-situ concrete can be cast by having only discrete props at desired locations. Since form work is eliminated and precasting is feasible, the system ensures speedier construction, and eliminates the need for ceiling plaster as the precast bottom surface cast on a masonry mould always leads to excellent surface finish (Fig.4).

Ferro Cement Products

Ferro Cement is a highly versatile form of mesh reinforced cement mortar that possesses excellent strength and serviceability characteristics. The material has been used a wide range of products such as single and multiple unit water tanks, storage bins, biogas plants, service core units (toilet / bath units), cupboards, rafters, trusses and other products. Until recently the skill of a mason was an essential requirement. But with the development of self compacting and freely flowing mortars, these can be made using form work also. Some of the Ferro cement products are should in Fig 5 and 6. Ferro cement products have been accepted by the society and used extensively throughout India.

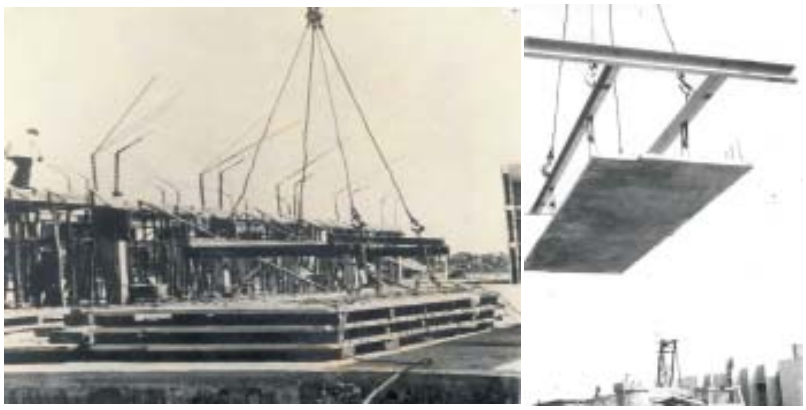


Fig. 4 Plate Floor System

Fibre Reinforced Manhole Covers and Frames

Fibre reinforcement in reinforced concrete structural elements leads to increased energy absorption, reduced wear and tear, better crack distribution leading to reduced crack widths, and better impact resistance. These properties make it as an excellent candidate for use in man-hole covers and frames. The technology of light duty, medium duty, and heavy

Fig. 5 (a) Multi-Cellular Water Tank

Fig. 5(b) Double T Roof Unit

Fig. 6(a) Single Service Core Unit

Fig. 6(b) A Row of Service Core Units for a Colony

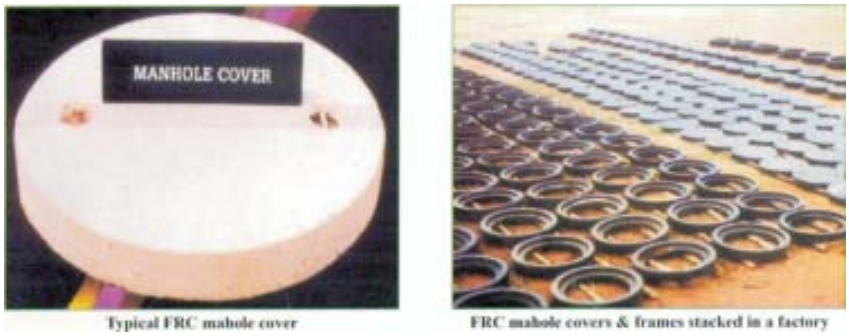


Fig. 7 FRC Manhole Covers and Frames

duty manhole covers was developed at SERC after extensive testing and evaluation and is being marketed by NRDC even now. High strength steel fibres having an aspect ratio of (length to diameter) 100 are preferred to avoid early pullout of fibres. Hooked fibres, crimped fibres, etc, are also available in the market. Normally the volume % of fibre varies between 0.5 to 2%. Fig.7 shows manhole covers and frames stacked in a factory.

Channel Units

Prefabricated channel units for use in roofs are a good option. Because of the large lever arm the reinforcement requirement is limited. Pre cast, prestressed concrete channels are also feasible for moderate spans, especially for use in office floors. While developing the technology, use of fly ash was also considered. At that point in time, advantage was not taken of the pozollonic activity of fly ash, and it was essentially used as cement replacement material for achieving economy. A full building was constructed at SERC, called as the Fly Ash Building which presently accommodates Experimental Mechanics Laboratory, Risk and Reliability Group, and IT infrastructure in addition to a medium capacity lecture hall. The powder samples taken from the prestressed and reinforced concrete slabs show that there has been absolutely no trace of corrosion. Good construction practice together with fly ash has a significant effect on durability of concrete channel units.

Brick Funicular Shell Roofing

The concept of funicular shells has been extended for roofs using brick shells supported over reinforced concrete edge beams. Timber formwork, preferably lined by plywood over a wooden framework, is first built. Over this formwork, bricks are set in cement mortar from the edges upwards or in strips leaving gaps (to be filled later) for shrinkage compensation for large shell roofs. A concrete screed of 25mm or more is laid over this and the top surface is waterproofed with bitumen felt or any other suitable waterproofing material. A movable formwork in steel has also been developed for the construction of brick funicular shell roofs for mass housing schemes. In this method, the peripheral walls are built at the first instance. A foldable and movable formwork is pushed into this space through a side opening (left at location of door opening). The formwork is raised and the profile of the shell is set. The bricks are then set with cement mortar and the shell is finished with concrete or mortar at the top with water - proofing admixture. After the concrete / mortar has set, the formwork is lowered by suitable built-in arrangement, folded and pushed out through the same opening and taken to a new location. As the shell is doubly curved and extremely rigid, lowering of forms can be done at the end of 4 or 5 days after laying the screed concrete / mortar finishing with water proofing compounds. These brick funicular shells can provide low-cost / cost-effective roofing in rural mass housing particularly, in row type of housing schemes. Fig.8 shows the moveable form work, a single funicular shell, and a row of fu-

Moveable Formwork

Independent House using Brick Funicular Shell

A Row of Houses Constructed using Moveable Formwork

Fig. 8 Funicular Brick Shell Roofing System

nicular shells constructed using moveable form work. The main advantages of this system are savings in cement, savings in steel, speedier construction and savings in over-all cost.

Material Development (1980 - Continuing)

After nearly 15 years of continuous R&D developing various products, SERC embarked on development of special concretes. The special concretes investigated include fibre reinforced concrete, concrete polymer composites, laced reinforced concrete, high performance concrete, high volume fly ash concrete, self-compacting concrete, and geopolymers.

Fibre Reinforced Concrete

The mechanical properties of fibre reinforced concrete were investigated. Based on analysis of voluminous test data on the stress - strain characteristics of fibre reinforced concrete with volume fraction of fibres in the range of 0.5 to 2.0%, the following empirical relationships were derived.

$$\varepsilon_u = 0.006 + 0.003\, v_f \text{ for } 0.5 < V_f \leq 2.0\% \quad \ldots \quad (1)$$

$$f_u = 0.75\, f_{peak} \quad \ldots \ldots \ldots \ldots \ldots \quad (2)$$

The stress-strain curve is parabolic in zero stress to peak stress region, and straight between peak to ultimate. Based on experiments conducted on flexure specimen the ultimate bending moment capacity of a reinforced concrete beam containing high strength fibre up to 2% by volume has been evaluated as

$$M_{u,SFRC} = Mu_{,RC}(1+10v_f) \quad (3)$$

where, $M_{u,SFRC}$ is the ultimate moment capacity of SFRC beams, $Mu_{,RC}$ is ultimate moment capacity of reinforced concrete beam with same % of longitudinal steel, and V_f is the volume fraction of steel fibres. Experiments also revealed that beams reinforced equally on compression and tension face, and containing steel fibre reinforcement had failure rotation at support in excess of 6.5 degree. Expressions have also been derived for flexural rigidity of SFRC specimen with loading and fibre volume.

Based on a series of tests conducted on SFRC beams a mathematical model for ultimate shear capacity of SFRC beams using failure mechanism approach has been suggested. Based on test data of fatigue performance of SFRC beams equations have been proposed for design. Comparison of cyclic test data of RC and SFRC beams clearly reveals the superiority of fibre reinforced concrete for specialized applications. (Fig. 9).

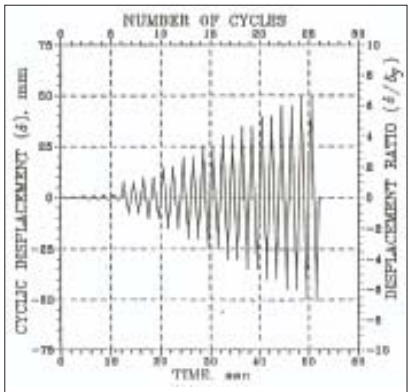
Recent tests on laced reinforced concrete beams with fibres under low shear span to depth ratios clearly revealed the advantages of including steel fibres in concrete matrix. In certain cases mode of failure itself was changed from shear to flexure which is a tremendous advantage.

Concrete Polymer Composites

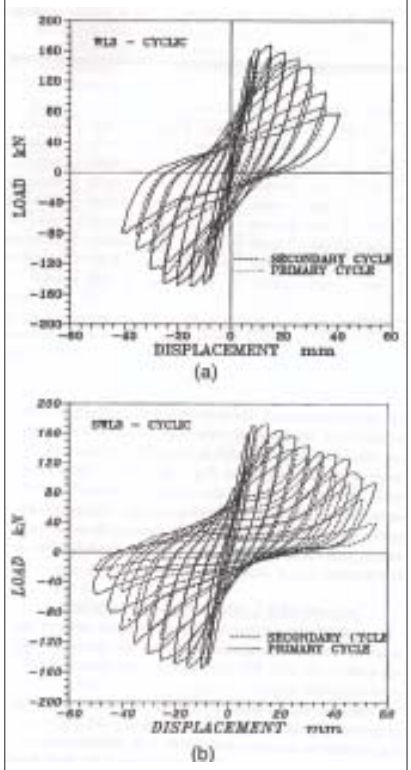
Concrete Polymer composites can be broadly classified into three major categories, namely:

- Polymer modified cement mortar (PCM) / polymer modified cement concrete (PCC)
- Polymer mortar (PM) / polymer concrete (PC); and
- Polymer impregnated mortar (PIM)/ polymer impregnated concrete (PIC)

Polymer modified mortars and concretes are prepared by mixing a polymer/monomer in a dispersed powdery or liquid form to the cement mortar or



Imposed Cyclic Displacement History



Hysteresis Plots:
(a) RC Test Specimen WL3; and
(b) SFRC Test Specimen SWL3

Fig. 9 Comparison of Behaviour of RC and SFRC Test Specimen under Cyclic Loading

cement concrete. The polymers used are natural rubber latex, styrene-butadiene rubber latex, acrylonitrile bututadiene rubber, and neoprene. These polymers when used along with cement concrete result in ductile and low modulus materials. Certain other polymers such as polyvinyl acetate and its copolymers, lead to glassy type of mixtures with high strength, high modulus but brittle type of failure. SERC has conducted extensive investigations on natural rubber latex modified polymer cement mortars.

Polymer mortars and concretes use a variety of thermosetting resins, tar modified resins, resin modified ashphalt and a wide variety of vinyl polymers. Polymer mortars and concretes can be used only for local repairs in concrete structures or in small sized precast products. Polymerisation and curing are accomplished through an initiator-promoter system. Curing is done at ambient temperature or at high temperatures. Silicone grease oils are used for mould-releasing.

Polymer impregnation is essentially filling the voids on the surface of the concrete by a process of expelling air from voids through a vacuum procedure, allowing low viscosity monomers, and resins to fill the voids and hot curing to achieve polymerization. SERC developed polymer impregnated ferrocement panels for use in Light Becon Towers (Fig. 10). In polymer impregnation procedures, only a certain thickness on the surface of concrete gets modified. However, this would improve the durability related properties of concrete structures.

Fig. 10 Light Beacon Tower made using Polymer Impregnated Ferrocement Panels

High Performance Concrete

The turn of the 1990's saw a large number of durability related problems of concrete structures. Also the environmental issues started taking the central stage. Realization that production of cement was energy intensive and also led to emission of 1.0 tonne of carbon dioxide into atmosphere for every tonne of cement produced, led to replacement of certain percentage of cement in concrete matrix by supplementary cementitious materials such as fly ash, ground granulated blast furnace stag, and other materials. Many of these were industrial wastes, and had problems of disposal. The supplementary cementitious materials reacted with the product of cement hydration namely Ca (OH)2 to produce stable and desirable C-S-H compounds. The availability of concrete chemicals such as super plasticizers, viscosity modifying agents, retarders, etc., enabled a concrete technologist to develop mixes which had enhanced durability characteristics. Fig.11 shows the cumulative intrusion of mercury as determined from mercury intrusion porosity meter.

Concretes containing fly ash and GGBS had less percentage of large sized pores as compared to OPC based concretes. This led to better durability of GGBS/fly ash based concretes. Table 1 shows the micro struc-

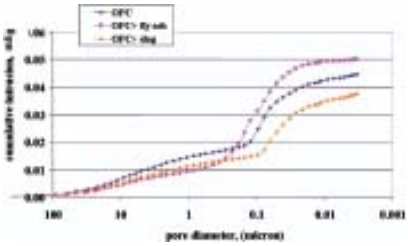


Fig. 11 Cumulative Intrusion Vs. Pore Size

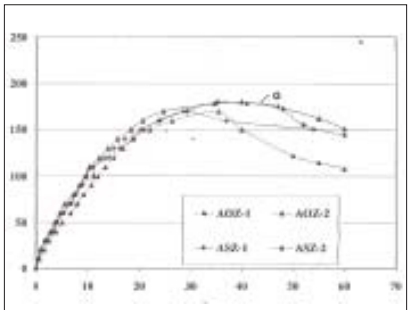
ture related properties of typical GGBS based concrete mixes.

M-20S refers to a mix with 20% replacement of cement by GGBS. Because of the advancements in cement industry, and the development of high performance concrete, high strengths in the range of 40 to 80 MPa could be easily attained. A large test programme on reinforced and pre stressed concrete elements was undertaken at SERC to verify whether, the equations derived for normal strength concrete mixes could be extended to high strength, high performance concretes. The load-deformation characteristics of high strength, high performance beams (Fig. 12), clearly revealed that the equations available predict the ultimate load (peak load) are sufficiently accurate.

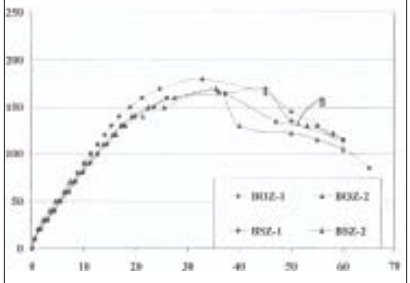
However, there was drastic load drop in the post peak region which is not desirable. A minimum of 0.25 p_t is to be provided as compressive reinforcement, where p_t is the percentage of tensile steel, while 0.50 p_t would be preferable. The minimum web steel provisions of thin webbed pre-stressed concrete members (Fig.13) were found to be inadequate, and needs upward revision.

Table-1: Micro-Structure Related Properties of GGBS Based Concrete Mixtures

Property	Mixture designation				
	M-0S	M-20S	M-30S	M-50S	M-70S
CRM(%)	0	20	30	50	70
Saturated Water Absorption,%	3.10	2.38	2.17	1.80	1.85
Porosity, η (%)	7.89	5.92	5.35	4.48	4.55
Coefficient of water absorption x 10^{-10} m^2/s	1.36	1.13	0.63	0.36	0.32
Modified sorptivity x 10^{-10} $m/\sqrt{s}$	9.04	8.00	6.58	5.03	4.91
Chloride diffusivity (x10^{-12} m^2/s) under 12V DC	0.204	0.128	0.104	0.076	0.084
Chloride permeability (ASTM equivalent) Coulombs	670	416	338	237	273



(a) Load deflection plot for HPRC beams (40 MPa, under reinforced section)



(b) Load Deflection Plots for HPRC Beams (60 MPa under reinf.)

Fig. 12 Deformation Characteristics of HPRC Beams

Fig. 13 Prestressed Beam-Failure by Web Crushing

Self-Compacting Concrete

Vibration and compaction are extremely important in concrete construction. In a large project this produces enormous noise pollution affecting the performance of the men on job. In complicate structural shapes and in structures having congested reinforcement vibration is extremely difficult. Self compacting concrete flows through these elements. SCC mixes always contain a powerful super plasticizer and a good viscosity modifying agent. The mixes usually have high powder content (cement+ fly ash+ sand) and low course aggregate content compared to conventional concrete mixes. Special tests such as slump flow test, U - box test, L-box test, V-funnel test and filling ability tests are conducted on a designed SCC mix to find its suitability for field application. Tests have been conducted on beams with congested reinforcement and compared with performance of similar conventional high performance concrete beams. Beams of size 150 x 400 x 3000 mm were tested under four point bending. The reinforcement details are given in Table 2, and the load deformation behavior is given in Fig. 14.

Self-compacting concrete beams exhibit slightly large rate of load drop in the post peak load region. One of the other

Table-2: Reinforcement Details

Beam	Bottom	Top	Web Steel
CVCC1	5-20#	2-16#	6 ϕ MS-2 legged @ 90 mm c/c
SCC1	5-20#	2-16#	- do -
CVCC2	5-20#	2-20#+1-12#	- do -
SCC2	5-20#	2-20#+1-12#	- do -

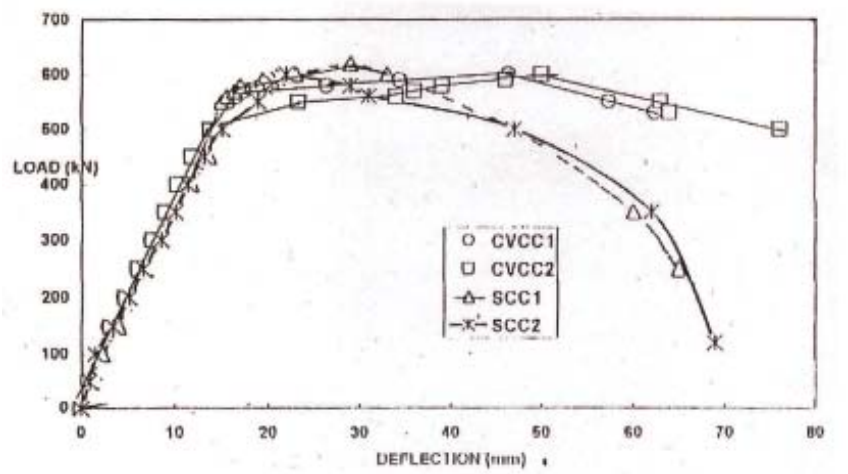


Fig. 14. Load Deformation Behaviour

interesting application of SCC would be in under reamed piles wherein good formation of bulbs can be ensured. Dynamic tests and pullout tests, conducted on SCC piles have proved the excellent performance of SCC under reamed piles. After the completion of the pull out tests, the piles were exhumed from the soil and it was seen that the formation of under reamed piles, particularly around the bulb region was superior to conventional concrete, as seen in Fig. 15.

Fig. 15 Exhumed Under-Reamed Piles

High Volume Fly Ash Concrete

Presently the use of fly ash in restricted to 30% of the powder content (cement + fly ash). However it is possible to use up to 50% of fly ash in concrete mixtures. These are called high volume fly ash concretes. Table 3 gives the typical gain in strength of normal and HVFC mixes with age. The bond strength of normal and HVFC mixes were also comparable as seen from Table 4. The durability characteristics of HVFC mixes, except for carbonation depth were superior to normal concrete, as seen from Table 5. Tests conducted using standardized acceleration corrosion testing procedure revealed that HVFC mixes did not show any sign of depassivation even after 33-days, while the control specimen showed corrosion initiation after 18 days. Tests conducted on beam and column elements for evaluating relative performance of normal and HVFC specimen showed similar behaviour (Fig. 16). The initial studies indicate that HVFC concrete can be used in structural elements with confidence.

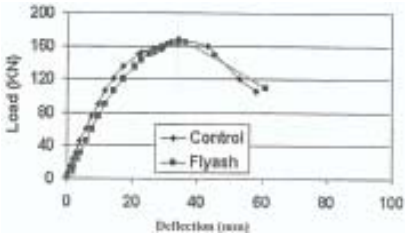


Fig. 16 Load Deformation Behaviour

Laced Reinforced Concrete

Concrete is a brittle material having low tensile strength and limited strain at failure even under compression. In linear elements, ductility to concrete is imparted by confining concrete by web steel. But this becomes difficult in planar elements. In chemical storage structures accidental blast loading cannot be avoided. It is impossible in many instances to avoid complete damage to the structure that had an accident. But adjacent building should be able to withstand the overloading due to shocks waves. It is seldom possible to design these structures in elastic range. Large ductility can be taken advantage of in the design of these structures and limit damage and avoid collapse. Laced reinforced concrete has continuous inclined reinforcement. Normally such structures have equal compression and tension steel which also enhances ductility. The lacing provides overall confinement, and reinforcement is present both in compression struts and tension tie regions

Table-3: Properties of Concrete Mixtures

Properties	Age of Test	Control Concrete	Fly Ash Based Concrete
Compressive Strength (MPa)	1 day	12.11	6.65
	3 days	26.00	16.64
	7 days	31.04	25.73
	28 days	42.65	44.72
	56 days	45.17	50.07
	90 days	47.73	54.29
Flexural Strength (MPa)	28 days	3.95	4.47

Table-4: Bond Strength with Age of Concretes

Age at Test	Slip	Control Concrete MPa	Fly Ash Based Concrete, MPa
28 days	0.025 mm slip	7.51	7.01
	0.25 mm slip	8.51	8.51
56 days	0.025 mm slip	7.51	7.35
	0.25 mm slip	9.07	8.86
90 days	0.025 mm slip	7.69	8.72
	0.25 mm slip	9.46	9.43
Abrasion/Wear resistance as per IS:1223-1980 28 days	Thickness, mm	1.49	1.29

Table-5: Durability Characteristics

Properties	Age of Test	Control Concrete	Fly Ash Based Concrete
Rapid Chloride permeability (Coulombs)	28 days	2819	341
	56 days	2489	257
	90 days	2198	189
Depth of carbonation (mm)	28 days	9.18	24.69
	56 days	7.88	11.88
	90 days	7.15	11.30
Water permeability (* 10" m/s)	28 days	8.63	7.50
	56 days	6.08	5.14
	90 days	4.43	2.34

Fig. 17 Laced Reinforced Concrete Beams

particularly under shear loading Fig. 17 shows a laced reinforced concrete beam. Normally the lacings have an angle of 45° or 60° to horizontal. Static tests, dynamic tests and cyclic tests were conducted on beam type of elements, and support rotation in excess of 6° could be achieved. Also expressions have been derived for failure rotation based on average strain in main steel reinforcement. Cubicles were tested under external blast loading, and the high ductility was clearly established. Design procedures for LRC cubicles have also been formulated. Recently a study has been undertaken were in high strength steel fibres were introduced to improve ductility in beams having low shear span to depth ratios. The results have been encouraging. Fig. 18 shows the failure of a fibre reinforced laced reinforced concrete beam under reversed cyclic loading having diameter of lacing as 8mm and angle of lacing 45°.

Slurry Infiltrated Concrete SIFCON

SIFCON is a special version of fibre reinforced concrete with fibre volume in the range of 5 to 12% and with no course aggregate. It is a material for special

Fig. 18 Failure of Fibre Reinforced LRC Beam under High Shear

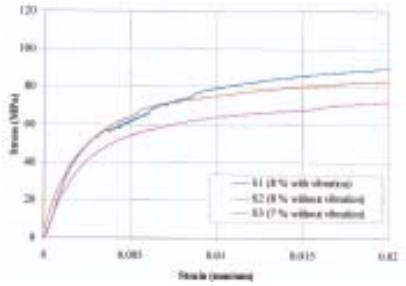


Fig.19 Stress-Strain Characteristics of SIFCON Specimens with Straight Fibres in Compression

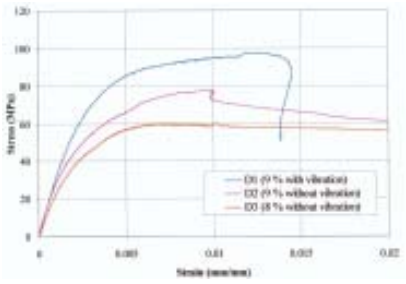


Fig.20 Stress-Strain Characteristics of SIFCON Specimens with Dramix Fibres in Compression

Fig. 21 Deformability of SIFCON Pipe

applications. Recently, underground shelter structures are being developed at SERC which need to perform when transmitted waves from a blast source reach the shelter. Two types of fibres, namely, hooked and straight fibres were used in its development. Typical stress-strain characteristics of SIFCON with straight and hooked fibres are shown in Fig. 19 and Fig. 20. The typical mechanical properties of SIFCON is given in Table 6. The extremely high deformability of SIFCON under loading is shown in Fig. 21.

Table-6: Results of the Tests Conducted to Evaluate the Mechanical Properties of SIFCON

ID	Vol. of % fibres	Comprehensive Strength (MPa)	Split Tensile Strength (MPa)	Flexural Strength (MPa)	Flexure toughness as per JCI standards (N-m)
S1	8	97.16	17.23	28.18	168.3
S2	8	79.88	16.41	22.97	139.4
S3	7	83.28	17.68	22.92	138.1
C1	7	77.58	14.63	22.56	126.5
C2	7	79.31	14.22	17.02	106.3
C3	6	79.71	14.10	18.27	110.4
D1	9	97.42	19.39	33.54	166.8
D2	9	77.64	16.63	31.21	169.2
D3	8	59.89	16.13	24.7	132.0

Summary

An attempt has been made to give a lion's eye view of R&D activities undertaken at the Structural Engineering Research Centre (SERC) on building materials and products. Because of space constraint, only brief write-ups have been possible on various products and materials developed.

More details on these can be had from the Director, SERC, Taramani, Chennai - 600113. The references have been so chosen as to limit their numbers. A number of papers have been published by scientists of SERC in journals, conferences, and seminars which give all the technical data and details.

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Establishment of Permanent Display Centres by BMTPC

The cost effective building materials and housing technologies is the subject of continuous interest for the researcher, technologists, scientists and users. Increasing demand of traditional building materials such as stone, steel, wood, bricks and cement and over use of natural resources for development and production of these traditional building materials has resulted in the environmental imbalances. On the other side the awareness about the various health hazards due to increasing industrial wastes and shortage of land for dumping of these waste materials has resulted in the development and promotion of various cost effective waste based building materials and technologies. In last few decades, large number of building materials and technologies has been developed by the various researchers and research institutions/organizations at laboratory level. Out of it, large number of building materials and technologies were commercialized and transferred to land and also adopted in various housing projects. BMTPC has played an important role for development and promotion of these cost effective waste based building materials and technologies at various levels. The Council with the support of technical experts has also published large number of technical documents for disaster resistant building materials and technologies.

In spite of very sincere efforts by promoting and implementing agencies including BMTPC, actively working in the area of building materials and housing technologies, these building materials and technologies are not adopted and utilized in various housing projects and schemes, as it was expected. The main reasons for non-adoption of these technologies are less awareness about these technologies among implementing agencies, practicing engineers, budding engineers and users. To fulfill these gaps and to disseminate the knowledge about the cost effective and waste based building materials and technologies all over the India, the Council is establishing Permanent Display Centres (PDC) in different parts of the country. These PDC act as a knowledge resource centre and disseminate the knowledge by organization of seminars, training courses and filed studies for the students, engineers, architects and academicians to share the research and development in the area of cost effective building materials and technologies. BMTPC has already established such PDCs at BVB College of Engineering & Technology, Hubli, Karanataka, Centre for Planning & Technology, Ahmedabad, Gujarat, Samrat Ashok Technological Institute, Vidisha, Madhya Pradesh and School of Planning & Architecture, New Delhi.

In continuation of the above, the Council established two more Permanent Display Centres in National Institute of Technology, Triuchrappalli, Tamil Nadu and Ordnance Factories Institute of Learning (Ordnance Factory Board), Ministry of Defence, Raipur, Dehradun, Uttrakhand.

Sustainable Human Settlements and Cost Effective Housing Technologies

*R.K.Garg**

Right from the prehistoric period, buildings and built environment have been at the top of the priority of human being in their quest for better living standards. In the past, human settlements and buildings were in close relationship with nature and did not disturb the delicate eco system. In India, the existing resources such as abundance of natural resources, diversified socio-cultural fabric, different geo-climatic conditions and architectural heritage were successfully conserved and construction technologies were developed based on the needs, locally available materials and skills in building construction.

In the changing global scenario, rapid pace of urbanization is taking place. India's urban population in 2001 was 286.1 million, which was 27.8% of the total population. Over the previous five decades, annual rates of growth of urban population ranged between 2.7 to 3.8%. During the last decade of 1991-2001, urban population of India increased at an annual growth rate of 2.7%. The urban cities all over the world in general are loosing the green spaces due to vast industrialization, commercialization, deforestation and haphazard growth resulting in the climate change. Advancements in science and technology have opened new avenues in the field of architecture, building materials and construction technologies on one hand and on the other hand it has led to overexploitation of natural resources resulting in their depletion, disturbing the delicate eco system.

In the present scenario sustainability has emerged as a key to the development of built-environment. For developing countries like ours it is more important, where issues like overpopulation, poverty, health, employment, finance and insufficient resource management, inadequate infrastructure exists. Coupled with potential impact on global warming and climate changes, these challenges need to be addressed in an effective way and innovative approach for the development is required for sustainable built-environment. National Urban Housing and Habitat Policy, 2007 has been launched by the Govt. of India to ensure sustainable development of all urban human settlements, duly serviced by basic civic amenities for ensuring better quality of life for all urban citizens and also lays special emphasis on provision of social housing for the EWS/LIG categories so that they are fully integrated into the mainstream of ecologically well-balanced urban development.

CBRI is a premiere organization working in the field of building research. In the institute, different aspects of habitat and built-environment have been studied for the development of environment friendly technologies. These technologies are cost effective and would help in the improvement in the quality of life of masses, especially for economically weaker section of the society. The paper focuses on the issues and innovative approach in producing cost effective building materials and construction technologies, developed in the institute.

Current Scenario

India's work force witnesses a rural to urban shift, because of more avenues for employment, prosperity, better infrastructure facilities and potential for economic growth, resulting

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in to more burden on the already overloaded and insufficient infrastructural facilities in the urban areas. It is therefore important that the rural and urban areas develop in a symbiotic manner. There is a huge gap between the demand and availability of the houses in urban as well as in rural areas for which the issues related to housing need to be identified. Following are some of the major issues in the context of current housing scenario in the country :

1. Rising costs and decreasing availability of land.
2. Exploitation of natural resources causing environmental hazards.
3. Increasing gap between demand and supply of building materials.
4. Absence of S&T inputs in arriving at the solution of shelter design and housing complexes for achieving affordable shelter and a livable environment.
5. Inadequate management of resources.
6. Inadequate existing infrastructure facilities such as solid waste disposal, water supply, sewerage, roads, storm water, drainage, communication etc, in urban and rural areas.
7. Lack of awareness about the new and innovative construction technologies and their adoption in the field.
8. Preparedness to mitigate hazards caused by natural calamities such as cyclones, earthquakes, land slides and fires etc.

To meet the present day challenges a scientific approach is needed.

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ronment. The theme further advocates that creating harmonious cities would first of all require the use of energy efficient and environment friendly technologies to reduce urban pollution. When half of humanity is living in towns and cities, cities are under enormous pressure to provide each and every individual a decent living where all have adequate shelter with basic services such as water, sanitation, electricity, decent healthcare, safer streets, etc. These factors are more important for developing countries where with rising population the services are limited thereby giving rise to competition. The competition sometimes definitely gives rise to stress and jealousy when there is unequal distribution of resources. The jealousy may give rise to violent and criminal activities especially among the youth. The young generation may not have that much patience to earn a living through right means and may indulge in corruption and illegal activities.

Thus we see that for creating a harmonious environment, it is really important that there is equal distribution of wealth and resources and the youth are taught to earn through right means. In the Hindu religion the belief in karma and dharma teaches to be simple, to earn through right means and be satisfied with whatever small you have. Harmony starts at home so to create socially and environmentally harmonious cities, the effort should begin at home. By educating the youth about what is right and what is wrong at an early age would help.

Some of the key issues in creating socially harmonious cities would include access to land , no forced evictions, pro poor compensations and land acquisition, social housing, city planning for migrants, health for all, pollution control, wealth distribution and social welfare, social safety nets and public services, curbing gender discrimination, slum upgradation or provision of low income housing. Environment related issues would include slum upgradation, pollution and waste management, water and sanitation, safe drinking water and healthier living conditions.

All this can be achieved if the possibilities of the participation of the residents are explored and innovative paths are adapted to reduce the vulnerability of cities and towns. People's participation would enhance their responsiveness and responsibility in achieving a better living environment and maintaining and sustaining the cities.

The need of the hour is to promote a culture of partnerships i.e. an increased commitment by all sections of the society to support a coalition of joint efforts to improve the urban environment at the local, regional, national and global levels for creating harmonious and attractive cities so that human beings can live in peace, dignity, safety, happiness and hope.

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Scientific approach for optimizing housing solutions

There should be a scientific approach for providing appropriate technology based on a technical analysis of the available options and cost analysis.

- There should be optimal space in the design considering efficiency of space, minimum circulation space.
- Cost of services should be considered, in the design of individual building, layouts, clusters etc.
- Cost effective construction systems should be adopted while preparing the specifications.
- Energy efficiency has gained considerable importance due to energy crises especially in developing countries. Orientation, built-form, openings and materials plays a vital role besides landscaping / outdoor environment.
- Quantification of different parameters for optimizing physical, socio-economic and environmental aspects.
- To evolve a workable mechanism for providing appropriate technology based shelter particularly to the vulnerable group, economically workstation and low-income group households.

CBRI has been involved in the research and development of the cost effective construction technologies based on different aspects of habitat and built-environment. These technologies would help in the improvement in the quality of life of masses, especially for economically weaker section of the society. Concept of prefabrication / partial prefabrication has been adopted for speedier construction, better quality components and saving in material quantities / costs. Some of these materials and construction techniques for wall and roof are as follows:

Non-Erodable Mud Plaster

The plaster over mud walls gets eroded during rains, which necessitates costly annual repairs. This can be made non-erodable by the use of bitumen cutback emulsion containing mixture of hot bitumen and kerosene oil. The mixture is pugged along with mud mortar and wheat/rice straw. This mortar is applied on mud wall surface in thickness of 12 mm. One or two coats of mud cow dung slurry (gobri) with cutback are applied after the plaster is dry.

The plaster enhances the durability of mud wall and reduces maintenance cost. This also makes the walls non-erodable and fire resistant.

Fire Retardant Thatch for Roofing

Thatch roofs are common in most parts of the country and through this process roofs can be made fire resistant and durable. The traditional thatch roof is loosely bound and deteriorates fast. It is highly prone to fire hazard.

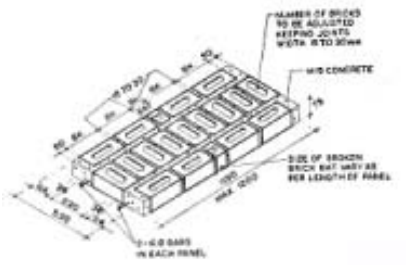
In the improved method, two identical frames of the room size are made and the thatching material is pressed between the frames made of split bamboo having a spacing of 20 cm with the help of GI wires and manually pressed. The non-erodable mud plaster is then applied on the top of the thatch. The roof becomes safe against fire and

lashing rains. It has a life of 5 years against 1 year for the traditional thatch roof. The cost of fire resistant thatch is about 50% higher than conventional thatch.

Prefab Brick Panel System for Roofing

This process is for making prefabricated brick panel roofing system. It is ideally suited for providing durable and economical roofing / flooring in the low cost houses specially for economically weaker sections of society in rural/urban areas.

This system consists of partially precast RCC joists (13cmx10cm), supporting the prefabricated brick panels of size 53cmx120cm, having 6mm dia. ms bars (2Nos.) in each panel and is covered with 35mm thick cement concrete.



View of Brick Panel

By this system the use of shuttering is eliminated.The length of panel may vary according to the room size. The 6mm dia bars are on each panel both-ways are provided over the panels before laying cement concrete to serve as negative distribution and temperature reinforcement. The system offers saving of 25-30 percent against 115 mm thick RB roof slab. The system has been adopted in various part of the country.

Prefab Jack-Arch Panel

This process is for roofing by making prefab jack-arch panels and RCC joists. RCC roof or traditional RBC roofs are costly due to high requirement of material and labour. Small size unreinforced jack arch panels (51x48 cm) are prefabricated

with brick and cement mortar over a humped platform and later one over the other. The partially precast RCC joists are made on a leveled platform using reinforcement as per design.

The jack arch panels are supported on RCC joists and haunches filled with cement concrete to level the top surface. By this system the use of shuttering is eliminated. The system offers 35% saving on overall cost of the roof as compared to conventional RCC. The ceiling provides an aesthetically pleasant look.

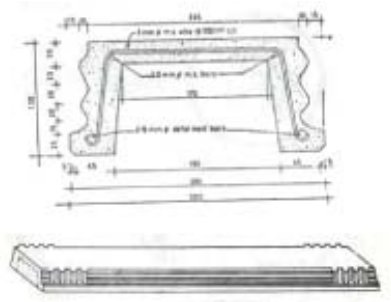
Precast RC Plank and Joist System

This is an efficient system for economical and faster construction of floors and roofs of single and multi-storyed buildings. The floor / roof is constructed with precast RC joist and precast RC planks. The size of precast RC plank is 30cm widex3-6cm thick x up to 4.2m long; precast RC joists 15 cm x 15cmxup to 4.2m long. The components are produced on casting platform at construction site.

As the walls reach the floor / roof level, the components are assembled and partly filled with concrete to form the floor roof. This results in 20% saving in overall cost, 25% in cement and 10% in steel as compared to conventional R.C. slab floor/ roof.

Precast RC Channel Unit for Roofing

RC channel unit are structurally efficient sections and can span up to 4.2m. Shuttering or propping is eliminated in this technique. Channel units are



RC Channel Unit System

fabricated in a mould on the casting platform using MS bars and cement concrete. The inner site of the frame of the mould is oiled and placed on a smooth & level plateform. The reinforcement cage is place d in position and M 15 concrete with 12 mm and down, graded aggregate is filled in the flange portion and vibrated with a plate vibrator.

After about one hour of casting, the frame is lifted off. These units are placed at roof level after curing. After erection and assembly, joints between the units are filled with concrete to complete the construction of floor/roof.

L-Pan Roofing

The precast full span RC L-panel is of section 'L'. The L-panels are supported on parallel gable walls and are used for sloped roof of a building. The RC

units can be cast with simple timber/steel moulds and are easy for manual handling with simple lifting and hoisting gadgets. L-pan roofing is quite lighter in weight, economic in construction and sound in per-

formance and durability.

In addition to roof, the L-panels can be used for making loft, cooking platform, parapets, and many other minor elements of buildings and structures. The technique has been used widely in many mass housing programme in the country.

Trapezonpan Roofing Flooring

Typical precast RC Trapezo-panel has trapezium section in orthogonal directions. The components are sound and can be manually handled with ease. These components are placed

in position to form roof/floor and haunch filling is done with insitu concrete to make a monolithic surface.

Trapezo-panels can be produced in stacks one above the other and have advantage in production, stacking and supply. These units are used for floors / roofs with / without deck concrete.

Concrete Skeleton System

The system is developed for the areas where bricks are of very poor quality and materials like sand and stone aggregate are locally available.

The system consists of prefabricated RCC pocket footings, hollow columns, beams, and unreinforced doubly curved tiles to form skeleton structure. Cladding walls can be constructed using locally available materials by self-help.

Unreinforced Pyramidal Brick Roof

Unreinforced Pyramidal Brick Roof Construction system is suitable for low cost houses in cyclone-affected and other coastal areas. Corrosion of reinforcement was found to be the major cause of failure of R.C.C. structure in coastal areas and a pyramidal roof with brick and cement concrete without reinforcement was therefore developed.

The roof is provided with peripheral R.C.C. ring beam. The beam is supported on eight brick columns or walls and is cast as integral part of the pyramidal roof using suitable shuttering. The roof can be of different sizes and shapes.

Frameless Door and Window Fixtures

The frames for door and windows consume substantial quantity of timber, which is scarce and costly. Frameless door and window fixtures save the use of timber and reduce the overall cost of the house. Special pivot type and fork type

hinges are used to eliminate the use of wooden frames. These are directly fixed in the wall/ floor and door lintels to support the shutters. These are useful for rural and urban houses constructed for Economically Weaker Section.

Clay Fly-Ash Bricks

Clay Fly-Ash bricks are made by manual or extrusion process involves mixing of Fly-Ash (60 %) with clay of moderate plasticity. The green bricks are dried under ambient atmospheric conditions or in shed to equilibrium moisture level of below 3 percent. Dried bricks are fired in traditional brick kilns at 1000° ± 30° C. These bricks reduce precious top soil as well as consumption of coal required in making conventional clay bricks.

Fly-Ash Sand Lime Bricks

By mixing of lime and Fly-Ash in the presence of moisture, Fly-Ash sand lime bricks are made. Fly Ash reacts with lime at ordinary temperature and forms a compound possessing

cementitious properties. After reactions between lime and Fly Ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound. Bricks made by mixing lime and Fly Ash are therefore, chemically bonded bricks.

The bricks are manufactured with the help of hydraulic press and are dried in the autoclave. These bricks are suitable for use in masonry just like burnt clay bricks and have various advantages over the clay bricks. It possesses adequate crushing strength, uniform shape, smooth finish and does not require plastering. These bricks are lighter in weight than ordinary clay bricks and have cement color in appearance.

Solid Concrete and Stone Blocks

This technique is quite appropriate in areas where stones and aggregates for the blocks are available at cheaper rates. Innovative techniques of solid blocks with both lean concrete and stones have been developed for walls. Mass production of the stone/concrete blocks is possible in parallel stacks. The Gang-Mould is developed for semi-mechanized faster production of the blocks.

In the manual process, single block moulds are used wherein the concrete is compacted with help of a plate vibrator. With the use of a portable power screw driven egg laying type machine, solid concrete blocks are made with higher productivity at low cost. Six blocks of 30x20x5 cm size are cast in single operation with an output of 120 -150/hr.

Mass Production in Parallel Stacks

Low Cost Latrine

Design and construction of low cost latrine is for areas where sewerage system is not available. It is suitable in the areas where sewerage system or septic tanks is not feasible due to financial constraints and / or shortage of water. The system consists of two leaching pits, PRAI type W.C. seat and water

seal trap. The leaching pits ($1.2m^3$) are connected with PRAI type seat through an inspection chamber using clay/ cement concrete / plastic pipes or brick channels.

Waste Water Disposal System

This system is suitable for disposal of wastewater from kitchen and bathroom in EWS houses. It is a simple, efficient and economical wastewater disposal system. It can also be precast by using ferrocement and the unit can be circular or rectangular in shape. The system consists of a silt-ahs trap chamber and a borehole for under-

ground disposal of wastewater within courtyard of the house.

The silt ash trap chamber is divided into two compartments each having a triangular duct. The ducts are provided with entry and exist at the bottom and are inter-connected at the top. The second compartment is filled with brick ballasts and is connected to 3m deep 30 cm dia borehole having brick ballasts. The unit is covered with prefabricated RCC pits covers.

Conclusion

Considering the importance of the sustainable development and eco- friendly built environment for ensuring better quality of life for all citizens, a holistic approach towards To ensure of all urban human settlements, duly serviced by basic civic amenities. The way to bring about such a symbiotic development between rural and urban areas is by adopting "a Regional Planning approach." The objective of such an approach is to develop a symbiotic rural-urban continuum, which is ecologically sustainable. The new Habitat Policy recognizes the sustainability limits of existing urban settlements. It also seeks to emphasize the mutual interdependence between towns and villages. It also lays special emphasis on provision of social

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Seismic Retrofitting of School Buildings – A Case Study

*Pankaj Gupta**

Introduction

According to latest seismic zoning map of India, about 59 percent of its land area is vulnerable to moderate to severe seismic hazards i.e. prone to shaking of MSK intensity VII and above. Depending upon the intensity, mud and adobe houses and random stone construction may have large deep cracks to partial collapse and even complete collapse; ordinary brick buildings, buildings of large blocks and prefab type and poor half timbered houses may have small cracks to complete collapse; and RCC Buildings may have fine plaster cracks to large deep crack and even partial collapse.

During the period 1990 to 2006, 6 major earthquakes in India, namely Uttarkashi (1991), Latur (1993), Jabalpur (1997), Chamoli (1999), Bhuj (2001) and Jammu & Kashmir (2005) have resulted in over 23,000 deaths and caused enormous damage to property and public infrastructure. Post disaster studies of these earthquakes have established that the casualties were caused primarily due to the collapse of buildings. The occurrence of these devastating earthquakes has also revealed that the housing stock of the country is extremely vulnerable and we are inadequately prepared to face the risk posed by them.

A majority of the buildings constructed in India, especially in suburban and rural areas, are non-engineered and built without adhering to earthquake- resistant construction principles. Most contractors and masons engaged in the construction of these buildings are also not familiar with the earthquake- resistant features specified in the building codes. It is thus necessary to empower communities to ensure the seismic safety of the built environment by encouraging the use of simple, easy and affordable technical solutions and institutional arrangements.

National Disaster Management Authority, Government of India in its National Disaster Management Guidelines has mentioned six pillars of earthquake management which are:

1. Ensure the incorporation of earthquake - resistant design features for the construction of new structures.
2. Facilitate selective strengthening and seismic retrofitting of existing priority and lifeline structures in earthquake - prone areas.
3. Improve the compliance regime through appropriate regulation and enforcement.
4. Improve the awareness and preparedness of all stake holders.
5. Introduce appropriate capacity development interventions for effective earthquake management (including education, training, R&D, and documentation).
6. Strengthen the emergency response capability in earthquake - prone areas.

Earthquakes pose unique challenges during each phase of the disaster management cycle (i.e. during preparedness, prevention, mitigation, response, rehabilitation and recovery). International experience has shown that the maximum gains from earthquake management efforts are secured by strengthening the pre-earthquake preparedness and mitigation efforts.

There are approximately 12 crore buildings in seismic Zones III, IV and V in India. Most of these buildings are deficient from earthquake-resistant point of view and are potentially vulnerable to collapse in the event of a high intensity earthquake. As it is not practically feasible or financially viable to retrofit all the existing buildings, it is required to carry out the structural safety audit at the first instance and subsequent retrofitting of select critical lifeline structures and high priority buildings. Such se-

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lection should be based on considerations such as the degree of risk, the potential loss of life and the estimated financial implications for each structure, especially in high-risk areas, i.e. in seismic Zones III, IV and V.

Lifeline buildings such as schools, hospitals are required to serve as shelters and medical camps during any disaster. Collapse of such buildings in past earthquakes have not only resulted in mass causalities but have also posed administrative difficulties to local authorities. Therefore, it is utmost important that such lifeline buildings are made strong enough to withstand earthquake forces.

Seismic Evaluation, Repair and Strengthening of Masonry Buildings-Guidelines

BIS has formulated IS 13935-2008 :Guidelines for Seismic Evaluation, Repair and Strengthening of Masonry Buildings (under print). Besides covering the selection of materials and techniques to be used for repair and seismic strengthening of damaged buildings during earthquakes, it also covers the damageability assessment and retrofitting for upgrading of seismic resistance of existing masonry buildings covered under IS 4326 and IS 13828.

General principles and concepts for seismic retrofitting as per these guidelines are as follows:

Non-Structural/Architectural Repairs

The buildings affected by earthquake may suffer both non-structural and structural dam-

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housing for the EWS/LIG categories so that they are fully integrated into the mainstream of ecologically well-balanced urban development.

For Cost Effective Housing and adoption of new and innovative construction technologies the following approach is proposed:

1. Strengthening and setting of national network of Building Centres to argument supply of alternative building materials and trained manpower in different regions of the country.
2. Standardization of building materials and components such as doors, windows, ventilators & lintels etc.
3. Resource Management through proper planning.
4. Establishment of relevant parameters in relation with local conditions, regarding planning, design, and construction particularly for EWS with available improved knowledge of the choices and priorities to bring down the cost of construction besides working out mechanism for providing appropriate technology based affordable shelter.

There adoption adds to improvement in the housing environment as well as improvement in the quality of life of the people. These technologies may be implemented with local labor and therefore improve the economic condition of the villagers.

Acknowledgement

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ages. Non-structural repairs may cover the damages to civil and electrical items including the services in the building. Repairs to non-structural components need to be taken up after the structural repairs and retrofitting work are carried out. Care should be taken about the connection details of architectural components to the main structural components to ensure their stability.

Non-structural and architectural components get easily affected/dislocated during the earthquake. These repairs involve one or more of the following:

a) Patching up of defects such as cracks and fall of plaster;
b) Repairing doors, windows, replacement of glass panes;
c) Checking and repairing electric conduits/wiring;
d) Checking and repairing gas pipes, water pipes and plumbing services;
e) Re-building non-structural walls, smoke chimneys, parapet walls, etc;
f) Replastering of walls as required;
g) Rearranging disturbed roofing tiles;
h) Relaying cracked flooring at ground level; and
j) Redecoration - white washing, painting. etc.

The architectural repairs as stated above do not restore the original structural strength of structural components in the building and any attempt to carry out only repairs to architectural/ non-structural elements neglecting the required structural repairs may have serious implications on the safety of the building. The damage would be more severe in the event of the building being shaken by the similar shock because original energy absorption capacity of the building would have been reduced.

Structural Repairs/Restoration

Prior to taking up of the structural repairs for restoration of original strength and any strengthening measures, it is necessary to conduct detailed damage assessment to determine:

a) The structural condition of the building to decide whether a structure is amendable for repair; whether continued occupation is permitted; to decide the structure as a whole or a part require demolition, if considered dangerous;
b) If the structure is considered amendable for structural repair then detailed damage assessment of the individual structural components (mapping of the crack pattern, distress location; crushed concrete, reinforcement bending/yielding, etc). Non-destructive testing techniques could be employed if found necessary, to determine the residual strength of the members; and
c) To work out the details of temporary shoring of the distressed members so that they do not undergo further distress due to gravity loads.

After the assessment of the damage of individual structural elements, appropriate repair methods are to be carried out component wise depending upon the extent of damage. The restoration work may consist of the following:

a) Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
b) Addition of reinforcing mesh on both faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it, suitably, with micro-concrete (maximum size of aggregate limited to 6 mm or less as suitable), and may be with use of micro-reinforcement as fibre or ferrocement.
c) Injecting cement, polymer-cement mixture or epoxy materials which are strong in tension, into the cracks in walls.
d) The cracked reinforced concrete elements like slabs, beams and lintels may be repaired by epoxy grouting and could be strengthened by epoxy or polymer mortar application like shotcreting, jacketing, etc.

NOTE : In mortar for masonry or plaster, fibres can be used.

Seismic Strengthening

The main purpose of the seismic strengthening is to upgrade the seismic resistance of a damaged building while repairing so that it becomes safer under future earthquake occurrences. This work may involve some of the following actions:

a) Increasing the lateral strength in one or both directions by increasing column and wall areas or the number of walls and columns.

b) Giving unity to the structure, by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.

c) Eliminating features that are sources of weakness or that produce concentration of stresses in some members. Asymmetrical plan distribution of resisting members, abrupt changes of stiffness from one floor to the other, concentration of large masses and large openings in walls without a proper peripheral reinforcement are examples of defects of this kind.

d) Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members.

The above provisions given for damaged buildings are also applicable to existing buildings which do not meet the seismic strengthening requirements of present earthquake codes due to original structural inadequacies and material degradation over time or alterations carried out during use over the years. Their earthquake resistance can be upgraded to the level of the present day codes by appropriate seismic retrofitting techniques, such as mentioned above.

BMTPC'S Initiatves for Retrofitting MCD Schools

Realizing the importance of lifeline buildings, BMTPC has initiated a project of retrofitting a few school buildings of Municipal Corporation of Delhi as demonstration project to showcase retrofitting techniques for masonry buildings and train local artisans.

Following five schools constructed initially as load bearing masonry structure, were selected by BMTPC in consultation with Municipal Corporation of Delhi for this project.

- MC Primary Model School, Vasant Vihar
- MC Primary Model School, Ramnagar
- MC Primary School (Girls) Rameshnagar No.1
- MC Primary Model School,Rana Pratap Bagh
- MC Primary Girls School, Sarai Rohilla

Based on the recommendations it has observed that all buildings were primarily made of load bearing brick masonry with RC slabs for intermediate floors as well as the roof. They range from G to G+2 storeys excluding the terrace. All buildings had long corridors with rooms on one side of them. There were brick masonry piers that support the upper storey corridor floor slab through RC beams. In most cases the RC beams that support the floor slabs were supported directly on the masonry walls. In some cases the walls were not plastered keeping the exposed brick finish.

The size of the class rooms was approximately 6m X 6m. In addition there were rooms for offices, staff room, and sanitation facilities. Typically the rooms had single door, approximately 3 windows in the exterior walls and, in many cases they had ventilators with swivel type shutter in the walls along the corridors.

Seven schools in different zones of MCD were identified in consultation with Municipal Corporation of Delhi. Out of which seismic retrofitting have been completed in five buildings. The details are given in Table-1.

Table-1: Details of retrofitted MCD School buildings

Sr	Schools	No. of Storey	No of Rooms	Total Built-up Area – sqm.
1	MC Primary Model School, Vasant Vihar	G	11	487.5
2	M.C. Primary Model School, Ramnagar	G + 2	30	1816
3	MC Primary School (Girls) Rameshnagar No.1	G + 1	28	1525
4	MC Primary Model School,Rana Pratap Bagh	G + 1	23	1330
5	MC Primary Girls School, Sarai Rohilla	G + 1	14	1574

School Building at Rana Pratap Bagh
(before retrofitting)

School Building at Ram Nagar
(before retrofitting)

School Building at Sarai Rohilla
(before retrofitting)

School Building at Ramesh Nagar
(before retrofitting)

Removal of mortar for horizontal belt and encasement

Drilling of hole for vertical corner reinforcement

Fabrication of belt with WMM & Galvanized bars.

Fixing of WMM belt at lintel level

Plastering of WMM belt at lintel level

Encasing of windows and horizontal belt at sill level

Window encasement with horizontal belt at sill and lintel level

Completion of lintel level belt and encasement of columns

Rana Pratap Bagh School Building after retrofitting

Ramesh Nagar School Building after retrofitting

Vasant Vihar School Building after retrofitting

Ram Nagar School Building after retrofitting

Building Vulnerability Assessment:

a) The Rapid Visual Screening of all five buildings was carried out using a special form as per the code. Since the data on the sub-soil conditions were not known for any site, subsurface investigations were carried out at each site. No vertical irregularity was observed in any school building. But two schools were observed to had plan irregularity.

b) The detailed documentation of the buildings was carried out since no "as-built" building plans were available. This involved the preparation of "as-built" drawings showing the dimensions, openings, all building elements (that were visible) including walls, all RCC elements including beams, columns, lintels, chhajjas (sun-shades) etc., materials of construction, size of all building elements including wall thickness, and the state of the building elements.

c) Based on the observed vulnerability, retrofitting plans were prepared alongwith Bill of quantities. The retrofitting measures conformed to the provision of Bureau of Indian Standard codes IS 13828 :1993 and IS 13935 :1993 for Seismic Zone IV with school buildings assigned the Building Category E.

d) Work was executed and completed "as-built" plans were prepared to show the measures carried out.

Vulnerability Description & Retrofitting Measures:

All schools had un-reinforced brick masonry walls.

In some buildings the exterior walls having windows had continuous RCC chhajja which would impart significant amount of stiffness as well as bending and tensile strength to the walls. But the other walls lacked such stiffening member. Thus the walls were weak against lateral bending as well as against in-plane tension. Therefore Seismic Belt at Lintel level made of galvanized weld mesh along with galvanized reinforcing bars was provided. In case of walls with length exceeding 5m the lintel level belt was installed on both faces of the wall. (Provision in IS Code regarding - reinforcement in seismic belts given in Table -2).

In some exterior walls there were excessive window openings. This further weakened the wall against in-plane or racking shear. To counter this, it was recommended to put Seismic Belt at Sill level in case of walls with 3 or more window openings.

The masonry walls lacked stiffness against bending about the horizontal axis. To counter this, as per codal provision Single Bar vertical reinforcement at the junctions of every wall were provided. Provision of vertical bar or mesh reinforcement in vertical belt at corners of rooms is given in Table-3.

All exterior corridors had masonry columns that support the roof slab above. These columns have little bending strength. Therefore column encasement with reinforcing rods was provided. Encasing rods were connected with the reinforcing bars of the beams that rest on the columns. In case of the slab resting on the column the rods went through the slab with holes grouted with non-shrink grout, and in case of the top story slab the bars were con-

Table - 2 : As per IS: 13935
Mesh Reinforcement in Seismic Belts in Various Building Categories

Length of wall m	Category B			Category C			Category D			Category E		
	Gauge	N	H	Gauge	N	H	Gauge	N	H	Gauge	N	H
< 5.0	g 14	9	250	g 13	9	250	g 12	9	250	g 10	10	280
6.0	g 13	9	250	g 12	9	250	g 10	10	280	g 10	14	380
7.0	g 12	9	250	g 10	10	280	g 10	14	380	g 10	18	460
8.0	g 10	9	250	g 10	14	380	g 10	18	460	g 10	23	580

Notes:

1. *Gauges: g10=3.25 mm, g11=2.95 mm, g12=2.64 mm, g13=2.34 mm, g14=2.03 mm.*
2. *N = Number of made longitudinal wires in the belt at spacing of 25 mm.*
3. *H = Height of belt on wall in micro-concrete, mm.*
4. *The transverse wires in the mesh could be spaced upto 150 mm.*
5. *The mesh should be galvanized to save from corrosion.*

Table - 3
Vertical Bar or Mesh Reinforcement in Vertical Belt at Corners of Rooms

No. of Storeys	Storeys	Category B			Category C			Category D			Category E		
		Single Bar	Mesh (g10)		Single Bar	Mesh (g10)		Single Bar	Mesh (g10)		Single Bar	Mesh (g10)	
		mm	N	B	mm	N	B	mm	N	B	mm	N	B
One	One	-	-	-	-	-	-	10	10	300	12	14	400
Two	Top	-	-	-	-	-	-	10	10	300	12	14	400
	Bottom	-	-	-	-	-	-	12	14	400	16		
Three	Top	-	-	-	10	10	300	10	10	300	12	14	400
	Middle	-	-	-	10	10	300	12	14	400	16	25	650
	Bottom	-	-	-	12	14	400	12	14	400	16	25	650

Notes:

1. *Gauge 10 (3.25 mm dia) galvanized mesh with 25 mm spacing of wires shall be used.*
2. *Single bar, if used, shall be HSD or TOR type. If two bars are used at a T-junction, the diameter can be taken as follows:*
   For one of 10 or 12 mm take 2 of 8 mm, and for one of 16 mm take 2 of 12 mm.
3. *N = Number of longitudinal wires in the mesh.*
4. *B = Width of the micro concrete belt, on each wall meeting at the corner or T-junction.*
5. *The transverse wires in the mesh could be at spacing up to 150 mm.*

nected to the bars of the slab.

Conclusion

The work has provided valuable lessons that could prove useful in the planning and execution for retrofitting of other public buildings in a big city like Delhi

1. Simultaneous coordination with multiple agencies including (a) funding agency, (b) agency occupying the building, (c) agency which owns the building and (d) the agency that is in charge of maintaining the building are required. Establishment of a separate cell for repair and rehabilitation to coordinate and get the work executed may be useful.
2. Retrofitting is normally carried out in buildings where already some activity is going on, therefore pre-planning with the building authority is required for getting the portions of the building cleared, so that once the work starts there is no hinderance. In case the occupants are children, ensuring their safety becomes important which also affects the pace of the work since it may involve time restrictions, work area restrictions etc.
3. Proper education of the building authority/occupant about the project and its purpose must be done in advance to promote positive view of the retrofitting work and, hence, ensure the cooperation from the occupants.
4. Most of the items of work done in retrofitting are not covered in schedule of rates which require detailed analysis of manpower and material requirement. These items may be included in Schedule of Rates.
5. Since retrofitting involves specialized activities, trained manpower is required for execution of work which is not easily available in the market. The training of contractors and masons is required to ensure that the retrofitting work is carried as per design and specification.

References:

1. *Project Report on Retrofitting of four MCD Schools prepared by NCPDP, Ahmedabad.*
2. *IS 13935-2008: Seismic Evaluation, Repair and Strengthening of Masonry Buildings- Guidelines*

Monolithic concrete construction - a panacea from the Sintex stable

The fast, economical and quality answer towards the country's developmental needs

*Sanjib Roy**

They say 'Rome wasn't built in a day'. But path-breaking innovations are every single day proving the contrary. Gone are the days when construction and building technology underwent advancement at a sluggish pace. Now, with a booming economy, increased buying power and higher aspiration values, not only the government, but every real-estate developer is talking about low-cost housing because there is demand there. Sintex's Monolithic Concrete Construction is a godsend, so as to steadily meet the demands of mass housing in the country.

Against the required 20 million housing units in India, we are able to construct only 4-5 millions a year in all the housing segments. Private builders concentrate on middle income and high-income groups, leaving most of the disadvantaged people deprived of proper housing facilities. Sintex – with its visionary zeal and innovation inspired solutions, has come up with the revolutionary concept of Monolithic Construction technology that offer speedy construction of high quality houses at affordable prices.

Monolithic construction is a method by which walls & slabs are constructed together giving the structure a complete box like (cubicle) shape. It's an improvement over in-situ construction. In this method fluid of cement concrete is poured in light weight formwork system while using nominal reinforcement bars for needed strength. This method has proved to be ideal for multistoried construction and mass housing of any kind wherein large number of units of similar configuration are needed to the be erected.

Sintex's Plastics Division started in the year 1975 and today possesses the most diversified manufacturing capabilities in plastic processing in the world, with 10 plants spread across the country, more than twelve manufacturing processes under one roof, having more than 500,000 sq. meter area and a 1000 strong work force. Sintex has created extensive finishing, assembling, metal fabrication and concrete products facilities. It is Sintex's engineering prowess over the last 30 years and commitment to innovation that has made it possible to develop such a revolutionary concept of Monolithic Concrete Construction.

Sintex was the first in India, to comprehend the potential of Plastics and has ever since established novel precedents by introducing innovative products and applications of Plastics. The invention and evolution of Plastics, has been at the heart of almost every conceivable industry including pharmaceuticals, electronics, packaging, automotive, aeronautics, and entertainment and has been powering their forward thrust. Most of these industries have accepted and welcomed this wonder material called plastics, into their fold.

Mr. Sanjib Roy, Senior President, Sintex Industries Limited – Plastic Division, said, "The building industry has finally recognized the significance and versatility of this wonder material but no one can deny the fact that it is only since the last 3 decades that plastics in all their polyforms have shed their proletariat status as binders, composites and infrastructures, to be appreciated as materials in their own right by architectural fraternity."

Sintex's revolutionary Plastic

* **Senior President**, Sintex Industries Limited, Plastics Division, Kalol, Gujarat

Formwork System is unique because it accelerates the construction process without compromising on quality. It forms all of the concrete in a building including walls, floor slabs, columns, beams, stairs, window hoods, balconies and various decorative features in exact accordance with the architectural design. The usage of a plastic composite, as a material for formwork is cost effective having all the inherent advantages of physical and mechanical properties.

The hardware consists of hundreds of standard pieces of formwork equipment, manufactured to fine tolerance. The majority of the equipment comprise of panel sections while the rest includes vertical and horizontal corner sections, bulkheads and special floor slab beams that can be dismantled without disturbing the props supporting the floor slab concrete. The major use of plastic allows the larger components to be big enough to be effective yet light enough to be handled by a single worker. Consequently, the need for cranes or other heavy handling equipment is eliminated. Steel pins and wedges join all individual pieces of equipment. The only tool required in assembly is the regular hammer. It certainly eliminates the need for skilled workers. The Sintex system is extremely adaptable to any building design. Based on the architectural and structural drawings of the building, a process of computer modulation is carried out. It involves iteration and optimization techniques, which select the most economical and practical fittings of the standard formwork components. The formwork layout and shop drawings are prepared for each project. This is the most important step in the pre-construction process and herein lies the uniqueness and strength of the Sintex system.

With urban Indians fast discovering that owning property could be well out of their reach, creating mass housing seems to be the only plausible solution. Sintex can meet the needs of not only the housing sector but also other sectors like consumer, education, cultural, community, infrastructure, industrial and telecom. Is an alternative to the conventional construction systems. Sintex's Monolithic Concrete Construction is the answer that will bridge the huge deficit of mass building requirements.

Sintex has been on the forefront of research and development in the field of construction and building materials and their application in new works. Sintex's products like Water Storage Tanks, Doors, Windows, Prefabs and Plastic Sections have already attained iconic status both in India and abroad. These products combined with Sintex's Monolithic Concrete Construction complete the full circle, proclaiming the advent of plastics in the building and construction industry.

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Advantages of Sintex Monolithic Concrete Construction:

Speed	The method allows speedy construction on mass scale
Strength	It's shape gives the building extremely high structural strength against vertical & horizontal forces.
Dead load	The dead weight of the monolithic structure is almost 50% of the conventionally constructed multistoried structures
Cost savings	Less dead load means savings in foundation cost.
Skilled labour	Very few skilled workers are required in this method, thus allowing time bound mass scale housing construction even with limited human resources.
Errorless construction	Modular shape leaves no scope for error as far as geometric irregularities or imperfections are concerned.
Smoothness	Proper formwork materials eliminate smooth plastering on walls
Maintenance free	The cement concrete monolithic structures once built will always be maintenance free
Environment friendly	Allows use of fly ash in the mix & Plastic and FRP made shuttering avoid the usage of valuable natural wood

Prefabricated Construction
- Status and Future Need

*J.K.Prasad**

Introduction

India, like many other developing countries of Asia, Africa and Latin America, has enormous housing problem. As per the Report with the Indian government, urban housing backlog in the year 2007 was 24.71 million. Out of which 99 percent is for economically weaker section and low income category.

A number of initiatives have been taken by the government to bridge the gap. At the Central level, Jawahar Lal Nehru Urban Renewal Mission (JNNURM) provides opportunities to States and UTs to give basic services to urban poor, with the important component of affordable housing. At state level, besides JNNURM, many states have also initiated their own housing schemes for the poor. For effective implementation of any scheme on affordable housing, proper planning, selection of cost effective technologies, effective construction management and quality control are needed.

National Urban Housing and Habitat Policy 2007 emphasizes many actionable points which include encouragement of prefabricated factory made components for mass housing, so as to achieve speed, cost effectiveness, and better quality construction.

It is utmost important that houses are constructed in most economical way- commensurate with locally available resources and in shortest possible time without sacrificing durability, serviceability and Functional utilities for which it is intended. Prefabrication is one of the obvious choice for fulfilling such need.

Having decided to go for Prefabrication, the next question is to what types of Prefabrication? Unlike European countries and former USSR, who could afford financially to adopt large panel prefabrication for speedy construction of houses, it has not been possible for our country to adopt such technologies. One of the main reasons being the high capital required in setting up the plant for such industrialized method and secondly lack of proper infrastructure facilities for handling, transporting and erection of such building components. However, adoption of appropriate low-cost construction techniques involving adoption of partial prefabrication using prefabricated building components of such size and weight which could be fabricated at construction sites or in industrial production units, have been found to be quite effective in many areas of the country.

Research institutions and other organizations both Govt. and NGOs are making concerted efforts to promote such new techniques in the country. Some of the projects in the country have successfully used prefabricated technologies. One such project is construction of 3164 houses for industrial workers in Bawana, New Delhi by Delhi State Infrastructure & Industrial Development Corporation.

Standardization at the highest level plays an important role in bringing new technologies from research to field. Bureau of Indian Standards through its several Technical Committees has formulated a number of Indian standards related to prefabricated construction. It may, however, be required to review the work already done and decide future approach keeping the National Housing Policy and the emerging technologies in mind.

Prefabrication leads to industrialization of building construction. In order to achieve the maximum benefit out of this technology, it is necessary to give attention to the following:

- selection of proper type of prefabrication
- system best suited to our country

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- development of new systems with the locally available methods
- planning - space, layout
- standardization of building parameter
- standardization of various components which go to make up the building
- codification of efficient and effective practices
- evaluation of performance of new materials and systems
- maintenance procedures

Each of these require to take into account regional requirements based on climate, locally available building materials, and local traditions and customs. The nationally or regionally applicable materials should be properly standardized. Standardization of these alone will lead to

- economies of scale
- variety reduction
- ease and economy in the development and transfer and training
- optimum utilization of research findings
- confidence in the minds of users

Advantages of Prefabrication

- Factory made products meaning rational and efficient manufacturing processes, skilled workers, repletion of actions, quality surveillance etc.
- Self supporting ready made components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.
- Construction time is reduced and buildings are completed sooner allowing an earlier return of the capital invested.
- Quality Control can be easier in a factory assembly line setting than a construction site setting.
- Prefabrication can be located where skilled labour is more readily available and costs of labour, power, materials, space and overheads are lower.
- Time spent in bad weather or hazardous environments at construction site is minimized.
- Less waste may be generated and in a factory setting it may be easier to recycle it back into the manufacturing process.
- Moulds can be used several times.

There are some disadvantages as explained below, which are required to be addressed while going for the prefabrication system.

- Careful handling of prefabricated components such as concrete panels or steel and glass panels is required.
- Attention has to be paid to the strength and corrosion-resistance of the joining of prefabricated sections to avoid failure of the joint.
- Similarly, leaks can form at joints in prefabricated components, if not properly done
- Transportation costs may be higher for voluminous prefabricated sections than for the materials of which they are made, which can often be packed more compactly.
- Large prefabricated sections require heavy-duty cranes and precision measurement and handling to place in position.

Standardization Need

Standardization work to promote prefabricated construction was initiated in a systematic manner from the time when such technologies were in infancy in India. A number of standards related to various aspects of prefabricated construction have been formulated by the Bureau of Indian Standards. With the emergence of new technologies, there is, however, a need to review the standardization status to cover newer areas.

Modular Coordination

For economical and speedy use of various options available for partial prefabrication, it is necessary to have selection of the most suitable dimension of structural elements such as slabs, beams, columns etc, and limiting their number so that they could be adopted to as large number of architectural building, design as possible. Studies have shown that modular coordination brings simplification and speed of construction in traditional construction resulting in economy. Additionally it opens up the possibility of using dimensionally co-ordinated prefabricated elements wherever these offer an alternative, which is cheaper in cost or consumption of scarce materials.

If modular dimension is extensively employed, the manufacturers of precast building components will be able to supply off-the-shelf standard components for incorporation in a building. The scope of application of the products will therefore be increased, which will result in lower cost as well as reduced

consumption of scarce materials. It will also reduce construction time.

- the use of dimensional coordination during the planning and designing stages will simplify the working which will result in saving design time.
- the use of dimensional coordination during the planning, designing and estimating process will simplify working and save time. Proven details will also be used for assemblies and components and this will improve the performance of building overall.

The Bureau of Indian Standards has brought out series of recommendations on modular coordination in building industry which are intended to serve as an introduction to the modular concept and also a working reference for design and construction of building. The purpose of these standards is to describe the general theory and application of modular co-ordination for providing guidance to designers, manufacturers and builders. *(For list of standards see BIS website www.bis.org)*.

Different Prefabricated Systems

Way back in 1973, the National Committee on Science and Technology Panel on "Prefabrication" including Industrialized system of buildings, had recommended that there was a scope for introducing full-fledged prefabricated buildings in metropolitan cities with a population of 1 million and over where heavy transport and hoisting equipments are available. The panel had also felt that in urban areas with a population of less than one million and in rural areas there may not be conditioned demand for residential and institutional buildings to justify setting up of capital intensive factories. Partial prefabrication combining standardized and optimized precast components such as solid and hollow concrete blocks, light weight concrete blocks, columns, beams, lintels, doors and windows, roofing units, sanitary case units etc. produced on-site or off-site combined with in-site wall may be solution.

In this period of more than three decades, several prefabrication systems were developed and used. A majority of the factories set up with considerable public financial participation and few under private sector. Many research organizations, engineering and constructing firms, State Housing Boards and planning organizations have done considerable on-site prefabrication for housing work in India.

Standards on different systems have been formulated from time to time. However, experience has shown that, compare to large panel prefabrication system, partial prefabricated construction has found more acceptance in Indian condition. However, some technologies of large panel used in other countries, appears to have good potential in our country. It, therefore, require a relook in the approach, including standardization.

IS 11447:1985 Code of Practice for Construction with large panel prefabricates was published with an idea to provide guidelines for the design of such construction in the country.

Large panel prefabricated construction, though used in the country, did not find success due to various reasons. Realising the need for partial prefabrication, a number of different types of such systems were evolved, covering different elements of a building.

Foundations: Conventional methods using insitu techniques are found to be economical and more practical. Prefabrication is not recommended for foundations in normal situations.

Walling: Compare to load bearing brick wall construction when blocks of larger sizes than bricks are used, the number of joints are reduced, there by providing saving in the consumption of mortar and increase productivity. Different types of components concerned are:

i) Hollow and solid concrete blocks [IS 2185 (Pt. 1)]
ii) Hollow and solid light weight concrete blocks [IS 2185 (Pt.2)]
iii) Autoclaved cellular Aerated concrete blocks [IS 2185 (Pt.3)]
iv) Autoclaved reinforced cellular concrete wall slabs [IS 6072]
v) Precast concrete stone masonry blocks [IS 12440]

Following Code of Practice are also available:

i) Light weight concrete block masonry [IS 6042]
ii) Autoclave concrete block masonry [IS 6041]
iii) Hollow and solid concrete block masonry [IS 2572]

Roofing/Flooring: The structural floor/roof account for

about twenty-five present of the cost of a building. It consumes maximum amount of steel and cement required for building and about one-fifth of the time of construction. On-site or off-site standardized and optimized roofing components where shuttering is avoided, therefore, are very useful in achieving quality, speed and economy. Some of the proven flooring/roofing technologies on which Indian Standards (Specification and Code of Practice) have been

formulated are: -

a. Precast RC plank and RC joist [IS 13990 & IS 13994]
b. Prefab brick panel and RC joist [IS 14142 & IS 14143]
c. Precast RC channel units [IS 14201 & IS 14215]
d. Precast 'L' panels for sloping roofs [IS 14241 & IS 14242]
e. Precast waffle units for large spans over 9 m [IS 10505]
f. Joists and hollow filler blocks
   i. With hollow concrete filler blocks
   ii. With hollow clay filler blocks
   iii. With precast hollow clay block joist and hollow clay filler block
   iv. With precast hollow clay block slabs panels
g. Precast reinforced prestressed concrete ribbed or cased slab units [IS 10297]

h. Autoclaved reinforced cellular concrete floor and roof [IS 6073]

Ferrocement roofing channels and filler slabs have also been used with success. It is required to formulate standards on these products.

Precast Lintels : Based on this RCC lintels can be made designed and precast. IS 9093 covers requirements of precast concrete lintels and sills. These have been adopted extensively by many organizations throughout the country. It saves the basic materials and increases the speed of construction.

Precast Concrete Door and Window Frames: Precast RC door and window frames are alternate to traditional timber frame. They are more suitable in wet areas and are resistant to termite, fungus and fire as compared to wooden frames. IS 6523:1983 covers the requirements of such frames.

New Technologies/Systems: With the industrial globalization, new technologies/ systems from other countries are being introduced in the country. Some of these technologies like large panels manufactured using fibre glass reinforced phosphogyp-sum based large panels, large panels manufactured using thermocol sandwiched between reinforcement cage, tunnel form construction are being tried by some of the agencies.

It is, however, important to evaluate such technologies for its effective performance under Indian conditions before it is used for mass scale housing. Performance Appraisal Certification Scheme (PACS) being

operated by BMTPC may be useful for such products and systems as third party evaluation of their performance based on lab and field tests (for details see www.bmtpc.org).

For evaluating the performance of any systems following parameters are required to be evaluated , as appropriate

For the individual components

- Dimension and dimension stability
- Unit weight
- Water absorption
- Compressive and tensile strength
- Fire resistance
- Durability requirements
- Thermal behavior
- Pull out test
- Biological effect
- Optical properties

For the systems

- Behaviour against vertical and horizontal load
- Seismic performance
- Rain penetration test
- Thermal properties
- Acoustic properties
- Water proofing and damp proofness
- Ease of working
- Consistency and workability
- Ease of fixing electrical and plumbing fixtures
- Fixing of door and window frames for single and double shutters

Future Approach to Standardization

With the development of new technologies, it becomes imperative to discuss future approach of standardization in the field of prefabrication.

Following approach comes to our mind, which may provide necessary guidelines / recommendations to all concern:

1) Identify various types of prefabricated construction suitable to the country considering climatic zone, seismic zone and natural hazard
2) Standardization of main parameters of the building.
3) Develop performance standards on various parametres

It is a most difficult task to arrive at a standardized parameters for residential buildings since requirements both architectural and functional varies from person to person. However, guidelines could be formulate general guidelines on Prefabricated construction, which will be applicable to all types of systems. This may include the following:

- Design basis and stability provision
  - i. Basis of design
  - ii. Handling stresses
  - iii. Compatibility
  - iv. Anchorage at supports
  - v. Joists
  - vi. Stability
  - vii. Durability
- Precast Concrete Construction
  - i. Framed structures and continuous beam
  - ii. Slabs
  - iii. Bearing of precast members
  - iv. Construction accuracy
  - v. Other forces at bearing
  - vi. Connection
  - vii. Site instruction
  - viii. Reinforcement detailing
- Serviceability limit state
  - i. Ultimate limit state
  - ii. Cover thickness
  - iii. Workmanship

For erection of prefabricated construction, it is necessary to properly design the joints of various components. Efficient jointing system forms an essential part of prefabricated construction. Joints are required to be designed in the light of the assessment with respect to feasibility, practicability, serviceability, fire proofing and appearance.

It is required to evolve performance standards depending upon the functional need of different elements and formulate Code of practice/guidelines for different systems of prefabricated construction keeping in mind the general requirements.

Conclusion

Prefabrication is very much needed for mass construction of houses so as to fulfill housing needs of the country. Standardization of some of the prefabricated construction system existing in the country has been done. However, there is a need to have a comprehensive and holistic approach to cover different requirements of prefabricated construction in a more systematic manner so that users have informed choice of the different systems. It is also required to develop appropriate testing facilities in the country for evaluating different performance requirements.

Technical Workshops for Strengthening Techno-Legal Regime for Safety against Natural Hazards in various States/UTs

An Expert Committee constituted by Ministry of Home Affairs with Secretariat in BMTPC formulated Model recommendations for amendments in Town and Country Planning Acts, Development Control Rules and Building Byelaws for safety against natural hazards. MHA also entrusted BMTPC to organize Technical Workshops in States and UTs so as to disseminate recommendations of the Expert Group and to help them in modifying their Town & Country Planning Act, Development Control Rules and Byelaws. In the 1st phase, Workshops were held in Uttar Pradesh, Chattisgarh, Bihar, Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Tamil Nadu, Pondicherry, Uttrakhand, Andaman & Nicobar Islands and 8 North Eastern States i.e. Assam, Meghalaya, Nagaland, Sikkim, Tripura, Mizoram, Arunachal Pradesh and Manipur. While discussing the recommendations, necessary amendments in Acts, Development Control Rules & Byelaws of respective States/UTs were also prepared clause-wise. Some of the States have already initiated actions for the necessary modification in their Byelaws and Acts for safety against natural hazards.

Based on the feedback received during the workshops, separate recommendations have been prepared for Municipal Councils and Nagar Panchayat, keeping the original recommendations for Municipal Corporations. Extending this exercise in the second phase, two workshops have been organized in Thiruvananthapuram, Kerala and Bangalore, Karnataka.

भारत और भूकंप

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भारत में प्रत्येक विनाशकारी भूकंप के बाद भूकंप सुरक्षा के संबंध में समाचार पत्रों और टी.वी. चैनलों पर काफी कुछ कहा जाता है । विभिन्न सरकारी एजेंसियां इस बारे में योजनाओं की घोषणा करती हैं । टी.वी चैनलों पर अनेक विशेषज्ञों का साक्षात्कार दिखाया जाता है ताकि वे ऐसी आपदाओं को कम करने के तरीकों पर अपना मत व्यक्त कर सकें । देश भर में अनेक सम्मेलन आयोजित किए जाते हैं और लोग इस बारे में आश्वास्त होने लगते हैं कि भूकंप सुरक्षा की समस्या का अब निदान हो जाएगा । लेकिन इस प्रकार का अगला भूकंप आते ही हम पाते हैं कि पिछली घटना के बाद से इस बारे में कुछ नहीं किया गया है । विनाशकारी कश्मीर भूकंप की पृष्ठभूमि में अब समय आ गया है कि भारत में भूकंप समस्याओं पर गंभीर आत्ममंथन किया जाए ।

भारत में भूकंपों के अध्ययन से स्पष्ट है कि ऐसे मकानों का निर्माण करना संभव है जिनसे भूकंप के समय लोगों के जान माल की क्षति न हो ।

मौजूदा परिदृश्य:

2001 के भूकंप के पश्चात भारतीय मध्यवर्ग में पहली बार यह देखा कि बहुमंजिला इमारतें ताश की पत्ते की तरह किस तरह गिर जाती हैं और यह पाया कि ये उसी किस्म के मकान हैं जिनमें वे रह रहे हैं या सेवानिवृति पर रहने की योजना बना रहे हैं । केन्द्र और राज्य सरकारों ने अनेक योजनाओं और कार्यकलापों की घोषणा की । और यह आशा की जा रही थी कि भूकंप सुरक्षा के लिए भारत में अब प्रभावी कार्यक्रम तैयार होगा और अधिकांश (यदि सभी नहीं) नए निर्माणों में भूकंपीय संहिताओं का पालन होगा । क्या इस प्रकार की आशाएं पूरी हुई हैं ?

मौजूदा लेखकों की जानकारी के अनुसार विभिन्न शहरों और नगरों में अब भी हर रोज बड़ी संख्या में असुरक्षित भवनों का निर्माण हो रहा है । 2001 के भूकंप के पश्चात अनेक नागरिक प्राधिकरणों ने संरचना इंजीनियरों(और अन्य जैसे कि वास्तुकारों और बिल्डरों)से यह प्रमाण पत्र जारी करने के लिए कहा कि भवन भूकंपीय संहिताओं के अनुरुप हैं या नहीं । दुर्भाग्यवश, ऐसे प्रमाण पत्र आसानी से प्राप्त हो जाते हैं, जिनका इस बात से कोई लेना देना नहीं होता है कि भवन कैसे बने हैं । जब तक नागरिक प्राधिकरण भवन संहिताओं के अनुपालन के संबंध में किए गए उपायों का परिपालन सुनिश्चित नहीं करेंगे तब तक विभिन्न कारणों से प्रमाण पत्र जारी होते रहेंगे ।

देश व्यापक विकास के चरण से गुजर रहा है जिसमें अवस्थापना पर अभूतपूर्व जोर दिया जा रहा है । यह एक अच्छा अवसर है जब हम सभी नई अवस्थापनाओं के लिए भूकंपीय अपेक्षाओं का अनुपालन सुनिश्चित कर सकते हैं । दुर्भाग्य से ऐसा नहीं हो रहा है ।

समस्या का विवरण:

इंजीनियरिंग में स्वयं समस्या के समाधान की बजाय अकसर समस्या को परिभाषित करना ज्यादा महत्वपूर्ण और कभी कभी ज्यादा चुनौतीपूर्ण होता है । प्राय: समस्याओं का वास्तविक विवरण, जैसी कि वे हैं, देने में हमारा राष्ट्रीय अथवा व्यावसायिक अहम आड़े आ जाता है जिससे समाधान ढूढ़ने का अवसर समाप्त हो जाता है ।

प्रत्येक हितबद्ध व्यक्ति (स्टेक होल्डर) यह सोचता है कि इस मुद्दे के समाधान में उसकी भूमिका सबसे अधिक महत्वपूर्ण है । इसलिए, समस्या का किस प्रकार समाधान किया जाए के बारे में वैज्ञानिकों, इंजीनियरों, प्रशासकों, समाज विज्ञानियों और गैर सरकारी संगठनों के बीच मतों में अंतर आना स्वाभाविक है । कुछ लोग कहेंगे कि सुरक्षित निर्माणों के लिए जन जागरुकता अभियान चलाना आवश्यक है तो कुछ और यह कहेंगे कि और ज्यादा भूकंपीय यंत्रों की व्यवस्था करना महत्वपूर्ण है । बहुत से यह सिफारिश करेंगे कि इस दिशा में कोई भी कार्य करने से पहले भूकंपीय माइक्रो जोनेशन किया जाए । तथापि, कोई भी इस बात से असहमत नहीं होगा कि यदि सभी भवन भूकंप झेलने में समर्थ हों तो समस्या अपने आप समाप्त हो जाएगी । यह स्पष्ट है कि असुरक्षित भवनों का स्टॉक

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ही समस्या है और इसका समाधान यह है कि (क) यह सुनिश्चित करना कि सभी नए निर्माण भूकंपरोधी हों और (ख) सभी मौजूदा संरचनाओं को एक निश्चित समयावधि में सुसंगत रिट्रोफिटिंग के जरिए भूकंपरोधी बनाया जाए ।

नए निर्माणों में सुरक्षा सुनिश्चित करना

सुरक्षित निर्माण सुनिश्चित करने के लिए लेखकों के अनुसार नीचे लिखे घटकों पर जोर देना होगा :

जन जागरुकता:

जन जागरुकता सुरक्षा कार्यक्रमों को कार्यान्वित करना काफी आसान हो जाएगा यदि लोग भूकंपीय जोखिमों के प्रति जागरुक हो जाएं । भुज में 2001 के भूकंप और कश्मीर में 2005 के भूकंपों से काफी जागरुकता आयी है । अब मात्र यह करने की जरुरत है कि हम निर्माण पर्यावरण में परिवर्तनों की जरुरत के बारे में लोगों को एक खाका मुहैया कराएं ।

कानूनी तंत्र:

2001 के भूकंप के पश्चात अनेक राज्य सरकारों और नागरिक प्राधिकरणों ने संहिताओं का अनुपालन अनिवार्य कर दिया है । अब सुरक्षा के संबंध में वास्तुकारों, संरचना इंजीनियरों, ठेकेदारों, निर्माण इंजीनियरों, विकासकों और नागरिक प्राधिकरणों के दायित्व के संबंध में स्पष्ट सोच विकसित करने की जरुरत है ।

तकनीकी क्षमता:

पिछले दशक में अनेक क्षमता निर्माण कार्यकलापों से भूकंपीय संहिताओं के बारे में संरचना इंजीनियरों की जानकारी स्तर को सुधारने में मदद मिली है । तथापि, इस संबंध में अभी बहुत कुछ किया जाना बाकी है ।

व्यावसायिक परिदृश्य :

वास्तुशास्त्र, चिकित्सा, एकांउटेंसी और विधि हमारे देश में विनियमित व्यवसाय हैं । इन व्यवसयों की संबंधित परिषदें यह सुनिश्चित करती हैं (i) प्रैक्टिस करने के लिए लाइसेंस प्राप्त व्यक्तियों की सक्षमता, और (ii) उनके सदस्यों द्वारा नीति सम्मत प्रैक्टिस । भारत में इंजीनियरी व्यवसाय को विनियमित करने के लिए एक प्रणाली की काफी अरसे से जरुरत है । भारत में भवन उद्योग से जुड़े कास्तकारों और तकनीशियनों की क्षमताओं में काफी कमी आयी है । एक मिस्त्री में आज दो दशक पहले के मिस्त्री से कहीं कम सक्षमता है । इसलिए कामगारों और मिस्त्रियों के लिए प्रमाण पत्र प्रणाली की जरुरत है । गुजरात राज्य सरकार ने इस दिशा में अहम काम किया है ।

परिपालन:

किसी भी ऑटोमोबाइल में सीट बेल्ट बांधने से कोई हानि नहीं होती है । लेकिन फिर भी जनता इसका अनुपालन करना सीखे उससे पहले पुलिस को इसका परिपालन कराना चाहिए । तो क्या हमें प्रत्येक संपत्ति विकासक से यह अपेक्षा रखनी चाहिए कि वह संहिता के अनुपालन के लिए स्वेच्छा से अतिरिक्त खर्च करें विशेषकर जब वह स्वयं भी ऐसे भवन में नहीं रहेगा ? इसलिए नागरिक प्राधिकरणों को न केवल भूकंपीय संहिताओं के अनुपालन का प्रमाण पत्र एकत्रित करना चाहिए बल्कि संरचना नक्शों की एकबारगी समीक्षा द्वारा स्वतंत्र रुप से ऐसे प्रमाण पत्रों की जांच भी करनी चाहिए ।

अनुसंधान और विकास:

हमारी निर्माण पद्धतियां विकसित देशों की निर्माण पद्धतियों से भिन्न हैं और अनेक तकनीकी समस्याओं के समाधान के लिए स्वदेशी अनुसंधान और विकास अपेक्षित है । देश में अब तक भूकंप विज्ञान पर दिए जा रहे जोर की बजाय भूकंप इंजीनियरिंग पर अनुसंधान पर ध्यान देने की जरुरत है ।

जन जागरुकता, कानूनी ढांचा और इंजीनियरों के क्षमता निर्माण के संबंध में यद्यपि हमने कुछ प्रगति की है । फिर भी हमने भवन निर्माण उद्योग और संबंधित संहिताओं के परिपालन के क्षेत्र में व्यावसायिक परिदृश्य को बेहतर बनाने की दिशा में बहुत कम काम किया है । ग्रामीण और अनौपचारिक निर्माणों के संबंध में, जो नागरिक प्राधिकरणों द्वारा विनियमित नहीं हैं, विभिन्न किस्म के दृष्टिकोणों की आवश्यकता है :

- हमें ऐसे प्रौद्योगिकीय समाधानों की जरुरत है जिनसे आम आदमी स्थानीय रुप से उपलब्ध संसाधनों से सामान्य भूकंपरोधी मकान बना सके । उत्कृष्ठ भूकंपरोधिकता वाले पारंपरिक निर्माणों के उदाहरणों में पूर्वोत्तर राज्यों में असम किस्म के मकान और कश्मीर में धज्जी द्वारी निर्माण शामिल हैं । ऐसे तथा अन्य प्रकार के निर्माणों की समसामयिक किस्म का विकास करने के लिए अनुसंधान करने की जरुरत है ।
- हमें बिना सक्षम इंजीनियरी पर्यवेक्षण के प्रबलित कंक्रीट ढांचा भवनों के निर्माण को हतोत्साहित करना चाहिए । इसके बजाय जब पर्याप्त इंजीनियरी साधन उपलब्ध

न हो तो सीमित चिनाई वाले भवन या प्रबलित कंक्रीट अपरुपण दीवारों वाले भवन ज्यादा उपयुक्त हैं ।

- जैसे जैसे शहरी क्षेत्रों में इस प्रकार की पद्धतियों में सुधार होगा वैसे-वैसे ग्रामीण क्षेत्रों में सुधार होगा क्योंकि अनौपचारिक क्षेत्र, औपचारिक क्षेत्र का अनुसरण करते हैं ।

मौजूदा निर्माणों की भूकंपीय रिट्रोफिटिंग

दुर्भाग्यवश रिट्रोफिटिंग कार्य करने के लिए अपेक्षित आधुनिक तकनीक को देश में पर्याप्त ढंग से स्पष्ट नहीं किया गया है । या तो इसके प्रति शिथिल दृष्टिकोण अपनाया गया है या फिर रिट्रोफिटिंग कार्य को काफी परेशानी वाला माना गया है । वर्ष 2001 के भूकंप के पश्चात गुजरात में अनेक सरकारी विभागों ने बहुत सी सरकारी इमारतों के लिए भूकंपीय रिट्रोफिटिंग के डिजाइन का कार्य कुछ संरचना इंजीनियरी फर्मों को सौंपा । दुर्भाग्य से यह सुनिश्चित करने का कोई प्रयास नहीं किया गया कि क्या वे फर्में इस प्रकार का कार्य करने के लिए समर्थ हैं या नहीं अथवा क्या उनसे की जाने वाली अपेक्षाएं व्यवहारिक हैं । अब यह स्पष्ट हो रहा है कि उनमें से अनेक फर्मों के पास इस प्रकार का कार्य करने के लिए कोई विशेषज्ञता नहीं थी । रिट्रोफिटिंग के संबंध में कुछ तथ्यों को पुन: स्पष्ट करने की जरुरत है ।

रिट्रोफिटिंग खर्चीली है

रिट्रोफिटिंग की लागत उसी प्रकार की नई सुविधा वाले भवन की लागत के 10 से 50 प्रतिशत तक हो सकती है ।

रिट्रोफिटिंग एक लम्बी अवधि की प्रक्रिया है

असुरक्षित निर्माणों और उपलब्ध संसाधनों की सूची के आधार पर इस कार्य के लिए दशकों तक चलने वाली समय सारणी की जरुरत होगी ।

रिट्रोफिटिंग के लिए काफी विशेषज्ञता और प्रौद्योगिकी अपेक्षित है

जटिल संरचनाओं या जब बेहतर जीवन सुरक्षा निष्पादन का उद्देश्य हासिल करने का लक्ष्य हो तो रिट्रोफिटिंग कार्य के लिए काफी तकनीकी जानकारी अपेक्षित है । भारत में हमें अभी भी मौजूदा भवनों के भूकंपीय आकलन और भूकंपीय रिट्रोफिटिंग के लिए मानदण्ड संबंधी सहमति विकसित नहीं हुई है ।

सरकार महत्वपूर्ण संस्थापनाओं की रिट्रोफिटिंग का कार्य शुरु करें :

हम ऐसा नहीं कर सकते कि एक तरफ तो हम प्रत्येक बच्चे को स्कूल भेजने पर जोर दें और दूसरी तरफ हम उन्हें ऐसे स्कूल में भेजे जो असुरक्षित भवन में चल रहे हैं । 2001 भुज भूकंप व 2005 कश्मीर भूकंप में स्कूल की इमारत गिरने से स्कूली बच्चों की मृत्यु जैसी दु:खद घटना भारत के अनेक शहरों में हो सकती है । निजी भवनों की रिट्रोफिटिंग पर जोर देने से पूर्व हमें सभी सरकारी इमारतों की रिट्रोफिटिंग के लिए गंभीरता से नीति बनाने की जरुरत है ।

प्राथमिकता प्रणाली अपेक्षित है

चूंकि संभी संस्थापनाओं की रिट्रोफिटिंग एक ही समय में एक साथ नहीं हो सकती है इसलिए खर्च की गई राशि से ही अधिकतम सुरक्षा सुनिश्चित करने के लिए हमें स्थल पर भूकंपीय जोखिम, संस्थापनाओं की संवेदनशीलता(वल्नरेबिलिटी) और होने वाली क्षति के परिणाम आदि पर विचार करते हुए एक युक्तिसंग प्राथमिकता प्रणाली तैयार करनी चाहिए ।

संक्षेप में रिट्रोफिटिंग के कार्य को गंभीरता से शुरु करने के प्रयासों से पूर्व काफी तैयारी और कार्य की पृष्ठ भूमि बनाने की जरुरत है ।

निष्कर्ष टिप्पणियां :

भूकंप की समस्या के प्रति सबसे बेहतर दृष्टिकोण यह होगा कि इंजीनियरी, विज्ञान और इंसट्रूमेंटेसन, जन जागरुकता, सार्वजनिक नीति आदि सभी पहलुओं पर साथ साथ कार्य किया जाए । भूकंप संबंधी आपदाओं को कम करने में विज्ञान की भूमिका को हम कम नहीं आंकना चाहते हैं । तथापि, यह महत्वपूर्ण है कि परिदृश्य में यही माना जाना चाहिए कि भूकंपीय सुरक्षा एक चुनौतीपूर्ण इंजीनियरिंग समस्या है जिसमें दशकों तक ध्यानपूर्वक कार्य करने की जरुरत है और विज्ञान के प्रति अपने उत्साह के जोश में हम इस पहलू की उपेक्षा नहीं कर सकते हैं ।

आइये, ऐसे भवनों का निर्माण करें जिससे आगे आने वाले भूकंप के दौरान जान माल की क्षति न हो और आने वाली पीढ़ियों को हमारी भूकंपरोधी भवन शैली पर गर्व हो ।

आभार

यह लेख, उन सभी लेखों, जो भारतीय शोधकर्त्ताओं द्वारा विभिन्न मंचों पर प्रकाशित किए गए हैं, का हिन्दी रुपांतरण है । हम सभी लेखकों का आभार प्रकट करते हैं जिन्होंने समय समय पर भारतीयों को भूकंप की समस्या से रुबरु कर सचेत कराया है ।

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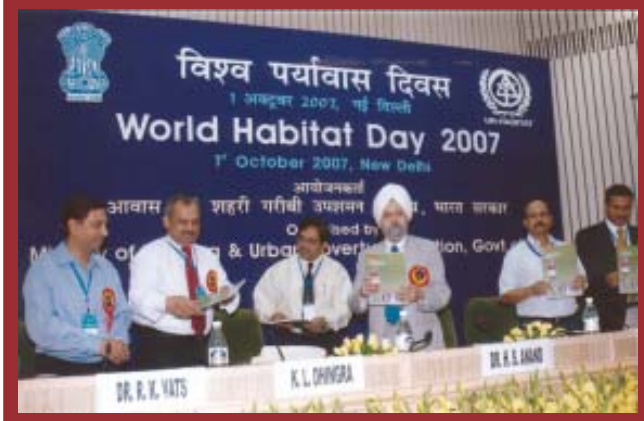
Community Mat Weaving Centre at Nattinampilly, Kerala set up by BMTPC




World Habitat Day 2007 Celebrations





Bamboo as an Alternative Housing Material
-The CBTC's Experience

*Kamesh Salam**

Introduction

Bamboo is one of the strongest natural building materials known to man and is widely regarded as one of the most versatile grass or forest product. In countries of its natural distribution, apart from use as raw material for pulp and paper, its most extensive utilization is for construction purposes - as post, rafter, frame, partition, floor and roofing. Bamboo is not just an ideal wood substitute, it transcends wood. It comes pre-finished by nature as its culms can be used straight, without much processing. In many places, its use is restricted almost exclusively for low cost housing, built by the owners themselves.[1] The usage of bamboo as a building material has many socio-economic benefits. Each bamboo growing country has a different kind of traditional bamboo building and the available knowledge is without any system or coherence. Attempts are being made to document these indigenous technologies. As an economic building material, bamboo's rate of productivity and cycle of annual harvest outstrips any other naturally growing resource. If three or four bamboo culms are planted, then in four or five years mature clumps will emerge, and in eight years these will be mature enough to build a comfortable, low-cost house.

Successful International Bamboo Housing Programme

There are learning experiences in the usage of bamboo as a structural material, which are available from different parts of the world. One of the most notable ones has been described below:

Costa Rica: A case study

The National Bamboo Project was started in 1986 as a new technological approach to prevent deforestation in Costa Rica. The idea was to replace the use of wood with an alternative cost-effective and seismically sound building material. The project has been monitored in three phases. The preparatory phase saw the pilot-project being transferred from experiences in Colombia and Ecuador. During the following two phases an intensive construction scheme in the rural areas was developed including technical training, massive bamboo cultivation, community and labour organization, environmental assessment of the technology and production of furniture and handicrafts for export. The project has fostered the sustainable use of bamboo as raw material for an indigenous housing programme and for the industrialization and marketing of by-products. In July 1995 a foundation was set-up (FUNBAMBU) to assist and eventually take-over the whole program, thus ensuring its sustainability. Up to now 700 low-cost houses have been built and 200 hectares of bamboo have been cultivated.

Current Usage of Bamboo for Housing in India

The current size of the housing segment in usage of bamboo is limited to the utilization that has been cited for internal consumption. This amounts to 1.2 million tonnes out of the to-

[1] *Structural Adequacy of Traditional Bamboo Housing in Latin America, INBAR*

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President, World Bamboo Organization (WBO).

tal consumption of 13.47 million tonnes. At present there is no value addition since the bamboos are used raw without any kind of treatment or finishing. Moreover the perception prevailing in the minds of the locals who use bamboos to make houses is that the houses are not safe. They aspire for houses made out of cement and bricks. These are however too expensive for a family with limited means.

Information has been collected through a primary survey among 1000 households in the bamboo growing regions of the NER on the type of house that they are living in presently. Three options were provided based on the different combinations of materials used; mud, bamboo and GCI sheet.

1. Mud wall with GCI sheet
2. Bamboo wall with GCI sheet
3. Mud and bamboo without GCI sheet
4. Other

The first two categories of houses are classified as semi pucca while the third category is classified as a kutcha house. In the case of the NER the distribution was skewed towards kutcha houses in the rural areas:

Based on this survey and assessing the Socio-economic issues, the CBTC has taken efforts to demonstrate the use of bamboo to upgrade the quality of habitat in the region. We have been working on developing a model for quality bamboo housing initiated since the year 2000.

CBTC's humble attempt

The CBTC was formed in the year 2000 under the UNDP/ UNIDO country programe for India and since it inception the CBTC has the mandate to develop the bamboo sector in the region. Since then it has embarked upon a concerted effort to contribute to the development of bamboo resources and development of craft and uses of bamboo in the region with the sole objective of improving the life and habitat of people form the region through the locally available materials.

A good part of the effort has been to popularize the use of bamboo for a sustainable and eco-friendly use in the low cost housing sector. As the area has already a tradition of building with bamboo, we have concentrated on improving the skills and techniques of bamboo construction and demonstrated a unique way of building with bamboo that is cost efficient and durable. Our work has created much awareness in showing the feasibility of using bamboo to come up with low cost, aesthetic and practical habitat solutions. A wide acceptance of our structures in the tourism sector has enhanced this view. The acceptance of our techniques and efforts in this sector shows the versatility of bamboo and rids it of its drawback.

Our primary objective had been to address the following issues.

- **Cost effectiveness**
- **Durability**
- **Earthquake resistance**
- **Upgrade vernacular architecture and skills.**

The cost effective nature of the technique was of primary importance to us and we

State/Type of structure	Pucca (%)	Semi pucca (%)	Kutcha (%)
Arunachal Pradesh	2.51	13.58	83.17
Assam	8.11	16.43	75.17
Manipur	0.7	26.92	69.97
Meghalaya	22.21	16.87	51.83
Mizoram	3.68	43.19	48.01
Nagaland	54.6	34.11	9.24
Tripura	3.29	14.22	82.39

achieved it by using the material which is locally available and at the same time by harnessing the skills of the local bamboo workers. The minimum use of brick, steel and mortar made it an attractive model for use. Our emphasis started from understanding the strengths of bamboo as a structural material and converging it with traditional and modern techniques of construction from other sources. With this we were able to upgrade and come up with a new technique that answers all our objectives.

To elaborate on the technique of our construction, it is essential to understand the physical character of bamboo and carry it forward from there. The bamboo in the pole form has immense stability and strength. Its strength is derived from its tubular form and the presence of internodes at regular interval. It is widely accepted and proven that the closer the internodes and thicker the wall, the stronger the bamboo. Another aspect for consideration is the longevity of bamboo is that since it is an organic material, it needs to be harvested at the right time, treated with chemicals or natural process to enhance its longevity and prevents its attack from fungus, termites etc that feed on starch. Once a bamboo has been selected properly and treated, it is ready for use in construction. While constructing, care is taken to prevent its exposure from water and moisture. The most viable construction practice in our experience is to erect the bamboo structure on a light R.C.C. Plinth and provide wide overhangs in the roof which shields it for incessant rain during the monsoons. The rest of the structure is carefully planned with all joinery secured by M.S Bolts and RCC grouting. This has been tried and tested and a variety of joining details developed for use in the different parts of the structure.

An important aspect of our approach to such construction is the revival of Bamboo Crete Wall, which has a history in the region but was neglected in recent times. Our use and experience of it has been good. It is essentially the use of bamboo mats and weaves of varying patters as a base for plastering and creating walls. Once plastered over the bamboo weave gains strength, it is very effective wall in the warm and humid climate of the region. Such walls are good for the region as it is light and does not trap heat and makes for comfortable living.

The effectiveness of such structure an earthquake prone region has also been of primary interest to everybody concerned. The structures are light weight and follows proper framing techniques, which makes it very effective against earthquake impact. This apart, the joinery details are done in such a manner that it allows the structure to absorb shock during the earthquake impact. Overall we have been able to demonstrate our technique in terms of cost effectiveness, longevity and seismic stability. In all this, we have had proven success record and have now generated wide awareness and interest in the building sector.

So far we have built for various organizations starting from the Block Level to State Goverments of Nagaland, Assam, Mizoram and Megahalaya. In addition to it we have built for various tourism stakeholders in the region. Currently we are working for the Postal department in developing a rural post office model and also working on a prefabricated low cost shelter for a flood rehabilitation program.

Capacity Building Programmes organised by BMTPC




Parliamentary Standing Committee on Urban Development visited Demonstration Houses under VAMBAY at Dehradun implemented by BMTPC




Principles of Sustainable Building Design in Urban Environment for Green Buildings

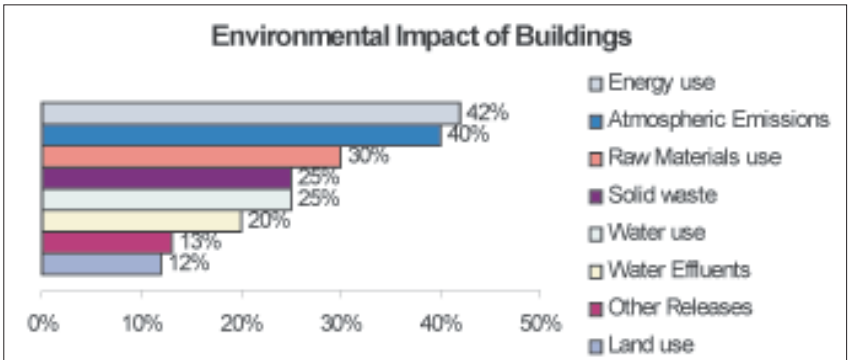
*D.P. Singh**

Introduction:

Building construction and operation have an enormous direct and indirect impact on the environment. As illustrated in the figure below (data for environmental impact of buildings in U.S.A.), buildings not only use resources such as energy and raw materials, they also generate waste and potentially harmful atmospheric emissions. With about 33% of energy consumption in buildings in India , the situation is almost similar in the country. As economy and population continue to expand, designers and builders face a unique challenge to meet demands for new and renovated facilities that are accessible, secure, healthy, and productive while minimizing their impact on the environment.

This challenge calls for an integrated, synergistic approach that considers all phases of the facility life cycle. This "sustainable" approach supports an increased commitment to environmental stewardship and conservation, and results in an optimal balance of cost, environmental, societal, and human benefits while meeting the mission and function of the intended facility or infrastructure.

The main objectives of design are to avoid resource depletion of energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create built environments that are livable, comfortable, safe, and productive. There are six fundamental principles on which there is general agreement for sustainable building design leading to development of green buildings.



Source: Levin, H. (1997) (Environmental Impact of Buildings in U.S.A)

What makes a Green Building Green?

A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving productivity of habitant using energy, water, and other resources more efficiently; and reducing the overall impact to the environment.

Urbanization & greenhouse gas emissions from Buildings

Most buildings are the biggest emitter of greenhouse gases and represent the best opportunity to cost-effectively reduce environmental impact and achieve sustainability. In fact, reports says that buildings are responsible for 39 percent of carbon dioxide emissions and 71 percent of commercial electricity consumption.

Investments in green building strategies consistently result in significant benefits for organizations today. Green buildings not only reduce the environmental impacts of natural resource consumption and green house gas emissions, they also provide

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economical benefits such as reduced costs, improved bottom-line performance and higher shareholder value. Green buildings also enhance occupant comfort and health and improve worker productivity, which in turn improves financial performance.

Economic Benefits of Green Buildings?

Integrating "sustainable" or "green" building practices into the construction of buildings is a solid financial investment. In the most comprehensive analysis of the financial costs and benefits of green building conducted in most of the advance countries adopting green building approach reveals that a minimal upfront investment of about two percent of construction costs typically yields life cycle savings of over ten times the initial investment. For example in USA, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of at least $1 million over the life of the building, assumed conservatively to be 20 years. The financial benefits of green buildings include lower energy, waste disposal, and water costs, lower environmental and emissions costs, lower operations and maintenance costs, and savings from increased productivity and health. These benefits range from being fairly predictable (energy, waste, and water savings) to relatively uncertain (productivity/health benefits). Energy and water savings can be predicted with reasonable precision, measured, and monitored over time. In contrast, productivity and health gains are much less precisely understood and far harder to predict with accuracy.

The financial benefits be understood in this context. Energy, waste, and water savings as well as emissions reductions can be viewed as fairly precise, reasonably conservative estimates of direct benefits that alone significantly exceed the marginal cost of building green. Health and productivity benefits can be viewed as reasonably conservative estimates within a large range of uncertainty.

Fundamental Principle of sustainable building design for Green Building

Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows). Building "green" is an opportunity to use our resources efficiently while creating healthier buildings that improve human health, build a better environment, and provide cost savings.

Buildings have major environmental impacts over their entire life cycle. Resources such as ground cover, forests, water, and energy are depleted to give way to buildings. Resource-intensive materials provide the skin to the building and landscaping adds beauty to it – in turn using up water and pesticides to maintain it. Energy-consuming systems for lighting, space conditioning, and water heating provide comfort to its occupants. Hi-tech controls add intelligence to 'inanimate' buildings so that they can respond to varying conditions, and intelligently monitor and control resource use, security, and usage of fire systems, etc. in the building. Water is another vital resource for the occupants, which gets consumed continuously during building construction and operation. Several building processes and occupant functions generate large amounts of waste, which can be recycled for use or can be reused directly. Buildings are thus one of the major pollutants that affect urban air quality and contribute to climate change. Hence, the need to design a green building, the essence of which would be to address all these issues in an integrated and scientific manner. It is a known fact that it costs more to design and construct a green building. However, it is also a proven fact that it costs less to operate a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in. Thus, the challenge of a green building is to achieve all its benefits at an affordable cost.

A green building depletes the natural resources to the minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources, when in use, and maximize the reuse, recycling, and utilization of renewable resources. It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site

sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. It is evolved through a design process that requires all concerned –the architect and landscape designer and the air conditioning, electrical, plumbing, and energy consultants – to work as a team to address all aspects of building and system planning, design, construction, and operation. They critically evaluate the impacts of each design decision on the environment and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment. In sum, the following aspects of the building design are looked into in an integrated way in a green building.

Optimize Site Potential

Creating sustainable buildings starts with proper site selection, including consideration of the reuse or rehabilitation of existing buildings. The location, orientation, and landscaping of a building affect the local ecosystems, transportation methods, and energy use. Siting for physical security has become a critical issue in optimizing site design. The location of access roads, parking, vehicle barriers, and perimeter lighting must be integrated into the design along with sustainable site considerations.

Optimize Energy Use

With supply of fossil fuel dwindling, concerns for energy security increasing, and the impact of greenhouse gases on world climate rising, it is essential to find ways to reduce load, increase efficiency, and utilize renewable energy resources. The following strategies may be adopted.

- Passive design strategies can dramatically affect building energy performance. These measures include building shape and orientation, passive solar design, and the use of natural lighting.
- Develop strategies to provide natural lighting. Studies have shown that it has a positive impact on productivity and well being.
- Install high-efficiency lighting systems with advanced lighting controls. Include motion sensors tied to dimmable lighting controls. Task lighting reduces general overhead light levels.
- Use a properly sized and energy-efficient heat/cooling system in conjunction with a thermally efficient building shell. Maximize light colors for roofing and wall finish materials; install high R-value wall and ceiling insulation; and use minimal glass on east and west exposures.
- Minimize the electric loads from lighting, equipment, and appliances.
- Consider alternative energy sources such as photovoltaics and fuel cells that are now available in new products and applications. Renewable energy sources provide a great symbol of emerging technologies for the future.
- Computer modeling is an extremely useful tool in optimizing design of electrical and mechanical systems and the building shell.

Conservation of Water

In many parts of the country, fresh water is an increasingly scarce resource. A sustainable building should reduce, control, or treat site-runoff, use water efficiently, and reuse or recycle water for on-site use when feasible.

- Design for dual plumbing to use recycled water for toilet flushing or a gray water system that recovers rainwater or other nonpotable water for site irrigation.
- Minimize wastewater by using ultra low-flush toilets, low-flow shower heads, and other water conserving fixtures.
- Use recirculating systems for centralized hot water distribution.
- Install point-of-use hot water heating systems for more distant locations.
- Meter the landscape separately from buildings. Use micro-irrigation (which excludes sprinklers and high-pressure sprayers) to supply water in nonturf areas.
- Use state-of-the-art irrigation controllers and self-closing nozzles on hoses.
- Use water harvesting system for recharging aquifer.

Materials Efficiency

A sustainable building should be constructed of materials that minimize life-cycle environmen-

Table – 1 : Industrial, mining, mineral wastes and their application in building materials as an alternate to traditional materials and natural resources

Sl. No.	Industrial waste/by-product	Application in building materials as alternative to traditional materials	Traditional material saved fully or partly (20 - 30%)	Natural resources saved fully or partly (10 - 20%)
1.	Blast furnace slags			
	(i) air cooled	• Dense aggregate in concrete or road	• Rock, stone	• Stone
		• Light wt. aggregate for concrete	• Traditional light wt. (high energy)	• Clay, slate, shale
	(ii) foamed	• Portland-slag cement super sulphate cement	• Ordinary portland cement (OPC) sulphate resisting portland cement	• Limestone, clay
	(iii) granulated			
2.	Ferro-alloys and other metallurgical slags	• Pozzolana-metallurigcal masonry cement	Lime pozzolana	• Clays (for pozzolana) • Limestone
3.	Flyash (Pulverised fuel ash)	• Portland-pozzolana	• OPC	• Limestone, clay
		• Concrete filler	• Fine aggregate	• Sand, crushed stone
		• Sintered light wt. aggregate	• Other L.W. aggregate	• Clay, shale, slate
		• Lime-flyash calcium silicate brick	• Sand-lime brick	• Sand, lime
		• Cellular concrete (flyash-lime)	• Cement-sand based cellular concrete	• Cement, sand
		• Clay-flyash brick	• Burnt-clay brick	• Clay
		• Stablisation in roads, mines, lagoons etc.	• Road materials & other fillers	• Traditional road material, clay
4.	Byproduct gypsum (from fertiliser, hydro fluoric acid, boric acid)	• Gypsum for cement	• Mineral gypsum plaster and blocks from mineral gypsum.	• Mineral gypsum • Mineral gypsum • Clay & limestone (for OPC)
		• Gypsum plaster & blocks	• Sulphate-resisting portland cement.	
		• Gypsum plaster fibrous board		
		• Special cements		
5.	Lime sludges form acetylene, sugar, paper & fertiliser industries	• Raw meal component in cement	• Raw meal in cement Traditional L.P.	• Limestone & clay
		• Lime pozzolana mixture, (L.P.)	• Lime from limestone	• Limestone
		• Building lime	• Limestone based masonry cement	• Limestone
		• Masonry cement		• Limestone
6.	Red mud (from alumina in aluminium)	• Cement raw meal	• Farraginous mailer	• Oxides of iron
		• Bricks and tiles	• High strength brick	• Clay, feldspar
		• Sintered aggregate	• Stone and other aggregates	• Clay, shale, slate
7.	Mine tailings (from zinc, copper, gold, iron mines)	• Filler in concrete	• Fine aggregates	• Sand
		• Calcium silicate bricks	• Sand (in sand-lime brick)	
		• Cellular concrete	• Ground sand	• Sand
		• Tailing-clay brick	• Clay bricks	• Clay
		• Masonry cement (tailing + cement)	• Limestone-cement based	• Limestone

Table – 2
Energy saving through use of industrial wastes

Sl. No.	Building material	Composition	Material compared	% Energy saving
1.	Portland pozzolana cement	75% OPC 25% Flyash	100% OPC	20
2.	Portland blast furnace slag cement	60% OPC 40% B.F. Slag	100% OPC	30
3.	Masonry cement	50% OPC 50% Tailings/waste chalk	100% (Masonry cement (50% OPC + 50% Limestone)	20
4.	Lime-pozzolana mixture	25% Acetylene gas lime 75% Flyash	25% Lime 75% Calcined brick	75
5.	Calcium silicate brick	90% FA Tailings 10% Lime (waste source)	Burnt clay brick	40
6.	Burnt-brick	75% clay 25% Flyash	Burnt clay brick	15

Table – 3
Resource and energy saving through use of natural fibres and agro-wastes in building materials

Sl. No.	Waste and source	Commercial product using natural fibre & agro-waste	Traditional resource fully or partly saved	Energy (%)
1.	Coir fibre (coir industry)	Coir fibre-cement roofing sheet & panels	Asbestos	10
2.	Rick husk (Rice mill)	Rick-husk- cement building board	Resin (PF or UF) bonded particle board timber	20
3.	Ground nut hulls (Oil mills)	Ground nut-hull cement building board	Resin-bonded particle board timber	20
4.	Jute fibre (Jute mills)	Jute-fibre-polymer bonded panel; door and window	Timber, metal	10
5.	Cotton waste (Textile mills)	Cotton-lint-cement bonded board	Gypsum, timber	25
6.	Bagasse (Sugar mills)	Bagasse-polymer- bonded boards	Timber fibres (in insulation board)	30
7.	Corn cobs (Corn mill)	Corn cobs-cement bonded boards	Timber, polymer	40
8.	Sisal fibre (Sisal plant)	Sisal fibre-polymer/ cement bonded roofing sheet, door, window	Asbestos fibre Timber	20-25
9.	Rice straw & wheat straw (Farms)	Compressed and paper covered board	Timber Polymer	40
10.	Banana fibre (Banana plant)	Banana fibre + cotton pulp/ paper pulp and polymer insulation boards	Timber Traditional light weight mineral viz. vermiculite or mica	25

tal impacts such as global warming, resource depletion and human toxicity. For this following actions are required.

- Select sustainable construction materials and products by evaluating several characteristics such as reused and recycled content, zero or low off gassing of harmful air emissions, zero or low toxicity, sustainably harvested materials, high recyclability, durability, longevity, and local production. Such products promote resource conservation and efficiency. Using recycled-content products also helps develop markets for recycled materials.
- Use dimensional planning and other material efficiency strategies. These strategies reduce the amount of building materials needed and cut construction costs.
- Reuse and recycle construction and demolition materials. For example, using inert demolition materials as a base course for a parking lot keeps materials out of landfills and costs less.
- Market plans for managing materials through deconstruction, demolition, and construction.

A number of materials and products have been developed by BMTPC and R&D Institutions in the country using industrial and agricultural wastes. Use of such materials helps in conservation of natural resources and energy. Table 1, Table 2 and Table 3 lists industrial and agriculture waste and there applications in building materials with possible energy saving.

Enhance Indoor Environmental Quality (IEQ)

The indoor environmental quality (IEQ) of a building has a significant impact on occupant health, comfort, and productivity. Among other attributes, a sustainable building should maximize day lighting; have appropriate ventilation and moisture control; and avoid the use of materials with high-VOC emissions. Additional consideration must be given to ventilation and filtration to mitigate chemical, biological, and radiological attack.

Optimize Operational and Maintenance Practices

Incorporating operating and maintenance considerations into the design of a facility will greatly contribute to improved working environments, higher productivity, and reduced energy and resource costs. Designers are encouraged to specify materials and systems that simplify and reduce maintenance requirements; require less water, energy, and toxic chemicals and cleaners to maintain; and are cost-effective

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Construction & Demolition Waste Recycling - An option for energy and materials saving for cities

Construction and demolition waste is a significant component of the waste stream and most of the materials involved can be reused or recycled with the minimum of reprocessing. The technology for segregation and recovery of useful materials from demolition waste and its recycling has already been established in other countries, however, in India still lot of work is required to establish this technology for commercial application.

Due to the high weight : volume ratio of construction and demolition materials, there are substantial savings to be made in reusing materials already available on site, rather than transporting virgin materials from a distance. There are, of course, limitations on the reuse of these materials particularly in construction where some performance specifications can only be assured using virgin materials.

In India, most of the big cities are dominated by a large area in which the old buildings are being used by the citizens mostly for residential purpose. Large number of these buildings have completed its life and common man and municipal authority are demolishing and renovating these buildings for construction of new buildings and structures. Most of these buildings in all big cities in India are located in the heart of cities and dumping of debris coming out from the demolished structures is the biggest challenge today for municipal authorities. On the other side, due to large distances transportation of the building materials for construction of new buildings is also an expensive preposition. Therefore, recycling of the debris for generation of the basic building materials and its utilization for development of per-fabricated building components is one of the options for suitable development. The technology may also be useful for rehabilitation work after occurence of natural events such as earthquakes.

BMTPC in pursuit of development of debris recycling technology, jointly with CIDCO-YUVA Building Centre (CYBC), Mumbai, has undertaken a project for development of commercial level technology for recycling and utilization of debris for production of building components. Test Results of the developed products at laboratory scale are as given below:

	Compressive Strength	Water Absorption
Bricks	52.8 kg/cm^2	10.6%
Pavers	407.4 kg.cm^2	8.0%
Blocks	45.0 kg/cm^2	11%

The present plant and machinery with CYBC is capable of recycling about 3-4 tonne debris per day and segregated materials can be used for production of bricks, pavers and blocks. The Council in collaboration with CYBC is at present working on following issues.

- Plant and machinery having capacity to recycle 12 tonnes of debris per day.
- Standardization of the developed technologies and the products manufactured.
- Training Manual for recycling of construction and demolition waste.
- Training programme on the technology for construction workers.

The CYBC supported by City Industrial Development Corporation (CIDCO), Navi Mumbai has got a greater chance for participation in the various developmental works by providing/extending this technology in large number of new upcoming projects in Mumbai. Once the technology is fully developed and established, BMTPC would initiate dissemination of technology in other regions and provide training to construction workers.

Value Added Building Materials using Granite Slurry Waste

India is endowed with one of the best granite deposit in the world having excellent verities comprising over 200 shades. India accounts for over 20% of the world resources in granite. Granite reserves in India have now been estimated by Indian Bureau of mines at over 42,916 million cubic metres. Varities of granites are available in the state of Karnataka, Andhra Pardesh, Tamil Nadu and Uttar Pradesh.

Karnataka State boasts of good deposits of Granite and has been in the forefront in meeting the in-house demands of our country as well as export of unfinished and polished granite as well. There are more than 1000 granite processing industries in small scale sector apart from about 500 Nos. of medium and large scale industries spread over various districts. Major granite processing units are located in Mysore, Tumkur Bellary, Hospet, Hilkal, Hassan, Mangalore and Udupi regions. However, these units are also generating large quantity of granite slurry. The disposal and utilization of this waste is an ever increasing problem for the Granite Industries all over the India.

In order to develop a value added product utilizing Granite slurry waste, BMTPC has undertaken a project on Gainful Utilization of Granite Slurry jointly with Andhra Pradesh Technology Development Centre (APTDC), Hyderabad. The technology has been developed for production of cement based floor tiles/wall tiles/pavers blocks from granite slurry. The products were also tested as per Indian Standards and found comparable to the other conventional flooring and walling building materials as mentioned in Table-1 and Table-2.

BMTPC and APTDC have jointly filed a patent application on the developed technology in June 2008. Now, the Council along with APTDC has identified a Granite industry cluster having 600 small units for cutting and polishing of Granite and also producing slurry as waste in Ongole district of Andhra Pradesh. One of the industries in this cluster has shown interest towards providing land and infrastructure for setting up a demonstration unit. This demonstration unit will be starting point for dissemination and training on the technology among the other Granite waste producing industries in this district.

Table-1: Wall Tiles (300 x 300 x 22 mm)

Sl.No	Test Property	Observed Value
1	Water absorption	5.75%
2	Breaking load under flexural strength	275Kg
3	Dimensional tolerance of Thickness	0.3mm

Table-2: Hexagonal Paver Blocks (50 mm thick)

Sl.No	Test Property	Observed Value
1	Compressive Strength	215 Kg/cm^2
2	Water absorption	5.5%
3	Dimensional tolerance	0.2mm

Demonstration Construction

using Cost Effective and Disaster Resistant Technologies - BMTPC's Initiatives

BMTPC has been promoting cost-effective and environment-friendly building materials and construction techniques in different regions of the country. During recent past, the Council has been laying emphasis on putting up demonstration structures utilising region-specific technologies. Such efforts for demonstrating innovative technologies have created a much better impact and helped in building up confidence and acceptability in private and public construction agencies, professionals and contractors etc. Details of the major projects are given as under:

Demonstration Housing Project at Laggere, Bangalore, Karnataka

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Location of site	:	Laggere, Bangalore
No. of Units	:	252 (Ground + 2)
Built-up area of a unit	:	275 sq.ft.
Unit consist of	:	Two rooms, 1 kitchen, 1 bath room, 1 WC
Cost per unit	:	Rs. 60000
Cost per sqft.	:	Rs.218/-
Nodal State Agency	:	Karnataka Slum Clearance Board

TECHNOLOGIES/SPECIFICATIONS

Foundation
- Random Rubble Stone masonry

Walling
- Solid Concrete Blocks for 200 mm thick walls
- Clay bricks for partition walls
- RCC plinth band for earthquake resistance.

Roof/Floor
- RC Filler Slab using clay bricks as fillers in ground and first floors
- RC Slab for second floor
- IPS flooring

Doors & Windows
- Pre-cast RCC door frames
- Coir Polymer Door Shutters
- Steel Sheet Window shutters
- Clay jalli in Ventilators

Others
- External cement plaster
- White wash in internal walls
- Waterproof cement paint on external walls
- Precast ferrocement lofts, shelves, chajjas

Unit Plan

Demonstration Housing Project at Nagpur, Maharashtra

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Location of site	:	Kalamna, Nagpur
No. of Units	:	70 (Ground + 1)
Built-up area of a unit	:	181 sq.ft.
Unit consist of	:	One room, kitchen space, bath room and WC
Cost per unit	:	Rs. 50,000
Cost per sqft.	:	Rs.276/-
Nodal State Agency	:	Nagpur Improvement Trust

TECHNOLOGIES/SPECIFICATIONS

Foundation
- Under Reamed Piles

Walling
- Solid/Hollow Blocks using flyash/gypsum
- RCC Tie and plinth band for earthquake resistance.

Roof/Floor
- RCC Filler Slab using blocks
- IPS flooring

Doors & Windows
- Pre-cast RCC door frames
- Ferrocement Door Shutters for main door
- Flyash polymer door shutter for toilet
- Cement jalli in Ventilators

Others
- External cement plaster
- White wash on internal walls
- Waterproof cement paint on external walls

Unit Plan

Demonstration Housing Project at Dehradun, Uttarakhand

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Locations of site	:	Dehradun: • Ram Kusth Ashram, Ryagi Road (28 DUs) • Rotary Club Kusth Ashram, Bhagat Singh Colony (34 DUs) • Shanti Kusth Ashram, Bhagat Singh Colony (38 DUs)
No. of Units	:	100
Built-up area of a unit	:	181 sq.ft.
Unit consist of	:	One room, kitchen space, 1 bath room, 1 WC
Cost per unit	:	Rs. 45,000
Cost per sqft.	:	Rs.249/-
Nodal State Agency	:	District Urban Development Agency

TECHNOLOGIES/SPECIFICATIONS

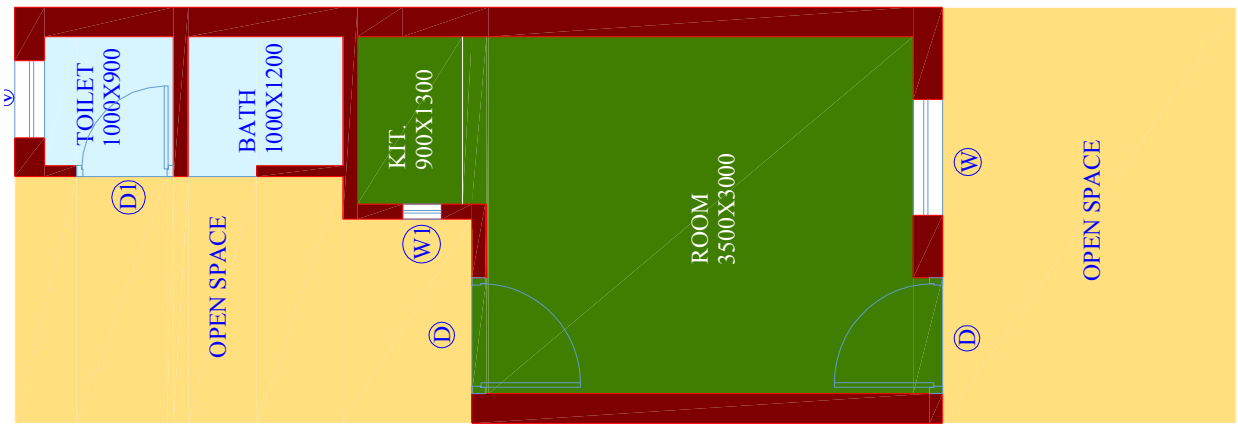
Foundation
- Step footing in solid concrete blocks

Walling
- Solid/Hollow Concrete Blocks
- RCC plinth, lintel, roof level band, vertical reinforcement in corners for earthquake resistance

Roof/Floor
- RCC planks and joists with screed
- IPS flooring

Doors & Windows
- Pre-cast RCC door frames
- Wood substitute door shutters
- Cement jalli in ventilators and windows

Others
- Internal and external pointing
- White wash on walls
- Precast ferrocement chajjas



Unit Plan

Demonstration Housing Project at Kudalu, Karnataka

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Location of site	:	Kudalu, Bangalore
No. of Units	:	70 (Ground + 2)
Built-up area of a unit	:	201 sq.ft.
Unit consist of	:	One multipurpose room, 1 kitchen, 1 bath room and WC
Cost per unit	:	Rs. 60,000
Cost per sqft.	:	Rs.298/-
Nodal State Agency	:	Karnataka Slum Clearance Board

TECHNOLOGIES/SPECIFICATIONS

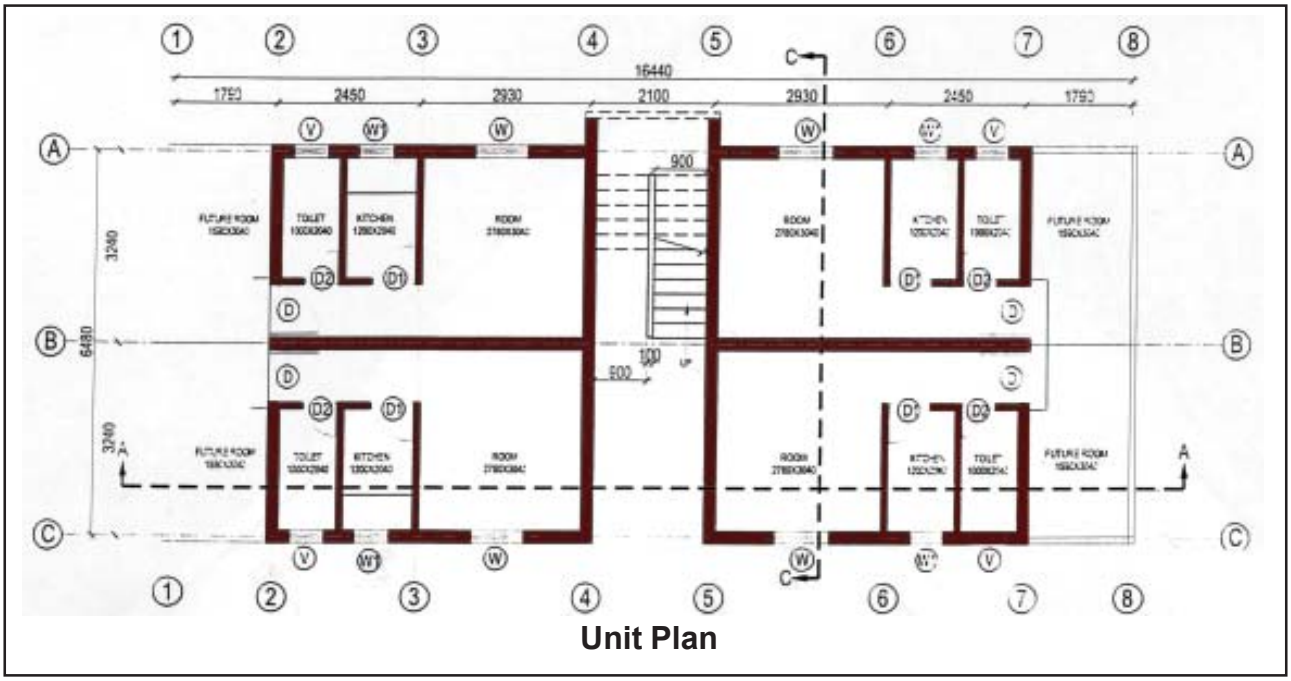
Foundation
- Random Rubble Stone Masonry

Walling
- Flyash Solid Block Masonry
- RCC plinth band for earthquake resistance.

Roof/Floor
- Precast RCC planks and joists for intermediate floors
- RCC slabs for top floor
- IPS flooring

Doors & Windows
- Pre-cast RCC door frames
- Composite Door Shutters
- Clay jalli for Ventilators

Others
- Ferrocement railings
- External and internal cement plaster
- White wash on internal walls
- Waterproof cement paint on external walls



Unit Plan

Demonstration Housing Project at Trichi, Tamil Nadu

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Location of site	:	Nagamangalam, Trichi
No. of Units	:	100
Built-up area of a unit	:	172 sq.ft.
Unit consist of	:	One multipurpose room, 1 kitchen, 1 bath room and WC
Cost per unit	:	Rs. 40,000
Cost per sqft.	:	Rs.232/-
Nodal State Agency	:	Tamil Nadu Slum Clearance Board

TECHNOLOGIES/SPECIFICATIONS

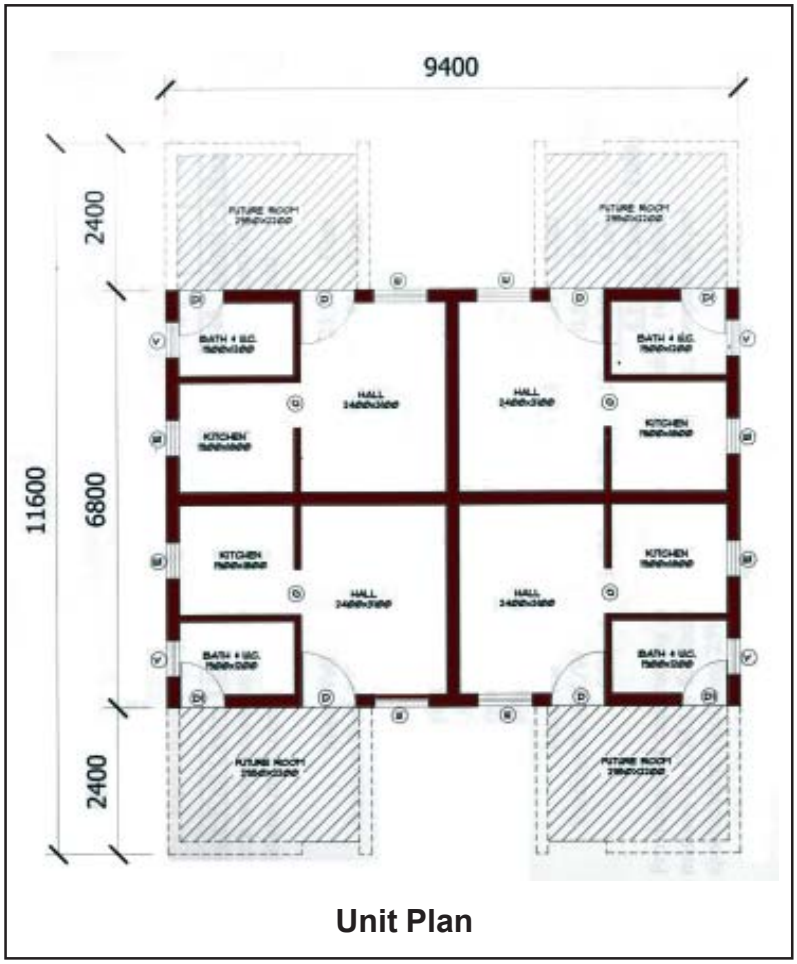
Foundation
- Random Rubble Stone Masonry

Walling
- Flyash Solid Block Masonry

Roof/Floor
- Filler slabs
- IPS flooring

Doors & Windows
- Pre-cast RCC door frames
- Composite Door Shutters
- Clay jalli for Ventilators

Others
- External and internal pointing
- White wash on internal walls
- Waterproof cement paint on external walls



Unit Plan

Demonstration Housing Project at Bilaspur, Chhattisgarh

PROJECT PROFILE

Name of Scheme	:	VAMBAY -Ministry of HUPA
Location of site	:	Bilaspur
No. of Units	:	100 (Ground + 1)
Built-up area of a unit	:	181 sq.ft.
Unit consist of	:	One multipurpose room, kitchen space, bath room & WC
Cost per unit	:	Rs. 40,000
Cost per sqft.	:	Rs.221/-
Nodal State Agency	:	Bilaspur Municipal Corporation

TECHNOLOGIES/SPECIFICATIONS

Foundation
- Single Bulb Under Reamed Piles

Walling
- Flyash Bricks
- RCC plinth band for earthquake resistance.

Roof/Floor
- RCC arched plank and joists with screed
- Flag stone flooring in ground floor
- IPS flooring in first floor

Doors & Windows
- Pre-cast RCC door frames
- Wood substitute Door Shutters
- Cement jalli in Ventilators

Others
- External and internal cement plaster
- White wash on internal walls
- Waterproof cement paint on external walls
- Enamel paint on doors and windows

Unit Plan

Jawaharlal Nehru Urban Renewal Mission - An Inclusive Mission

*C.N.Jha**

Need of the Mission Mode approach for Urban Renewal

Most of the developed countries of the world are highly urbanized and industrialized countries and its urban areas have mainly contributed to their growth. India, though a developing country, is following the same trend. In post independence era while population of India has grown three times, the urban population has grown five times, which as per 2001 population census, stands at 285.35 million people constituting 27.8% of the total population. The contribution of urban population to GDP is increasing rapidly, however at the same time, the rising urban population has created an excessive pressure on already ailing urban infrastructure and given rise to number of urban poor and slum population. The urban population constituted an increasing share in total GDP from about 41 percent in 1980-81 to 46 percent in 1993-94 and to 52 percent in 1999-00. Most importantly, urban share in India's GDP is expected to go up to 65 percent by the year 2011. But on the other side, urban areas have poor infrastructure and very high slum population, as high as 49% in case of Mumbai (as per 2001 Population Census).

Launch of the Mission

The above scenario makes it imperative to draw up coherent urbanization policy/ strategy to cope with massive problems that have emerged as a result of rapid urban growth and to make the growth of the cities sustainable. It is in this context, Jawahar Lal Nehru Urban Renewal Mission, one of the flagship programmes of Central Govt., was launched by Hon'ble Prime Minister, Shri Manmohan Singh on December 03, 2005.

Components and Implementation Aspects

The Mission is to be implemented mainly in 63 selected large cities and cities of historical/religious importance, designated as Mission Cities. There are two sub-components of this mission, namely Urban Infrastructure & Governance (UIG) and Basic Services to Urban Poor (BSUP). Under UIG, admissible components are City level infrastructure items such as transportation network, roads and flyovers, conservation of water bodies, augmentation of water supply, improving coverage of sewer network, etc. While BSUP sub component makes provision for 7 point charter to slum dwellers/ urban poor consisting of security of tenure (housing at affordable cost), water supply, sewer network, road connectively, health, education and social security.

In order to develop smaller cities and towns other than 63 Mission Cities, Urban Infrastructure Development for Small and Medium Cities (UIDSSMT) and Integrated Housing and Slum Development Programme (IHSDP) having similar components as of UIG and BSUP respectively are under implementation.

The role of BMTPC under BSUP & IHSDP of JNNURM

The Council has been extensively involved in many BSUP activities, which have been summarized below;

Appraisal of DPRs

BMTPC is one of the Appraisal Agencies for Detailed Project Reports under JNNURM-Basic Services to Urban Poor (BSUP). It has so far appraised total 93 numbers of proposals under BSUP and 5 numbers of proposals under IHSDP received from 19 States/ UT agencies. The proposals were worth 5862.5 crores having Govt. of India (GoI) share of 3122.7 crores & envisages construction of 293110 dwelling units along with all basic physi-

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cal as well as social infrastructure. The appraisal activity also included framing of Administrative & Technical Check lists, DPR Preparation formats etc and extensive discussion/ interaction with State Govt. Officials on regular basis to ensure that the DPRs submitted were in compliance with Mission Guideline.

Capacity Building Programmes

In order to bring improvement in the quality of DPRs being received by the Ministry from State Agencies, and to address to various project implementation issues, the Council's activity included organizing capacity building programme for State & Municipal Officials on various topics such as preparation of DPRs, Project management, Quality control of projects, etc. The Council organies workshops/seminars jointly with M/o HUPA, GoI. In addition, representatives of the Council regularly participated as resource person in various workshops and programmes organized at State level and at designated resource institutions like YASHDA Pune, CGG Hyderabad etc.

Towards improving Technical Aspects of the DPR

Council developed well designed options of various components of DPRs particularly based on the observations of Project Sanctioning Committee. These components along with some of its features are enumerated below;

- Internal house design; Ensuring privacy for occupants of both rooms, adequate lighting and ventilation, etc
- Layout of cluster housing; ensuring social cohesion, common green area (CGA) for the occupants, common walls etc.
- Neighborhood colony layouts controlled entry/ exit to the colony, restricted vehicular movement along arterial road, etc.
- Provision of separate informal sector market and livelihood centre distinguishing between production and selling activities and based on socio economic survey of beneficiaries.
- Community centre having provision of multi purpose hall, crèche, health centre etc.
- Infrastructure promoting physical fitness; ensuring 15% organized green area, jogging tracks, tree guards etc.

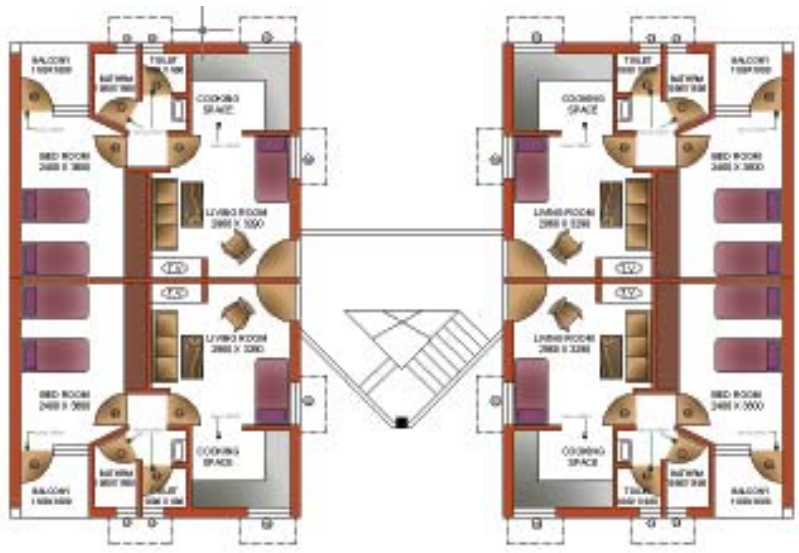
Some of the design options were included as standardized designs of the Booklet published by JNNURM Directorate namely "Habitat for Urban Poor: the Design Perspective - Inclusive Planning & Architecture". This booklet also recommends use of following material/ technologies to ensure Eco-friendly Habitat and Cost effectiveness;

- Effective use of low cost building technologies and materials
- Use of energy efficient fittings; insulation through hollow blocks/ rat trap bond/ cellular lightweight blocks etc; and other appropriate technologies and materials
- Careful selection of building technologies and materials for promoting thermal comfort
- Provision for water harvesting, cleaning and utilization

The standardized designs of the booklet have later been used extensively by State Agencies while formulating new DPRs

Monitoring of the Projects under BSUP & IHSDP

The Council has also been designated as Monitoring Agency by M/o Housing & Urban Poverty Alleviation, GoI for undertaking monitoring of projects



Model Design for EWS Housing

under BSUP and IHSDP. The scope of the work includes analysis of Progress Reports submitted by State Agencies, actual physical inspection of project sites, monitoring of the reforms being undertaken at State and ULB level, etc. An e-Tracking system has been developed by the Ministry for on line monitoring of physical as well as financial progress of BSUP & IHSDP projects. The Council has uploaded the financial & physical details of all its BSUP projects on this monitoring web site. It has so far inspected 21 BSUP projects & 15 IHSDP projects being implemented in 7 States namely Uttar Pradesh, Gujarat, Andhra Pradesh, Haryana, West Bengal, Rajasthan & Maharashtra. Subsequent to the visits, physical and financial progress of the projects is reported to the Ministry.

Monitoring of JNNURM Projects

Significance of the JNNURM-BSUP & likely outcome

The significance of BSUP needs to be emphasized as under no other Govt. housing schemes so far, such elaborate provision of physical and social infrastructure were made. Under VAMBAY, large numbers of houses were built in the States, however, many of the houses built under the scheme, still lack basic infrastructure services.

Under BSUP and IHSDP nearly 1.1 million houses have so far been sanctioned, out of total 1.5 million houses envisaged for the entire mission period. The target may not appear very much significant in the light of 24.7 million housing shortage, however, it also needs to be highlighted that construction of housing units for urban poor is not a one time affair during the mission period only. The construction of housing and provision of other services becomes continuous activity, as a result of series of reforms which State and Urban local bodies agree to undertake within the specified time frame. Three main reforms applicable in case of BSUP are namely a) providing 7-point charter to urban poor, b) reserving 20-25% of developed land in all housing projects (by both public & private agencies) for EWS/ LIG category with a system of cross-subsidization and c) internal earmarking within local body budgets for basic services to urban poor. As it is evident from the text of reforms itself, this is going to have enormous implication in terms of including urban poor into main stream of development process. With the signing of Memorandum of Agreement (MoA) by 61 out of 63 Mission cities & 427 towns by now to undertake reforms, the time is not far before we realize our dream of slum free cities.

Monitoring of JNNURM Projects

International Technology Workshop on "Innovations in Cost-Effective Construction Technologies", 27-28 December 2007, Patna

BMTPC in cooperation with International Centre for Advancement of Manufacturing Technologies (ICAMT-UNIDO) organised two days International Technology Workshop on "Innovations in Cost-Effective Construction Technologies" with specific focus on appropriate and affordable housing technologies on 27-28th December 2007 at Patna, Bihar, India.

The Workshop was inaugurated by the Shri S.K. Singh, Joint Secretary (Housing), Ministry of Housing & Urban Poverty Alleviation. This workshop focused on the various cost-effective, environment friendly and alternative building materials and housing technologies.

The two days programme was attended by more than 100 delegates and was addressed by eminent national and international experts, technologists and product manufacturers. Representatives from Bhutan and Canada also participated in the International Workshop.

On this occasion, an exhibition on innovative technologies was also organized. About 10 Agencies exhibited various alternative building products & housing technologies which provided a perfect opportunity to the participants, users, technocrats, architects, policy-makers on the latest innovations in cost-effective construction technologies.

Promotion of Bamboo based Technologies in the North Eastern Region

BMTPC is actively involved in developing bamboo based technologies and has close association with the National Mission on Bamboo Applications and National Mission on Bamboo Technology and Trade, to promote these technologies in the North-Eastern Region and other bamboo growing areas, by encouraging commercial production of bamboo based products, construction of demonstration houses and setting up of Bamboo Mat Production Centres for processing of bamboo. The Council has undertaken following activities in the North-Eastern Region:

Development of Bamboo based Technologies

The BMTPC in collaboration with Indian Plywood Industries Research & Training Institute (IPIRTI), Bangalore, jointly developed following technologies to promote use of bamboo in housing and building construction in the bamboo growing regions including North East:

- Bamboo Mat Corrugated Roofing Sheets
- Double storeyed house using bamboo based technologies.
- Bamboo mat ridge cap for roofing applications.
- Prefabricated bamboo houses.

Bamboo Mat Corrugated Roofing Sheets are durable, strong, water-proof, and decay-insect-fire resistant. The Council transferred this technology to a private entrepreneur located at Byrnihat, Meghalaya for commercial production and marketing. The product has been accepted by the consumers and is becoming increasing popular as an alternate roofing option in the north eastern part of the country. It is estimated that in full capacity this unit will generate livelihood for nearly 7000 women/men (through mat weaving) in rural regions where bamboo is abundantly grown.

Construction of School Building in Tripura based on Bamboo based Technologies.

Construction of Demonstration Structures using Bamboo based Components

The Ministry of Housing & Urban Poverty Alleviation sanctioned two projects for putting up demonstration buildings using bamboo based technologies in Mizoram and Tripura. BMTPC is putting up 10 nos. demonstration structures, in both the States, using bamboo based technologies. The demonstration structures include houses, school buildings, library buildings, OPD buildings, Picnic huts, etc. The cost of construction using conventional technologies in these areas is around Rs. 800/- per sq.ft. This is considerably reduced using bamboo based technologies and the cost of construction being achieved is Rs.315 to Rs.622 per sq.ft. for different types of structures.

Establishment of Bamboo Mat Production Centres

BMTPC is establishing Bamboo Mat Production Centres in the States of Assam, Tripura, Mizoram and Meghalaya (2 Nos. in each State). In the first phase, the Council is setting up Bamboo Mat Product Centres at Kowaifung, Tripura; Sairang and Bualpui, Mizoram and Sokhar Nongtluh Village, Meghalaya, with the help of State Governments.

The main objectives of Bamboo Mat Production Centres are to provide uninterrupted supply of bamboo mats to manufacturing units of bamboo based building components for increasing the productivity and improving quality, to provide training in mat production process and to create employment opportunities in the North Eastern region. The mats produced by 8 Bamboo Mat Production Centres are likely to utilized by various manufacturers who are producing Bamboo Mat Corrugated Roofing Sheets and Bamboo Mat Boards. Besides the above, the Centres can also generate income by supplying bamboo sticks made out of bamboo waste, to the artisans for making handicraft items.

Capacity Building & Employment Generation

The Council provides training on bamboo mat production to the artisans of Bamboo Mat Production Centres through CBTC, Guwahati on continuing basis. The production capacity of one production centre is 300 mat per day. It is estimated that the Centre will be able to produce the mat at the rate of Rs.35 per mat and would be able to sell at the rate of Rs.45 per mat. This will provide employment generation of nearly 150 women/men per day i.e. 45,000 women/men days per year per Centre.

The Council is also establishing a Technology Demonstration cum Production Centre in Tripura.

New Initiatives

In addition, the following projects have also been initiated and undertaken in the North Eastern Region:

- Training Programme on Modern Bamboo Housing and Construction at Kaziranga, Assam in March, 2008.
- Construction of two demonstration structures using bamboo based technologies in Kohima, Nagaland.
- Construction of two demonstration structures using bamboo based technologies in Shillong, Meghalaya.
- Setting up Bamboo Mat Production Centre in Mopaya Village, Arunachal Pradesh.
- Construction of Community Centre in Mopaya Village, Arunachal Pradesh.
- Construction of demonstration houses for Tea Workers in Assam.
- Setting up of one Bamboo Mat Production Centre in Bamboo growing areas of Garo Hills.
- Setting up of a Bamboo Mother Park in Bynihat, Meghalaya.

Promotion of Cost-Effective and Disaster Resistant Technologies in African Region

BMTPC under the guidance of the Ministry of Housing & Urban Poverty Alleviation, organized a seires of exhibitions and seminras entitlted "International Exhibition cum Seminar on Innovative Building Materials and Construction Technologies for Sustainable Housing in Africa" in Mozambique, Zambia, Botswana and Ethiopia in the month of April 2008. These events received overwhelming response towards adopting Indian technologies for construction of cost effective housing in their respective countries. The response received from African countries are as under:

Mozambique:

The High Commissioner of India in Maputo, while submitting the report on International Seminar cum Exhibition held in Maputo on 3-5 April, 2008, informed that H.E.Prof. Venancio Massingue, Minister for Science and Technology, Government of Republic of Mozambique has mooted a proposal for opening of three Technology Demonstration & Diffusion Centres spread over North, South and East of Mozambique to train youths in various facets of low cost technologies in building construction field. Also a proposal has been mooted by Permanent Secretary of public Works and Housing for training of 128 technicians (drawn from different provinces) in the areas of low cost building technologies which can be replicated in Mozambique to be organized either in India or Mozambique.

Zambia:

The H.E. Minister of Local Government and Housing, Government of Republic of Zambia addressed the Hon'ble Minister of HUPA, Government of India and while appreciating the efforts taken by Government of India by way of organizing International Seminar cum Exhibition in Lusaka, the Hon'ble Minister has desired to send a small team of officer to India to learn about various cost effective technologies. Similarly, the High Commissioner of India in Lusaka, Zambia while submitting the report on International Seminar cum Exhibition held in Lusaka, Zambia on 9-10 April, 2008 expressed that there is a demand in Zambia for construction of low cost houses.

Maputo, Mozambique – 3-5 April, 2008

Lusaka, Zambia – 9-10 April, 2008

Gaborone, Botswana – 14 April, 2008

Addis Ababa, Ethiopia – 15-16 April, 2008

Botswana:

The High Commissioner of India to Botswana informed that as a follow up programme, couple of customers have requested for setting up of Demonstration cum Production and Training Centres in Gaborone.

Ethiopia:

The Ambassador of India to Ethiopia desired to take the following steps:

- Signing of an overall agreement in the low cost housing sector.
- Sending a follow-up delegation to discuss issues and potential of cooperation.
- Training of trainers in low cost housing techniques
- Use of low cost housing technology from India should be put in to practical use for a real demonstrative effect in Ethiopia.
- Providing low cost technologies utilizing local materials to reduce their costs to develop housing for the labour and staff at Greenfield Tendaho Sugar Factory in the Afar Regional State.
- Providing low cost technologies for labour housing, schools and hospital buildings in Oromia Regional State in areas earmarked for tea development.

To strengthen the South-South cooperation, a Project Proposal for India Africa Technical Cooperation Programme in the field of Housing and Human Settlements was prepared and submitted to Ministry of External Affairs by Ministry of HUPA.

The Cabinet has approved the proposal for implementation. The five years project is envisaged to be the initiating point for the implementation of a wider programme designated as Human Settlements Programme addressing the shelter needs of the lower income group of the African region having prime focus towards low cost housing, technology promotion, dissemination and transfer of technology from India. The major components of the project are:

- Establishment of Human Settlement Centres in Mozambique, Botswana, Zambia, Ethiopia and Namibia.
- Establishment of Technology Demonstration and Diffusion Centres in Mozambique, Botswana, Zambia, Ethiopia and Namibia.
- Adaptation of technologies, R&D for adaptation, testing, certification, prototype development and batch production
- Facilitation for technology transfer including support to the professionals, students, delegations for training
- Organisation of Seminars/ Exhibitions across the region including public private partnership
- Construction of 40 demonstration houses each at five locations
- Construction of 400 houses each at five locations with the funding support of Govt. of India's contribution of 10% and 90% by the host country
- Training of engineers, skilled & semi-skilled workers, small entrepreneurs, project managers both in India and host country.

Priced Publications of BMTPC

DIRECTORY OF INDIAN BUILDING MATERIALS & PRODUCTS (with information on Nepal & Bhutan) 2006
550 pages, Rs. 1000 + 200 postage

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

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

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

MANUAL FOR REPAIR AND RECONSTRUCTION OF HOUSES DAMAGED IN EARTHQUAKE of 0ct.91 in the Garhwal Region of U.P.
81 pages, Rs. 150 + 75 postage

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

GUIDELINES FOR DAMAGE ASSESSMENT AND POST EARTHQUAKE ACTION - JABALPUR
(Three Parts)
- Rs. 250 + 75 postage for each part

PRECAST BUILDING COMPONENTS
- 28 pages, Rs. 150 + 30 postage and packing

GUIDELINES FOR DAMAGE ASSESSMENT AND POST EARTHQUAKE ACTION
(Two Parts)
- Rs. 250 + 75 postage and packing for each part

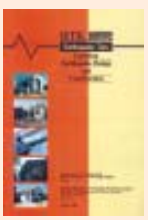
BUILDING WITH COMPRESSED EARTH BLOCKS
28 pages, Rs. 60 + 30 postage

GUIDELINES FOR IMPROVING EARTHQUAKE RESISTANCE OF HOUSING - 76 pages, Rs. 350 + 75 postage

STANDARDS AND SPECIFICATIONS FOR COST EFFECTIVE INNOVATIVE BUILDING MATERIALS AND TECHNIQUES
128 pages, Rs. 200 + 75 postage

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

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



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

ARCHITECTURE OF SAARC NATIONS.
196 pages, Rs. 250 + 75 postage

Promotional Publications of BMTPC

1. Areas of Activity
2. BMTPC Newsletters
3. Build Your Home with Earthquake Protection
4. Environment Friendly Building Materials & Construction Technologies
5. Guidelines for Cyclone resistant houses
6. Grah Nirman Mein Vishesh Savdhaniyan
7. Reconstruction of Earthquake Resistant Houses in Garhwal Region - Guidelines in Hindi
8. Retrofitting of Stone Houses in Marathwada Area of Maharashtra
9. Saste Makan: Vibhinn Vikalp Avam Suvidhain - in Hindi
10. Useful tips for House Builders
11. Strengthening Technological Base of the Building Materials Industry
12. Local Vegetable Fibres + Industrial & Mineral Waste for Composite materials
13. Machines developed by BMTPC
14. An Introduction to the Vulnerability Atlas of India
15. Performance Appraisal Certification Scheme
16. Catalogue for Machines
17. National Network on Building Technology
18. Green Houses for ITBP at Leh
19. Bamboo - A Material for cost-effective and disaster resistant housing
20. Corporate Brochure - in English and Hindi
21. Retrofitting of Hospital in Kupwara, Kashmir, J&K for Safety Against Earthquakes
22. Simple Ways to Earthquake Safety for Jammu & Kashmir - in English and Urdu
23. Bamboo in Housing & Building Construction - Initiatives of BMTPC
24. Disaster Prevention & Mitigation - Major Initiatives by BMTPC.

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

Films Produced by BMTPC

1. **MAKAN HO TO AISA** *15 min.*
Film on improving buildings in earthquake prone areas of Garhwal. This is an instructional documentary film in Hindi for imparting training in repair and reconstruction of damaged houses using local materials and earthquake proof structures.

2. **ABHIVARDHAN** *30 min.*
Film on nature of damages and what needs to be done for making houses disaster resistant in the Uttarkashi region. The film focuses directly on the needs of households and artisans to reconstruct their houses using traditional techniques with a catalytic input of modern materials and design techniques

3. **A BETTER WAY TO BUILD** *25 min.*
This film focuses on technology delivery system for cost-effective housing. It highlights the activities of Building Centres as technology transfer agents for improving housing delivery system at grass-root level. Building Centres are being set up in different parts of the country under a Central Scheme of the Ministry of Urban Affairs and Employment. Nearly 250 Centres have already been set up in different states and these are making useful contribution to promoting cost-effective innovative building materials and construction technology for house construction.

4. **AASHRAY** *28 min.*
Film depicts the application of low cost building materials and technologies. It also gives guidance to common man to procure financial support and a house.

5. **LESSONS FROM LATUR** *20 min.*
Film is a rapid survey of causes, nature and extent of damage due to the earthquake in Latur and Osmanabad districts of Maharashtra and Gulbarga district of Karnataka in September 1993. The film is available in Hindi, English and Marathi. The direct relationship between housing structure and materials used in affected areas and the enormity of the impact of the disaster have been reflected through illustration and interviews with affected people. Rescue, immediate relief and temporary rehabilitation have also been shown in the film. The film also discusses measures for constructing earthquake resistant buildings. Alternate layout plans for reconstruction of villages, retrofitting of existing structures which are disaster prone, different technological options and social tensions arising out of the process of resettlement/relocation, etc., are covered.

6. **HOMEWARD BOUND** *16 min.*
This film was produced on World Habitat Day, October, 1993 on the UNCHS (United Nations Commission on Human Settlements) theme Women and Shelter Developments. The film covers significant contributions and achievements made by India by encouraging participation of women in shelter process in different parts of the country.

7. **FLYASH UTILISATION** *20 min.*
Nearly 40 to 45 million tonnes of flyash is being generated annually as waste by 70 thermal power stations in the country. Apart from covering large areas of useable land it leads to environmental problems by contributing to air-borne and sub-soil water pollution. The film shows various methods of utilising flyash to manufacture building materials. This can convert waste to wealth as country is facing severe shortages of building materials, especially for housing. The film covers various on-going activities of flyash utilisation through small, medium and large scale production of flyash-based building materials in different states.

8. **SEISMIC RETROFITTING** *20 min.*
This film, in four parts, is a series of training films on the techniques of strengthening of houses in the earthquake affected regions of Marathwada in Maharashtra. This film was produced under guidance and direction of Dr AS Arya, Professor Emeritus (Earthquake Engg.),University of Roorkee.

Part 1 Installation of headers
Part 2 Reduction of weight on the roof
Part 3 Installation of knee braces
Part 4 Installation of seismic bands

9. **A STITCH IN TIME** *15 min.*
This film is a capsule on the techniques of strengthening partially damaged houses in the earthquake affected Marathwada district of Maharashtra, India. The programme is an illustrated lecture by Dr AS Arya (Professor Emeritus, Earthquake Engineering and UGC Emeritus Fellow, University of Roorkee)

10. **PHOSPHOGYPSUM-BASED BUILDING MATERIALS** *14 min.*
Phosphogypsum is generated as a by-product of the phosphoric acid based fertiliser industry. The interaction of ground phosphate rock with sulphuric acid produces 10- to 40 per cent free moisture along with phosphogypsum. Nearly 4.5 million tonnes is generated per year. Over 10 million tonnes has accumulated at plant sites. The fluoride contents of phosphogypsum causes land and water pollution. This film shows the various methods of utilisation of phosphogypsum in production of building materials for ceiling, partition walling, etc.

11. **BUILDING THE FUTURE BLOCK BY BLOCK** *28 min.*
Film on the activities of various Building Centres located in southern India and the ways they are helping in promoting cost-effective technologies.

12. **BUILDING CENTERS: DELIVERING TECHNOLOGIES TO THE MASES** *15 min.*
A brief film on the Rajasthan Building Centre, and the manner in which they are helping to develop and promote innovative building materials and cost effective technologies ehich have been adopted by the Centre in their construction.

13. **IN SEARCH OF HOME** *28 min.*
A film on the theme of 'Home and the Family' on the occasion of World Habitat Day, 1994. It shows the poor civic amenities in substandard shelters and outlines the possibilities for improvement by using alternate cost-effective and eco-friendly building materials and technologies to convert a shelter into a home.

14. **SHANKER BALRAM SEPTIC TANK** *21 min.*
This film in Hindi describes the method of constructing the maintenance free Shanker Balram Septic Tank for low cost sanitation. It also explains the advantages of this tank over the conventional septic tanks available in India. This was based on a rapid survey carried out by WordSmithy on behalf of BMTPC.

15. **A SUCCESS STORY OF PLASTICS WASTE MANAGEMENT** *25 min.*
Plastics are being used in every walk of life and in the end results in wastes. This films shows various aspects of plastics waste management and the ways to recycle it.

16. **ROOF FOR THE ROOFLESS** *18 min.*
A film on Gram-awas 95 held during the India International Trade Fair 1995. The film shows shortage of housing in the country, various housing schemes launched by the Government of India and the cost-effective innovative building material and technologies for the rural poor.

17. **TARA CRETE — A ROOF FOR MILLIONS** *18 min*
The film details the introduction, the manufacturing technology of Micro Concrete Roofing Tiles (MCR), the benefits of Tara Crete Roof, how to build with it and how much it would cost.

18. **HOUSING AND INFRASTRUCTURE** *18 min.*
The films shows the various aspects of housing and cost-effective innovative building materials and technologies developed in India.

19. **BUILD A SAFER TOMORROW** *12 min.*
The film covers the natural disaster prepardness and mitigation strategies covered in the Vulnerability Atlas of India prepared by the Council.

20. **BUILD A SAFER TOMORROW ON CD ROM** *12 min.*

21. **REKINDLING HOPE** *12 min.*
The film shows the activities of BMTPC in the rehabilitation after Gujarat earthquake.

22. **MICRO ENTERPRISES THROUGH BUILDING COMPONENTS PRODUCTION** *15 min.*
The film covers the activitiesof demonstration cum production units set up by the Council at various locations for generating employment and micro enterprises.

23. **BMTPC - PROTECTING HOME AND LIVES** *15 min.*
A film on multifarious activities of BMTPC.

24. **ASHA AUR ASHRAY** *11 min.*
The film covers BMTPC's efforts in dissemination of information through construction of demonstration houses under VAMBAY.

RS. 1000 EACH FILM + PACKING AND POSTAGE CHARGES RS. 100. TO PURCHASE ANY OF THESE FILMS, PLEASE WRITE TO BMTPC.

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Harmonious cities

World Habitat Day

6 OCTOBER, 2008

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, cost-effective, environment-friendly, disaster resistant building materials and technologies including locally available materials from lab to land for sustainable development of housing."

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