World Habitat Day – 4th October, 2010
A Newsletter of BMTPC

“Creating Enabling Environment for Affordable Housing for All”
I have great pleasure in bringing forth our special Newsletter to commemorate World Habitat Day, 2010, which is aptly on the theme Better City Better Life. There has been unprecedented exodus towards urban areas in developing countries adding to the woes of already struggling cities which have failed to provide basic minimum infrastructure, social amenities to its fellow citizens. The obvious fall out has been growth of slums and squatter settlements in these urban centers. The theme of this year’s habitat day would give the opportunity to city managers to rethink and carve out long term policies so that cities become centre of attraction and an ideal place to lead a better and prosperous life. Govt. of India has been quite serious on the subject and one of its major initiatives for making cities better has been Jawaharlal Nehru National Urban Renewal Mission (JNNURM) which aimed for slum up gradation by in-situ as well as relocation development along with basic services, social security, education and health convergence. The mission started in 2005 and will culminate in 2012. The changes made through the mission are now perceptible and Indian cities are slowly but steadily transforming into better places to offer better life for one and all. However, we need not be complacent and there is lot to be done. Some of the areas which require immediate attention are (a) urban planning: The master plan of a city is must have document and has to be revisited now for the cities before taking up any developmental work with the help of not only professionals, policy makers but also the people of the cities. Have we ever cared to share the view points of our people while drawing up plans for the future? (b) Assessment of existing infrastructure: There is need to take stock of the existing facilities so that we are better equipped to the future load. There has to be synergy between what we create and what exists? (c) Environmental issues: Any growth in a city should be in harmony with nature and should not adversely affect the health of existing eco system. Eco friendly development has to come as a culture in any activity we undertake in future. (d) Safety against natural hazards: All developed countries have systems in place to combat natural hazards. It is high time when we put safety regulations in our land use planning, development control regulations and building bye laws. A disaster takes the city and its people back by several years. Any future infrastructural or housing work must ensure safety of the people for whom it is being developed. (e) Capacity Building and empowerment: The growing human resource can become blessing in disguise, if capacities are built within and people specially the poor at large are trained for special crafts.

BMTPC has been doing its bit for the cause of this year’s theme by way of promoting cost effective eco-friendly building materials and construction technologies. Apart from home grown technologies, we are also contemplating to adapt emerging potential technologies from abroad suiting to mass social housing which will not only save time, cost but also provide safe, quality and sustainable development. BMTPC has been constantly publishing value added literature in the area of sustainable development and disaster mitigation & management keeping into mind the common man so that knowledge percolates right up to the bottom level.

Let us direct our efforts towards future development in such a way that posterity looks at us with pride not with disdain.

(Dr. Shailesh Kr. Agrawal)
As our world grows predominantly urban, World Habitat Day provides an annual opportunity to reflect on how we can make our towns and cities better places for all. With the theme "Better City, Better Life", this year's observance highlights the actions and policies that can improve well-being for the billion people who live in slums and other sub-standard housing around the world.

Typically living in developing countries, and largely powerless, disenfranchised and under the age of 25, the urban poor are too often condemned to a life without basic rights, hope of an education or decent work. Lacking adequate provision of fresh water, electricity, sanitation or health care, they suffer privations that all too often provide the tinder for the fires of social unrest. Vulnerable to exploitation and corruption, they need and deserve better cities and a better life.

The challenges of urban poverty – from pollution to criminal gang culture – are not insurmountable. Many cities are finding successful solutions. Smart cities recognize the importance of good governance, basic urban services for all, and streets and public spaces where women and children feel safe. They also recognize that better cities can help to mitigate global challenges, such as climate change, by promoting energy conservation and environmental sustainability.

Creating better cities demands the combined efforts of national and local governments, civil society and the private sector, supported by the best efforts of the United Nations system. On World Habitat Day, let us pledge to join hands to make better cities for a better future for all.
Cities are the greatest legacy of humanity and the greatest achievement of our civilization. Around the world and through the centuries cities have endured and survived wars, famine, natural disasters, epidemics, crumbling empires, and the disappearance of the gods, kings and queens for whom they were built.

But we have to keep improving our cities, and doing that means making our cities better for those who live in them and for those yet to be born in a world that will be from here on forever urban. Today half of humanity lives in towns and cities, and the trends show that this figure will increase to two-thirds within the next two generations.

This is why the theme chosen for World Habitat Day, Better city, better life is so important to all of us. To that I would add the term smarter city, for it is only a smart city that can provide its citizens with a better life in our planet’s new urban era. It is an era we are entering with many unknowns, especially when it comes to the global impact of climate change.

We have all the tools at our disposal in good science to mitigate against most such problems. We also have the tools and knowhow for good governance, education – especially for women and girls – health services, toilets for all, or energy efficiency.

We are smart, but we have to be smarter. And World Habitat Day 2010 is an occasion to highlight five strategic steps that can be taken:

1. **Improve the quality of life**, especially for the estimated 1 billion people living in slums and other sub-standard housing around the world. Improved access to safe and healthy shelter, secure tenure, basic services and social amenities such as health and education are essential to a better life for every individual.

2. **Invest in human capital**. This is a condition for socio-economic development and a more equitable distribution of the urban advantage. This will also enable cities and regions to implement policies more effectively and to ensure that they are properly adjusted to local needs.

3. **Foster sustained economic opportunities**. Cities can stimulate sustained economic growth for the poor through labour-intensive projects. These include primarily public works and the construction industry. Cities in the developing world are starting to provide social security to give better access to economic opportunities for those traditionally excluded.

4. **Enhance political inclusion**. Today, more and more municipal and national authorities share the same basic philosophy: bringing government within the reach of ordinary people through enhanced mutual engagement. This means engaging people and their neighbourhoods in dialogue and participation in decision-making as a fundamental aspect of local democracy.

5. **Promote cultural inclusion**. Culture has historically been left out of the conventional international development agenda. More and more local development policies take into account the cultural dimensions of urban life, such as social capital, tradition, symbols, a sense of belonging and pride of place. This helps integrate ethnic minorities, preserve regional values, safeguard linguistic and religious diversity, resolve conflicts and protect the heritage.

As we move into a world of better cities with smarter policies, these are the five essential catalysts for success and a better life for all.
Global observance of World Habitat Day this year with the theme "Better City, Better Life" highlights the vision of a sustainable urban world that harness potential and possibilities, mitigates inequalities and disparities, and provides a home for people of all culture and ages, both rich and poor. In this regard, Government of India has taken major initiatives. National Urban Housing and Habitat Policy, 2007 with multi-pronged approach promotes sustainable development of habitat in the country having equitable supply of land, shelter and services at affordable prices to all section of society. The ongoing Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is already helping State Government in improving the basic services of the urban poor with security of tenure, water, sanitary, health, education, social security in towns and cities. Similarly the new scheme of "Rajiv Awas Yojana" envisages a "Slum Free India" by encouraging States/Union territories to tackle the problem of slums in a definite manner. It focuses on bringing existing slums with the formal system and enabling them to avail the same level of basic amenities as the rest of the cities. All these will surely pave the way for Better City, Better Life.

BMTPC has an important role in promotion and adoption of cost effective housing technologies, capacity building and awareness generation throughout the county. The Council should also look for cutting edge technology options now available across the world to bring further improvement in housing construction.

I am happy that BMTPC is bringing out a Special Issue of its Newsletter "NIRMAN SARIKA" on the occasion of the World Habitat Day. I extend my best wishes to the Council for the efforts and also wish the publication all success.

(Kumari Selja)
Inclusive Urban Growth for Better Life

This paper examines facets of Urban Divide with a particular reference to promote better life among cities and towns in India. It is globally recognized that urbanization is inevitable and is a natural consequence of public policy agenda on development. However, developing economies have not been able to accelerate supply of shelter, services and livelihood opportunities to the growing population in their urban areas. It has resulted into deteriorating quality of urban life which is a matter of serious and immediate concern.

Urban inclusion in India, as elsewhere, is an integral part of public policy to ensure a minimum acceptable level of quality life to urban residents. Although, urban areas with a share of 30-35 percent of Indian population, generate a vast majority of GDP, the size of urban poor and disadvantaged group is fairly high. Yet, the contribution of urban poor in productivity is critical, unavoidable and significant to maintain competitive edge of India and sustain pace of economic development.

This paper brings out the need for inclusive urban growth in the light of urban divide in India and suggest corrective measures thereon. These actions include equitable and affordable supply of land, services, shelter, income/employment generation opportunities and capacity building of various stake-holders through improved governance. The national strategy on Urban Inclusion needs to have common areas of actions to be designed in the light of local variations. Finally, it is suggested that the attending the Urban Divide should be based on financial inclusion, secure tenure, improvement (up gradation), pro poor housing, Environmental protection, pro poor housing finance and promotion of service and growth centers at different regions/parts of the country.

The Global Context

The global policy agenda in the beginning of 21st century has a consensus to promote inclusive urban growth wherein the citizens have a sense of ownership, belongingness, pride, mutual respect, understanding and coordination, equal opportunities and cohesive living environment. It is particularly important in the context of rapid pace of urbanization, regional balance, cultural integration and peaceful co-existence. Overall ‘inclusion’ on these parameters has a single most important concentration in the form of facilitating the urban poor.

It is in this background that Habitat Agenda, World Summit on Sustainable Development (WSSD) 1992 at Reo 2002 at Johannesburg, World Urban Forum 2002 (Kenya), 2004 (Span) and 2006 (Canada) 2008 (Nanjing), 2010 (Reo) and Millennium Development Goals have a common focus to promote inclusiveness covering urban poor, poor women and children in terms of services, amenities and livelihood opportunities.

Urban Divide in India

India is undergoing a transition from rural to semi-urban society. Around 30% of population is now living in urban areas. It is estimated that during the next 18 years – by the year 2025 – well over 40% population will be living in the urban areas. The magnitude of urban divide, as among other developing countries, in India also

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This year’s World Habitat Day focuses on the theme “Better City Better Life”, and echoes the desire of the 357 million people now living in urban India. The occasion gives us the opportunity to contemplate the complex dimensions arising out of the relentless growth and expansion of our towns and to deliberate on the solutions to the challenges that we face from the widening gap between demand and supply of urban services, housing and social infrastructure. Urban land space and affordable housing shortages, the base reason for the proliferation of slums, is today acknowledged as the major urban problem. In addition, new problems of growth are surfacing: all cities need to invent new ways to achieve sustainable development. Few cities, even in the developed world, have met all the challenges of the 21st century of low-carbon energy production, public health for all, sustainable clean water, reduced air and water pollution, effective waste management.

The Building Materials & Technology Promotion Council (BMTPC), functioning under the aegis of this Ministry assists in the effort of a better city for a better life by promoting and popularizing cost effective, environment-friendly, energy-efficient and alternate building materials and technologies in the housing and building sector. The Council should use this World Habitat Day to intensify its efforts, and also consider widening its engagement in emerging areas of concern.

I am happy that the BMTPC is bringing out the Special Issue of newsletter “Nirman Sarika” on the occasion of the World Habitat Day. I extend my best wishes to the Council in their efforts.

22-9-2010

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

Typology of Urban Divide in India

Urban divide in India has a set pattern and nature of exclusion which can be covered under a seven point typology as follows:


Ad hoc/Conventional Planning

By and large there has been a wide gap between planning and policy (wherever applicable) and planning and implementation. Investments have been made on top down project based approach without linking them with actual requirement and potential for upkeep at agency level. This has led to a wide gap in the urban services, amenities and quality of life. Delhi model followed by many other cities follow the same pattern.
Master Plans have been significantly different than actual urban growth. Regional plans/Area Plans too have not been different in terms of meeting the requirements due to the same region as above.

Financial Exclusion

Majority of urban households particularly those living in slums and squatters and are employed in the informal sector do not have access to formal banking system. Although Reserve Bank of India has initiated ‘No-frills’ account with zero balance, suitable mechanism on KYC (Know Your Client) formalities has not been devised. This is one of the main barriers for causing financial exclusion.

As per recent estimates only 30% urban households have access to formal banking. The unbanked segment of urban households have several disadvantages in terms of their inability to have access to credit, savings instruments, insurance etc. and, therefore, they are not integrated with the overall financial system.

Due to the financial exclusion, the urban poor fail to make best use of their earnings and always remain hand to mouth to meet their necessary expenditure on food, shelter and services, thus, not giving any attention towards education, health and other necessary commitments.

Informal Land Tenure

Land tenure is a vexed subject. Borrowed from the common law systems, the term refers to a legal regime where land is said to be held by an individual who is its owner. In older times, it was the sovereign king who held all land. Everyone else was a tenant or sub-tenant. Tenure signified the relationship between tenant and the owner. This “usually involves a lease or equivalent entitling the lessee to quit enjoyment of the property for a fixed time, or until certain conditions are fulfilled, as long as the rent is paid and the property is maintained.

An occupant resides on such land or housing to which he or she has no legal claim, such occupancy falls in the category of informal ownership. Most slum dwellers in India would fall in this category, and go by such different names in the country as “Jhuggi” “Jhompri” “Jhopadpatti” basti etc. Such occupants are also termed squatters.

Illegal subdivisions in India, such settlements are known as unauthorized colonies gunthewari unauthorized layouts etc. These refer to settlements where the land has been subdivided, resold, rented or leased by its legal owner to people who build their houses upon the plots that they buy. These settlements are also illegal owing to the following additional factors: low standard of the services or infrastructure provided, breaches of land zoning, lack of planning and building permits, or the irregular nature of the land

Informal land tenure has been a result of public sector failure to acquire requisite land for housing. It was also caused by inadequacies of Urban Land Ceiling and Regulation Act of 1977 (which has since been repealed by most states to make necessary land available for public acquisition. As a result, migrants coming to cities have bought land from informal market and put up their permanent structure. Therefore, most of the low income housing has come-up on the land with insecure tenure. This has also contributed to short supply of serviced land, leading to high prices of land in the formal market. We may recall that majority of land supply in Delhi and Mumbai and other mega cities is in the form of illegal land subdivision. Other towns too are not much different. A vast majority of Dwelling Units (DUs) among these towns is put up with out necessary approvals.

Substandard Housing

Housing units which have been put up illegally on informal land are mostly sub-standard as per minimum levels of habitation. These do not follow necessary safeguards to minimize congestion, unhealthy living and lack of safe sanitation as well as access to basic services. Many cities have sub-standard housing in a range of 20-60% of total housing stock. These segments of clusters of households constitute slums, squatter and unauthorized colonies.

These households form a NEED BASED DEMAND which is identified by XI Five Year Plan document of government of India (2007-12) as 99% + of total housing backlog of 24.7 million dwelling units in the urban areas of the country. On the other hand, supply of formal housing is not adequately cover this main segment of demand providing hardly 10-15% DUs to these households.

Inadequate Basic Services

Normative standard of urban basic services is fairly low. This is particularly affecting the urban poor in slums/unauthorized colo-
nies at Mega cities and low income household and small and medium towns. The water supply has inadequacies in terms of quantity, quality, continuity and coverage. Due to O&M deficiencies, supply of treated water gets affected by pollution caused during the transmission. Similarly, due to leakages (ranging upto 50%) the total quantity remain almost half of the capacity utilized for supply. The share of non-revenue water therefore is fairly high. The 24 x 7 supply is a matter of dream whereas coverage of existing standards to low income housing areas is fairly low.

Another, important basic service of sanitation is also lacking in terms of access to sewage system (only 30-40% of households) and a majority of house holds do not have safe system for disposal of human waste. Further, treatment of sewage is done for only for a small part of sewage water among a few cities only. This has wide ranging implications not only within city, but also down the line up to the places connected to the down stream of water.

Solid waste Management is yet another services having poor delivery covering collection ratio of 50%, safe treatment of 10-20%, inadequate fleet to transport the waste and provision for waste collection points at intra-city locations.

Municipal roads are highly congested combined with poor maintenance. Also services connected to roads such as bus terminus/ stops, street lighting, parking places, roundabouts, foot over bridges, flyovers, relief roads etc. are highly inadequate.

Our cities and towns have been centres of civilisation, and also engines of growth but the stress of increasing urbanization and industrialization has simultaneously led to problems of shortage of housing and infrastructure, increasing poverty and unemployment and environmental degradation. All these conditions are affecting the quality of life in our cities. The theme for this year’s World Habitat Day - BETTER CITY, BETTER LIFE - is topical as it gives us the opportunity to assess the magnitude and nature of challenges before us, take measures to address these problems thereby laying the foundation of better and inclusive cities in the future.

Amongst the multifarious problems facing us, one of the most important is that of equitious and efficient urban planning. Innovative ideas from cities around the world have shown that sustainable urbanization with focus on environmental conservation is achievable provided we take adequate care of the needs of the urban poor who are significant contributors to the economic growth of the city. Urban poor need improved tenure and access to land, adequate housing, access to basic civic and social amenities like water supply, sanitation, health, education and social security. The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is striving to develop an integrated approach towards housing, slum development and basic services to the urban poor. BMTPC is actively involved in implementation of JNNURM through appraisal, monitoring of projects and capacity building of ULBs. It is hoped that the Council will continue its efforts in the area of promotion and development of cost effective, environment friendly, energy efficient and disaster resistant construction technologies.

I am pleased to know that on the occasion of World Habitat Day, BMTPC is bringing out a Special issue of its Newsletter “Nirman Sarika”, to raise awareness amongst the stakeholders and I hope this will trigger constructive dialogue culminating in innovative ideas and projects.

I take this opportunity to wish BMTPC every success in its endeavours.

(Dr.P.K.Mohanty)
Environmental Degradation

Focus on environment has specially emerged since Rio Summit on sustainable development in 1992. This aspect, although, has been included in the list of municipal functions, progress made so far is fairly unsatisfactory. Although, Model Municipal Law makes a provision of environmental audit, the practice has not been implemented by most of urban local bodies.

There is a lack of proper planning, necessary funding and technical expertise at local level. It is also having high degree of external impact affecting health and productivity covering the poor directly under it’s implications. As indicated above Environmental Degradation is directly linked to adequacy of basic municipal services. The supplies of water, sanitation, SWM, roads, social forestry etc. do not have suitable actions aiming at resource conservation and recycling. It is observed in terms of noise pollution, air pollution, water pollution, congestion etc.

Poor Intra-city Connectivity

House, particularly, for poor is also a work place. It is further noted that house to work place relationship plays a critical role for obtaining high productivity. Core city area is declining in terms of service standards and shelter structure. Urban renewal strategies are not planned in a systematic manner.

Adequate, transportation at affordable rates is not available to poor forcing them to sacrifice their place of stay. Further globalization is also aiming at cheaper production at the cost of poor. Empirical evidence suggests that employment elasticity of production is declining which is a matter of concern for urban inclusion.

Regional Disparities

Development process and investment pattern has been skewed towards some states (western and southern states and super metro cities) and some regions within states of Indian union. These regions have developed towns as a focal point for immigration and urbanization. This has promoted regional imbalance and a large number of small and medium towns have remained under developed which is prominently reflected in the poor housing conditions of such areas.

Inclusion Strategies

India since last couple of decades has undergone several steps to promote inclusive urban growth. These efforts include affordable urban housing, good urban governance and investment promotion. One important initiative of Government of India needs special mention is the first ever urban housing policy (Box-1). Further, 74th Constitution Amendment Act of 1992 has provided a process of political, functional and fiscal decentralization. ULBs now have a wider representation (including women), better finances and increasing focus on adequacy of services. Further, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) has promoted wide ranging investments in the area of urban infrastructure and basic services which promotes inclusive growth in a wider context of urbanization.

The inclusive urban growth to minimise urban divide as above needs to be taken up under a seven pronged inclusion strategy which should cover: Inclusive Planning, Financial Inclusion, secure tenure, slum up gradation, pro poor housing supply of housing, Efficient City Transport, finance, Environment Friendly Urban Growth and promotion of service and growth centers.

Inclusive Planning

JNNURM, the pioneering programme of Government of India has promoted a modal of City Development Plans (CDPs) to be prepared at sample cities. These plans, however, not linked with a reliable and locally based process of implementation. The institutional system is complex and ‘local’ component in this process is still weak.

Further, planning is not backed up by policies. Most of the states have not prepared their Urban Housing and Habitat Policy. Similarly, other areas of planning such as land, environment, infrastructure, business promotion etc. too are not connected with broad policy guidelines.

Therefore, there is a need to promote bottom up planning which gives due cognisance to interest groups, pressure group, community structure, NGOs, ULBs and has policy back-up, fiscal support, regulatory system in place to address realistic targets for inclusive urban growth.

Financial Inclusion

Urban poor and lower middle
income group of urban households who are employed with the informal sector need to be integrated with formal financial system. In this regard, suitable mechanism needs to be devised to simplify KYC to enable them to access no-frills account under formal banking system. UID (Unique Identification Scheme) as planned by Government of India will go a long way to facilitate financial inclusion of urban households. However, the speed of UID implementation is rather slow.

In this context, states should devise a suitable alternative to link urban poor with KYC of banking system. Another alternative is to proliferate Micro-finance institutions to cover large number of urban households. Recent RBI guidelines to facilitate banking credit with wholesale finance (refinancing) to MFIs (Micro finance institutions) need to be implemented and linked with financial inclusion.

These two steps will also facilitate financial services through mobile banking which is emerging slowly at some places in the country. Service providers and banks need to be provided suitable exposure on current initiatives e.g. the Central Bank remittance services in Mumbai so that they can expedite financial inclusion.

Yet another area of financial inclusion is cover financial education on savings instruments, insurance cover schemes and modalities for remittance and payments. Community organizations/structures at grass-root level need to be motivated to promote financial education with the help of urban local bodies. Specific programmes

Better City Better Life – has been adopted as the theme for this year’s World Habitat Day being celebrated globally on 4th October 2010. With rising population in our urban centers, availability of adequate water supply and sanitation services has been receiving priority in the various initiatives being taken by the Ministry of Housing & Urban Poverty Alleviation to promote sustainable development of urban areas.

Rapid growth of cities and towns has posed a challenge to the professionals involved and also stressed upon the need of having a relook on the development processes being adopted hitherto. The focus has to be on the improvement of living conditions of the poor on a sustainable basis. The Ministry of Housing & Urban Poverty Alleviation has initiated a number of policy measures and schemes including National Urban Housing & Habitat Policy for urban areas; Jawaharlal Nehru National Urban Renewal Mission; Interest Subsidy Scheme for Housing the Urban Poor for providing interest subsidy on housing loans availed by EWS/LIG for acquisition/construction of house and Affordable Housing in Partnership to facilitate and incentivize land assembly for affordable housing.

Housing activity has received a phenomenal thrust in the last decade, with quantum jump in mass housing projects. However, the housing needs of Weaker Sections, Low and Middle Income Group continue to face difficulties with the rapid increase in construction costs due to rise in input costs for materials and labour costs. These have impacted more the housing costs of Weaker Sections and Low Income households. Another concern is the low levels of awareness about the technological options available at the level of practicing professionals, artisans dealing with house construction and among the general public.

The Building Materials & Technology Promotion Council has been playing proactive role in dissemination and promotion of cost-effective, environment-friendly, energy-efficient building materials and safer construction technologies amongst a wide spectrum of users, entrepreneurs and construction agencies.

I am happy to learn that BMTPC is bringing out a Special Issue of newsletter "Nirman Sarika" dedicated to the theme "Better City Better Life" on the occasion of World Habitat Day. I hope, this publication will focus on technology related areas for improving quality and speed in the housing and building sector in the country.

I wish BMTPC all success in their endeavours.
NUHHP 2007 is the first ever policy of Government of India which exclusively covers Housing and Habitat sector in the urban context only. The policy intends to promote sustainable development of Habitat with a particular reference to Affordable Housing for All. The policy identify roles for different stakeholders such as Public Sector (Central, Provincial and Local Governments), Prastatal, Financial Institutions, Research and Development Organizations, Private Sector and Urban Community as a whole, covering different civil society organizations, poor, informal sector, etc. The policy further identifies 8 different areas of action whereby various stakeholders have to take Administrative, Legal, Financial, Fiscal, Planning, Academic and Partnership related actions to develop synergy and convergence under the overall objectives as above.

The urban housing backlog in the year 2007 is estimated to be 24.7 million dwelling units out of which 99% constitute the requirements of poor and low-income households. On the other hand, access to housing finance/mortgage credit is largely confined to middle and high-income households. In this regard, the policy encourages developing sustainable network of micro-finance institutions to facilitate low-income households for necessary housing credit.

The policy also give focus on rental housing to adequately cover a cross-section of households along with PPP projects having 10 to 15% of land or 20 to 25% of FAR/FSI for low income housing. The policy also suggests a systematic action plan based on a bottom-up planning and effective monitoring at Centre, State and Local levels.

Secure tenure

Provision of secure tenure, particularly, for low income and poor households holds the key for ‘housing inclusion’ among Indian cities and towns. This needs to be done under three types of solutions covering (i) direct land title through sale or lease (ii) Usage rights including tenancy and (iii) shared ownership through cooperatives/communal groups. There are several examples on these initiatives at Madhya Pradesh, Maharashtra, Gujarat, Tamil Nadu and Andhra Pradesh etc. which need to be replicated and adopted at other places.

Secure tenure has to be introduced through a couple of pre-requisites covering updating the land records and necessary legal and regulatory reforms by public sector and creating community structure at grass root level.

Slum Upgradation

In-situ slum development has been taken as consensus approach to rejuvenate urban system globally. However, this needs to be taken up through proper planning and participatory approach covering incremental and self-help – mechanism involving the households as well as Public Private Partnerships to take up house improvement in low income areas. In this process, role of NGO’s and CBO’s is equally important.

There are certain pre-requisites in this process also which cover bottom-up planning, secure tenure and access to innovative financing. There are several examples in India which include participatory and incremental approach to slum upgradation covering the cities of Ahmedabad, Indore, Hyderabad, Chennai etc. which have involved various stakeholders from Public, Private sector and Civil Society to have synergy and convergence for this common cause.

Pro-poor Housing Supply

Formal housing supply in India as elsewhere in similar context is not addressing the Need Based Demand from low income and middle income households. This needs to be addressed in the light of NUHHP-2007 through suitable strategy which includes:

- Reservation of land and DUs for low income housing.
- Rental housing covering con-
cessions and incentives on rent received.
- Protection of Landlords from tenants (Timely eviction)
- Extension of rental housing to poor including hire purchase method of allotment.
- Mass-scale construction of low income housing by public sector and
- Private sector construction as per reservation of plots/flats for low income households.

Simultaneous actions for pro-poor housing supply also require bottom-up planning, innovative resource mobilization for low income housing through (a) top down allocation; (b) use of Transfer of Development Rights (TOR) to generate funds for low income housing and (c) using the funds under (a) and (b) for subsidizing low income housing under a well designed scheme. Public Sector construction, TDR, interest rate subsidy etc. are already used by public sector in India for accelerated supply of housing/basic services. Government of India has recently promoted Partnership Scheme for low income/affordable housing and Rajiv Avas Yojna to address inadequacies of shelter and services at grass-root level. These will go a long way to promote inclusive urban growth.

Efficient City Transport

Mass rapid Transport System (MRTS) needs to be promoted among mega cities. However, secondary cities and small towns need a different approach of traffic management and road maintenance. It should include flyovers, over bridges, bypass, underpass, urban relief roads etc as per requirements.

These are essential to promote cities for economic development and social inclusion. Community structure, pro poor transport policy and positive work place relationship are also essential to strengthen links of cities with income and employment.

Pro-poor Housing Finance

Housing finance market in India does not cover the poor. It is partly covering the middle income housing whereas the coverage of speculative demand is fairly high. This calls for evolving innovative and pro poor housing finance system which is based on Interest rate subsidy, Hire Purchase Schemes and a network of Micro-finance institutions.

There are couple of Micro finance institutions (MFIs) which are successfully extending housing finance among others to low income households on the basis of thrift and credit mechanism. However, there is a need to ‘proliferate’ MFI’s among urban centers through suitable provision of LIQUIDITY and modified prudential norms other than those applied for conventional banking system. The issue of liquidity should be covered under funds for wholesale finance to be provided to an intermediary link institution.

The issue of liquidity should be covered under funds for wholesale finance to be provided to an intermediary link institution. In this regard, initiatives need to be taken on the lines of Khula Foundation at South Africa which is providing adequate amount of liquidity to MFI. In addition, legal and regulatory frame-work should be revised to simplify prudential norms for replicating MFI’s at state and regional levels.

Environment Friendly Urban Growth

Environmental protection is emerging slowly to guide the process of urbanization in India. National Mission for Sustainable Habitat (NMSH) has been approved by GOI for suitable follow up by Ministry of Urban Development. It is a part of National Action Plan for Climate Change (NAPCC). Further, Bureau of Energy Efficiency is also taking several steps to engage cities for adaptation and mitigation of climate change. It has issued Energy Conservation Building Code (ECBC) to guide and regulate development of green buildings.

National Disaster Management Authority has issues guideline for Urban Flooding. Similarly Model Municipal Acts expects environmental audit at ULB level. These steps need to be linked with a sustainable and effective policy on climate change and sustainable urban energy use.

Promotion of Service and Growth Centers

Role of cities in the economic development needs to be recognized and understood properly. Accelerated supply of ‘housing’ among small and medium towns will attract/divert migration and generate income and employment
opportunities as well as attract business industry and trade. It will also facilitate smaller towns to operate as service centers to their hinterland.

There are certain pre-requisite to ensure balanced growth through bottom-up planning, reform agenda at local govt. level to engage various stakeholders for adequate and accelerated supply of land and housing. Satellite towns and counter-magnate of land and housing. Satellite towns need to be provided at different parts of the country.

**Follow-up for Inclusive Urban Growth**

Strategy for urban inclusion as above should be taken up through a well planned follow-up covering:

- Bottom-up planning- to identify local issues and priorities in a realistic manner and prepare a district/regional plan for policy feedback at regional and national level.
- Innovative Resource Mobilisation and Allocation covering local resources and better sharing of funds from provincial and central government.
- City to city cooperation and competition to learn from each other.
- Exchange of Best Practices and Lessons from Failure to firm up local strategy.
- International cooperation to engage and motivate various stakeholders for development of synergy and convergence of resources.

In addition, global focus on sustainable development of human settlements provides a set of options to examine in the local context. These should be seen in a wider context of urban divide covering shelter, related services livelihood opportunities and necessary space for amenities and facilities to achieve our common goal of sustainable cities. Urban inclusion in a broader sense will also be a significant milestone to achieve overall objective of better cities and better life.

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Safer Cities : Safer Life
(the context of JNNURM)

1. The Context

The JNN Urban Renewal Mission, envisaging an investment of Rs.55,000 crores, covering 615 cities, inter-alia, provides a great opportunity for improving safety of our cities with respect to natural hazards which often tend to become disasters as experienced in the recent past. It needs to be considered that each project, when developed particularly in disaster prone region should include a component for reduction of impact of natural hazards that may occur in the area, and likely damage it may cause to life and assets to be built in the scope of that project.

2. Justification

The Disaster Mitigation and Management Act, 2005 recognizes the need to consider Disaster Mitigation Measures and Strategies as an integral part of all development activities in the country, specifically the Act provides as follows :

- Section 11 (3)(b) states that the National Plan shall include measures to be taken for the integration of mitigation measures in the development plans; and
- Section 23(4)(c) states that the State plan shall include the manner in which the mitigation measures shall be integrated with the development plans & projects.

More than 59% of the Indian landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12% of land) is prone to floods and river erosion; close to 5700 km long coast line, is prone to cyclones and tsunamis. Further, hilly areas are also at risk from landslides cloud bursts and avalanches.

It is, therefore, necessary that all investments going for creation of physical infrastructure as a part of this national development scheme (JNNURM) take cognizance of the likely adverse impact of natural hazards on the assets proposed to be created in the cities falling in the disaster prone regions. The losses of life and property could be minimized in the future projects to be implemented in the cities (which lie in the disaster prone regions of the country), if the BIS Codes of Practice and Guidelines framed by various organizations and institutions in the country are incorporated in all the stages of project formulation, sanction, implementation and monitoring.

In the above background recommendations are made herein for the following seven sectors which are covered under the JNNURM:

i) Redevelopment of inner (old) city areas
ii) Water supply (including desalination plats) and sanitation.
iii) Sewerage and solid waste management
iv) Construction and improvement of drains and storm water drains
v) Urban Transportation including roads, highways, MRTS and metro projects
vi) Parking lots and spaces on PPP basis
vii) Development of heritage areas.

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3. Hazard Proneness of Cities under JNNURM

3.1 Earthquake Proneness

a) From the earthquake hazard proneness point of view, the following 8 cities fall in Seismic Zone V with very high damage risk, with the highest intensity considered MSK IX or higher. (example of such an earthquake in recent times is Kachchh earthquake of 26th January, 2001 which devastated cities of Bhuj, Anjar and Gandhidham):-

Guwahati, Itanagar, Imphal, Shillong, Aizwal, Kohima, Agartala & Srinagar (J&K)

b) The following 14 cities are classified in Seismic Zone IV considered high damage risk zone with MSK Intensity VIII considered probable (recent example of such an earthquake is that occurred in Uttarkashi 1991 and Chamoli earthquake of 1999):-

Delhi, Patna, Faridabad, Ludhiana, Amritsar, Meerut, Jammu, Shimla, Gangtok, Dehradun, Nainital, Chandigarh, Mathura and Haridwar.

c) The following selected 26 cities fall in Seismic Zone III i.e. moderate damage risk zone with MSK Intensity VII considered probable (recent example of such an earthquake is that occurred in Jabalpur in 1997):-


d) Other selected cities are in Seismic Zone II that is low damage risk zone with MSK Intensity VI considered probable

3.2 Cyclone Proneness

a) The following 7 coastal cities may be affected by very high cyclonic wind velocities causing severe damage to tall flexible & sheeted residential & industrial structures are:-

Chennai, Kolkata, Vishakapatnam, Bhubaneshwar, Agartala, Puri & Pondicherry

b) Other 5 cities which can also be affected by cyclonic winds:–

Greater Mumbai, Vadodara, Surat, Goa & Thiruvananthapuram.

3.3 Landslide Proneness (fig.4)

a) The following cities are located in severe to high landslide prone areas:-

Coimbatore, Shimla, Imphal, Shillong, Aizwal, Kohima, Gangtok, Dehradun, Nainital & Srinagar (J&K).

From the foregoing summary, it will be seen that while most cities are prone to earthquake damage of varying intensities, some cities have multi-hazard proneness. The cities in hill areas are additionally liable to landslide damage which can be further intensified due to the earthquakes or severe monsoon rains. Low lying areas in all cities may be subjected to flooding during high 24 hour rainfall intensities.

4. JNNURM an Opportunity for Disaster Mitigation

The urban Renewal Mission provides a great opportunity, while considering the projects for urban renewal, to provide safety to the cities from the impacts of natural hazards considered probable to occur in the future. It will be most appropriate to carry out in each proposed project a study of disastrous impact of hazards on the proposed development. This impact will have to be considered from two angles:–

a) How the elements of the proposed project would be adversely impacted by any one or more of the natural hazards and how to safeguard the proposed development?

b) Whether the proposed projects will have adverse effect in enhancing the hazard proneness of the city and if so, then how to eliminate the features that may cause such an adverse impact?

A few considerations and suggestions are given in the following paragraphs in regard to the seven sectors specified for eligibility under JNNURM. As the earthquake hazard will be the most damaging to a city, greatest alteration is devoted here to it. The assessing and monitoring authorities should consider all these disaster related issues while approving the projects.
5. Sectorwise Recommendations on Disaster Resistance

5.1 Redevelopment of inner (old) city areas [including widening of narrow streets, shifting of industrial and commercial establishments from non-conforming (inner city) areas to conforming (outer city) areas to reduce congestion, replacement of old and worn out pipes by new and higher capacity ones, renewal of the sewerage, drainage, and solid waste disposal system etc.]:-

Problem Statement:-
The core area of a city is one of the most vulnerable areas as far as earthquake is concerned. This is primarily due to:-

i) presence of narrow streets (which will be a major constraint in conducting rescue & relief operations),
ii) existence of old buildings and structures which were not designed/constructed keeping in mind earthquake safety,
iii) poor infrastructure facilities like exposed electric poles with hanging electric wires,
iv) choked sewers, drains etc.

From the past earthquakes, we have seen that the narrow streets get blocked as the houses on both the sides of the road collapse killing the people moving on (More than 300 children and teachers were crushed to death in Anjar during Kachchh earthquake of 2001 due to building collapsing on them from both sides. In Kobe city fire tenders could not go on streets as the streets were filled with fallen facades, display boards etc.)

Recommendations:-
For safety of lives & property in the core areas following measures are recommended:-

- The most important issue is the safety of vulnerable buildings from the impact of earthquakes. The following Indian Standards have already been developed to deal with these issues:
  - Design & Construction of safer new buildings as well as Seismic retrofitting of unsafe existing buildings
  - IS: 1893(Part 1)-2002 “Criteria for Earthquake Resistant Design of Structures (Fifth Revision)”.
  - IS:13920-1993 “Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice”.
  - IS:4326-1993 “Earthquake Resistant Design and Construction of Buildings - Code of Practice (Second Revision)”.
  - It may be noted that most inner city areas are composed of masonry buildings of various types consisting of brick and/or stone. The information given in IS:4326, IS:13828 and notably IS:13935 will be found most important in this regard.
  - In order to safeguard against the collapse of buildings on to narrow streets reinforced concrete or steel frames of special designs could be erected to provide lateral support to the buildings on both sides. States may be advised to establish panels of earthquake experts to carryout studies in this regard and help develop the safety systems for such areas.
  - If such areas consist of burnable wooden buildings, special precautions by providing diagonal bracing and against fire safety may be carried out for protection.
  - Where new structures are proposed for improvement of civic facilities, all such structures should be designed to be earthquake resistant as per the above BIS Codes.

5.2 Water supply (including desalination plants) and sanitation.

Problem Statement:-
The disruption of water and sewer lifelines could seriously affect emergency facilities, fire suppression systems, telecommunication systems, water supplies.

- **Emergency facilities**: Water could be unavailable to serve emergency facilities.

- **Telecommunication systems**: The cutoff of water supplies with the resulting shutdown of cooling systems could render computer-dependent telecommunication systems inoperable.

- **Water supplies**: If distribution systems were damaged, drinking water would have to be trucked in until the water system could be restored. Businesses would have to remain closed until water service was restored because of health and fire hazards.

(Due to Bhuj earthquake in 2001, the drinking water supply was adversely affected in 1340 villages of...
the 5 earthquake affected districts of Gujarat. The most severely damaged facilities were: two dams, two water treatment plants, and over 1500 km of pipelines. The RCC underground tanks and overhead tanks could withstand the impact, whereas masonry structures collapsed. Other damages were ruptures and dislocation of transmission pipelines, resulting in leakages. 

(Water supply pipes were broken at hundreds of places during Kobe, Japan earthquake of 1995 resulting in not only flooding but also scarcity of water for extinguishing of fires of thousands of burning wooden buildings)

Recommendations:-
• Wherever new water supply reservoirs or overhead tanks are proposed, they should be designed to be safe under the postulated earthquake forces. A special standard IS:1893 (Part – 2) namely Liquid Retaining Structures is now under printing and should be used for insuring structural safety of overhead water supply tanks.
• To avoid breakage of underground water pipe systems due to large ground movements of soft soils, enough flexibility in the joints either by looping or by special joints needs to be installed particularly in large mains to avoid such problems. Standards for such constructions have not yet been developed in India but are available in some developed countries. One of the knowledgeable institutions such as IITs may be commissioned to assist in the designs.

5.3 Sewerage and solid waste management.

Problem Statement:-
• Sewer: As a result of loss of power and damage to pump station buildings and equipment, sewage (in reduced volumes because of water system dysfunction) would overflow from manholes into city streets, back-up into basements, and run into drainage conduits. Sewers in areas that suffer significant permanent ground deformation would be destroyed completely. Sewers in less-affected areas might sustain damage that would go unnoticed, presenting a hazard to health.
• Sewage treatment plants: In an earthquake, sewage treatment plants not designed for seismic resistance would sustain damage. Raw or inadequately treated sewage that had reached the sewage treatment plant would be discharged into the receiving water body.

Recommendations:-
• For sewer lines the recommendations as for water supply mains are relevant.
• Any structures required for the sewerage treatment plant will need to be designed using the Earthquake Resistant Design Codes.

5.4 Construction and improvement of drains and storm water drains.

Stability of all drains including storm water drains may be checked using the provisions of earthquake resistant design standards available for the design of retaining walls used for retaining earth in Indian Standard Part-3 Bridges and Retaining Walls (under print).

5.5 Urban transportation including roads, highways, expressways, MRTS, and metro projects.

Problem Statement:-
The consequences of failure in a transportation lifeline due to natural hazard can involve:
• Direct loss of life due to collapse or structural failure of the lifeline
• Indirect loss of life due to inability to respond to secondary catastrophes, such as fires, and/or provide emergency medical aid
• Delayed recovery operations
• Release of hazardous products (e.g., losses from tank cars derailed by track failure, gas leaks from ruptured utility lines)
• Direct loss of property and utility services (e.g., the collapse of a bridge carrying utilities)
• Losses due to interruption of access.

Although transportation lifeline disruption or failure is not considered a major risk to lifesafety, the socioeconomic consequences can be particularly devastating to the general public. These include the primary impacts that flow directly from impeded access to hospitals, evacuation areas, emergency relief centers, and fire departments, and the secondary impacts due to closed mass-transit facilities and the inability to get to or from work for an extended period of time.

Historically, bridges have proved to be vulnerable to earthquakes of MSK Intensity VIII or
higher that is, in seismic zones IV & V, sustaining damage to substructures and foundations and in some cases being totally destroyed as substructures fail or superstructures are unseated from their supporting elements. Pavements are also vulnerable to earthquake damage, due principally to ground failure such as liquefaction.

A survey of damage to railroad components during past earthquakes shows damage to bridges, embankment failures, vertical and horizontal track misalignments, tunnel misalignments, failure of tunnel linings, structural damage to railroad buildings, and overturned rail cars and locomotives.

Ports and waterways are, by their nature, constructed on soft, saturated sites that are susceptible to site amplification effects and/or soil failure. Historically, damage due to cyclones has included flooding due to storm surges, earthquake leading to tsunamis, massive flows and flooding due to liquefaction, and structural damage to wharves and container cranes. Even relatively minor damage can close a port for an extended period of time, and loss of export revenue can have a crippling effect on the economy.

Failures of airport runway pavements have occurred in the past because of ground deformation and/or liquefaction effects. The potential for severe structural damage appears to be lower for airports than for other transportation systems, principally because the basic components are pavements and buildings. However, even minor structural damage can cause closure of a facility and severely impede recovery efforts. Control towers at airports are particularly vulnerable to contents damage and consequential loss of operation.

Similarly, loss of electric power, telecommunication, or radar equipment due to relatively minor structural damage can have a major impact on both local and regional air traffic operations.

Due to Bhuj earthquake in 2001, in the road sector, maximum damage was caused to bridges and culverts. The old Surajbadi bridge, which had been constructed in the 1960s, suffered significant damage during the earthquake. The bridge was closed for traffic for the first two days. It was temporarily restored for slow single-lane traffic.

The railway infrastructure suffered relatively minor destruction. Most of the damage was to buildings – stations and staff quarters. With regard to ports, there was significant damage to the Kandla port. Five of the ten dry cargo jetties developed major cracks. The oil jetty and a small wharf were damaged. Twelve of the forty ports managed by the Gujarat Maritime Board were damaged. Most of the marine structures, cargo handling equipment, storage facilities, residential/office buildings, roads, bridges etc., were destroyed.

Recommendations:-

i) The city areas having high water table and sandy soils should be studied for determination of liquefaction potential under seismic conditions particularly in Seismic Zone IV & V areas and the soil condition improved as found necessary while laying the transportation routes.

ii) All transportation structures namely flyovers, bridges and culverts should be designed for appropriate seismic forces as per the Indian Standards namely IS:1893 – 1984 [the special Bridge Code (IS:1893 – Part -3) covering bridges and retaining walls is at the final approval stage]

iii) Needless to say that earthquake resistant design must be used in the design of all port and airport structures for their safety during the probable maximum earthquakes in the concerned cities.

5.6 Parking lots and spaces on PPP basis

The multi-storied parking lots need to be designed using the appropriate BIS Codes for earthquake safety as listed above under 5.1.

5.7 Development of heritage areas

Problem Statement:-

Most of the India’s cultural heritage is located in active seismic zones, which accelerate the vulnerability of these constructions. These constructions should be preserved over time including its fabric and structure mainly against earthquakes, which nowadays constitute the most devastating phenomenon.

(In Gujarat out of the 212 protected monuments with the Archaeological Survey of India, 69 structures were affected by the earthquake: two of them completely collapsed, 25 had major damage and 42 monuments had minor damage. Apart from these many heritage buildings were used
for public purposes such as schools, hospitals, administrative buildings, museums, rest houses, police stations and officers bungalows. There were about 3000 such administrative buildings, out of which 954 were damaged and 194 were destroyed).

Recommendations:
All heritage buildings & structures need to be protected from the impact of the natural hazards namely earthquakes. Two issues will need consideration; firstly, the buildings will have to be retrofitted for safety against collapse and severe damage using the earthquake codes. Secondly, the valuable contents of these buildings such as museum artifacts, will have to be stabilized against falling or sliding to prevent damage even if the buildings do not collapse. The project proposals should take care of both these issues.

6. General Recommendation
The project monitoring, assessing and approving authority may develop a proforma for drawing the attention of the State Governments for preparing the projects taking into account the hazard safety of the cities and the same considerations may be applied by authority while approving the progress. Utilizing the great opportunity provided to the Urban Local Bodies by the JNNURM, the local body authorities and the state governments may simultaneously undertake a capacity building program for their officers, architects and engineers to continue the work of improving the existing city facilities by retrofitting procedures to make the whole city safer against impact of natural hazards in future.

A Safer City will provide Safer Life to its Citizens.

Brain Storming Session
with faculty members & scientists from academic institutions & CSIR laboratories and estate developers, public & private agencies on cost effective building materials and construction technologies: problems & prospects - 26th and 27th August, 2010, New Delhi
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 fields. The earliest permanent settlements were 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 He (Hwang Ho) in China. Officials and priests, who administered empires and invoked the gods, inhabited the earliest cities. Around them in the city lived the lower classes craft persons, artisans, and labourers. Cities grew at the intersections of trade routes, at harbours and at the mouths of rivers with easy access to the sea. Athens, Rome, Alexandria, and Carthage were located near the sea. Mecca, Damascus, and Samarkand were in land cities located on caravan routes.

In the 20th century, the World has moved rapidly to urbanisation. Large number of people has left the countryside. The dispersal of urban areas has led to a new type of social entity, which is called ‘metropolitan area’, consisting of a city and its adjacent suburbs. About one third of world’s population lived in urban areas in the year 1975. The urban population is expected to double by 2025. Further growth in urbanization is expected to take place only in developing countries, as in the developed countries, this growth has already taken place to a large extent. Urbanization level in African and Asian countries is only between 30 and 35 per cent. In these regions, urbanization growth is estimated at 4 per cent per annum. At this rate, both in Asian and African regions, urban population is expected to be about 54 per cent by the year 2025. However, rate of growth differs from region to region; it will comparatively be higher in the poorest regions and also in the regions where there is rapid economic growth.

Due to rapid urban growth rates many cities in developing countries, are expanding horizontally. A commonly used term for measuring urban growth is the ‘Mega city’ i.e. a city with a population exceeding 8 million. Whereas in 1950, only two such Mega cities existed viz. New York (population 12.3 million) and London (population 8.7 million), by the year 1990; the number of these Mega cities increased to 21, of which 16 were in developing countries. In the year 2015, the number of such Mega cities is likely to increase to 33 across the world, out of which 27 will be in developing countries. Some cities in Asia and Latin America have grown to enormous size even though the countries as a whole are still largely rural. The cities are growing from outside rather than inside, as the migrants from rural areas settle on the periphery rather than in the central parts of the cities.

Most of the developing countries are experiencing the tremendous impact of rapid population growth, increasing industrialisation and large influx of rural population in urban areas, which leads to serious housing shortages and over congestion in urban centres. The formation of slums and squatter settlements further adds to the problems. Inadequate community facilities and health services, ever-increasing metro-
politan traffic creating pollution hazard, wasteful sub division and use of urban land, sky rocketing land prices and cost of building materials are some of the major problems, faced by cities in most of the developing countries. About 50 percent of the urban population lives in slums and squatter settlements. These settlements are neither legally recognised nor serviced by local authorities and do not enjoy many of the benefits of urban life. Further the informal sector is indispensable to economic growth and sustenance of prosperity of cities. Unfortunately, enjoyment of life with dignity remains distant dream for these hapless slum people.

Most of the developing countries are faced with the problem of widespread poverty. About 21% population in developing countries is poor according to national income poverty line and 37% population is poor, according to Capability Poverty Measure (CPM). Whereas the CPM reflects the percentage of people who lack basic or minimally essential human capabilities like capability to be well nourished and healthy, capability for healthy reproduction, and capability to be educated and knowledgeable represented respectively by proportion of children under 5 who are underweight, birth unattended by trained health personnel and female illiteracy.

Further, increased urbanisation has created a host of health related problems causing many dangerous diseases like acute respiratory infections, tuberculosis and other airborne infections. The diseases occur more in the poor and crowded localities of cities in developing countries, say the State of World Population Report of the United Nations Population Fund.

The ordeal of environmental issues in India rising majorly from the adverse affect of urbanization include various natural hazards, particularly cyclones and annual monsoon floods, population growth, increasing individual consumption, infrastructural development, poor agricultural practices, and resource misdistribution. These have led to substantial human transformation of India’s natural environment. An estimated 60% of cultivated land suffers from soil erosion, water logging, and salinity. It is also estimated that between 4.7 and 12 billion tons of topsoil are lost annually from soil erosion. From 1947 to 2002, average annual per capita water availability declined by almost 70% to 1,822 cubic meters, and overexploitation of groundwater is problematic in the states of Haryana, Punjab, and Uttar Pradesh. Forest area covers 18.34% of India’s geographic area (637000 km²). Nearly half of the country’s forest cover is found in the state of Madhya Pradesh (20.7%) and the seven states of the northeast (25.7%); the latter is experiencing net forest loss. Forest cover is declining because of harvesting for fuel wood and the expansion of agricultural land. These trends, combined with increasing industrial and motor vehicle pollution output, have led to atmospheric temperature increases, shifting precipitation patterns, and declining intervals of drought recurrence in many areas.

The Indian Agricultural Research Institute of Parvati has estimated that a 3 °C rise in temperature will result in a 15 to 20% loss in annual wheat yields. These are substantial problems for a nation with such a large population depending on the productivity of primary resources and whose economic growth relies heavily on industrial growth. Civil conflicts involving natural resources—most notably forests and arable land—have occurred in eastern and northeastern states.

The cities around the world are facing a variety of social and environmental problems e.g. pollution, unemployment, poor health and absence of education. Such cities generate societal crime because poverty and deprivation is the chief cause of eternal and perpetual crime. Experience has shown that it is in the most populous cities, comprising the poor that one finds higher unemployment, increased and prolonged welfare dependency, rising crime rate, problems relating to public health, etc. To tackle these problems, the governments have to drain out scarce resources for developmental work relating to upkeep of schools, parks, libraries etc. and combat other maladies e.g. drug abuse, etc. for promoting societal homogeneity and stability. It is imperative to do so in order to curb the possibility of potential urban violence that may be caused due to prevalence of disparities between the poor masses and rather a minority section of economically affluent people who control the social and economic infrastructure in urban regions. Notwithstanding the fact that the urban violence is not a spontaneous phenomenon, it is rather the product of a society
characterized by inequality and social exclusion. Further, rapid urbanization and poverty are linked to the scale and extent of urban violence and crime. Erosion of moral values and the collapse of social structures and familial institutions, put communities at greater risk of urban violence and crime.

In the past, the focus of development policy particularly in India has been on rural areas in order to help agricultural growth and to improve living conditions of the rural people. This strategy was aimed to limit migration to cities and lead to growth and equitable development of the country. Unfortunately, it has not helped and migration to cities continues at a faster rate. Now, the importance of cities is being realised because of following reasons;

- The efficient cities are essential if national growth is not to be held back.
- The level of poverty in urban areas is more than it is in rural areas.
- Economic prospects rely on industrialisation that mostly takes place in towns and cities. In India, the urban population (28%) is estimated to contribute over half (55%) to the GDP. This contribution is expected to go up to 70% in the next twenty years.

Therefore in order to keep pace with economic development, it has become necessary to develop urban infrastructure rapidly.

More than one billion people around the globe still fail to meet basic consumption requirements, despite a runaway growth in consumption of goods and services according to a Human Development Report of United Nations. On consumption imbalances between developed and developing nations, the Report finds out that among 4.4 billion people living in developing countries almost 3/5th live without basic sanitation facilities, nearly 1/3rd are without safe drinking water and 1/4th lack adequate housing. Besides in the developing economies, 1/5th live beyond the reach of modern health services, 1/5th of children do not get as far as grade 5 in schools and an equal percentage are under nourished.

Creating an enabling legal, planning, financing and regulatory framework for the sustainable augmentation of housing, particularly for the poor and low income groups is essential. Housing provision should be an integral part of urban development programme. Every city must have a long-term human settlement structure plan and people should be involved in the process of planning and implementation to improve the facilities and to create better living conditions in cities. This is where housing cooperative plays a vital role. It has been providing decent houses to its members and also strives to create an environment that is conducive to the fulfillment of the physical, social, economic and spiritual needs of its members. The key role of housing co-operatives is “to establish and carry on its own account or jointly with individuals, educational, physical, social and recreational activities particularly for the benefit of its members”. A co-operative also provides services for basic amenities like water, electricity, sanitary services, etc., to its members. Its efforts are further directed towards building up a community life within the co-operative, based on good neighbourhood and fellow feelings and it transforms itself into a new community wherein “each is for all and all are for each”.

Life within housing co-operative is based on common management and sharing. The relationship thus established creates a bond between members which inspires them to undertake further activities and social life on a shared basis. The essence of the co-operative movement is that the people concerned should themselves look after the management of their affairs including economic betterment and social welfare. The management of housing co-operative is, therefore, not restricted or limited to management of housing estates, but encompasses all social and cultural activities as are aimed to improve the social life within the cooperative. The members themselves determine, by their collective wisdom, how the affairs of their co-operative should be managed. They are, therefore, motivated to manage their affairs in a manner as would improve their social conditions.

Cooperative activities often include managing shops, laundries, etc., and provision of social, educational and cultural services like running kindergarten schools, maintenance of play grounds, recreation rooms, cinemas, study groups, youth clubs, etc. Thus, housing co-operatives do not restrict their activities to merely cre-
ating better houses for their members; they rather aim at building up a new social life based on shared responsibility and shared benefits and free from crimes.

The history of housing co-operatives reveals that they have been instrumental in rebuilding the social life of people uprooted from their old surroundings. The pioneers in the field of co-operative housing sector were people who had migrated to big cities in search of employment etc. These people although succeeded in finding work opportunities, yet they felt alienated and distanced from their old surroundings. To overcome the life of isolation in their new urban or metropolitan environs, they ventured into housing co-operatives which gave them not just housing but also an entire social environment based on sharing of their joys and sorrows. In furtherance of their aim of fostering a new community life, these co-operatives undertook various educational, cultural and social interaction activities that motivated them to work collectively for common good and common welfare.

To give the cities and its inhabitants a better life, housing companies and Research Organisations should work in close co-operation and efficient co-ordination to ensure continuous supply of low cost housing. Innovative low cost housing designs developed by technical institutions should be show cased and promoted with the involvement of public, private and co-operative sectors. They should also be involved in water supply, sanitation, drainage and solid waste management, health centres, schools, proper maintenance of roads. Due emphasis should be given on preservation of green areas and creation of parks and permanent efforts should be made to provide environmental education to city dwellers particularly children.

The potential roles of housing co-operatives in solving the problems which are currently faced by our cities are outlined in the following paras:

(a) **Housing for Homeless:** The problem of housing for the homeless has assumed serious proportions, especially, in developing countries and has been engaging world wide attention. Housing co-operatives can play a useful role in providing to the homeless not only shelter but also an environment in which they can live with dignity.

(b) **Problem of Rural Migration:** Due to rapid urbanisation and industrialisation in the developing world, there is large scale migration of rural population to urban centres. The conditions of housing in which these people live are often miserable and crowded. Some are condemned to live in isolation having separated from their families. The best means for socially rehabilitating such people is through housing co-operatives. These co-operatives can provide the migrants housing as well as special services as are required for their physical and mental well being and cultural upliftment.

(c) **Clearance of Slums:** Existence of slums is the bane of rapid urbanisation in all developing countries. In these slums, there is not only lack of living space in houses, but also total absence of essential sanitary facilities required for the health and comfort of occupants. The problem of slums cannot be solved by individual efforts. Even the assistance of the government or the local authorities can be of minimal help. Cooperative efforts alone can succeed in building up the social life of slum dwellers.

(d) **Industrial Pollution:** Problems of pollution are attendant on industrialisation. Today, largely on account of lack of proper planning in the location of industrial units or absence of adequate arrangement for clearance of pollution, people residing near factories and industrial plants are unwilling victims of industrial pollution. The modern world is, therefore, faced with the problem of large scale shifting of the population to safer zones. Co-operatives can play a useful role in performing this task. Although the state and local authorities may assist the people in building homes in safer areas, their social rehabilitation can be best achieved through housing co-operatives.

(e) **Rehabilitation of Destitute:** Floods and earthquakes are a spectre we see almost every year, more frequently in one or the other part of the world. Such natural calamities create the problem of rehabilitation of their victims which entail not just the provision of houses in safer areas, but also the creation of all such facilities and
services as are required for the purpose. This gigantic task can be most satisfactorily secured only through housing co-operatives.

(f) **Social Evils and Housing Co-operatives:** The social life of people all over the world today is infected with many evils. In every country and in every society there are tensions created on account of racial, linguistic and religious differences. Housing co-operatives wherein people voluntarily choose to live often maintain strict neutrality towards caste, religion and language etc. and perform moderating role in lessening the conflict. Similarly, housing co-operatives can help to fight the menace of drug addiction particularly amongst youth inasmuch as they can promote a variety of youth activities to engage them fruitfully.

(g) **Ecological Improvement:** Another problem faced by the modern world is the near loss of ecological balance. Indiscriminate destruction of flora and fauna has disturbed the balance of nature. The human society has been consequently condemned to suffer on account of constant droughts, floods, and other calamities. Housing co-operatives, through the example of their own programmes of planting trees and maintaining gardens etc. can create awareness in the minds of the people towards preservation of ecological balance.

With the concept of providing basic shelter to the people for betterment of city life, congruent is the concept of cleaner city with hygienic sanitation facilities. Industries which are polluting the city and are located near them should be moved to suburban areas and asked to maintain higher environmental standards. The institution of green rating system recently introduced in India is an appreciable step to control pollution and force industries to maintain required environmental standards by properly treating their waste effluent before releasing it into the environment.

The concept of Ecological sanitation (Ecosan) offers a new philosophy of dealing with what is presently regarded as waste and wastewater. Ecosan is based on the systematic implementation of reuse and recycling of nutrients and water as a hygienically safe, closed-loop and holistic alternative to conventional sanitation solutions. Ecosan systems enable the recovery of nutrients from human faces and urine for the benefit of agriculture, thus helping to preserve soil fertility, assure food security for future generations, minimize water pollution and recover bioenergy. They ensure that water is used economically and is recycled in a safe way to the greatest possible extent for purposes such as irrigation or groundwater recharge.

Ecosan is a new holistic paradigm in sanitation, which is based on an overall view of material flows as part of an ecologically and economically sustainable wastewater management system tailored to the needs of the users and to the respective local conditions. It does not favour a specific sanitation technology, but is rather a new philosophy in handling substances that have so far been seen simply as wastewater and water-carried waste for disposal.

The Water Supply & Sanitation Collaborative Council (WSSCC), a multi-stakeholder organisation under the umbrella of the World Health Organization in Geneva, has been almost single-handedly trying to put sanitation and hygiene on the international agenda. It succeeded in including sanitation as one of the UN’s Millennium Development Goals (MDGs), at the World Summit on Sustainable Development in Johannesburg in 2002 (the precursor to which was the spectacular Earth Summit at Rio 20 years earlier). Countries have now pledged to halve the number of people without access to sanitation in the world, a staggering 2.5 billion, by 2015.

Considerable progress has been made towards this, with the glaring exception of sub-Saharan Africa, which, like South Asia, suffers from deep poverty and acute water scarcity to boot. Increasingly, governments and multilateral institutions are realizing that it will be impossible for the state to provide sanitation and inculcate hygiene practices on the scale required to meet the MDGs. The only solution is to allow people to do these themselves, with a little institutional and financial support.

Also, there is an emergent need to undertake appropriate measures to control population growth. Development of rural areas and other infrastructure facilities there is needed urgently so that people don’t move to cities.
Efforts should be made to rehabilitate those who have already migrated and settled in slums and on city pavements. The slums and squatter settlements should be upgraded with proper planning. It is, therefore, imperative that the civic authorities, Government and people should come together to address the problem of slum dwellers and others living in inhuman conditions. The NGOs, CBOs, cooperatives, local residents’ associations can play meaningful role in creating better environment in slum colonies. These organisations can also impart value based education and training to the residents on various precautionary measures to safeguard against fire, spread of diseases and prepare them for dealing with emergencies and also to bring them in the mainstream of city life.

Most importantly, every citizen at all walks of lives has to transform into a ‘responsible citizen’. It includes being law-abiding, environmentally friendly, paying taxes on time etc. It is often the responsibility of those individuals who have been blessed with financial gains to help out those less fortunate individuals. This doesn’t necessarily mean giving away money, but it does mean donating some of your time to helping others to touch a life with kindness.

An issue of India Today had enumerated fifty-seven ways as to how to make India a better place to dwell in an article written by S. Prasannarajan. He had rightly mentioned that if water is priced higher it will be used sparingly. Encourage cities to invest in water recycling plants. At the micro level, promote innovative solutions like that of Bangalore-based architect couple Chitra and Viswanath who incorporated rooftop rainwater harvesting in their home in 1995. The process now yields 80,000 litres of water every year. As far as dwelling units are concerned, India is short of 50 million houses, which means the country needs to spend Rs 1,75,000 crore more to give every citizen a home. A probable solution is: archaic real estate laws need to be changed to free land for low cost high-rises. Partnerships between the state and private sector have to be encouraged to make building affordable. For e.g. Kapil Mohan, former DC of Hubli-Dharwad, Karnataka, showed the way with the Ashraya project where 1,240 houses were built with state help.

BMTPC Board of Management meeting held on April 12, 2010
It is well known that Bamboo produces biomass faster and has superior physical and mechanical properties as compared to wood available from many fast-growing wood species. Earlier studies have revealed that bamboo in panel form is best suited to substitute wood in several applications. The decline in timber availability and the emergence of new technologies and product options have spurred interest in bamboo–based composites and wood substitutes. This article discusses in brief about properties of various bamboo based products developed at Indian Plywood Industries Research and Training Institute (IPIRTI). Research and Development efforts made at IPIRTI has given birth to the development of number of eco friendly bamboo based products viz., Bamboo Mat Board (BMB) and Bamboo Mat Veneer Composite (BMVC) as alternate to plywood, Bamboo Mat Corrugated Sheet (BMCS) as an alternate to metal, asbestos-cement corrugated roofing sheets etc., Bamboo Mat Compreg, Bamboo Wood (BW), Bamboo Flooring Tiles, Flattened bamboo board, High Density Shuttering grade panels as alternate to wood and wood composites.

The decline in timber availability and the emergence of new technologies and product options have spurred interest in bamboo–based composites and wood substitutes. Many bamboo-based composites products provide promising linkages between the organized and unorganized sectors, for instance, resin-bonded boards (organized) made from hand woven mats (unorganized). This highlights the potential for employment, especially in areas that are relatively disadvantaged. The highest priority—because of the employment intensity and the linkages between industrial scale units and the cottage sector—needs to be accorded to mat-based composites.

Extensive studies have been carried out in IPIRTI on use of bamboo/bamboo composites, such as Bamboo Mat Board (BMB), Bamboo Mat Veneer Composite (BMVC), Bamboo Mat Corrugated Sheet (BMCS) etc., which can lead to reduction of pressure on non-renewable building material, reduce pollution and lead to substantial energy conservation. In other words bamboo composites emerge as a potential eco friendly building material.

Bamboo in its natural form has several uses especially mature bamboo which is very strong and durable. Split bamboo is very susceptible to fungus and termite attack unless given proper preservative treatment. To Convert bamboo into panel or wood like products preliminary processing of bamboo is required which converts hollow, cylindrical bamboo into basic raw materials—slivers/bamboo mat or strips—to be used for further processing into useful products. Bamboo can also be split open & crushed and glued to panel products.

Use of any new material depends upon its suitability for various applications vis-a-vis the materials already in use. Development of appropriate application technology plays an important role in acceptance of any new material.
The properties of some of the Bamboo based panel products developed at IPIRTI are:-

- Bamboo Mat Board
- Bamboo Mat Veneer Composites
- Bamboo Mat Corrugated Sheet
- Bamboo wood
- Bamboo strip board
- Bamboo flooring tiles
- High Density Shuttering Grade BMB/ Bamboo mat compreg
- Flattened bamboo board
- BWP grade bamboo composites.

**Bamboo mat board (BMB)**

BMB is a layered composite comprising several layers of woven mats having excellent internal bond strength, and are resistant to decay, insects and termite attack. They have physical and mechanical properties at par with BWP grade of plywood and are fire resistant. Their mechanical properties depend upon the material used for making mats, i.e. bamboo slivers, the weaving pattern and the adhesive used for bonding.

However, these properties can be altered by changing the weaving pattern of bamboo slivers used in mat making used for making board in order to get required values for Modulus of Rupture (MoR), Modulus of Elasticity (MoE), Tensile strength etc., Thus, it can be inferred that the strength and stiffness of BMB is related to the weaving pattern of the mats. However, modulus of rigidity (G) or shear modulus of BMB in the plane of the board is very high and is comparable to the required values for structural plywood as per Indian Specifications (IS: 10701, 1984). It is interesting to note that MoR of BMB far exceeds that of both structural plywood and wood. This is attributable to the herringbone weave pattern. Clearly, BMB has high in-plane rigidity and hence high racking strength and is more flexible than equivalent plywood. This property of BMB can be advantageously used in many engineering applications. In fact BMB has been found especially useful as sheathing material in structural and semi structural uses such as walling, partitions, roof sheeting, door skins, box furniture, built up hollow beams, gussets, and containers. The properties of BMB of different thicknesses are given in Table 1.

**Bamboo mat veneer composite (BMVC)**

In BMVC, wood veneers are placed in between the layers of bamboo mats. The properties of BMVC depend upon the mechanical properties of wood veneers that are placed in between bamboo mat layers, in addition to the properties of the bamboo mats and the adhesives used in bonding.

Investigations have shown that strength of a panel made by plantation timber is substantially enhanced when made in combination with bamboo mats. MoE and MoR of BMVC are higher than equivalent plywood and this depends on the number of layers of veneers for a given thickness of BMVC. Due to the presence of woven bamboo mats, BMVC has different mechanical properties along and across the length of the board and are given in Table 2. The properties are comparable to that of structural plywood. Hence for all practical purposes BMVC can be used in a similar way to plywood for structural applications.

**Bamboo Mat Corrugated Sheets (BMCS)**

Considering the flexibility of bamboo mats due to “Herring-Bone” weave pattern, an idea was mooted to produce moulded products like trays in various forms like rectangular, round, as well in different sizes. A process was developed including the moulds to produce such products get them in finished form which can be subsequently finished with coating materials to enhance the appearance and acceptability by the consumers. The moulded products like trays, were found to be highly durable and leak proof which can be conveniently used for various ap-

### Table 1: Properties of BMB of different thickness

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Property</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thickness of the panels</td>
<td>3mm 6mm 6mm* 8mm 9mm</td>
</tr>
<tr>
<td>2</td>
<td>Density, kg/m³</td>
<td>766 711 935 790 892</td>
</tr>
<tr>
<td>3</td>
<td>Internal Bond Strength, N/mm²</td>
<td>Dry 2.18 2.42 0.82 1.97 2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet 1.98 2.14 0.61 1.73 1.8</td>
</tr>
<tr>
<td>4</td>
<td>Surface Strength, N/mm²</td>
<td>Dry 11.42 11.23 4.9 9.47 13.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet 11.42 10.47 3.47 9.1 10.5</td>
</tr>
<tr>
<td>5</td>
<td>Tensile strength, N/mm²</td>
<td>22.69 26.59 89.17 29.54 31.4</td>
</tr>
<tr>
<td>6</td>
<td>Compressive strength, N/mm²</td>
<td>16.77 30.35 56.3 35.3 57.5</td>
</tr>
<tr>
<td>7</td>
<td>Modulus of Rupture, N/mm²</td>
<td>50.74 60.31 102.57 59.35 68.8</td>
</tr>
<tr>
<td>8</td>
<td>Modulus of Elasticity, N/mm²</td>
<td>3678 3220 12033 3114 3930</td>
</tr>
<tr>
<td>9</td>
<td>Modulus of Rigidity, N/mm²</td>
<td>5881 6050 3527 6066 5750</td>
</tr>
</tbody>
</table>

* Pattern of weaving is rectangular
plications like the ones based on metals, plastics etc. The idea of development of corrugated sheets was a result of development of bamboo mat moulded products like trays to enhance stiffness for the BMB developed through corrugation techniques. Roofing materials such as asbestos cement corrugated sheeting (ACCS), corrugated fiber reinforced plastics (CFRPs). Corrugated aluminum sheeting (CAS), corrugated galvanized iron sheeting (CGIS) which have been established for more than several decades, are being subjected to scientific scrutiny on several counts, including their impact on workers health and environment, the energy requirement for their manufacture, and sustainable supply of raw materials. Of late priority is being given, and rightly so to ‘green’ building materials, based on renewable resources. The results of all the properties of BMCS determined including statistical data are given in Table 3.

Bamboo Wood (laminates)

Development of appropriate technologies for the manufacture of both horizontal and vertical laminates, using UF, MUF and PF resins have been developed. Design and Development of machinery for exerting side pressure for making laminates has also been made. Preliminary tests carried out on these laminates shows that it is superior to plantation timbers. End use application such as furniture, other household components and flooring have been developed and put to use. Table 4 gives the strength properties of bamboo laminates.

### Table 2: Properties of BMVC

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>BMVC (21mm thick)</th>
<th>Prescribed values as per IS 10701</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density kg/m³</td>
<td>602</td>
<td>750</td>
</tr>
<tr>
<td>2</td>
<td>Internal Bond Strength, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>2.30</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>1.65</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Surface Strength, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>8.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>6.80</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Tensile strength N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along</td>
<td>36.40</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Across</td>
<td>35.80</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>Compr. Strength, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along</td>
<td>43.90</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Across</td>
<td>40.20</td>
<td>29</td>
</tr>
<tr>
<td>6</td>
<td>MOR N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along</td>
<td>68.50</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Across</td>
<td>55.40</td>
<td>29</td>
</tr>
<tr>
<td>7</td>
<td>MOE N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along</td>
<td>7820</td>
<td>7355</td>
</tr>
<tr>
<td></td>
<td>Across</td>
<td>3210</td>
<td>3923</td>
</tr>
<tr>
<td>8</td>
<td>Mod. of Rigidity, N/mm²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Properties of BMCS

(Average thickness = 3.8 mm)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Results</th>
<th>Average</th>
<th>Standard Deviation</th>
<th>Variation Coefficient,%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load Bearing capacity N/ mm, Dry</td>
<td>4.26</td>
<td>0.39</td>
<td>9.12</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Load Bearing capacity N/ mm, Wet</td>
<td>3.31</td>
<td>0.44</td>
<td>13.34</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Failing hard body impact, visual observation</td>
<td>No sign of rupture, crack or tear</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Impermeability, visual observation</td>
<td>No droplets of water</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Water Absorption, % (after 24hrs immersion in water)</td>
<td>12.59</td>
<td>1.8</td>
<td>14.29</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cyclic test, visual observation</td>
<td>No delamination</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Flame penetration, minutes</td>
<td>13.67</td>
<td>3.35</td>
<td>15.99</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Rate of burning, minutes</td>
<td>24.78</td>
<td>5.93</td>
<td>16.61</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Surface spread of flame, mm²</td>
<td>3045.67</td>
<td>452.71</td>
<td>14.86</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: Properties of bamboo laminates

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Vertical Laminates</th>
<th>Horizontal laminates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density, Kg/m³</td>
<td>728</td>
<td>782</td>
</tr>
<tr>
<td>2</td>
<td>Modulus of Rupture, N/mm²</td>
<td>122.5</td>
<td>149.1</td>
</tr>
<tr>
<td>3</td>
<td>Modulus of Elasticity, N/mm²</td>
<td>12028</td>
<td>16570</td>
</tr>
<tr>
<td>4</td>
<td>Compressive strength, N/mm²</td>
<td>61.7</td>
<td>84.7</td>
</tr>
<tr>
<td>5</td>
<td>Block shear strength, N/mm²</td>
<td>11.89</td>
<td>12.8</td>
</tr>
<tr>
<td>6</td>
<td>Screw withdrawal strength, N</td>
<td>4999</td>
<td>4006</td>
</tr>
<tr>
<td>7</td>
<td>Abrasion resistance, mg/revolution</td>
<td>0.36</td>
<td>0.36</td>
</tr>
<tr>
<td>8</td>
<td>Moisture resistance</td>
<td>Withstand cyclic test</td>
<td>Withstand cyclic test</td>
</tr>
</tbody>
</table>
Strength properties are good and some of the properties are comparable to teak wood. The laminates are eco-friendly. The laminates can be manufactured in different thicknesses and width to meet the end use requirements.

**Bamboo Strip Board**

Laboratory scale technology has been developed at IPIRTI to make Bamboo strip boards from bamboo strips. The developmental work was limited to laboratory scale of size 45cm x 45cm. The panel developed possesses high strength, stiffness and rigidity. It is characterized by resistance to deformation, abrasion and weathering. Its bending strength properties are superior to wood panel and therefore have application potential, particularly as platform boards, vehicle platforms, transport floorings etc. The properties of Bamboo strip board are given in Table 5.

**Bamboo flooring tiles**

Bamboo flooring is an alternative to wood or laminate flooring. The appearance of bamboo is very similar to wood flooring. These bamboo floorings are practical and durable in that they have better wear and tear and stain resistance than wood and vinyl, they can be installed as floating floor over most existing floors therefore, costly, tedious sub floor preparation/removal of existing flooring can be avoided, and these can be used in radiant heated floors also. Bamboo flooring tiles can also be refinished when its gets worn or damaged. The properties of Bamboo Flooring Tiles are given in Table 6.

| Table 5: Properties of bamboo strip board |
|------------------------|------------------------|
| Sl. No. | Property | Result |
| 1. | Density, kg/m³ | 921 |
| 2. | Modulus of Rupture, N/mm² | 118.56 |
| 3. | Modulus of Elasticity, N/mm² | 12383 |
| 4. | Block shear strength, N/mm² | 5.67 |

| Table 6: Properties of Bamboo Flooring Tiles |
|------------------------|------------------------|
| Sl. No. | Property | Average | Standard deviation | Variation coefficient, % |
| 1. | Moisture Content % | 9.5 | 0.57 | 6.07 |
| 2. | Density kg/m³ | 700 | 30 | 4.13 |
| 3. | Cyclic Test | No separation or delamination observed |
| 4. | Water absorption %(24hr immersion) | 14.0 | 0.62 | 4.42 |
| 5. | Thickness swelling %(24hr immersion) | 3.8 | 1.10 | 28.71 |
| 6. | Modulus of Rupture, N/mm² | |
| a) Along | 122.5 | 13.7 | 11.2 |
| b) Across | 27.0 | 3.9 | 14.6 |

| Sl. No. | Property | Average | Standard deviation | Variation coefficient, % |
| 7. | Modulus of Elasticity, N/mm² | |
| a) Along | 15957 | 2122.2 | 13.3 |
| b) Across | 1383 | 178.2 | 12.9 |

| Sl. No. | Property | Average | Standard deviation | Variation coefficient, % |
| 8. | Compressive strength, N/mm² | |
| a) Parallel to laminae | 52.6 | 4.43 | 8.43 |
| b) Perpendicular to surface | 63.0 | 1.36 | 2.16 |
| 9. | Shear strength, N/mm² | 4.4 | 1.2 | 28.3 |
| 10. | Static hardness, N | 6237 | 1149 | 18.42 |

| Sl. No. | Property | Result |
| 11. | Hard body impact (wt=4.25Kg. Ht=0.5m) | No crack or breakage observed |
| 12. | Abrasion test, Number of revolutions | 50 |
| 13. | Resistance to cigarette burn | No mark or stain observed |
| 14. | Resistance to crack | No crack or delamination observed |
| 15. | Resistance to steam | No sign of blister, delamination or change in surface finish observed |
| 16. | Resistance to stain | No stain observed |

**High Density Shuttering Grade BMB/ Bamboo mat compreg**

High density shuttering grade bamboo mat boards developed in at IPIRTI will be an alternate to compreg manufactured at present. It has high physical mechanical properties and can be used wherever compreg is used.

Bamboo mat compreg is developed at the institute and its properties are given in Table 7. The Properties of Bamboo mat compreg can be compared with General purpose compreg GM grade (IS:3513) made out of wood veneers and is superior to Shuttering grade plywood (IS:4990) as shown in Table 7.

**BMP grade bamboo composites (BMB & BMVC)**

BMP grade bamboo composites (BMB & BMVC) developed in at IPIRTI is an alternate to BWP
grade plywood viz. marine, shuttering and structural grades, designed to provide structural/weather exposed surfaces of building components of industrial, residential, agricultural, commercial and institutional types of buildings and for decorative and other purposes. The properties of the BWP grade bamboo composites are comparable with similar wood composites viz. marine, shuttering and structural plywood. The properties of BMP grade bamboo composites are given in Table 8.

Flattened bamboo board

Flattened bamboo board developed at IPIRTI is designed to provide structural/weather exposed surfaces of building components of industrial, residential, agricultural, commercial and institutional types of buildings and for flooring and other purposes. The properties of Flattened bamboo board are given in Table 9., which are comparable with shuttering plywood.

Based on the research carried out at this Institute, it has been established that various bamboo mat based and strip based products developed are comparable to wood based panel products and solid wood and thus can replace wood and wood products in many end uses.

Research studies on the suitability of bamboo mat board shows that they can be used for non-load bearing applications similar to plywood in areas like housing, furniture, packaging, storage and transportation. Utilization of bamboo mat board for load bearing structural applications similar to structural plywood, concrete shuttering plywood, etc., were not found suitable due to

### Table 7: Properties of bamboo mat compreg/High density BMB

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Results</th>
<th>Prescribed values as per IS:3513</th>
<th>Prescribed values per IS:4990</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>1.1</td>
<td>0.95 to 1.25</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Moisture content %</td>
<td>8.01</td>
<td>6 to 12</td>
<td>5 to 15</td>
</tr>
<tr>
<td>3</td>
<td>Tensile strength N/mm²</td>
<td>57.18</td>
<td>59</td>
<td>32.5</td>
</tr>
<tr>
<td>4</td>
<td>Static bending strength, N/mm²</td>
<td>107.6</td>
<td>59</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Modulus of Elasticity, N/mm²</td>
<td>5701</td>
<td>-</td>
<td>7500</td>
</tr>
<tr>
<td>6</td>
<td>Compressive strength, N/mm²</td>
<td>-</td>
<td></td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td>Parallel to laminae</td>
<td>68.5</td>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Perpendicular to laminae</td>
<td>181.2</td>
<td>130</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Impact strength, Kg/cm²</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Parallel to laminae</td>
<td>0.55</td>
<td>0.2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Perpendicular To laminae</td>
<td>0.60</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Hardness (Rockwell ‘H’ Scale)</td>
<td>96.67</td>
<td>60</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 8: Properties of BWP grade bamboo composites (BMB & BMVC)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>BMB</th>
<th>BMVC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard</td>
<td>Variation coefficient, %</td>
</tr>
<tr>
<td>1</td>
<td>Moisture content, %</td>
<td>7.36</td>
<td>1.90</td>
</tr>
<tr>
<td>2</td>
<td>Density, kg/m³</td>
<td>840</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>Internal Bond Strength, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In dry state</td>
<td>1.32</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>In wet state</td>
<td>1.01</td>
<td>0.36</td>
</tr>
<tr>
<td>4</td>
<td>Tensile strength, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>29.45</td>
<td>4.88</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Modulus of Rupture, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>68.55</td>
<td>13.31</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Modulus of Elasticity, N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>4.19</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 9: Properties of Flattened bamboo board

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Average</th>
<th>Standard deviation</th>
<th>Variation coefficient, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture content, %</td>
<td>8.63</td>
<td>1.17</td>
<td>13.54</td>
</tr>
<tr>
<td>2</td>
<td>Density, kg/m³</td>
<td>900</td>
<td>0.12</td>
<td>13.68</td>
</tr>
<tr>
<td>3</td>
<td>Internal Bond Strength, N/mm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In dry state</td>
<td>1.35</td>
<td>0.37</td>
<td>27.52</td>
</tr>
<tr>
<td></td>
<td>In wet state</td>
<td>1.17</td>
<td>0.38</td>
<td>32.82</td>
</tr>
<tr>
<td>4</td>
<td>Tensile strength, N/mm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>68.55</td>
<td>11.12</td>
<td>16.22</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td>49.73</td>
<td>6.75</td>
<td>13.57</td>
</tr>
<tr>
<td>5</td>
<td>Modulus of Rupture, N/mm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>136.04</td>
<td>32.39</td>
<td>23.81</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td>59.04</td>
<td>18.72</td>
<td>31.70</td>
</tr>
<tr>
<td>6</td>
<td>Modulus of Elasticity, N/mm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along the grain</td>
<td>10.33</td>
<td>2.77</td>
<td>26.78</td>
</tr>
<tr>
<td></td>
<td>Across the grain</td>
<td>5.06</td>
<td>1.10</td>
<td>21.82</td>
</tr>
</tbody>
</table>
lower strength and stiffness ratio to that of density of bamboo mat board. However, introduction of wood veneer in the panel has increased these properties considerably except modulus of rigidity depending on the number of veneers and their position in the assembly. Though modulus of rigidity of composite panels has come down considerably as compared to the values obtained for bamboo mat boards, the composite panels have still much higher modulus of rigidity [4 to 9 times] than the values prescribed for structural plywood and thus bamboo mat veneer composites can be used for structural purposes.

Another important product variant from bamboo mat is Bamboo Mat Corrugated Sheet [BMCS]. These are light but strong and possess high resilience. Being manufactured from bamboo, these are environment and people friendly and are expected to revolutionize house construction activity, particularly in disaster prone areas as prefab houses.

High density bamboo mat board [density upto 1.4] is an excellent replacement of compreg made from wood veneer. The product meets all physical and mechanical properties required for wood veneer based compreg. Whereas wood veneer based compreg requires prime quality timber, bamboo mat based compreg can be made from 2-3 years old bamboo.

Parallel bamboo strip based products – Bamboo laminates and Cross laminates are ideal replacement of solid wood. Physical-mechanical properties of bamboo parallel laminates are comparable to teak wood and can be used where solid wood is being used. Both vertical and horizontal laminates have been developed and properties standardized for use in furniture, boxes, walling, flooring, door, etc.

Cross laminates have been designed for flooring. 3 to 5 ply cross laminates made in the same fashion of plywood can be of different density and thickness. When densified upto specific gravity of 0.8 to 0.9, the board can be used for truck flooring. Medium density floor board having specific gravity of 0.7-0.75 can be used for house floor. Being cross laminated, these are dimensionally stable. Floor boards are also resistant to water, termite, mould and fire. Thus these are superior to conventional floor board made of wood, particle board and MDF.

Almost all products which can be made from wood can also be made from bamboo and it revealed that bamboo in panel form is best suited to substitute wood composites in several applications. These products are biodegradable and therefore do not pollute the environment. Bamboo in all forms is environment friendly, and it is a renewable raw material base at short cycle for making many useful industrial products for human consumption for the future.

BMTPC’s Permanent Display Centre at Dept. of Civil Engg., IIT Roorkee - Inaugurated by the Executive Director, BMTPC on February 10, 2010
Introduction

Building materials account for 60%-70% (Table 1.0) of the total cost of construction. Due to large-scale construction programmes in the country, the demand for conventional building materials like cement, steel, bricks and timber has outstripped their supply. Moreover, the exponential population growth and the existing housing shortage have made the situation even more alarming. There is a general shortage of conventional building materials like cement, steel, bricks and timber in different parts of the country. In 2003, there was an estimated shortage of 55,000 million bricks, 17 million tonnes of cement, 285 million tonnes of stones, 2.7 million tonnes of steel and 13 million cum. of timber (Table 2.0). It is thus quite obvious that the present available stock of building materials in the country is not in a position to meet the ever-growing demand of housing. In the present situation, the country has very little option but to rely increasingly on locally available cost-effective building materials and components. The R&D efforts undertaken in the country by various research organisations like CBRI, Roorkee; SERC, Madras; National Council for Cement and Building Materials (NCB), Ballabgarh; Central Fuel Research Institute (CFRI), Dhanbad; NBO and BMTPC have led to development of various low cost, low energy consuming building materials using several industrial and agricultural wastes. There is considerable potential for exploitation of the agro-industrial wastes for their commercial production and large-scale application in construction programmes.

Table 1.0 : Average cost break-up of building construction

<table>
<thead>
<tr>
<th>Materials (67%)</th>
<th>Labour (33%)</th>
<th>Component-wise (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement 17%</td>
<td>Mason’s wages 12%</td>
<td>Foundation 10%</td>
</tr>
<tr>
<td>Iron &amp; steel 9%</td>
<td>Carpenter’s wages 6%</td>
<td>Walls 30%</td>
</tr>
<tr>
<td>Bricks 15%</td>
<td>Unskilled labour 15%</td>
<td>Roofs 25%</td>
</tr>
<tr>
<td>Timber 12%</td>
<td>Doors &amp; Window 15%</td>
<td></td>
</tr>
<tr>
<td>Sand 6%</td>
<td>Flooring 10%</td>
<td></td>
</tr>
<tr>
<td>Aggregate 8%</td>
<td>Finishing 10%</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.0

<table>
<thead>
<tr>
<th>S. Particulars</th>
<th>Demand (Urban Areas)</th>
<th>Availability (Rural Areas)</th>
<th>Shortage</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) New Construction 94.53</td>
<td>416.30</td>
<td>159458</td>
<td>11.76</td>
</tr>
<tr>
<td>(b) Upgradation 4.87</td>
<td>10.72</td>
<td>3082</td>
<td>0.07</td>
</tr>
<tr>
<td>(c) New Construction 29.25</td>
<td>121.97</td>
<td>118875</td>
<td>2.08</td>
</tr>
<tr>
<td>(d) Upgradation 3.33</td>
<td>6.95</td>
<td>5081</td>
<td>0.03</td>
</tr>
<tr>
<td>2. AVAILABILITY 114.93</td>
<td>270.35</td>
<td>231598</td>
<td>11.24</td>
</tr>
<tr>
<td>3. SHORTAGE 17.05</td>
<td>285.59</td>
<td>54898</td>
<td>2.70</td>
</tr>
</tbody>
</table>

* Prof. & Head, Civil Engineering Department, Samrat Ashok Technological Institute (Engg. College), Vidisha (M.P.) India. Ph. No. 07592-250412 (O), 250232 (R) Mobile : 09826244840 E-mail : jsccivil@rediffmail.com; jschouhan@indiatimes.com
The building materials and components are being produced by using a wide variety of processes ranging from labour intensive to capital intensive. Continuing dependence of building industry on conventional, energy intensive building materials is adversely effecting the construction costs. To meet the shortages of building materials appropriate investment in Research and Development during past three to four decades have resulted in a large number of innovative building materials and construction techniques, prefab systems etc. In order to promote these low cost building material technologies through large scale adoption and production in different regions, BMTPC has been set up for strengthening technology transfer mechanism in the country.

The Housing Policy envisages the need to promote use of standardized low-cost components in the housing and building construction.

Availability of finance required for construction of houses is a big problem in the way of increasing housing stock. In order to tackle this problem Govt. of India provides institutional finances. Housing Development & Finance Corporation (HDFC) and Housing Promotion Finance Corporation were established to cater to needs of finance exclusively for housing to Individuals, groups and corporate enterprises. Many commercial banks also provide finance for housing.

The government envisages a more active role for commercial banks with their country wide branch network in provision of housing finance. Housing and Urban Development Corporation (HUDCO) plays a very vital role by providing finance for building material industries and housing.

The most important development in strengthening the housing finance system has been establishment of National Housing Bank (NHB) as an apex housing finance institution.

In order to encourage housing, Government of India has offered Income Tax incentives. For encouraging building material industries in the country. The housing finance institutions are considering to form a consortium to extend loan and equity participation to the entrepreneurs. The existing system of taxes, levies on production of building components and systems has been rationalized.

Choice of Materials

The policy should also promote use of appropriate building materials for mass housing constructions. The matrix to guide the choice of building materials for low-cost housing is shown in Fig. 1.0.

Special emphasis in national policy would have to be laid on prevention of environmental degradation, energy conservation, and ecological balance.

![Fig. 1.0 Matrix to guide choice of building materials in low-cost housing](image)

<table>
<thead>
<tr>
<th>NOTATIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EASY</td>
<td>E</td>
</tr>
<tr>
<td>LOW</td>
<td>L</td>
</tr>
<tr>
<td>NORMAL</td>
<td>N</td>
</tr>
<tr>
<td>HIGH</td>
<td>H</td>
</tr>
<tr>
<td>NOT APPLICABLE</td>
<td>NA</td>
</tr>
</tbody>
</table>
Prevention of Environmental Degradation

Production of building materials is undertaken mostly in a decentralized manner all over the country, particularly in small-scale and cottage industries. Appropriate measures have, therefore, to be devised to prevent pollution of environment due to the process of producing these building materials. For example, burning of bricks in the vicinity of mangroves damages plant life, and digging of soil for brick making causes collection of waste water in cess pools creating unhygienic conditions and erosion of good agricultural soils.

Energy Conservation

Production of durable materials requires use of energy in significant proportion. In light of severe constraints with regard to availability of conventional energy resources and their high cost, it is necessary to adopt measures which result in energy conservation and also to use non-conventional energy resources for production of building materials to the extent possible.

Ecological Balance

Only such types of building materials and products should be used for construction of houses which do not disturb ecological balance. For example, excessive quarrying of limestone for lime burning or cement manufacturing and extraction of timber has denuded forest wealth and destroyed the ecology of hilly regions.

Indigenous Building Materials

Indigenous building materials have been used extensively for building houses at affordable cost. They are easily available locally at little or no cost and local people are conversant with the technology of using them for construction of houses largely through self-help.

The performance of the houses built with indigenous building materials is suited to the geoclimatic conditions. However, frequent repairs and reconstruction are required. Moreover, large-scale damage and destruction takes place due to natural disasters like heavy rainfall and floods, earthquakes and land slides, strong winds and cyclones, and fires.

It is, therefore, incumbent on builders to achieve economic optimisation in the use of indigenous building materials by application of modern science and technology, so that more durable and liveable houses can be constructed at lowest possible cost. This is also necessary to ensure sustainable development without causing environmental degradation and ecological imbalance, which have become matters of over riding significance.

Some notable progress has been made in some developing countries in the improved use of indigenous building materials for low-cost housing and is briefly mentioned here, along with its potential for tackling the massive problem of shelter for the people at affordable cost.

Organic Materials

Organic materials include widely used materials such as grasses and leaves, husks and straws, reeds and bamboos, and wood and wood products which are vulnerable to early decay and insect attack. Improved techniques for extending the service life of these materials have been developed which will lead to economic optimization in the use of organic materials.

Inorganic Materials

Inorganic materials include commonly used materials like soils and laterite, burnt clay bricks and tiles, building lime and clay pozzolana, stones, and sands. As a result of research work done by CBRI, Roorkee, India and similar research organisations in other developing countries improved use of these materials for construction of low-cost houses has been made for achieving economy. Some of these are as given below:

1. Techniques of soil stabilisation using materials such as lime, cement, and emulsified bitumen to make the walls stronger and durable, with better dimensional stability.
2. Water-resistant mud plaster using bitumen emulsion for application on soil-based walls and roofs to prevent erosion caused by rainfall.
3. Good quality laterite and lime bricks for construction of walls.
5. Good quality building lime and clay pozzolana and also ready to use lime and lime pozzolana mixtures.
6. Stone spalls with cement concrete to produce economical stone blocks for masonry work.
7. Sand-lime bricks and blocks that are strong and durable.
2. Use of rice husk with cement to form roofing sheets.
3. Production of small roofing tiles using straw mixed with mud.
4. Reed boards formed by compressing a small bunch of reeds to gather and wiring them tightly.
5. Use of bamboo treated with preservatives and also bamboo-reinforced cement concrete construction.
6. Use of secondary species of timber after preservative treatment and solar kilns for seasoning of timber.

### Substitute For Scarce Materials

Research findings of various research institutions like CBRI, NCB and CFRI, etc. have led to introduction of number of alternative building materials like hydrated lime, asphaltic corrugated sheets, cellular concrete, flyash bricks, plastic pipes, secondary species of timber, pozzolana cement and ferrocement overhead tanks, etc. The NBO had proposed feasibility reports for setting up plants for manufacture of such building products. Application of these substitute materials have resulted in the saving of scarce materials like cement and steel. Some of the alternative materials which are promoted by CETDEC, SATI, Vidisha for low cost housing are listed below.

### References

1. Advance in Building materials and construction published by C.B.R.I. Roorkee
2. Analysis of Grid floors published by N.B.O. Delhi
3. Building with Earth published by the Mud Village Society Delhi

---

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Component</th>
<th>Size (mm)</th>
<th>Cost per Components (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cement Concrete Blocks</td>
<td>400x100x200</td>
<td>12.00</td>
</tr>
<tr>
<td>2</td>
<td>Cement Concrete Blocks</td>
<td>400x150x200</td>
<td>15.00</td>
</tr>
<tr>
<td>3</td>
<td>Cement Concrete Blocks</td>
<td>400x200x200</td>
<td>20.50</td>
</tr>
<tr>
<td>4</td>
<td>Cement Concrete Hollow Blocks</td>
<td>300x150x150</td>
<td>11.50</td>
</tr>
<tr>
<td>5</td>
<td>Cement Concrete Hollow Blocks</td>
<td>400x150x200</td>
<td>14.50</td>
</tr>
<tr>
<td>6</td>
<td>Cement Concrete Hollow Blocks</td>
<td>400x200x200</td>
<td>20.00</td>
</tr>
<tr>
<td>7</td>
<td>Stone masonry Blocks</td>
<td>300x150x150</td>
<td>8.00</td>
</tr>
<tr>
<td>8</td>
<td>Soil stabilized blocks</td>
<td>250x130x150</td>
<td>2.00 to 3.00</td>
</tr>
<tr>
<td>9</td>
<td>Precast R.C.C. Beam</td>
<td>300x150x150</td>
<td>200/RMT</td>
</tr>
<tr>
<td>10</td>
<td>Precast R.C.C. Channel</td>
<td>3500x300x60</td>
<td>175/RMT</td>
</tr>
<tr>
<td>11</td>
<td>Precast R.C.C. Plank</td>
<td>1500x300x60</td>
<td>120.00</td>
</tr>
<tr>
<td>12</td>
<td>Precast R.C.C. Lintel</td>
<td>1500x200x75</td>
<td>100.00</td>
</tr>
<tr>
<td>13</td>
<td>R.C.C. Chaukhat</td>
<td>900x2100</td>
<td>400 to 500</td>
</tr>
<tr>
<td>14</td>
<td>Funicular shell roof</td>
<td>900x900x25</td>
<td>175.00</td>
</tr>
<tr>
<td>15</td>
<td>Filler slab</td>
<td></td>
<td>80.00</td>
</tr>
<tr>
<td>16</td>
<td>Ferrocement water tank</td>
<td></td>
<td>4.00 to 3.00/lit.</td>
</tr>
<tr>
<td>17</td>
<td>Ferrocement Tree Guard</td>
<td></td>
<td>275/each</td>
</tr>
<tr>
<td>18</td>
<td>Ferrocement Urinal</td>
<td></td>
<td>5500/each</td>
</tr>
<tr>
<td>19</td>
<td>Ferrocement Bench</td>
<td></td>
<td>1500/each</td>
</tr>
<tr>
<td>20</td>
<td>Ferrocement Chair</td>
<td></td>
<td>800/each</td>
</tr>
<tr>
<td>21</td>
<td>Ferrocement Sign Board</td>
<td></td>
<td>500/each</td>
</tr>
<tr>
<td>22</td>
<td>Ferrocement wash basin</td>
<td></td>
<td>200/each</td>
</tr>
<tr>
<td>23</td>
<td>Ferrocement sink</td>
<td></td>
<td>250/each</td>
</tr>
<tr>
<td>24</td>
<td>Ferrocement U-Shape drain</td>
<td></td>
<td>75/RMT</td>
</tr>
<tr>
<td>25</td>
<td>Ferrocement Manhole cover</td>
<td></td>
<td>150/sq.ft.</td>
</tr>
<tr>
<td>26</td>
<td>Ferrocement shell roof</td>
<td></td>
<td>50/sq.ft.</td>
</tr>
<tr>
<td>27</td>
<td>M.C.R. Tiles</td>
<td></td>
<td>8-12/No.</td>
</tr>
</tbody>
</table>
आर.सी.सी. ढांचों की पुनस्थापना – वास्तविकता से कितने दूर?

डा. शैलेश कुमार अग्रवाल *
अरुण कुमार तिवारी **

1. सारांश
ह सारांश है कि भूकंप निरोधी समावेश के साथ पहली बार बनता निर्माण करना सस्ता है, बाज़ बाद में मस्तम एवं सुदृढ़करण कार्य करने से भूकंप निरोधी समावेश के प्रभावी निर्माण करना सस्ता है। इन तथ्यों के अवतुल बनाने को भूकंप रोकने वाला निर्माण करना सस्ता है। पछताने भूकंपों के दौरान आर सी सी ढांचों का असफलता इसके गाथे के रूप में है।

भूकंपीय पुनस्थापना या पुनर्स्थापन में यह अभी अभी में भजन में तीन प्रकार के सूचक की अवशेष होती है, जैसे कि मस्तम—केंद्र संपतीय एवं सजावटी सुपारी या बदलते होते हैं।

जीपियाढा—बाधागत मस्तम, जैसे कि यह अभी अभी वालों को पुन: बनाना, राष्ट्रों को गांठना, पिलाई (पाउजिंग), सूचकों को बदलती आचार, ताकि भवन की मूल निरक्षावता प्राप्त हो जाए।

प्रतिक्षाकरण (रेडियोकिट)—बाधागत बदलते हैं जैसे कि अवधारणा (रेडियोकिट), प्रतिवेद (शीर्ष), या दीवारें लगाना, टेक एवं स्थिरण आदि ताकि भवन में भूकंप हो जाए और अधिक उच्च निराधारता प्राप्त हो जाए। हालांकि, कार्य क्षेत्र में भूकंपीय पुनर्स्थापना का बहुत ही गैर निर्माणकारी दंग से मुक्त किया जाता है। प्राय: रिसाइकलिंग/सजावटी मस्तम को भूकंपीय पुनस्थापना से समस्त किया जाता है। भूकंपीय पुनस्थापना को एक सुशुष्कित इंजीनियरिंग (बहुल निरंतर अभियंता) के द्वारा किया जाना चाहिए तथा इसके लिए व्यावसायिक रिजर्व एवं इंजीनियरिंग नीति की जरूरत होती है। इसमें सही भवन के दूरी को मौत रोकने के लिए भूकंपों को मौत किया जाना चाहिए और फिर अवधारणाओं अनुसार उनको पुनर्स्थापित किया जाना चाहिए। विश्वभर भवन की भूकंपीय रोकना का मूल्यांकन करने अपने आप में एक ठंडा कम है और भारतीय परिवेश में तो विकल्प नया भी है। यहाँ पर उपरांत उद्देश्य के लिए कोई भी मानक को उपलब्ध नहीं है। भारत में भूकंप रोकने के लिए की गई रेडियोकिट (उपस्थापन या मस्तम) के मूल्य अस्किंड उपलब्ध नहीं हैं। हमारे देश में सामाजिक प्रतिबन्धों के अंतर्गत परराष्ट्रीय तरीके के रूप में कसी भवन की मस्तम, गांठना, पिलाई, जेडिंज (अवधारणा बनाना) आदि का उपयोग होता है। प्रीमियर कार इस पर संन्यास करने को बुझा है कि इन तकनीकों से सुदृढ़ एवं तपता में वृद्धि नहीं होती है, बक्सा घाटी और दिशा हो जाता है। हम दोनों वातावर में, सुदृढ़ता बढ़ाने के बाद मस्तम का कार्य करते हैं। इस तकनीकों के लिए कि 'सैटिक (बेटन)' या आक्षेपण, प्रतिवेद दीवारें, ब्रेकिंग (टेक लगना), नए बेल्र्वर या लगना, कुछ तयार करने के साथ (उपकर) को लगना, उत्तरा वियोजन आदि को इस तक के बावजूद कि ये मूक कसी समय बेहतर विपरीति करते हैं कभी भी इशारा की कोरिएशन नहीं की गई जबकि ये विविध पर में विश्लेषण कुछ प्रभाव किए जा रहे हैं।

यह लेख पुनर्स्थापना के दौरान अपनाया जाने वाला विभिन्न स्थानों (पौड़ा) का निर्देशन करता है तथा यह भी बताता है कि किस प्रकार से इंजीनियर्स रेडियोकिट के प्रिंटिंग के सिद्धांत को समझ बिना करके करते हैं और उन्होंने के साथ-साथ दीवार दिखावे को अधिक जीतिंग भर व नाज़ुक बनाते हैं। इसके अतिरिक्त लेख में आर.सी.सी. भारत के पुनर्स्थापन हेतु अपनाया जाने वाले लाभ प्रभावी रेडियोकिट (स्वतंत्रता गोपनों) की मूल्य विश्लेषण करते हैं।

2. परिचय
‘भूकंपीय पुनर्स्थापना’ को एक व्यापक बाद के रूप में पुनरुत्साहित किया गया है, जिसमें ‘भूमत’, ‘उन्नयन’, रेडियोकिट तथा सुदृढ़करण की धारणाएं समाहित हैं जो भवन की भूकंपीय पुनर्स्थापन के लिए निर्देशक हैं।
3. सजावट रेट्रोफिटिंग प्रक्रियाएं

भारत में, 26 जनवरी, 2001 को आया निरमाण कार्यों को साधित करने का कार्यक्रम शुरु किया गया था। इस कार्य के लिए चुनी गई थी जिसके द्वारा संस्थानों के मुक्त क्षेत्रों को निर्माण किया गया। इस कार्य के लिए चुनी गई थी जिसके द्वारा संस्थानों के मुक्त क्षेत्रों को निर्माण किया गया। इस एक अद्वितीय आदर्श कार्यक्रम के तहत, जिसमें बहुप्रजातीय रेट्रोफिटिंग कार्य की जानी गई थी।

- अधिकारक स्थानों पर, दौड़ कोठाओं/बैठक की जानी गई थी।
- अधिकारक स्थानों पर, दौड़ कोठाओं/बैठक की जानी गई थी।
- आदर्श आवास के अन्तर्गत कंट्रोल (आर.सी.सी.) दौड़ के लिए अन्य कार्यक्रमों में बहुप्रजातीय रेट्रोफिटिंग की जानी गई थी।
- आदर्श आवास के अन्तर्गत कंट्रोल (आर.सी.सी.) दौड़ के लिए अन्य कार्यक्रमों में बहुप्रजातीय रेट्रोफिटिंग की जानी गई थी।

भारत में आया निरमाण कार्यों के प्रयास के साथ-साथ मुक्त क्षेत्रों के लिए अद्वितीय आदर्श कार्यक्रम की जानी गई थी।

निरमाण सरिका 39
• कुछ जगहों पर धार्मिक ग्राह अर्जित एक कुरानों को नॉट करने के लिए जमीन से श्रीम तक इंटरनेट के कारणों द्वारा भरा गया।

• बीमों की जगह के पर्सिटर स्टील (आई सेंटर) या वित्ता सेंटर) इंडस्ट्री से की तेक लगाई गयी। तीसरा इसका प्रयोग से कंटेनर बोमी को, जो छात्रों के कारणों के सहारे के लिए थे, जिन्हाँ कारण स्टील के भागों या भागों की दीवारों से समाप्त किया गया।

• कमजोर (डबल) पहली मूल्य की अर. री. इस्लाम में शीर्ष दीवार (प्रत्यक्ष) के प्रयोग में बायोवाट न होने दुःख निष्कासितों ने नॉट के आर.पी. त्रिकोण द्वारा पहले से खुले/खुले मांड़े निधि से भरे हो कर बी. यह तत्कालिन शीर्ष वाला न तो ठोके से निर्मित की गई और न ही लेनट प्रभाव प्रतिरोध के कारण दिखता है। इसकी दीवार के लिए बिजली दीवार के बाहर तीन के ला फु'दी हो दीवार का सिर्फ़ ग्राउंड पर टिकी पाई गई।

उपर सिखे कथनों से विस्तार है कि मुख्य (प्रतिरोध) पुनरुत्पादन के कार्य भोजन के बढ़कर ही तार्किक होती गई। यह, विकास्तीर राजस्व मुख्य (सम्बन्ध) को मूलभूत पूर्ववर्ती विषय के साथ सम्बन्धित किया जाता है। मुख्य (पुनरुत्पादन) के कारण के एक वातु (रब्बरप्रबंध) इंजीनियर के हार्य किया जाना चाहिए, जिसके लिए गुंडा निष्कासित एवं इंजीनियरिंग (आवश्यकता विभाग) निर्मित की अप्रमाणता होती है। इसके सभी पहले कार्य को मूलभूत रोध के लिए लिखा गया किया जाता है। इसके बाद मानी भाषा अनुप्रस्तुतियाँ द्वारा परिवर्तित करता है। विज्ञान भवन के मूलभूत भवन को स्वीकार करने वाला एक धार्मिक पूर्ववर्ती को रेडिएंटिकिंग के बाद करना एक उत्तमी पूर्ववर्ती कार्य होता है। इस कार्य क्रम: उन वातु को इंजीनियरों के लिए विविधता बुद्धि खाली करता है जो अद्वितीयता रेडिएंटिकिंग योजनाओं का उपयोग करते हुए एक धार को रेडिएंटिक करते हैं।

प्राय: विज्ञान भवन के रेडिएंटिकिंग की दो प्रभावित अवधारणा हैं, (१) वैशाली (स्वशील) रेडिएंटिक, (२) स्वास्थ्य (सूक्ष्म) रेडिएंटिक। वैशाली रेडिएंटिक की तार्किक प्रतिरोध चलन है जब कुल मिलाकर भवन भूषण रोध रहता है। इस प्रभावित के अन्तर्गत शीर्ष (केंद्र) दीवार, इंजीनियर वाला (दीवार), ब्रेक (दीवार) के प्रेम कूट लगाया, संयुक्त अवस्था साधन तथा भूषण आइसोलेशन आदि शालियों है। ये स्वास्थ्य रेडिएंटिक की मूलभूतता होता है। इसका अंतर्गत डील जेनरेटर (आवश्यकता), कंटेनर आवश्यकता, काफी फाइबर आवेदन (हिमिन) यात्रा फाइबर जेनरेटर (आवश्यकता) आदि शालियों है। जब यह रेडिएंटिक उपाय कार्यम में रोकी होती है जब तक जो कार्य न करता है। भुनियों जो न करता है। इसका अंतर्गत डील जेनरेटर (आवश्यकता), कंटेनर आवश्यकता, काफी फाइबर आवेदन (हिमिन) यात्रा फाइबर जेनरेटर (आवश्यकता) आदि शालियों है।

दुलार 3 शीर्ष दीवार (प्रतिरोध प्राथमिक) में भवन को उपयोग करने वाला वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का उपयोग करने वाला (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रतिरोध प्राथमिक) का (प्रति...
4.2 परिरोध जोड़ना (कफ्फाईनेंट)

गैंग तथ्य (गौतम झर्टाइल) कंक्रीट कॉलम की विकृत क्षमता को बाहरी परिरोध जैकेटिंग (आवश्यक) के प्रावधान द्वारा बढ़ाया जा सकता है। कॉलम को जैकेटिंग करने का सरलतम तरीका यह है कि विभाग कॉलम के कमजोर हिस्से के क्षेत्रों को विगमित करने के प्रयास परिकृत विशेषता दिखाई दें (चित्र 3) और नए विवाह कॉलम सरियों के बीच पत्थर (बांध) उपलब्ध किया जाये। यह इसी दौरान, बीम कॉलम के स्वच्छ छोटे एवं विवाह सरियों के बीच योजना (बांध) देखते अनुसार सरियों लगाने चाहिए तथा कॉलम के शीर्ष पर बेंगलुरू में छाया पर कीपाकड़ उपलब्धता के द्वारा विधेय रूप से होने की आवश्यक करने से रोकने पर ध्यान दिया जाना चाहिए (चित्र 4)। हालांकि जब कल्प का सुधारकरण कर रहे हैं, यह आयोजन होता है कि दीवार और काल्पन के जोड़ों के बीच मजबूत प्रदान करें। ताकि मुख्य के समय पैदा होने वाली बड़ी परशिशिरता का प्रतिरोध हो। अनुवंशिक कस्टो मर्ग, कूटिंग स्वर तक निरंतर होने चाहिए तथा कूटिंग का वाहन भाग (प्रतिबन्ध) जैकेट (उपवर्त) होना चाहिए; ताकि विवाह एवं नए कंक्रीट के बीच पत्थर (अंडा) विकसित अखंडता रहे (चित्र 5)। उपरोक्त का उपयोग कर विवाह चित्र 5 में समतुल्य किया गया है। यद्यपि बीम की जैकेटिंग, निर्माण की नजर से काफी जटिलस्वरूप होती है, इसलिए यह प्राक्रिकतापूर्वक होता है कि जहाँ भी अपेक्षित हो आरसी. बीम/स्टील धंड उपलब्ध कराए या फिर उपयुक्त स्थल पर
4.3 बंच मुक्त चोटिल/बांध (बेस्क प्रक्रिया)

स्टील का बंच मुक्त चोटिल या बांध एक विद्यमान भवन की मजबूती एवं संपर्कगति की उपलब्धता बढ़ाने के लिए एक अवश्य समाधान प्रदान करता है। हालांकि, भारत में यह उन्नत लक्ष्य नहीं है जो विशेष रूप से बंच मुक्त प्रक्रिया की प्रकाशीयता रूप से देखिया किया जाए।

5. भूकंपीय रेट्रॉफिक (मार्मत) के निवेदन उपादेय

भूकंप के बुरे परिणाम, भवनों के संचालक के लिए जोड़ी एवं नाजुक हिस्सों को रेट्रॉफिक करने की अनिवार्यता है, जिससे पर्याप्त मरम्मत भाव सबसे गहरी स्तर पर जानकारी देने से पहले निर्माण के अंतर्गत आवश्यकता के प्रतिस्पर्श बन दिए जाते हैं। चित्र-7 एक पुनर्विश्लेषण कार्य के दर्शाता है जिसमें गुरुवार में भूकंप प्राप्त एक वातावरण शेड में लेखकों के आनुमान के बाद दर्शाता है।

चित्र-6 कॉलम एवं पंकिंग जेकेटिंग का अनुप्रयोग (काट) विवरण
कि ये अवधारणाएँ उपयोग में आसान, तीव्र क्रियाचरण, भारतीय गणरा में उच्च स्तरीयता, क्षण हेतु अत्यंत प्रतिक्रिया का पता तथा पर्यावरणीय क्षण में प्रतिक्रिया, अपने में अनुकूलनशीलता तथा अध्यात्मिक कार्यक्रम की किसी आकृतित में ठहरने की क्षमता वाले होते हैं।

5.2 आवार विलयन (बेस आइसोलेशन)

यह उपयोग भवन के एक नए वेरिगन द्वार, सुनामी द्वार के लिए, ऊर्जावर भार शरण प्रणाली, विशेष रूप से आवार के पास प्रकट करने के लिए अपेक्षित होती है। भारी का विवरण ऐसा होता है कि वे अवधारणा निम्न तनाव, अल्ल अवधारणा, विकृत स्थान तथा स्वाभाविक उर्जा विशेष प्रतिक्रिया वाले हो सकते हैं। इस विकल्प प्रणाली की प्रतिस्थापन के परिणामस्वरूप भवन की आधारभूत प्रतिक्रिया अधि में एक तात्कालिक कृत्रिम होती है, तथा संस्कृत यह सुन्मिथा (अधिनियम) प्रभावी होता है।

पूर्व विकल्प भार द्वारों से अधिक संपादित अनुवृत्ति होते हैं अत: भूमिका द्वारा संपादित विवृति मांग उत्तरन करने के द्वारा कंट्रोल वर्ग है भार वृक्ष है लघु तथा विलयन भवन के उपर दिये में हिस्से की संपादित मांग (स्वाभाविक) वापस दे घट जाती है। हालाँकि, भारत में, भूमिका के पश्चात यह पुनर्विकास के व्यवहार में नई लापरवाही जाती है।

6. निफर्त

इस लेख में गुजरात में आरा सी एम वाले भवन के पुनर्विकास के दौरान अपने जाने वाले विभिन्न आदर्श एवं वात-प्रति रेट्रोफिटिंग (सरमर्म) योजनाओं का प्रस्तुत किया गया, इन योजनाओं को जाने विभिन्न अवधारणाओं के स्वाभाविक विकल्पों के दौरान ढांचे पर जीवित को आर्थिक बढ़ाने के लिए किया गया। संघर्ष में, लेकिन इस बात पर जोर देना चाहिए है कि क्यों भी रेट्रोफिटिंग तत्कालीन की प्रभावशीलता/निफर्तावधकता विद्यमान इस बात पर निर्णय करती है कि विद्यमान मेम्बर्स को रेट्रोफिट मेम्बर्स के साथ ऐसे जोड़ा जाये तकके भूमिका के दौरान बलों का सहवत अंतर को रखकर। अंत में यह कहना चाहिए कि रेट्रोफिटिंग एक साइंटिफिक प्रक्रिया है तथा इसको बिना एक्स्पर्ट्स की सलाह व डिटेल्ड स्टडी के करना बहुत ही जोखिम भरा हो सकता है।
Monitoring of BSUP and IHSDP Projects under JNNURM

BMTPC along with HUDCO and experts from academic institutions have been visiting various cities to ascertain quality of the BSUP and IHSDP projects being undertaken by different State Governments.
International Seminar "Waste to Wealth"
on green building materials and construction technologies using agricultural and industrial wastes

BMTPC organised an International Seminar "Waste to Wealth" on green building materials and construction technologies using agricultural and industrial wastes during 12-13th November 2009 at New Delhi.

Around 110 delegates from R&D institutions, public and private sector, technocrats, experts, professionals, architects, engineers etc. both from within and outside the country deliberated in the two days event.

On the occasion, a publication entitled "Waste to Wealth" edited by Dr. Shailesh Kr. Agrawal, ED, BMTPC and Dr. Amit Rai, DO(BM-PD), BMTPC was released. The publication comprising of Technical Papers on the various issues connected with green building materials and construction technologies was released by Joint Secretary (Housing), Ministry of Housing & Urban Poverty Alleviation.
“Lok Awaas Yatra”
- A knowledge journey to facilitate sustainable habitat for the poor

The Council undertook a project on “Lok Awaas Yatra- A knowledge journey to facilitate sustainable habitat for the poor” in collaboration with Development Alternatives, New Delhi. The project envisions to bring together participants from various fields ranging from the local community members, masons, PRIs, NGOs, professionals, students, environmentalists, architects, consumers, and others interested in the area of climate change and rural habitat adaptation practices. The group of people would come at common platform in selected regions and will be exposed to different models of safe habitat practices that also contribute towards conservation of the environment. The Yatra is being undertaken in western, central, southern eastern and northern parts of India in five phases. The Yatra would connect with the concerns of natural disasters and share knowledge on low cost disaster resistant houses, ecological sanitation and waste management solutions clean drinking water models, rural housing finance possibilities, livelihood in the habitat sector and clean domestic energy solutions. The Yatra would act as an impetus to make people aware about their options, rights, and means of safe sustainable habitat using environmental and climate friendly techniques.

The Lok Awaas Yatra - a journey for habitat for the people, intends to mobilize the rural masses, ULBs and other stakeholders towards understanding the impact of climate change and the alternative
habitat technologies available for adapting safe habitat. The Yatra will include, Group orientation workshop, Active sharing and learning, Computation of energy consumption, Group sharing regional seminar and will culminate with a Lok Awaas Karmi Sammelan at Delhi.

The project addresses the following existing constraints:
- Lack of understanding and sharing on issues of climate change and required adaptive measures for rural housing and habitat.
- Lack of documented knowledge, awareness and exposure to existing efficient technologies for safe habitat practices and utilization.
- Lack of skills/training to operate at higher levels of productivity and efficiency in use of available resources.
- Lack of proper advocacy and networking among key stakeholders to address the issues of safe rural habitat.
The Yatra includes a face-to-face dialogue between different actors especially the local government functionaries of the Yatra regions and the participants to encourage the multiplication of the good practices identified and influence policies on housing and habitat issues. The Lok Awaas Yatra has been divided into 5 phases across India. Each Phase covers the following:

- **Day 1:** Group orientation Workshop on the geo-climatic aspects of the region and the local issues of climate change and need for adaptation for sustainable rural habitat technologies
- **Day 2:** Active sharing and learning through exposure to the identified models of habitat practices in safer affordable structures/sanitation/water. Detailed documentation of the whole process.
- **Day 3:** Computation of energy consumption by the rural and peri-urban community using carbon calculator and spreading awareness on the need for low carbon consumption.
- **Day 4:** Active sharing and learning through exposure to other identified models of habitat practices in safer affordable structures/sanitation/water. Detailed documentation of the whole process.
- **Day 5:** Group sharing regional seminar and documentation of discussions on new appropriate, affordable technology on green habitat practices by the rural areas, empowering the PRIs and communities.

The first phase of the Project was held between 26th – 30th March 2010 in the eastern regions of India covering Bihar and Orissa. The Yatra consists of three trails from Bihar, Orissa and Sunderban. The focus in this yatra was on visit to projects on sustainable habitat development, people’s participation, water and sanitation and integrated habitat development models. The trails concluded in a regional seminar at Patna on 30th March 2010 that identify key enablers for enhancing the quality of rural habitats in the eastern region.

The first two Yatras covering in the rural areas of the central and western part of India have already been successfully conducted in September 2009 and January 2010 respectively where more than 350 yatris including women – practitioners like masons, artisans, Sarpanches, Self Help Group members, architects, students, district level officers, technical institutes and civil society organisations participated.

Source: www.lokawaasyatra.net

Showcasing of Alternate and Cost effective building materials and construction technologies during Lok Awaas Yatra
The Council has undertaken a project for development of commercial level technology for recycling and utilization of debris for production of building components in association with CIDCO-YUVA Building Centre, Mumbai. The objective of the project is to develop plant and machinery having capacity to recycle 12 tonnes of debris per day and standardization of the developed technologies and the products manufactured.

The Pilot Plant Facility has been established at Kharghar, Navi Mumbai and recycling of construction and demolition waste on a commercial basis has been started. The Executive Director, BMTPC inaugurated the Pilot Plant Facility developed under this project for recycling of debris waste on 11th February 2010.

With the present production capacity of 1300 blocks per day, it is one of its kind in India backed by sound and innovative technology. The products such as Blocks, Interlocks, bricks etc. meet the standard specifications and quality and are available in much cheaper than the prevailing market prices. The training module/guidelines under this project are under preparation and will be used for further dissemination of this technology.
A cloud burst occurred on the 5th and 6th of August 2010 in the Leh Valley causing colossal damage to life and property of the area. As per assessments made by the District Administration the number of houses damaged in various blocks of Leh District are as under:

<table>
<thead>
<tr>
<th>Houses</th>
<th>Fully damaged</th>
<th>Partially damaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leh Block</td>
<td>520</td>
<td>376</td>
</tr>
<tr>
<td>Khalti Block</td>
<td>97</td>
<td>152</td>
</tr>
<tr>
<td>Nubra sub-division</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Nyoma sub-division</td>
<td>7</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>634</td>
<td>637</td>
</tr>
</tbody>
</table>

Since the aim of the team was to explore the possibility of construction of houses in the flash flood affected area of Leh in synchronisation with the traditional architectural style, a reconnaissance survey was carried out to understand the size of the dwelling units, social and living needs of the people. Accordingly, a few houses of local residents were visited and the layout proposed by the Engineering Department of the Local Administration was discussed threadbare. The team suggested that the layout and the proposed plan of DUs should also take care of the site conditions such as existing geological strata and hydrological formations. After holding several meetings with the public administration, affected people and public representatives, the plan of individual Dwelling Units was frozen. As regards the layouts, since the allotments of parcels of lands were under way in accordance with needs of the locals, it is felt that the proposed layout by the administration should be adopted as it is.

However, the following emerged out of the visit:

1. It was agreed that the working season available for undertaking the rehabilitation work is up to the end of October 2010 and at best extendable to 15th of November ie before the onset of winter. Therefore anything that has to be built has to be provided before the above said date.

2. After this natural disaster, majority of the labour has moved out of Leh and as on date, the labour force is more or less nil and whatever labour is available demands a premium wages as the harvesting season is in progress.

3. As the disaster has affected a larger belt of Leh Valley, the natural resources like stone, mud, cement and steel which are the basic building materials are in high demand and scarce. If at all they are available, they are at far away places and hence need to be transported over long distances.

4. The local authorities taking care of infrastructure works are engaged in meeting the day to day emergency requirements of providing basic amenities like drinking water, electricity, road network, education and health facilities.

5. In line with the vernacular ar-
chitecture in mind, the dwelling unit plan which was decided to be provided would take at least about 6 to 8 months for completion. These would have traditional specifications ie random rubble masonry in foundation, compressed earth blocks in walling and roof made out of wooden ballies with mud mortar and suitable roofing top.

6. As the execution in local style would take time, whereas the harsh winter during which construction may not be possible in just two months, it was deliberated that we adopt a combination of pre-fab and construction with local materials to meet both the short term and long term relief measures. The short term objective is ie providing basic accommodation of one room of 14 x 12 ft size with local architectural features over the windows and roof with minimum slope before the onset of winter. The long term objective is to construct the agreed dwelling unit by adding rooms to the single room being provided initially blending the local architecture with the pre-fab structure during the next season by the affected households themselves. Community toilet facilities would also be provided as per the requirements.

7. Certain technologies which can withstand the prevailing temperatures in Leh which vary between −25 to +30 deg. Centigrade and have been constructed in the ITBP and Army areas are PUF injected insulation panels for walling and roofing with the inner structure of steel or timber.

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Demonstration Construction
using Cost Effective and Disaster Resistant Technologies

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 alternate 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.

Demonstration Housing Project at Raipur Phulwari, Amethi, Distt. Sultanpur (U.P.)

**PROJECT PROFILE**

- No. of houses : 24 (G+1)
- Built up area of each unit : 38.22 sq.mt.
- Unit consists of: One living room, one bedroom, kitchen, one separate bath and WC.
- Status: Finish work is under progress alongwith infrastructure work.

**TECHNOLOGIES/SPECIFICATIONS**

**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.

**Finishing**
- Internal plastering.
- External walls exposed finish with water proof cement paint
- Enamel painting on doors/windows
Community Centre at Naggal-Khojkipur, Ambala, Haryana

PROJECT PROFILE

- Covered Area : 635 sq.mt (approx)
- No. of Storeyes : Ground and First floor
- Provision of a Multi-Purpose Hall for community activities and social functions for individual families with appropriate dias alongwith male/female toilets and greenrooms.
- Provision of two Multi-Purpose Rooms (one for males and one for females) for group activities.
- Provision of crèche with exclusive entry by tiny tots and their parents combined with open play area.
- Provision of specially designed toilets for tiny tots in the crèche.
- Provision of a Library-cum-Reading Room
- Provision of Community Centre Office for effective management of the Centre.
- Provision of Colony Health Centre with separate rooms for male doctor, female doctor and compounder (for dressing injuries and safe custody of medicines) as well as patients waiting space.

Status

Structure of the building has been completed. Finishing and Infrastructure work is in progress.

TECHNOLOGIES/SPECIFICATIONS

Walling
- Rat trap bond in bricks; Interlocking type compressed earth blocks; Flyash bricks; Modular bricks

Roof/Floor
- RCC planks and joists; prefabricated panels; prefab brick arch panels; RCC filler slab; doubly curved shell
- IPS flooring.

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

Finishing
- Internal plastering.
- External walls exposed finish with water proof cement paint
- Enamel painting on doors/windows

Miscellaneous
- Precast sunshades, Lintels, Staircases
Demonstration Housing Project at Bitna Road, Pinjore, Distt. Panchkula, Haryana

### PROJECT PROFILE
- **No. of houses**: 24 (G+1)
- **Built up area of each unit**: 38.22 sq.mt.
- **Each Unit consist of**: One living room, one bedroom, kitchen, one separate bath and WC.
- **Project includes**: Onsite infrastructure facilities like pathways, septic tank, electrical works, Boundary wall etc.
- **Other Features**: Provision of community work centre, multi-purpose meditation room. Houses includes Earthquake Resistant Features.
- **Status**: The work has been started on the first floor after completion of the ground floor.

### TECHNOLOGIES/SPECIFICATIONS
- **Walling**
  - Rat trap bond in bricks
- **Roof/Floor**
  - RCC filler slab
  - IPS flooring
- **Doors/Windows**
  - Pre-cast RCC door/window frames in place of traditional frames to achieve cost effectiveness.
  - Wood substitute door/window shutters.
- **Finishing**
  - Internal plastering.
  - External walls exposed finish with water proof cement paint
  - Enamel painting on doors/windows
- **Miscellaneous**
  - Precast sunshades, Lintels, Staircases
Model Informal Market in Vishakhapatnam, Andhra Pradesh

**PROJECT PROFILE**

Locations : Visakhapatnam, Andhra Pradesh  
Area of Market : 14150 sq.ft.  
Facilities : Plateform for vendors, Activity rooms, creche, Reading Area, Health Centre, Toilets, Amphitheatre, Park, etc.  
Status : The construction work of Informal Market at Viskhapatnam has been started. After completion of market shed, work on the open theater and park area is in progress.

**TECHNOLOGIES/SPECIFICATIONS**

**Walling**  
- Stone Masonry/Flyash bricks  
- RCC lintel band and roof level band for earthquake resistance.

**Roof/Floor**  
- Filler Slab  
- IPS flooring  
- Concrete pavers.

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

**Finishing**  
- External and Internal plastering.  
- Water proof paint on exterior walls.  
- Enamel painting on doors/windows.
Jawaharlal Nehru National Urban Renewal Mission (JNNURM)-Role of BMTPC

Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a flagship program of Govt. of India was launched on December 03, 2005 and is being primarily implemented in 65 mission cities of the country. Under it’s two Sub components namely Urban Infrastructure & Governance (UIG) and Basic Services to Urban poor (BSUP), it mainly focuses on improving quality of infrastructure in urban areas while making provision for basic services to urban slum dwellers in terms of affordable housing and basic infrastructure. It need not be emphasized that improvement in quality of infrastructure while taking into environmental considerations results in better and safer cities and also contributes to it’s sustainable development. The mission is now at advanced stage of implementation. As on mid September, 2010, under the BSUP Sub component, 1434 projects including 15, 32, 370 dwelling units have been sanctioned. Out of this, 3,37,712 dwelling units stand completed as on date while dwelling units in progress are 4,71,151. BMTPC has been involved in the implementation of BSUP Sub-component of JNNURM in various ways which are detailed below:

Appraisal of Detailed Project Reports (DPRs)

Under BSUP, total 144 Detailed Project Reports (DPRs) from 22 numbers of States/UTs with total project cost of 8102.75 crores have been appraised by the Council and sanctioned by Central Sanctioning & Monitoring Committee(CSMC) of M/o Housing & Urban Poverty Alleviation (HUPA), Gol. Further, 50 DPRs under Integrated Housing and Slum Development Programme (IHSDP- part of BSUP Sub component to be implemented in small & medium towns) have been appraised with a total cost of 612.73 crores and sanctioned by the central sanctioning committee of M/o HUPA, Gol. Under appraisal the scope of activities includes; Adherence of proposal to 7 point charter (security of tenure at affordable prices, improved housing, water supply, sanitation and ensuring delivery through convergence of other already existing universal services of the Government for education, health and social security), CDP approval, Clearance from State Level Steering Committee, Project Sustainability details etc.

Monitoring of BSUP and IHSDP Projects

Monitoring under sample visit basis:

The Council has also been designated as Monitoring Agency for monitoring of BSUP and IHSDP

* Development Officer (BM-PE), BMTPC, New Delhi
projects being implemented all over the country on sample basis by Mission Directorate of the Ministry. About 160 projects from 35 mission cities (BSUP) and 130 projects from 112 towns (IHSDP) have been inspected by the Council so far. The monitoring team comprises of expert from reputed Technical Institution/ R&D Organizations, representative from HUDCO, Official from JNNURM Directorate of Ministry as per the availability, apart from BMTPC Official. The monitorable parameters include the various project aspects as Physical progress, financial progress, quality control, deviations w.r.t. sanctioned parameters, cost overrun, time overrun, etc. The monitoring reports are submitted to Mission Directorate.

**Against VIP references on non compliance issues in certain projects**

As the projects are in advanced stage of implementation, some VIP references regarding non compliance of BSUP guidelines in the implementation of some projects are received from some States from time to time. The issues mainly pertain to aspects as non eligible persons/ households inclusion in the beneficiaries list, non consent of beneficiaries for shifting to relocated sites, improper quality of construction etc. After visiting the project, report on factual position of references is submitted to the Ministry.

**Review of TPIMA reports**

As an important tier of the Quality Control Structure, Third Party Inspection and Monitoring
(TPIM) agencies have been appointed by various States as per the direction of GoI. The TPIM agencies scope of work pertains to evaluation of projects in various stages as Pre-construction stage, Construction stage, Project completion stage & Post construction Stage. After visiting the projects, TPIMA submits its report to the States & Mission Directorate. The Mission Directorate has entrusted the council to review these reports. So far 50 reports have been reviewed & observations have been submitted to JNNURM Directorate.

**Capacity Building Programme**

As per the direction of Mission Directorate, the council has conducted a large number of programmes/workshops focusing on interaction with the officials of State Govt./ ULBs/ Implementing agencies regarding issues related to preparation of DPRs, project implementation issues, monitoring of projects. The related toolkits are circulated during workshop. Recently 3 programmes on standard reporting format by TPIMA & Quality control issues were conducted in Agra, Bhopal & Delhi for TPIM & PROJECT implementing agencies.

Further, BMTPC has also prepared a Quality Control Guideline which includes well defined procedures for achieving, desired quality of Projects (primarily housing) complying with the requirements of projects specification and design as per contract document. The same is under consideration of Mission Directorate & once finalized would be circulated to all the ULBs.

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**World Urban Forum 5**

*Rio de Janeiro, Brazil – 22-26, March, 2010*

Under the auspices of UN-Habitat, World Urban Forum 5 was organised in which Indian Delegation led by Hon’ble Minister of Housing & Urban Poverty Alleviation and Tourism, Kumari Selja put forward its views and interventions in the area of urban renewal, slum upgradation and human settlements.
Release of Publications of BMTPC

Kumari Selja, Hon’ble Minister of Housing & UPA and Tourism releasing the publications of BMTPC during World Habitat Day Celebrations at New Delhi on 5th October, 2009

Special Issue of News Letter "Nirman Sarika" on the occasion of the World Habitat Day 2009

Book on "Standards & Specifications for Cost-Effective Innovative Building Materials and Techniques Including Rate Analysis"

Common Man’s Guide to Build a Hazard-Resistant House

CD on Guidelines for Technical Training of Masons
Seismic Strengthening of School Buildings – A Case Study

J.K. Prasad*

The theme “Better City Better Life” of World Habitat Day 2010 represents common wish of people for a better living in future urban environments. In order to make a city better, among other things, it is also necessary that the city is safe from natural hazards and is ready to face with all facilities in the event of any natural calamity. With 59% of the land area of the country exposed to earthquakes threat of varying degrees, it is important that our buildings are safe to withstand the earthquake forces. Ideally all structures, whether commercial, residential, infrastructure, schools and hospitals are required to be safe from earthquake hazards. However considering that a large percentage of structures in the country, both in Urban and rural areas, are unsafe, prioritization of structures becomes important. 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

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 damages. 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:

- Patching up of defects such as cracks and fall of plaster;
- Repairing doors, windows, replacement of glass panes;
- Checking and repairing electric conduits/wiring;
- Checking and repairing gas pipes, water pipes and plumbing services;
- Re-building non-structural walls, smoke chimneys, parapet walls, etc;
- Replastering of walls as required;
- Rearranging disturbed roofing tiles;
- Relaying cracked flooring at ground level;
- 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 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 ferro-cement.

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 retrofittting techniques, such as mentioned above.
BMTPC ‘ Initiative

The Building Materials and Technology Promotion Council (BMTPC) has initiated a school safety programme within the Municipal Corporation of Delhi school system wherein it has been planned to demonstrate seismic retrofitting of one school in each twelve zones of MCD to render them safer against future earthquakes. So far five MCD schools located at Vasant Vihar, Ramnagar, Rameshnagar, Ranapratapbag, and Sarai Rohilla have been completed. In 2010, another two schools in Lajpatnagar and Vivek Vihar have been taken. This further the retrofit work already undertaken in the Ludlow Castle School as part of the Delhi Earthquake Safety Initiative Project begun in 2004 and covering five life-line buildings in the capital.

Delhi, the capital city of India, is located in Seismic Zone IV as per IS 1893(Part 1)-2002. This implies that the city is likely to experience Intensity VIII shaking. Delhi is approximately 200 and 300 km from Main Boundary Thrust (MBT) and Main Central Thrust (MCT) respectively, which are the two most active thrust planes of the Himalayas. Moreover, the city sits over the thick soft alluvium soil of Yamuna sedimentary Basin that is subjected to relatively high site amplification during an earthquake. Furthermore, the city faces severe seismic threats from the Central Himalayan seismic gap, which is approximately 300 km away from it (Bilham, 1995; Khattri, 1999; Rajendran and Rajendran, 2005).

In consultation with MCD officials, two schools located in Lajpat Nagar and Vivek Vihar were identified. Both are about 40 years old and are unreinforced brick masonry buildings with moderate level of maintenance. Details of Lajpat Nagar school is given below.

Primary Model School, Lajpat Nagar-III, Delhi

Building Description

The building is a two story masonry building located on Ramsharanam Marg connecting to Feroze Gandhi Marg towards Lajpat Nagar Central Market (Fig 1). The building also houses the Election Office for Lajpat Nagar area. The location of the building is shown in Figure 1.

The building is C shaped in plan with two storey. The two parallel arms of the C are 31.29 m in length while the connecting block at perpendicular to the two parallel arms is nearly 37m in length. No expansion joints have been provided at the intersection zones between the arms and the perpendicular block though the lengths of the blocks require provision for expansion joints to allow for thermal expansion. The change in geometry wherein re-entrant corners are created also warrant seismic gaps to mitigate earthquake induced torsional effects that are quite common with such geometrical configurations. The total covered area on all floors adds up to 1682 sq m equally distributed across the two floors. The structural system is load bearing unreinforced masonry.

The soil type is light brown sandy silt. The soil test conducted indicates that it does not have any liquefaction potential. The walls are 400mm in thickness with cement sand mortar. The floor and roof diaphragms are of 125mm thick RC slabs. The original structure had no vertical reinforcement bars located at corners, T junctions or door/ window jambs. The building does not have horizontal seismic bands at plinth, sill, lintel or roof level. The building has freestanding masonry parapets which pose a falling hazard even in smaller intensity earthquakes.

Evaluation as per IS13935

As per procedures laid down in IS13935, as a first step Rapid Visual Assessment, based on Annexure I Rapid Visual Screening of Masonry Buildings for Seismic Hazards given in IS13935 was done. The building is classified as an ‘Important’ building. The building is not
RAPID VISUAL SCREENING OF MASONRY BUILDINGS FOR SEISMIC HAZARDS

Seismic Zone V

1.1 Building Name: M.C. Primary Model School
1.2 Use: Primary School
1.3 Address: Lajpat Nagar, Delhi
1.4 Other Identifiers: None
1.5 No. Of Stories: 2+1
1.6 Year Built: Not known
1.7 Total Covered Area: all floors (Sq.m) 1682 sq.m.
1.8 Ground Coverage (Sq.m): 841 sq.m.
1.9 Soil Type: Light brown sandy silt
1.10 Foundation Type: Strin foundation for walls & Spread footing for RC columns
1.11 Roof Type: RCC
1.12 Floor Type: RCC
1.13 Structural Components:
1.13.1 Wall Type: Burnt Brick Masonry
1.13.2 Wall Thickness: 450mm
1.13.3 Slab Thickness: 125mm
1.13.4 Mortar Type: Cement: Sand
1.13.5 Vert. R/F bars: Corners __ T-Junctions __ Jams __
1.13.6 Seismic bands: Plinth __ Lintel __ Eaves __ Gable __

*B3 - Burnt Brick,
*RCC: Reinforce Cement Concrete

2.0 OCCUPANCY
2.1 Important Building: Hospitals, Schools, monumental structures, emergency buildings like telephone exchange, television, radio stations, railway stations, fire stations, large community halls and subway stations, power stations, important industrial establishments, VIP residences & Residences of important Emergency person.
* Any building having more than 100 Occupants may be treated as Important.

2.2 Ordinary buildings: Other buildings having occupants<100

3.0 SPECIAL HAZARD
3.1 High Water Table (within 3m) & if sandy Soils
Then liquefiable site indicated Yes __ No __
3.2 Land Slide Prone Site
Yes __ No __
3.3 Severe Vertical Irregularity
Yes __ No __
3.4 Severe Plan Irregularity
Yes __ No __

4.0 FALLING HAZARD
4.1 Chimneys
Yes __ No __
4.2 Parapets
Yes __ No __
4.3 Cladding
Yes __ No __
4.4 Others
Yes __ No __

5.0 SPECIAL OBSERVATION
5.1 Length of wall between two cross walls are as per IS:13826 or IS:13828
Yes __ No __
5.2 Percentage of openings in walls as per IS:4326 or IS:13828
Yes __ No __
5.3 Ratio of height & width of wall as per IS:4326 or IS:13828
Yes __ No __

5.0 Probable Damageability in Few/Many Buildings

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Masonry Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage Ability in Zone V</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>G5</td>
<td>G5</td>
</tr>
</tbody>
</table>

Note: + sign indicates higher strength hence somewhat lower damage expected as stated. Also average damage in one building type in the area may be lower by one grade point than the probable damage ability indicated. Surveyor will indentify the Building Type: encircle it, also the corresponding damage grade.

Executive Engineer's Name: Harshad Talpada
Date of Survey: 20/06/03

Nirman Sarika 63
exposed to any special hazard as per the RVS format. As per the evaluation format, the building is classified to have Damageability Grade in Zone V since this is a life-line building in Zone IV as C. Recommended action is (1) detailed evaluation for need to retrofit to achieve grade C+, and (2) removal or strengthening of falling hazards. Both aspects have been addressed in the retrofit solution for the building.

Next, 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.

Based on the observed vulnerability, retrofitting plans were prepared alongwith Bill of quantities.

The Retrofit Solution

Retrofit solutions are based on IS13935-2008, and IS4326,. According to the provisions in the code, the building is a category E building which is the classification for Important buildings in Seismic Zones IV and V and all buildings in Seismic Zone V. The recommended retrofit solution with regard to inclusion of seismic features and strengthening of existing elements, is based on the recommendations in IS13935 (Appendix I). These are summarized in the following section.

Foundation

There is no recommendation for plinth band since the foundation rests on “soil that is not soft”. The building has load bearing walls in both orthogonal directions resting on continuous strip foundations.

Configuration

The C shaped plan is unsymmetrical resulting in a global deficiency. Reentrant corners are evident in the building plan.

Introduction of seismic features

The seismic features recommended in the retrofit solution include:

1.Lintel level seismic belt in all walls on both side
2. Sill level seismic belt on one face of the walls
3. Connections between seismic belts
4. Door and window encasement
5. Masonry pier encasement
6. Vertical single bars at wall corners and T junction
7. Vertical seismic strap
8. strengthening of parapet

Effectiveness of seismic belt is achieved if it does not get separated, it is important that proper procedure are adopted for fixing the belts. This involves a) cutting the exiting plaster, raking the masonry joints to a minimum depth of 20mm, wetting and initial cement slurry application before first coat of plastering, b) drilling through holes for providing wire connection between he outer and inner belts while fixing the reinforcing bars and mesh and c) applying the second coat of plaster.

In addition to these, following recommendations have been made:

1) Every class room should have two doors . Therefore additional door to be provided which should open outside.
2) To improve the shape of the building in plan from seismic safety angle, it will be useful to convert the building in full quadrangle by construction of a wing on the fourth side, fully connected with the perpendicular wings. Alternatively this connection may be provided by constructing a reinforced concrete verandah, the slab of which will have to be fully connected with the slabs of exiting wings. An additional staircase is also recommended.

Similar details were worked out for Vivek vihar school.

Due to financial constrain, MCD has been advised to take necessary action on the item 2 as mentioned above. For the remaining items tenders were floated in two bid system. It was noticed hat very limited agencies are there who does such job. Based on technical capability and rates the agency was selected. Retrofitting work in both the schools are in progress.

Retrofitting work, being typical, one has to take certain decision based on the actual condition at site and engineering judgement. These include removal and replacement of electric lines, water connection. Another constrain is that it is not possible to get the entire building vacant at a time, and since schools are running for both the shift, the working time is also limited. Therefore one has to plan it properly with the agency
occupying the building for efficient and effective execution of the job.

In addition, following points are important, which must be kept in mind and consideration

a) Material flow specially galvanized mesh are required to be taken from a reliable source. Since it is not a standard item, it has to be custom made Seismic belts, has to be planned based on actual situation at site. At many times engineering judgment is required to be taken at site.

ii) Safety of children from the protruded metals or other construction materials

iii) 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.

iv) 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. Items which are standardized in retrofitting work may be included in Schedule of Rates.

v) 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.

The whole process is being documented. It is also planned to organize awareness programme at site for engineers and architects.
Performance Appraisal Certification Scheme
– An effective Tool for Transfer of Innovative Technologies

Performance Appraisal Certification Scheme (PACs), being operated by BMTPC, is a third party voluntary scheme for providing Performance Appraisal Certificate (PAC) to manufacturers or installers of a product which includes building materials, products, components, elements and systems etc. after due process of assessment.

Performance Appraisal certificates (PAC) for the 14 products have been issued so far covering various items viz. Wooden/FRP/PVC Doors, Gypcrete Wall Panel, Block Making Machine, Pan Mixer, Recron Fibre, Plastocrete/Insulated Panels, Underground water Storage Tanks. Applications has been received for another 14 following products:

1. HDPE Cover Blocks:
   HDPE Cover Blocks are made of High Density Polyethylene. These blocks are used in place of concrete cover blocks.

2. Low Cost Shree Binder:
   Low Cost Shree Binder is made from recycling marble slurry waste, fly ash and hydrated lime.

3. Ecosafe Panel:
   Ecosafe Panels are made from EPS Granules and Galvanised wire.

These panels can be used as replacement for bricks and hollow blocks.

4. Deep Penetrating Sealer:
   Deep Penetrating Sealer is a non-toxic, non-flammable, odorless, clear water soluble liquid compound. This can be used on walls & floors for waterproofing and preserving concrete etc.

5. Veneer Laminated Lumber:
   Veneer Laminated Lumber is made from rubber wood and is used for making doors, windows and ventilator shutters/frames.

6. Underground Septic Tanks:
   Underground septic tanks are made of polyethylene. These are suitable for houses, schools & hospitals, etc.

7. Continuous Sandwich Panels:
   Continuous Sandwich Panels are formed by plain Pre-coated sheet in between foamed with Polyurethane foam (PUF) along
with corrosion resistant metallic facing.

8. FRP Manholes:
FRP Manholes can be used in underground sewer pipe lines, storm water pipe lines and water pipe lines.

9. uPVC Windows:
uPVC Windows are made out of extruded uPVC multi-chamber hollow profiles and reinforced with galvanized steel.

10. Monolithic Formwork:
Monolithic Formwork is the system by which the formwork for all the components of the structure is erected at one time.

11. Monolithic Concrete Construction:
Monolithic Construction is a method by which walls and slabs are constructed together giving the structure a complete box like shape.

12. Marshal Doors:
Marshal Door Shutters are made out of G I Precoated Sheet on both sides with core of the shutter filled with High Density Polyurethane foam.

13. Copper Slag:
Copper Slag is produced during the manufacture of Copper. Copper Slag can be used as replacement for sand in concrete and mortar.

14. Recycled Roofing Sheets:
These are made from waste/rejects of tetrapack, recycling of polyethylene and aluminium. These are used for covering roof, partition and fencing etc.

Since the Scheme is operated for the product/system where no relevant Indian Standard is available, it is required to first work out the desired specifications for Performance Appraisal. For the items under considerations, International procedures have been studied. In few cases the specifications recommended by the manufacturers have been modified based on international practices. One such item is Underground Septic Tank where specification & performance is modified based on Australian/ New Zealand Standard. Another item is Deep Penetrating Sealer which is an imported material for which no testing facilities are available in India.

One of the constrains faced for evaluation is lack of proper testing facilities in Accredited independent laboratories. For this, facilities available with the firms are being utilized. Third party agencies having adequate exposure & experience are being involved for in-house testing wherever laboratory testing is not operational.

The latest Status Report of the applications received is as follows:
I. Products for which inspection of premises & drawl of the samples to be carried out
• Veneer Laminated Lumber
• Low Cost Shree Binder
II. Products for which Detailed Application Forms (DAF) under process
• Ecosafe Panels
• FRP Manholes
• uPVC Windows
• Continuous Sandwich Panels
• Monolithic Formwork
• Monolithic Concrete construction
III. Products for which Preliminary Applications under process
• Recycled Roofing Sheets
• Marshal Doors
• Copper Slag
Housing conditions in terms of quantity and quality is an important indicator of financial stability and economic well being as also levels of social inclusion in any country. These issues are closely linked to levels of housing affordability- a concept which varies from the developed to the developing world. In today’s scenario the housing conditions are appalling in the developing world which a direct reflection on the levels of affordability to construct houses. To add to the conditions of housing is the aspect of houselessness, which is also a serious concern. Most countries in Asia, Africa and Latin America are facing this problem, where the growth of population and urbanization levels is high.

In terms of the UN HABITAT report, every year the worlds urban population increases by about 70 million, most of which is in developing countries where economic capacities of people do not match with the housing and urban service provisions.

Affordability Concept

“Affordability” reflects the ability of the individuals to pay for the house they aspire town. The generally accepted definition of affordability is for a household to pay no more than 30% of its annual income on housing. Families who pay more than 30% of their income for housing are considered cost burdened and may have difficulty affording other necessities such as food, clothing, transportation and medical care. The lack of affordable housing is a significant hardship for low-income households preventing them from meeting their other basic needs, such as nutrition and healthcare, or saving for their future and that of their families.

Affordability is a function of cost of the various inputs on the one hand (finance, land, technology, building materials) and income of people on the other. Recent years have witnessed steep rise in the cost of land, building materials, construction costs etc. On the other hand the income levels of the people have not kept pace with the above said rising costs. This has resulted in reduction of affordability levels in the housing sector. People belonging to the EWS and LIG have been greatly affected on this account.

In recent times, ‘Affordable Housing’ has emerged as a challenge for all the stakeholders involved in the process. These include the policy makers, town planners, construction agencies, housing finance institutions etc. Although the need for affordable housing has been recognised by all, there is an urgent need to bring about comprehensive solutions by them, for the benefit of the needy.

Government of India Initiatives

Government of India has been, over a period of time, laying great emphasis to provide housing for various cross-sections of population in the country. This has been adequately reflected in the provisions as contained in various Five Year Plans. During the initial stages, emphasis was laid on housing for specific sections of society. Subsequently, the Plans emphasized upon the creation of Institutions like Housing Boards, Development Authorities etc at the State levels to cater for a wider sections, with an aim to provide affordable housing for all.

In the early seventies Housing and Urban Development Corporation (HUDCO) was set up to facilitate easy flow of funds in the housing sector. The Building Materials and Technology Promotions Council (BMTPC) was established in the early nineties whose objectives
Announced by the Ministry of Housing and Urban Poverty Alleviation, GOI in December 2007, aims to ensure sustainable development of all urban human settlements, having the necessary basic civic amenities thereby ensuring a better quality of life for all urban dwellers. It also lays special emphasis on provision of social housing for the EWS/LIG categories so that they are fully integrated into the mainstream of balanced urban development.

It also forging strong partnerships between public, private and cooperative sectors for accelerated growth in the Housing Sector and sustainable development of habitat.

The Policy lays emphasis on Government retaining its role in social housing so that affordable housing is made available to EWS and LIG category of the population as they lack affordability and are hopelessly out priced in urban land markets.

It aims to promote development of cost-effective, quality approved building materials and technologies with a view to bringing down the cost of EWS/LIG houses thereby making them more affordable.

Indira Awaas Yojana

The Government of India had been implementing Indira Awaas Yojana since the year 1985-86, with the objective of providing assistance, to the Below Poverty Line (BPL) rural households belonging primarily to the Scheduled Castes, Scheduled Tribes and freed bonded labour categories. From the year 1993-94, its scope was extended to cover rural BPL. Benefits of the Scheme have also been extended to families of ex-service men of the armed and paramilitary forces killed in action.

Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

JNNURM was launched in December 2007 to support 63 cities (7 mega cities, 28 metro cities and 28 capital cities and towns of historical/religious importance) across the country in terms of perspective plans called City Development Plans (CDPs).

On the basis of CDPs, JNNURM seeks to fill up the gaps in infrastructure and deficiencies in housing and basic services through appropriate investments. The Mission approach is reform based with releases being made subject to specified reform agenda being implemented. It also seeks to encourage private sector participation with the Government.

In addition to the 63 identified cities, urban infrastructure and slums are also being addressed in the remaining Non-Mission cities through the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) and Integrated Housing and Slum Development Programme (IHSDP).

The Vambay scheme has now been merged with the JNNURM scheme.

Integrated Housing and Slum Development Programme (IHSDP)

IHSDP was launched for having an integrated approach for improving upon the conditions of the urban slum dwellers who do not possess adequate shelter. It combines...
the VAMBAY and NSDP schemes and is applicable to all cities and towns as per 2001 Census, except cities/towns covered under JNNURM.

The basic objective of the Scheme is to strive for holistic slum development with a healthy and enabling urban environment by providing adequate shelter and basic infrastructure facilities to the slum dwellers of the identified urban areas.

The components which are covered under the scheme include all slum improvement / upgradation / relocation projects including upgradation / new construction of houses and infrastructural facilities, like water supply and sewerage.

Basic Services for the Urban Poor (BSUP)

BSUP seeks to provide seven entitlements/services – security of tenure, affordable housing, water, sanitation, health, education and social security – in low income settlements in the 63 Mission Cities of JNNURM.

Interest Subsidy Scheme of Housing for the Urban Poor (ISHUP)

The Interest Subsidy Scheme for Housing the Urban Poor (ISHUP) has been launched in December 2008 with a view to enable access of urban poor to the long term institutional finance. The prime objective of the scheme is to improve upon the affordability levels of the poor.

The Scheme seeks to provide interest subsidy to Economically Weaker Section (EWS) and Low Income Group (LIG) beneficiaries on availing loans from the Banks / Housing Finance Companies (HFCs). Under this scheme, an interest subsidy of 5 percent per annum is given upfront on loans upto Rs. 1,00,000/- taken from Banks / Housing Finance Companies (HFCs) during 11th Five Year Plan. The Loan repayment Period would be 15-20 years. The Scheme is positively inclined towards EWS households and out of 3.10 lakh dwelling units envisaged under the scheme, 2.70 lakh dwelling units are targeted for EWS housing.

Swarna Jayanti Shahari Rozgar Yojana (SJSRY)

With a view to ameliorate the living conditions of the urban poor and to reduce urban poverty, the Swarna Jayanti Shahari Rozgar Yojana (SJSRY) is being implemented as a Centrally Sponsored Scheme for the benefit of the urban poor on all India basis, since December 1997.

The scheme has been comprehensively revamped with effect from 2009-2010.

Building Materials and Technology Promotion Council (BMTPC)

BMTPC was established in 1990, under the aegis of the Ministry of Housing & Urban Poverty Alleviation, as an apex level autonomous organisation and registered under the Societies Registration Act, 1860. The prime objective of BMTPC is to bridge the gap between the laboratory development and large scale field application of cost effective and affordable, environment friendly and energy-efficient innovative building materials and disaster resistant construction technologies.

State Government Schemes

In addition to the Schemes of the Central Government, several State Governments have also been announcing schemes to provide housing for the poorer segments of the society. Some of the State Government schemes include Integrated Novel Development in Rural Areas & Model Municipal Areas and Rajiv Gruha Kalpa (Andhra Pradesh); KUDUMBSHREE (Kerela); Mahamaya Housing Scheme (Uttar Pradesh) etc.

All the schemes have the prime objective of providing affordable housing for the poorer sections of the society.
Sensitization Programme

The Council has started organizing sensitization programmes at the Demonstration Housing Projects under execution so that the alternate/emerging technologies are popularized at the local level. One such programme was organized on 6th February, 2010 at Demonstration Project site at Village Khojkipur-Naggal, Ambala wherein 150 students from Deptt. of Civil Engg., NIT Kurukshetra, Deptt. of Architecture, Deen Bandu Chotu Ram University of Science and Technology, Murthal, Sonipat and other polytechnic colleges participated in the programme. During this one day event, hands-on training to 23 local masons on the Demonstration Project site was also organized.
Solid waste is material, which is not in liquid form, and has no value to the person who is responsible for it. Although human or animal excreta often end up in the solid waste stream, generally the term solid waste does not include such materials. Synonyms to solid waste are terms such as “garbage”, “trash”, “refuse” and “rubbish”.

The term municipal solid waste refers to solid wastes from houses, streets and public places, shops, offices, and hospitals, which are very often the responsibility of municipal or other governmental authorities. Solid waste from industrial processes are generally not considered “municipal” however they need to be taken into account when dealing with solid waste as they often end up in the municipal solid waste stream.

Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and to public health. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance. This has been acknowledged by most governments, however rapid population growth over-whelms the capacity of most municipal authorities to provide even the most basic services. Typically one to two thirds of the solid waste generated is not collected. As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in Subsidization of the full range of initiatives for waste reduction (from changes in manufacturing and packaging to source-separation collection and the promotion of recycling and composting) by governments and/or private industry is becoming a norm in affluent countries.

Most cities in Western Europe, North America, Australia, New Zealand, Japan, and some in Korea have adopted municipally sponsored source separation and collection systems. In some cases, the separation of post-consumer materials by waste generators has been made mandatory.

The engines of waste recovery and recycling in the poorer countries include: scarcity or expense of virgin materials, the occurrence of absolute poverty, the availability of workers who will accept minimal wages, the frugal values of even relatively well-to-do households, and the large markets for used goods and products made from recycled plastics and metals. If one takes into account the use of compost from dumps sites as well as materials recovery, in countries like India, Vietnam, and China, the majority of municipal wastes of all kinds are ultimately utilized.

Systematic Waste Management is Based on Three Principles:

1. Waste prevention: This is a key factor in any waste management strategy. If we can reduce the amount of waste generated in the first place and reduce its hazardousness by reducing the presence of dangerous substances in products, then disposing of it will automatically become simpler. Waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging.

2. Recycling and reuse: If waste cannot be prevented, as many of the materials as possible should be recovered, preferably by recycling. The European Commission has defined sev-
eral specific ‘waste streams’ for priority attention, the aim being to reduce their overall environmental impact.

3. Improving final disposal and monitoring: Where possible, waste that cannot be recycled or reused should be safely incinerated, with landfill only used as a last resort. Both these methods need close monitoring because of their potential for causing severe environmental damage.

Municipal solid waste management in India

Collecting, transporting and disposing of MSW represent a large expenditure for Third World cities: waste management usually accounts for 30-50 percent of municipal operational budgets. Despite these high expenses, cities collect only 50-80 percent of the refuse generated. In India, for instance, about 50 percent of the refuse generated is collected, 33 percent in Karachi, 40 percent in Yangon, and 50 percent in Cairo. And disposal receives less attention: as much as 90 percent of the MSW collected in Asian cities end up in open dumps.

In areas that lack refuse collection—usually low-income communities—residents tend to either dump their garbage at the nearest vacant lot, public space, creek, river, or simply burn it in their backyards. Uncollected waste may accumulate on the streets and clog drains when it rains, which may cause flooding. Wastes can also be carried away by runoff water to rivers, lakes and seas, affecting those ecosystems. Alternatively, wastes may end up in open dumps legal and illegal, the most common disposal method in the Third World.

India has experienced tremendous growth in all spheres, including population, urbanization, traffic, industries, trade and municipal solid waste generation. Future changes will only emphasize the problems of today. In general, municipal solid waste management is a three-step process: collection, transportation and disposal. In many developing countries like India, the municipal solid waste management system is fail at the collection stage. The municipal solid waste generation rate 0.37 to 0.62 kg per capita per produced in ten largest cities of India (Table 1)

With the rapid increase in the population living in urban areas, the composition of municipal solid waste is likely to vary from place to place considerably. Around 50% of the municipal solid waste is biodegradable.

The Municipal Solid Waste notifications by Ministry of Environment and Forest, Government of India, provide a comprehensive framework for proper management of municipal solid waste to address their responsibility of collection, transport, treatment and safe disposal. Various methods of disposal have been tried such as waste pelletization, composting, vermiculture, incineration with and without energy recovery, anaerobic digestion, and biogas generation from garbage and sanitary landfills.

Waste management in developed countries:

The waste management industry has also become the global leader in recycling. Japan has perhaps the best success record to date, with over 70% of all municipal waste recycled. In the US, this amount is approximately 33%, and in the UK the total is a little over one-quarter of the MSW produced. Not only does recycling reduce waste disposal, but it saves production energy.

Table 1: Municipal solid waste generation of ten largest cities in India

<table>
<thead>
<tr>
<th>City</th>
<th>Waste generation (kg/capital/day)</th>
<th>Kilo tonnes per year</th>
<th>Tonnes per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delhi</td>
<td>0.57</td>
<td>2161</td>
<td>5920</td>
</tr>
<tr>
<td>Greater Mumbai</td>
<td>0.45</td>
<td>1941</td>
<td>5320</td>
</tr>
<tr>
<td>Chennai</td>
<td>0.62</td>
<td>1108</td>
<td>3035</td>
</tr>
<tr>
<td>Kolkata</td>
<td>0.58</td>
<td>968</td>
<td>2650</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>0.57</td>
<td>798</td>
<td>2185</td>
</tr>
<tr>
<td>Bangalore</td>
<td>0.39</td>
<td>609</td>
<td>1670</td>
</tr>
<tr>
<td>Ahmedabad</td>
<td>0.37</td>
<td>475</td>
<td>1301</td>
</tr>
<tr>
<td>Pune</td>
<td>0.46</td>
<td>428</td>
<td>1172</td>
</tr>
<tr>
<td>Kanpur</td>
<td>0.43</td>
<td>401</td>
<td>1098</td>
</tr>
<tr>
<td>Surat</td>
<td>0.41</td>
<td>365</td>
<td>1000</td>
</tr>
</tbody>
</table>
There are a number of other disposal options used by the waste management industry to reduce the need for landfills. Incineration is a mature technology, but some plants are now equipped to convert the waste they burn to energy in the form of heat, electricity or gas. Many of these facilities sort out the recyclable products first, and then use the heat from the incinerators to convert water to steam to run the plant, or to produce electricity. Japan has been very successful in using energy from waste processed at advanced thermal treatment (ATT) plants to supply some of their municipal power needs. Large scale ATT plants have also been built in Europe and North America.

Waste can be treated with heat, chemical, biological and physical processes. One biological disposal option being explored by the waste management industry is the use of aerobic digestion. In 2002, the Thomley waste transfer station in County Durham, UK, opened with two aerobic digestion towers. This plant processes unsegregated MSW, successfully diverting over 70% of the waste processed from landfills or incinerators.

Table 2: European Waste strategies: some examples (√ = measures known to be already in widespread use

<table>
<thead>
<tr>
<th>Country</th>
<th>Widespread multi-material</th>
<th>Widespread Deposit return systems</th>
<th>Thermal treatments (inc. new technologies) &gt;3% for BMW</th>
<th>Tax on waste to landfill</th>
<th>Absolute Ban on landfill of BMW</th>
<th>Widespread use of Product Taxes</th>
<th>Widespread use of Raw Materials Tax</th>
<th>Widespread rationalising of Other instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
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<tr>
<td>Belgium</td>
<td>√</td>
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<td>Denmark</td>
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<tr>
<td>Finland</td>
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<tr>
<td>Germany</td>
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<tr>
<td>Netherlands</td>
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<tr>
<td>Norway</td>
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<tr>
<td>Sweden</td>
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<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

45%  62%  27%  30%  50%  45%  40%  34%

Table 3: Common Options for waste treatment and disposal in developing countries

<table>
<thead>
<tr>
<th>Disposal Option</th>
<th>Description</th>
<th>Application for Low Income Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled dumping</td>
<td>Waste is dumped at a designated site without any environmental control measures</td>
<td>This is not a disposal option but a common practice in low income countries. It has high environmental health risks.</td>
</tr>
<tr>
<td>Sanitary Landfilling</td>
<td>Controlled burial of waste. The site is engineered and managed to meet certain standards.</td>
<td>Comparatively low cost and simple technology solution when land is available. Presents some risks in certain circumstances.</td>
</tr>
<tr>
<td>Composting</td>
<td>Biological decomposition of organic matter in waste under controlled conditions.</td>
<td>Requires sufficient proportion of bio-degradable material in the waste. Not a complete disposal system; if there is no market for compost a further disposal option will still be needed. Large mechanised schemes have not been successful.</td>
</tr>
<tr>
<td>Incineration</td>
<td>The controlled burning of waste at high temperature to reduce its volume. Plant is designed to recover the energy released by combustion.</td>
<td>High capital costs, requires highly skilled operation and control. The waste must have a high calorific value, which is unlikely in low and middle income countries. Cost-effective only if landfill sites are not available.</td>
</tr>
<tr>
<td>Gasification</td>
<td>Biological decomposition of organic matter in waste under controlled conditions to obtain combustible by-products.</td>
<td>High cost and technologically complicated for developing countries.</td>
</tr>
<tr>
<td>Refuse Derived Fuel</td>
<td>Separation of combustible materials from solid waste for fuel purposes.</td>
<td>Depends on the presence of combustible material in the waste. Expensive and therefore of limited use in developing countries.</td>
</tr>
<tr>
<td>Pyrolysis</td>
<td>High temperature conversion of organic materials in the absence of oxygen to obtain combustible by-products.</td>
<td>Capital intensive with high running costs. Technically complex; the full operational and cost issues are not widely known</td>
</tr>
</tbody>
</table>
Steps for proper solid waste management:

A proper dealing with solid waste represents a main pillar of far-sighted, sustainable environmental management.

1. Occupational health & safety requirements: No bare handed operation with any sort of refuse during collection and treatment / disposal, no scavenging at landfill sites without suitable work protection and regular health control.

2. Collection systems: Installation of regular waste collection systems for all urban, suburban and regional areas (exceptions should only be granted for remote residences where occupants can prove to have a safe individual waste disposal facility). Integration of phased targets for the availability of municipal waste collection systems into relevant legal framework.

3. Waste disposal standards: Landfills need to be fenced and patrolled. Wastes accepted at the landfill must be recorded. Waste placed in the landfill needs to be regularly covered with suitable material (e.g. construction debris) in order to reduce odour, windblown litter and vermin. Adjacent groundwater bodies must be monitored. Depending on local hydrogeologics suitable measures for groundwater protection (such as landfill liners and leachate collection) need to be in place.

4. Waste management planning: Waste management strategies should contain a step wise reduction/phase-out of landfilling of specific waste streams, related to their recyclability and/or impacts caused by their disposal (e.g. biodegradable waste).

5. Institutional: The institutional level which shall be responsible for the management of wastes from households, commercial activities, institutions, and construction and demolition activities is the municipality. Municipalities which are too small to provide the relevant services should be contracted to Regional Associations.

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Reinforced Interlocking Hollow Block System for Earthquake Resistant Construction using Industrial Waste- BMTPC initiative

D.P. Singh*

Introduction
The interlocking masonry system (IMS) replaces the conventional brick and mortar by using the interlocking masonry blocks. The other components of the conventional building system remain largely unchanged. Dry stacked-Interlocking masonry system enables speedier construction of high quality, aesthetic and affordable building. The blocks have an extremely appealing face-brick finish and provide a pre-pointed straight masonry. The walls may be left exposed, plastered or finished with cement paint. These blocks are made using block making machine with an option to make them at the site of construction itself. The interlocking construction is suitable for both load bearing structures as well as framed structures-single or multi-storey.

In conventional construction, brick could be good but of mortar used is normally weak it makes the overall masonry work weak. This is taken care by recent development at Jamia Millia Islamia (JMI) through BMTPC project which virtually use no mortar for making masonry uniform and strong.

The user also has option to use mortar slurry within the blocks. These are solid/hollow blocks for all kind of wall applications. Blocks can be made using industrial waste as additive to meet relevant technical requirements.

Dry interlocked masonry provides flexibility in application and technically superior for making earthquake resistant structures with vertical cavities for reinforcements.

India is prone to earthquake & is being visited by devastating earthquakes. India’s seismic zone map depicts that over 60% of land area in India is under moderate to severe earthquake hazard (IS: 1893, 2002). Unsafe building stock makes the built environment vulnerable and this in turn results in loss of human life and property in the aftermath of earthquakes. Hence, the built environment must be made earthquake resistant so that lives are not lost through the collapse of unsafe buildings. This requires the active participation of various professionals associated with the construction industry and all the stakeholders in building development and delivery. IMS can be effectively used for earthquake resistant construction incorporating necessary structural design and reinforcements-horizontal/vertical. This masonry system is perfect for Indian condition where housing shortage is alarming area is prone to earthquake.

Issues & Basis
Shelter is a basic human requirement affecting the largest number of people worldwide. The building Industry accounts for nearly half of the G&P of most nations. It is interesting to note the following points regarding buildings and building related activity:

• The building industry is the largest consumer of resources whether it is materials, capital or energy.
• It causes the largest amount of environmental degradation as a result of quarrying, mining process, depletion of natural resources.
• It is also one of the largest progenitors of waste output, for example, construction debris, etc.
• Building materials produced in industrial processes are responsible for pollution and global warming.
• Monopolised Industrial pro-

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cesses increase cost of building products resulting in a rubber-stamping effect of products and negating a response to locally available materials and needs.

- The building industry is second only to agriculture in providing employment for the maximum number of people.
- Walling materials constitute approximately 30% of construction and the largest mass and surface area of a building.
- Walls account for the maximum capital resource in the structure.
- Walls have the largest surface area and account for maximum recurring maintenance costs. Failure of the walls is the single largest factor responsible for the collapse of structures in case of calamities such as earthquakes.

The strength requirement of a walling material rated at 150 kgs/sq cm in itself is a fallacy. The soil bearing capacity is usually 2 to 3 Kg/sq cm and the load on a wall is less than 1 Kg/sq cm per floor. The high compressive strength of a walling block is the direct consequence of its surface requirements. The ideal block would therefore require a resilient non-erodible surface with a lean backup body material. Another important criterion should be the feasibility of manufacture at the site, with minimal capital. Interlocking mortar less system has the potential to reduce costs & energy without sacrificing performance.

**Mortared system drawbacks**

Building conventional masonry with mortar is time-consuming. A good crew (one mason and two helpers), working on straight walls with minimal reinforcement, can lay 150 to 200 blocks per day on average. Some crews have been known to place 300 units a day. More extensive horizontal and vertical reinforcement and grouting complicate the installation and reduce output. A major factor in these productivity rates is the time it takes to apply mortar and maintain the proper horizontal and vertical alignment. Many common workmanship problems also relate to mortar, e.g. moving a unit after its initial set; improper toothing; incompletely filling head and bed joints; omitting horizontal wire reinforcing; and leaving mortar droppings in cores to be grouted. All these practices compromise a masonry assembly’s performance, often increasing maintenance and repair costs after the project is completed. Minimizing such problems would greatly increase masonry’s attractiveness to building owners and designers.

**Dry-Stack Systems in the World market**

Dry-stack masonry systems available in the market are: Haener Block, Azar Block, Sparlock, Durisol, Faswall, Endura Block, IBH Block, H Block, W Block, JMI BMTPC Interlocking Block, KLB System, Mc IBS Inc Block, Whealen Interlocking Block, Barlock Interlocking Block, German KS-R system, I-Shaped Block

**Benefits of interlocking dry-stacked systems from past practice and application**

Self-aligning concrete masonry systems that use minimal amounts of mortar offer several potential benefits that could improve masonry’s overall effectiveness.

- Problems associated with mortared joints, such as inadequate bond and mortar cracking that provide an obvious path for water penetration would no longer be factors in an assembly’s performance.
- Quality control of the assembly would lie with the manufacturer of the interlocking block, substantially reducing responsibility at the job-site.
- Using interlocking units without mortar, the mason could put more units in the wall in a given period of time. Output has been as much as 900 to 1,200 units a day per crew.
- Units could be placed by semi-skilled and unskilled labour with proper guidance. The combined effect of less skilled labor and increased output has been estimated to reduce labor cost by as much as 80%.
- Because interlocking block provide stability during construction, floor and roof loads could be placed on wall assemblies without waiting for mortar to cure, thus further speeding construction.

The other advantages are:

- Environment friendly
- Save mortar & plaster cost
- High finish design & aesthetics
- Speedier construction
- Simple to use
- No skilled labour is required
- Environment friendly
- Standardized product & quality
- Suitable for earthquake prone area
- No plastering is required
- Employment generation
- Space saving
**Principles of practical interlocking systems**

Any practical block system has to follow some basic principles:

**Ease of design:**

The interlocking mechanism must be clearly thought out and explained so that architects can understand how it works and design with it easily. The blocks themselves should meet requirements contained in existing material standards and building codes. The geometric relations of the system also should be expressed as equations that allow design in accordance with established structural principles and building codes.

**Ease of production:**

The blocks must be capable of being produced economically on conventional block machines. Most mortarless block systems have relied on tongue-and-groove or dovetail patterns to achieve interlocking. But experience has shown that manufacturing block with tongue-and-groove face shell bedding surfaces is impractical, given the configuration of standard block machines and the difficulty of meeting close tolerances.

**Ease of construction:**

The system should be designed from the outset for un grouted, partially grouted, or fully grouted applications. Systems that may be reinforced and grouted need to provide for the placement of steel and grout. Construction methods should accommodate the use of unskilled or semiskilled labor. The number of shapes or components included in the system should be kept low, to simplify estimating quantities and minimize confusion on the job site.

**Current products**

Among the many mortarless block systems that have been developed around the world, two that are commercially available now seem the most promising. A third system, known as Alternating face shell system, not yet in production but under study under JMI BMTPC, project also seems to have commercial potential. This dry-stacked system, developed and need market in India, consists of stretcher, corner, and jamb units in both full and half heights. It provides positive interlock horizontally, through shear keys, and vertically, through a stepped arrangement of alternating courses produced through a half-height base course. A overlap creates continuity past the weak areas of the bed joints. The discontinuity of both head and bed joints through the wall enhances the system’s fire resistance, reduces accidental sound transmission, and improves resistance to air flow. As with conventional construction, workers with some technical skill are needed to ensure straight lines and verticality, but beyond this, semiskilled labour is sufficient to install the block. The interlocking features provide stability during construction, assist with alignment and leveling, and limit the construction tolerances. Projecting lug system. Another commercially available system combines lugs molded into the webs with tongues and grooves molded into the end faces to permit the blocks to stack and lock together without mortar. It has three standard units—a stretcher, a half block, and a corner also used as an end block. Recesses between the lugs provide for reinforcement to be placed horizontally and vertically without tying. The initial course must be laid flat and plumb to allow for positive dry-stacking of the remaining units. Technical skill is required for this phase, but once it is completed, semiskilled and unskilled labour can be used to stack the remaining courses. It is possible for a crew to dry-stack more than 1,000 units in one day.

The Dovetail Interlocking block system, is still under development, takes an interesting alternative approach. It features interlocking dovetail slots and lugs at opposite ends of the blocks. Notched-web units can be used to hold horizontal reinforcing steel and large cells accommodate vertical rebar and grout. As the system was originally designed, horizontal alignment was to be accomplished by grooves formed in the face shells.
Because of the difficulty of producing roved face shells with current technology, researchers are now working on an alternative interlocking method. For surface bonded or grouted walls, however, the system could compete with other commercially available systems.

**Completion options**

Depending on the building’s final occupancy, the assembly can be completed in one of three ways—plain, surface bonded & grouted. Plain dry-stacked units can be used for retaining walls, foundation walls, partitions, and load-bearing walls up to about 3 meter tall in structures not intended for human occupancy. For surface-bonded walls, dry stacked units can be finished on both sides with a cementitious or acrylic bonding matrix reinforced with fiberglass mesh or plastic fibers. This material serves as a rain and air barrier, as well as provides the final surface finish and color. Height limits can be as high as 6 metre for two-storey load bearing walls. In grouted construction, dry-stacked interlocking units have their cores partially or fully fill with grout, and can include horizontal and vertical reinforcement. Unreinforced grouted wall provide for greater load capacity and heights than simply surface bonded assemblies. Reinforced, grouted walls provide masonry assemblies with properties and load capacities similar to conventional reinforced masonry systems. Height limits can go upto 9 meter for three-storey load bearing walls.
With the emergence of new building materials, advancement of technologies and the need for disaster resistant construction to mitigate the effect of natural disasters, it is important that working professionals regularly update their knowledge and understanding. Realising this need of capacity building of professionals, BMTPC has continued its efforts in organizing structured training programmes on subjects related to advancement in the area of building materials for professionals on regular basis. BMTPC, in association with Dr.Fixit Institute, a Not for Profit Institute, organised a series of Training Programmes indifferent regions of the country. The details are as follows:

“Advances in Concrete Mix Design & usage of Admixtures”
Organized a training programme on “Advances in Concrete Mix Design & usage of Admixtures” from 17 – 18 December 2009 at Bangalore, Karnataka. The programme was attended by around 20 participants from various organizations such as MNNIT, Shapoorji Pallonji & Co. Ltd, Mysore City Corporation, Oil India Ltd, Army Welfare Housing Organisation, DSIIDC, Karnataka Slum Clearance Board, A P State Housing Corporation, Karnataka Housing Board etc. The faculty was distinguished experts from organisations like Grasim Industries, IISC, Civil Aid Technoclinic Private Limited, SERC, IIT. The broad themes covered were need
of concrete mix design (proportioning); type of Mix; chemical and mineral admixtures; role of admixtures; special admixtures of SCC & HSC and Future role of admixtures in concrete.

“Structural Protection, Repair and Rehabilitation of Buildings”
Organized a training programme on “Structural Protection, Repair and Rehabilitation of Buildings” from 18–19 March 2010 at Guwahati, Assam. The programme was attended by around 25 participants from various organizations. The broad themes covered were distress in concrete structures; health monitoring of concrete; repair methodologies; modern repair materials and their applications including earthquake resistance. The programme not only provide a unique platform but also an opportunity to interact and learn from the experts regarding structural protection.

“Building Maintenance – Water Proofing and General Repairs”
Organized a training programme on “Building Maintenance – Water Proofing and General Repairs” from 12-13 August 2010 at New Delhi. The programme was attended by around 25 participants from various organizations such as RITES, NCCBM, CSIR, Haryana Housing Board, Tata Housing Development Co. Ltd, Urban Administration and Development Division, Madhya Pradesh, Ultra Tech Cement Limited etc. The overall programme was well appreciated by participants and requested Council to organize such programmes in future also. The faculty was distinguished experts from various organisations like IIT, Ministry of Defence, SERC, Geo-hazards International, 3R Construction Solutions, CBRI, Golder Associates etc. with years of experience in practical field. The broad themes covered were Leakage, Cracking & Manifestation of Distress, Advanced Waterproofing Materials, Modern Repair materials and Repair Methodologies, Crack and Crack Repair Materials, Periodic Health Checks, Maintenance Schedules & Strategies.
The BMTPC jointly with Department of Earthquake Engineering, IIT Roorkee organized a short Term Training Course on “Codal Practices on Earthquake Resistant Design and Construction” from 28-30th January, 2010 at New Delhi. The main objective of the training course was to provide knowledge and training to engineers and architects about the current codal practices on earthquake resistant design and constructions. The course covered various aspects of Codes and Indian Standards, Construction practices in India, Earthquake resistant designs & constructions, Performance of R.C. buildings, Ductility provision for better seismic performance, Repair & seismic strengthening of buildings etc. The course was attended by various professionals, engineers, architects etc., from government as well as private sector organizations.
Technology for Utilization of Marble Slurry in Self Compacting Concrete

In order to provide an environment friendly solution for marble slurry utilization, a project was undertaken jointly with IIT Delhi for utilization of marble slurry in self compacting concrete. The study has been completed and the final report has been received. The report presented in two parts, covers Part A - Environmental Analysis of Marble Waste Management options and Part B - Utilisation of Marble Slurry in Self Compacting Concrete. Marble Powder was used in self compacting concrete as fine filler. Two different approaches were adopted. In the first, fly ash was replaced upto 20% by volume with marble and secondly sand was replaced by two varieties of marble powder. The results can be summarized as below:

Using marble powder
Dry marble powder should not be used as marble powder absorbs water from concrete and affects workability and strength. Marble powder should be soaked in water for at least 24 hours in water before using and water correction done.

Replacing fly ash with marble powder
1. Flowability (Workability) decreases with addition of marble powder replacing fly ash.
2. Segregation Resistance of self compacting concrete increased with marble powder on replacing fly ash. This was due to the fact that marble powder being heavier increases the density of mortar.
3. Slight decrease in strength (upto 3 MPa) was observed when fly ash was replaced with marble powder. Over all not much change in strength was observed.
4. Cohesiveness and Viscosity of the concrete increased with addition of marble powder while replacing fly ash.

Replacing sand with marble powder
1. Flow increased when marble powder was added in partial replacement of sand upto20%.
2. Segregation index decreased with higher percentage of marble powder. Marble powder upto 10% is recommended limit of replacing sand. Above this segregation resistance decreases drastically.
3. Passability (V-funnel) of self compacting concrete increased when sand was replaced by marble powder.
4. Strength of SCC was observed to decrease by maximum 5MPa.
5. Adding marble powder in lieu of sand decreases segregation resistance.

Effect of different types of marble powder
1. Fine marble powder decreases the viscosity more than rough/coarser marble powder.
2. Density is clearly not the only determining factor. The texture and fineness of the powder also have a large effect.

Considering the above results following conclusions have been drawn about usage of marble powder in self compacting concrete:

- Marble powder can be used to stabilize the segregating mix by replacing fines, with limitation of 20% of marble powder of total fines by volume. Though slight decrease in strength (upto 3 MPa) could be experienced.
- Marble powder can be utilized to increase the passability (decrease V-funnel time) of Self compacting concrete by replacing sand upto 10% by volume.
- Marble powder can be utilized to make economical self compacting concrete with lower s/a ratio. This can be done by incorporating marble powder as fine filler by replacing sand upto 10%. This will increase the fine proportion of concrete and will have higher passability and workability.
- Marble powder should not be used in dry form. It should be moist (above SSD condition).
- The texture of the marble powder used should be chosen according to the decrease in viscosity desired.

mışın
Rapidwall panel is a building panel system, manufactured essentially using calcined gypsum plaster (made using phosphogypsum, an industrial waste from fertilizer plants) to the extent of 96.5%, water repellent emulsions, chemicals and reinforced with micro strands of glass rovings. The material is reported to have been developed in Australia in 1991 and in use there since then as building material in construction of wall panels, floor/roofs. This has also been used in Malaysia.

Gypcrete/Rapidwall panels of thickness 120 mm and of various sizes as per design are machine manufactured with hollow cores. During the manufacturing process, glass fibers of about 300-350 mm in length are randomly distributed inside the panel skins and in the ribs.

In building construction, the standard large panels are cut in the factory into building components that may have window and door opening. These components are then, transported to the construction site and erected in a similar way to the construction of precast concrete panels. The cavities (hollow cores) inside the panel can be filled with various materials such as concrete or insulating materials, to serve different purposes such as to increase the strength or improve the thermal and sound insulation. Depending upon the design requirement, necessary reinforcement are also placed through the cores. In a rapid wall building system, most or all the building components are constructed with glass reinforced system panels.
Thus it serves as both architectural and structural walls.

Initially Gypcrete Building India (P) Ltd, Madras, in collaboration with the Australian company had set up a plant in Chennai to manufacture the panels in India. Recently, Rashtriya Chemicals and Fertilizers, Mumbai has set up a plant in Chembur to manufacture Rapidwall panels and have also formed a Joint Venture Co. with the Fertilizers and Chemicals Travancore Ltd, Cochin, called FACT-RCF Building Products Ltd. The Joint Venture has set up another plant in Cochin, Kerala. Thus three plants in different locations have been set up for the manufacturing product. Three model demonstration buildings have so far been constructed at RCF Campus in Chembur by RCF, at Vizagapatnam by Coromandel Fertilizers Ltd and at Cochin by newly formed RCF & FACT Joint JV Co. respectively.

To study the physical properties and behavior under static loading of the panels in Indian condition, a set of panels were brought from Australia and tested separately in IIT Madras for physical properties and Structural Engineering Research Centre, Madras for behaviour under Static Loading.

The performance of gypcrete panel were further evaluated using six housing models against simulated earthquakes and found to be meeting the requirements of IS 1893 (Part 1): 2002 Indian Standard Criteria for Earthquake Resistant Construction, for Seismic Zone V. Performance Appraisal Certificate by BMTPC was issued based on above laboratory tests and other data on samples brought from Australia. It was, however, emphasized that once the panels are manufactured in India, the same will be tested for its performance vis-à-vis the requirements based on which the system has been designed. Now the production in RCF has commenced in India. Test results of the panels in factory lab have been found to be satisfactory. For independent testing, samples from the production line have been drawn from the plant. These Panels have been tested at SERC Chennai & IIT, Chennai for various performance parameters including structural strength, water resistance, thermal behaviour etc. Complete design manual for the system is being developed on the basis of results obtained from the panels manufactured in RCF plant with the help of IIT Chennai.

BMTPC visited Rashtirya Chemicals & Fertilizers (RCF) Ltd. to study the production of Rapidwall panels for its usage in mass-scale construction of housing projects. In order to demonstrate the concept for mass application, it is planned to construct building with G+7 floors with 4 dwelling units in each floor. The RCF would be providing land and infrastructure. In this regard, an MoU has been signed with M/s RCF for construction of 32 demonstration houses using rapidwall technology at Chembur, Mumbai on cost sharing basis (BMTPC 75: RCF 25). Based on the results obtained on testing of panels manufactured by RCF, some modification in design is being worked out. Accordingly, drawings and estimates will be finalized.
Promotional Publications of BMTPC

1. Corporate Brochure - in English and Hindi
2. BMTPC Newsletters
3. Environment Friendly Building Materials & Construction Technologies
4. Grah Nirman Mein Vishesh Savdhaniyan
5. Reconstruction of Earthquake Resistant Houses in Garhwal Region - Guidelines in Hindi
6. Retrofitting of Stone Houses in Marathwada Area of Maharashtra
7. Useful tips for House Builders
8. Local Vegetable Fibres + Industrial & Mineral Waste for Composite materials
9. Machines developed by BMTPC
10. An Introduction to the Vulnerability Atlas of India
11. Performance Appraisal Certification Scheme
12. Catalogue for Machines
13. Green Houses for ITBP at Leh
14. Bamboo - A Material for cost-effective and disaster resistant housing
15. Retrofitting of Hospital in Kupwara, Kashmir, J&K for Safety Against Earthquakes
16. Simple Ways to Earthquake Safety for Jammu & Kashmir - in English and Urdu
17. Bamboo in Housing & Building Construction - Initiatives of BMTPC
18. Disaster Prevention & Mitigation - Major Initiatives by BMTPC.
19. Aam Aadmi Series - House Building Digest (Series 1 to 10)
20. Brochure on Dissemination of Information, Demonstration Construction using Cost Effective and Disaster Resistant Technologies"
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. **ABHIJITRAHAN 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. **ASHRAY 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-sol water pollution. The film shows various methods of utilising flyash to manufacture building materials.

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 Aya, Professor Emeritus (Earthquake Engineering), 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 Aya (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 content 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 MASSES 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 which 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 standard 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 Shankar 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 WorldSmsy 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-aways 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 Cret, roof, how to build with it and how much it would cost.

18. **HOUSING AND INFRASTRUCTURE 18 min.**
The film 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 preparedness 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 activities of BMTPC to promote cost-effective innovative building materials and technologies developed in India.

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 VAMBAAY.

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