


Special Issue

निर्माण सारिका

A Newsletter of BMTPC

World Habitat Day – 4th October, 2010

Better City Better Life








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

"Creating Enabling Environment for Affordable Housing for All"

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From the Desk of
Executive Director

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 prosper 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)

BAN KI-MOON
Secretary - General
UNITED NATIONS

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.

A message for World Habitat Day 2010

Inga Björk-Klevby
Officer-in-Charge of UN-HABITAT
Assistant Secretary-General of the United Nations
and
Deputy Executive Director, UN-HABITAT

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.

सत्यमेव जयते

KUMARI SELJA
Minister of Housing and Urban Poverty Alleviation
and Minister of Tourism
Government of India

Global observance of World Habitat Day this year with the theme "Better City, Bet ter 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

*Dr.K.K.Pandey**

This paper examines facets of Urban Divide with a particu lar 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 the 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 ,slum 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

* **Professor**, Urban Management and **Chairman**, Centre for Urban Studies, Indian Institute of Public Administration, New Delhi, India

is fairly wide. India has 286 million people living in over 5000 cities and towns out of which 61.7 million or nearly 22 percent urban population is living in slums and squatter settlements. Incidence of poverty and slums are closely linked with each other and nearly 26 percent of urban population is estimated to be living below poverty line. The incidence of poverty is associated with inadequate access to shelter, sanitation, employment opportunities and income generation. This situation is a result of mis-match between demand and supply of shelter, services and land for the fast growing urban population in 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:

(i) Ad hoc and Conventional Planning, (ii) Financial Exclusion, (iii) Informal Land Tenure, (iv) Substandard Housing, (iv) Inadequate Basic Services, (v) Environmental Degradation, (vi) Poor Intra city connectivity, (vii) Regional Disparities.

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.

सत्यमेव जयते

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

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)

Master Plans has been significantly different then 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 subtenant. 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 substandard 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.

सत्यमेव जयते

DR. P.K.MOHANTY

Addl. Secretary & Mission Director (JNNURM)
Ministry of Housing & Urban Poverty Alleviation
Government of India

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 inadequacy 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 cognigence 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

सत्यमेव जयते

SUNIL KUMAR SINGH
Joint Secretary (Housing)
Ministry of Housing & Urban Poverty Alleviation
Government of India

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 re-look 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.

20/9/10
(Sunil Kumar Singh)

Box 1
National Urban Housing and Habitat Policy (NUHHP) 2007

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.

like SJSRY (Swarna Jayanti Shahri RozgarYojana), and RAY (Rajiv Avas Yojana) should give specific attention on financial education.

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 adaSpted 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 Up gradation

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 up gradation 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 net work 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 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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World Habitat Day 2009 Celebrations

Safer Cities : Safer Life

(the context of JNNURM)

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FNA, FNAE, FIE

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):-

Greater Mumbai, Ahemdabad, Chennai, Kolkatta, Lucknow, Nashik, Pune, Cochin, Varanasi, Agra, Vadodara, Surat, Kanpur, Coimbatore, Jabalpur, Asansol, Vijaywada, Rajkot, Dhanbad, Indore, Panaji, Thiruvananthapuram, Bhubaneshwar, Puri, Tirupati and Pondicherry.

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 & Thiruvanathapuram.

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)".
- IS:13828-1993 "Improving Earthquake Resistance of Low Strength Masonry Buildings - Guidelines"
- IS:13935-1993 "Repair and Seismic Strengthening of Buildings - Guidelines".
- 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 over head 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 over head water supply tanks.
- To avoid breakage of under ground 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:-

- *Sewers*: 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 bunglows. 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.

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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

Housing Cooperatives Instruments of Better City Life

*Dr. M.L.Khurana**

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-

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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 air borne 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 fulfilment 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 bio-energy. 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, co-operatives, 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.

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.

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.

♦♦♦

BMTPC Board of Management meeting held on April 12, 2010

Bamboo based Building Materials and their Properties

*Anand Nandanwar** *C.N.Pandey***

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.

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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

Sl. No	Property	Results				
1	Thickness of the panels	3mm	6mm	6mm*	8mm	9mm
2	Density, kg/m^3	766	711	935	790	892
3	Internal Bond Strength, N/mm^2					
	Dry	2.18	2.42	0.82	1.97	2.2
	Wet	1.98	2.14	0. 61	1.73	1.8
4	Surface Strength, N/mm^2					
	Dry	11.42	11.23	4.9	9.47	13.1
	Wet	11.42	10.47	3.47	9.1	10.5
5	Tensile strength, N/mm^2	22.69	26.59	89.17	29.54	31.4
6	Compressive strength, N/mm^2	16.77	30.35	50.6	35.3	57.5
7	Modulus of Rupture, N/mm^2	50.74	56.31	102.57	59.35	68.8
8	Modulus of Elasticity, N/mm^2	3678	3220	12033	3114	3930
9	Modulus of Rigidity, N/mm^2	5881	6050	3527	6066	5750

* *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

Sl. No.	Property	BMVC (21mm thick)	Prescribed values as per IS 10701
1.	Density kg/m^3	602	750
2.	Internal Bond Strength, N/mm^2		
	Dry	2.30	-
	Wet	1.65	-
3.	Surface Strength, N/mm^2		
	Dry	8.00	-
	Wet	6.80	-
4.	Tensile strength N/mm^2		
	Along	36.40	54
	Across	35.80	34
5.	Compr. Strength, N/mm^2		
	Along	43.90	34
	Across	40.20	29
6.	MOR N/mm^2		
	Along	68.50	49
	Across	55.40	29
7.	MOE N/mm^2		
	Along	7820	7355
	Across	3210	3923
8.	Mod. of Rigidity, N/mm^2	3316	588

Table 3: Properties of BMCS

(*Average thickness = 3.8 mm*)

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

Table 4: Properties of bamboo laminates

Sl.	Property	Vertical Laminates			Horizontal laminates
	Resin used ->	UF	MUF	PF	MUF
1	Density, Kg/m^3	728	745	796	782
2	Modulus of Rupture, N/mm^2	122.5	149.1	145.2	164.4
3	Modulus of Elasticity, N/mm^2	12028	16570	16800	17300
4	Compressive strength, N/mm^2	61.7	84.7	96	87.9
5	Block shear strength, N/mm^2	11.89	12.8	12.7	9.65
6	Screw withdrawal strength, N				
	Face	4999	4006	4683	3235
	Edge	2333	3659	3216	5375
7	Abrasion resistance, mg/revolution	0.36	0.36	0.36	0.36
8	Moisture resistance	Withstand cyclic test	Withstand cyclic test	Withstand cyclic test	Withstand cyclic test

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 posses 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/m^3	921
2.	Modulus of Rupture, N/mm^2	
	Along	118.56
	Across	59.47
3.	Modulus of Elasticity, N/mm^2	
	Along	12383
	Across	3556
4.	Block shear strength, N/mm^2	5.67

Table 6: Properties of Bamboo Flooring Tiles

Sl. No.	Property	Result		
		Average	Standard deviation	Variation coefficient, %
1.	Moisture Content %	9.5	0.57	6.07
2.	Density kg/m^3	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/mm^2			
	a) Along	122.5	13.7	11.2
	b) Across	27.0	3.9	14.6
7.	Modulus of Elasticity, N/mm^2			
	a) Along	15957	2122.2	13.3
	b) Across	1383	178.2	12.9
8.	Compressive strength, N/mm^2			
	a) Parallel to laminae	52.6	4.43	8.43
	b) Perpendicular to surface	63.0	1.36	2.16
9.	Shear strength, N/mm^2	4.4	1.2	28.3
10.	Static hardness, N	6237	1149	18.42
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

Sl. No.	Property	Results	Prescribed values as per IS:3513	Prescribed values per IS:4990	
				Along	Across
1	Specific Gravity	1.1	0.95 to 1.25	-	-
2	Moisture content %	8.01	6 to 12	5 to 15	
3	Tensile strength N/mm^2	57.18	59	32.5	22.5
4	Static bending strength, N/mm^2	107.6	59	50	30
5	Modulus of Elasticity, N/mm^2	5701	-	7500	4000
6	Compressive strength, N/mm^2				
	Parallel to laminae	68.5	75	-	-
	Perpendicular to laminae	181.2	130		
7	Impact strength, Kgm/cm^2			-	-
	Perpendicular to laminae	0.55	0.2		
	Parallel To laminae	0.60	0.5		
8	Hardness (Rockwell 'H' Scale)	96.67	60	-	-

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

Sl. No.	Property	BMB			BMVC		
		Average	Standard deviation	Variation coefficient, %	Average	Standard deviation	Variation coefficient, %
1	Moisture content, %	7.36	1.90	25.76	7.83	0.58	7.44
2	Density, kg/m^3	840	80	9.45	830	70	8.20
3	Internal Bond Strength, N/mm^2						
	In dry state	1.32	0.53	39.81	1.05	0.22	21.19
	In wet state	1.01	0.36	35.93	0.80	0.19	24.23
4	Tensile strength, N/mm^2						
	Along the grain	29.45	4.88	16.57	57.70	10.71	18.55
	Across the grain				43.79	5.97	13.64
5	Modulus of Rupture, N/mm^2						
	Along the grain	68.55	13.31	19.42	74.29	20.19	27.17
	Across the grain				49.37	9.60	19.44
6	Modulus of Elasticity, N/mm^2						
	Along the grain	4.19	0.71	16.98	6.29	0.92	14.69
	Across the grain				4.17	0.58	13.87

Table 9: Properties of Flattened bamboo board

Sl. No.	Property	Average	Standard deviation	Variation coefficient, %
1	Moisture content, %	8.63	1.17	13.54
2	Density, kg/m^3	900	0.12	13.68
3	Internal Bond Strength, N/mm^2			
	In dry state	1.35	0.37	27.52
	In wet state	1.17	0.38	32.82
4	Tensile strength, N/mm^2			
	Along the grain	68.55	11.12	16.22
	Across the grain	49.73	6.75	13.57
5	Modulus of Rupture, N/mm^2			
	Along the grain	136.04	32.39	23.81
	Across the grain	59.04	18.72	31.70
6	Modulus of Elasticity, N/mm^2			
	Along the grain	10.33	2.77	26.78
	Across the grain	5.06	1.10	21.82

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.

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

Environment Friendly Energy Efficient Building Materials for Cost Effective Urban Housing

*Dr. J.S. Chauhan**

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

Materials (67%)		Labour (33%)		Component-wise (100%)	
Cement	17%	Mason's wages	12%	Foundation	10%
Iron & steel	9%	Carpenter's wages	6%	Walls	30%
Bricks	15%	Unskilled labour	15%	Roofs	25%
Timber	12%			Doors & Window	15%
Sand	6%			Flooring	10%
Aggregate	8%			Finishing	10%

Table 2.0

S.	Particulars	Cement Million Ton	Aggregate Million	Bricks Million Cum.	Steel Million Ton	Timber Million Cum.	Houses (No.) Million
1	**DEMAND**						
	Urban Areas						
(a)	New Construction	94.53	416.30	159458	11.76	24.93	8.46
(b)	Upgradation	4.87	10.72	3082	0.07	0.64	1.09
	Rural Areas						
(c)	New Construction	29.25	121.97	118875	2.08	3.33	9.51
(d)	Upgradation	3.33	6.95	5081	0.03	0.19	2.17
2.	**AVAILABILITY**	114.93	270.35	231598	11.24	15.75	—
3.	**SHORTAGE**	17.05	285.59	54898	2.70	13.34	—

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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.

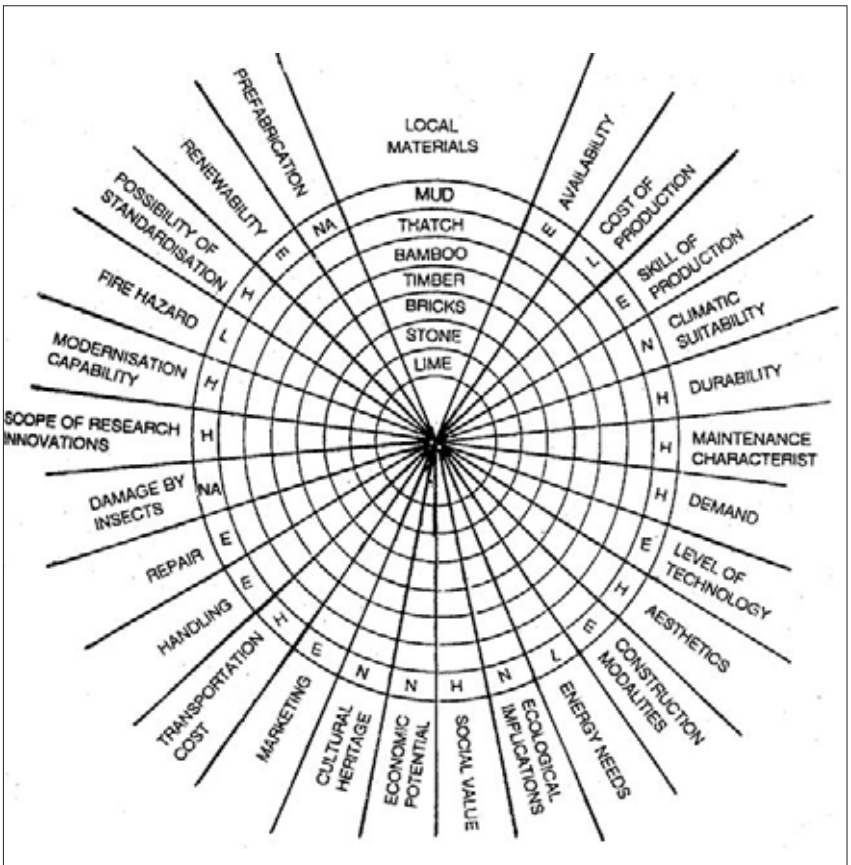

Fig. 1.0 Matrix to guide choice of building materials in low-cost housing

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.

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.
4. Better quality burnt clay bricks and tiles for construction of walls and roof.
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.

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 are as follows :

1. Application of chemical treatment for preservation and extending the service life of grass thatch and palm leaves.

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.

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

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.

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आर.सी.सी. ढांचों की पुनर्स्थापना – वास्तविकता से कितने दूर?

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अरूण कुमार तिवारी **

1. सारांश

यह सर्वविदित है कि भूकंप निरोधी समावेशन के साथ पहली बार भवन निर्माण करना सस्ता है, बजाय बाद में मरम्मत एवं सुदृढ़ीकरण कार्य करने से भूकंप निरोधी समावेशन की विशिष्टताओं के साथ मकान बनाना सामान्य निर्माण की अपेक्षा 2% से 5% महंगा होता है। जबकि सामान्य घरों में बाद में भूकंपरोधी मरम्मत एवं सुदृढ़ीकरण में प्रारंभिक लागत से 4 से 8 गुना ज्यादा लागत आती है। इन तथ्यों के बावजूद भवनों को भूकंप रोधन विशिष्टता के साथ निर्मित नहीं किया जाता है। पिछले भूकंपों के दौरान आर सी सी ढांचों की असफलता इसके गवाह के रूप में हैं।

भूकंपीय पुनर्स्थापना या पुनर्वसन में सही अर्थों में भवनों में तीन प्रकार के सुधारों की अपेक्षा होती है, जैसे कि **मरम्मत–** केवल दर्शनीय एवं सजावटी सुधार या बदलाव होते हैं। **जीर्णोद्धार**–ढांचागत मरम्मत, जैसे कि दरारों वाली दीवारों को पुनः बनाना, दरारों को गांठना, पिलाई (ग्राउटिंग), सरियों को बदलना आदि, ताकि भवन की मूल निष्पादकता प्राप्त हो जाए; तथा **प्रतिउपस्करण (रेट्रोफिट)**–ढांचागत बदलाव जैसे कि आवरण बनाना (जैकेटिंग), प्रतिबल (शीयर) व दीवारें लगाना, टेक एवं स्थिरण आदि ताकि भवन में मूल ढांचे की अपेक्षा और अधिक उच्च निष्पादकता प्राप्त हो जाए। हालांकि; कार्य क्षेत्र में भूकंपीय पुनर्स्थापना को बहुत ही गैर जिम्मेदाराना ढंग से प्रयुक्त किया जाता है। प्रायः दिखावटी/सजावटी मरम्मत को भूकंपीय पुनर्स्थापना से सभ्रमित किया जाता है। भूकंपीय पुनर्स्थापना को एक स्ट्रक्चरल इंजीनियर (भवन निर्माण अभियंता) के द्वारा किया जाना चाहिए तथा इसके लिए उचित नियोजन एवं इंजीनियरिंग निर्णय की जरूरत होती है। सबसे पहले भवन के ढांचे को भूकंप रोधन के लिए मूल्यांकित किया जाना चाहिए और फिर आवश्यकताओं अनुसार उसको पुनर्स्थापित किया जाना चाहिए। विद्यमान भवन की भूकंप रोधकता का मूल्यांकन करना अपने आप में एक टेढ़ा काम है और भारतीय परिप्रेक्ष्य में तो बिल्कुल नया भी है। यहां पर उपरोक्त उद्देश्य के लिए कोई भी मानकीकृत दस्तावेज उपलब्ध नहीं है। भारत में भूकंप रोधन के लिए की गई रेट्रोफिटिंग (उपस्करण या मरम्मत) के बहुत कम आंकड़ें उपलब्ध है। हमारे देश में सामान्य प्रविधियों के अंतर्गत परंपरागत तरीके जैसे कि दरारों की मरम्मतें, गांठना, पिलाई, जैकेटिंग (आवरण बनाना) आदि का उपयोग होता है। प्रयोगात्मक तौर पर यह सत्यापित हो चुका है कि इन तकनीकों से सुदृढ़ता एवं तन्यता में वृद्धि नहीं होती है, बल्कि ढांचा और संदिग्ध हो जाता है। हम लोग वास्तव में, सुदृढ़ता बढ़ाने के बजाए मरम्मत का कार्य करते हैं। नई तकनीकें जैसे कि रैपिंग (वेष्टन) या आच्छादन, प्रतिबल दीवारें, ब्रेसिंग (टेक लगाना), नए फ्रेम अलग से लगाना, ऊर्जा छितराव के साधन (उपस्कर) को लगाना, आधार वियोजन आदि को इस तथ्य के बावजूद कि ये भूकंप के समय बेहतर निष्पादकता करते हैं कभी भी इस्तेमाल की कोशिश नहीं की गई जबकि ये विश्व भर में सफलतापूर्वक प्रयुक्त किए जा रहे हैं।

यह लेख पुनर्स्थापना के दौरान अपनाई जाने वाली विभिन्न स्कीमों (योजनाओं) का निर्वहन करता है तथा यह भी बताता है कि किस प्रकार से इंजीनियरस रेट्रोफिटिंग के निहितार्थ को समझे बिना कार्य करते हैं और उसी के साथ–साथ ढांचा को अधिक जोखिम भरा व नाजुक बनाते हैं। इसके अतिरिक्त लेख में आर.सी.सी. भवनों के पुर्नस्थापना हेतु अपनाए जाने वाले लागत प्रभावी रेट्रोफिटिंग (मरम्मत) योजनाओं की मुख्य विशिष्टताओं को बताया गया है । रेट्रोफिटिंग के लिए यहाँ पर यह बताना जरूरी है कि डी सी आर (मांग–दक्षता अनुपात) उपागम के द्वारा भवन का प्रमात्रात्मक भूकंपीय मूल्यांकन पूर्वापेक्षित होता है।

2. परिचय

'भूकंपीय पुनर्स्थापना' को एक व्यापक शब्द के रूप में प्रयुक्त किया गया है; जिसमें 'मरम्मत', 'उन्नयन', रेट्रोफिटिंग तथा सुदृढ़ीकरण की धारणाएं समाहित हैं जो भवन की भूकंपीय

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सुकुमारता (सिस्मिक वलनरेबिलटी) को कम करने की दिशा में काम करती हैं। पूरी दुनिया में, भूकंप प्रभावी क्षेत्र में विद्यमान भारी संख्या में इमारतों को भूकंपीय पुनर्स्थापना की कई कारणों एवं उत्प्रेरकों की वजह से आवश्यकता है, जैसे कि कोडल माडीफिकेशन (सहिंता सुधार), भूकंपीय क्षति। भूकंप से क्षतिग्रस्त भवन के क्षतिग्रस्त हिस्से को पुनः उपयोग के लिए मरम्मत के साथ–साथ सुदृढ़ीकरण की आवश्यकता (भूकंप के बाद पुनर्स्थापना) हो सकती है। सामान्यतः उन्हें इस तरह से पुनर्स्थापित किया जाता है ताकि भविष्य में उन्हें धरातलीय हलचल से बेहतर भूकंपीय निष्पादकता प्राप्त हो। विद्यमान बहुमंजिला भवनों की रेट्रोफिटिंग प्रायः तब आवश्यक बन जाती है जब ऐसे भवनों को संरचनात्मक (ढांचागत) रूप में वर्तमान भूकंपीय कोडों (संहिताओं) की आवश्यकताओं को पूरा कर पाने में अपर्याप्त पाया जाता है। भूकंपीय कमजोर भवन, जिसका डिजाइन वर्तमान भूकंप कोडल प्रावधानों को पूरा नहीं कर पाता है, को भी पुनर्स्थापना (भूकंप पूर्व पुनर्वसन) की आवश्यकता हो सकती है। एक स्ट्रक्चरल इंजीनियर को विद्यमान भवनों की भूकंपीय रोधन रेट्रोफिटिंग (मरम्मत) करना एक अति चुनौतीपूर्ण कार्य होता है। इस प्रकार के कार्य प्रायः उन इंजीनियरों के लिए और चुनौती खड़ी करते हैं जो अवधारणात्मक रेट्रोफिट (मरम्मत) योजनाओं को एक भवन के रेट्रोफिट करने में इस्तेमाल करते हैं।

3. सजावटी रेट्रोफिटिंग प्रक्रियाएं

भारत में, 26 जनवरी, 2001 को आया भूकंप शहरी क्षेत्रों को सर्वाधिक रूप से प्रभावित करने वाला अत्यंत विनाशक भूकंप था। इस भूकंप ने एक नया कोण जोड़ा था, जब अहमदाबाद में विशाल आर.सी.सी. (कंक्रीट) ढांचे की संरचना से बने भवन ताश के पत्तों की तरह से ढेर हो गए। भुज भूकंप के दौरान कंक्रीट (आर.सी.सी.) ढांचों के लिए अपनाए गए रूप विन्यास, विवरणों एवं निर्माण प्रथाओं के साथ उनके नष्ट होने की बानगी या प्रतिरूपों को कहीं न कहीं साहित्य में वर्णित किया गया।

कोई भी विनाशकारी भूकंप, जोकि व्यापक रूप से भवनों एवं ढांचों को विनष्ट करता है, वह भवनों के गिरने का आतंक एवं भय पैदा करता है और साथ ही साथ इंजीनियरों एवं भवन निर्माताओं द्वारा अपनाई गई निर्माण प्रथाओं की कमजोरियों को भी उजागर करता है। भविष्य में संपत्ति एवं जीवन के जोखिम को बचाने के लिए, स्थानीय इंजीनियर एवं भवन निर्माता, भवनों का सुदृढ़ीकरण प्रारंभ करते हैं, जैसा कि वे उचित समझते हैं। यद्यपि इनमें से अधिकतर को पहले से भूकंपीय मामलों का पूर्व अनुभव नहीं होता है। इसके साथ ही काम करने वाले इंजीनियर, भूकंपीय रेट्रोफिटिंग की प्रविधियों के बारे में विशेषज्ञों से राय/मार्गदर्शन भी नहीं प्राप्त करते हैं। वे साधारणतः भूकंपीय झटकों के बाद भवन को गिरने से बचाने के लिए कुछ करते हैं और उसमें रहने वालों में पुनः विश्वास पैदा करते हैं। इस लक्ष्य को पाने के लिए, कई बार साधारण रूप से भवन में भविष्य में आने वाले भूकंपों के संपार्श्विक सुदृढ़ीकरण (लेटरल स्ट्रेंथ) को बढ़ाए बिना, केवल खड़े अवलंब (टेक)/सपोर्ट (सहारा) लगा देते हैं।

भुज में आए भूकंप के पश्चात, कंक्रीट (आर.सी.सी.) ढांचों के पुनर्स्थापन हेतु अनेक रेट्रोफिटिंग (मरम्मत) योजनाओं को अपनाया/अवलोकित किया गया। जैसे कि–

- अधिकतर स्थानों पर, दीवारें कॉलमों/बीम के जोड़ों (संधि स्थलों) से अलग हो गई तथा दीवारों में दरारें भी इन परिस्थितियों में, भरी गई दीवारें (इनफिल) की दरारों एवं कॉलमों के लिए पुनः पलस्तर करने एवं टीपटाप को अपनाया गया है। ऐसे मामलों में जिनमें इनफिल दीवार में बड़ी दरार होती है, ऐसी दीवारों को निकालकर नई दीवारें बनाई गई ।
- अहमदाबाद के अधिकतर कंक्रीट इमारतें Soft ground storey वाली हैं। इन इमारतों के बुनियादी तल्लों के कॉलमों में महत्वपूर्ण रूप से अधिकतम क्षति, तन्य एवं लचीली (शियर एवं फलेक्सर) दरारों के रूप में हुई। ऐसी परिस्थितियों में क्षतिग्रस्त

चित्र–1 पुरानी आर.सी.सी. बीम एवं कॉलमों को जोड़े बिना ही सजावटी कालम जैकेटिंग को अपनाया गया।

बुनियादी तल्लों के लिए कंक्रीट (आर.सी.सी) जैकेटिंग (आवरणन) की गई। कॉलम जैकेटिंग में बुनियाद में नया सरिया नहीं प्रतिष्ठापित किया गया एवं पुरानी कंक्रीट दीवारों से पलस्तर भी नहीं उतारा गया। इसके अलावा, सरियों को जो अतिरिक्त कंक्रीट वाले भाग में डाले गये, उनको पुरानी आर.सी.सी. (कंक्रीट) बीम व कॉलम से जोड़ हुए बिना ही बाहर निकलता हुआ छोड़ दिया गया (चित्र–1)। कुछेक मामलो में, पुराने कालमों के चारों और जहां के तहां, अतिरिक्त कंक्रीट एवं सरियों को जोड़ दिया गया। कुछ जगह पुराने कालमों को चारों तरफ से चुस्त स्टील एंगलों एवं पत्तरों से लपेट दिया गया तथा पुराने कालमों को सतहों को खरोंचे बिना ही कंक्रीट से ढक दिया गया। यह भी देखने में आया कि भूकंप के ठीक बाद, बुनियादी तल्लों पर कॉलमों की भारी आकार की अनावश्यक जैकिटिंग (आवरणन) की गयी जिसके कारण अन्य उद्देश्यों जैसे पार्किंग, वाणिज्यिक गतिविधियों के लिए जगह नहीं बची, जोकि पहले इसी के लिए छोड़ी गई थी।

- कुछ जगहों पर क्षति ग्रस्त ग्राउंडस्टोरी कॉलमों को सर्पोट देने के लिए जमीन से बीम तक ईंटों के कॉलमों द्वारा भरा गया। बीमों को बीच की जगहों पर रोल्ड स्टील (आई सेकशन या बिल्टअप सेक्शन) खंडों से की टेक लगाई गयी। ठीक इसी प्रकार से कैंटीलीवर बीमों को, जो छज्जों के कालमों के सहारे के लिए थी, चिनाई करके, स्टील के कड़ियों या चिनाई की दीवारों से समर्थित किया गया।
- कमजोर (दुर्बल) पहली मंजिल की आर. सी.सी. इमारतों में शीयर दीवार (प्रतिबलन) के उपयोग को मान्यता देते हुए कुछ भवन निर्माताओं ने भूतल के आर.सी. ढांचा पैनल के पहले से खुले/खाली भाग में चिनाई से भराई कर दी। यह तथाकथित शीयर वाल्स न तो ठीक से विन्यासित की गई और न ही लेटरल प्रभावी प्रतिरोधन के लिए विद्यमान ढांचे के साथ ठीक से जोड़ी गईं हो दीवारे सिर्फ ग्रांउड पर टिकी पाई गई।

उपर लिखे कथनों से विदित है कि भूकंपीय (प्रतिरोधन) पुनर्स्थापना के बारे में कार्य क्षेत्र में बड़ी ही लापरवाही बरती गई। प्रायः दिखावटी /सजावटी मरम्मत को भूकंपीय पुनर्स्थापना के साथ सम्भ्रमित किया जाता है। भूकंपीय पुनर्स्थापना के कार्य को एक वास्तु (स्ट्रक्चरल) इंजीनियर के द्वारा किया जाना चाहिए, जिसके लिए उपयुक्त नियोजन एवं इंजीनियरिंग (अभियंत्रकीय) निर्णय की आवश्यकता होती है। सबसे पहले ढांचे को भूकंप रोधन के लिए मूल्यांकित किया जाता है इसके बाद मांग क्षमता अनुपात (डी.सी.आर) पर निर्भर करता है कि क्या इसे पुर्नस्थापित किया जाए। विद्यमान भवन का भूकंपीय मूल्यांकन अपने आप में टेड़ा (जटिल) कार्य है और भारतीय परिप्रेक्ष्य में यह एकदम नया है। डी.सी.आर. मांग (एक ढांचे पर भूकंप का प्रभाव) तथा भवन की प्रतिरोधन क्षमता के बीच तुलनात्मक माप पर होता है और अगर यह एक से ज्यादा हो तो रेट्रोफिटिंग (मरम्मत) की रणनीति के बारे में निर्णय लेना होता है, कि करने योग्य है या नहीं। भूकंप के पश्चात विद्यमान भवन के भूकंपीय पुर्नस्थापन को रेट्रोफिटिंग के द्वारा करना एक चुनौती पूर्ण कार्य होता है। यह कार्य प्रायः उन वास्तु इंजीनियरों के लिए सर्वाधिक चुनौती खड़ा करता है जो अवधारणात्मक रेट्रोफिट योजनाओं का उपयोग करते हुए एक भवन को रेट्रोफिट करते हैं। प्रायः विद्यमान भवन के रेट्रोफिटिंग की दो प्रविधियां प्रचलित है, (1) वैश्विक (ग्लोबल) रेट्रोफिट, (2) स्थानीय (लोकल) रेट्रोफिट। वैश्विक रेट्रोफिट की तब आवश्यकता पड़ती है जब कुल मिलाकर भवन भूकंप रोधन रहित है। इन प्रविधियों के अंतर्गत शीयर (कैंचा) दीवार, इनफिल वाल्स (दीवार), ब्रेस्ड (टेक) फ्रेम/पुश्त लगाना, संपूरक अवमंदन साधन तथा बेस आइसोलेशन आदि शामिल है। स्थानीय रेट्रोफिट तब पर्याप्त होता है जब केवल कुछ खंडों को सुदृढ़ीकरण की आवश्यकता होती है। इसके अंतर्गत स्टील जैकेटिंग (आवरणन), कंक्रीट आवरणन, कार्बन फाइबर आवेष्टन (रैपिंग) ग्लास फाइबर जैकेटिंग (आवरणन) आदि शामिल होते हैं। जब यह रेट्रोफिटिंग उपाय क्रियान्वित किये जा रहे हों, तब पुराने ढांचे के साथ नए ढांचे की ढांचागत संयोजिता का पूरा ध्यान रखा जाना चाहिए ताकि उपयुक्त ढंग से भूकंपीय पाथ (मार्ग) एवं भार हस्तांतरण प्राप्त किया जा सके। विद्यमान भवनों की भूकंपीय पुनर्स्थापना के लिए मांग–क्षमता उपागम का प्रयाश तथा प्रतिबलन दीवार (शीयर वाल्स), कार्बन–फाइबर आवेष्टन आदि द्वारा रेट्रोफिटिंग की लेखकों द्वारा केस स्टडी के रूप में विभिन्न मंचों पर परिचर्चित किया गया है।

4. भूकंपीय रेट्रोफिटिंग (मरम्मतकारी) तकनीकें

अपर्याप्त संपार्विक बल रोधक (लेटरल रसिसटेंस) युक्त भवन के लिए प्रणाली सुदृढ़ीकरण एवं स्टिफनिंग (कसना) को सर्वाधिक सामान्य रूप से भूकंपीय निष्पादक सुधार रणनीतियों के रूप में अपनाया जाता है। गुजरात में भूकंप से क्षतिग्रस्त भवनों की सुदृढ़ता के लिए, लेखकों द्वारा विशिष्ट प्रणालियों को लागू किया गया, जिसमें अतिरिक्त नए ऊर्ध्वाधर अवलंब, शीयर (प्रतिबलन) दीवार, बंधनी फ्रेम तथा जैकेटिंग (आवरणन) आदि शामिल थे। सभी रेट्रोफिटिंग विकल्पों के बीच में; हर मामले के आधार पर उपयुक्त विकल्पों को उचित भूकंपीय मूल्यांकन एवं गुण दोषों का विवेचन करते हुए चुना जा सकता है; जिन्हें यहां पर संक्षेप में परिचर्चित किया जा रहा है–

4.1 शीयर वाल्स (प्रतिबलन दीवार)

विद्यमान कंक्रीट ढांचे में शीयर वाल्स (प्रतिबलन दीवार) का उपयोग भवन की सुदृढ़ता एवं सख्तीपन, दोनों को बढ़ाने के लिए अत्यंत प्रभावी प्रविधि है। एक शीयर वाल प्रणाली प्रायः सस्ती एवं अन्य कंक्रीट ढांचों की तुलना में जल्दी पूर्ण होने वाली प्रवृत्ति से युक्त होती है। हालांकि, एक विद्यमान ढांचे में शीयर वाल का जोड़ा जाना, कुछ विपरीत प्रभाव भी डाल सकता है जैसे कि एक भवन मे भारी संख्या में शीयर वाल का जोड़ा जाना भवन के भार/आकार में महत्वपूर्ण वृद्धि कर सकती है और इनके कारण भूकंप के दौरान भवनों पर ज्यादा बल लगता है तथा इसको सहने के लिए ज्यादा सुदृढ़ता की आवश्यकता होती है। शीयर वाल्स प्रायः वास्तु शिल्पीय प्रघात का परिणाम हो सकती है

चित्र–2 शीयर वाल्स (प्रतिबलन दीवार) के साथ आर.सी. भवन

क्योकि इनके लगाने से खिड़कियों की हानि है तथा फर्श स्तर का क्षेत्रफल भी कम हो जाता है, साथ ही उसके आधार पर उलटाव के रूप में भारी बल (ओवरर्टनिंग फोर्स) उत्पन्न हो सकता है जिसे बुनियाद के कार्य में संपूरक की आवश्यकता हो सकती है, जो कि प्रायः महंगा होता है। **चित्र–2 में** राजकोट में स्थित आर.सी.सी. फ्रेम की एक भवन को दर्शाया गया है जो की ओपन ग्राउंड स्टोरी है। इसको भूकंप के बाद लेखकों द्वारा शीयर वाल्स लगाकर सुदृढ़ किया गया, बिना भूतल में जगह को घेरे हुए ।

4.2 परिरोध जोड़ना (कन्फाईनमेंट)

गैर तन्य (नॉन डक्टाईल) कंक्रीट कॉलम की विकृत क्षमता को बाहरी परिरोध जैकेटिंग (आवरणन) के प्रावधान द्वारा बढ़ाया जा सकता है। कॉलम को जैकेटिंग करने का सरलतम तरीका यह है कि विद्यमान कॉलम के कमजोर हिस्से के सरियों को विगोपित करने के पश्चात परिसीमित सरियें दिये जाएं (**चित्र 3**) और नए एवं विद्यमान सरियों के बीच पर्याप्त बंधन (बांड) उपलब्ध किया जाये। ठीक इसी दौरान, बीम कॉलम के संधिजोड़ों पर पर्याप्त बंधन (जुड़ाव) देकर अनुलंब सरियें लगाने चाहिए तथा कॉलम के शीर्ष पर फ्रेमवर्क में छोर पर कीपाकार उपलब्धता के द्वारा, विशेष रूप से हॉनी कॉम्बिग बनने से रोकने पर ध्यान दिया जाना चाहिए (**चित्र 4**)। हालांकि जब कालम का सुदृढ़ीकरण कर रहे हों; यह आवश्यक होता है कि बीम और कालम के जोड़ों के बीच मजबूती प्रदान करें; ताकि भूकंप के समय पैदा होने वाली बड़ी गतिशीलता का प्रतिरोध हो। अनुलंबात्मक सरियें, फुटिंग स्तर तक निरंतर होना चाहिए तथा फुटिंग का बाहरी भाग (परिधि) जैकेटेड (आवरित) होना चाहिए; ताकि विद्यमान एवं नए कंक्रीट के बीच पर्याप्त ढांचागत अखंडता रहे (**चित्र 5**)। उपरोक्त को उपखंडात्मक विवरण **चित्र 6** में प्रस्तुत किए गया हैं। चूंकि बीम की जैकेटिंग, निर्माण की नजर से काफी जटिलतापूर्ण होती हैं, इसलिए यह प्राथमिकतापूर्ण होता है कि जहां भी अपेक्षित हो आर.सी. बीम/स्टील खंड उपलब्ध कराएं या फिर उपयुक्त स्थल पर

चित्र–3 विद्यमान कालम के सरियों का विगोपन

चित्र–4 कंक्रीट (खंभे) के कॉलम शीर्ष पर कीपनुमा फ्रेम वर्क

चित्र–5 फुटिंग (आधार) से बीम कॉलम संधि जोड़ तक उपयुक्त ढांचागत अखंडता के साथ कॉलम जैकेटिंग (आवरणन लगाना)।

अतिरिक्त कॉलम उपलब्ध कराएं ताकि लंबे स्पैन/अति कैंटीलिवरेज (प्रास) में कमी हो।

4.3 बंधन युक्त चौखटा/ढांचा (ब्रेस्ड फ्रेम्स)

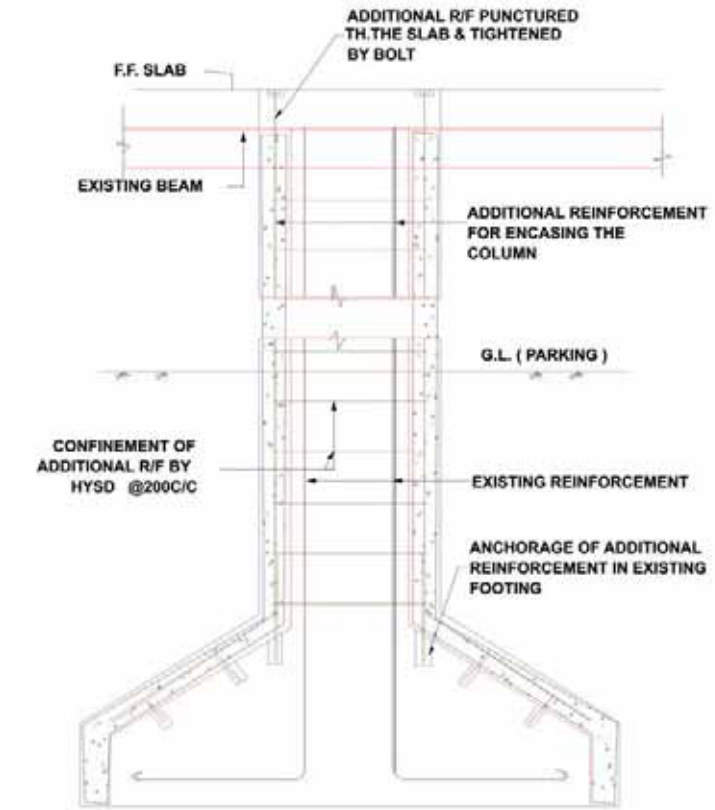
स्टील का बंधन युक्त ढांचा या चौखटा एक विद्यमान भवन की मजबूती एवं संपार्श्विक तन्यता बढ़ाने की एक अन्य सामान्य प्रविधि है। हालांकि, भारत में यह उतना लोकप्रिय नहीं है क्योंकि विद्यमान आर.सी.फ्रेम (ढांचे) में बंधनयुक्त चौखटों को प्रभावी रूप से जोड़ना कठिनतापूर्ण है। विशिष्ट रूप से, बंधनयुक्त फ्रेम तन्यता व मजबूती को निम्न स्तर प्रदान करते हैं अपेक्षा कृत शीयरवाल (प्रतिबलन दीवार) के। लेकिन ये ढांचे में कम भार बढ़ाते हैं और सेवाओं को कम बाधित किए बिना तथा प्रकाश को कम रोके बिना लगाए जा सकते हैं तथा भवन के अंतर्गत आवागमन के प्रतिरूप पर लघु प्रभाव डालते हैं। **चित्र–7** एक पुर्नस्थापना कार्य को दर्शाता है जिसमें गुजरात में भूकंप प्रभावित एक औद्योगिक शेड में लेखकों के अनुमोदन पर कालमों की जैकेटिंग एवं अतिरिक्त बंधन युक्त फ्रेम लगाएं गए हैं।

5. भूकंपीय रेट्रोफिट (मरम्मत) के नवीन उपागम

भूकंप के तुरंत पश्चात, भवनों के सर्वाधिक जोखिम एवं नाजुक हिस्सों को रेट्रोफिट करने की ओर ध्यान दिया जाता है, जिसे परंपरागत मरम्मत बनाम सशक्तीकरण योजनाओं जैसे कि बुनियादी तल के कॉलमों की जैकेटिंग, शीयर वाल आदि को लगाना आदि शामिल होतें है और ये मुख्यतः समाज–आर्थिक विचारशीलता से नियंत्रित होते हैं। हालांकि; ये भूकंपीय रेट्रोफिट योजनाएं लागू नहीं की जा सकती हैं; चूंकि निम्नलिखित में एक या एकाधिक दशाएं उपलब्ध रेट्रोफिट योजनाओं के निर्धारण में प्रायः उच्च प्राथमिकता वाली होती हैः–

- निर्माण की जगह, अवधि एवं समय की सीमा
- कार्य के दौरान शोर, धूल एवं कंपन
- वास्तु विन्यास एवं/या ढांचागत डिजाईन का संरक्षण
- ढांचागत निष्पादकता के साथ–साथ कार्यात्मक निष्पादकता
- निर्माण के दौरान सेवा क्षमता/देयता

अनेक नई प्रौद्योगिकीय विकल्पों जैसे यथा भूकंपीय विलगन, संपूरक ऊर्जा फैलाव, सक्रिय नियंत्रण तथा रेट्रोफिटिंग के लिए उच्च निष्पादक सामग्री की उपलब्धता उच्च लागत के कारण भारतीय परिवेश में इन तकनीकों के उपयोग को बाधित करती हैं। हालांकि, हाल ही में विकसित रेट्रोफिट तकनीक, स्ट्रक्चरल खंडों का कार्बन फाइबर से आवेष्टन (रैपिंग) को भूकंप के पश्चात भुज क्षेत्र में, लागत को विचार में रखने के बावजूद अनेक बहुमंजिला इमारतों में सफलतापूर्वक पुनर्स्थापना कार्यों में लागु किया गया। इसके कार्यान्वयन की गति एवं टिकाऊपन के कारण इसने परंपरागत मरम्मत तकनीक के ऊपर लाभ प्राप्त किया है। यह प्रयोगात्मकता के साथ–साथ विश्लेषणात्मक रूप से सत्यापित हुआ कि कमजोर बीमों एवं कालमों के ऊपर कार्बन–फाइबर का आवेष्टन (रैपिंग) प्रबलीकरण को बढ़ाता है और इसी कारण आनमन (फलैक्सर), शीयर (प्रतिबल) तथा मान्यता (डक्टिलिटी) की शक्ति बढ़ जाती है।



चित्र–6 कॉलम एवं फुटिंग जैकेटिंग का अनुप्रस्थ (काट) विवरण

5.1 आर.सी.सी. कॉलमों की कार्बन फाइबर जैकेटिंग

फाइबर आवेष्टन प्रणाली एक उच्च मजबूती वाला फ्रैविक/इपोक्सी संघटक है जो ई–ग्लास तथा केलवर/ऐरामाइड फाइबर्स (रेशों से) तथा एक ईपोक्सी रेजिन (राल) में सन्निहित होने से बनता है। यह योजना मूलतः विद्यमान आर सी कॉलमों की तन्यता को बेहतर बनाने के लिए लक्षित होती है जोकि एक भूकंप के दौरान दबाव/प्रतिबल में असफल हो जाते हैं। कार्बन फाइबर जैकेटिंग के उपयोग का लाभ यह है

कि ये अपेक्षाकृत उपयोग में आसान, तीव्र क्रियान्वयन, भारानुपात में उच्च सुदृढ़ता, क्षरण हेतु अच्छा प्रतिरोधक तथा पर्यावरणीय क्षरण में प्रतिरोधी, अपनाने में अनुकूलनशीलता तथा अधःस्तरीय कंक्रीट की किसी आकृति में ढलने की क्षमता वाले होते हैं।

5.2 आधार विलगन (बेस आइसोलेशन)

यह उपागम भवन के एक स्तर के अंतर्गत धारक/सुनम्य दबाव के लिए ऊर्ध्वाधर भार वहन प्रणाली, विशिष्ट रूप से आधार के पास प्रविष्ट कराने के लिए अपेक्षित होती है। भारकों का विन्यास ऐसा होता है कि वे अपेक्षाकृत निम्न तन्यता, अत्यंत संपार्श्विक, विकृत सक्षम तथा सर्वोत्तम ऊर्जा वितरक विशिष्टता वाले हो सकते हैं। एक विलगन प्रणाली की प्रतिस्थापना के परिणामस्वरूप भवन की आधारभूत प्रतिक्रिया अवधि में एक तात्विक वृद्धि होती है, तथा संभवतः यह सुनम्यता (डंपिंग) प्रभावी होता है। चूंकि विलगन भारक स्वयं ढांचे से अधिक संपार्श्विक अनुवृत्ति वाले होते हैं अतः भूकंप द्वारा संपार्श्विक विकृति मांग उत्पन्न करने के द्वारा कंक्रीट स्वतः ही भारक वृत्ति लेते हैं। एक साथ होने वाले इन प्रभावों के परिणाम स्वरूप, विलगन भारक के ऊपर टिके भवन के हिस्से की संपार्श्विक मांग (दबाव) व्यापकता से घट जाती है। हालांकि, भारत में, भूकंप के पश्चात यह पुनर्स्थापना के व्यवहार में नहीं लायी जाती है।

6. निष्कर्ष

इस लेख में गुजरात में आर सी फ्रेम वाले भवनों के पुनर्स्थापन के दौरान अपनाए जाने वाले विभिन्न आदर्शों एवं स्वतः प्रेरित रेट्रोफिटिंग (मरम्मत) योजनाओं को प्रस्तुत किया गया, इन योजनाओं को जाने बिना कि ये योजनायें भूकंप के द्वौरान ढांचे पर जोखिम को और बढ़ा देगी,किया गया। संक्षेप में, लेखक इस बात पर जोर देना चाहतें है कि किसी भी रेट्रोफिटिंग तकनीक की प्रभावशीलता/निष्पादकता विद्यमान इस बात पर निर्भर करती है कि विद्यमान

मेम्बर्स को रेट्रोफिट मेम्बर्स के साथ ऐसे जोड़ा जाये ताकि भूकंप के दौरान बलों का सहज अंतरण हो सके। अंत में यह कहना चाहेगें कि रेट्रोफिटिंग एक साईंटिफिक प्रकिया है तथा इसको बिना एक्सर्पटस की सलाह व डिटेल्ड स्टडी के करना बहुत ही जोखिम भरा हो सकता है।

♦♦♦

चित्र–7 एक औद्योगिक शेड की रेट्रोफिटिंग के लिए बंधन युक्त फ्रेम का जुड़ाव तथा कॉलम जैकेटिंग

Monitoring of BSUP and IHSDP Projects under JNNURM

BMTPC alongwith 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.


Surat


Vadodara


Faridabad


Lucknow


Meerut


Varanasi


Meerut


Saharanpur

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 envisages 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.

Messages on different sub-themes issued during the Lok Awaas Yatra

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 has been completed successfully. The Regional Yatra - Eastern Region was held between 26th – 30th March 2010 in the eastern regions of India covering Bihar and Orissa. The Yatra consist 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

♦ ♦ ♦

LOK AWAAS YATRA
हर आवास प्रकृति के पास

Showcasing of Alternate and Cost effective building materials and construction technologies during Lok Awaas Yatra

Pilot Plant Facility for Recycling of Construction and Demolition Wastes

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.

Visit to Affected Area of Leh due to Cloud Burst by BMTPC, HUDCO and HPL

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:

	Fully damaged houses	Partially damaged houses
1. Leh Block	520	376
2. Khaltsi Block	97	152
3. Nubra sub-division	10	14
4. Nyoma sub-division	7	95
Total	**634**	**637**

As a part of the initiative to rehabilitate the affected peoples of Leh District, the Ministry of Housing and Urban Poverty Alleviation advised the organizations attached to the Ministry of HUPA viz. BMTPC, HUDCO and HPL to visit the site for preliminary assessment. The team visited the affected areas at length from 3rd to 5th September, 2010 in close coordination with the local authorities from the Office of the Dy. Commissioner, PWD, Ladakh Hill Development Council, Tourism Dept., Block Panchayat Office. The team interacted with local affected people in the affected areas of Choglamsar which is one of the worst affected area.

Since the aim of the team was to explore the possibility of construction of houses in the flash flood affected area of Leh in synchronization 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 upto 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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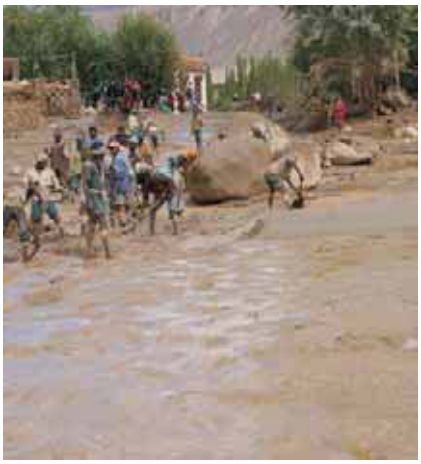






Demonstration Construction

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

Miscellenous
- 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

Miscellenous
- 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 earth-quake 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

*C.N.Jha**

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), GoI. 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, GoI. 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 it's 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

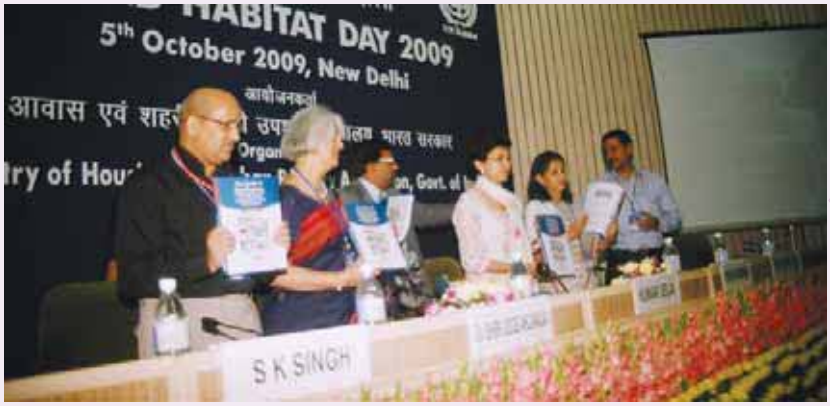
Rio de Janeiro, Brazil – 22-26, March, 2010

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 Sudy

*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:

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

The architectural repairs as stated above do not restore the original structural strength of structural components in the building and any attempt to carry out only repairs to architectural/

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non-structural elements neglecting the required structural repairs may have serious implications on the safety of the building. The damage would be more severe in the event of the building being shaken by the similar shock because original energy absorption capacity of the building would have been reduced.

Structural Repairs/Restoration

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

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

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

a) Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
b) Addition of reinforcing mesh on both faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it, suitably, with micro-concrete (maximum size of aggregate limited to 6 mm or less as suitable), and may be with use of micro-reinforcement as fibre or 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 retrofitting 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 Lajapatnagar and Vivek Vihar have been taken. This furthers 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 lifeline 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

Figure 1: MC Primary School Lajpat Nagar III-Location Map

RAPID VISUAL SCREENING OF MASONRY BUILDINGS FOR SEISMIC HAZARDS

Seismic Zone V

Photograph

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: G+1 1.6 YearBuilt: 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 : Strip 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: 400mm 1.13.3 Slab Thickness: 125mm

1.13.4 Mortar Type : Cement : Sand

1.13.5 Vert. R/F bars: Corners ___ T-Junctions ___ Jambs ___

1.13.6 Seismic bands: Plinth ___ Lintel __ Eaves ___ Gable__

*BB - 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 __

4.2 Parapets ☒

4.3 Cladding __

4.4 Others __

5.0 SPECIAL OBSERVATION

5.1 Length of wall between two cross walls are as per IS:4326 or IS: 13828 Yes ☒ No __

5.2 Percentage of openings in walls is as per IS:4326 or IS:13828 Yes __ No ☒

5.3 Ratio of height & width of wall is as per IS:4326 or IS:13828 Yes ☒ No __

RECOMMENDED ACTION:-
__ A or B, B+ : evaluate in details for need of reconstructions or possible retrofitting to achieve type c+ or D
☒ C: evaluate in details for need for retrofitting to achieve type C+, D.
__ If any Special Hazard 3.0 found, reevaluate for possible prevention /retrofitting.
☒ If any of the falling hazard is present, either remove it or strengthen against fall.
__ Special observation if not compliant may lead to more severe damage and will call for retrofitting.

Surveyor's Name Harshad Talpada

Executive Engineer's Name Rajendra Desai

Date of Survey 20/06/08

5.0 Probable Damageability in Few/Many Buildings

Building Type	5.1 Masonry Building						
Damage - Ability in Zone V	A	B	B+	(C)	C+	D	
	G5	G5	G4	G4	G3	G3	

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.

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 lifeline 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* (sunshades) 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 costum 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.

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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:

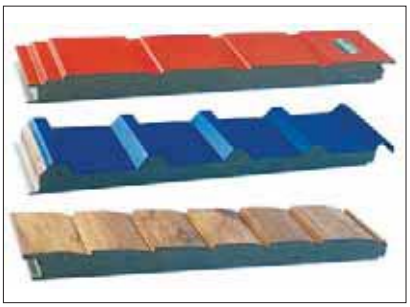
Deep Penetrating Sealer is a non-toxic, non-flammable, odorless, clear water soluble liquid compound. This can be used on walls & floors for waterproofing and preserving concrete etc.

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 samples carried out:
   - Veneer Laminated Lumber
   - Low Cost Shree Binder

II. Products for which inspection of the premises & drawl of the samples to be carried out
   - Underground Septic Tanks
   - HDPE Cover Blocks
   - Deep penetrating Sealer

III. Products for which Detailed Application Forms (DAF) under process
   - Ecosafe Panels
   - FRP Manholes
   - uPVC Windows
   - Continuous Sandwich Panels
   - Monolithic Formwork
   - Monolithic Concrete construction

IV. Products for which Preliminary Applications under process
   - Recycled Roofing Sheets
   - Marshal Doors
   - Copper Slag

Housing Affordability

*Sunil Bery**

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 provisos 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

* **Consultant**, BMTPC, New Delhi

inter-alia included propagation of new and innovative methods of construction which would make housing affordable to the public. Building Centres were also set up in the length and breadth of the country to provide new and improved materials and technologies for house construction at local level.

The Central Government keeps formulating number of schemes having an element of subsidy to make housing is accessible to the poorest of the poor of society. These included Nehru Rozgar Yogna, Indira Awas Yojna, VAMBAY, Jawaharlal Nehru National Urban Renewal Mission etc. Various State Governments accordingly floated a number of such schemes to provide housing at affordable levels.

A National Housing Policy (NHP) was brought out earlier in 1998 which gave a comprehensive view of the policy measures to be taken for providing adequate housing in the country. In keeping with the fast changing scenario in the country the NHP was revised and a 'National Urban Housing and Habitat Policy' (NHHP) was announced in 2007, having a much larger perspective. Several State Governments either have already announced or are in the process of finalizing their housing policies. A number of Working Groups and Committees have also been formulated to have deeper insight into the subject and suggesting solutions for providing affordable housing for all.

National Urban Housing and Habitat Policy

The National Urban Housing and Habitat Policy (NHHP) 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 forges 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-servicemen 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.

Integerated 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 Rojgar 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.

Options for Solid Waste Management in Cities

*Dr.Amit Rai**

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-separated 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-

* **Development Officer (BM-PD)**, BMTPC, New Delhi

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 Yangoon, and 50 percent in Cairo. And disposal receives less attention: as much as 90percent 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

City	Waste generation (kg/capital/day)	Kilo tonnes per year	Tonnes per day
Delhi	0.57	2161	5920
Greater Mumbai	0.45	1941	5320
Chennai	0.62	1108	3035
Kolkata	0.58	968	2650
Hyderabad	0.57	798	2185
Bangalore	0.39	609	1670
Ahmedabad	0.37	475	1301
Pune	0.46	428	1172
Kanpur	0.43	401	1098
Surat	0.41	365	1000

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

Country	Widespread multi-material Kerbside recycling/ intensive bring systems	Widespread Deposit return systems	Thermal treatments (inc. new technologies) >20% for BMW*	Tax on waste to landfill	Absolute Ban on landfill of BMW	Widespread use of Product Taxes	Widespread use of Raw Materials Tax	Widespread Home Composting	Other instruments Eg Producer Responsibility	MSW** recycling rate
Austria	√	√		√				√	√	48%
Belgium (Flanders)	√	√		√	√***	√		√	√	62%
Denmark	√	√		√	√	√	√		√	27%
Finland	√	√	√	√	√ From 2005			√	√	30%
Germany	√	√	√		√ From 2005			√	√****	50%
Netherlands	√	√	√	√	√				√	46%
Norway	√	√	√	√	√				√	40%
Sweden	√	√	√	√	√ From 2005	√	√	√	√****	34%

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 build 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 Durhan, 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 3: Common Options for waste treatment and disposal in developing countries

Disposal Option	Description	Application for Low Income Countries
Uncontrolled dumping	Waste is dumped at a designated site without any environmental control measures	This is not a disposal option but a common practice in low income countries. It has high environmental health risks.
Sanitary Landfilling	Controlled burial of waste. The site is engineered and managed to meet certain standards.	Comparatively low cost and simple technology solution when land is available. Presents some risks in certain circumstances.
Composting	Biological decomposition of organic matter in waste under controlled conditions.	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.
Incineration	The controlled burning of waste at high temperature to reduce its volume. Plant is designed to recover the energy released by combustion.	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.
Gasification	Biological decomposition of organic matter in waste under controlled conditions to obtain methane and other gases.	High cost and technologically complicated for developing countries.
Refuse Derived Fuel	Separation of combustible materials from solid waste for fuel purposes.	Depends on the presence of combustible material in the waste. Expensive and therefore of limited use in developing countries.
Pyrolysis	High temperature conversion of organic materials in the absence of oxygen to obtain combustible by-products.	Capital intensive with high running costs. Technically complex; the full operational and cost issues are not widely known

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 land filling 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 tooling; 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

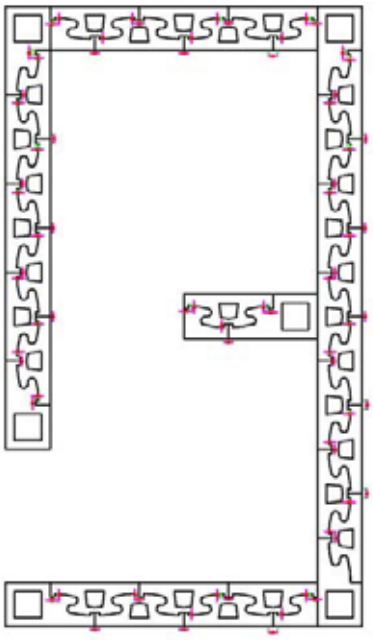
Any practical block system has to follow some basic principles:

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.



Assembly of Blocks

Ease of construction:

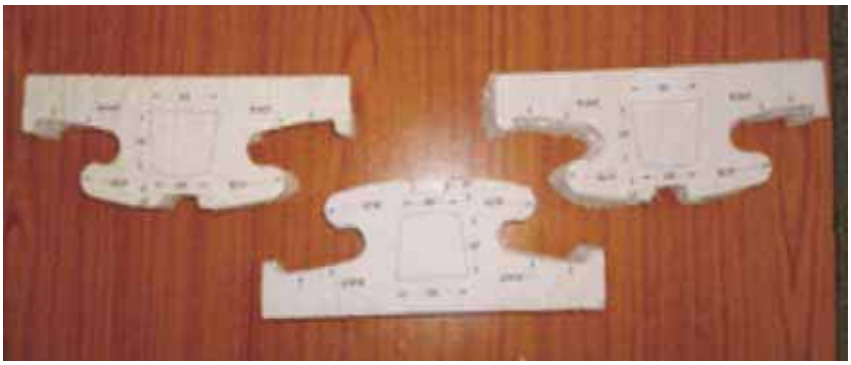
The system should be designed from the outset for un grouted, partially grouted, or fully grouted applications. Systems that may be reinforced and grouted need to provide for the placement of steel and grout. Construction methods should accommodate the use of unskilled or semiskilled labor. The number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

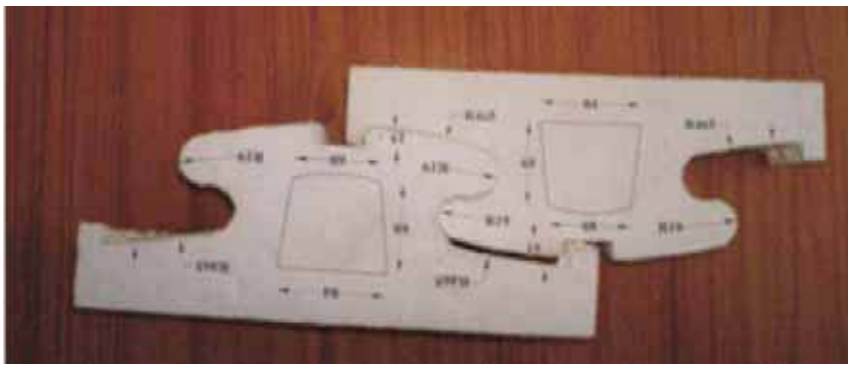
Current products

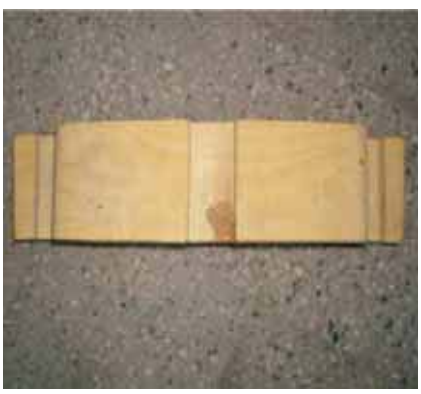
Among the many mortarless block systems that have been developed around the world, two that are commercially available now seem the most promising. A third system, is know as Alternating face shell system not yet in production but under study under JMI BMTPC, project also seems to have commercial potential. 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 Inter locking 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.

Capacity Building of Construction Professionals

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, Karanataka 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, Geohazards 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.

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Training Programme

on "Codal Practices on Earthquake Resistant Design and Construction, 28-30th January 2010, New Delhi

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 Marle 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 aiso 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 passablity 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.

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Emerging Technology – Rapidwall Panels

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 Malyasia.

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.

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Priced Publications of BMTPC

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

VULNERABILITY ATLAS OF INDIA (First Revision – 2006) - Earthquake, Windstorm and Flood Hazard Maps and Damage Risk to Housing - 900 pages, Rs. 5000 + 200 postage

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Promotional Publications of BMTPC

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

Films Produced by BMTPC

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

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

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

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

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

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

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

8. **SEISMIC RETROFITTING** *20 min.*
This film, in four parts, is a series of training films on the techniques of strengthening of houses in the earthquake affected regions of Marathwada in Maharashtra. This film was produced under guidance and direction of Dr AS Arya, Professor Emeritus (Earthquake Engg.),University of Roorkee.
Part 1 Installation of headers
Part 2 Reduction of weight on the roof
Part 3 Installation of knee braces
Part 4 Installation of seismic bands

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

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

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

12. **BUILDING CENTERS: DELIVERING TECHNOLOGIES TO THE 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 ehich have been adopted by the Centre in their construction.

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

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

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

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

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

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

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

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

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

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

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

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

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

Vision

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

Mission

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

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