Speical Issue

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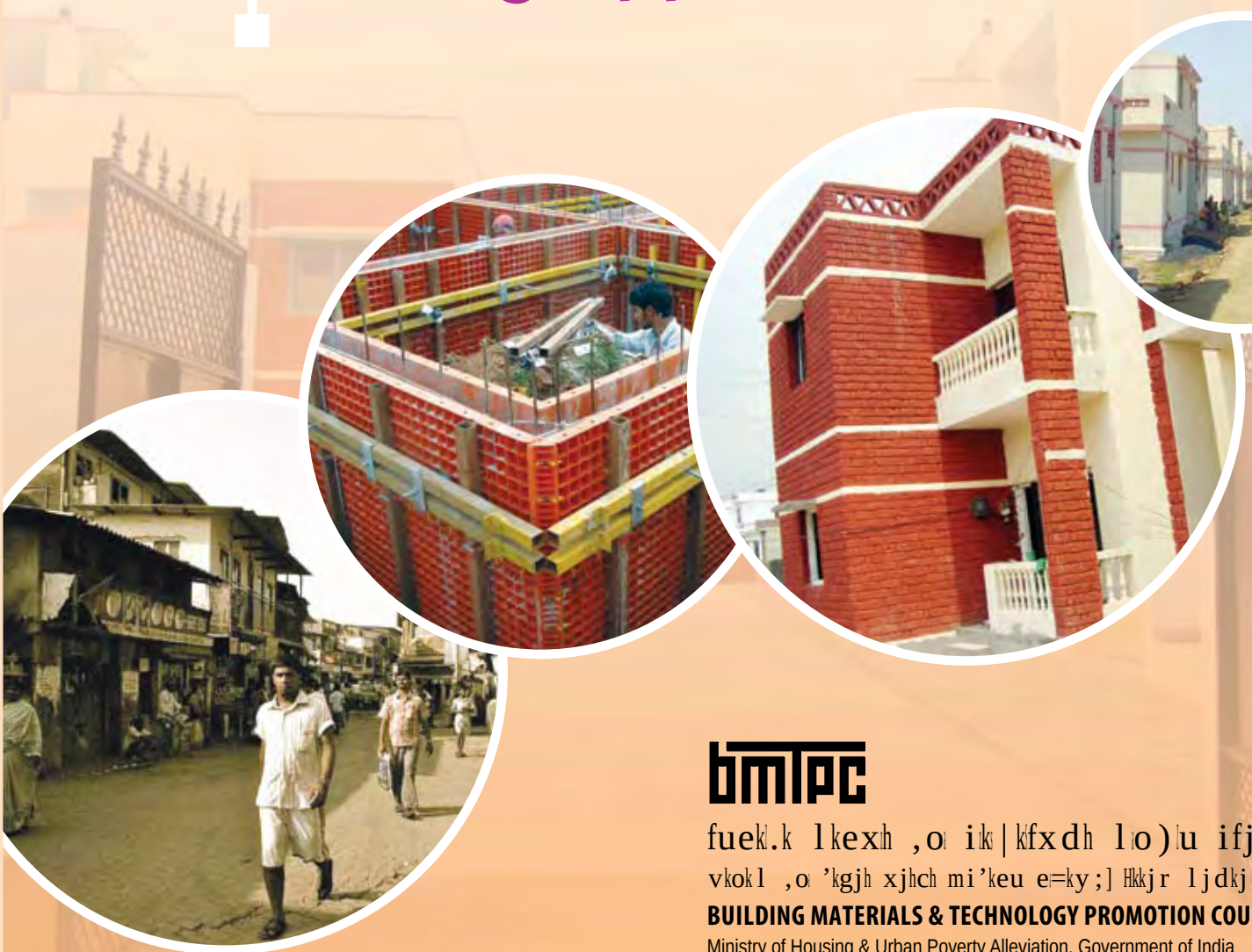
World Habitat Day

1st October, 2012

Changing Cities, Building Opportunities



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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

BMTPC brings out the special issue of its quarterly Newsletter Nirman Sarika to commemorate World Habitat Day every year. The theme for this year chosen by United Nations ***Changing Cities, Building Opportunities*** is fitting in the backdrop of urban migration taking place the world over. Indian cities in particular are undergoing transition and expected to perform effectively so as to keep the aspiration of the people moving into these cities. It is an arduous task; however, Govt. of India has made definitive visible strides towards urban renewal through its mission mode programme Jawaharlal Nehru National Urban Renewal Mission (JNNURM). The mission has two components namely Urban Infrastructure & Governance and Basic Service to Urban Poor. The mission was supposed to end by March, 2012; however, it has been extended till 2014 so as to complete the ongoing works. The mission is reform driven and could help identified Indian cities, small and medium towns in providing better urban infrastructure and service delivery mechanisms, active community participation, and improved accountability of urban local bodies towards citizens. The Government's role as facilitator, enabler instead of provider could ignite the desire of Urban renewal in all the stakeholders and it is believed that the same will continue in years to come and our cities will become better place to live with.

BMTPC within its mandate to bring technological interventions in the housing technologies so as to bring speed, quality, economy and sustainability has successfully identified eight technologies for social mass housing projects. These are technologies which are largely based on precast, prefabricated modular systems and make efficient and optimum use of basic building materials such as cement, aggregates and steel. It is sincerely hoped that with the induction of newer technologies, we would be able to construct faster and reduce the urban housing shortage especially for urban poor. It is good to see the use of technologies such as fast track technologies by state governments for slum renewal projects. Time is ripe, when others especially real estate developers will follow the suit. The technologies also play a vital role in changing the fabric of the city and building opportunities within cities. The Delhi metro in our capital city is the living example.

On this occasion, Let us remind ourselves of our collective responsibility of inclusive and equitable growth of cities where all has right to live and lead a healthy, harmonious and improved life.

(Dr. Shailesh Kr. Agrawal)

BAN KI-MOON
Secretary - General
UNITED NATIONS

Half the world's people now live in towns and cities. In little more than a generation, two-thirds of the global population will be urban. As the proportion of humanity living in the urban environment grows, so too does the need to strengthen the urban focus of our efforts to reduce global poverty and promote sustainable development.

From necessity springs opportunity. Better planned and better functioning cities can help guide us to the future we want: cities where everyone has adequate shelter, water, sanitation, health and other basic services; cities with good education and job prospects; cities with energy-efficient buildings and public transport systems; cities where all feel they belong.

Good practices of managing urban development exist in all regions – and we can learn from the examples they provide. But we are a long way from turning the ideal of sustainable, inclusive cities into reality. Urban areas are responsible for most of our waste and pollution. Many are particularly vulnerable to disasters, including the growing risks associated with climate change. And, while we have achieved the Millennium Development Goal target of significantly improving the lives of at least 100 million slum dwellers 10 years in advance of the 2020 deadline, absolute numbers continue to grow. Nearly a quarter of urban residents – more than 850 million people – live in slums or informal settlements.

Ninety per cent of the world's urban expansion is in the developing world. A sizeable proportion of the inhabitants are young people – by 2030, as many as 60 per cent of all urban dwellers will be under the age of 18. It is essential that these young people have access to decent employment and quality education.

This year's Rio +20 conference on sustainable development recognized the importance of cities to economically, socially and environmentally sustainable societies. It stressed the importance of global partnerships in implementing the Habitat Agenda and highlighted the key role of municipal governments in setting a vision for sustainable cities, from planning new urban areas to revitalizing older cities and neighbourhoods. On this World Habitat Day, let us urgently commit to work together for integrated, holistic management of the urban environment for the benefit of people and the planet.

Message on World Habitat Day 2012

DR. JOAN CLOS
Executive Director, UN-HABITAT

We selected the theme, *Changing cities, building opportunities*, for World Habitat Day this year because our quest to improve cities and provide better services and opportunities for the world's growing urban populations is more urgent than ever.

In little over a generation from now, our projections show that two-thirds of the global population will be living in towns and cities – up from 50 per cent today in the fastest urbanisation ever experienced in history.

If we are not careful, and do not plan for this what will become of our cities, the greatest legacy of our human civilisation?

The main challenges confronting cities and towns all over the world today include unemployment, especially among youth; social and economic inequalities; unsustainable energy consumption patterns; urban sprawl; high percentages of people living in slums; high levels of vulnerability to natural disasters; inadequate urban basic services, especially water, sanitation and energy; poor mobility systems and increasing emissions of greenhouse gases.

Given that, historically, urbanisation has been a source of development rather than a result of it, it is clear that it can be used as a powerful tool for transforming production capacities and income levels in developing countries. This requires a mindset shift on the part of decision makers, away from viewing urbanisation as a problem, and instead towards seeing it as a tool for development.

This was strongly reaffirmed by our partners at the sixth session of the World Urban Forum in Naples last month. And at the 2012 Rio +20 summit in June this year, world leaders formally recognised the "important role" cities play in sustainable development.

They cited the need for a holistic approach to urban development and human settlements which provides for affordable housing and infrastructure and prioritises slum upgrading and urban regeneration. And they further stressed their commitment towards improving the quality of human settlements, so that all people have access to basic services, housing and mobility.

The latest edition of our flagship report, *The State of the World's Cities 2012-2013 – the prosperity of Cities*, we call for new thinking on how we can advance towards the urban future, particularly in seeking for shared and holistic prosperity.

We should create a new type of city – the city of the 21st century – a smart, people-centred city, one that is capable of integrating the tangible and more intangible aspects of prosperity; a city able to rid itself of the inefficient, unsustainable urban habits of the previous century.

It is time for changing our cities and for building new opportunities. The synergies between urbanisation and development should help us to improve the quality of life of millions of citizens. This implies a fundamental paradigm shift and a reappraisal of how we have traditionally conceived urban development. Place matters. We can no longer afford to develop plans and strategies as if location is an irrelevance.

Major changes are necessary. We have the science and the knowhow. And we know too that our ever growing cities are just where the changes can be implemented fastest and new opportunities created. We must all become city changers.

सत्यमेव जयते

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

MESSAGE

As the global urban population has become the larger half of the total, urban landscape across the world has started changing quickly. India with its rapidly growing urban population is not an exception. People from different regions are migrating to cities in search of multi-faceted opportunities. The exponentially growing mass movement towards urban areas puts further stress on our limited resources to support quality urban life. The hurried demographic growth in and around the urban areas is leading to transformation in the physical dimensions of the cities alongside population density, land uses, spatial structure and thus changing the pattern of urban habitat. One of the ideas to celebrate World Habitat Day is to be reminiscent of collective responsibility of the community for the future of human habitat. The theme of 2012, "Changing Cities, Building Opportunities" is relevant from the perspective of emphasizing the requirements of apposite urban planning to prevent disorganized development, growth of urban sprawl etc. and thus calls for an integrated approach for inclusive planning of our cities.

Government of India has taken several steps to work towards an urban India which acts as an engine of growth and inclusion; where the common citizen, especially the poor and marginalised, will have access to decent shelter, basic amenities, livelihoods and above all, a voice in governance. The flagship programme of the Government, Jawaharlal Nehru National Urban Renewal Mission (JNNURM), launched in 2005, aims towards this goal. A new scheme, Rajiv Awas Yojna, launched in June 2011, has a vision of 'Slum free India". Swarna Jayanti Shahari Rozgar Yojana (SJSRY), Integrated Low Cost Sanitation (ILCS) Scheme, Affordable Housing in Partnership and Interest Subsidy Scheme for Housing the Urban Poor are other programmes which seek to provide opportunities to improve the cities.

Building Materials & Technology Promotion Council (BMTPC) has to play a pro-active role in introducing environment friendly, cost effective, energy intensive and fast track technologies in construction of urban neighbourhood. I hope 'Nirman Sarika" being published on the occasion of World Habitat Day 2012, brings out various related issues for wider dissemination of the subject. I extend my best wishes to BMTPC for their effort.

(Kumari Selja)

सत्यमेव जयते

ARUN KUMAR MISRA
Secretary
Ministry of Housing and Urban Poverty Alleviation
Government of India

MESSAGE

It is befitting that United Nation has chosen "Changing Cities, Better Opportunities" as the theme for the World Habitat Day celebration this year. This reminds the world, specially developing countries like India, the need to ponder upon the changing scenario of the cities, considered as engine of growth, to review/initiate measures to create necessary infrastructure and facilities, where present and future generation with diverse social and language background can have proper shelter with adequate provisions of services such as health, education, water supply, sanitation, social protection and employment.

Changing Cities are reservoirs of capital and skill. They are the source of diverse employment opportunities-formal and informal. They are also the centres of productivity and innovation. Cities act as the generators of public finance resources, so essential for national development, including rural development. They act as catalysts of social change and cultural transformation. Cities remain in the forefront of civilization.

Due to increasing urbanization Indian cities are fast growing. As per the provisional population data of Census 2011, for the first time since independence, the absolute increase in population is more in urban areas than in rural areas. With 377 million urban population (31.16% of total), level of urbanization in the country has increased from 27.81% in 2001 to 31.16% in 2011 census, and is likely to increase further.

Migration, natural increase and addition of new areas in urban areas are the main causes of population growth in urban areas. The cities are thrown to new challenges to tackle with increased slum development, inhabitation in areas vulnerable to natural disasters, inadequacy of water supply and sanitation system, clogged transportation network, overcrowded housing, inadequacy of health and education facilities, increased solid wastes, high energy demand and social gaps leading to crime. All these call for inclusive planning of the cities, where everyone, regardless of their economic means, gender, race, ethnicity or religion, is enabled and empowered to fully participate in the social, economic and political opportunities that city has to offer.

Ministry of Housing and Urban Poverty Alleviation, through Jawaharlal Nehru National Urban Renewal Mission and Rajiv Awas Yojana, aims for an integrated approach for slum upgradation to bring urban poor to mainstream of the society. Building Materials & Technology Promotion Council, with proactive actions, can help introducing construction materials and technologies, which are cost effective, energy efficient, disaster resistant and fast track, in this time bound slum upgradation programme.

I am happy that BMTPC is bringing out a Special Issue of its Newsletter "Nirman Sarika" on the occasion of the World Habitat Day focussing on the theme – Changing Cities, Building Opportunities, to create awareness among various stakeholders.

My best wishes to BMTPC in their efforts to promote the alternative technologies and for the success of the publication.

(Arun Kumar Misra)

सत्यमेव जयते

DR. P.K.MOHANTY
Addl. Secretary & Mission Director (JNNURM)
Ministry of Housing and Urban Poverty Alleviation
Government of India

MESSAGE

The UN-HABITAT has chosen the theme "Changing Cities, Building Opportunities" for this year's World Habitat Day to ponder on the state of our towns and cities, and the basic right of all to adequate shelter and also to remind us of our collective responsibility for the future of the human habitat.

Cities are already overwhelmed by the number and complexity of services they need to provide. On top of this, tens of thousands of new residents arrive every day straining urban infrastructure through their additional requirements of housing and basic services. Adding climate change and disaster risk to the challenges cities are already facing is an enormous burden.

Half of the global population currently lives in cities; a proportion that will rise to 70% in less than 40 years. As cities now account for roughly 60% to 80% of global greenhouse gas emissions, their combined action is critical to the world's response to climate change. Cities have to be mobilized to take the lead, not only in reducing the effects of climate change but in creating genuinely sustainable patterns of economic growth and habitat development.

To make our cities better and liveable, some of the critical issues and challenges need to be addressed and strategies devised accordingly. Foremost amongst them is the formulation of a city vision based on economic, social, environmental and culturally sensitive policies that allow everyone to improve economically as the physical infrastructure improves.

In order to turn the inclusive city vision into reality, good urban governance with professionalism is perhaps the single most important factor that can transform cities into vibrant economic, social and cultural centres without marginalising vast segments of the population. In addition, appropriate land use policy covering mixed land use and environmentally sound land use zoning at local level needs to be adopted for better city planning. There is also a critical need to create affordable, accessible and quality housing in all parts of the city.

The task ahead for city governments is not just to provide a roof over the heads of the urban poor, but also to significantly improve the quality of housing made available to the urban poor, providing privacy for women and better amenities to ensure sustainable human settlements development.

BMTPC has been playing important role in the promotion and adoption of cost effective, green and safe housing technologies, capacity building and awareness generation throughout the country.

I am happy to learn that BMTPC is bringing out special issue of Nirman Sarika on the occasion of World Habitat Day highlighting important issues related to the theme.

I wish BMTPC all the success in their continued efforts.

(Dr. P.K. Mohanty)

Changing Cities, Building Opportunities

*Dr.M.L.Khurana**

City is referred to certain urban communities by virtue of some legal or conventional distinction. It also points towards what we call an 'urban community' whose generic culture is often called 'urbanism'. In legal terms, in the United States, for example, a city is an urban area incorporated by special or general act of a state legislature. In Australia and Canada, city is a term applied to the larger units of municipal Government under state and provincial authority respectively.

As a type of community, the city may be regarded as a relatively permanent concentration of population, together with its diverse habitations, social arrangements and supporting activities; and having a cultural importance that differentiates it from other types of human settlement and association.

City is a dynamic entity in itself. In 1900, cities were home to just 9% of the world's population. Now a century later, more than half of it lives in cities. If the present trend continues, by 2025 cities will be home to two thirds of humanity. To study a city is essential because city is a uniquely powerful form of human settlement. For centuries, the cities have been the heart, the lifeblood of various civilizations – the centre of economic, political and artistic events. Today cities are so much a part of our lives that they seem both natural and inevitable. In the larger perspective, cities are not a very new idea. Cities began to appear about 10,000 years ago.

Historical View

There is enough historical evidence to show that human settlements are found in rich tropical areas of the Indus, Nile, the Euphrates, the Tigris and the Yellow River. The obvious reasons were, favourable environmental factors, adequate water supply, ready materials for providing shelter and easy access to other people. Gradually these fertile tropical areas were used to raise their own food. This domestication of plants, or agricultural revolution is the single most important event in human history.

Over a period of some 5000 years, villages evolved and multiplied since then. Permanent settlements mushroomed where they raised crops and learned to domesticate animals for use in the fields or as a food supply. Permanent settlements also transformed patterns of social structure. These settlements were characterized by a complex pattern of division of labour. This was a radical shift from the social structure that prevailed earlier; it forced people to specialize in specific tasks. It afforded people the opportunity to specialize not just in food production, but in religion, military affairs, trade etc. The process of specialization benefited everyone; the farmer gained the protection of the military and the value of the priest's greater insight into religious matters, while the priest and the soldier received the fruits of the farmers labour.

By 3500 BC urban population came to be distinguished by literacy, technological progress (in metal), social controls, political organizations etc. It was thus the first urban revolution. These urban settlements multiplied and their populations grew to sizes. The city's positive attributes and its ability to increase peoples' standard of living resulted in migration of diverse groups to one centre. Also the cities were continually renewed with inventions, innovations and new ideas supplied by trade and people of different backgrounds. All the early cities

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

सत्यमेव जयते

SUSHEEL KUMAR
Joint Secretary (Housing)
Ministry of Housing and Urban Poverty Alleviation
Government of India

MESSAGE

Cities have been considered as significant centres of productive activity and economic growth. They also play vital role towards social development and are recognized as important contributor towards the socio-economic development of a nation. Cities, particularly bigger ones, attract wider cross-section of population through internal migration due to availability of the range of basic services such as potable water, sanitation, education, health and housing, employment, infrastructure etc.

Indiscriminate urbanization has negative effects on the quality of environment and on the sustainability of the social and economic progress achieved. Intensive human activities in the cities put pressure on local land use thereby having varying degree of impacts on environment, ecology and climate change. Natural disasters like earthquake, floods, drought, cyclone etc. also have wide implications on the city's dynamism and configuration of human settlements. Cities are generally not self-supportive in terms of natural resources and raw materials such as energy, food, water and other inputs for the sustenance of inhabitants. In view of the fast changing scenario, the theme **Changing Cities, Building Opportunities** chosen by United Nations for World Habitat Day 2012 celebrations is the most appropriate one.

As cities are the engines of growth, there is a need to plan our cities with an inclusive agenda in such a way that all city dwellers whether rich or poor are enabled and empowered to fully participate in the social, economic and political opportunities that cities have to offer.

I am aware that the BMTPC is playing a major role in the development of well planned, socially secure and green cities through propagation of cost-effective building materials and technologies and as an appraisal and monitoring agency for JNNURM and RAY prograrmnes of Ministry of Housing and Urban Poverty Alleviation, Government of India. Over the years, Council has played an important role in realizing the dream enshrined in the National Housing and Habitat Policy 2007 for providing affordable housing for all.

I am sure that the publication of Special Issue of Nirman Sarika of the Council, brought out on the occasion of World Habitat Day 2012 would go a long way in sharing the experiences and disseminating the knowledge to the masses.

I wish all the success to BMTPC in its future endeavours.

(Susheel Kumar)

were characterized by certain combinations of favourable ecological conditions, some sort of trade or food surplus and a complex social structure.

The early cities did not show any smooth progression of growth. There was discontinuity and change, rise and fall. Secondly, they were only 10,000 people strong and even the largest settlements never went much beyond the quarter-million mark. Third, regarding the power structure, many early cities had a theocratic character – a fused religious and political elite in which kings were also priests. Everywhere the first cities were characterized by inequalities in power and benefits.

With the development of urban trade and craft during 5th to 11th Centuries cities became the stepping stones. The emergence of a complex and competitive commercial class at the centre of the on-going trade dominated from the 11th Century onward by craft guilds, contributed to a newly vibrant city life.

The period from the 12th Century until about the 16th Century was a period of general urban rebirth or renaissance. It was during this stage that the city gradually captured interest in art, literature and architecture.

Urban Revolution: Rise of Modern Cities

Cities were rapidly gaining prominence. Commerce began to replace agriculture and a new middle class began to rise to power. This class – the capitalist, was composed of shopkeepers, traders and manufacturers. The government officials and people got engaged in commercial ventures. As wealth increased in the cities, they began to attract more people. By the mid 17th Century, capitalism was making its mark. Around the beginning of the 18th Century, the industrial revolution had begun. Consequently, city's population witnessed exponential growth. With the urban population enjoying more wealth, more efficient means of production and better health and sanitation conditions both migration and natural population growth were high. This influx, coupled with technological improvement and advances in health and sanitation services, created what is known as demographic transitions. De-population of rural areas as people moved to cities, many abandoning their farms in search of white collared jobs in cities also took place. These migratory trends have now gained so much prominence that it is the central concern of demographers.

Migration and its reasons

Migration has been taking place since time immemorial for various reasons. Industrialization and its effect have only accelerated the pace and intensity of migration. Migration is not only concentrated to certain regions, but is part of global trend of people moving from villages to towns and cities. It is part of international migration – people seeking a better life in other countries both in the north and in the south. It is very difficult to stop the flow of people into towns and cities. According to the International Organization for Migration (IOM), migration is considered one of the defining global trends of the early 21st Century with more and more people on the move today than at any other time in history. According to latest UN research, the total number of international migrants has increased over the last 10 years from an estimated 150 million in 2000 to 214 million persons today.

However, the percentage of migrants varies greatly from country to country. Countries with a high percentage of migrants include Qatar (87 per cent), United Arab Emirates (70 per cent), Jordan (46 per cent), Singapore (41 per cent), and Saudi Arabia (28 per cent). Asian countries are experiencing an explosion of rural to urban migration. Unemployment and agricultural interruption are push factors, the lure for better life and more money are pull factors. This is probably associated with the rapid industrialization that has occurred during the last few decades.

In India, industrialization has widened the gap between rural and urban areas, prompting the workforce to move to industrial areas. In developing countries such as ours, the workforce shift has been dominated by the expansion of the informal sector. Seasonal workers are mostly absorbed into the informal sector. Studies have shown that migration is an important economic strategy for poor households in several regions of India. The National Commission of Rural Labour concluded that uneven development was the root cause of seasonal migrants. Workers could be locked into a debt-migration cycle where earnings from migration are used to repay debts at home which in turn make migration an economic necessity. In 1991, 39 million people migrated in rural-urban patterns of which 54% were female.

City's Response to its Migrants

Cities are the destinations for people escaping poverty, conflict,

human rights violations, or simply those looking for a change, for something better. A city is a provider of services to its citizens, which can be measured by the quality of its services (access to telephone services, water, sewerage or electricity); the reliability of such services over time (as measured by the quality of infrastructure services) and the degree to which a city involves its citizens in decision making; is responsive to their demands, and is well governed in general.

Cities are hubs of national production and consumption, are centres of economic and social progress and generate wealth and opportunity. People come to cities with hope and expectations and a desire to earn a better life. But to what extent, do the cities or the urban centres prove to be centres of development and hope. The large influx of population that enters the city has direct or indirect impact on the infrastructure. The progressive degeneration of urban infrastructure, questions the fundamentals of the urban development concept. The Indian Infrastructure Report 2011, by Infrastructure Development and Finance Company Ltd., which focuses on India's water future especially in cities. The report states that in case of India, along with rapid and constant economic growth, one should expect a concomitant rise in investment and fast improvement of urban infrastructure. However, this does not seem to be the case. Despite an aggregate which indicates that urban India will achieve the MDG, the story is less rosy if one looks at the percentage of households with a house connection. As argued by Mehta and Mehta (2010) in their assessment of the JNNURM programme, the decline in the percentage of in-house connections from 52 to 48 per cent in the last 20 years demonstrates the weak link between higher investment in infrastructure and better services for all.

One of the many startling features of migration for urbanization on which several debates have been launched is that most Indian cities are manifestations of unplanned growth and are managing more number of inhabitants than they can sustain. This results in congestion, noise, traffic jams, air pollution and major shortages of key necessities. Every major city in India faces the same proliferating problems of grossly inadequate housing, transportation, sewage, electric power, water supplies, schools and hospitals. In such a situation, the migrant population adds to the burden of the cities. The foremost thing that a migrant looks for when he comes to the city is an affordable shelter and followed by employment opportunity; they are exposed to large uncertainties whether it is the job or the dwelling place. Most of them land in slums or makeshift shelters that promise no services be it the basic necessities of water or electricity or security of tenure or health service.

To add to their woes, the decentralized Government frameworks as in our country, local authorities have to cope with migrants and their problems. Lack of coordination among the many layers of Government in a city or metropolitan is the norm adding to their limited capacity to manage migration.

The growing migrants and the issues of urban segregation and poverty pose a fresh challenge to local authorities.

But this trend of migration cannot be curbed or controlled and will continue at its pace. The best possible option we have today is to manage migration. There are a few things which can be done to make our urban centres sustainable and also centre of development and hope.

- Cities should be made friendlier to newcomers. The private, public and cooperative sectors should work hand in hand to make provisions for the migrants. As said earlier that housing is the foremost necessity for a migrant who comes to a new city. Provision of a secure dwelling place at affordable rate would give a sense of security and would also check the growth of slums and shanty dwelling places. Housing cooperatives, being member centered and member driven organizations provide affordable houses to its members with a clean and healthy environment. Housing cooperatives also build rental housing units and thus add to the national housing stock. Housing cooperatives should be promoted in order to attend to the problem of housing shortage and slums improvement that our country is facing today.

- Developing rural hinterlands and providing them the facilities that are available to urban centres. This in a way to some extent would bring down the migration rates.

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New Generation Environment-Friendly Building Materials

*Dr.Shailesh Kr.Agrawal**

Prologue

Due to rapid mechanisation the world over, the onus has shifted to urban cities. The increasing pressure on cities due to mass exodus of rural people for want of better opportunities, avenues has rendered these cities short of even basic amenities what to talk about housing and infrastructure. The introspection would lead to the conclusion that it resulted because we could not handle the natural resources judiciously while developing our built environment. The Indian cities comprise on one hand typically multi-storeyed buildings and huge infrastructure made up of high performance materials such as cement and steel and on other hand cluster of squatter settlements, slums made up of mud, grass, wooden planks and twisted tin sheets with dingy roads, no access to water, open defecation, no electricity and so on and so forth. The only way to get rid of this situation is to make houses for slum dwellers with basic services and requisite infrastructure. The housing shortage in urban sector is increasing exponentially and it cannot be replenished until we resort to environment friendly building materials. The environment friendly building materials and construction technologies leading towards sustainable development is a broad term which includes not only aspects related with housing and infrastructure but also issues related with environment, green house gases, natural resources, eco friendly technologies, hazard resistance, site planning, water conservation, waste management, energy efficiency. To elaborate all the aspects of sustainability are not possible in this article, however, building materials and construction technologies which form the major integral part of any construction activity are being discussed herein so as to achieve overall sustainability.

Building Materials Revisited

The availability of building materials for the construction industry in particular the housing sector has been dismal. In order to meet the housing shortage of about 26.53 million at the end of 11th five year plan, all core materials such as cement, steel, bricks, timber and aggregates register a major shortfall at present rate of supply. The most commonly used building materials for construction are stone, timber, stone aggregates, brick, cement, steel, glass, plastics, ceramics, aluminium etc. All these materials depend directly or indirectly, on a finite natural resource base which is fast depleting putting the demand and supply of materials on an imbalance.

The direct consequence of an increased demand would be the increasing price due to shortage of supply, leading to the increased cost of housing. The indirect consequence would be rapid and irrationally managed utilization of finite natural resources. Enhanced use of top fertile soil, use of timber for firing bricks, lime quarrying, surface working in stone belts etc. are some possible manifestations leading towards environmental degradation.

On the other hand, factory made materials such as cement, steel, aluminium etc. call for high energy inputs in an already power starved economy. Greater demand would also be made on the transport networks for the purpose of transporting raw materials and finished products, thus enhancing the cost of a unit of output. Thus, enhancing supply of these conventional materials would not always be feasible nor recommendable under these circumstances.

So the options are (a) to promote alternative building materials

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which have raw materials resource bases related to waste products of other common technologies. (b) Use of alternative construction technologies using the existing materials with a view to a more efficient use. These options have prompted the professionals the world over to rethink and change the prevalent practices of the construction industry.

Need for Alternatives

There has not been any perceptible need to use alternate materials and sustainable technologies by Indian construction Industry. The building centre scheme to transfer these technologies and local materials at the grass root level could attain limited success. Over and above, on account of, ever increasing land prices and improper delivery mechanisms, it has been stated repeatedly that the alternate materials and cost effective technologies by themselves have not been accepted.

There is general impression amongst professionals that these technologies are perhaps not as cost effective as they claim to be. There is also the question of their durability, functional performance, capabilities, both structural and climatic, and finally their life cycle cost in terms of maintenance and repair. Finally, there is question as to why it has not found wide application if they are cost effective.

Therefore, there is need to distinctly identify the sustainable building materials and alternative construction technologies which are cost effective, energy efficient and eco friendly so as to optimise the cost of construction.

Sustainable Building Materials

There has been unprecedented upsurge in construction industry all over Indian cities turning them into concrete jungles and moreover depleting the precious natural resources. The construction industry mainly uses conventional building materials i.e. cement, steel, brick, wood etc. which are highly energy intensive materials. Their production leads to irreversible & irreparable environmental impact. Therefore, sustainable building materials are the only alternative, if we wish to plan for urban future. Let me define sustainable materials as those which are eco friendly causing least possible damage to the environment. Also, these are materials which have lesser effect on human health and the environment when compared with conventional materials such as cement, steel etc. that serve the same purpose. It is not that only building materials can be sustainable, we may have sustainable technologies also which make use of conventional materials using eco friendly techniques.

Properties of Sustainable Building Materials

Any material or technologies qualifies to be sustainable, if it is based on the following

Renewable Source

The natural resources which are rapidly renewable such as bamboo, wood from certified forest.

Reuse of Waste Product

The conversion of agricultural, industrial waste into useful building materials or any value added product is the clarion call and is the way to achieve sustainability. The use of salvaged products such as used steel, tins, old plumbing materials, door & window frames, construction & demolition frames to produce materials is also underway and add to sustainability. Recycled contents of agriculture/ industrial waste to produce materials such as rick husk ash blocks, bagasse boards etc. are eco friendly materials.

Embodied Energy

While using the materials, one should bear into the mind the energy required to produce that material. For example, brunt bricks require huge stock of fossil fuel. Another dimension to energy is transportation. The transportation cost to bring the product to the construction site should not be high.

Local Availability

Take cue from our rural technologies, they always used the local materials such as mud, stone, thatch, straw to make buildings. The materials not available locally, the transportation cost may form the significant part of embodied energy. For example, cement and steel, they are always transported from far flung places.

Reduction in air, land and water pollution

The material should be such that its production should cause minimum pollution to air, water and land. For example, use of materials with low Volatile Organic Compounds (VOCs) emissions such as cement, paints cause little air pollution.

Materials should prevent leaching. Leaching is an environmental concern when it contributes to groundwater contamination. To avoid land pollution, materials that reuse waste that would otherwise

resulted into hazardous waste dumps and landfills such as fly ash bricks, recycled aggregates, red mud bricks etc.

Durability and life span

Life cycle cost of materials is of paramount importance while planning materials for urban future. Materials that are exceptionally durable or require low maintenance are to be preferred such as PVC pipers over GI pipes.

Reduce Material Use

There is inclination towards technologies which minimise the use of conventional materials in construction. These technologies are not only energy efficient but also help in reduction of dead load of buildings such as ferro cement, mortar less masonry, fibre cement boards fixed with light gauge steel studs and light weight concrete etc.

Energy Efficiency

There has been lot of work being done all over the world to come out with green technologies. Building materials and components which require less energy during construction e.g. pressed blocks and bricks, precast slabs; materials that help reduce the cooling loads such as aerated concrete blocks, hollow bricks; products that conserve energy like solar heating, CFL; fixtures and equipments which conserve water like dual flush cisterns are the materials and technologies to look for.

Biodegradability

Concrete, steel and other conventional building materials do not decompose and huge chunk of construction & demolition waste is being created which is often seen in the outskirts of the city. The building Materials which decompose easily are to be preferred such as wood or earthen materials.

Reuse/Recycle

Any material which can be reused or recycled is sustainable such as use of recycled steel, aluminium is now more common than before.

Conventional Future Materials

Based on the above discussion, here is list of conventional building materials which are future material for planning sustainable habitat:

1. Bamboo, Bamboo Based Particle Board & Ply Board, Bamboo Matting
2. Sun dried Bricks
3. Precast cement concrete blocks, lintels, slab. Structural and non-structural modular elements
4. Calcined Phospho-Gypsum Wall Panels
5. Calcium silicate boards and Tiles
6. Cellular Light Weight Concrete Blocks
7. Cement Paint
8. Clay roofing tiles
9. Water, polyurethane and acrylic based chemical admixtures for corrosion removal, rust prevention, water proofing
10. Epoxy Resin System, Flooring, sealants, adhesives and admixtures
11. Ferro-cement boards for door and window shutters
12. Ferro-cement Roofing Channels
13. Fly-ash Sand Lime Bricks and Paver Blocks
14. Gypsum Board, Tiles, Plaster, Blocks, gypsum plaster fibre jute/sisal and glass fibre composites
15. Laminated Wood Plastic Components
16. Marble Mosaic Tiles
17. MDF Boards and Mouldings
18. Micro Concrete Roofing Tiles
19. Particle Boards
20. Polymerised water proof compound
21. Portland Pozzolana Cement Flyash / Calcined Clay Based / Portland Slag Cement
22. RCC Door Frames
23. Ready Mix Cement Concrete
24. Rubber Wood Finger Jointed Board
25. Stone dust

Potential Materials & Techniques for Future

The potential sustainable materials & techniques which are cost effective, energy efficient and eco friendly (CEEF) developed over the years by putting concerted R & D efforts by research laboratories and a few successfully transferred by BMTPC to the field are as follows:

1. Bagasse Board
2. Bricks from Coal Washery Rejects
3. Building Blocks From Mine Waste
4. Burnt Clay FlyAsh Bricks
5. Coir Cement Board
6. Compressed Earth Blocks
7. EPS Composites and Door Shutters
8. Fibre Flyash Cement Boards
9. Fibre Reinforced Concrete Precast Elements, Wall panels, Blocks, Manhole Covers
10. Fibrous Gypsum Plaster Boards
11. Flyash Cellular Concrete, Flyash Cement Brick, Blocks
12. Flyash Lime Cellular Concrete
13. Flyash Lime Gypsum Brick
14. Insulating Bricks from Rice Husk Ash
15. Jute Fibre Polyester

16.Non Erodable Mud Plaster
17.Polytiles
18.Timber from trees such as Poplar, Rubber, Eucalyptus
19.Precast walling roofing components
20.Prefab Brick Panel System

Suggestions for Sustainable Eco Friendly & Energy Efficient Building Materials

Any planning for urban future entails large scale adoption of environmentally sustainable construction in the peri-urban areas so as to arrest the adverse environmental impact of mind boggling construction and infrastructural growth. The most common materials used for construction of a building are cement, steel, bricks, blocks, sand, aggregates, sanitary & drainage, plumbing pipes, wooden window, door frame and shutters, paints, water proofing compound etc. Here are a few suggestions as regards efficient building materials which are to be considered before using any conventional material. This would provide a meaningful differentiation and edge over the conventional thinking as regards impact on environment is considered.

1. Base material for construction: Reinforced Cement Concrete

Replace Ordinary Portland cement with Blended Portland Cement (BPC)

In order to reuse / recycle waste product and prevent landfills, it is strongly recommended that 25% Pozzolana material blended Portland cement is to be used. The Pozzolana material content (flyash/slag/Calcined clay) can be attained through use of blended Portland cement as per IS1489, IS455 & IS3812.

Further, it is suggested to add pozzolana material content in BPC to 30-35% by direct addition of raw pozzolana materials i.e. slag, calcined clay or flyash.

Replace natural sand and aggregates with manufactured ones

The constituent part of concrete is aggregates i.e. sand and coarse aggregates. There has been dearth of natural resources of aggregates due to environmental degradation and therefore, use of sand and aggregates from pulverized debris and/or sintered flyash is better viable option for sustainable development. The Indian standard IS3833 dwells upon equivalent to coarse and fine aggregates from natural sources.

Replace steel with Recycled Steel

Use of recycled steel forms and bars for reinforcement in RCC is to be encouraged. The IS432, IS1785, IS1786 gives requirements of steel reinforcement bars whereas IS961 is for high tensile structural steel.

Indian standards are being referred here just to stress a point that use of these materials does not violate the code requirements and the structures are as good as conventional ones using these materials in RCC.

2. Alternative Structural Systems

The traditional structural systems are mainly comprises either of load bearing walls made up of bricks, blocks or RCC column-beam framed structure with brick or blocks walls as infill. These systems are being replaced by alternate systems in order to achieve economy, speed and quality. A future would be of precast factory made building components for walls, roofs, columns, beams, staircases, lofts, balconies, and slabs. Some options for precast components being practiced successfully in the field are precast RC lintels, precast RC staircase components, RC planck and joist systems, waffle units, ribbed slabs and RC channel units, brick panel & cored units for roofs, RC L-panels to replace tiles and sheets for pitched roofs. Ferro cement, light weight concrete, fibre cement boards fixed with light gauge steel studs, load bearing panels from Phospho-Gypsum and other waste stiffened with steel stiffeners and filled with concrete are a few emerging and must technologies for sustainability. The cement used for these technologies must be blended Portland cement or ordinary Portland cement blended with raw pozzolana materials and reinforcement steel should be recycled steel.

Use of ready mix concrete and resinous curing agent instead of water is to be encouraged for mega projects. The basic intent is to use lesser quantities of material and to reduce site wastages, thus reducing the amount of resource extraction.

3. Masonry

To proscribe topsoil denudation and minimise use of fossil fuels as a result of burnt clay bricks, it is must to use bricks/blocks made from the following materials individually or in combination:

- Flyash + sand + lime bricks/ blocks (IS4139)
- Pulverized debris + Cement bricks/blocks
- Red mud, Industrial waste based bricks/blocks
- Aerated Lightweight blended

Portland cement based concrete blocks (IS2185)
- Phospho-gypsum based blocks (IS12679)
- Laterite + Cement blocks (IS12440)
- Solid or hollow concrete blocks using artificial lightweight aggregates

4. Mortar

The mortar comprises of cement and sand. Both are dependent upon natural resources and energy intensive materials. In order to obviate dredging of water bodies for sand, depletion of natural resources and precious sources for energy for making cement and to reuse waste materials, Replace cement with 25% pozzolana material blended Portland Cement and further use of pozzolana material up to 30-50% by direct addition of raw pozzolana material such as Calcined clay, slag or flyash. Replace sand with sand from pulverized debris and / or sintered flyash.

5. Plastering

The alternative plasters which are recommended for eco-friendly construction are calcium silicate plaster, fibre reinforced clay plaster, Phospho-gypsum plaster, non-erodable mud plaster. Use of resinous curing agent instead of water is further suggested.

6. Roofing & Ceiling

Use of energy efficient building materials and materials from renewable sources for roofing and ceiling is the future. Replace AC sheet, CGI sheets with micro-concrete roofing tiles or bamboo mat corrugated sheets. The conventional roofing of PVC, Foam PVC, Polycarbonates, Acrylics ought to be replaced with Fibre Reinforced Polymers (FRP) which is eco-friendly material.

7. Flooring, Paving and Road Work

To reuse/recycle waste products as building materials and to use energy efficient building materials, here are options:
- Flyash/industrial waste/pulverised debris blocks in Blended Portland Cement and/or lime-pozzolana concrete paving blocks (IS10359) for all outdoor paving (IS7245)
- Bedding sand for pavement and outdoor hard surfaces has to be from pulverised debris
- Terrazzo floor for terraces and semi covered areas (IS2114)
- Use ceramic tiles non-vitrified (IS13712)/ Mosaic tiles/ Terrazzo flooring (IS2114)/ Cement tiles (IS1237, 3801)/ Phospho-Gypsum tiles (IS12679)/ Bamboo board flooring, individually or in combination for interior spaces

8. Windows, Doors and openings

To use lesser quantities of material and to reduce site wastages, thus reducing the amount of resource extraction, the proposed alternatives are:
- Ferro cement and Precast R.C.C. lintel (IS9893), chajja and jalis instead of RCC
- Masonry bond combinations for jali work (achievable in rat trap bond)

9. Timber and Aluminum / Steel frames

To use lesser quantities of material, to reduce site wastages and to recycle waste products and prevent landfills, the timber and metal frames are to be replaced by
- Ferrocement and Precast R.C.C. frames (IS6523)/ frameless doors (IS15345) and/or Bamboo Reinforced Concrete Frames
- Hollow recycled steel channels (IS1038,7452) and recycled Aluminium Channels (IS1948) and Components

Timber if used for Shutter and Panels must be renewable timber from plantations with species having not more than 10 year cycle or timber from a government certified forest/ plantation or timber from salvaged wood.

10. Shutters and Panels

The shutters and panels made up of timber, plywood, glass, and aluminum, the use of following alternatives so as to protect rainforest from excessive logging, and to reuse waste as building products is suggested.
- Use of MDF Board (IS12406)
- Use any of the following individually or in combination - Red Mud based composite door shutters, Laminated Hollow Composite Shutters, Fibre Reinforced Polymer Board, Coir Composite Board (Medium Density IS 15491), Bamboo Mat Board (IS13958), Bamboo mat Veneer Composite (IS 14588), Bagasse Board, Finger Jointed Plantation Board, Recycled Laminated Tube Board and Aluminium Foil+Paper+Plastic Composite Board
- Use PVC/ FRP Doors (IS14856)/ poly carbonate and/or recycled aluminum components in wet areas.

11. Electrical

To use energy efficient products and products having higher recycling properties (un- plasticised PVC) and to use recycled products of non-biodegradable components,

the few suggestions for eco friendly electrical fittings are

- Use un plasticised PVC or HDPE products instead of aluminum, brass, PVC, G.I.,
- Use products with recycled aluminum and brass components

12. Water supply, sanitary and plumbing system

To prevent lead and asbestos contamination of water, to use energy efficient products and products having higher recycling properties (un-plasticised PVC) and to use recycled products of non-biodegradable components, replace the conventional systems with the following:

- Use R.C.C., un-plasticised PVC (IS15328), G.I., C.I. pipes instead of lead, A.C. pipes.
- Where applicable use products with recycled aluminum and brass components for fittings, fixtures and accessories
- Use Polymer Plastic (Random) (ISO EN 15874) hot/ cold water system instead of G.I.
- Manholes and covers - use precast cement concrete and high strength un- plasticised PVC instead of C.I. (IS12592)

13. Wood Work

Timber used must be renewable timber from plantations with species having not more than 10 year cycle or timber from a government certified forest/ plantation or timber from salvaged wood. If Plywood is used, it should be phenol bonded and not urea bonded. The basic intent is to protect rainforest from excessive logging, to use renewable resources and wood substitutes made from waste products and to use chemicals with low VOC emissions. Instead of plywood and natural timber, use the following alternatives

- Use of MDF Board (IS12406)
- Use any of the following individually or in combination - Bamboo Ply/ Mat Board (IS 13958), Fibre Reinforced Polymer Board, Bagasse Board, Coir Composite Board (Medium Density IS 15491), Bamboo mat Veneer Composite (IS 14588), Finger Jointed Plantation Timber Board, Recycled Laminated Tube Board and Aluminium-Foil+Paper+Plastic Composite Board
- Use of Mica Laminates and Veneer on composite boards instead of natural timber

14. Water proofing chemicals, additives, sealants and adhesives

The use of water based chemicals instead of solvent based and use Epoxy resins instead of tar felt/ pitch is recommended.

15. Painting, polishing, priming and similar surface finishing

The use of Cement Paint (IS5410)/ Epoxy Resin Paint for external surfaces and use of Water based paints, enamels, primers and polishes is advised with the intent to use efficient building materials and chemical with low VOC emissions.

Epilogue

Building materials constitutes 60-70% of the house construction cost in general. Any judicious use of materials will go a long way in cutting down the overall construction costs, achieving energy efficiency and eco-friendliness which are most essential and integral part of sustainable urban habitat. The increased back log of housing in urban areas coupled with limited resources available, it is high time to have a closer look at the performance of conventional usage of materials as well as newer materials and alternative technologies. There is need to sensitize the individuals regarding various alternate options available with their merits and demerits. The mindsets of professionals, public and private construction agencies need to be changed so that the myths related with alternative technologies can be dispelled. It is a wakeup call for all of us to understand that the any construction activity taken today will not be appropriate unless it takes into account environmental aspects, sustainability issues, eco-friendliness in to account.

References

1. *Building Materials in India: 50 Years, A commemorative Volume*, BMTPC, 1998
2. *Low Cost Housing & Infrastructure*, Indian National Academy of Engineering & BMTPC, New Delhi, 28-30 March, 1994
3. Jagadish K.S., Reddy Venkatarama B.V. & Rao Nanjunda K.S. *Alternative Building Materials & Technologies*, New Age International (P) Limited, 2007
4. *Eco Housing Assessment Criteria*, International Institute for Energy Conservation, Mumbai
5. Mhaskar Zigisha *Eco-Friendly Building Materials & Technologies,* University of Pune
6. Madhava Rao A.G. & Murthy Ramachandra D.S. *Appropriate Technologies for Low-Cost Housing*, Oxford & IBH Publishing Co. Pvt. Ltd., 1996
7. Grover Aruna Ramani *Alternative Construction Systems – Towards Cost Optimisation*, Deep & Deep Publications, 1997
8. Rai mohan & Jaisingh M.P. *Advances in Building Materials & Construction*, CBRI publication, Roorkee 1986

Sustainable Development in Building Materials

*Dr. J.S. Chauhan**

Introduction

India is a vast country with a population of little more than one billion. A major portion of the population live in villages with improper and in adequate housing facilities. With modernization and urbanization of the cities the tendency of the village population migrating to cities has increased. This tendency if not checked in time will have long range repercussions on the national economy. Migration of population from rural to urban areas can be checked by providing improved housing in rural areas. The Prime minister of India, Dr. Manmohan Singh has recently said that the centre is spending about Rs. 17,000 crores on Rural development, annually, but the states are not properly utilizing the amount allotted to them. The states, in turn complain to the centre that sufficient amount has not been allocated to their states for proper development of rural areas. The villager is the final sufferer. This vicious circle should be broken and transparency should be brought out so that the money is properly utilized for the purpose for which it is meant.

Habitat

Habitat is a basic human necessity next to food and clothing. It is not only a place for protection from the vagaries of weather, but also for enlargement of one's personality. It is an institution in itself. Utmost care is to be taken in planning and designing the houses, keeping in view not only the affordability of the occupant but also ensuring that the social customs are taken due care. Functional requirements and quality of construction should not be sacrificed in an attempt to reduce the cost of construction. The skill of the planner and the designer lies in reducing the construction cost by adopting cost effective construction techniques and using energy efficient and eco-friendly building materials. As building materials account for 70 to 75% of the overall cost of the house, sufficient reduction in cost can be affected by selecting locally available materials suitably improved by modern engineering techniques.

Technology inputs

The technology to be adopted should be indigenous as far as possible using the locally available materials suitably improved by modern engineering techniques. It should serve the goals of development viz. eradication of poverty, environmental sustainability and improved equity. These goals can only be achieved if basic human needs like food, clothing and shelter are met. The technology should be relevant and ready for use by the common people and should aim directly at improving the quality of their lives and aspirations. It should derive maximum leverage from the local cultural environment, by drawing upon the existing managerial and technical skills and providing the basis for extending them. The technology should be able to use the physical potential of the area maintaining man's harmony with nature. Preference should be given to indigenous items, though their cost may be more, in the initial stages, to promote indigenous technology, care being taken to ensure quality. Fiscal measures as necessary should be introduced to ensure the above objectives.

Efforts should be made to reduce the demand on energy from non-renewable sources as the fossil fuels are rapidly depleting and the oil prises are constantly increasing. Alternative/renewable sources of

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energy should be given a serious thought. Development and utilization of solar energy, wind energy and other non conventional energy sources should be popularized and if necessary, should be made mandatory in rural and remote areas. The world's largest solar cooking system which has been installed at Tirumala, A.P. (India) in Oct. 2002 consisting of 106 automatic tracked parabolic concentrators arranged in a series and parallel combination to prepare food for 15000 people/ day is a glaring example to show that India is marching in right path in the matter of utilization of solar energy for cooking purposes.

The proposal to set up a desalination plant for making the drinking water available to the citizens of Chennai (approx. 30 crores of litres/day from sea water) announced by the Finance Minister, GOI in the recently announced budget is a commendable step to tide over the crisis of drinking water shortage in metropolis located in coastal region.

Harmony with Environment

We should ensure harmony with environment, preserve the ecological balance and improve the quality of the habitat. Poorly planned efforts to achieve apparently rapid development ignoring the long term effect of many technologies on the environment have resulted in serious ecological damage. Air pollution, acid rain, industrial waste disposal, toxic effluent noise and vibrations, crowding and congestion and many other side effects of urban and industrial activity are now widely recognized as the costly by products of activities which otherwise produce useful outputs. More recently there is also a growing concern on global issues such as climate change, global warming, sea level rise and stratospheric ozone depletion etc. so it is essential to analyze the environmental impact of the application of each technology before it is actually adopted in real practice. Success demands a conscious integrated approach covering technology assessment, development, acquisition, absorption, utilization and diffusion and connects aspects of financing, based on overall national interests, priorities and the attainment of the most challenging technological goals. In addition to the deteriorating quality of air, water and other components of our environment, the quality of life for the poor comprises to a far larger degree of lack of access to basic amenities such as food, water, clothing, housing, transport and other basic needs which for majority of our people continue to be unfulfilled. This perhaps, is the most crucial area of human concern linking technology with Environment.

Role of NGO's in Technology Diffusion

While Governments must necessarily play a leadership role through education, creation of awareness, provision of infrastructure and overall planning, their policies on Science and Technology must be geared primarily to the promotion of creative action at the individual and community level. The promise of Science and Technology can only be fulfilled through the introduction of the fruits of the scientific enterprise into the lives of common people. It cannot be expected that Government alone can disseminate the technologies among the people. NGO's and voluntary organizations should come up in the promotion and dissemination process so that the fruits of Science and Technology can reach the common man effectively. The technical institutions, the Building Centres, self help Groups have a vital role to play in the technology transfer among the common people. Trades in cost effective construction techniques can be started in ITI's as five hundred new ITI's are proposed to be started soon as mentioned in the budget speech of the Finance Minister GOI on 8th July 2004.

Sustainable Development

The rapidly growing population is putting lot of pressure on the increasing demand of resources. The resource depletion should be controlled timely. If timely action is not taken it will result in ecological imbalance. It is high time to introduce environmental and resource management in to the policy making process. The available land per capita is decreasing and the cost of the food grains is increasing. This is obviously so because of the uncontrolled growth in the population. To increase the agricultural production on the limited area available, chemical fertilizers and pesticides are being used which, in turn, is the cause for resurgence of malaria and other diseases over the past few years.

Development that does not conserve over a sufficiently long period into the future the resource base on which it stands cannot be sustained, resources may be either water, oil, natural gas, fossil fuels etc. or forest wealth. The future policy makers and planners should not forget this aspect while addressing the issues of productivity, self reliance, equity and other fundamental aspects of development.

Conserving the resources is an important factor to be considered while planning for development.

Wasteful over utilization of natural resources provides one of the primary threats to our environment. If development is to lead to sustainable benefits for mankind effluent people should change their habits of using the natural resources and should learn to conserve them for the future.

Much of the environmental degradation faced by the third world counties is also caused by over utilization of resources. Governments and international organizations have a role to play in designing and realizing such a development but the ultimate responsibility and action for improving their lives rests with the people themselves. Environmentally sound development cannot take place unless drastic changes are made in the structure of the society. The exploitation of nature by man is to be put to an end in an effective manner.

Environmentally sound development requires several preconditions viz. infrastructure, capital, knowledge, systematic change and above all the willpower. This is not possible without the peoples participation in the various activities related to meeting their basic needs i.e. food, clothing, shelter, education, employment, transport, health care and energy. Almost all these basic needs have a close relationship with environmental values. People should have an access to the methods, tools and products of modern science and technology to achieve these objectives. They should have the necessary know how of the finance involved, technologies developed and also the importance of resource conservation. This is possible only through education. New technologies and products have come up where in the resource base and environmental protection have been taken care off e.g. biogas, windmills, solar devices like cookers, pumps, lighting devices, bicycle carts, mud block making machines, multifuel and multipurpose engines, Integrated village energy systems, food storage bins etc. These technologies, though, they are apt and relevant to the present and future needs have not percolated properly and are still unpopular among the beneficiaries due to their

- Economic non viability in production, marketing and use
- Lack of proper linkages between the processes of innovation production and marketing
- Lack of active participation of the people and their lack of interest in knowing the know how of these technologies
- Non availability of spare parts and ancillaries
- Problems of repairing and maintenance especially in rural areas in case of breakdown
- Proper awareness not being created among the people in the importance of using alternate sources of energy/waste utilization & preventing the environmental degradation and resource depletion
- Technology transfer from lab to land not done in an effective manner. Many such technologies are lying in the laboratories, workshops & archives.
- Inadequate Government machinery to monitor the technology transfer to the grass root level. N.G.O.'s and voluntary organizations should come up and take up this task in a missionary zeal.
- Non existence of promotion, training and extension services to a satisfactory level.
- Non availability of information or improper dissemination of information to the people.
- Improper managerial skills and lack of interest of social organizations promoting these technologies as per local needs and requirements.
- Complicated operational methods and improper training regarding the use of these technologies.
- Unable to convince the people about the improvement of these technologies over traditional methods.
- Unable to make the use of these technologies mandatory for eg. Solar devices in rural and semi urban areas, use of Mud blocks in rural areas in place of burnt clay bricks etc.
- Improper delivery mechanism
- Non existence of marketing organizations and unable to cope up with the demand and supply of certain products.

Solid Concrete Blocks

The production of solid concrete blocks for construction of load bearing walls is being done as per IS 2185 (Part-I) 1983. The technology for production of solid concrete blocks was developed and patented by Central Building Research Institute, Roorkee. For the production of solid concrete blocks, lean concrete mix of cement, fine and coarse aggregate (12 mm to 40 mm stone) is prepared with controlled water cement ratio. The concrete mix is poured in the steel moulds and after sufficient vibrating, demoulding is done. In the solid concrete block masonry,

the quantity of mortor required is very less (12%) as compared to conventional stone masonry (33%) and Brick Masonry (25%). The thickness of plaster required also is very less (12 mm) as compared to conventional stone masonry (25 mm) and Brick masonry (20 mm). Further the additional advantages of more floor area, as compared to conventional masonry is there by adopting the solid concrete block masonry.

Solid Concrete Blocks

Hollow Concrete Blocks

The production of cement concrete hollow blocks for construction of load bearing walls as well as for non - load bearing walls is being done as per IS 2185 (Part - I) 1983. The technology for production of hollow concrete blocks was developed in western countries and now has gained much popularity in India too due to reduction of load on foundation and fast construction. The production of hollow concrete block is being done with machine. The designed mix of cement, sand and stone grit (6 mm) with controlled water cement ratio is prepared through concrete mixer. The masonry with these blocks require less quantity of mortor (8%) as compared to conventional masonry (25% and 33%) for brick and stone masonry. The thickness of plaster required is also very less (12 mm) as compared to conventional wall construction 25 mm. Further the additional advantages of increased floor area in comparison to conventional wall construction is there by adopting the hollow block masonry.

Hollow Concrete Blocks

Fly Ash Building Bricks

Good quality building bricks with superior performance can be produced with advantage from fly ash using clay lime, cement or sodium silicate as binder. The mixture of fly ash binder and coarse fillers in suitable proportions are moulded into bricks. The cement bonded fly ash bricks are water cured at room temperature and lime bonded fly ash bricks are autoclaved or steam cured. However the sodium silicate and clay bonded flay ash bricks are burnt at elevated temperature. These products meet the performance requirements for building bricks IS 1077-1976 and can be used in place of common burnt clay bricks for all types of applications. The manufacture of bricks seems to be the best mode of fly ash utilization.

Fly Ash Building Bricks

Calcium Silicate Bricks

Calcium silicate bricks is one of the most promising alternative walling material in which fly ash, being a siliceous material, could be used together with sand and lime.

The process consists of preparation of raw materials, mixing, shaping/ pressing and curing. The strength of the bricks depends on the operating parameters like moulding pressure, and steam pressure and duration of curing and steam pressure in the autoclave.

This product has a higher strength in addition to a number of other advantages as they are uniform in size, shape and surface as well as low coefficient of variations in strength. Thus the thickness of the walls can be smaller and the walls do not require plastering on both sides.

Calcium Silicate Brick

Lime

In the case of building lime, which is an economical substitute for cement in mortars and plasters, the non-availability of standard quality lime is one of the important factors in its limited use. Efforts have been made by NBO to introduce the manufacture and use of dry hydrated lime as well as clay pozzolana conforming to IS Specifications. A number of plants for producing dry hydrated lime and clay pozzolana have been set up but such products are available to a limited extent only.

Cement

Cement which is a vital material for construction has been found to vary greatly in quality. A Working

Group constituted earlier by the then Ministry of Works & Housing, under the aegis of NBO, had laid great stress on the availability of cement as per IS Specifications. This is a pre-requisite for adoption of strength mix design concept in place of nominal mix design thereby improving the quality of construction. It is a good augury that the Government has recently directed all cement manufacturers in the country to strictly adhere to quality standards as per Indian Standards Specifications. In an effort to improve the quality of concrete, production and use of ready-mixed concrete is also being propagated by NBO.

As the quality of buildings, houses and other structures basically depends on the quality of building materials and products used, great importance is attached to adoption of more scientific methods of production of building materials to achieve the desired levels of quality.

Durability

Durability of construction depends on a variety of factors but it is basically governed by the quality of materials and appropriate techniques adopted for construction. As such selection of right type of materials, products and techniques of construction are matters of paramount importance. While doing so, the impact of environmental factors which cause deterioration in buildings and structures and upgradation of materials and products should be duly considered to enhance the durability of buildings and structures. This is a complex issue and in many situations where aggressive and extreme environmental conditions are met with, such as heavy rainfall areas and industrial & coastal environments, special protective measures are required to be taken in such situations in order not to jeopardise the durability of buildings and structure.

On the basis of local situations, considerable research and development work is required to be undertaken to evolve appropriate products, techniques and methods of construction to extend the durability of structures.

Corrosion

One of the important problems in durability which has been experienced in our country, pertains to fast rate of corrosion of steel reinforcement in RCC structures, particularly in the coastal regions. To study this matter, the NBO had sponsored a research study to the Central Electro-Chemical Research Institute at Karaikudi, which had suggested some remedial measures to be taken in this regards.

Organic Materials

Durability is an important consideration, when organic building materials, like timber wood based panel products; bamboos, reeds, thatch, etc, are used for construction. Seasoning of timber and application of preservative treatments extends the service life of such building materials.

Inorganic Materials

In the case of inorganic building materials, it is necessary to adopt the use of such materials and construction techniques which prevent their early decay and deterioration due to weathering and climatic agents, such as prevention of ingress of rain water; efflorescence in masonry, corrosion of steel in reinforced concrete constructions.

Degradation Factors

Degradation Factors (Agents) relevant to building performance include mechanical agents, electromagnetic agents, chemical agents biological agents.

The degradation factors affecting the service life of materials and components include.

i) *Weather factors*—radiation, temperature, water, normal air constituents, air contaminates, freeze-thaw and wind.
ii) *Biological factors*—micro-organisms, fungi and bacteria.
iii) *Stress factors*—sustained periodic and random stresses and physical action of water such as rain, hail, sleet, snow, etc.
iv) *Incompatibility factor*—chemical and physical.
(v) *Use factors*—design of system, installation and maintenance procedures, normal wear and tear, abuse by user, etc.

Performance

The performance of buildings and structures is basically dependent on the design, choice of materials and construction techniques. More exacting demands as regards quality and performance of structures are being made in modern days. To fulfil these, use of new and innovative materials and construction techniques has to be made.

Performance concept in building needs to be further developed. To ascertain the extent of satisfactory performance it is necessary to evolve suitable criteria for its evaluation and also tests to ascertain them. A lot remains to be done in this field. The National Building Code of India, lays emphasis on performance concept and suggests that building specifications and

codes of construction practices should be rewritten to cater to performance requirements. This would have the advantage that the designers and builders would have a wider choice to select appropriate materials and construction techniques to fulfil the specific performance requirements. It will encourage adoption of innovations in construction.

In predominantly tropical climatic conditions, great importance is attached to performance of buildings and houses to provide thermal comforts, prevent dampness in buildings through floors and walls, water proofing of roofs, etc. It is, therefore, necessary to make right choice of building materials and products and adopt appropriate construction techniques to improve the performance of building and houses in regard to the above.

Many parts of our country are vulnerable to earthquakes, cyclones, floods, heavy rainfall, snowfall and avalanche, etc., and therefore buildings and other structures should be so designed and constructed so as to prevent damage and destruction to the extent possible. The use of right type of building materials and construction techniques is a matter of crucial importance. A lot of research and development work is required to be pursued in this direction.

Service Life

The service life of buildings and structures is a factor mainly dependent on :

(a) Specifications of materials and construction techniques adopted;
(b) The extent of satisfactory maintenance and repair work undertaken periodically;
(c) The environmental factors affecting the durability and performance of buildings.

Great importance should be attached to extending the economic service life of buildings and structures. It is, however, not yet a practice to take into consideration life-cycle cost of buildings and houses. Most often stress is laid on low initial investment and inadequate funds are provided for maintenance and repairs over the life span of the building. On account of this, early deterioration of buildings and structures takes place and the service life of buildings and structures is reduced.

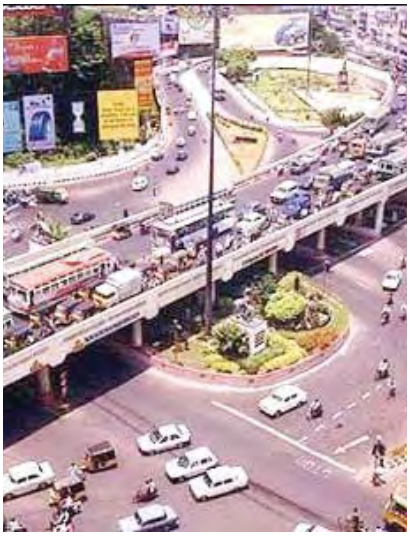
There is no doubt, that besides the above it is due to the natural phenomenon also that deterioration and decay of buildings and structures takes place progressively. However, these are expedited on account of aggressive environmental conditions. Moreover, much depends on proper usage, upkeep and care of buildings and structures by the occupants and the users to prevent their yearly deterioration.

In addition to technological factors, there are other social and economic aspects which contribute to the early deterioration of buildings and structures. These include the rent control, legislation, organisation and management of maintenance, repair and reconstruction work.

Data on the service life of building materials and products are essential to the selection of cost effective use of materials. In the case of traditional building materials, their service life could be predicted on the basis of past experience. However, in the case of new materials and products, such data is not available and hence it is difficult to predict their service life. As such, suitable tests should be evolved to determine the service life of new materials and products. Service life test method includes both a property measurement test and on again test.

Conclusion

Improved housing facilities in rural areas needs immediate attention in order to prevent migration of people from villages to cities. The technologies to be adopted should aim at improving the quality of lives of common people without causing resource depletion and environmental degradation. Locally available materials suitably improved by modern engineering techniques should be used in construction. NGO's, technical institutions and Building centres have a vital role to play in the technology transfer mechanism to the grass root level. People's participation in the various activities related to the improvement of their basic amenities and standard of living is a must in order to ensure that environmentally sound development takes place.



Rationale & Engines of Urban Growth in India

*G.B.Singh**

The urban centers in India are growing at a very fast pace. This is throwing-up unique challenges to the administrative machinery of the respective central and state governments. There are logical reasons for this growth. Major amongst these could be listed as: -

- Growth of Indian economy @ 7% to 9%, which is the second highest in the world, next to China, leading to creating plenty of new job opportunities in the service, Industrial and real estate sectors, Since these opportunities are in and around metropolitan centres, there is rush to urban areas
- There are 53 urban agglomerations now in India with a population of 1 million or more as of 2011 against 35 in 2001. The number of Indians living in urban areas grew by 31.2% between 1991 and 2001, and currently about 43 percent of the urban population of India lives in these cities
- The percentage of Indians in the age group of 15 to 64 is 64.3%. The literacy rate of 71.7% as of 2001, has gone up to 81.4% as of 2006 and is improving further now. The median age of an Indian today is 25.1 yrs, (It is expected that, in 2020, the average age of an Indian will be 29 years, compared to 37 for China and 48 for Japan) The country, therefore, has and will continue to have plenty of working hands to assist in uplift of economy..

Tremendous Demand for Buildings to meet Housing & Business needs.

Growing cities have warranted great pressure on up-gradation and extension of infrastructure and building activities to meet the growing demand. A Technical Group constituted by the Ministry in 2006 to assess the urban housing shortage has estimated that at the end of the 10th Five Year Plan (2007-08), the total housing shortage in the country was 24.71 million. The housing shortage during the plan period (2007-2012) including the backlog has been estimated to be 26.53 million units. This is expected to rise with requirement of housing touching 90 million units in another fifteen years. Like-wise around sixty million square meters of office space would be required in the next 5 years due to the advancing sectors of services and Information Technology.

Measures by Governments to meet the Challenge

India has 28 states and 7-centrally administered territories. Housing is a state subject. Each one of these Government authorities is fully alive to this influx to metropolitan centres and have taken appropriate measures to deal with this influx.

The major concentration centers, however, are the metropolitan centres like Mumbai, Delhi, Bangalore, Chennai, Kolkata, Hyderabad, Pune, Ahmedabad & Jaipur. Some of the regulatory and other measures taken by specific authorities include: -

i) Expanding boundary limits of the city with extended infrastructure. For instance Delhi's National Capital Territory (NCT) of 1,480 km^2 has been enlarged into much larger National Capital Region (NCR) of 33,580 km^2. by including adjoining areas of adjacent states.

Chennai, Mumbai, Chennai, Kolkata Pune authorities have decided to extend metropolitan/ municipal area limits to provide more area for development. Some others State Governments like Gujerat & Chhattisgarh have decided to develop new state capitals next

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to existing capitals of Ahmedabad and Raipur.

ii) Improvement of infrastructure like constructing expressways, bridges, new airports (Mumbai, Delhi, Hydrabad, Bangaloru, Chennai), power plants, schools, hospitals, introduction of metro rails systems (Delhi, Mumbai, Kolkata, Hyderabad, Bangalore etc.)

iii) Permitting higher FSI, so as to enable building additional spaces on existing land parcels. Hyderabad for instance has no limit on FSI. Chennai, Mumbai, Noida have raised FSI utilization limits.

iv) There used to be an Urban Land Ceiling Regulation Act (ULCRA), which prevented aggregation of land by private developers for construction of townships or take-up other large development projects. The Central Government took the initiative to repeal this act in 1999-2000. Most of the state Governments have also followed suit. This has now made it possible for entrepreneurs to aggregate land for building construction

v) To ensure equitable availability of dwelling units for all sections of society, building regulations have been amended, to provide for a certain percentage of units of specified minimum sizes, to be built in all developments to accommodate economically weaker section of society.

vi) In order to free prime land parcels, illegally occupied by the slum dwellers in the heart of the city, the Mumbai Metropolitan Authorities have come-up with a unique "Slum Rehabilitation Scheme", whereby the developers first provide for, alternative permanent multi-storied dwellings units of specified minimum size to the jhuggy dwellers, on their existing plots and exploit the remaining land parcel for constructing houses for sale to public.

FDI Funded Slum Rehab, Alta Monte Malad,-Mumbai

vii) Like-wise the industrial units located within the city limits of Mumbai, Delhi, Chennai etc. have been directed to move out of city limits to designated industrial areas etc outside city limits. and the land parcels freed are made available for construction of residential and /or commercial buildings.

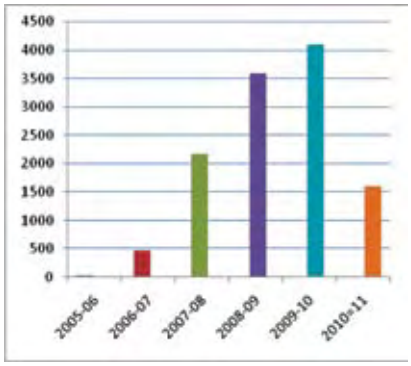
Funds for Construction and Purchase of Real Estate

i) Construction Funding

The land records across the country are still being manually maintained, with the result, that there is lack of clarity on majority of titles. Most Governments are currently working to implement e-governance to improve land title registration, but till then it is estimated that ownership of nearly 90% land, could be subject to conflicting claims. However, despite mounting these shortcoming, even if the developers aggregate land, they were not able to obtain bank funds for execution of developments. This is because of certain RBI restrictions to use national funds for other priority sectors. The execution of projects was therefore suffering.

In order to overcome this constraint the Govt. of India decided to liberalize the FDI norms in the construction sector. This has perhaps been the most significant economic policy decision taken by the Government of India. Earlier, only Non-Resident Indians (NRIs) and Persons of Indian Origin (PIOs) were permitted to invest in the housing and the real estate sectors. However, the guidelines prescribed via Press Note 2 (2005) series, issued by Ministry of Commerce & Industry, opened out FDI in townships, housing, built-up infrastructure and construction-development projects. Major corporations are taking initiative and are wooing international players soliciting investments for major projects.

As per ASSOCHEM/ FICCI sources, the FDI in Real Estate saw significant flow from 2005 onwards. It was US $38.71 m in 2005-06,



surging to $470 m in 2006-07 and rising to 2.1 billion in 2007-08. The inflow climbed to $3.6 billion in 2008-09 and US$ 4.10 billion in 2009-10. It has unfortunately declined in 2010-11, but the industry experts feel, that it is expected to grow to US$ 25 billion in the next 10 years.

FDI has really enabled Indian real estate market to take off. The hibernation period is definitely over. The bulk of this investment of around 80% has gone to affordable sector of housing and most of the balance towards putting-up commercial offices, retail etc.

The introduction of FDI has additionally benefitted the real estate sector in India by way of bringing in International Architects/ developers. Regular availability of funds and constant monitoring by Fund Managers, has led to timely completion of good quality constructions, executed following safe

An FDI sponsored Green Commercial complex in Bangalore

construction practices. It may also be mentioned, that the concept of green townships has been first introduced by one of the FDI funds only, with the construction of a township of around 3,500 apartments in Noida.

ii) Organization of funds by Purchasers

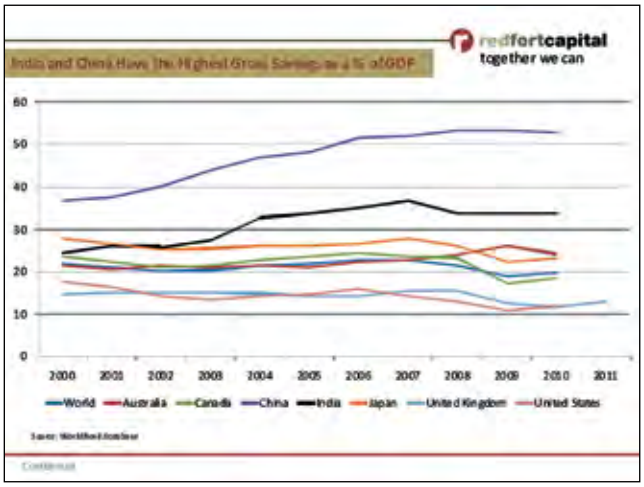
Indians like the Chinese are by nature savings conscious, as compared to their counterparts in developed world, who heavily draw on their plastics. Having a dwelling for themselves is prime desire of all individuals in India. More-over the growth of economy has offered well paid jobs to young professionals. The family's paying capacity increases substantially if husband, wife team are both working professionals.

It is true that the cost of housing is increasing day by day. However,

FDI sponsored First Green Township Noida-NCR

at the same time, the extent of compensation to individuals is going up at a much higher pace, with the result that the affordability of acquisition is not eroded. Two illustrations below would help to enforce the points made above.

The Indian commercial banks, have for some time now, been offering relatively cheaper mortgages to working professionals, with 20-30 year loan terms. The banks in India are, however, very careful in insisting for higher initial payments and take due precautions to rule out any possibility of Sub-prime situation, that arose in the USA. Easy mortgages and healthy pay packets have enabled young individuals/couples to own their personal residences in their 30's, while their parents could manage that only towards their retirement.



National Symposium

on Earthquake Resistant Design & Construction for Urban Social Housing Projects

The recurrent earthquake in Indian sub-continent and the huge losses to lives and property on account of faulty construction and non-adherence to the Indian Standards on disaster resistant construction prompted Government of India to enact Disaster Management Act 2005 which entails that capacities need to be built up at all levels so that India becomes disaster resilient. Therefore, a need was felt to build the capacity of the professionals, to comprehend hazard resistant features given in Indian standards and use them while designing and preparing the project report and provide the first hand information on hazard resistant practices to all including policy makers.

In light of above, a National Symposium on Earthquake Resistant Design & Construction for Urban Social Housing Projects was organised on July 19-20, 2012 at New Delhi so as to sensitise the State level Engineers and other stakeholders as regards the current practices of earthquake resistant design and Codal provisions and bring forth the vulnerability, risk and other associated issues. The National Symposium was inaugurated by the Secretary, Ministry of Housing & Urban Poverty Alleviation. More than hundred participants from various State level Housing & Urban Development Authorities, Housing Boards, Urban Local Bodies; practicing architects & engineers participated in the National Symposium.

Concrete Filled Tubes: A More Logical Composite Column

*Pramod Kumar Gupta**

Introduction

In civil engineering constructions, the merits of a material are based on the factors such as availability, structural strength, durability and workability. No natural material possesses all these properties to the desired level. The engineering problem therefore consists of an optimization involving different materials and methods of constructions, with the objective of building a structure at a minimum cost to meet the requirements.

Composite construction exploits the synergistic actions of two or more different materials in a single structural member. In earlier days in general, masonry and bamboo were used to construct the columns. Both fall in the category of either composite materials or composite construction. Presently three types of columns are used in the building construction, which are shown in Fig. 1. These include steel column, RCC column and Steel-RCC column. RCC is also a composite material and most widely used in the present time due to its inherent engineering properties.

There are peculiar problems associated with the construction processes of either steel or concrete due to their unique material properties. For example, steel structural members are generally fabricated as components consisting of thin plate elements, so they are prone to local and lateral buckling, as well as to fatigue. Therefore, steel standards are concerned predominantly with the prevention of failure by instability or buckling. Conversely, concrete structural members are generally thick and are unlikely to buckle. However, concrete is very week in tension, and is inclined to creep and shrinkage with time. In order to overcome the problem of weak tensile strength, a major effort in design is in placing steel reinforcing bars as a substitute for the weak concrete.

Steel and concrete composite columns

Composite columns are a very important application of composite construction and they find widespread use, particularly in high rise office buildings. The general term 'composite column' refers to any compression member in which a non concrete element acts compositely with the concrete element, so that both elements resist compressive forces. Steel hollow tubes filled with concrete commonly termed as concrete filled steel tube (CFST) column as shown in Fig. 2 is also a composite construction which is more logical as compared to the normal RCC column. The concrete filled steel tube (CFST) column can be either square or rectangular (RCFT) or circular in shape as shown in Fig. 2.

Mechanics of concrete filled steel tube (CFST) column

In current international practice, concrete-filled steel tube (CFST) columns are used in the primary lateral resistance systems of both braced and unbraced building

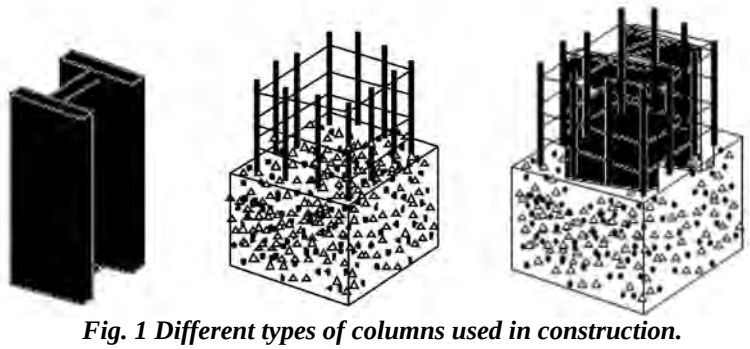


Fig. 1 Different types of columns used in construction.

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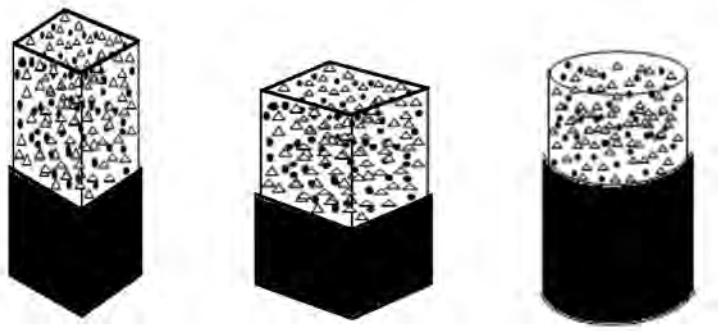


Fig.2 Different types of concrete filled steel tube (CFST) columns.

structures. There exist applications in Australia, Japan, Europe, United States of America, China, UK and Singapore where CFST columns are used in different constructions including building industry. Fig. 3 shows the pictures of different types of structures constructed in some of the countries.

The CFST structural member has a number of distinct advantages over an equivalent steel, reinforced concrete, or steel-reinforced concrete member. The orientation of the steel and concrete in the cross section optimizes the strength and stiffness of the section. The steel lies at the outer perimeter where it performs most effectively in tension and in resisting bending moment. Also, the stiffness of the CFST column is greatly enhanced because the steel, which has a much greater modulus of elasticity than the concrete, is situated farthest from the centroid, where it makes the greatest contribution to the moment of inertia. The concrete forms an ideal core to withstand the compressive loading in typical applications, and it delays and often prevents local buckling of the steel. Additionally, it has been shown that the steel tube confines the concrete core, which increases the compressive strength and the ductility for CFST columns. Therefore, it is most advantageous to use CFST columns for structural elements subjected to the large compressive loading plus bending. Fig. 4(a) shows the load carrying mechanism of CFST columns subjected to axial compression. The stress-strain variations for confined and unconfined concrete are shown in Fig. 4(b). It is clear from Fig. 4 that CFST columns bear greater load in comparison to a RCC column having same dimensions.

In contrast to reinforced concrete columns with transverse reinforcement, the steel tube also prevents spalling of the concrete and minimizes congestion of reinforcement in the connection region, particularly for seismic design. Numerous tests have illustrated the increase in cyclic strength, ductility and, damping by filling hollow tubes with concrete. Recent applications have also introduced the use of high strength concrete combined with high strength thin-walled steel tubes with much success. When high strength concrete and thin-walled steel tubes are used together, the more brittle nature of high strength concrete is partially mitigated by the confinement from the steel tube, and local buckling of the thin steel tube is delayed by the support offered by the concrete.

Advantages of CFST columns

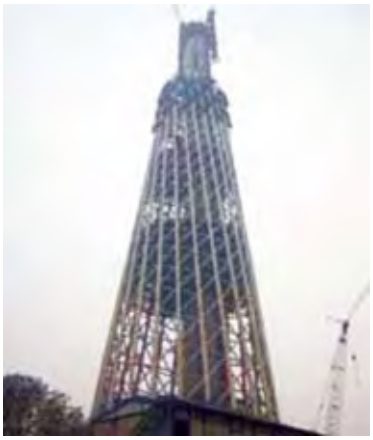
CFSTs columns provide excellent monotonic and seismic resistance in two orthogonal directions. Hence they are quite helpful for high rise buildings in zones of high seismicity. The smaller and lighter framework of CFSTs imposes lesser load on foundations. Due to interaction between steel tube and concrete the local buckling of steel tube is delayed and the strength deterioration after buckling is moderated due to restraining effect of concrete. Strength of concrete is also enhanced due to confining effect of steel tube.

In RC columns the reinforcement cage provides good confinement for inside core but doesn't confine cover which spalls of during earthquake and thus results in degradation of column shear strength and stiffness. This drawback is not there in CFST columns. Also drying shrinkage and creep of concrete are much smaller than in ordinary concrete. The steel ratio in the CFSTs columns is much larger than in the ordinary concrete and since it is located at the periphery of the section the CFST section is well plastified under flexural and compressive loading. Due to this reason CFST columns are well suited for compression and biaxial bending.

CFST columns used as a part of moment resisting frames have high strength to weight ratio due to confinement of concrete and continued bracing of steel tube which delays local buckling, improves damping behavior, ductility and toughness. The steel tubes serve as formwork in construction and their erection can precede the concrete by several stories, which

(a) CFT columns used in construction of SEG Plaza in Shenzhen, China, Height = 291.6 m

(b) A transmitting pole with CFT legs 370 m in height (China)



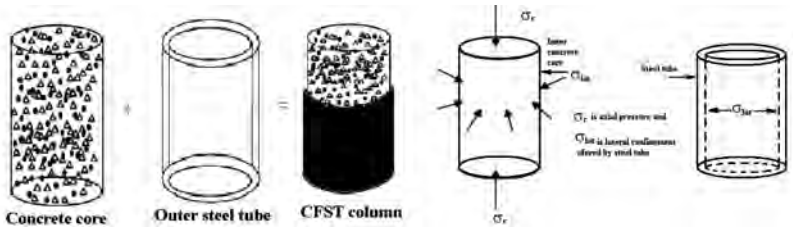
(c) A TV tower having 610 m height (China)

(d) Latitude building located Sydney having height-222 m.

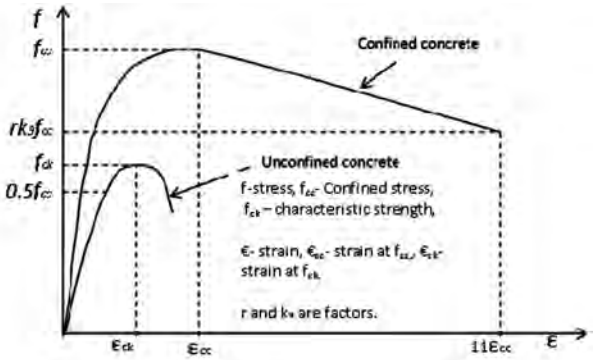
(e) C Bank Tower in Germany, Height-300m

(f) City hall, located in London having height-45 m

Fig. 3 Some of the structures constructed using CFST columns across the world



(a) Load carrying Mechanism of CFST column.



(b) Stress-strain variations for confined and unconfined concrete

Fig. 4 Load carrying mechanism of concrete filled steel tube (CFST) column.

decreases labor and material costs. During seismic excitation, the cyclic response of CFST columns and their connections provide full hysteresis loops with substantial energy dissipation.

In construction of CFST columns Labor for form work and reinforcing bars is omitted. Concreting is also done by tremie or pump up method. This leads to cleaner construction site and reduction in manpower, construction cost & project length. Hence a Better cost performance is obtained by using CFST columns.

Limitations

There are a certain limitations in use of to CFST column and its construction which are enumerated here. There is a difficulty in the compaction of the concrete inside the steel pipe which leaves a weak point in the structural system. There is no way to ensure compactness or to repair this difficulty. To compensate, high quality concrete with low water content and a super plasticizer for enhanced workability is used in the construction. To avoid this it is always advised to use self compacting concrete to avoid honey combing. Another weak point of the CFST column is the connections. Beam to column connections is still under researched and therefore; always designed on conservative side.

Design Methods

Various countries have developed their codes of practice for the design of CFST columns due to their positive engineering features over the traditional RCC and steel columns. Some of the standard codes of practice are given in Table-1.

In addition Australia, China and Egypt have worked on their own design methods and the studies on these are also available. Till now no standard is available in our country which can be used for design of such columns in Indian context. It is a need of time that researchers and practicing engineers should come forward to formulate a suitable standard for design of CFST columns, so that they can be used in infrastructure development of our country.

Table-1: Some of the standard codes of practice of CFST Columns

(a)	ENV1994 “Design of Composite Steel and Concrete Structures”	European Code
(b)	BS 5400	British Code
(c)	AIJ Code	Japanese code
(d)	AISC- LRFD	American Code
(e)	ASI 318- 89	American Code
(f)	NBR 8800:2008(21)	Brazilian Code
(g)	CAN/CSA S16-01:2001(24)	Canadian Code
(h)	ANSI/AISC 360:2005(23)	American Code

Building on Slums to Transform India

*P. Gopinathan**

India's urban population grown from 285 million in 2001 to 377 million in 2011. This represent 31.2% of total population of the country. In absolute number 92 million population added up in the last .10 years (2001 to 2011). Mckinsey projected India's urban population to become 590 million by 2030. In another two decades to add 213 million more people into our cities and towns. Explosion of India's urban population is throwing up many major challenges.

Urban housing shortage

Increasing Urban population necessitate delivery of additional many millions of housing units in our metros/ cities 7 towns. But supply of housing for the poor and lower income segment by market players is almost nil. This segment can look up on only to government subsidized housing programmes. According to National Housing Policy (1994), urban housing shortage in 1991 was 10.4 million units. As per housing policy and habitat policy (2007) urban housing shortage in 2007 at the beginning of 11th plan is 24.7 million with 99% shortfall pertaining to economically weaker sections and lower income groups.

Burgeoning of Slum Population

Slum dwellers or slum population of the country in 2001 was 75.26 million. According to the study by committee headed by Pranabsen, Principal advisor to the planning commission estimated slum population in 2011 is 93.06 million. Due to non-availability of land and its astronomical price and high cost of construction, securing own housing by slum dwellers is impossible. The only option is to look up on government assisted public or social housing programmes. Though the existing shortage of housing for the this segment in 2007 is 24.7 million housing units, under 11th five year plan, centrally assisted housing for economically weaker sections/ urban poor under Rajeev Awas Yojana is only for construction of 1.5 million units. This will meet only a very small fraction of housing requirement. Naturally the housing shortage in urban area will continue to increase at the end of 11th plan. This will further increase slum population of the country.

Slum free India : Housing with 25 sqm/ 269 sft carpet for urban poor families / slum dwellers

Latest policy of Central Government stated that slum dwellers to the provided with durable and disaster resistant housing of 25 square meter (269 sq.ft.) carpet area. Under slum dwellers housing programme, Central Government also decided that 7 years lock in period to prevent the sale or lease of allotted property and conferring property rights in the name of female headed household or in the joint name of male head and his wife are much progressive steps. To have 25 sq.m. carpet area require an apartment size of at least 35 sq.m (377 sq.ft.) which include common area like staircase, lift, access / passage etc. Assuming an average 5 persons per slum dwelling unit for 93.06 million slum dwellers require 18.61 million dwelling units.

As per Central Government declared policy India would become slum free in 5 years. This is one of the most laudable goal fixed by the Government to make India slum free. Not only this require the existing slums to be redeveloped providing durable housing to slum dwellers, but also need to address

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the problem of shortage of 24.7 million housing units. Otherwise urban poor and lower income segment who constitute 99% of this shortage will become slums or move on to slums. Therefore urban housing shortage of 24.7 million units at the beginning of 11th plan(2007) and redevelopment /rebuilding of slums to provide 18.61 million dwelling units to slum dwellers to achieve slum free cities total urban housing requirement is 43.31 million units.

Slum redevelopment in-situ -a better option

Non availability of suitable land and its very high price make it impossible to undertake re-settlement of slum dwellers elsewhere other than in existing slum area. In metros and large cities, multi-storey affordable mass housing is the only feasible and more practical option to provide durable and disaster resistant, quality housing to slum dwellers. To shift or rehabilitate slum dwellers moving them away from existing slum location will meet with resistance from slum population, as it will deprive them livelihood / employment opportunities they already have. There will also political dynamics as it will disturb the existing mass base vote bank nurtured by political parties. Huge cost involved in land acquisition to resettle them is another hurdle.

Experience of Tamilnadu Government of shifting slum dwellers from Chennai to Thuraipakam, 30 km away on the outskirts of Chennai city is worth studying. After dwellers moved over to new housing colony built for them, number of families returned to Chennai city after renting out their new housing unit and taking on rent cheaper housing back in city or moved over to new slums in the city for continuing with their livelihood / employment or to gain new jobs.

Present policy is only to provide shelter/ dwelling units:

Present policy of the Govt. is to rehabilitate slum dwellers only to provide them with shelter/ dwelling units. No provision in the housing scheme / programme to generate livelihood or job opportunities. So when the slum rehabilitation housing project is planned far away from the existing slum location, once the slum dwellers mover over to their newly provided housing, they are deprived of their livelihood opportunities or job which is essential for their survival. So they again return to their original location or to some other part of city where to gain job for survival and find another slum to settle.

Planned redevelopment of the slum with vertical growth or multi storey housing at in-situ for with provision for livelihood opportunities, integrating with the overall development of the city, might be a better option. Such a redevelopment will protect their existing livelihood opportunities / employment. This approach will get more acceptability of slum dwellers and local political consensus to the project.

The case of Dharavi – Asia's largest slum

Dharavi slum in Mumbai spread over 577 acre of land with more than 5 lakhs people live there with their livelihood opportunities from shops tailors, cobblers uphostery, tyre threading, potters, recyclers, drycleaners, leather tanners, laundry, cold storage, mobile repairs, TV repairs, auto rickshaws, automobile workshops, painters, barbers, steel and aluminium fabricators, photo studios, IT solutions, micro financiers, computer centres, internet centers computer graphics, hotels, tea/ coffee shops, fast food, electrical, plumbing services, provision shops, juice stall, liquor shops, glass cutlers, flex board makers, courier agents, travel agents, man power recruiting agents, driving schools, fish and meat stalls, textile shops, furniture shops and so on. These are all urban services required not only the slum inhabitants but also by larger segment of the city.

Multi storey built space @ affordable rent/lease for micro enterprises/ self employment to retain existing livelihood jobs/ services - as a strategy

For each and every slum dwellers, existing livelihood opportunities or employment is very critical for their survival. So when the redevelopment of slums planned, it is imperative that, the plan to be included provision for protection or generation of livelihood opportunities / jobs. Services provided by this informal sector are also critical to the population of the city.

For example in Mumbai's Dharavi slum we can see that already exist 3 to 4 storey level micro entrepreneurs / micro enterprises. So it will be a better if can include in the programme of slum re-development to build multi storey from low rise to medium rise building to provide hundreds or thousands of micro shops/ space, as per the needs of respective towns/ cities/ metros up to 100 sq.ft., to be allotted to the slum dwellers at affordable rent or lease to the existing slum dwellers to have their own micro enterprises / entrepreneurs at an average 2 livelihood jobs per

slum dwelling units.

For this, it is necessary to construct number of medium rise (6-7 storey) buildings with thousands of micro built spaces/ shops of each with to be given on affordable rent, which can generate 6-8 jobs or livelihood employment per micro enterprises/ shops/service centers

Built space say up to 100 sft for setting up micro enterprises/ self-employment opportunities / shops/ livelihood opportunities utilizing their own skills may be allotted/ leased based on prior survey conducted on the existing or felt needs of the slum dwellers at affordable rent or lease amount . At least 50 % of this space/ shops to be reserved for existing slum dwellers with one shop/ space of 100 sft per 6-8 slum dwellers to work as self-help groups/ micro enterprises. Remaining space to be given out on commercial rent or lease. This is to develop as low-cost shopping cum service complex cater to the needs of the masses while it ensure employment to the redeveloped slum population and others.

Based on the local or regional needs of respective cities/ metros, number of storeys of such buildings can be decided locally. Additional project cost / investment required for construction of buildings to provide built spaces for service, or commercial or flatted or service industry etc. can be treated as commercially viable or recoverable income through affordable lease amount or rent within a specified period of the project. Proper maintenance and operational management of the low cost shopping cum service complex etc. may be rest with the concerned Govt. agency/ local body which implement the project.

If this can be adopted as a national strategy, it will generate / protect millions of existing jobs / livelihood opportunities. These buildings have to be planned in the midst or alongside or at demarcated location close to the residential dwellings/ housing up to 9-10 floors to rehabilitate the existing slum dwellers. This has to be based on the local situations of respective cities/ metros whether low rise to medium rise housing projects to resettle slum dwellers including additional built space for micro enterprises/ self-employment opportunities.

Network of Micro finances and banking support

Support of commercial banks and micro finance institutional to extend financial assistance to these micro enterprises / entrepreneurs will help to integrate them with into formal market sector. This will broaden city's tax base and GDP, there by tax base and GDP of the nation will also be increased. This will become a sustainable and inclusive development.

This can be a strategy to transform the unorganised or informal sector into an organised /formal sector. Imparting of skill up gradation training and quality improvement in products and services, welfare schemes for labours, exposure to management skills etc. will help to improve health and educational base of the neglected segment with better human resource development. This will also help to improve law and order economic, social and environmental development.

Number of such low cost shopping cum service complexes in the cities/ metros will benefit the people as well as the low income segments. It will help to protects existing jobs and services and will generate additional jobs also. Redeveloped slums with affordable mass housing projects and adjoin low cost shopping cum service complexes will help to transform from informal sector to formal sector and transform the towns/ cities/ metros into a far better environment.

Planning and integrating with city development plan/master plan

Re-development of slum area has to be taken into consonance with overall development of the city to the possible extend. Land required for city roads or its widening, internal roads, drainage, public utilities and service sector requirement etc. need to be taken care off. Since existing slum population has to be provided with planned quality housing at in-situ, multi storey housing alone is feasible. The residential density has also to takes note of impending future increase of urban population. Therefore based on the population pressure, number of floors / storeys for such public or social housing to be adopted by respective metros/cities and towns.

Relevance of innovative building materials & construction technologies:

There are paths breaking, innovative building materials and construction technologies by which fast track building construction, saving time upto 75% and cost saving of 25-30% for repetitive affordable mass housing is available. The advantage and benefit of such energy efficient, eco-friendly building materials and modern construction

techniques to be adopted to suit India's conditions.

In slum re-development plan, apart from affordable housing programme, provision of separate multi storey built space for setting up micro enterprises and service industry to generate livelihood / job opportunities to slum dwellers and setting up micro finances and banking service to extend financial assistance will bring a dynamic change in slum re-development program to achieve the national goal of slum free India.

If re-settlement of slum dwellers with affordable housing can be achieved within 50% of land, 20% for roads/road widening, internal roads / lanes, open space and 5% of land for multi storey built space on rent/lease at affordable rate for micro enterprises / micro entrepreneurs, 5% of land for public / common amenities like post office, police station, schools, hospitals, health centers, shopping centers, market, water supply, taxis, auto rickshaws, and so on. Remaining 20% of land can be auctioned off for high end housing or commercial or mixed development. Public Private Partnership (PPP) model will be more apt as it will in fuse resource /investment, modern and innovative building materials and construction technologies will bring time bound implementation, saving of time and cost of housing project. Such a convergent programme will help to transform our cities into much cleaner metros and cities. It will contribute to the much needed environmental protection, sustainable and inclusive development.

National Seminar

on Emerging Building Materials & Construction Technologies

BMTPC organised a National Seminar on Emerging Building Materials & Construction Technologies from 31st July to 01st August, 2012 at New Delhi. The main objective of the Seminar was to bring all important organizations working in the area of upcoming and emerging building materials and construction technologies at a common platform for its large scale application and dissemination at national level. The National Seminar was inaugurated by the Secretary, Ministry of Housing & Urban Poverty Alleviation. More than 125 participants from various stakeholders including systems/technology providers of emerging technologies participated in the National Seminar. During the National Seminar, the Chief Guest kindly released two publication titled "GFRG/Rapidwall Building Structural Design Manual" and "A Report on Monolithic Construction for Mass Housing".

Production of Innovative Construction Materials from Aluminium Industrial Wastes for Urban Housing Applications

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Introduction

In modern life housing is not strictly meant for providing shelter. In fact urban housing is a reflection of the cultural, social and economic values of a society. In recent years, urbanization in developing countries results explosive population growth in cities and leads rapid deterioration of city housing and living conditions. The rapid increase in the population of urban centres has resulted increased demand of traditional building materials like stone, clay, sand, gravels cement, brick, block, tiles etc. All these building materials have been produced from the existing natural resources and will have fundamental uniqueness for damaging the environment due to their continues exploitation.

It is noticed that, during the last decade, the cost of construction materials in India is doubled due to short supply of products and raw materials. The high transportation cost of materials for urban usage has further increased the cost of quality construction in city areas. To cope with the short supply of raw materials, increasing construction and transportation cost as well as the ever increasing demand for quality urban housing needs, it is essential to find practical substitutes for conventional building materials.

During refining of bauxite to alumina using Bayer process produces large quantity of a solid waste called "red mud" (the production of 1 ton of alumina generally results in the creation of 1–1.5 t of red mud). Such residue is characterized by very high alkalinity and its major constituents are *hematite* (Fe_2O_3), *boehmite* (-AlOOH), *quartz* (SiO_2), and *sodalite* ($Na_4Al_3Si_3O12Cl$), and re-precipitated *gibbsite* Al(OH)3. The red mud generated during bauxite to alumina production may create an environmental problem. Therefore, high volume and low / affordable cost and innovative methods of utilization of red mud with minimum or no waste generation may be the right choice of handling of red mud issue. Indian aluminium industry produces approximately five million tons of red mud annually. The composition of red mud depends on the source of bauxite and technology adopted. The details of the composition of red mud are shown in Table - I. It is observed that red mud generated from east coast bauxite is higher in iron and lower in TiO2 contents whereas the opposite is true for red mud of central India bauxite. In view of energy savings, minimum toxic emission, upkeep of natural resources JNARDDC, Nagpur and NALCO, Bhubaneswar have jointly taken initiatives for recycling of red mud into useful products. Considering the scope of large utilization of red mud for making products such as bricks and tiles and their genuine requirements in building and construction for urban housing applications, light weight foamed bricks (LWFB) and glass ceramic tile (GCT) have developed.

The characteristic features of LWFB are light weight, all through porous structure, low thermal conductivity, good impact resistance and non toxicity. All through glassy structure, better abrasion resistance, varying colors and aesthetic appearance and good surface finish are feature of GCT developed from red mud.

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Development of light weight foamed bricks (LWFB)

The literature on processing and utilization of red mud, it was found that red mud with certain additives when fired at 1000°C exhibited a crushing strength of 130-160 kg/cm² [1,2]. Similarly, low density (1.1-1.2 gm/cm3) hollow foamed bricks with strength varying from (50-260 kg/cm²) was also prepared using red mud and approximate 1 % proprietary foaming agents. These hollow foamed bricks may find extensive application in cost effective construction of multi-storied building. Accordingly, an experimental model has been designed for the development of light weight foamed bricks from red mud with minimum processing steps.

The average chemical composition of red mud and fly ash in percentage weight used for the study is shown in Table - II. A two component raw materials consisting of red mud and fly ash were mixed in high speed mixer. The homogenized mass was made into slurry with water and foaming agents and molded in to bricks of standard size and shape. Bricks then fired at elevated temperature in electric furnace for 1-2 hours. An ideal composition range of 30-60 % red mud and 0.25-1% foaming agents in LWFB were derived from the experimental trials.

The typical chemical composition of LWFB derived under the optimized experimental conditions is shown in Table – III.

JNARDDC conducted research activities for the development of light weight foamed bricks and optimized the experimental conditions in terms of better compressive strength, impact resistance, weight reduction as well as maximum red mud utilization (3). The laboratory R&D activities attained maximum utilization of 45-50% red mud in LWFB with density 0.9-0.93 cm-3.The firing temperature and foaming agent composition etc. were also optimized and a draft was submitted for patent filing.

It is envisaged that the utilization of LWFB from red mud in urban housing and construction activities will lead to (i) substantial reduction in the total weight of walls and partitions in multi storied buildings; thus reducing the foundation costs and total building cost (ii) the presence of all through tiny air filled cells (Fig. 1) provides excellent acoustic performance of foamed bricks and they are highly suitable for partition walls, floor screens / roofing and panel material in auditorium. (iii) The low thermal conductivity of LWFB provides low thermal exchange between inner and outer atmospheric conditions.

Table-1 Chemical composition of red mud Composition (%)

Sl.No	Al_2O_3	Fe_2O_3	TiO_2	SiO_2	CaO	Na_2O	LOI
1	17.82	57.50	3.72	3.80	0.84	4.32	11.33
2	22.40	33.20	10.80	7.60	11.32	5.80	9.90
4	18.00	27.50	18.50	8.20	6.90	9.11	14.00
6	21.00	33.90	11.20	19.30	5.78	3.90	9.40

Generated from bauxite of various geological origin and different plant conditions

Table - II

Sl.No	Parameters	Red mud	Fly Ash
1.	Fe_2O_3	40-70	2-7
2.	Al_2O_3	10-20	20-35
3.	SiO_2	3.-8	45-60
4.	TiO_2	2-7	0.5-2
5.	Na_2O	2-6	-
6.	CaO	0.5-3	-
7.	Loss on ignition (LOI)	6-12	-

Table - III

Major Constituents	Composition %
Fe_2O_3	16.96
Al_2O_3	25.20
SiO_2	49.24
TiO_2	2.65
Na_2O	1.37
CaO	1.68
LOI	0.59

Fig.1 Light weight foamed bricks from red mud

Fig.2 Light weight foamed slabs and tiles s made from red mud

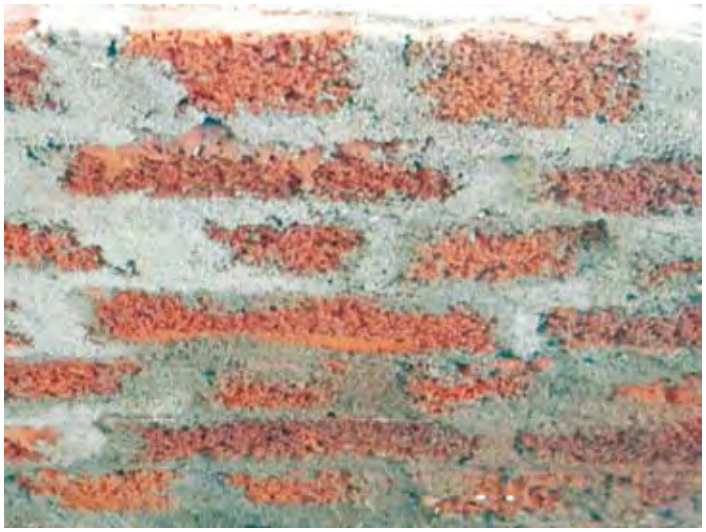


Fig.3 Partition wall made of LWFB

Hence it reduces the load on air conditioner during summer season and reduces energy consumption. The lightness and irregular porous structure in the material increases resistance against earthquake and causing less chance of loss / damage to human lives. The feasibility of developing such light weight slabs and tiles as shown in Fig. 2 was also studied. The possibility of utilizing LWFB for construction application was also verified (Fig.3).

Light weight foamed fly ash brick

A similar study was also conducted with fly ash for production of light weight foamed fly ash bricks (LWFFB). In-house R&D work successfully developed light weight foamed fly ash bricks similar to red mud foamed bricks. The physical properties of fly ash and red mud bricks are found to be comparable.

Production of glass ceramic tiles from red mud

Glass-ceramics are fine-grained polycrystalline materials formed when glasses of suitable compositions are heat treated under controlled condition (4, 5). One or more crystalline phases may form during heat treatment and their compositions are normally different from the precursor (parent) glass.

The mechanical properties of glass-ceramics are superior to the parent glass. Laboratory studies

were carried out in developing glass ceramic tiles using a mixture of red mud, fly ash / sand and glass forming substance. Combination of these materials produces glass ceramic tiles. These tiles have excellent glossy finish, good mechanical strength and abrasion resistance. The dark shades and colour of glass ceramic tiles can be varied by modifying the composition or adding coloring agents (6) and the results obtained are very promising. Glass ceramics tiles may be a cost effective substitute as compared to decorative wall tiles. The hardness, abrasion resistance and textures of glass ceramic tiles were also varied by modifying the composition of additives.

The mixture consists of 40-80% red mud, 0-35% fly ash (or similar siliceous material) with few other oxides and coloring agents. The homogenized dry mixture was heated at elevated temperature till it turned into bubble-free molten mass of a glassy substance. Subsequently, the melt was poured in to suitable molds, subjected to slow and steady de-vitrification for 1-20 hrs to obtain glass ceramic tiles of different texture and colour combinations as shown in Fig. 5. A comparative study on the physical properties of red mud glass ceramic tiles with regular tiles was carried out. The results of these studies are summarized in Table - IV.

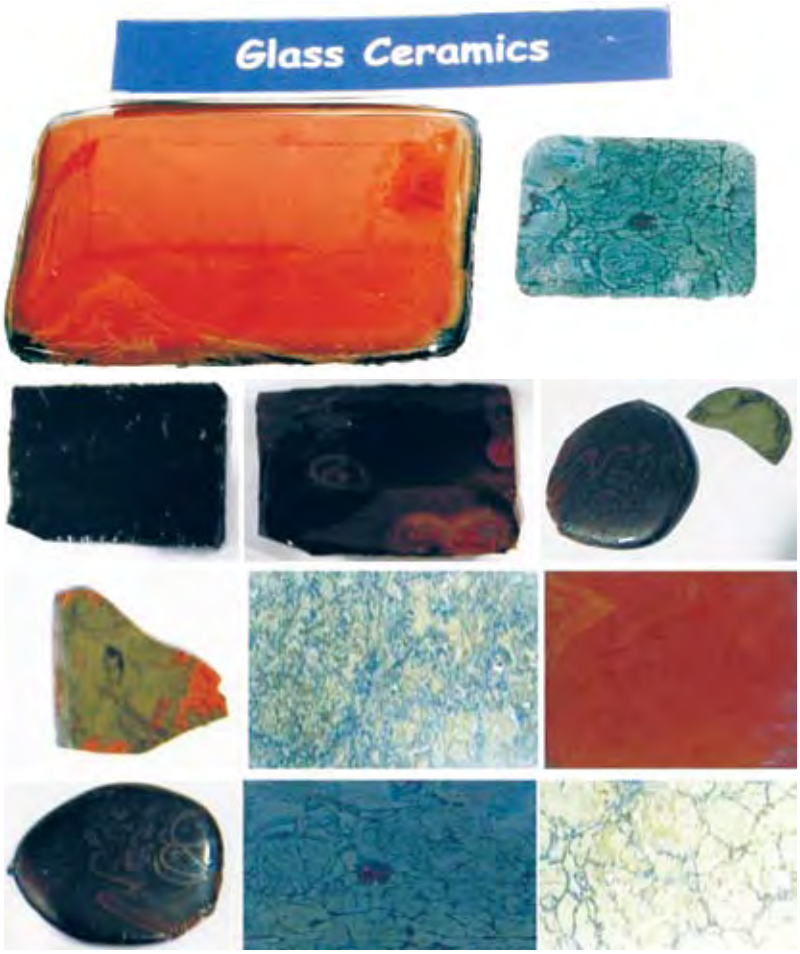


Fig. 5 Texture and colour of glass ceramic tiles made from red mud

Conclusions

There is a tremendous demand for all building material of high class as well as conventional items, such as, building brick, block, ceramic & roofing tiles and stone chips for construction and infrastructure developments. Utilization of red mud and fly ash preserve considerable quantity of natural resources such as clay, sand and soil required for making normal bricks, tiles, stone chips etc. In the process, dual ben

Contd. on Page 47....

Table- IV Physical properties of glass ceramic tiles made of Red mud

Comparative Data on Properties on Red mud and Ceramics Tiles			
Mating surface	SiC paper # C – 1000		
Track length	20 cm		
Specific Wear Rate kg/m² at			
Sample different load	0.2 kg	0.45 kg	0.65 kg
Red mud tile 1	8.0×10^{-4}	8.2×10^{-4}	9.4×10^{-4}
Red mud tile 2	6.6×10^{-4}	7.5×10^{-4}	7.6×10^{-4}
Ceramic tile (commercial)	9.9×10^{-4}	12.5×10^{-4}	13.5×10^{-4}

Demonstration Construction
with 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 Bitna Road, Pinjore, Distt.Panchkula, Haryana

The Council has undertaken construction of 24 (G+1) Demonstration Houses with Community Centre & Multi-purpose Meditation Room at Bitna Road, Pinjore, Distt.Panchkula, Haryana. Having built up area of 38.22 sq.mt. each Unit consist of one living room, one bedroom, kitchen,one separate bath and WC. The project includes onsite infrastructure facilities like pathways, septic tank, electrical works, Boundary wall etc. The Houses includes Earthquake Resistant Features. The technologies used are rat-trap bond in bricks, RCC filler slab, precast concrete door/window frames, etc. In the Community Centre and Multi-Purpose Meditation Room, the technology used are concrete blocks for walling, filler slab for roofing, micro concrete roofing tiles, precast concrete door/window frames etc. Finishing work of the project is nearing completion.

PROPOSED INITIATIVE

Demonstration Housing Project at Rai Bareli, Uttar Pradesh

PROJECT PROFILE

No. of houses	:	24 (G+1)
Built up area of each unit	:	32 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	:	Houses will includes Earthquake Resistant features and Rain Water Harvesting features.

TECHNOLOGIES/SPECIFICATIONS

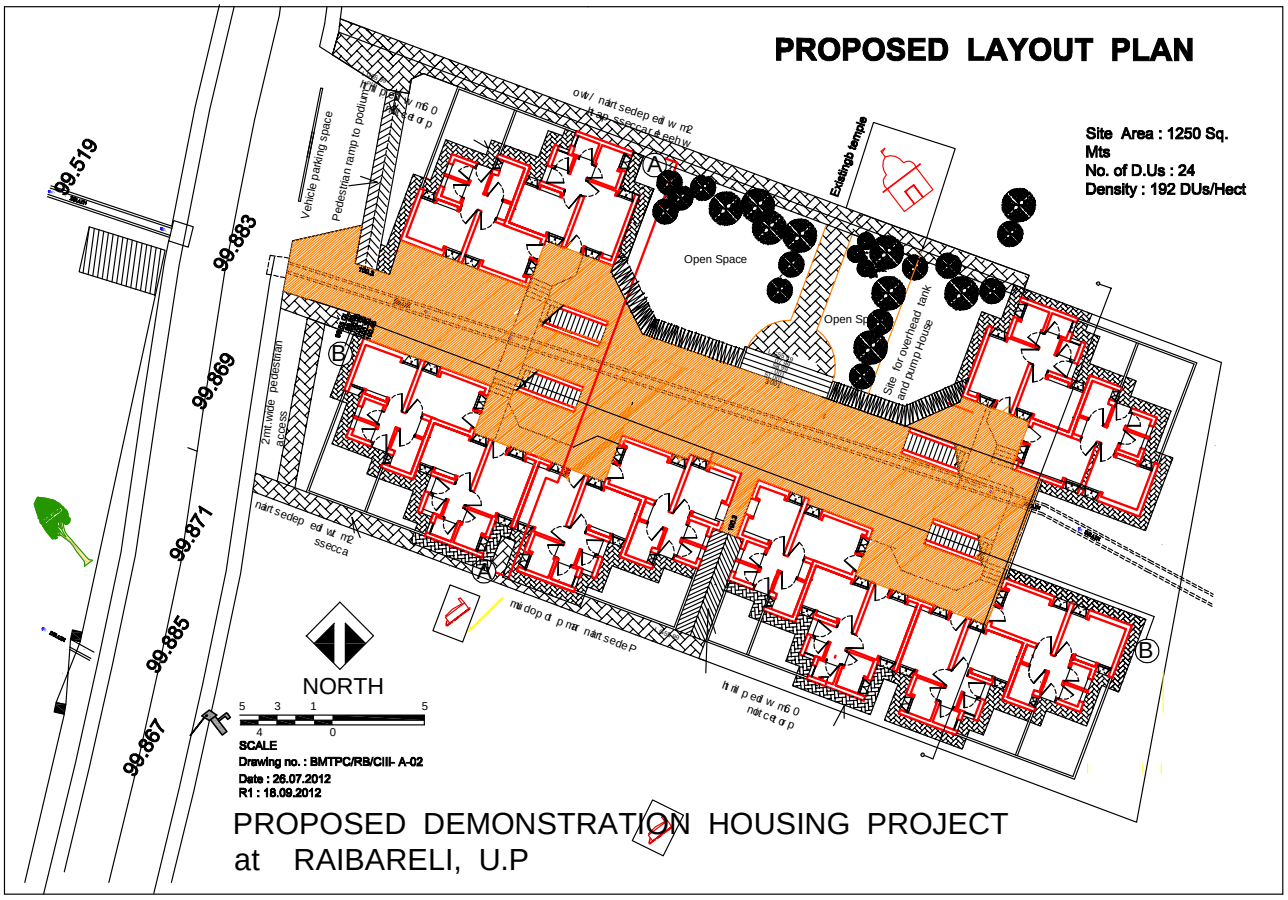
Walling
- Rat trap bond in bricks

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



Hydraform Interlocking Building System

*Deepak Davar**

Preamble

The Interlocking block masonry commonly known as Hydraform block masonry replaces the conventional brick and mortar based construction masonry. The other components of the conventional building system remain largely unchanged. The system is a dry stacked-Interlocking masonry and enables aesthetic and affordable building, speedier construction of high quality in stretcher bond. 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.

The system has originated from South Africa and has extensively been in use over different continents. A number of constructions have been made using interlocking building system in India over last few years.

Interlocking Masonry technical details and its innovative features

Interlocking Block

Interlocking Profile : The locking of a male face of one block with the female face of another or the locking of the bed of one block with the ridge of the one below it is called Interlock.

Bed and Ridge : The recessed under surface of the block is referred to as the bed. The raised top surface of the block is called the Ridge.

Block laying Courses : One (horizontal) layer of blocks is called a course. Height of a course = 115 mm.

Corners : Corner requirements are: Shaved ½ blocks is prepared. It must be remembered to shave off the ridge and male face of the corner block, as shown and further ensuring that the shaved ridge points upward and the shaved male face point's outwards. One must start the first course with a ½ block.

Compatibility for Reinforcement for Earth Quake Resistant Construction : The interlocking blocks can be easily reinforced (because of the grooves) against the Conventional masonry. All the relevant bands i.e. roof bands, gable Band, lintel band, cill band and plinth band etc. can be easily incorporated in the masonry (as per the requirements of the seismic design). Both vertical and horizontal Reinforcement can be provided by means of the

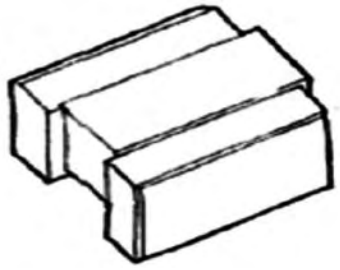


Figure 1: Interlocking Block

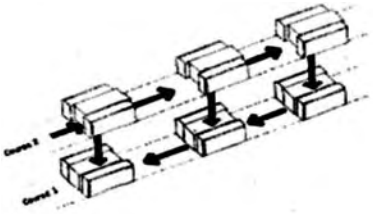


Figure 2: Placing of Interlocking Blocks

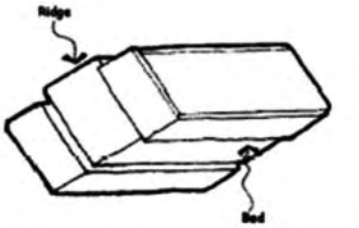


Figure 3: Bed and Ridge

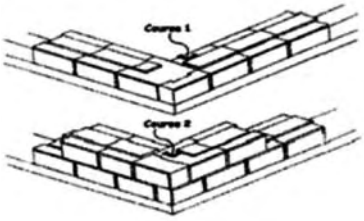


Figure 4: Course of masonry with bonding

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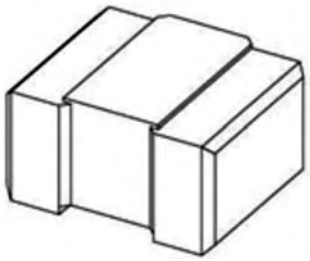
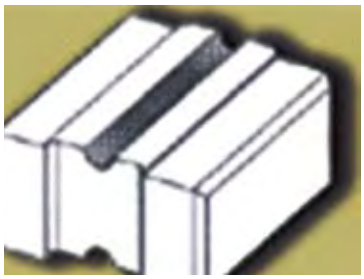
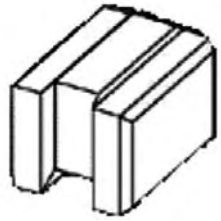


HF: 220mm



HF: 220 conduit



HF: 150mm

Figure 5: Size & Dimensions of Hydraform Interlocking Block

grooves. The sizes of the grooves can be increased also.

The Interlocking Building System

It comprises of three primary aspects:

(1) Interlocking Block
(2) Block making Machine
(3) Advantages of interlocked stacking of blocks

Table 1: Parameters for the Hydraform blocks

	H F 220 / Conduit	H F 150
Use	External Walls / Boundary wall	Interior/ Partition Walls
Width	220mm (9 inc)	150mm (6/4.5 ins)
Height	115 mm	115 mm
Length	100- 240 mm	100- 240 mm
Weight	9-11kg approx	4.5 -6 Kg approx

Other size options can be made depending on design requirement. Density can vary with raw material used and mix ratio.

The Interlocking blocks:

The blocks are of mainly of following size and dimension to suit standard application requirements. However size can be tailored for large quantity application requirements. Parameters for the Hydraform blocks are given in Table-1. Interlocking Masonry system.

Interlocking Masonry system

The interlocking dry stacked masonry comprises of compressed earth blocks/ fly-ash interlocking blocks that can be laid dry - stacked or using minimal mortar slurry in a stretcher bond.

Dry stacking is mortar-less method of constructing masonry. Except first two block layers above DPC and top two courses leading to roof band, blocks are not laid on mortar, they rely on the Interlocking mechanism to provide resistance to applied loads. Dry stacking results in reduction of building costs due to saving in construction time, reduced requirement for skilled labour and Costly material especially cement and reusability of the blocks. The requirement for unskilled labour makes dry stacking particularly attractive against labour based work.

There are many examples of dry stacked structures, one such being in the Egyptian Pyramids that relied on their self weight to resist external forces. Whereas

Figure 6 : Bonding -Steel Bars & Conduits

interlocking dry stacking utilizes interlocking mechanisms of shear keys as well as self -weight to resist the external loads.

As per the requirement of IS 4326:1993 (Indian Standard on Earthquake Resistant Design and Construction of Building- Code of Practice), a thin mortar of the specified type can be used even in these Interlocking types of the blocks.

With an extremely appealing face-brick finish that provides for pre-pointed straight masonry, these blocks gives flexibility of achieving the final finish.

The Masonry uses minimal or no mortar, construction is fast, blocks are produced on the site saving Transportation cost, Requirement of Skilled labour is less, blocks are water cured and do not require burning of Fuel, wall face surfaces are Even, Plastering is not required but can be done as an option, the thickness of the masonry can be controlled giving more carpet area and less cubic contents of the blocks, are the this masonry's advantages.

Block Compressive Strength

The HYDRAFORM Interlocking blocks/bricks when tested in accordance with IS 3495 Part I-1976 following minimum compressive strength after 28 days of curing was recorded.

Table 1. Hydraform SEB blocks

Class designation	Compressive strength in (N/mm^2)
(i) 30	not less than 30
(ii) 75	not less than 75

Table 2:Hydraform fly-ash blocks

Class designation	Compressive strength in (N/mm^2)
(i) 75	not less than 75
(ii) 100	not less than 100
(iii) 125	not less than 125

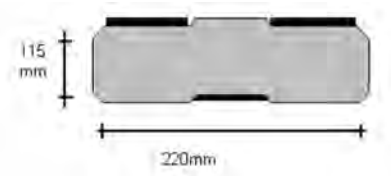
Compressive strength test procedure

Compressive strength test should be done in compression testing machine. Blocks should be placed between the jaws and load should be applied gradually. Precaution should be taken such that load should be applied to the flanged portion of the blocks. For this two steel plates of sizes 50mm x 240mm and thickness 10 mm are placed on top flange and gradual load is applied over the plates till the failure occurs and not the maximum load at failure. The load at failure shall be the maximum load at which the specimen fails to produces any further increase is the indicator reading on compression testing machine.

The compressive strength calculation shall be given below:

$$\text{Compressive strength} = \frac{\text{Maximum load at failure}}{\text{Average net area of flanged portion}}$$

The compressive strength of any individual block shall not fall below the minimum average compressive strength by more than 20%. (In accordance with IS: 1725-1982.)



Steel Plates: 50mm x 240mm x 10mm

Figure 7: Test Sample- Block with Bed Plates

Water absorption limit

The HYDRAFORM Interlocking blocks when tested in accordance with the procedure laid down in IS 3495 Part II-1976, after immersion in water for 24 hours, the average maximum water absorption was:

- For the blocks/bricks with (FAL-G (Fly ash/Cement) bricks/ blocks) not more than 15% (by weight).
- For the blocks/bricks with (SEB (Soil Earth Stabilized) bricks/ blocks) not more than 15% (by weight).

Drying shrinkage limit

The average drying shrinkage of the blocks when tested by the method described in IS 4139:1989. The average of three was not exceeding 0.15%.

Weathering limit

When tested in accordance with IS 1725-1982 Appendix A, the maximum loss of weight was not exceeding 5%.

Rainwater Penetration limit

Rain water penetration tests were conducted to evaluate the weather durability of the blocks. In a test, two test walls were constructed and subjected to the rain penetration test. This test was run for a 24hour period at a water spray rate of 40 –50 mm depth of water per hour. This test relates to a mean annual rainfall of more than 1000 mm and hourly mean wind speed of 30m/s. Both the test walls were coated with a cement based water proof finish on the external walls. The internal wall was plastered to a thickness of 10mm. After a 24hour period no dampness or leakage was recorded on the interior surface of either of the walls.

Relevant Indian Standards

The interlocking blocks (SEB and fly ash blocks) are in accordance with relevant Indian standards. The references are given in Table no 4.

Structural Performance

To evaluate the structural performance of the Interlocking blocks

masonry these test were conducted: -

- Load Testing
- Wind load testing.

Test Conclusion:

The Prism was made from Interlocking Block as per the procedure given in IS 1905, and the basic compressive stress was found to be quite satisfactory. Many test like shake table, Shock Table besides the prism test on this masonry have been done at many places and results were encouraging. However these are still under compilation stages.

Indian masonry design standard (IS 1905-1987) does not deal with dry interlocking block masonry, hence does not prescribe the design values for this masonry like basic compressive stress, tensile stress & shear stress. However the same code recognizes some other types of masonry and recommends that a prism test of different masonry may be done and these values may be accepted for designing the masonry.

This masonry, if is used with cement mortar or thin mortar slurry within the interlock, than it is governed by Indian Design Standard for Masonry i.e. IS 1905.

Construction Procedure

A dry stacked interlocking masonry is laid on conventional strip footing. Foundation walls are built with blocks of higher strength laid in mortar bed or even conventional type foundation. First course above DPC must be laid on mortar bed.

HUDCO has done a large number of construction using Hydraform Interlocking and other type of SEB (Soil stabilized Blocks), throughout India (Gujarat Earthquake Rehabilitation Works, Vivekananda Kendra, Kanyakumari, Development works around Qutub Minar, Delhi, PWD, BMTPC and host of private construction organisations have used Hydraform interlocking masonry all over India and found these blocks suitable for masonry. While some projects used dry stacked interlocking masonry, whereas other used, cement slurry in the groove to join these blocks, as per IS 1905, as Indian Design Standards do not recognizes the Interlocking block based masonry, concept yet.

Different conventional finishes can be applied to suit the aesthetic needs of the owner. The Construction details are as per Figure No 2 & Figure No 4. The Horizontal Bands are as per Figure no 6 and vertical Bands as required may be incorporated.

Suitability of Interlocking Block works in:

Load Bearing Masonry

Since blocks are on 220 mm width and can be made of block strength > 75 N/mm^2, same can be safely used for Load Bearing construction. Depending on structural requirements of the building and zonal building codes, appropriate RCC bands can be used. Extensive Tests have been conducted from time to time for conformity of dry stacked masonry. Fly Ash based interlocking blocks can be made of higher compressive strength to suit the Load bearing construction requirements beyond Ground floor to suit structural requirements. In terms of IS 1905, masonry can be done with thin mortar slurry of 1:3 to satisfy this requirement.

Framed Structure Masonry

Framed construction mainly require brick / block work to be used as an infill only, therefore dry stacked interlocking block work can be used in out walls of +- 220 mm thickness. For block work of lesser width it is recommended to validate the structural design and use mortar slurry in the blocks. Blocks have standard height of 115 mm makes it easier to design the beam height for required number of courses. Ends with beams and columns are same as in brick work.

Reinforced Masonry

Interlocking blocks with horizontal and vertical cavity provide and ideal solution for using reinforcements to suit the structural design requirements, of reinforced masonry.

Table 4: Bureau of Indian standards

IS 12984: 1990	Fly –ash- lime bricks-specification
IS 2110: 1980	Code for practice for in situ construction of wall in building with soil cement
IS 1725:1982	Specification for soil-based blocks used in general building Construction.
IS 4326: 1983	Earthquake resistant design and construction of building code of practice
IS 3495: 1992	Method of tests of burnt clay-building bricks
	Part (1) Determination of compressive strength
	Part (2) Determination of water observation
	Part (3) Determination of efflorescence
IS 13759: 1993	Fly ash building bricks specification.
IS 1905: 1987	Code of practice for structural use of unreinforced masonry.
IS 1893: 2003	Indian standard for Seismic Zoning & Earthquake resistant design.
IS 5454: 1978	Method for sampling of clay building bricks.

Figure 8: Building with Hydraform Dry Stacked Interlocking Blocks

Boundary Walls

Dry stacked Interlocking block work is well suited for this application and is very fast, aesthetic and cost effective. Depending on height, Area, application, Width and other parameters structural design can be done to adopt intermittent columns, and band can be designed. Conduit blocks can also be used for intermittent reinforcement to act as beam / Column.

Advantages of Hydraform Interlocking masonry over conventional masonry

- Cost Effective against conventional masonry
- Structurally compatible for Earthquake resistant construction
- Density of masonry can be reduced in the range of 1300 - 1700 kg/m^3 against the Conventional fired brick system (1920 kg/m^3) in terms of unit weight.
- High finish blocks so made result in exposed finish aesthetic walls, saving on plaster & finishes.
- High quality product in terms of technical parameters and aesthetics.
- Speedier construction.
- blocks can be made with lower water absorption
- Dry-stacked masonry results in speedier construction.
- blocks can be made with reinforcement / conduit features facilitating Earthquake resistant construction.
- Blocks made and interlocking masonry are eco friendly and suitable for Green building construction
- Lower embodied energy against conventional masonry
- Training & Technical support
- Local/ unskilled labour can be constructed.

Figure 9: Vertical Steel in Masonry

Figure 10: Boundary wall with Interlocking Blocks

- Can be used as exposed brick finish.
- Suitable for use of locally available materials and for tropical regions
- Lower maintenance over life cycle
- Better Thermally capacity over conventional materials
- Since raw material and density can be changed, it is possible make blocks as per required U values
- Fly ash blocks have better fire safety rating
- Plumbing, conduiting and chase cutting is possible as in conventional masonry
- Plaster is optional
- Independence to make at site of construction.
- Adoptability for using hardware, doors, plumbing and electrical system available in India
- Adoptability for any alterations/ additions in future, if necessary

World wide applications

The Hydraform Blocks and interlocking masonry has been in use in over 50 countries world wide including lot of developing countries where there is a net shortage of housing and has tropical weather. The masonry is compatible and structural design can be easily aligned with local building bye laws. Many of the locations use soil stabilized blocks whereas other places use locally available waste like fly ash, husk ash, marble powder while blending with sand & cement to make the blocks.

The masonry has successfully been used in construction of Houses, community centres, ware houses, industrial sheds, Factories, Building Complexes, Schools, Shopping Malls, commercial structures and Security / Boundary Walls etc.

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.....Contd. from Page 39

efits are achieved in terms of (i) utilization of waste i.e. red mud and (ii) environmental sustenance.

Furthermore glass ceramic products recyclable. If required, the used material can be processed for remolding for future use and it is noted that the utilization of above products in urban housing and building applications will address environmental problems as well as promotion of greener technology for recycling and utilization of secondary resources to a larger extend.

References

1. J. C. Knight, A.S. Wagh, W. A. Reid, Materials Science Laboratory, The mechanical properties of ceramics from bauxite waste, Journal of Materials Science 21(6)1986, 2179-2184.
2. M. Sglavo, R. Campostrini, S. Maurina, G.Carturan, M. Monagheddu, G. Budroni and G. Cocco, Bauxite 'red mud' in the ceramic industry, Part 1: Thermal behaviour,Journal of the Europian Ceramic Society, 20 (3) 2000, 235 -244.
3. Process for preparation of light weight foamed bricks (LWFBs) utilizing red mud and fly ash admixtures, Patent Filed, No. 1051/KOL/11.
4. McMillan, P.W., Glass-Ceramics. 2nd ed. Non-Metallic Solids, ed. J.P. Roberts. Vol. 1. London: Academic Press Inc. (London) Ltd. (1979)
5. Hölland, W., Beall, G., Glass-Ceramic Technology, The American Ceramic Society, Westerville, OH, (2002).
6. Process for preparation of glass ceramic tiles utilizing red mud as the main base material, Patent filed, No. 1045/KOL/11.

Green Building Materials - Quantification of Embodied Energy of Houses

*Deepak Bansal**

Introduction

Any Building construction primarily requires building materials comprising of Cement, Steel (Reinforcement), Bricks/ Blocks, Sand, Aggregates, Water, Glass, timber, Insulation materials, marble/granite/tiles, Plumbing and Electrical wares etc. Out of these , Bricks/Blocks consume major share of cost and Embodied Energy in any building construction and especially in Housing units in those countries, which do not emphasize on HVAC systems, for tropical climatic conditions like India.

To understand the Cost effectiveness and sustainability of housing units up to 25 sqm of plinth area, scores of such houses are analysed in HUDCO (Housing & Urban Development Corporation Limited, New Delhi, India) and a hypothesis is formed. The houses analysed, were cost effective houses conforming to all building bylaws and local climatic and living conditions and are presented in this paper.

The housing typology studied in the present case study is defined in **Table 1**. The Design of the typical housing typology is given in **Plate 1.** In a single, two, three and four storied building, the consumption pattern of basic building materials, is as defined in **Table 7.** This is derived based on an average Carpet area of housing unit as 21 sqm and wall area in plan is 20%, having a total plinth area of 25 Sqm per unit[2].

Different building materials have different physical, structural properties, and different costing parameters, which are also presented in this paper. The Thermal comfort of different building materials have not been analysed in the present case.

- Here the Houses are reinforced with horizontal and vertical RCC Bands as per the requirements of seismic provisions given in IS 4326:1993, as per class C Buildings (Seismic Zone III with Importance Factor 1.0) [3].
- The Houses are having same foundation up to two storied Houses (750x750mm continuous spread stepped footing) and in three & four Storied Houses, foundations are slightly increased to (900 x 900mm / 1000 x 1000mm) continuous spread stepped footings) for a soil Bearing Capacity of @ 11 T/sqm (nett.).
- Vertical Steel has been provided from foundation to top RCC slab in Three & Four Storied houses only.

Different Building Materials available

Till today there is no alternate for Cement, steel, sand or aggregates for any mass housing Project in India, but there are good options for substitution of Bricks/Blocks. Many of these options have been used in different construction projects and have shown encouraging results. The National Building Code (NBC) of India 2005 and Bureau of Indian standards(BIS) have recognized the specifications of these building materials and have prepared Indian Standards on them. The Compressive stress, Tensile & shear stress, slenderness ratio, weathering effects, water absorption, hardness, dimensional stability, Poisson ratio, etc. have been defined. Some of the commonly used Alternative Bricks/Blocks & their specifications are listed in **Table 2.**

Embodied Energy of Building Materials:

The embodied energy is the total quantification of energy required in making of the building materials from excavation, handling, transportation, process, and final usages in the buildings. The production process and transportation lead distances of

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Table 1- Brief Specifications of Housing Typology Studied [2].

S. No.	Specifications	
1	Structure	Load Bearing Structure
2	Walls	230/200 mm thick brick masonry in 1:6 (cement: coarse sand) mortar
3	Roof	Flat RCC roof (M25 concrete),115 mm thick TMT Fe 500 D Steel reinforcement
4	Flooring	40 mm thick cement concrete (1:2:4)
5	Skirting in Rooms/Dado in Toilets & Kitchen	12 mm thick 300/1200 mm high in 1:6 (cement: coarse sand) mortar
6	Plaster/Rendering	12/15mm thick 1:6 (cement: coarse sand) mortar
7	Mud Fuska/Terracing	100 mm thick (average) with brick tiles
8	Parapet	900mm high 115 mm thick brick masonry in 1:4 (cement coarse sand) mortar
9	Joinery and Doors	MS Frames with steel grill and 4 mm float glass panel in windows, Flush Door Shutters.
10	CC Gola/Khurrah/coping	1:2:4 PCC (Plain cement concrete)
11	Earthquake Resistant Features	RCC Plinth/Lintel Bands for all and Vertical Steel in 3rd and 4th floor buildings only.

Table 2- Different Building Bricks/Blocks Available [6]

Building Material	Size (mm)	Comp Strength (N/Sqm)MPa	Weight (N)	Density (KN/Cum)	EEV (Block) MJ	EEV (MJ/N)
Fired Clay Brick (conventional)	229x114x76	7.5	27.5	13.86	4.5	0.164
Hollow Cement concrete block	400x200x200	4.0	268.8	16.80	11	0.041
AAC/CLC	400x200x200	4.0	192	12.00	11.5	0.060
Fal G Block	300x200x150	7.5	180	20.00	7.9	0.044
Solid Concrete Block	300x200x150	7.5	216	24.00	10.4	0.048
HF SEB (soil-cement block)	230x220x115	5.0	110	18.90	6.1	0.055
HF (fly ash block)	230x220x115	7.0	95	16.33	5.3	0.056

Table 3- EEV of basic construction materials [4]

Items	EEV (MJ)	Units	Sizes in mm
Soil	0	0	0
Cement	0.67	MJ/N	0
Sand	0	0	0
Fly ash	0	0	0
Steel	3.20	MJ/N	0
Standard Burnt Bricks (Fired Clay)	4.50	MJ/Bricks	229*114*76
Clay Fly ash Bricks	2.32	MJ/Bricks	200*100*100
Sand Lime Bricks	2.79	MJ/Bricks	200*100*100
Hollow Cement Concrete Blocks	11.00	MJ/Blocks	400*200*200
Aerated Blocks	11.50	MJ/Blocks	400*200*200
Fal G Blocks	7.90	MJ/Blocks	300*200*150
Solid Concrete Blocks	10.40	MJ/Blocks	300*200*150

Table 4- Properties of Hydraform block (Hydra form India (P) Ltd) [5]

Basic Data:

Block Dimension(mm)	Length(mm)/ Width (mm)/ Height(mm)
	230 / 220 / 115
Production Capacity of machine by working for 8 hours	2800
Weight of Soil based block(kg)	11
Weight of Fly ash based block (kg)	9.5
Total weight of Soil based mix (kg)	30800
Total weight of Fly ash base mix(kg)	26600
Volume of each Block (in cu.m)	0.006
Total volume of blocks produced (cu.m)	16
Density of soil base block(per cu.m)	1890
Density of Fly ash base block(per cu.m)	1633

building materials are not uniform in any country; hence there is no consensus on EEV (Embodied Energy Values) of different building materials. However the values assumed in this case are taken from a paper published in the Journal of institution of Engineers (India) as represented in **Table 3:**

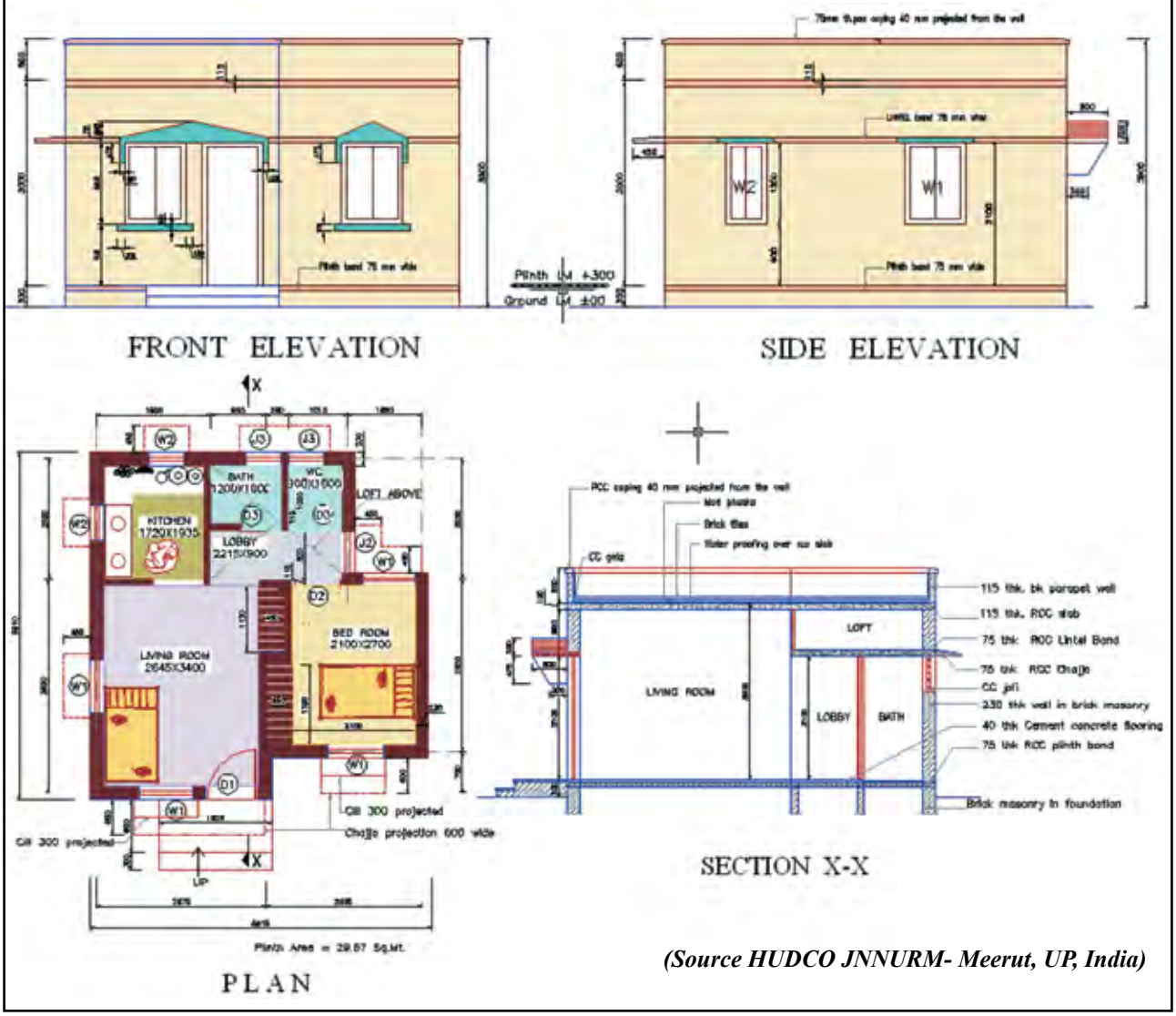
The EEV indicated in **Table 3**, are without adding for handling/ transportation inputs. Apart from these, there are soil stabilized blocks, made by manual press and hydraulic press, with or without fly ash, which can be used in load bearing masonry construction. The proportion & specification of manufacturing process of the soil stabilized blocks manufactured by Hydra Form (HF) machine is given below in **Table 4.**

The calculations for the EEV of interlocking SEB (stabilized earth block) using Hydra form machine and fly ash interlocking block using Hydra form machine are given below in Table 5 and Table 6 respectively.

Table 7 to **13** above, demonstrates the building materials requirement in different storied building construction and nos of brick/ Blocks required per sqm of plinth area. This also illustrates that Four Storied (G+3) is the most optimum type of Construction of housing units in India in terms of material requirements. There is marginal increase in steel quantities, which is getting off -set by other materials.

Computation of EEV of housing units: The EEV of the Basic building materials and the quantities of the basic building materials is available, which enables us to calculate the EEV of housing units per Sqm of Plinth area. This will give designers a fair idea regarding the energy

PLATE-1, Typical Drawings of the Housing Typology Chosen in the Study:



(Source HUDCO JNNURM- Meerut, UP, India)

Table 5- EEV of SEB block (Hydraform India (P) Ltd) [5]

Raw Material (for 2800 blocks)	% age	Weight (kg)	EEV (MJ)
Soil	62.00	19096	0
C. Sand/ St. Dust	30.00	9240	0
Cement	8.00	2464	16509
Total	100.00	30800	16509
Power : 18.5 kwh x 8 hr x 3.6 MJ			533
Total EEV per day production			17042
EEV per Hydra form Block (SEB) (size: 230 x 220 x 115) in MJ			**6.09**

Table 6- EEV of fly ash block (Hydraform India (P) Ltd) [5]

Raw Material (for 2800 blocks)	% age	Weight (kg)	EEV (MJ)
Fly Ash	65.00	17290	0.00
C. Sand/ St. Dust	27.00	7182	0.00
Cement	8.00	2128	14258
Total	100.00	26600	14258
Power : 18.5 kwh x 8 hr x 3.6 MJ			533
Total EEV per day production			14791
EEV per Hydra form Block (Fly Ash) (size: 230 x 220 x 115) in MJ			**5.28**

Table 7- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with fired clay bricks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	Fired Clay Bricks	No	460	366	369	345
2	Cement	Bags of 50 Kg	5	4.4	4.3	4.2
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.65	0.56	0.55	0.53
5	Aggregates	Cum	0.45	0.39	0.38	0.36

Table 8- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with Hollow Cement Concrete Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	Hollow CC Block of 400x200x200 mm	No	60	47	47	44
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

Table 9- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with AAC Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	AAC Block of 400x200x200 mm	No	60	47	47	44
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

Table 10- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with FalG Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	FalG Block of 300x200x150 mm	No	105	82	83	77
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

Table 11- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with Solid CC Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	Solid CC Block of 300x200x150 mm	No	105	82	83	77
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

footprint of the housing units (but without adding for handling, transportation and sundries energy as this aspect has innumerable variations in Indian context). This is explained in **Tables 14** & **15.**

Hence from Embodied Energy Values pespective Two Storied (G+1), Load bearing structure is the best model in this situation and Four Storied Housing is also very close to Two Storied Housing in terms of Embodied Energy Values. More options have not been worked upon as Indian Standards IS 1905 do not allow unreinforced Load bearing Construction higher than Four Storied (G+3) in India, due the different loading and wall slenderness combinations.

However this masonry option, although widely practised in India, is not energy & cost efficient, as the EEV of Fired Clay Brick is much higher compared with other building blocks options available and wall thickness is also 230 mm, whereas in other options wall thickness can also be controlled as other blocks can be designed as per requirement.

Comparison

In this exercise attempt is made to draw a comparison between conventional building blocks (Fired Clay Brick) with other commonly available options and draw a parallel to understand the energy and cost footprint of the building for a chosen housing typology in India, with only one variable i.e. building block.

This gives a broad idea that the correct application of building blocks can influence economies of scale on energy and cost without compromising on functionally and structural performance of the building.

Table 12- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with HF SEB Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	HF SEB Block of 230X220X115 mm	No	150	117	118	110
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

Table 13- Consolidated statement of Basic Building Materials requirement per sqm of plinth area of a load bearing housing unit up to 25 sqm of Plinth Area, for House constructed with HF Fly ash Blocks

S No	Item	Units	Single Storied	Two Storied	Three Storied	Four Storied
1	HF Fly ash Block of 230X220X115 mm	No	150	117	118	110
2	Cement	Bags of 50 Kg	4	3.4	3.5	3.3
3	Steel	Kg	16	15	18	18
4	Sand	Cum	0.55	0.46	0.46	0.44
5	Aggregates	Cum	0.40	0.35	0.34	0.33

Table 14-EEV per sqm of Plinth area of Houses

S No	Type of Masonry	Single Storied	Two storied	Three Storied	Four Storied
1	Fired Clay Brick	4257	3597	3677	3516
2	Hollow CC Block	2512	2153	2256	2176
3	AAC Block	2542	2177	2280	2198
4	Fal G Block	2681	2285	2390	2300
5	Soild CC Block	2944	2490	2597	2492
6	HF SEB	2767	2352	2457	2363
7	HF Flyash	2647	2258	2362	2275

Table 15- Comparative Chart for EEV with different Masonry option for a Single Storied House per sqm of Plinth Area

S No	Masonry with following	EEV(MJ)/sqm of plinth area	% Saving
1	Fired Clay Brick	4257.00	0
2	Hollow concrete Blocks	2512.00	41
3	AAC/CLC Blocks	2542.00	40
4	HF Flyash Block	2647.00	38
5	FalG Block	2681.00	37
6	HF SEB Block	2767.00	35
7	Solid Concrete Block	2944.00	31

Table 16- Comparative chart for EEV of 1 sq. m. of Masonry with different building materials (Prices in Indian Rupees for the Year 2012)

Building Materials	Sizes(mm)	Wall thickness (mm)	No of Blocks/ Bricks required per sqm of Wall Area	Cost/cum (INR*)	Cost/Sqm (INR*)
Standard Burnt Brick (Fired Clay Bricks)	229x114x76	230	116	4000	920
Hollow cement concrete blocks	400x200x200	200	13	4000	800
AAC Block	400x200x200	200	13	5000	1000
FalG	300x200x150	200	23	5000	1000
Solid CC Block	300x200x150	200	13	5000	1000
HF SEB(soil cement blocks)	230x220x115	230	40	5000	1150
HF(fly ash blocks)	230x220x115	230	40	5000	1150

1 USD is about 50 INR as on April 2012.

Conclusion

The exercise shows that Hollow Cement Concrete Blocks uses least cost (INR 800 per sqm of wall area) and least energy (2512 MJ per sqm of Plinth area) of Housing unit, which is 41 % less than Fired Clay Brick house and have less wall thickness (200 mm compared to 230 mm in case of Clay fired Bricks), resulting in more carpet area.

IMS Journal [11] also reported that thermal performance of brick houses is also much better than that of Timber houses with insulation, giving a boost to Hollow Cement Concrete Blocks as they offer better thermal properties than Fired Clay bricks .Translating the above benefits of inherent thermal properties to Energy Efficiency shall form a separate study.

It is proposed to carry out further exercise for other building materials also up to Four storied, to understand the EEV of the other types of buildings also.

References:

1 Report of the Technical Group [11th Five Year plan: 2007-12] on Estimation of Urban Housing Shortage in India;

2 Bansal Deepak, Affordable houses & Cost Effective Technologies, Hudco Darpan, Issue 4, October 2008, pp. 29-30, www.hudco.org;

3 IS 4326:1993, Indian Standard on Earthquake Resistant Design and Construction of buildings-Code of Practice (Second Revision) www.bis.org.in;

4 IE (I) Journal-AR-, vol. 84, October-2003, Dr P S Chani, Dr Najamuddin, and Dr S K Kaushik) pp. 47-50;

5 Hydra Form Asia (P) Ltd, New Delhi, India. Website www.hydraformasia.com;

6 Bansal Deepak, et el, International Conference on Structural Engineering, Construction and Management, Kandy, Sri Lanka, Dec 2011, pp. 3;

7 Bansal Deepak, Masonry from Stabilized Earth Blocks-sustainable & structurally viable Option, International Journal of Earth Sciences and Engineering, ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp. 772-779;

8 Bansal Deepak, Nandy Pooja & Safaya Manju, et el, Sustainable Urban Development & Bio Diversity, Hudco Shelter, Vol. 13, No 1&2, Oct 2011, pp. 15-28;

9 Bansal Deepak, et el, embodied energy in residential cost effective Housing, International Conference on Sustainable Built Environment, Kandy, Sri Lanka, Dec 2010, pp.D11;

10 Bansal Deepak, et el, embodied energy in residential cost effective Housing, TERI-BMTPC Conclave, New Delhi, India, Nov 2010;

11 T H McNeilly, For Energy Conservation in Houses, Construction Mass out Performs insulation in most Australia. Journal of International Masonry society UK.

This is authors personal research, HUDCO may or may not agree with the same.

Rajiv Awas Yojana – RAY of hope for Shelterless Urban Poor in India

*C. N. Jha**
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The National Urban Housing and Habitat Policy, 2007 envisages sustainable development of all urban human settlements, duly serviced by basic civic amenities for better quality of life for all urban citizens. The Policy, 2007 also lays special emphasis on provision of social housing for the EWS/LIG categories so that they are fully integrated into the mainstream of ecologically well-balanced urban development. At the beginning of 11th Five Year Plan, the housing shortage was estimated to be 24.7 million & the same at the end of plan period including the backlog has been computed as 26.53 million. Urban areas in our country are also characterized by severe shortage of basic services like potable water, well laid out drainage system, sewerage network, sanitation facilities, electricity, roads and appropriate solid waste disposal system. Almost a quarter of the country's urban population lives in notified and non-notified slums –even higher in the metros, is an indication of lack of vision in urban planning system, urban land management practices and land legislation that have not been able to adapt to the pace or profile of indigenous urban growth. As urbanization grows, and the share of urban households is expected to rise in the next two decades from the current 28% to 50% of the country's population, we may expect that slums will grow, seriously crippling the productive capacities of a growing number of people by the denial of basic services, shelter and security, increasing inequity and retarding the productive potential of urban areas.

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) with its separate sub-mission on the urban poor comprising of the Basic Services for Urban Poor (BSUP) and the Integrated Housing and Slum Development Programme (IHSDP) has been successful in achieving the overarching aim of focusing State attention on the problems of inequity in urban areas, and drawing budgetary resources to the welfare of the urban poor. There is an increasing assumption of responsibility towards the slum dwellers, and their entitlement to conditions conducive to a dignified quality of life. Simultaneously, there is an acceptance at policy level, both in the State and the municipality, that the emergence of new slums can be prevented only by increasing the availability of affordable housing.

The foundation laid by the above initiatives now needs to be built upon, by unlocking the potential of the most important asset in the context of slums in cities i.e. land, through assigning legal property rights to the urban poor. It is in this regard that Rajiv Awas Yojana (RAY) introduces a bold new vision and a new direction,viz., a Slum free India, in which those who live in slums are enabled to aspire for formal acceptance in urban areas by the assignment of property rights to them over their dwelling space.

Rajiv Awas Yojana envisages a 'Slum-free India' with inclusive and equitable cities where every citizen has access to basic civic and social services and decent shelter. It aims to achieve this vision by encouraging States/Union Territories to tackle the problem of slums in a definitive manner, by a multi-pronged approach focusing on:

i) Bringing all existing slums, notified or non-notified within the formal system and enabling them to avail the same level of basic amenities as the rest of the town;
ii) Redressing the failures of the formal system that lie behind the creation of slums; and
iii) Tackling the shortages of urban

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land and housing that keep shelter out of reach of the urban poor and force them to resort to extra-legal solutions in a bid to retain their sources of livelihood and employment.

Thus, the main focus of RAY is an integrated approach aimed at bringing within the formal system those who are denied of right to services and amenities available to those with legal title to city spaces, and at correcting the deficiencies of the formal system of urban development and town planning that have failed to create conditions of inclusiveness and equity; so that, henceforth, new urban families, whether by way of migration or natural growth of population, have recourse to housing with municipal services, and are not forced to create encroachments and slums and live extralegal lives in conditions of deprivation of rights and amenities.

The choice of cities would be made by the States, according to their aspirations and financial and resource arrangements in consultation with the Centre that will oversight as to adherence to the spirit and guidelines of the scheme. About 250 cities, mainly Class I, are expected to be covered by the end of the Twelfth Five Year Plan.

Central Government support under RAY

Fifty percent (50%) of the cost of provision of basic civic and social infrastructure and amenities and of housing, including rental housing,- and transit housing for in-situ redevelopment -in slums would be borne by the Centre, including O&M of assets created under this scheme. However, for the North Eastern and Special Category States, the share of the Centre would be 90% including the cost of land acquisition, if required. The decision would be left to the State/ UT as to the sharing of this amount between infrastructure costs and shelter subsidy, and the means of raising their matching share, subject to the following advice:

a) That provision of infrastructure and civic amenities will be by State, and no cost will be passed on to the slum dwellers.
b) That state share should come to a minimum of 20% of the cost of provision of infrastructure and civic amenities, to ensure their financial and monitoring stake in the works.
c) A minimum beneficiary share of 12%, (10% in the case of SC/ST/ BC/OBC/PH and other weaker sections) of the cost of the shelter is recovered from the beneficiary, so that it has value to him/her; and where the beneficiary is a vulnerable female-headed household, a household with one member physically or mentally handicapped, etc., the state may not ask for more than the minimum contribution;
d) From other beneficiaries, asking for a larger contribution will be a state decision, but in such cases, there will be a ceiling on beneficiary share so that the EMI burden created on him is in no case more that 25% of his/her monthly household income.

Pilot projects under Rajiv Awas Yojana

With the aim of evolving, demonstrating and establishing models that can thereafter be scaled, Govt. of India has decided to take up pilot projects to incentivize innovation and encourage new approaches and solutions that can demonstrably improve the quality and quantity of shelter and services for the poor. These innovations could include:

i) Projects with strong community participation i.e. Slum upgradation/ redevelopment projects initiated/spearheaded by the community; or with their demonstrable involvement and participation in design, planning and implementation.
ii) Creation of fresh rental housing stock and transit shelters.
iii) New models of public-private partnerships whereby the private sector can be encouraged to take up affordable housing for the EWS/LIG.
iv) Innovations in planning, demonstrating integrated livelihoods, shelter and services ; or convergence
v) Innovative or cost effective and green building design and technologies.
vi) Financial innovations in delivering the city/state wide programme (Community fund, incremental savings, PPP fund, etc)
vii) Any other innovation for which the city feels it needs to design models and determine guidelines for larger application.

Role played by BMTPC

BMTPC has been contributing as an appraisal and monitoring agency for BSUP & IHSDP components of JNNURM under the aegis of Ministry of Housing & Urban Poverty Alleviation, Government of India. Ministry has now entrusted the work of appraisal of Pilot projects under Rajiv Awas Yojana.

Following Pilot projects appraised by BMTPC have been approved /considered by the Central

Sanctioning cum Monitoring Committee, the competent authority to sanction projects at Central level.

i) Keshavnagar Slum Insitu Redevelopment Project, Hyderabad, Andhra Pradesh

The proposal envisages construction of 334 new dwelling units on 240 plots along with basic infrastructure in in-situ redevelopment mode while adopting whole slum approach & participation of community. The innovative approach/components adopted in the project include:

- Community participation & willingness for proposed design of housing lay out & overall project layout
- Fresh Transit housing (894 Numbers), &
- The revenue generated from some portion of slum land (expected to become free as a result of prposed in-situ redevelopment) under PPP development, has been proposed to subsidize beneficiaries contribution

Keshavnagar Slum Insitu Redevelopment Project, Hyderabad, Andhra Pradesh

ii) Rangamatia Cluster Improvement Project, Bhubaneswar, Orissa

In five slums of Rangmatia cluster, for 576 households (comprising of owners as well as renter households), both in-situ upgradation & rehabilitation in the form of G+ 3 structures (608 new Units) on Govt. land within the cluster has been proposed. In addition, 384 number of transit accommodation has also been proposed. The innovative approach/components adopted in the project include:

- The Proposal envisages rainwater harvesting or storage system to capture at least 50% of the runoff volumes from the roof

Rangamatia Cluster Improvement Project, Bhubaneswar, Orissa

surfaces.

- At least 2.5% of the total building materials by cost used in incremental housing intervention have been proposed to be salvaged material – namely laterite blocks that has been used earlier.
- At least 50% (by cost) of all new wood used in the building are to be either FSC (Forest Stewardship Council) certified or the local Forest Department certified wood.
- The Proposal envisages using only such water fixtures as have low average flow rate / capacities.

iii) Dhall Mill Area slum under Rajiv Awas Yojana (RAY Pilot Project-1), Vijaywada, Andhra Pradesh

The proposal envisages benefitting 304 households by construction of new dwelling units (19 blocks with G+3 configurations) with basic infrastructure in in-situ redevelopment mode at Dhal mill slum area while adopting whole slum approach. The innovative approach/components adopted in the project include:

- Creation of ground space for construction of Building Blocks by changing alignment of existing storm water drain
- Community participation has been ensured
- Provision of temporary transit housing for construction period
- Use of Fly Ash bricks in buildings
- Ample lighting and ventilation making it greener in terms of efficiency

iv) Pilot project for redevelopment and relocation at Lalganga Slum in Raipur, Chhattisgarh:

It is proposed to redevelop the entire Lalganga slum with construction of 300 DUs. 158 households are presently living in Lalganga slum and 142 households will be shifted from adjoining Arjun Nagar. Whole slum approach has been adopted for redelopment of Lalganga slum and shifting of slum dwellers from Arjun Nagar slum. The innovative approach/components adopted in the project include:

- Community consultation at planning stage.
- Bio-digester for sewage treatment on trial basis.
- During implementation inhabitants shall be fully involved to establish good quality work, they are ready to assist the RMC in all respect during execution of work so as to complete the work as per planned schedule.
- A livelihood centre is proposed where the present Blacksmiths can also get space to continue their profession more effec-

Pilot project for redevelopment and relocation at Lalganga Slum in Raipur, Chhattisgarh:

Dhall Mill Area slum under Rajiv Awas Yojana (RAY Pilot Project-1), Vijaywada, Andhra Pradesh

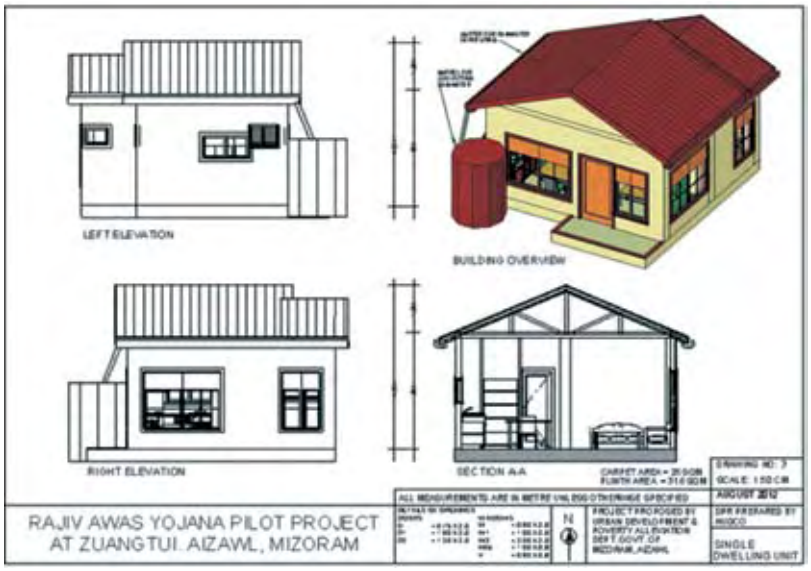
tively.

- Participation of beneficiaries in implementation & Operation / Maintenance of the assets created.

v) Rajiv Awas Yojana (RAY) Pilot Project At Zuangtui, Aizawl, Mizoram

The proposal envisages benefitting 142 households by construction of 78 new single storied units on plots owned by beneficiary households & 64 rental housing units (4 RCC building blocks in G+3 configurations @ 4 units/ floor). The innovative approach/components adopted in the project include:

- Community consultation and focus group discussion were held at the time of conceptualization.
- 64 units of rental housing have been proposed
- Solar street lighting systems and solar home lighting systems are proposed to be installed in the area and the DUs covered in the project. This may reduce consumption of conventional energy.
- Rain water harvesting system is incorporated in the building designs. Also, innovative design of RCC water collection tank cum public water point for harvesting natural stream water as well as rainwater is incorporated to supplement municipal water supply.
- Bio-Gas plant is proposed for 100 households which can generate limited electricity/cooking gas also.



Rajiv Awas Yojana (RAY) Pilot Project At Zuangtui, Aizawl, Mizoram

Delhi

Monitoring of BSUP & IHSDP Projects under JNNURM by BMTPC


Gujarat


Gujarat


Jammu & Kashmir


Maharashtra


Madhya Pradesh


Madhya Pradesh


Uttar Pradesh


West Bengal

Performance Appraisal Certification Scheme (PACS)

*A.K.Tiwari**

Rapidly rising construction market in the country is attracting increasingly greater investment in all aspects of construction activities be it development of land, infrastructure, railways, roads, dams or buildings and housing. Building materials accounts for substantial part of costs in all forms of construction but in housing and building construction it may account for 65/70 percent. Thus, housing and building being material and capital intensive activity the owners can ill afford not to have minimum life and expected performance of their buildings.

With changing market scenario, liberalisation of economy and technological developments a large variety of new building materials, products, components and composites are emerging in building construction market. The architects/engineers, construction agencies, builders and other customers are frequently confronted with the question of quality, durability, serviceability and performance of new building materials, products, components and systems. Though status of national standards on building materials and construction techniques in India is far superior to many developing and even some developed countries but process of standardisation is time consuming and requires the support of field performance of materials before standards are formulated to cover these. Since standards cover generic qualities and properties these can not be comprehensive enough to cover each and every new alternate (and its differential performance level) which emerges in the market. There are claims and counterclaims made by the manufacturers for superior performance of their product and systems over other available counterparts. The designers and specifiers do require performance appraisal/evaluation and quality assurance services by a recognised body to guide the selection of new materials and products to be sure about the expected life and durability of their buildings.

In short, a large number of building products, components and composites are being marketed with several claims of superiority which cannot be sustaintiated either due to non-availability of relevant standards or lack of test and evaluation methods/or proprietary nature of products revealing not much about their character, design, etc. Such a situation requires (as per practice in large number of industrialized countries) for providing Performance Appraisal/Evaluation Certification Services by an independent agency to guide the architects, engineers, builders and other users of building materials, products and building systems.

Keeping in view of the above, the Government of India, Ministry of Housing & Urban Poverty Alleviation authorized BMTPC through Gazette Notification No. I16011-/5/99 H-II in the Gazette of INdai No. 49 dated December 4, 1999 to operate Performance Appraisal Certification Scheme (PACS to promote use of new materials, construction systems, machines for production of building elements not so far covered by Indian Standards.. PACS is a third party operated voluntary scheme for providing Performance Appraisal Certificate (PAC) to a manufacturer/supplier/installer of a product which includes building materials, products, components, elements and system etc. after due process of assessment.

The above Notification authorizes BMTPC to operate the scheme through Technical Assessment Committee (TAC) with which is responsible for overall Technical Assessment. TAC consists of a Chairman and 21 members out of which 10 are permanent and 11 invitee members. The constitution of the Committee is reviewed after every three years by the Board of Agreement (BOA) of BMTPC. The member Secretary of the BOA is the Chairman of TAC. In the absence of the member Secretary,

* Chief (PMT & Admn), Building Materials & Technology Promotion Council, Ministry of Housing & Urban Poverty Alleviation, Government of India, New Delhi

Executive Director, BMTPC may officiate.

HOW DOES "PACS" WORK?

Through a well defined and documented procedure which includes:-

- Preliminary Application
- Evaluation wherein product can be certified
- Detailed Application
- Preparing Specification/Performance requirements.
- Working Out method of Evaluation.
- Identify/Establish test Methods
- Conduct Laboratory Tests and Evaluation in Use
- Study Past History, if any.
- Prepare Report
- Final evaluation of the Product by TAC
- Prepare Draft Certificate
- Approve/Issue Certificate
- Make copies available to all concerned
- Inform regulatory Authorities

PRELIMINARY APPLICATION FORM (PAF)

Designed to obtain Information on the following:-

- Organization/Company profile
- Product Profile
  i. Use
  ii. Process
  iii. Performance Characteristics
- Production Data
- Experience in Use
- Quality Assurance
- Social Aspects.

COMPOSITION OF TAC

A. Permanent Members

1. Builder Association of India (BAI)
2. Building Materials & Technology Promotion Council (BMTPC)
3. Bureau of Indian Standards
4. CPWD
5. CSIR
6. Dy. Director General, Quality Assurance , DGS&D
7. Indian Inst. of Architect (IIA)
8. Institute of Engineers (India)
9. Military Engineers Services
10. One representative of CII/FICCI/ASSOCHAM/NSIC by rotation.

B. Invitee Members

Depending on the proposal to be considered a max. of 11 more members as follows may be invited for meeting of TAC, as may be decided by Chairman, TAC

Construction Agency -3.
Research & Development – 2
Practicing/Consulting Engineers/Architects/MCDs/ State PWDs -2
Housing Board/ Development Authorities -2
Academic Institute -1
Housing finance Institute – 1 (HUDCO/NHB/IDBI/IFCI) .

CRITERIA FOR DECIDING WHETHER A PRODUCT CAN BE COVERED UNDER PACs OR NOT?

- Documents authenticating the name of the Firm and its location should be available.
- The Applicant should have Access to Competent technical person related to the product.
- If standards relating to the product and tests are not available enough, Data should be available for formulating a standard for the product and tests.
- Product not under BIS Certification
- If the product is certified under the BIS certification if it is to be covered under PACs, the applicant product should satisfy some additional requirements over and above those specified in the Indian Standards formulated by BIS.
- Test methods to test the products/Materials and performance requirements should be available. Test methods developed by applicant will also be considered.
- Test facilities should be available/ABLE TO BE CREATED WITHIN A REASONABLE TIME
- FIELD USE/FIELD EVALUATION DATA SHOULD BE AVAILABLE OR CAPABLE OF BEING GENERATED WITHIN A FIXED TIME FRAME.
- Should provide at least one of the several social benefits listed in item and of preliminary application form.

- Should not violated existing acts related to environment and pollution.
- Should not be violative of any provision of the National Building Code of India.
- If any of the above criteria is not satisfied at the time of evaluation of the preliminary application or is not capable of being satisfied within a specified time frame, the product would be considered as unsuitable for PACs at the time of evaluation. The applicant is free to apply again when the infirmities are removed.

DETAILED APPLICATION FORM (DAF) WILL BE PREPARED USING INFORMATION FROM PAF WHICH WILL INCLUDE THE DATA FOR SUITABILITY IN THE INSPECTION OF WORKS/FACTORY

Guidelines for performance criteria

Any product (which includes Building Materials Products, components, Elements, Sub systems and Systems) are required to be assessed against. Certain performance criteria for the purpose of PACs parameters against which detailed criteria will be evolved for evaluating a product will generally focus on the following, as applicable.

- Material quality
- General appearance
- Dimensions and Dimensions stability
- Structural Stability including strength property
  - Lateral & Horizontal stability
  - Compression
  - Tension
  - Shear
  - Bending
  - Torsion
  - Impact
  - Hardness
  - Resistance to Fatigue
- Fire Safety
- Durability
- Durability of specified Components
- Thermal Properties
- Mechanical Properties
- Acoustic properties
- Optical properties
- Biological Properties
- Environmental Aspects
- Working Characteristics
  - Ease of Handling
  - Consistence
  - Workability
- Ease of Cutting, Bending, Sawing
- Capability of Being Jointed to other Building components/ surface treatments.
- Capability to withstand rough handling
- Capability to withstand storage.

Detailed Criteria will be worked out from Product to Product.

TYPICAL CONTENTS OF THE CERTIFICATE

- Scope of Product
- Design Data
- Performance Characteristics
- Use/Installation
- Limitation in Use
- Training Modules for Installation
- Maintenance Needs
- Responsibility of Certificate Holder including quality assurance
- Dealing with user complaints
- Other relevant aspects

BENEFITS OF PACS

Society : Promotes uses of newly developed materials for Cost Reduction, Fast Construction, Improved quality, Environment Protection

User : Provides third party assessment of claims made by Manufacturer / Suppliers / Installer.

- Provides necessary Date
- Provide Confidence and reduces risk
- Redressal of genuine Complaints as a third party mechanism.

Manufacturer/ Supplier/ Installer:

- Involvement of Experts
- Marketing Tools
- Technical Assistance
- Globalization of Trade

Designer:

- Selection of Alternative Product
- Confidence
- Maintenance requirements
- Information of limitations

Construction Agency:

- Confidence in Product
- Scope for use of alternate Product
- Provides Installation instructions
- Identify manpower & training
- Needed for use of Product

Performance Appraisal Certificates (PAC) for the following products has so far been issued by BMTPC:

1. **HDF Board Solid Core Door Shutter:** These doors manufactured by M/S Kutty Flush Doors and Furniture Co., Chennai are solid core flush doors incorporating phenolic bonded oil tempered HDF panels with rails, stiles and core strips of non-forest timber. These are used for internal locations in residential, commercial and factory buildings.

2. **Moulded Raised HDF Panelled Door Shutter:** These doors manufactured by M/S Kutty Flush Doors and Furniture Co., Chennai are pre-primed high density fibreboard with deep moulded raised panel designs and with wood grains etched on the panels. These doors are used for internal locations in residential, commercial and official buildings.
3. **Gypcrete/ Rapid Wall Panel:** Gypcrete/ Rapid wall panels are factory made panels manufactured by M/S Gypcrete Co., in collaboration with an Australian firm. These panels are made from phospho-gypsum and are used in high rise and other buildings for faster construction.
4. **Block Making Machine:** Block Making Machine Manufactured by M/S Susanji Udyog, Hyderabad is an electrically or diesel operated machine using vibration for compaction of mix placed in a mould on top plate connected to the vibrator. The machine is used for making solid blocks, hollow blocks, pavement blocks etc. using stone chips, sand, cement, fly ash. marble slurry etc
5. **Pan Mixer:** Pan Mixer manufactured by M/S Susanji Udyog, Hyderabad is an electrically operated machine used for homogeneous mixing of aggregates (upto 6mm) with fine material such as fly ash, lime, marble slurry, stabilized mud for manufacture of bricks/blocks and pavers. It can also be used for mixing mortar for plastering.
6. **Recron 3S Fibre:** Recron 3S fibres manufactured by M/S Reliance Industries, Mumbai are made from polymerization of pure teraphthalic acid and mono ethylene glycol using catalyst. These polyster staple fibres are mixed in concrete and mortar to enhance certain properties.
7. **Plastocrete Panel:** Plastocrete panels manufactured by M/s Sintex Industries, Gujarat consist of outside plastocrete wall and inside wall of various materials such as PVC hollow sections, PUF panels attached PVC layer, AC Sheet and also plastocrete. These are light weight, easy to install with simple tools & require low labour. These panels are suitable for construction of school buildings, site office, security cabins, housing, modular toilets, hospitals etc.

8. **Insulated Roof Panel:** Insulated Roof Panels manufactured by M/s Sintex Industries, Gujarat are formed by plain precoated sheet in between foamed with polyurethane form (PUF) which acts as core that gives excellent insulation. These are built with leak proof ceiling and thermally insulated walls which are water proof, dust proof and rot proof. These are of light weight modular design for easy and quick assembly. These panels can be used for construction of telecom shelters, office blocks, toilet blocks and industrial sheds etc.
9. **Underground Water Storage (Sump) Tanks:** Underground Water Storage Tank (Sump) manufactured by M/s Sintex Industries, Gujarat are one piece moulded tanks made of polyethylene. These are non-porous and do not allow contamination of water kept in the tank. These underground tanks are suitable for houses, school, hospitals, offices etc.

10. **Endura Door:** Endura doors manufactured by M/s Sintex Industries, Gujarat are made by combining hot pressed Sheet Moulding Compound (SMC) sheets on both sides. The core of the door is filled with polyurethane foam (PUF). These medium duty doors are suitable for internal and external locations. These doors are available in different sizes and are of off-white shade.

11. **Fomura Door:** Fomura doors manufactured by M/s Sintex Industries, Gujarat consist of tubular MS frame covered with PVC foam sheet. These light

duty doors are suitable for internal locations. These doors are available in different sizes and in grey, ivory and white shades.

12. **PVC Flush Door:** PVC Flush Doors manufactured by M/s Sintex Industries, Gujarat are made out of one piece multi-chamber extended hollow PVC sections with the core filled with high density Polyurethane foam (PUF). The door is provided with a MS tube structure on the hinge side for fixing hinges. These medium duty doors are suitable for internal locations. These doors are available in different sizes and Thai teak and steam beach shades.

13. **PVC Profile Door:** PVC Profile doors manufactured by M/s Sintex Industries, Gujarat are made of PVC extruded profile sections. These doors are provided with suitable polymeric reinforcement. These light duty doors are suitable for suitable for internal locations. These doors are available in different sizes and in standard shades.
14. **Frontura Doors:** Frontura doors manufactured by M/s Sintex Industries, Gujarat are made with Fiberglass Reinforce Plastic (FRP) panels on either side and the core of the door is filled with high density Polyurethane Foam (PUF). These heavy duty doors are suitable for indoor and outdoor locations. These are available in different sizes.

15. **HDPE Cover Blocks:** HDPE Cover Blocks are made of High Density Polyethylene. These blocks are used in place of concrete cover blocks. These blocks not only help to keep the reinforcement bars at the specified place but they also offer convenience of use. Cover blocks are available in various shapes and sizes. Testing agencies have been requested to confirm whether the tests of the product can be done in their laboratory.
16. **Low Cost Marble Slurry Binder:** Low Cost Marble Slurry Binder is made from recycling marble slurry waste, fly ash and hydrated lime. This can be used in place of cement for masonry and plaster. Inspection of the premises has been carried out and samples of the product given for testing.
17. **Underground Septic Tanks:** Underground Septic Tanks are made from polyethylene. These are suitable for houses, schools and hospitals.
18. **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. These are built with leak proof ceiling & thermally insulated walls. These can be used as Industrial sheds, Malls, Multiplexes and Workshops etc.
19. **FRP Manholes:** FRP Manholes can be used in underground sewer pipe lines, storm water pipe lines and water pipe lines.
20. **uPVC Windows:** uPVC Windows are made out of extruded uPVC multi-chamber hollow profiles and reinforced with galvanized steel. These are available in single & double glazing and are partially fixed & openable. These can be used in residential, commercial and official buildings.
21. **Monolithic Formwork:** Monolithic Formwork is the system by which the formwork for all the components of the structure is erected at one time. It consists of hundreds of standard pieces of form work equipment.
22. **Monolithic Concrete Construction:** Monolithic Construction is a method by which walls and slabs are constructed together giving the structure a complete box like shape. In this method fluid of cement concrete is poured in light weight formwork system. This method is ideal for multistoried construction.
23. **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. These are used for residential, commercial and official

complexes.

24. Glass Fibre Reinforced Gypsum Panel System: PACs have been awarded to M/s RCF, Mumbai & M/s FACT-RCF Building Products Ltd. (FRBL, Cochine). Maintenance manual is also prepared to facilitate the basics to the users.

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 to be 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 constraints faced for evaluation is lack of proper testing facilities in accredited independent laboratories in India. In view of 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.

Future Plan of Action:

Through Global Expression of Interest, BMTPC is in the process of identifying emerging technologies. It is proposed to evaluate these technologies under PACS of BMTPC. Further vigorous efforts will be made to cover more and more new products/systems through PACS.

Capacity Building Programme

on "Quality Assurance and TPIM of BSUP and IHSDP projects under JNNURM"

16-17 Feb 2012 - Chandigarh

08-09 Dec 2011 - Indore

27-28 Dec 2011 - Patna

हरित निर्माण के माध्यम से भवन बनाने के अवसर

डॉ.शैलेश कु. अग्रवाल*
एस.के. गुप्ता**

हरित भवन वे हैं जो पारंपरिक भवनों की तुलना में कम जल खपत, अधिकतम ऊर्जा क्षम, प्राकृतिक संसाधनों के संरक्षक, कम कचरा जनक तथा निवासियों को यथेष्ट स्थान प्रदान करते हैं। यह एक ढांचे को निर्मित करने की प्रथा एवं प्रक्रियाओं का उपयोग है जो एक भवन के पूरे जीवन चक्र में पर्यावरणीय उत्तरदायी और संसाधन क्षम होती है। यह चीजें एक डिजायन (अभिकल्पना) की उपवेशन (तैयारी) से निर्माण, प्रचालन, अनुरक्षण, मरम्मत (पुनर्नवीकरण) तथा अनिर्माण तक होती हैं। यह प्रथा श्रेणीकृत भवन अभिकल्पना (डिजायन) की मितव्ययिता (कीमत), उपयोगिता, टिकाऊपन एवं सुविधा को विस्तारित एवं प्रशंसित करती है। हरित भवन अवधारणा मुख्य रूप से अवसंरचनात्मक (इंफ्रास्ट्रक्चर्स) उद्योग के विकास में भागीदारी करती है जो कि भारतीय संदर्भ में तीव्रगति से वृद्धि कर रही है। हरित भवन अभिकल्पना (डिजायनिंग) का मुख्य उद्देश्य मानव स्वास्थ्य एवं प्राकृतिक पर्यावरण पर विनिर्माण से पर्यावरण से पड़ने वाले कुल प्रघात (प्रभाव) को निम्नांकित से कम करना है–

- सक्षमतापूर्वक ऊर्जा, जल एवं अन्य संसाधनों का उपयोग करना
- निवासियों के स्वास्थ्य को संरक्षित करना तथा कर्मचारियों की उत्पादकता को बेहतर बनाना
- कचरे, प्रदूषण को घटाना तथा पर्यावरण के क्षरण को घटाना

vfHkik;

इस बात को मानते हुए कि भवनों के लिए ऊर्जा का उपयोग एवं वायु प्रदूषण महत्वपूर्ण मुद्दे हैं, भारत सरकार ने ऊर्जा संरक्षण अधिनियम (ईसीए 2001) बनाया जोकि ऊर्जा दक्षता (सक्षमता) एवं संरक्षण को बढ़ावा देता है। ऊर्जा संरक्षण अधिनियम ने ब्युरो आफ इनर्जी इफीसिएंसी, अर्थात् ऊर्जा दक्षता केन्द्र (बीईई) के निर्माण को अधिदेशित किया जो ऊर्जा संरक्षण भवन संहिता (ईसीबीसी) के स्थापित करने के लिए बीईई को प्राधिकृत करता है। इसके साथ ही ऊर्जा दक्षता के मुद्दे को अंशतः भारतीय राष्ट्रीय भवन संहिता (एनबीसी 2005) में संबोधित किया है। हालांकि ऊर्जा मंत्रालय और ऊर्जा दक्षता केन्द्र (बीईई) ने 2007 में ईसीबीसी (ऊर्जा संरक्षण भवन संहिता) जारी किया था। यह भारत की पहली एकमात्र राष्ट्रीय भवन ऊर्जा संहिता है। यद्यपि, वर्तमान में यह स्वैच्छिक है, ईसीबीसी भवन आवरण, प्रकाश, ताप, संवातन तथा वातानुकूलन (एचवीएसी), विद्युत प्रणाली, जल तापन तथा पंपिंग प्रणाली आदि के लिए न्यूनतम ऊर्जा दक्षता की आवश्यकता को निर्धारित करता है।

बी.एम.टी.पी.सी., हडको और ग्रीन बिल्डिंग काउंसिल (आईजीबीसी), द इनर्जी एंड रिसोर्सिस इंस्टीट्यूट (टेरी) जैसे गैर लाभकारी संगठन सक्रियता के साथ भारत में हरित भवनों को बढ़ावा दे रहे हैं। निम्नलिखित पाचं क्षेत्रों की निष्पादकता को संबोधित करते हुए स्थाईत्व को हासिल करने के लिए संपूर्ण–भवन उपागम हेतु बढ़ावा देना आवश्यक है–

- स्थाई (टिकाऊ) साइट (कार्यस्थल) विकास
- जल बचत
- ऊर्जा दक्षता
- सामग्री चयन
- अंदरूनी पर्यावरणीय गुणवत्ता

आवास एवं शहरी गरीबी उपशमन मंत्रालय की छत्रछाया में निर्माण सामग्री एवं प्रौद्योगिकी संवर्धन परिषद (बीएमटीपीसी) हरित भवन प्रौद्योगिकियों को विकसित एवं संवर्धित कर रही है जोकि समाज में विशिष्ट निम्न आय समूह के लोगों को मूल्य प्रभावी (सस्ता) समाधान उपलब्ध कराने के रूप में मदद करती है। परिषद सक्रियता के साथ मूल्यांकन, प्रभावीकरण तथा नई प्रौद्योगिकियों के प्रसार में, विशेष रूप से कृषि उद्योग अपशिष्ट (कचरे) एवं सहउत्पादों पर आधारित प्रौद्योगिकियों को उपलब्ध कराने में संलग्न है। ये नई प्रौद्योगिकियां अपनी पारंपरिक प्रतिरूपी की तुलना में, सामग्री एवं ऊर्जा गहनता, दोनों ही मामलों में, अधिक ऊर्जा दक्ष एवं पर्यावरण मैत्रीपूर्ण है।

भवन निर्माण के निर्माता कृषि एवं औद्योगिक अपशिष्ट की उपयुक्त उपयोजिता एक ऐसे उपागम को प्रोत्साहित करती है जो ''मिट्टी से सोना'' (वेस्ट टू वेल्थ) तथा ''कचरे से संसाधन'' (रिफ्यूज टू रिसोर्स) पर आधारित है। निर्माण की लागत घटाने, ऊर्जा खपत एवं पारंपरिक सामग्रियों की मांग एवं आपूर्ति के बीच अंतर को घटाने के क्रम में राष्ट्रीय आवास एवं पर्यावास नीति ने इन पर्यावरण मैत्री वैकल्पिक सामग्रियों के प्रोत्साहन पर जोर दिया है। इन सामग्रियों की उत्पादकता एवं उपलब्धता को बढ़ाने के लिए भारत सरकार ऐसी सामग्रियों के उत्पादों पर उत्पाद करों में छूट तथा अपशिष्ट आधारित सामग्री एवं पूर्व निर्मित (प्रीफैब) घटकों के निर्माण संबंधी मशीनों एवं संयंत्रों की आयात पर सीमा शुल्क में छूट प्रदान करती है।

* कार्यकारी निदेशक, ** उप प्रमुख (टी.डी.ई एवं आई.सी), निर्माण सामग्री एवं प्रौद्योगिकी संवर्द्धन परिषद्, नई दिल्ली

इसके अलावा, लीड इंडिया ने भवन निष्पादकता हेतु अनेक न्यूनतम मानदंड (निर्देश चिंह) कायम किए हैं। रेटिंग लेबल (स्तर) ''प्लैटिनम'', ''गोल्ड'', ''सिल्वर'' तथा ''सर्टीफाइड'' आदि उस सीमा को दर्शाते हैं जोकि एक भवन विशिष्टता हेतु राष्ट्रीय कोड से अपेक्षित होते हैं। पिछले कुछ वर्षों से, ''गो ग्रीन'' (हरित भव) दर्शन की स्वीकार्यता एवं विकास में आईटी एवं आईटीईएस प्राथमिक हिस्सेदार है। एक महत्वपूर्ण मामले के रूप में, चेन्नई के पाइयानुर में टर्बो इनर्जी लिमिटेड (टेल) का आए एंड डी तथा प्रशासन खंड, जिसे कि लीड के द्वारा भारत की सर्वाधिक नं. एक तथा विश्व की द्वितीय नं. की हरित बिल्डिंग (भवन) के रूप में प्रमाणित किया गया है। अन्य महत्वपूर्ण हरित परियोजनाओं में आईटीसी ग्रीन सेंटर (गुड़गांव), आईजीपी आफिस परिसर (बैंगलूरू), कल्पतरू स्क्वायर (मुंबई) तथा सीआईआई– गोदरेज ग्रीन बिजेनस सेंटर (हैदराबाद) को शामित किया जा सकता है, यद्यपि अभी इस संकल्पना ने व्यापक मंच को नहीं पकड़ा है। इसके साथ ही, भारत के सबसे बड़े बैंक, भारतीय स्टेट बैंक ने एक समर्थक भूमिका प्रकट की है। इसने हरित विकासों के निर्माण हेतु छूट प्रस्तावित की है जो इस उद्योग में सामान्य प्रवृत्ति को बढ़ावा देने की शुरूआत हो सकती है।

पर्यावरण एवं वन मंत्रालय ने एक निश्चित आकार एवं मूल्य से अधिक वाली बड़ी निर्माण परियोजनाओं के लिए पर्यावरण अनापत्ति प्रमाण (क्लीयरेंस) अनिवार्य कर दिया है। इस पर्यावरण अनापत्ति के तहत आने वाली परियोजनाओं से अपेक्षित होता है कि वे पर्यावरण मैत्री मापदंडों एवं तकनी. कों को अपनाएं। नए टाउनशिप (नगरों) औद्योगिक नगरों, पुर्नस्थापन कालोनियों, वाणिज्यिक काम्पलेक्सों (परिसरों), होटलों के परिसरों, अस्पतालों, औद्योगिक स्थलों तथा एक निश्चित सीमा से ऊपर के सभी परिसरों (कांप्लेक्सों) के लिए पर्यावरण प्रभाव मूल्यांकन (ईआईए) को अनिवार्य कर दिया है। यह पर्यावरण अनापत्ति केन्द्र सरकार से एक नई परियोजना को शुरू करने से पहले प्राप्त करना होता है। पर्यावरण प्रभाव मूल्यांकन (ईआईए) प्रक्रिया यह सुनिश्चित करता है कि नई परियोजनाओं में विधि सम्मत जन भागीदारी और अधिकतम संसाधन खपत प्रथाओं के साथ पर्यावरण संबद्धताओं (सह चिंताओं) का समेकन हो।

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आज के परिदृश्य में, दुनिया भर में हरित भवन (ग्रीन बिल्डिंग) को स्वीकार कर लिया गया है, लेकिन अभी भी एक वृहद समुदाय या तो इस टिकाऊ डिजायन संकल्पना से अनजान है या इसके उद्देश्यों से मतभेद रखता है या इसके फायदों से अभिप्रेरित नहीं है। टिकाऊ डिजायन के लाभों के बारें में मालिकों, भवन निर्माताओं एवं अभिकल्पकों (या अन्य पणधारकों/उत्तरदायियों) को प्रेरित करने हेतु, यह आवश्यक है कि उनमें हरित भवन संकल्पना के अनेक लाभों के बारे में समझ पैदा की जाए। ऐसा करने के लिए यह अत्यंत महत्वपूर्ण है कि सभी समुदायों पर आधारित उनके प्रेरक (विक्रय) बिंदुओं के बारे में विचारों/रायों को समझा जाए।

एक (मकान) मालिक के लिए, वित्तीय (सहायता) आधार रेखा हो सकती है। एक वास्तुविद के लिए यह पर्यावरण और एक इंजीनियर के लिए यह एक निष्पादकता हो सकती है। यहां पर एक हरित भवन निर्माण के अनेक कारण हो सकते हैं जोकि टिकाऊ डिजायन प्रदान करेगा। वास्तुविदों को विशिष्ट श्रोताओं हेतु अनुकूल एक उपयुक्त तर्क उपलब्ध कराने के लिए संसाधित होना चाहिए। टिकाऊ डिजायन (अभिकल्पना) के निम्नलिखित फायदे हैं

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एक टिकाऊ, आवास के लिए आवश्यक होता है कि भवन निर्माण सामग्री के उत्पादन, भवन के निर्माण तथा भवन के शीतलन, तापन एवं प्रकाश में खर्च होने वाली बिजली की जरूरत की मात्रा में कमी आए। आज निर्माण क्षेत्र में प्रतिदिन खपत होने वाली अधिकतर ऊर्जा जीवाश्म ईंधन, गैर चिरस्थायी स्रोतों तथा विनाशी संसाधनों से प्राप्त की जाती है। टिकाऊपन को सुनिश्चित करने के क्रम में, यह अति आवश्यक हो जाता है कि हमारी ऊर्जा की आवश्यकतायें पुनः उपयोगी यानि पुनर्नवीकरण स्रोतों के माध्यम से प्राप्त हो। इसके साथ ही नवीनीकृत प्रौद्योगिकियों के माध्यम से ऊर्जा की खपत को आशावादी (मितव्ययी) बनाया जाए। दिन के प्रकाश, थर्मल (तापीय) मास एवं शैडिंग (छाया) जैसी रणनीतियों को अपनाकर या फिर उच्च निष्पादकता प्रणाली को अपना कर हम अपने भौतकीय (यांत्रिक) तंत्र की ऊर्जा मांग को महत्वपूर्ण रूप से घटा सकते हैं। इस प्रकार से यह बिजली घरों के प्रचालन एवं जीवाश्म ईंधन की विमोचन क्षीणता (खनन) की आवश्यकता को कम कर सकते हैं।

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जल दक्षता डिजायन के साथ, हरित भवनों में गैर खपत वाले उपपयोगों में जल की आवश्यकता की मात्रा में कमी आ सकती है। दक्षतापूर्ण भू–दृश्य (लैंड स्केप) एवं छत की डिजायन बरसाती पानी के बह जाने की गति को न्युनीकृत कर सकता है जिसके परिणाम स्वरूप जल निकासों (नलियों) एवं सीवर प्रणाली के भार में कमी आती है। ये बातें सही मायनों में स्थानीय क्षेत्रीय एवं वैश्विक जल बहाव प्रणालियों में प्रदूषण घटाती है और प्राकृतिक जल भंडारों को समर्पित करती हैं।

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यहां पर अनेकों ऐसे अपरोक्ष प्रदूषण के स्रोत हैं जैसे कि भवन उत्पादों की वाहनों से ढुलाई करने से उत्पन्न प्रदुषण तथा भवन निर्माण उत्पादों के विनिर्माण में होने वाला प्रदूषण। यहां पर अनेक प्रत्यक्ष प्रदूषक स्रोत है जैसे कि एचवीएसी रेफ्रीजेंट्स (कूलक) तथा हमारे परिसज्जा कार्य (फिनिशिस) से विसर्जित विषाक्त उत्सर्जन। ये सभी चीजें वैश्विक तापवृद्धि (ग्लोबल वार्मिंग), ओजोन क्षय (विनाश) तथा वायु प्रदूषण पर गहन प्रभाव डालती है।

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खनन, परिवहन तथा निर्माण प्रक्रिया के कारण, स्थानीय एवं प्राकृतिक सामग्रियों के अपने भवनों में प्रयुक्त करने से उपरोक्त तीन रणनीतियों को प्रत्यक्ष लाभ पहुंचता है, इसके अतिरिक्त पुनर्चक्रित, सुधार्य या बचायी हुई सामग्री कचरा स्थान की जगहों को घटाते हुए हमारी लैंडफिल (भू–भरण) के बोझ को

घटाने में सहायक हो सकती है।

vYi dkfyd Qk;n

हरित भवन उपयोगिता क्षेत्र की लागत में तुरंत बचत प्रदान कर सकते हैं। चाहे वे विद्युत ऊर्जा एवं जल के उपयोग को घटाकर करें या फिर तीव्र बरसाती पानी के बहाव की अवसंरचना के न्युनीकरण से लागत की कमी के द्वारा करें, हरित भवनों के पास यह विकल्प या सुअवसर होता है कि उपयोजिता उपकरणों के बिलों में कमी लाते हैं। इसके अतिरिक्त, दक्ष ले आउट से युक्त भवन विनिर्माण सामग्रियों एवं निर्माण कचरे (अपशिष्ट) की लागत में कमी लाते हैं। इसके साथ ही, यदि भवन थोड़े छोटे एचवीएसी उपकरण का उपयोग करता है और उष्मीकरण एवं शीतलीकरण हेतु सहनशील रणनीतियों पर अधिक आश्रित होता है तो पहले चरण में उपकरण की लागत कम हो सकती है। यहां पर यदि भवन में स्थानीय कंपनियों द्वारा विनिर्मित टिकाउ डिजायन रणनीतियों के उपयोग के द्वारा वित्तीय लाभ भी प्राप्त किया जा सकता है।

nh?kZ dkfyd Qk;n

दीर्घ काल में उपयोगिता मूल्य बचत संभवतः आगे बढ़ी हुई लागत का फायदा प्रदान कर सकती है। हालांकि फोटोवोलैटिक पैनल जैसी मदों की पे बैंक (पुनर्भरपाई) अवधि बहस का मुद्दा है, लेकिन कुछ अन्य उपाय पे ऑफ को जल्द ही वास्तविकता में बदल सकते हैं। सहनशील (पैसिव) प्रणालियों की चालू अनुरक्षण लागत न के बराबर या थोड़ी हो सकती है। इसलिए, एक भवन का स्वामी भवन प्रचालन की लागत में बचत कर सकता है। यह हमारे भू दृश्य (लैंडस्कैप) डिजायन में परिवर्तित हो सकता है। पारंपरिक भू–दृश्यों की तुलना में प्राकृतिक भू–दृश्यों में प्रायः कम अनुरक्षण की आवश्यकता होती है। लचीले ले आउट के साथ डिजायन किए गए भवन पुनर्विन्यास की लागत को कम कर सकते हैं।

ifj;kstuk eY; ¼egRrk½ esa c<+r

आजकल बहुत सारे मालिक ''ग्रीन डिजाइन'' को एक विक्रय बिन्दु के रूप में इस्तेमाल कर रहे हैं। प्रापर्टी को पट्टे पर देने या पुनः बेचने के लिए टिकाऊ भवन नए उपभोक्ताओं एवं नए बाजार को आकर्षित कर सकते हैं। यह विशेषता शीघ्रतापूर्ण बिक्री एवं उच्च किराये का रूप ले सकती है। इसके अतिरिक्त, नए कर्मचारियों की भर्ती (एवं उन्हें अपने साथ बनाए रखना) उनको काम के लिए आकर्षक एवं स्वस्थ माहौल देकर सहज बनाया जा सकता है। कई अध्ययन दर्शाते हैं कि एक स्वस्थ एवं अच्छे माहौल में काम करने वाले कर्मचारी अधिक उत्पादनशीलता के साथ काम करते हैं तथा वे कम स्वास्थ्य अवकाश लेते हैं एवं अपनी फर्म के साथ अधिक वफादार रहने को प्रवृत्त होते हैं।

gkfu;k

हरित भवनों की एक सर्वाधिक सामान्य हानि या अलाभ इसमें आनेवाली अतिरिक्त लागत के प्रति आलोचना है। यह एक महत्वपूर्ण विचार बिन्दु है, हालांकि अतिरिक्त लागत या मूल्य सामान्यतः ऊर्जा बचत के द्वारा संतुलित हो जाती है; फिर भी यह एक अतिरिक्त लागत है जो उपभोक्ता/ग्राहक की जेब से जाती है। इसीलिए यह आलोचना वैध मानी जाती है। इस आलोचना के लिए एक अच्छी खबर यह है कि हरित बाजार में हाल ही की वृद्धि अधिक प्रतियोगिता पूर्ण बनती जा रही है, परिणाम स्वरूप निकट भविष्य में अतिरिक्त भवन मूल्य (लागत) महत्वपूर्ण स्तर तक कम होने की संभावना हो सकती है। वास्तव में, यह पहले ही विकसित हो रहा है और प्रतियोगिता ने मूल्य में गिरावट दर्ज की है।

अब बहुत ज्यादा देर नहीं होगी जब स्थानीय गृह निर्माण आपूरक स्टोरों में एक हरित भवन खंड भी होगा जहां पर ये उत्पाद आसानी से प्रतियोगी मूल्यों में उपलब्ध होंगे। लेकिन हरित भवनों के लिए एक सबसे बड़ा अलाभ मुख्य आलोक बिंदु पर्यावरण होगा। यह कथन थोड़ा अटपटा दिख सकता है, क्योंकि पर्यावरण के लिए हरित भवनों से अनेक लाभ प्रदान किए जाते हैं। उदाहरण के लिए, हाल ही के वर्षों में अधिकांश अमेरिकी घर अधिक से अधिक ऊर्जा दक्षता वाले हो रहे हैं, जिन्होंने अंदरूनी वायुगुणवत्ता में एक समस्या बढ़ा दी है। लाभार्थियों के घर इतने वायुरोधी बन गए हैं कि उनकी अंदरूनी वायु आंतरिक प्रदूषण से प्रभावित होती है। यद्यपि, हरित भवन अंदरूनी वायु की गुणवत्ता के मुद्दे को संबोधित करते हैं, लेकिन इनका ध्यान मुख्यतः भवन के कुल प्रभाव एवं पर्यावरण पर भवन निर्माण प्रक्रिया के प्रभाव पर होता है तथा वहां रहने वाले का स्वास्थ्य प्राथमिकता पर नहीं होता है। इसलिए ऐसे समय पर, यह ध्यान केन्दग्र आंतरिक वायु की गुणवत्ता की कीमत पर हो सकता है, जो अंततः एक स्वास्थ्य समस्या का रूप ले लेता है। एक हरित भवन शायद बल्व की लाइटों के बदले ऊर्जादक्ष फ्लूरोसेंट लाइटों को अपनाने का चुनाव कर सकता है पर ये अधिक रेडिएशन उत्सर्जन के लिए जानी जाती हैं। शोध अध्ययन दर्शाते हैं कि यह रेडिएशन संभाव्य तौर पर स्वास्थ्य समस्याएं पैदा कर सकता है।

gfjr Hkou fØ;kUo;u esa pukSfr;k

हाल ही में निजी एवं सरकारी क्षेत्र के पणधारकों के द्वारा प्रेरक प्रयासों से भारत में हरित भवन विकास को गति पकड़ने की उम्मीद हैं इस संकल्पना के क्रियान्वयन के पथ में अनेक बाधाएं हैं।

जोकि निम्नांकित हैं–

fØ;kUo;u

पहली एवं अविलंब आवश्यकता उर्जा संरक्षण भवन संहिता (ईसीबीसी) के क्रियान्वयन की है। फिलहाल, अभी तक ईसीबीसी स्वैच्छिक है, लेकिन भविष्य में, केन्द्र सरकार या फिर राज्य सरकारों को इसे एक अनिवार्य मानक के तौर पर अपनाना चाहिए। अभी तक किसी भी राज्य ने इसे नहीं अपनाया है। ईसीबीसी को प्रोत्साहित करने के लिए बीईई राष्ट्रीय एवं राज्य स्तरीय सरकारों के साथ निकटता से काम कर रही है। ऐसा माना जा सकता है कि एक बार यदि ईसीबीसी किसी भी राज्य या केन्द्र सरकार में अनिवार्य बन जाए तो क्रियान्वयन एवं प्रबलन उपागम एक समान होगी जो सभी अन्य भवन संहिताओं में

अनिवार्यता से लागू होगा।

xHkhjrk ,oa urRo dh deh

सरकार के द्वारा संरक्षण के संबंध उठाए गए सभी कदम दीर्घ कालिक ऊर्जा नीति के लिए अभी तक परिशिष्ट मात्र बने हुए हैं। अभी तक उठाए गए कदम कुछ खास घटनाओं की प्रतिक्रिया का परिणाम है। मार्च 2002 में बीईई की स्थापना जोहांसवर्ग में रियो+10 सम्मेलन के साथ संबंद्ध है। इसके बावजूद बीईई के गठन के पश्चात भी यह लगभग गैर प्रचालनीय है। प्रशासनिक छोर से और अधिक गतिशीलता की अवश्यकता है ताकि दीर्घकालिक ऊर्जा दक्ष के लक्ष्य की प्राप्ति एवं विकसित महाशक्ति के रूप में भारत वास्तविक धरातल पर देखा जा सके, यहां तक कि यदि अल्पकालिक हो तो हमें इसके लिए चुकौती करनी चाहिए।

oSf'od foi.ku vko';drk dk fy, tkx:drk

ऊर्जा सघनता की बेहतरी का संकेत पिछले डेढ़ दशक के दौरान अर्थव्यवस्था के खुलने पर अवलोकित किया गया है। बाहरी एवं घरेलू, दोनों ही स्तरों पर सुधरी हुई प्रतियोगिता ने वाणिज्यिक नेतृत्व को विवश किया कि ऊर्जा लागत को बचाने के लिए वैकल्पिक विकल्पों की ओर देखें। इस नई सदी में, जहां अधिकतर उद्योग अपने निर्यात को बढ़ावा देने के लिए गति बढ़ा रहे हैं, तब उन्होंने महसूस किया कि अंतर्राष्ट्रीय बाजार में गलाकाट प्रतियोगिता में ऊर्जा उनकी लागत को क्षरित कर रही है। भारत में, पिछले दस वर्षों के दौरान बिजली की कीमत में तीन गुना वृद्धि हुई है। इसे संभवतः इस तरह वर्णित किया जा सकता है, क्योंकि हरित भवन के लिए अनुमानित किया गया है कि संभवतः उससे 40 प्रतिशत तक ऊर्जा की कमी आएगी जो वैश्विक बाजार में मुकाबले के लिए आगे होगी।

vkfFkd ifjis{; dk lkFk lcd/ku

यह बताया जा चुका है कि ''महत्वपूर्ण मात्रा में पर्यावरण संघात को न्युनीकृत करने के लिए अच्छी अर्थव्यवस्था के साथ अच्छी इंजीनियरिंग के साथ–साथ उपभोक्ता की प्राथमिकता के साथ बदलाव में समिश्रण की आवश्यकता होती है।'' हाल ही के अनुभव कुछ महत्वपूर्ण एवं अनमोल सबक देते हैं कि ''ग्रीन बिल्डिंग मायोपिया'' (हरित भवन की निकटदृष्टिता) के सामान्य गर्तों से बचा जाना चाहिए।

यद्यपि बड़ी बात यह है कि इसकी संकल्पना के लाभों के प्रति केवल गहन हरित लगाव वाले उपभोक्ता का ध्यानाकर्षित करता है। हालांकि भारी संख्या में उपभोक्ता पूछेंगे कि ''यदि हम हरित भवन संकल्पना को प्रयुक्त करें तो इसमें हमारे लिए इसमें क्या हैं।'' व्यवहार में हरित अपील संभवतः मुख्य धारा के उपभोक्ताओं को तबतक आकर्षित नहीं करेगा, जब तक कि लागत में बचत या सुधरी हुई उत्पाद निष्पादकता न हो।

tksf[ke ,oa vfuf'prrk

यद्यपि हरित भवनों में निवेश और लोगों की रूचि तेजी से बढ़ रही है, तथापि रियल स्टेट (भू–संपदा) एवं विकास समुदायों में हरित भवन ने सख्ती के साथ अपनी पकड़ नहीं बनाई है। यहां पर हरित भवन के परिप्रेक्ष्य में भू–संपदा समुदाय में अनेक जोखिम विद्यमान है। ये निम्नाकिंत हैं–

- हरित भवन प्रौद्योगिकियों के ऊपर विश्वसनीयता की अनिश्चितता
- हरित भू–संपदा विकास के ऊपर लागत मूल्य पर अनिश्चितता
- हरित भू–संपदा की आर्थिक लाभों पर अनिश्चितता
- एक समय के उपरांत हरित भवन की निष्पादकता के बारे में अनिश्चितता

vuHkoh dk;cy dh deh

भारत में उपभोक्ताओं के बीच हरित भवन की संकल्पना की ग्राहकों के बीच स्वीकार्यता बनाने एवं क्रियान्वयन करने में झेली जाने वाली सबसे बड़ी समस्या अनुभवी कार्यबल की कमी है। भारत में हरित भवन के क्षेत्र में पर्याप्त अनुभवी परामर्शदाताओं की भारी कमी है जोकि तीव्रता से वृद्धि करते इस उद्योग के अनुसंधान एवं साहित्य के साथ समंजित हों। इस उद्योग के विस्तार को अनुभवी कार्यबल की कमी का भारी खतरा है। अपनी सेवाओं में एक बेहतरी (प्रीमियम) की खोज में हरित भवन के क्षेत्र में गैर अनुभवी एवं अप्रशिक्षित सेवा दाताओं के प्रवेश करने वालो द्वारा और अधिक जोखिम बढ़ जाता है।

mi lgkj

तीव्रता से बढ़ते अवसंरचनात्मक उद्योग में हरित भवन एक उच्च स्तरीय संकल्पना है। यह वैश्विक तापवृद्धि एवं जलवायु बदलाव के लिए एक समाधान है। जोकि मुख्यतः दुनियाभर के कार्बन उत्सर्जन के कारण हुआ है सभी विकसित एवं विकासशील देश कार्बन उत्सर्जन के मामले में बहुत ही गंभीर हैं। भारी कार्बन का मोचन परिवहन एवं निर्माण उद्योग से भी है। हरित भवन टिकाऊ भवन है जोकि पंरपरागत भवनों की तुलना में 40 प्रतिशत कम ऊर्जा की खपत करते हैं। इसके साथ ही उनके निवासियों को स्वास्थ्य विवर (स्थल) भी उपलब्ध कराते हैं। इसलिए इस संकल्पना ने बहुत सारे देशों को आकृष्ट किया है और अनेकों विकसित देशों में वर्ष 2000 के प्रारंभ में क्रियान्वित किया गया है। लेकिन भारत में यह संकल्पना अभी भी अनेक, क्रियान्वयन मुद्दों के कारण स्वीकार्यता के प्रारंभिक चरण में है। भारतीय सरकार को जरूरत है कि इस दिशा में, प्रमुख कदम उठाते हुए यह सुनिश्चित करे कि यह संकल्पना सभी राज्यों सरकारों द्वारा औचित्यपूर्ण ढंग से अपनाई जाए। इसके लिए एक परिषद एवं एक कमेटी को स्थापित किए जाने की आवश्यकता है जो इस संकल्पना को क्रियान्वित करे और भारत में कार्बन के पदचिंह (फुट पिंट) को घटाए, जिससे वैश्विक तापवृद्धि एवं जलवायु परिवर्तन के संघात को कम किया जाए। मजबूत नेतृत्व के साथ, स्पष्ट दूरदृष्टि (विजन) एवं नीतियों एवं व्यवहारों के सही समिश्रण के साथ, भारत सभी नई एवं विद्यमान इमारतों के लिए एक हरित भवन मानक प्रथाओं की तैयारी कर सकता है। आज हरित भवनों को समर्थन देने के लिए सुदृढ़ संवेग विद्यमान है। हमें निश्चित रूप से इस संवेग से लाभ उठाना चाहिए।

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Demonstration of Cost-effective Alternate Technologies

The Council had put up a BMTPC Pavilion in HUDCO BuildTech on Emerging Housing and Building Technologies including Cost Effective Technologies during India International Trade Fair 2011 from 14-27 November, 2011. A house constructed with proven cost effective, environment friendly, energy efficient and disaster resistant technologies having built up area of 350 sq ft with living room, bedroom, kitchen alcove, bath-cum W.C. and balcony has been showcased.

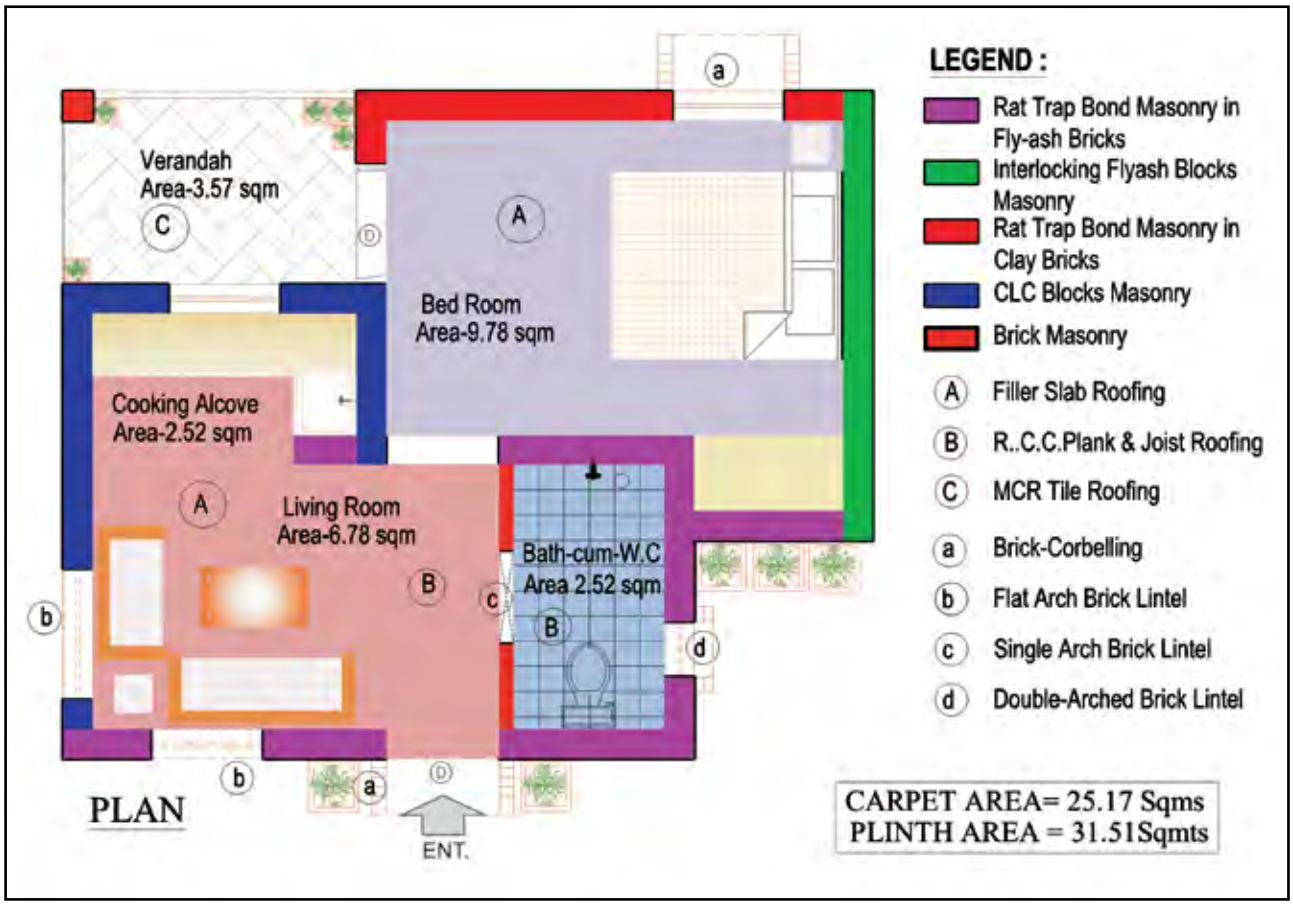
The alternate and proven technologies were used in construction of the demonstration house which apart from reducing the cost of construction by reduction of quantity of building materials through improved and innovative techniques or use of alternate low-energy consuming materials can play a significant role in reduction of GHGs emission and thus help in the protection of environment.

The Demo House attracted a number of professionals including general visitors. Many of the visitors requested BMTPC to provide technical assistance for construction of such type of houses in their respective region.

The Specifications of the house constructed for demonstration are given hereunder:

Space Norms:

- Plinth Area of 31.51 Sqm. and Carpet area of 25.17 Sqm.
- Two Habitable Independent Rooms
- Kitchen Alcove
- Combined Bath & Toilet
- Court Yard/Balcony
- Part of a Cluster of 4 Units at one Floor



Building Materials/ Construction Technologies:

Masonry:

- One wall with Fired Clay Bricks in 1:4 Cement Coarse sand mortar, in Rat-Trap Bond
- One wall with Fly ash Bricks in 1:4 Cement Coarse sand mortar, in Rat-Trap Bond
- One Wall in Cellular Lightweight Concrete Blocks
- One Wall with Fly Ash Interlocking Blocks

Roofing:

- RCC Filler slab with Bricks and earthen Pots as infill
- Precast RC Planks and Joist Roofing
- MCR Tile Roofing

Openings:

- Brick arches
- Inbuilt Brick Jallies
- Brick on Edge Lintels
- RCC Door Frames
- Steel section glazed window
- Brick Corbelling
- Bamboo mat door
- Ferro cement Shelves, Sunshades, Kitchen Slab

Flooring:

- Precast concrete tile flooring

Finishing:

- Cement Pointing

Earthquake/Cyclone Resistant Features:

- RCC Plinth Bands, Lintel Bands, Roof Band and Vertical Steel Reinforcement at corners & Junctions
- Cement Coarse Sand Mortar of 1:4
- Designed as per NBC, BIS Specifications

Sustainability:

- Thermal efficiency due to cavity in Rat-Trap Bond Masonry
- Reduction in bricks and mortar quantity due to Cavity in Masonry
- Concrete quantity reduces due to Filler slab, without compromising structural Strength
- RCC Door/Window Frames reduces demand for Timber/ Steel
- Brick Jallies eliminates requirements of windows frames and shutters
- Ferro Cement shelves reduces Stone/RCC slab
- No Plastering is required
- Locally available building materials may be used as per availability and Costing,
- Locally available materials are low Embodied Energy materials
- Embodied Energy of the house can be decreased by about 30 % without increase in Cost

Costing:

- Cost is dependent on geographical area, volume/scale of work and time, however cost of construction with these technologies is about 10% - 15% less than the cost as per standard specifications of CPWD/ States PWDs/ Housing Boards/ Development Authority's
- No Complicated construction Techniques
- No Proprietary Items of works as all are covered in BIS
- A number of such units have already been constructed throughout India.

BMTPC Pavilion on

Emerging Housing and Building Technologies including Cost Effective Technologies during IITF 2011

BMTPC Pavilion on Emerging Housing and Building Technologies including Cost Effective Technologies in HUDCO Build Tech during India International Trade Fair 2011 from 14-27 November, 2011, was inaugurated by the Hon'ble Minister of Housing and Urban Poverty Alleviation and Minister of Culture, Kumari Selja ji.

The main attraction of the BMTPC pavilion was the demonstration of proven cost effective technologies as well as emerging housing technologies from India and abroad. Besides the house constructed with proven cost effective technologies, the emerging technologies demonstrated were Panel building system using steel mesh, polystyrene core and chipping concrete from Malaysia, Technology using expanded steel mesh panels, polystyrene beads and alleviated concrete from U.K., Prestressed precast prefab technology using hollow core slab, beams, columns, solid walls, stairs etc. from Finland, Monolithic concrete technology using plastic / aluminum composite formwork from USA/ India, Precast concrete panels, using concrete, welded mesh and plates, polystyrene core from New Zealand, bamboo based technologies such as bamboo mat corrugated sheet/bamboo mat ridge cap for roofing, bamboo mat board for walling, partitioning and false ceiling from India, GFRG / Rapid wall Building System Technology using precast panel made of gypsum plaster reinforced with glass fibres from Australia/ India, Maintenance free Bio Digester Toilet for Sanitation. With fast depleting natural resources; need for environment protection to protect green house effect; need for bringing more speed, durability and quality in construction, these showcased technologies have potential for possible application in mass housingas a cost effective substitute for conventional system. These technologies/systems have been selected based on Global Expression of Interest and Performance Appraisal Certification Scheme (PACS) of BMTPC.

As a culmination of the event, an **International Seminar on Cost-Effective, Energy Efficient & Ecologically Appropriate Building Materials &Technologies for Housing** was held on 26th November, 2011 jointly by BMTPC and HUDCO at Conference Complex, Pragati-Maidan, New Delhi. Apart from Representatives of SAARC, more than 150 representatives from R&D and Academic Institutions, NGOs, Building Centres, Professionals, Manufacturers, Builders, Real Estate Consultants, Housing & Urban Development Authorities, public and private sector departments/ agencies working in the area of housing and building construction participated in the International Seminar. The Seminar was inaugurated by the Secretary, Ministry of Housing and Urban poverty Alleviation.

International Seminar on Cost-Effective, Energy Efficient & Ecologically Appropriate Building Materials &Technologies for Housing – 26th November, 2011

Exhibition Seminar

bmtpc expo'12

Appropriate Building Materials & Housing Technologies

November 6 – 8, 2012

NSIC Exhibition Complex
Technical Service Centre
Okhla, New Delhi

First Announcement

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India

Development of Criteria for Certification of Ready Mixed Concrete

Ready Mixed Concrete, is defined as concrete mixed in a stationary mixer in a control batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at site or into the purchaser's vehicle. Speed and quality are the two main pillars which distinguishes RMC from site-mixed concrete. One can achieve speed by employing plant and equipment of required capacity, but the quality, it is not only the sophisticated equipment & Plant but also expertise in concrete technology and capability to exercise strict control on process parameters.

The construction scene has undergone major change during the last 10 years. Now RMC plants have sprung up in all major cities of India. Many cement manufacturing industries have taken initiative to set up most of these plants and utilize part quantity of cement production in RMC.

Leading RMC plants have formed an Association, namely, Ready-Mixed Concrete Manufacturers Association (RMCMA) with an idea to make Ready Mixed Concrete (RMC) as most preferred building material of construction in India. As an unique initiative RMCMA developed quality framework based on practice followed in developed countries like USA and UK for self regulation. The production facilities of members are subjected to annual audit by external auditor based on check list approved by RMCMA. However, in the absence of any third party certification, there is still lack of confidence in the minds of user agencies about the quality being supplied by such plants. The very purpose of bringing quality concrete construction through RMC compared to site mix concrete is being affected.

With the initiative taken by Ready Mix Concrete Plant Manufacturer's Association themselves, Quality Council of India (QCI) and BMTPC have joined hands for developing the criteria for Certification of Ready Mix Concrete Plant though a Technical Committee represented by CPWD, Delhi Metro, National Highway Authority, CBRI, NCCBM, Leading Structural Engineers and others.

Basic document has already been prepared covering requirements for the production Control of Ready Mixed Concrete which includes requirements of resource managements, plant and equipments, laboratory, key personnel, control on quality of incoming materials, production and delivery, control on process control equipment and maintenance and feed back mechanism.

CPWD and Highway Authority have welcomed this move, and are looking forward to the certification process to start to utilize certified plants for their projects.

ROAD SHOW EXHIBITION SEMINAR

Exhibition-cum-Seminar on

Emerging Technologies for Mass Housing

December 18-19, 2012

Tamil Nadu Trade Promotion Organisation,
Chennai Trade Centre Complex,
Nandambakkam, Chennai

Jointly Organised by:

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India, New Delhi

Indian Concrete Institute
Chennai Local Chapter
Chennai

BMTPC Activities during World Habitat Day 2011








Priced Publications of BMTPC

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 12)
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 on-going activities of flyash utilisation through small, medium and large scale production of flyash-based building materials in different states.

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

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

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

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

12. **BUILDING CENTERS: DELIVERING TECHNOLOGIES TO THE 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.

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

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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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