Special Issue

निर्माण सारिका

A Newsletter of BMTPC

भाग २, अंक १, अक्टुबर २००९, नई दिल्ली Vol. 2, Issue 1, October 2009, New Delhi

PLANNING OUR URBAN FUTURE

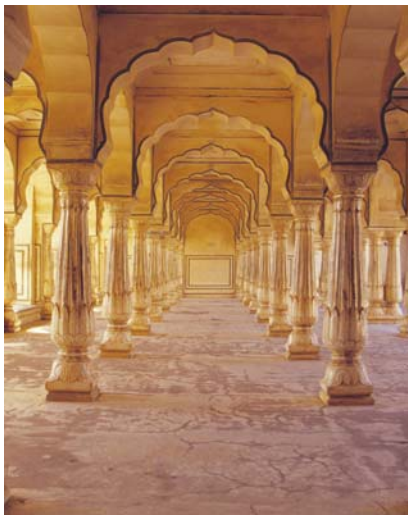
World Habitat Day | 5 October 2009

bmtpc

fuekZ.k lkexzh ,oa izkS|ksfxdh lao/kZu ifj"kn
vkokl ,oa 'kgjh xjhch mi'keu e=ky;] Hkkjr ljdkj

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

"Creating Enabling Environment for Affordable Housing for All"



CONTENTS

From the Desk of
Executive Director

The publication of special issue on the theme of World Habitat Day has been the practice over the years by BMTPC. However, the release of Nirman Sarika today, a quarterly newsletter of BMTPC carries a special place in my heart as it was initiated by me after taking reins of BMTPC in 2008. The newsletter was launched on the foundation day of BMTPC which is celebrated on 29th June every year and since then, our Nirman Sarika is being circulated to one & all involved in promotion of appropriate technologies so as to create enabling environment of affordable housing for all. Through this newsletter, our endeavour has been to create awareness about field level applications of the innovative building materials and construction technologies leading towards sustainable development amongst all stakeholders involved in construction Industry. The sustainability is the key for planning our urban future which has been chosen fittingly as a theme to commemorate World Habitat Day 2009.

Today, India is the second fastest growing economy in the world. The Indian construction industry is an integral part of the economy and a conduit for a substantial part of its development investment, is poised for growth on account of industrialization, urbanization, economic development and people's rising expectations for improved quality of living. In India, construction is the second largest economic activity after agriculture. Construction accounts for nearly 65 per cent of the total investment in infrastructure and is expected to be the biggest beneficiary of the surge in infrastructure investment over the next five years. Investment in construction accounts for nearly 5-6 per cent of India's Gross Domestic Product (GDP).

Have we ever thought what price we are paying for this unprecedented growth? Our natural resources are being irreversibly depleted, land is being degraded, trees and forests are being destroyed, water and air is being polluted, and ground water level is going down. A large quantity of wastes and by-products are being produced and disposed off creating huge landfills posing health and environmental hazards. It is now high time when we regulate the use of materials, technologies, processes and energy so as to save our Planet Earth. Let us practice environmentally responsible and resource-efficient construction processes for planning our urban future. Any construction project used to have traditionally three key elements i.e. cost, speed and quality. Let us add another one which is sustainability of environment. To wrap up, I quote the lines by Gro Bruntland to define planning for urban future:

"Meeting the needs of the present without compromising the ability of future generations to meet their needs"

(Dr. Shailesh Kr. Agrawal)

BAN KI-MOON
Secretary - General
UNITED NATIONS

The theme of this year's observance of World Habitat Day, Planning our Urban Future, is meant to underscore the urgency of meeting the needs of city dwellers in a rapidly urbanizing world.

The major urban challenges of the twenty-first century include the rapid growth of many cities and the decline of others, the expansion of the informal sector, and the role of cities in causing or mitigating climate change. Evidence from around the world suggests that governments at all levels are largely failing to address these challenges. Urban sprawl and unplanned development are among the most visible consequences. Hundreds of millions of urban dwellers are also increasingly vulnerable to rising sea levels, coastal flooding and other climate-related hazards.

A troubling trend has emerged in many cities in developed and developing countries alike: the growth of up-market suburban areas and gated communities, on the one hand, and the simultaneous increase in overcrowded tenement zones, ethnic enclaves, slums and informal settlements, on the other. Stark contrasts have also emerged between technologically advanced and well-serviced business sectors, and other areas defined by declining industry, sweatshops and informal businesses.

Better, more equitable urban planning is essential. New ideas from smart cities around the world are pointing the way toward sustainable urbanization. But there is far more to do. Urban poor need improved tenure and access to land. All cities need safer and more environmentally friendly public transport, housing security, clinics and public services. There is also a need to mobilize financing for urban development.

Planning is at the heart of this agenda. But planning will work only where there is good urban governance and where the urban poor are brought into the decisions that affect their lives. And planning will work best only where corruption is honestly tackled. United Nations bodies such as UN-HABITAT can provide vital help with capacity building, research, and knowledge management and exchange.

At the dawn of this new urban age, we recognize the problems and we know how to tackle them. We understand perhaps more clearly than ever before that no-one can be excluded, especially the poor. On World Habitat Day, let us pledge to do our part to follow through on our plans for a better, greener, more sustainable future for our increasingly urban planet.

Statement of
Anna Kajumulo Tibaijuka
Executive Director, UN-HABITAT

We have chosen the theme, *Planning our Urban Future*, for World Habitat Day 2009 for a simple but very important reason: In many parts of our world urban planning systems have changed very little. Indeed, they are often contributors to urban problems rather than tools for human and environmental improvement.

It is clear to us at UN-HABITAT and to our partners in government, municipalities, and at community level that current approaches to planning must change and that a new role for planning in sustainable urban development has to be found.

Yet to blame urban planners and their plans for our urban problems is like turning back the clock and going back in history to a time when no-one could have foreseen the problems we now face.

It is a fact that slums are the worst manifestations of urban poverty, deprivation, and exclusion in the modern world. And it is a fact that today we have the technological know-how such as satellite-based Geographical Information Systems – undreamed of until not so long ago – the power, and the money to plan effectively for the targets established in the Millennium Declaration.

Many of the ills of urbanisation have been conveniently left at the doorstep of urban planners and planning. However, there are many reasons why that job may not result in a better living environment for all. In many countries planning has not been very powerful and developers, the private sector and individual citizens – who do not have the public good uppermost in their considerations – are relatively unconstrained in their activities. Powerful economic interests may feel threatened by planning recommendations. Politicians may not have an adequate sense of the public interest or plans may not reflect their priorities. Alternatively, planners may not have adequate training and their advice may be good or bad, taken or ignored. Plans may be unrealistic, given their resource requirements. Plans may not reflect the priorities of community groups. On top of all this, the implementation authority may be fragmented among jurisdictions.

In trying to correct these deficiencies, planning has opened itself to public participation and preference and to taking a more realistic view of the limits of the possible, while factoring in the resources likely to be available for implementation.

Yet, in today's world, despite many success stories that have come about due to planning's ability to reinvent itself, it would appear that the planning function still falls short in some parts of the world. Slums are multiplying, urban crime is rampant, development keeps sprawling, transport efficiency is declining, energy costs are rising, and health problems are increasing, while many citizens are walling themselves off from others. What's happening here? Has planning failed and does it need to be replaced by a more effective function?

Actually, there is no replacement for planning. It is a function that results from our uniquely human ability to anticipate consequences. As the world grows more and more urban, it is vital that, as governments accept urbanisation as a positive trend, planning fulfils its proper role in guiding urban development when it comes to improving access to services, and economic and social opportunities.

Urban planning will therefore have to continue to adapt so it is able to carry out its much-required effective role in shaping a positive urban future.

सत्यमेव जयते

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

We are all aware that cities and towns, both in the developing and developed world are being greatly influenced by the rapid change in environment, population growth, urbanization, industrialization, change in living habits and lifestyles etc. These factors deserve thoughtful consideration while planning and designing the cities and towns in the coming era and will significantly influence reshaping the towns and cities, physically and socially.

In view of the challenge ahead, the theme of the World Habit Day this year "Planning Our Urban Future" amply focuses on raising awareness about the need to improve upon the urban planning process to enable it to deal with the new major challenges of the 21st century. Planning is a function which is an outcome of the political will, skills of the professionals, lessons learnt from the past and the ability to anticipate results. Urbanization has to be seen as a positive trend and we have to appreciate that planning facilitates improving upon the access to basic services and economic and social opportunities.

The National Urban Housing & Habitat Policy, 2007 has been a forerunner for planning our urban future which stresses upon the need for having appropriate perspective plans for towns and cities in order to improve upon the living conditions of people in urban areas. Similarly, the Jawaharlal Nehru National Urban Rural Mission (JNNURM) aims at improving upon the housing conditions of the poor, especially those living in slums as also improving upon the basic infrastructure facilities in the area. My Ministry is also formulating Rajiv Awas Yojana for the slum dwellers and the urban poor in an effort to promote a slum-free India.

BMTPC has been playing a key role in promotion of new and innovative building materials & construction technologies to bring construction costs within affordable limits of the masses. I am sure the Council will put concerted efforts to improve productivity and efficiency of the housing delivery systems by promoting use of cost-effective building materials in different regions of the country.

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

(Kumari Selja)

Role of Planning for Urban Development: A case study on North Eastern Region

Dipul Kalita, Tapas Das* and Dipankar Neog**

Introduction

Urbanisation is the process in which the number of people living in urban area increases compared with the number of people living in rural areas. A country is considered to be urbanised when over 50% of its population lives in urban places. Urbanisation may be slow or rapid depending on the socio economical development of the country.

The term urban planning is used to indicate the arrangement of various components or units of an urban in such a way that the urban as such attains the significance of a living organism. Urban planning also includes ways and means to be adopted for the improvement of the existing urban or for the extension of urbans. Thus, the knowledge of urban planning helps in achieving the best possible advantages of the situation of urban with respect to its land and the surrounding environments. Urban planning demands active imagination and sharp common sense of the understanding of various needs of the society occupying or likely to occupy the urban.

The urban planning is a science as well as an art too. The science consists in collecting, correlating and analysing the facts about a town. The art lies in arranging the components of a town in such a way that the final result is in the form of a beautiful, convenient, economical and efficient unit. Thus, science and art must sit together when a new urban is being designed or when an existing urban is being remodeled. The science and art must join their hands and work as co-partners in the difficult task of bringing out a well arranged urban. The gap between guesswork and prediction in planning can be brought down to a minimum by the co-operation of various agencies involved in the use and development of land.

The urbans of the modern time have to be designed for problems such as climate change, resource depletion, food insecurity, population growth and economic instability. In urban planning, it becomes necessary to maintain a proper balance between the four essential objects or ideals of any urban planning scheme viz. beauty, convenience, environment and health and not to give emphasis on any one of them at a disadvantage of the others.

In modern urban planning, the following salient features are to be incorporated in planning.

- The urban should be designed to satisfy both the needs of the future generation and the probable growth and development of the urban. Care must be taken to see that the urban does not develop in any hapazard fashion.
- The development plan of an urban should be prepared by keeping in view the regional conditions rather than local conditions.
- Urbanisation should be preceded by landscape plans. Communities should found new settlements which conserve the existing landscape and create new public goods.
- The growth of urban should be according to the predetermined plan. The growth of urban should be horizontal rather than vertical to avoid the both natural & artificial calamities.
- A control mechanism should be developed to control the development activities in accordance with the development plan in the urban development area.
- Extreme care should be taken to provide housing accommodation to various categories of people. If slums exeunt, they are to be cleared by the provision of some alternative arrangement.
- A well-balanced grouping and distribution of various public buildings throughout the urban should be designed. Any unnecessary concentration of public buildings at certain

* North East Institute of Science & Technology, Council of Scientific and Industrial Research, Jorhat 785 006, Assam

spots of the urban should be avoided.

- The road systems should be designed in such a manner, so that it can accommodate the traffic in the coming future based on the rate of urbanisation.
- The urban should be provided with suitable transport facilities so that there is minimum loss of time from place of work to the place of residence.
- The urban should be divided into suitable zones/sectors and suitable rules and regulations should be formed for the development of each zone/sector.
- The size of the urban can be limited by the provision of green belt on the periphery of urban.

Role of planning for providing infrastructure and housing in urban sector

Urban India today, faces serious challenges of growth and its management. Across geographies, the issues of urbanization manifest in the form of overcrowding, congestion, insufficient infrastructure, inadequate service provisioning-mainly in terms of drinking water, sanitation, energy, transport, solid waste management, environmental degradation, and pollution, etc. These, along with the poor management of rapid growth, affect the socioeconomic development of the country. At the core lies the question of urban planning and its capacity to organize towns, manage their growth and make them more efficient and sustainable.

सत्यमेव जयते

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

World Habitat Day, celebrated every year to promote reflection on issues of urbanization, has this year 'Planning Our Urban Future' as its theme. With 50% of the global population already living in cities and the size of urbanization projected to grow as the economies of developing countries pick up pace, it is appropriate that we take stock of the impact of urbanization on the quality of urban life and our habitat. Clearly, growing shortages of urban lands, housing and infrastructure will exacerbate, with consequent growth in slums, inequity, ill-health, population and crime, unless appropriate action is taken - and urgently taken - to revisit urban planning systems and processes to redesign them to respond more effectively to making cities economically productive, socially inclusive and economically sustainable. The various stakeholders in the urban habitat should use the World Habitat Day deliberations to review and redesign their respective strategies. Building Materials & Technology Promotion Council (BMTPC) as an important stake holder with a mandate clearly directed towards futuristic planning, has already begun to re-look its approach and to widen the definition of what may constitute a cost effective technology in the current and ensuing urban context.

I hope the Council will further intensify its efforts to help in capacity building with urban communities, to adopt innovative and cost-effective building technologies, by enhancing their production and application in different regions of the country. I am happy that the Council is bringing out a special issue or newsletter "Nirman Sarika" on the occasion of the World Habitat Day.

I convey my best wishes to the Council in its endeavor.

Dated: 22nd September, 2009

(Kiran Dhingra)

Like many other countries with high rate of urban development, India too acknowledges insufficient and inappropriate planning, which raises the questions of its relevance while triggering skepticism. Large parts of cities today completely 'escape' mainstream planning. The considerable 'illegal development' (illegal layouts, un-authorized constructions, slums) in many towns is a frightening reality that threatens the future of urban areas and the credibility of main plan documents and regulations.

As society progresses, the process of economic development and resulting urbanization get momentum which in turn creates demand for urban services and infrastructure facilities. For example, the process of urbanization in India is going on with increasing momentum. At the end of last millennium about 305 million Indians, comprising 30% of its population, are living in nearly 3700 urban agglomerations spread across the country. Urban India has grown by nearly five times during the last fifty years, while the population of India has grown two and half times in the same period.

A matrix on the assessment of City Development Plans for two major cities of North Eastern Region is presented in Table-1.

It is reported that approximately 13% of Assam's population is living in urban areas out of which 24% lives in Guwahati city alone.

Table 1: Appraisal of stakeholder consultations carried out during City Development Plan preparation

City	Overall quality	Spatial Spread & Socioeconomic diversity	Convergence between CDP & stakeholder consultation
Guwahati	The City Development Plan has been revised. But the problems of overcoming multiplicity of agencies need to be addressed more effectively.	• Five workshops were held over a period of three months at different stages of CDP preparation. • Various groups were consulted. However, there seems to be no representation of the poor. • Selection of stakeholders based on spatial spread is not clear.	CDP reflects convergence in projects based on stakeholder consultations.
Kohima	Baseline survey well collated and analyzed. Financial aspects over -estimated at places withoutgiving due consideration to the population of the city and creditworthiness of the urban local body.	Fairly equitably spread out all over the city. Community consultation groups were divided into – primary and secondary stakeholders. Stakeholders views taken on board and issues identified on a macro and micro-level.	Convergence well brought out and techniques used covered convergence issues quite comprehensively. However, some projects that have been added are not required for a city of this size and type.

Population Growth: Guwahati Metropolitan Area

The population of Guwahati was 8,394 in 1891, which crossed the one lakh limit in 1961. The population of Guwahati Municipal Corporation Area (GMA) in 2001 was 809,895.

Based on the past population growth trends low, medium and high population estimates for Guwahati Metropolitan Area for the period 2005 to 2025 have been worked out. It is estimated that the population of GMA may vary from low of 19.10 lakhs to a high of 22.50 lakhs in 2025. A medium projection of 21.74 lakh for GMA for the perspective year 2025 is adopted and the same is used for the planned development of GMA. The statistical data over the 1921 to 2002 indicates that urban population in the city has a decadal growth varying from 23% to 131% whereas decadal GM area growth varied up to 83% with negative growth of -40% during 1980-1990.

Existing building type of Guwahati Urban Area

India has a very complex socio-cultural environment and its built environment encompasses the widest possible range from non-engineered dwellings built with traditional skills to the most modern buildings, and Guwahati is no exception. The existing building types are:

Building Category

Type A: Rural structures bamboo reinforced biomass wall cladding, thatched/CI sheet roof,

unburnt brick house, Assam Type Houses in timber frame.

Type B: Brick Masonry Wall 150 mm x 150 mm to 250 mm x 250 mm corner columns with lintel bend and tie, timber trussed CI sheet roof, buildings of the large block and prefabricated type, half-timbered structures, building in natural hewn stone

Type C: Reinforced Concrete Building-Engineered & Non-Engineered with beam, column & slab construction, well built wooden structures.

Type X: Other types not covered in A, B, C.

Road Network Characteristics

A main road network of 171.3 km in GMA has been studied. Of this arterial roads accounted for 42.3 km and sub-arterials for 54.3 km.; 54.1 km of roads had a median; Only 42% of the road length had a carriageway of 7.0 m (2 lanes) and above; 72% of road length did not have footpaths; 40% of the road length did not have drainage facility; Nearly 70% of the road length did not have street lighting facility.

Traffic Characteristics

A total of 71,824 vehicles (107,819 PCUs) entered and exited the study area at the Outer Cordon (OC), on an average day (2004). The peak hour volume at OC stations ranged between 7.4% and 14.4% of Average Daily Traffic (ADT). Goods modes accounted for 18.6 % of the ADT at the OC. 2.9% of the passenger modes and 7.8% of goods

सत्यमेव जयते

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

I am glad that the World Habitat Day, this year is devoted to the theme "Planning Our Urban Future". Continuing rapid urbanisation is exerting pressure on the urban fabric leading to problems of urban poverty, lack of housing & infrastructure, environmental degradation and social tension. Recognising the seriousness and complexity of these issues the Government of India has taken several initiatives including launching of National Urban Housing & Habitat Policy which intends to promote sustainable development of habitat in the country for realizing the goal of Affordable Housing for All. The objectives of these initiatives are: achievement of social sector goals; community empowerment; creating sustainable support systems; employment generation and skill upgradation; environmental improvement and shelter upgradation. In the light of some of the recent initiatives and programmes, I hope the theme selected for observance of the World Habitat Day this year will help in reviewing the various programmes, aimed at improving the quality of life in urban human settlements.

The Building Materials & Technology Promotion Council has been actively engaged in enhancing the technology climate for efficient and effective implementation of the programmes initiated within the framework of the National Urban Housing & Habitat Policy. I am happy to note that the Council through their promotional efforts is providing technology support in the various programmes of this Ministry.

I am glad to know that BMTPC has planned to highlight the importance of the theme chosen by United Nations by bringing out a Special Newsletter "Nirman Sarika". The publication will highlight planning needs of the housing and settlement development programmes in the context of urban future.

I extend my best wishes to the Council.

(S K Singh)

Type A

Type B

Type C

Type X

Existing Building Types of GDA

modes at OC were 'through' in nature. 25% of the goods vehicles at the OC were empty.

Travel Demand - Inter-city

The inter-city traffic has been estimated based on projected growth rates, by mode type. The growth rates of traffic from the previous studies are adopted to estimate the future inter city and through traffic. The estimated traffic (inter city and through), at Outer Cordon, by 2025 is expected to increase by 500% for two wheelers, 350% for cars and 430% for buses over a period of 20 years.

Present housing situation - Census of India, 2001

In 2001, Guwahati Metropolitan Area contains 183,491 housing units out of which 178,838 units are exclusively residential and 4,753 are put to residence-cum-other uses. Out of the total housing, 48.4% households live in owned residences, 46.4% in rented and 5.2% in other accommodations. Out of the total 178,838 residences in 2001, 98,889 (55.3%) are of good condition; 68,383 (38.3%) of livable condition and 11,466 (6.4%) in dilapidated condition. 57% of the population lives in one- or two-roomed accommodation; 29.6% in three- or four-roomed accommodation and 12.4% in 5-roomed and above.

Housing Shortage in 2001 and 2005

Housing shortage in Guwahati Metropolitan Area in 2001 is 12,817. Census data on the number of households, number of residential houses is as follows:

A.	Total no of households	1,84,454
B.	Total number of residential houses and houses used for residence-cum-other purposes	1,83,491
C.	Backlog of housing required (A-B)	963
D.	Dilapidated houses (Residence and Residence-cum-other uses)	11,854

The total housing requirement by 2025 may increase approximately to 2.80 lakhs against the requirement of around 60,000 for the period 2006 - 2010.

Considering the rapid growth of urban population and inadequate infrastructure in the existing system, a new approach of urban development is suggested for mitigating the intensifying insurmountable situation.

Clustered Development: A new approach to Urban Development

Different approach has been made throughout the world towards urban development.

Of almost all the problems related with the Urbanization in India are the unplanned development/ constructions in the leading cities of the country. Although in all such developments / construction up-to-date engineering and technical measures are taken, the overall problems like, transport and traffic, drinking water, drainage, sewage, electricity etc in all such cities are increasing day by day.

In the present approach it is tried to solve such problems by introducing Clustered Development. The clustered development means "developing a cluster of few square kilometer areas in the city in- stead-of solving individual problem by creating all the basic facility in that particular cluster which is designed for a particular population and the next cluster will be developed as the first cluster becomes saturated". A schematic diagram shows the concept below:

The following points describe

the salient features of the concept:

- New development / constructions must be done cluster-wise.
- The competent authority will have to give permission of any construction which is pre defined in a particular cluster.
- Each cluster must be self sufficient in all respects.
- All basic facilities like market complex, educational institutions, medical -`facilities, banking etc. must be available in each cluster so that the inter cluster travel or travel to the main city can be reduced. It will reduce the overall traffic in the city.
- To encourage the use of the basic faculties of own cluster, there must be some provisions of getting discount in utilizing the facilities of such clusters.
- Similar to the concept of Carbon Credit for industries, it is possible to introduce the concept of credit points in utilization of water, plastic, electricity and fuel etc. and the same can be benefited through electricity bill, mobile bill etc.
- Road network must be predetermined in a particular cluster, e.g. the road networks from schools and colleges to the residential complexes should be such that other road networks from other establishments which are high traffic dominant will not cross each other.

Source data:
1. http://www.gmda.co.in/master_plan.htm
2. Census report of India - 1991 and 2001.
3. Project report: Seismic Vulnerability of Guwahati Region, Seismology Division, Ministry of Earth Science, Govt. of India, New Delhi 110 003, 2008.

Eco-friendly Cities of the World

Reykjavik, Iceland

Reykjavik has been putting hydrogen buses on its streets, its heat and electricity come entirely from renewable geothermal and hydropower sources and it's determined to become fossil-fuel-free by 2050.

Portland, Oregon

The City of Roses is the first U.S. city to enact a comprehensive plan to reduce CO_2 emissions and has aggressively pushed green building initiatives. It also runs a comprehensive system of light rail, buses, and bike lanes to help keep cars off the roads.

Curitiba, Brazil

With citizens riding a bus system hailed as one of the world's best and with municipal parks benefiting from the work of a flock of 30 lawn-trimming sheep, this midsized Brazilian city has become a model for other metropolises.

Malmö, Sweden

Known for its extensive parks and green space, Sweden's third-largest city is a model of sustainable urban development.

Vancouver, Canada

Drawing 90 percent of its power from renewable sources, British Columbia's biggest city has been a leader in hydroelectric power and is now charting a course to use wind, solar, wave, and tidal energy to significantly reduce fossil-fuel use.

Copenhagen, Denmark

With a big offshore wind farm just beyond its coastline and more people on bikes than you can shake a stick at, Copenhagen is a green dream. The city christened a new metro system in 2000 to make public transit more efficient.

London, England

London will soon switch 25 percent of its power to locally generated, more-efficient sources, cut CO2 emissions by 60 percent within the next 20 years, and offer incentives to residents who improve the energy efficiency of their homes.

San Francisco, California

San Francisco has also been a leader in green building, with more than 70 projects registered under the U.S. Green Building Council's LEED certification system.

Sydney, Australia

Sydney hosted a city-wide one-hour blackout to raise awareness about global warming. Add to that their quest for carbon neutrality, innovative food-waste disposal program, and new Green Square, it is well on its way to becoming the Emerald City of the Southern Hemisphere.

Barcelona, Spain

Hailed for its pedestrian-friendliness, promotion of solar energy, and innovative parking strategies, Barcelona is creating a new vision for the future in Europe.

Source: http://listphobia.com/2009/07/01/10-most-eco-friendly-cities-of-the-world/

STRUGGLING CITIES

Need for Sustained Planning and Powerful Urban Governance

Dr.M.L.Khurana*

We may be proud of our ancient cities of Mohenjodaro and Harappa and may boast of the town planning our ancestors did. The urban planning, the housing structure, the storing space and the road building or any other architectural arrangement they did in those times with limited means and less of technology is worth to be proud of.

But the present grim situation of our present cities no way reflects that we inherited the same architectural and planning mindset. The present situation of our cities has been worrying. There has been uncontrolled growth of urban areas, indiscriminate use of the precious natural resources, uneven distribution of the resources, uncontrolled migration, and lack of proper infrastructure in the cities. The amount of pressure the cities today face has led urban planners to think what went wrong with the development approaches.

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

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

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

While on one hand the urbanization process has led to suffocating and struggling cities i.e. the cities that have reached the limits of their carrying capacity to sustain human life. There is dearth of basic amenities like water, power, land, housing and this is giving rise to fight for basic needs. Crime and violent activities has increased and cities are now becoming miserable due to rising expectations and aspirations beyond the available means. Cities today are struggling with the limited resources it has and the number of people it has to take care for. The per capita availability of resources is gradually decreasing. Not only this, cities today are facing a variety of social and environmental problems. These include pollution, unemployment, inadequate infrastructure, increased rate of crime and violent activities.

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

But this vision of attaining a sustainable city is good as a

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

concept. The reality check of this concept has revealed that a sustained effort on the part of the urban government and strong citizen participation is required to attain our goal of sustainable cities. And the effort has to be a continuous one and not in patches. Overall view of all the sectors has to be taken care of. For instance, meeting alone the water or power problem of the city would not help if the sewage disposal is not taken care of or developing alone the residential units of some localities and not taking care of the slums would not change the picture of the city. Various simultaneous steps are to be taken so that the city remains a liveable place for the present generation and also for the future generations. For this the various departments of the government have to be in constant link and have to take the responsibility together.

NEED FOR A STRONG URBAN GOVERNANCE

Various steps that are required for good urban governance are:

- Promoting the specific goals of decentralisation,
- Integration of the poor and marginalised,
- Environmental sustainability,
- Improved municipal finance,
- Transparency and accountability
- People's participation and
- Increased women participation.

This would help in building inclusive cities a place where everyone, regardless of wealth, gender, age, race or religion, is enabled to participate productively and positively in the opportunities, cities have to offer. Because, we all know that cities are our common future, we need to take all possible steps that make cities a liveable place. The main question is how we organize and govern our cities. . In many cities of the world, the absence of well-coordinated urban and regional planning contributes to economic and social deprivation, loss of community, social segregation and other negative urban trends, which in turn contribute to social diseases like crime, alcohol abuse and drug problems as well as to psychological disorders.

The future of humanity is being shaped by the urban living conditions and the answers are to be found for the developments that are taking place because of this accelerating urban growth. This years World Habitat Day is based on the similar theme of **Planning our urban future**. The theme emphasizes on the essentiality of equitable urban planning and calls for a concerted action on part of every individual, every section of the society and every department of the government agency to make an effort for this.

It would be a great symbol of global urban solidarity if more and more cities from industrialized countries were to form partnerships with cities from developing countries, or countries in transition, for the transfer of know-how and technology and for the exchange of experience on the platform provided by the UN. The vision of 'sustainable cities' is gaining more and more ground with local government institutions, with planners and architects, contractors and engineers and, most importantly, with the citizens who, in their daily lives, will make the adjustments required for a sustainable life-style. We need the power of this vision, the imagination and the talent of all these people.

Only a sustained effort with the strong administrative attempts which look into all the sections of the infrastructure can bring a change. It is not to be said that developing a city is the sole responsibility of the government agencies but time and again participation of the people has been discussed. The vision of attaining a sustainable city needs a volunteer effort on part of the citizens and a joint effort on the part of government and non government agencies. Unlike traditional community development approaches, sustainability strategies emphasize: the whole community; ecosystem protection; meaningful and broad based citizen participation and economic self reliance. The main part of focus should be on people's participation for they better know what is required and how that can be attained. Even the community based organizations and non government organizations have focused on people's participation. UN agencies have time and again talked of people involvement and thus people aiding in their own development. There have been numerous examples where citizen participation has proved fruitful, be it building houses or finding solutions to solve their daily problems, like maintaining hygiene, keeping surroundings green and clean or sanitation facilities, etc.

Urban Planning In India

Shirish B Patel*

Urban planning is as much or as lit-tle a part of urban governance as you want it to be. In India it has long since been turned into an irrelevance. Part of the responsibility lies with policy makers. In Maharashtra for example, successive Chief Ministers have stead-ily eroded all urban planning func-tions in every organization, from the municipalities to the regional plan-ning authorities. All such decisions, for every town in the State, are now centralized in the Urban Development Department in Mumbai, directly under the Chief Minister. They consist essentially of modifying the Develop-ment Control Regulations, the set of rules that regulates development. These are now framed, cast or recast by bureaucrats, with no participation by urban planners in the process. Builders, as it happens, have more influence over the changing of these rules than do urban planners.

But some of the responsibility for their irrelevance surely lies with urban planners themselves. For dec-ades they have not questioned the viability of the urban planning pro-cesses as set up in our legislation. That process is roughly as follows: every 20 years or so, prepare a map of existing land use, carry out socio-economic surveys and study population and eco-nomic trends. On this basis, project what you think the city will be like 20 years from now, including details of the future mix of economic activities and socio-economic characteristics of the population. Ignore the fact that every such projection in the past has been a spectacular failure, with the reality turning out to be very different from what was projected 20 years earlier.

One might put this down to the incompetence of an earlier generation of planners. Assume that one is now far, far smarter, and that in 20 years time the city will turn out to be exactly as predicted. Further, that no new eco-nomic activity or new technology (of which one is not now aware) will be invented in the coming decades. On the strength of this assumption, one can decide which parcel of land shall be put to which use, and draw up a master plan which will be sacrosanct and binding on all for the next 20 years, regardless of how the situation may change and the cracks begin to show between what one thought would happen and what is actually happening. The master plan will be accompanied by a set of building con-trol regulations, which may be tink-ered with from time to time, but there is no changing the master plan until its next revision 20 years later.

Delhi's first master plan (1961-1981) was amended and extended for another 20 years (1981-2001), but published in 1990, halfway into the plan period. Not long ago the Supreme Court to its horror discovered that the city had developed in ways contrary to the provisions of its master plan. Close to over two-thirds of the con-struction in Delhi was in one way or another illegal. To bring everything within the bounds of legality would require either large-scale demolitions, or recasting the master plan such that it accommodated the existing realities. The new master plan (up to 2021) was formulated accordingly, in a great hurry, and opened up to the public for suggestions and objections. Interestingly, very few questioned the planning process itself. The idiocy of the current process should be self-evident.

Ideally, urban planning should be a three-step process: First, a decla-ration of principles that will drive the planning process, and serve thereafter as a signpost against which each subsequent policy or project proposal is judged.

Typical principles might be the following. These are just by way of example:

i) Provide municipal services

* Chairman Emeritus, Shrish Patel & Associates Consultant Pvt. Ltd., Mumbai

to all income groups in the city.

ii) All localities must be mixed-income and mixed-use localities with a variety of housing sizes to suit dif-ferent income groups.

iii) Densities should be variable, with the highest densities concentrated around transport nodes (stations or other interchange points where trans-port mode transfers take place), taper-ing off to lower and lower densities as one gets further away from the node.

iv) When resettlement is undertaken, and plots or pitches assigned, the period of lease will be not less than 30 years; and when such a lease comes up for renewal it must be based on a fair valuation derived from current market prices, unless the land is needed for some more urgent public purpose.

v) Public transport has priority over private transport: each receives fund-ing in proportion to the number of its users.

vi) Discourage the use of cars; manage traffic with a combination of improved technology, better policing, and pricing policies.

vii) Encourage preservation of the character of the city.

viii) Expand green spaces and make them accessible to all, within walking distance of where they live.

Such principles, and their order of priority, will vary from city to city. They should be established after care-ful debate that involves the public and reviewed and readjusted every five or ten years.

The second stage of planning should be the formulation of a strategy plan for the city that looks far into the future, including in particular the economic future, and sets out the basic strategies for dealing with the fundamental issues of broad land use, transporta-tion, water supply, sewage treatment, solid waste disposal sites, power supply and the creation and maintenance of a GIS database for the region. The vision for the future should recognize that economic activity may change in unforeseen ways; and the strategies proposed should be flexible enough to cope with such change.

Another essential constituent of the strategy plan would be a parallel companion plan for financing and recovery of investment. Without this no part of the strategy plan proposal should even be considered. This cannot be sufficiently emphasised. All plans for urban development in the past have remained just that: only plans, with no clear direction as to how they are to be implemented. In future we should expect every plan, whether at the strategy or at the more detailed local level, to be accompanied by a detailed, companion financing plan, which covers how capital is to be raised, where the funds for servicing loans will come from, and how bor-rowed capital is to be repaid. Accept-ance of the strategy plan should necessarily require simultaneous acceptance of the financing plan. Only if this is done will the plan proposals be meaningful and implementable. Pure technical plans, even if accom-panied by cost implications, in the absence of clear tax and financing arrangements, often remain little more than wishful thinking.

A further, equally essential con-stituent of the strategy plan would be the action plan, setting out the respon-sibilities for implementation–who is going to do what–with datelines. Once again, as with the financing plan, the strategy plan is meaningless unless accompanied by a companion action plan.

The strategy plan should also set out the guidelines to be followed for the next level of detailed area plan-ning, including in particular specify-ing the range of desirable densities and various kinds of possible build-ing controls. Note that transportation and land use planning would go hand--in-hand, with densities of occupation as an integral part of land use plan-ning. Mixed land use could be permit-ted in any zone, with restrictions if desired, but very few fixed prescrip-tions at this strategic level of which particular plot of land should be used for what.

Prepared at the level of the regional planning authority, the stra-tegic plan should be reviewed every five years. It would be sent in draft form to the next lower level of plan-ning for comments and suggestions. Differences of opinion would be resolved after giving the public an opportunity to be heard. A mechanism would be in place for time-bound con-flict resolution.

The third and final stage would be the preparation of de-

tailed area plans which show detailed land use plan-ning and development controls. The preparation of these local area plans would be the responsibility of the various local authorities, typically acting for a locally elected municipal councillor, working in conjunction with local residents. They would also be reviewed every five years and would cover the following:

Water distribution network; storm drainage network, including rain-water harvesting; sewage collection network; solid waste primary collection, including sorting of garbage; location of bus stops, taxi parking ranks, public parking; power distri-bution; road and footpath widening; location and demarcation of public open spaces; location and sizing of various public amenities, including public toilets, schools, colleges, hos-pitals, police stations, fire brigade stations; definition of land uses at the detailed, local level, in consonance with the overall regional guidelines; development of building control regulations, which may vary from one locality to another within the local area, but which are again in conso-nance with the guidelines spelt out in the regional plan. For both the planning and the implementation of the above, we may involve what might be called citizens' area *sabhas.*

These would be much like Mumbai's advanced locality management groups, except that each area sabha should have a footprint coinciding with that of an election booth (between 800 and 1,500 persons).

Here too, as in the case of the strategy plan, it is important to have a companion document that sets out the tax and financing arrangements proposed, and another companion document setting out the action plan, so that one can be assured of success-ful implementation.

The really vexed question in the matter of detailed land use planning is the determination of the rights of land owners in the locality. There are two problems here: one concerns respecting individual plot boundaries; the other is the decision as to where (on whose plot) a public facility such as a school or a public toilet should be located.

The first issue, of readjusting plot boundaries to provide more public space, should be resolved on the basis that the primary owner of all land in an urban area is the public authority; and that the ownership of individual owners is secondary and subordinate to the first. We have years of experience of town planning schemes, where an entire locality is taken up for development, a layout is prepared, and existing landowners are given plots in the new develop-ment which are smaller than their earlier plots, but in proportion to the earlier holding. The same mechanism could apply to a situation of redevelopment where roads need to be widened or common facilities provided which did not exist earlier. Everyone in the locality benefits from the improved public facilities provided, and everyone contributes some fraction of his land ownership to this end.

Where exactly should a particular public facility, such as a school or hospital, be located is normally open to a variety of options. Why one particular plot owner rather than another should be the sacrificial goat–even if he is in principle compensated in some way for giving up his land–is a matter to be resolved. The answer surely lies in making the giving up of land for a public purpose so attractive that the public authority will have multiple offers to choose from, and can do so following any procedure that is open to scrutiny and fair to all.

One instrument whose potential has not been fully explored is the right to construct floor space. Today that instrument is the floor space index, FSI, which defines the ratio of build-able floor space to plot area. It is assumed that this must be some kind of constant number across the whole city, or at least across large swathes of it. Now there is no reason why own-ership of land must necessarily carry with it the implicit permission to build large amounts of floor space on it. The right to build could be separate from the ownership of land.

Once this principle is accepted, the right to build could for example arise from the surrender of land for a public purpose. The owner of the right to build is free to sell that right to someone else who owns land but cannot build on it unless he purchases that right to build from someone else. The public authority should of course be careful that it parts with rights to build only in such measure as the locality can sustain.

These rights to build may be issued by the public authority in a variety of ways and for a variety of rea-sons: in exchange for

land to be used for a public purpose; or sold for money to finance infrastructure; or given in exchange for the construction of middle or low-income housing. The point is to treat the right to build as a trad-able commodity in urban areas, sub-ject to such constraints on its use as may be important in particular localities.

There is another vexed question, and this concerns the rights of occupants of lands and buildings who are not the owners but who happen to be in pos-session, either as legitimate tenants or as squatters. Mumbai still has tenants whose rents are frozen at World War II levels. And it has half its total population living in slums–that is, in unauthorized occupation of land that belongs to someone else. Slum dwellers in Mumbai have acquired a kind of semi-legitimacy which does not exist for example in Delhi, where slum settlements are ruthlessly bulldozed regardless of how long they have been there, and regardless also of whether years ago they were officially put there in the first place by government.

In Mumbai, the difference is that slum dwellers throughout the city have been promised that if they can prove they came to live in the city irres-pective of where they happen to be before 1 January 1995 (the 'cut-off' date, which keeps getting regularly extended), they can continue to live where they are. They will also be pro-vided with free *pucca* accommoda-tion constructed without cost and effort on their part, at their current location. This is to be achieved by inviting developers to build slum dwellers' free housing financed through free sale in the open market of an equiva-lent amount of floor area, both on the same plot. Profits from the free sale are more than enough to pay for the free housing for slum dwellers, and the scheme has been shown to work.

Unfortunately, it can work only for those slum pockets which are in localities where property prices are high, and the high profits realized are sufficient to pay for the free cons-truction. Moreover, if the scheme is expected to cover the entire popula-tion of slum dwellers, which is half of Mumbai's total, it can only work if there is a large enough number of new city residents willing to buy so many new flats, scattered throughout the city where various slums now exist.

This kind of large market for so many new high-value flats sounds unrealistic. But there is another more fundamental problem–there is an upper limit on how high densities can go. So if a slum is already densely occupied, there can be no question of adding further numbers who will occupy the 'for sale' component because the densities then become unmanageably high.

This has been realized only recently, when the question came up of further densifying Dharavi beyond its present levels of occupancy. The realization arose from asking the following question: The Government of Maharashtra has specified a minimum built-up floor area of five sqm. per capita *inside* the house (by stipulating a minimum house size, and we assume a family size of five, the norm for Mumbai); but what is the assured ground area per capita *outside* the house? Here we find that no assurance of any kind has been provided and indeed, all plans are proceeding on the basis that ground area per capita outside the house can be reduced to zero. This is clearly untenable. People need a minimum amount of space on the ground just to circulate–after all, they live in the city not just to be at home around the clock. They need to get out, to do a job, or acquire an education, or visit friends. If we analyse existing localities around the world[1] and measure the amount of circulation space people have, we find that in the most crowded places the amount of ground space per capita for roads and footpaths alone cannot be less than 3 sq m. More would be better. There is also a minimum amount of ground space needed for social amenities, for schools and hos-pitals, the fire brigade, police stations, electric sub-stations.

While amenities ideally should not be less than 10 or 12 sqm per capita, a rock bottom minimum might be 2. Open spaces for recreation are extra and ideally should be around 16 sq m per capita. Let us provide zero on this account, because we are seeking not a comfortable city, but the most densely packed city possible. We find we cannot do with less than 5 sq m per capita of ground area. That is, we need not less than 5 sq m per person inside the house (on any floor) and not less than 5 sq m per person outside

the house, on the ground. We call this area outside the house public ground area (PGA).

Now if we assume we have a hec-tare of land (10,000 sq m), at a PGA of 5 sq m per capita, we cannot have more than 2,000 people on that area. They will need all that ground space for circulation and minimal amenities, with nothing left to build on. If we set aside 40% of the total area for cons-truction (4,000 sq m), with the rest as PGA, we can have 1,200 people (1,200 X 5 = 6,000 sq m of PGA) and on the buildable plot of 4,000 sq m we would house our 1,200 in 6,000 sq m of built-up area (which they need at 5 sq m per capita) for an FSI of 1.5 (6,000 sq m built up on a plot of 4,000 sq m). The critical conclusion is that our gross densities, even with the best management, cannot for practical purposes exceed 1,200 per hectare. And the interesting additional insight is that if you want more crowding you need to reduce the plot areas devoted to construction: the smaller the plot areas in relation to the total, the more people you can have by way of den-sity (but of course you would have to build higher).

While we argue about how densely you can pack the poor, the cities of the developing world seem to be drifting towards a sharp social and economic segregation. There are gated commu-nities of the rich and ghettos of the poor, distinguished not so much by the amount of built-up floor space per capita as by the PGA: the rich, with their golf courses, tennis courts and horse riding trails will have enormous amounts of 'public' ground area per capita compared to the poor–the 'public' in this case being restricted to members of the club.

Kemer Country,[2] a gated com-munity half an hour out of central Istanbul, is spread over 1,200 acres (480 hectares) and is expected to even-tually house 5,000 people, that is, a total ground area of about 960 sq m per capita, or if you prefer, a gross den-sity of about 10 persons per hectare. This should be seen in the context of 5 sq m per capita (corresponding to 1,200 persons per hectare) being grudged to the population of Dharavi. There are already gated communities of the rich in Mumbai, with their own swimming pools and clubhouses and jogging tracks and even schools–it would be interesting to know the public ground area per capita within these communities, accessible only to mem-bers and their guests, as compared to the PGA in the rest of the city outside these gated walls.

When we have such wide dispa-rities of income, with half the city's population living in slums, is there an alternative to gated communities of the rich (projects vigorously pursued by developers and the providers of high volume housing finance) and ghettos of the poor (proj ects mandated by government for one reason or another)? Does all new city growth have to take place only in this way?

As it happens, there exists in north-west Mumbai at Charkop a wonderfully successful example of mixed-income housing, ranging from middle-income apartments to sites-and-services, that is, the provision of plinths with wet points–a water and a sewage connection–on which former slum dwellers were given secure tenure and allowed to build whatever kind of shack they wanted, and improve it over time. Today, 20 years after the scheme was started, Charkop is a thriving settled community with everyone in a pucca house, some single-storeyed, some double. The settlement is organized into multiple societies of 46 families each, with each society built around a common courtyard. Some families are in larger, single-house plots and some people in apartment blocks. The school, playground, public recreation ground and streets are shared by all. The gross density is 850 persons per hectare. The settlement covers 57 hectares and could be similarly extended to any size. We have a real-world, working example of successful mixed-income housing. This needs to be replicated instead of leaving it to builders to turn large tracts of urban land over to the very rich for their private use.

References:
1. Shirish B. Patel, Alpa Sheth and Neha Panchal, 'Urban Layouts, Densities and the Quality of Urban Life', *Economic and Politi-cal Weekly,* 30 June 2007, 2725-2736.
2. Serife Genis, 'Producing Elite Localities: The Rise of Gated Communities in Istanbul', *Urban Studies* 44(4), April 2007, 771-798.

Integrated Regional Planning for Managing Urban Sprawl

*Dr.T.V. Ramachandra**

Urban sprawl is the out growth along the periph ery of cities and along highways. It is characterized by an unplanned and uneven pattern of growth, driven by multitude of processes and leading to inefficient resource utilization. Urbanisation in India has never been as rapid as it is in recent times. As one of the fastest growing economies in the world, India faces stiff challenges in managing the urban sprawl, while ensuring effective delivery of basic services in urban areas. The urban areas contribute significantly to the national economy (more than 50 per cent of GDP), while facing critical challenges in accessing basic services and necessary infrastructure, both social and economic. The overall rise in the population of the urban poor or the increase in travel times due to congestion along road networks are indicators of the effectiveness of planning and governance in assessing and catering for this demand. Agencies of governance at all levels: local bodies, state government and federal government, are facing the brunt of this rapid urban growth. It is imperative for planning and governance to facilitate, augment and service the requisite infrastructure over time systematically. Provision of infrastructure and assurance of the delivery of basic services cannot happen overnight and hence planning has to facilitate forecasting and service provision with appropriate financial mechanisms.

Proper implementation of master/development plans is a critical aspect in regulating the development of urban areas. Although 1,200 master/development plans for important towns and cities have been prepared in India, their implementation so far has not been satisfactory due to a variety of reasons. City planning mainly addresses the preparation of land-use plans through zoning to cater for projected populations. However, civic authorities also need to plan for meeting the demand for infrastructure facilities and ensuring delivery of basic services. This is dismal in current planning practice since these are normally static master plans or development plans mostly addressing land-use issues. These plans are also less equipped to review and evaluate any policy decisions dynamically by visualising the potential implications of a policy directive and the regions of potential sprawl. It is therefore necessary to support administrators and planners by providing them with better understanding, methods and tools to tackle the problem of urban sprawl. Further, administrators and planners need to be informed of possible areas of sprawl to take corrective actions to mitigate the implications. The problem of urban sprawl is observed to be an outcome of improper planning, inadequate policies and lack of effective governance due to various reasons. The inability of the administration and planning machinery to visualise probable areas of sprawl and its growth is persistent with the lack of appropriate spatial information and indicators. This emphasises the need for quantifying the pattern of sprawl and capturing the processes that involves analysis of causal driving factors. This requires understanding and visualising the consequences of policies applied by local planning and administrations to sprawl, like the lack of an effective public transport system with varying work-home distances, giving rise to independent motor vehicles and the resultant congestion and spatial expansion.

*****

* Centre for infrastructure and Sustainable Transportation & Urban Planning (CiSTUP), Indian Institute of Science (IISc), Bangalore - 560012, E-mail: cestvr@cistup.iisc.ernet.in

Intelligent Cities: Planning for Urban Future

Ved Mittal *

Introduction:

India is a vast country with a geographical area of about 3.2 million sq.km are having 28 States and 7 Union Territories for administration. The total population is 1027 million. There are 5161 towns and cities and about 5, 80,000 villages. The degree of urbanization is at 27.8% in 2001 and it is anticipated that 50% of population would reside in urban areas by 2021.

According to census of India, the urban population in India is 286mn, as on 1st March 2001 out of which 46.6mn. are slum dwellers who live in 607 cities/ towns across India. It shows that 1 out of every four persons living in slums is in these cities / towns. These slums generally lack basic infrastructure, social amenities which in turn have implications to the health and productivity of the people living in these areas.

According to the Ministry of Urban Housing and Poverty Alleviation (2007), the total housing shortage in India (as per 2001 Census) was about 24.71 million Dwelling Units (DUs).

Out of which 21.78 million DUs relate to the Economically Weaker Section (EWS), while 2.89 million DUs are required for the Low Income Group (LIG).

The housing shortage during the 11th Plan period (2007 – 12) is expected to be 26.53 million DUs.

Vision of Urban India:

- Make every urban settlement safe, healthy, productive and sustainable place.
- With adequate shelter, basic services, socially desirable quality of life with adequate employment opportunities.
- By providing institutional, legislative and financial institutions. To work as open, transparent & efficient links between society.

To achieve this vision, not only good urban governance but effective, practical & rational development plans are required.

Land as a Resource for Urban Future:

Legal access to land is a strategic pre-requisite for provision of adequate shelter for all and for the development of sustainable human settlement. The failure to adopt at all levels, appropriate rural and urban land policies and land management practices, remains a primary cause of inequity and poverty. It is also the cause of increased living cost, the occupation of hazard-prone land, environmental degradation and increased vulnerability of urban and rural habitats, affecting all people, especially disadvantaged and vulnerable groups[1].

In most cities, the people who migrate from rural areas or small towns are not able to find land legally. They either go to live in already existing slums or squatter settlements which are located on public land earmarked for green belts or open spaces, even under high tension lines, along the city storm water drainage system, wet lands along the ponds, unused railway land etc. There are also many who cannot even afford the luxury of slums, live on pavements, railway platforms etc., or wherever, they are able to find a place.

It has been observed that people living in slums/squatter settlements over a long period of time, try to purchase land from the unscrupulous people who either sub-divide the illegal land with fake kind of titles or purchase land from farmers with proper titles and sell to those who really need housing and desire to have some kind of quasi-legal shelter. The payment for purchasing land is arranged from their savings or loans from near and dear ones or through selling some assets

* Ex-Consultant UNDP, Ex-Chief Architect & Town Planner, Development Authorities UP

[1] Habitat Agenda: 1997: No. 75

back home in rural areas. Once the land so purchased and registration obtained through sale deed is done in one's favors, one takes a very calculated risk in building incremental house against all violations and most of the time in connivance of those responsible for enforcement of laws. Such people conglomerate and form a group to resist all kind of threats including demolition and seek the patronage of local leaders and politicians. These groups tend to influence local authorities and get the incremental services extended to their areas. In course of time, they get a pole of electricity and the brick paving of the lanes through some programme like environmental improvement of slums etc., slowly and steadily get even telephone and water lines extended to such areas. Ultimately, over a period of time, such quasi-legal informal settlements become a political agenda for regularization.

Inclusive cities do not marginalize the poor

The emergence of such informal settlements is being seen as product of poverty which provides essential domestic and other services to the city's population and also contributes to its economy. It is, therefore, suggested that 'inclusive' approaches should be adopted, whereby residents of informal settlements should be seen to have "equitable rights to the city". There is, therefore, a need to identify land for such uses and reserve the same for the urban poor in the development plans of the cities, in order to further prevent the slums/squatter settlements through quasi-legal sub-divisions etc.

Availability of Land

In India, the land-man ratio has dropped from 0.90 hectare per person in 1951 to around 0.32 ha in 2001 would be below 0.20 hectare per person by 2051. Land is therefore a scarce resource worsening by the day. As per trends, between 2001 and 2051 nearly 10 million hectares of good agricultural would be eaten by settlements and their linkages. Thereby, a decreasing amount of agricultural land would be available to cater to a near doubling of food production by 2051. Thus, policies need to address the concern to avoid misuse, abuse and underutilization of the land.

Planning and Development Process of futuristic settlements

In view of scarcity of land and unauthorized growth as one facet and livable and environmentally sustainable cities, the other, two pronged strategy is required:

- Reasonable restrictions on unapproved sub-division and registration of land through legislative provisions.
- To involve people in planning process and to plan settlements with due care for sustainable environment and intelligent cities with efficient circulation, mass transportation and pedestrianization, energy efficient colonies/layouts and buildings for safety and livability.

Legislative provisions

In order to check quasi-legal unplanned growth in cities, it is necessary to make amendment in the concurrent planning legislation similar to section 7A of Haryana Development and Regulation of Urban Areas Act, 1975 as follows:

7A Registration of certain documents *– notwithstanding anything contained in any other law for the time being in force, where any document is required to be registered under the provisions of Sec. 17 of the Indian Registration Act, 1908, purporting to transfer by way of sale or lease any vacant land having an area of less than one hectare in an urban area as may be notified specifically by the Government from time-to-time for the purposes of this Section, Registration Officer appointed under the above said Act shall not register any such document unless the transferor produces before such Registration Officer a no objection certificate issued by the Director or an officer authorized by him in writing in this behalf, to the effect that the said transfer does not contravene any of the provisions of this Act and its rules and such no objection certificate shall be issued within ninety days of the date of receipt of the application for the same:*

Thus, such legal provisions will certainly curb quasi-legal unauthorized growth as informal settlements in our cities.

Futuristic Intelligent Settlements:

The settlement planning with people's participation must address the following concerns:

a) Top-down and disaggregated

approach from regional planning to settlement level development plan with rural-urban linkages and improving living conditions in rural areas to reduce population pressure in urban areas.

b) In existing cities bottom-up approach commencing from Area Sabhas/ Wards Committees, to achieve greater public participation especially of urban poor, for preparation of development plan and zonal development plans.

c) Preparation of Settlement Development Plan as an aggregated document of area sabhas, wards to municipal zones, sectors and settlement thereby synthesizing higher and lower levels of planning, and synergizing pro-poor concerns in the local and regional context.

d) Maximum utilization of land with optimum size of cities.

e) Higher city level density to conserve land with optimum high rise construction vis-à-vis with considerations of energy consumption, fire and structural safety measures.

f) Smart growth for living and working with:
- Total Security, safety, wi-fi enabled communication system with energy management
- Walk able community with desirable places to live, to work, to shop, to learn, to worship and to play
- Optimization of the use of:
  - Natural Light
  - Natural Air
  - Power/Energy
  - Water/recycled waste water
  - Traffic circulation and parking with pedestrianisation
- Environment friendly with entertainment/recreational, physical and social infrastructure within walking range.
- Cost effective environment through integration of systems, services including solid waste disposal, maintenance and management.
- Electronic savy campus areas and e-homes with e-letter box, biometric security, Surveillance camera view of children play area, Card lock / key lock, Multi level automated parking and Auto electrical load management etc

Thus, our future cities in order to be livable and sustainable settlements must adhere to very efficient land policies, legal provisions to check unauthorized growth is more than necessary, conservation of energy and use of natural energy, recycling of waste water and solid waste and safety concerns in terms of utilizing development in Information Technology, fire and structural safety against natural hazards.

Centre for urban planning, infrastructure set up in Bangalore

January 2nd, 2009 - 8:10 pm ICT by IANS

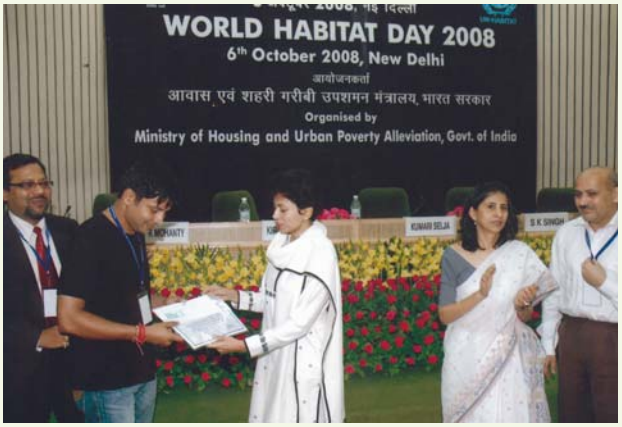
Bangalore, Jan 2 (IANS) A centre for infrastructure and sustainable transport and urban planning has been set up at the Indian Institute of Science (IISc) here. Established with a corpus of Rs.300 million/Rs. 30 crore/$6 mn, it is the first such government-academia facility in the country that will address urban planning and critical infrastructure issues arising out of rapid growth of greater Bangalore and other cities in the state.

"The centre is modelled on the lines of institutes such as the School of Planning and Architecture (SPA) in New Delhi and the Centre for Environment Planning and Technology (CEPT) in Ahmedabad to improve urban infrastructure and ensure sustainable transportation with modern concepts and technology," IISc director P Balaram said at its inauguration.

The four state-run transport corporations and Bangalore Development Authority (BDA) have contributed to the corpus fund.

"The state government will approach the Union urban development ministry for a matching grant of Rs 300 million (Rs 30 crore) from the Jawaharlal Nehru Urban Renewal Mission (JNURM) fund to the centre for specific projects that will improve the service of public utilities," Chief Minister B S Yeddyurappa said inaugurating the centre.

World Habitat Day 2008 Celebrations



The World Habitat Day - Serving the Cause of Shelterless

*Sunil Bery**

A safe and livable habitat is a cherished desire of every individual. For the shelterless, a house or a habitat brings about a profound social change in his or her existence, endowing the individual with an identity, thus integrating the human being with the immediate social surroundings. However, a large percentage of the world population is deprived of this privilege and either have no roof over the head or squat on roads. These poorest of the poor live in slums and squatter colonies or by whatever way these settlements are designated.

According to UN more than 100 million people are homeless, millions more face acute housing problems, like overcrowding, unsafe structures, no tenural rights, inadequate sanitary provisions, unsafe drinking water, irregular or no electric supply etc. As per estimates over 1.5 billion people live in inadequate shelter and one billion in slums. Further, by 2030 two billion people will live in slum communities and by 2030 an additional three billion people will need housing.

Global Housing and Habitat Concerns

The housing for all has been catching the attention of Governments authorities worldwide, especially since the later part of the twentieth century. Policies at the local and national levels have been framed to improve upon the housing quantitatively and qualitatively across the world. The United Nations has been dwelling on this issue with great concern. As far back as in 1948, there was a UN Universal Declaration of Human Rights in which 'Housing Rights' was one of the key issues. The UN declaration on Social Progress and Development of 1969, more specifically called for provision of community services for large families and individuals having low incomes. It urged governments to adopt low cost housing programmes in rural and urban areas. The International Convention of Economic, Social and Cultural Rights held in 1976 had included housing as a part of adequate standard of living. Further, the Vancouver Declaration on Human Settlement in 1976 elaborated upon the need for decent housing for the people.

The World Habitat Day

On the eve of the 10th year of the Vancouver conference of 1976, the UN declared that first Monday of October each year would be celebrated as the World Habitat Day (WHD). It was officially designated by the United Nations in 1985 and first celebrated in 1986. On this day, we reaffirm that adequate shelter is a basic human right, and we focus on the housing conditions of cities and towns around the world.

The basic purpose of the celebrating World Habitat Day is to bring forth the state of our cities and towns keeping in mind the basic human right & adequate shelter. It also aims to remind the world of its collective responsibility for the habitat for the present and future generations.

Since 1986, WHD has been a major event and large scale functions of varied nature are organized the world over. Each year the UN declares a theme related to habitat and an official function is organized at a designated venue. The themes and function venues during the years since inception of WHD are given in Table-1.

For the 2009, the United Nations has chosen the WHD theme as "Planning Our Urban Future" and the official function will be held in Washington, D.C., USA The theme is meant to underscore the urgency of meeting the needs of city dwellers in a rapidly urbanizing world.

* Ex.Assistant General Manager, National Housing Bank, New Delhi

Table - 1

Year	Theme	Venue	Year	Theme	Venue
1986	*Shelter is my Right*	Nairobi	**1998**	*Safer Cities*	Dubai
1987	*Shelter for the Homeless*	New York	**1999**	*Cities for All*	Dalian
1988	*Shelter and Community*	London	**2000**	*Women in Urban*	Jamaica
				Governance	
1989	*Shelter, Health and the Family*	Jakarta	**2001**	*Cities without Slums*	Fukuoka
1990	*Shelter and Urbanization*	London	**2002**	*City-to-City Cooperation*	Brussels
1991	*Shelter and the Living*	Hiroshima	**2003**	*Water and Sanitation*	Rio De Janeiro
	Environment			*for Cities*	
1992	*Shelter and Sustainable*	New York City	**2004**	*Cities - Engines of Rural*	Nairobi
	Development			*Development*	
1993	*Women and Shelter*	New York City	**2005**	*The Millennium*	Jakarta
	Development			*Development Goals and*	
				the City	
1994	*Home and the Family*	Dakar	**2006**	*Cities, magnets of hope*	NaplesKazan
1995	*Our Neighbourhood*	Curitiba	**2007**	*A safe city is a just city*	The Hague,
					Netherlands
					Monterrey, Mexico
1996	*Urbanization, Citizenship*	Budapest	**2008**	*Harmonious Cities*	Luanda, Angola
	and Human Solidarity				
1997	*Future Cities*	Bonn			

Messages for this years WHD

UN Secretary General in his message for this year's World Habitat Day has shown concern on the state of the cities and towns the world over identifying major urban challenges of the twenty-first century, amongst others the rapid growth of many cities and the decline of others. Further, in many cities both in the developed and developing countries alike there has been a growth of up-market suburban areas on the one hand and simultaneous increase in overcrowded tenement zones, slums and informal settlements, on the other. To tackle these issues, more equitable and better urban planning is essential. New ideas from smart cities around the world are pointing the way forward towards sustainable urbanization. It has been urged that on the occasion of WHD, we should pledge to do our part to follow through on our plans for a better, greener, more sustainable future for our increasingly urban planet.

In the statement by the Executive Director, UN-Habitat made for the occasion, it has been said that in many parts of our world, urban planning systems have changed very little. They are often contributors to urban problems rather than tools for human and environmental improvement. However, to blame urban planners and their plans for our urban problems is like turning back the clock and going back in history to a time when no-one could have foreseen the problems we now face. Urban planning has to continue to adapt and carry out its much-required effective role in shaping a positive urban future.

Chief Executive Officer Habitat for Humanity International has highlighted that WHD is a special chance for us to join the world to draw attention to the need and importance of housing and exchanging effective ideas and solutions that would address the world housing needs.

WHD a Worldwide Movement

World Habitat Day is not only a programme of the UN. It is a worldwide movement in which functions are held by National Governments of the member countries, Regional Governments, public bodies, private bodies, NGOs' etc. Painting, quiz and other such competi-

tions are organised at various levels, especially for children to bring about awareness on the importance of habitat. World Habitat prizes are offered at the worldwide celebration of WHD.

World Habitat Awards

The World Habitat Awards were established in 1985 by the Building and Social Housing Foundation (BSHF) as part of its contribution to the United Nations' International Year of Shelter for the Homeless in 1987. Two awards are being given annually to projects, from the Global South as well as the North, that provide practical, innovative and sustainable solutions to current housing needs and which are capable of being transferred or adapted for use elsewhere. Entries are assessed by a panel of international judges and an award of £10,000 is presented to the two winning projects at the annual UN-HABITAT global celebration of World Habitat Day.

A large number of projects have been recognized and awarded since its inception. As on date three projects from India have been recognized which include Sonatala Milan Sangha Project in West Bengal in 1986, Indore Habitat Project in 1994 and Rural Health and Environment Programme, Orissa in 2003.

Habitat Scroll of Honour

The Habitat Scroll of Honour award was launched by the United Nations Human Settlements Programme in 1989. Its aim is to acknowledge initiatives which have made outstanding contributions in various fields of shelter provision, highlighting the plight of the homeless, leadership in post conflict reconstruction, and developing and improving the human settlements and the quality of urban life.

Individuals, organizations, projects and any Habitat Agenda partner can be nominated for the Habitat Scroll of Honour. These include the Government and inter-governmental organizations or agencies, cities, local authorities or their associations, civil society organizations, the private sector, National Habitat Committees or focal points, research and academic institutions, public or private foundations, Multilateral Agencies (United Nations Agencies, World Bank, etc.) and individuals

Many organizations and individuals have been recipient of the Scroll of Honour. From India, Centre for Development Communication was its recipient in 2004, Mrs. Sheela Patel in 2000, National Slum Dwellers Federation in 1999, Mr. Gangadhar Rao Dattari in 1995, Mr. Laurie Baker in 1992 and HUDCO and HDFC in 1991.

International Celebrations

WHD is celebrated worldwide in a number of ways by organising competitions for various events including painting, cycling, debates etc. Most of the National Governments have been evincing keen interest and supporting the cause of WHD. In India the, Ministry of Housing and Urban Poverty Alleviation has been actively celebrating WHD since its inception. This year's programme is also being organised at New Delhi at which eminent dignitaries will be participating and sharing their views.

Building Materials & Technology Promotion Council (BMTPC), Centre for Environmental Management, The Institution of Engineers - West Bengal State Centre, Habitat for Humanity India, Bangalore, Department of Architecture, Integral University in Lucknow, Bhagidari Jan Sahyog Samiti, an NGO in New Delhi, Osmania Medical College Doctors' Forum, Hyderabad, Local Governance Network in Bhubaneswar, Phagwara Environment Association in Phagwara and many other organizations are celebrating WHD by way of bringing out publications, organizing seminars and workshops, painting and other competitions etc. to highlight the current year's theme of "Planning Our Urban Future"

Ultimate Goal

The privileged people, having their own safe and decent habitat, may be celebrating WHD in their own way but it has to be realized that there are a large numbers of under privileged ones who need a habitat of their own. Efforts on a continuing basis have, therefore, to be directed towards achieving the goal of shelterlessness.

International Workshop and Exhibition

on Emerging Housing Technologies at National Co-operative Union of India, New Delhi on 24th-25th November, 2008

BMTPC organised an International Workshop and Exhibition on Emerging Housing Technologies at National Co-operative Union of India, New Delhi on 24th-25th Nov, 2008. The event was inaugurated by Secretary (HUPA) in the presence of Jt. Secretary (H), MoHUPA. The Secretary conveyed the message of Hon'ble Minister of State (I/C) for Housing & Urban Poverty Alleviation, who could not participate due to some other exigency. The main objective of the Workshop was to bring important companies dealing with emerging housing technologies systems developed indigenously and from abroad. The workshop was attended, besides government representative, by architects, engineers, planners, policy makers and users. Eight private sector companies/ organizations exhibited their innovation in building materials and construction technologies at the exhibition. Around 110 delegates from different government bodies, public & private sectors, research institutions also participated in the two days workshop and deliberated on the subject of innovations in building materials and construction sector. The consequence of the exhibition was that a few companies demonstrated their systems by actually constructing a single room house using their system at the exhibition area.

Planning Sustainable Building Materials for Our Urban Future

*Dr. Shailesh Kr. Agrawal**
*J.K.Prasad***

Prologue

Due to rapid mechanisation the world over, the onus of sustainability 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 sustainable development. The 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

* Executive Director, Building Materials & Technology Promotion Council (BMTPC), New Delhi
** Chief (Building Materials), BMTPC, New Delhi

under these circumstances.

So the options are (a) to promote use of building materials made from local resources (b) to promote alternative building materials which have raw materials resource bases related to waste products of other common technologies (c) 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 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

Building materials, which are neither recyclable nor biodegradable like thermosetting plaster should be avoided. The building Materials which do not 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. Sun dried Bricks
2. Precast cement concrete blocks, lintels, slab. Structural and non-structural modular elements
3. Cellular Light Weight Concrete Blocks
4. Fly-ash Sand Lime Bricks and Paver Blocks
5. Gypsum Board, Tiles, Plaster, Blocks, gypsum plaster fibre jute/sisal and glass fibre composites
6. Bamboo, Bamboo Based Particle Board & Ply Board, Bamboo Matting
7. Calcined Phospho-Gypsum Wall Panels
8. Ferro-cement Roofing Channels
9. Particle Boards
10. Epoxy Resin System, Flooring, sealants, adhesives and admixtures
11. Ferro-cement boards for door and window shutters
12. Calcium silicate boards and Tiles
13. Cement Paint
14. Clay roofing tiles
15. Water, polyurethane and acrylic based chemical admixtures for corrosion removal, rust prevention, water proofing
16. Laminated Wood Plastic Components
17. Marble Mosaic Tiles
18. MDF Boards and Mouldings
19. Micro Concrete Roofing Tiles
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 plantation 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.

Base material for construction: Reinforced Cement Concrete

Replace Ordinary Portland cement with Blended Portland Cement (BPC)

In order to reuse/ recycle waste product, it is strongly recommended that maximum percentage of pozzolana materials may be used as technically feasible by properly blending with portland cement. Use of blended cements conforming to IS 455, IS 1489 should be encouraged with necessary awareness and guidance for their use.

Wherever feasible supplementary cementitious materials like flyash, granulated blast furnace slag, metakaoline, rice husk ash may be used in concrete. Provisions given in IS 456 may be utilised for this purpose.

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.

Recycled Steel

Every tonne of recycled steel saves 1134 kg of iron ore, 635 kg of coal and 55 kg of limestone. Therefore, recycled steel may be utilised provided the end product meet the requirements of the relevant standard. IS 432, IS 1785 and IS 1786 give requirements for mild steel and medium tensile steel, hard drawn steel ores and high strength deformed bars respectively.

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

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.

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 (IS 4139)
- Pulverized debris + Cement bricks/blocks
- Red mud, Industrial waste based bricks/blocks
- Auto claved Aerated Lightweight blended Portland cement based concrete blocks (IS 2185)(P-III)
- Phospho-gypsum based blocks (IS 12679)
- Laterite + Cement blocks (IS 12440)
- Solid or hollow concrete blocks using artificial lightweight aggregates
- Cellular Light Weight Concrete Blocks (IS 2185)(P-IV)

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 blended Cement and further use of pozzolana material up to 30-50% by direct addition of raw pozzolana material such as Calcined clay or flyash. Replace sand with sand from pulverized debris and / or sintered flyash.

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.

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.

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

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)

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.

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.

Electrical

To use energy efficient products and products having higher recycling properties (unplasticised 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

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 (unplasticised 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 unplasticised PVC instead of C.I. (IS12592)

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

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.

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

Training Programmes in North Eastern Region on Bamboo Based Technologies

Consultative Meet

on Knowledge Network of Innovative Housing Technologies

At the behest of the Ministry of Housing & Urban Poverty Alleviation, BMTPC organised a Consultative Meet on Knowledge Network of Innovative Housing Technologies on June 12, 2009. About 80 architects/ builders, R&D institutions, Academic institutions, NGOs, Building Centres, State Govt. Agencies, Professionals participated in the Meet. The Consultative Meet was chaired by Joint Secretary (Housing), Ministry of Housing & Urban Poverty Alleviation, GOI.

The main objective of the Meet was to deliberate and share view point on the following issues so as to identify potential technological options in different regions and framing time-bound action plan on various aspects:

i. Drawing up technical Specification for better known Alternative materials
ii. Collaboration with State PWDs and CPWD to draw Specification and Schedule of Rates.
iii. Drawing up curricula for introduction of courses in collaboration with Colleges of Architecture and Civil Engineering, National Council for Vocational Training and CIDC on cost-effective technologies.
iv. Academic research on techniques & materials.
v. Training modules and skill development for artisans.

Industrialisation of Civil Engineering for Cost-effective housing

*Krishan Myer**

Preamble

All over the world, experts have defined technology as "to do more with less: less of materiais, less of machines, less of human labour, less of time and hence less of money". It is also professed that the number of dwelling units that will have to be built during the next 30 to 40 years will be equal to the number of dwelling units that have been built since the inception of civilization. This is possible only by industrialisation of Civil Engineering.

Construction industry is one of the oldest and yet it has been overtaken by all other industries like automobiles, electronics etc, and the reasons are age old traditions and prejudices, proper understanding is lacking, there are vested interests and the civil engineering fraternity has also resisted change.

Premier Housing and Industrial Enterprises Ltd. (PHIEL)

PHIEL was one of the first Public Limited Company exclusively devoted to Housing Development and in particular it specialised in providing quality affordable homes for middle and lower income groups and over 1000 Apartments have already been completed and handed over. It was the first housing company to rated by CRISIL.

An industrial approach to building and housing is necessary to increase the efficiency and productivity of the building and housing industry, especially for reducinq the cost of construction & increasinq the speed in building and enhancing the capacity of the industry to undertake large scale housing and building projects.

At present low productivity, high costs, long building cycles, and poor quality materiais are the main challenges of constructing houses on a large scale. Major new efforts are needed to define housing policy, goals and standards, finance, production, and maintenance of housing as well as the role of housing and the construction industry in national development. It should be determined under what circumstances increased investments and output in the building materials and construction industry can accelerate economic development and at the same time fulfill social goals and objectives.

Having studied the problems in detail Premier Housing decided to adopt a multi disciplinary approach and decided to look at all the aspects and for this purpose a team of eminent social workers, architects, university professors and builders was formed to understand the actual requirements of the people and to deliver a final product in line with their needs.

To start with, it was necessary to study existing technologies and find out the existing cost at various stages of construction to determine the most strategic area on which to concentrate the efforts in the initial stages.

It was found that the maximum scope for standardisation lay in the area of foundation, walling and roofing. It was decided to look for standardisation of other elements like door and window frames and shuttering etc. in the second stage since it would delay the commencement of the work if all the elements were to be taken up for standardisation in a single stage. The goal was to develop a system with built-in quality audit which will give us mass manufactured new multi quality,

* Former Head - Corporate Planning, Premier Housing and Industrial Enterprises Limited, Madras.
Trustee Centre for Housing Science and Construction Technology

multi benefit standardised materials and structural components of uniform and accredited quality, and hence protect the customer interests and also achieve the quality audit, both by the stringent manufacturing conditions of the manufacturers themselves, and also these materials can be brought under BIS norms and marks. It was decided by Premier Housing to go into a programme which would cover the following:

- The technology selected should be total, meaning thereby that any structure, right from one room tenement for the poorest of the poor to richest of the wealthiest such as multistoried apartments, schools, hospitals, commercial and administrative buildings, factories, farm houses, stables etc. should be capable of being modularly planned, speedily erected, quickly finished and completed with the very same materials, thus avoiding class hatred and discrimination, present in conventional methods and materials.
- The technology must be open and componentalised and prescribe components like high-grade dense concrete heavy weight wall and floor panel systems which are now discarded being misapplication. The constituent components must be small to be manufactured with indigenous and local raw materials, easy to handle and transport in normal trucks, easy to erect without costly mobile cranes and perfectly jointed. The new components and materiais must satisfy all theoretical engineering codal formulae and all other requirements under National Building Code. Otherwise, building permissions cannot be given by the municipal corporations and loans will not be available from the Financing Institutions.
- The constituent components and materials must be capable of being modularly standarised for mass manufacturing in factories/site under controlled conditions for quality and economy and thus bringing them under the purview of Bureau of Indian Standards (BIS) and/or specialised manufacturer's norms and marks, both individually and in combination.
- All the new building materials must be light, having high strength to weight ratio, as then only, dead loads on load bearing members and foundations can be reduced for economy by increasing strength to weight ratio.
- The new building materials technology must eliminate the use of costly and scarce materials like cement, steel, agricultural soil for bricks, high energy and must attempt to totally eliminate use of timber and forest products of all types and categories as indiscriminate and heavy cutting of forests and trees has created lot of annually recurring national calamities.
- The technology should be based on maximum employment of unskilled workers and upgrade their skills and minimise the requirement of skilled workers and artisans by resorting to standardisation, mass production and thus making all operations easy, simple and avoiding colossal wastages at sites due to obsolete methods and materials i.e. wastages of materiais, man hours, machines and money.
- The technology must be universal based on pre-

A COMPARITIVE STATEMENT OF 190mm THK STRUCTURAL CONCRETE MASONARY WALL AGAINST 230mm THK BRICK WALL/ 1 SQM PANEL

230MM THK BRICK WALL		**190MM THKSTUCT.BLOCK WALL**	
Bricks 115 Nos @ Rs Al-	Rs.460.00	Blocks12.75 Nos@ Rs. 36/-	Rs.459.00
Cement1.26bagx0.23@265/-	Rs.76.80	Cement 0.10bag@Rs.265/-	Rs.26.50
Sand10cftx0.23(a)Rs.23/-	Rs.52.90	Sand0.85cft @Rs.23/-	Rs.19.55
		Lime 0.12cft @Rs125/-	Rs.15.00
Labour @ 360/-x0.23Cum	Rs.82.80	Labour/Sqm	Rs.110.00
Cost / Sqm (0.23cum)	Rs.672.50	Cost/Sqm	Rs.630.00
Internal Plastering (20mm)	Rs.200.00	Internal plastering(10mm)	Rs.180.00
External Plastering	Rs.180.00	External Plastering	
Total Cost/ Sqm of wall	Rs.1052.50	Total cost/sqm	Rs.810.05
Hence on 1 Sqm Wall Panel			
1052.50-810.05	= Rs. 242.45 (i.e.) 23%		

formed structural building components that are feasible of being manufactured in all areas and regions and hence suitable for all types of structures and thus acceptable to all. Unless all these minimum pre-requisites are fully satisfied, any new building materiais technology cannot technically and financially survive.

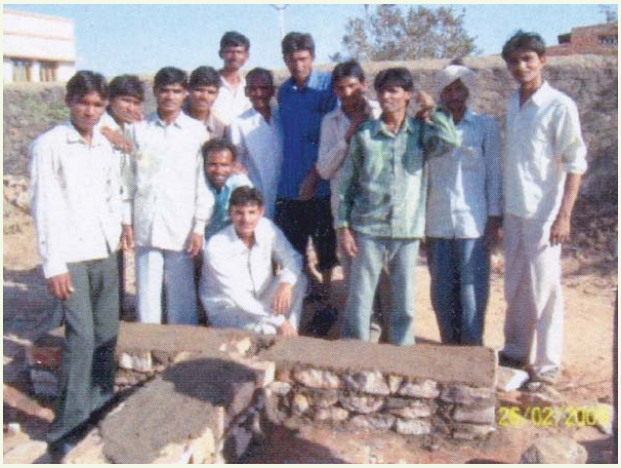
MARCH 2009

ECMU FOR G+3 • DIRECT ECONOMY AT A GLANCE

MATERIAL AND LABOUR COST FOR A G+3 STRUCTURE USING ECMU COMPARED TO CONVENTIONAL RCC FRAMED & BRICKS

SLNO.	DESCRIPTION		QUANTITY ECMU	QUANTITY RCC	UNIT COST	FACTOR	TOTAL COST ECMU	TOTAL COST RCC
					RS.P		RS.P	KS.P
1	ECMUM30	NOS.	10025	0	35.00	1.01	354383.80	0.00
2	ECMUM20	NOS.	21775	0	34.00	1.01	747753.50	0.00
3	BRICKS	NOS.	33705	242807.83	3.85	1.10	142740.70	1027444.20
4	CEMENT	BAGS.	2518.37	3719.92	265.00	1.06	707410.00	1044926.00
5	RIVERSAND	CFT.	9257.25	13904.15	22.00	1.10	224025.50	338480.40
6	STONE-40MMDN	CFT.	1734	1288.2	20.00	1.08	37454.40	27393.10
7	-20MMDN	CFT.	8576.39	12141.88	24.00	1.08	170460.00	314717.00
8	-19MMDN	CFT.	1598.55	0	20.00	1.08	34528.70	0.00
9	PIT SAND	CFT.	4743	5626.5	6.00	1.10	31303.80	37134.90
10	REBAR	MT.	17	31	34000.00	1.06	612680.00	1117240.00
11	FORMWORK	SQM.	1535	2104	200.00	1.03	316210.00	433424.00
12	LIME	CFT.	228.96	0	80.00	1.10	20148.50	0.00
13	TOTAL MATERIALS						3399099.00	4338760.00
14	LABOUR							
15	SKILLED LABOUR - I	M-DAYS.	1588.81	2060	350.00	1.06	589446.50	764260.00
16	SKILLED LABOUR - II	M^AYS	2538.21	3055.19	250.00	1.08	872095.70	809825.40
17	UNSKILED LABOUR	M-DAYS	591.8	824.04	180.00	1.06	112877.30	157226.80
18	TOTAL LABOUR (WITHOUT LIFT)						1374421.50	1731112.20
19	SKILLED LABOUR- II	M-DAYS	404	523,61	250.0C	1,06	107136.90	138772.60
20	TOTAL LABOUR (WITH LIFT)						1481558.40	1869884.80
21	TOTAL LABOUR + MATERIALS						4880657.00	6208644.00
22	TOTAL PLINTH ÁREA						14526.00	14842.00
23	FACTORED DIRECT COST PER UNIT PLINTH ÁREA						336.00	424.00
	SAVINGS						RS. 88.00 / Sqft	

Capacity Building of Construction Workforce



Training Programme on Disaster Resistant Construction Practices for Masons at Baroda, March 2009

Training Programme for Brick making using Fly Ash at Potka, Jharkhand, May 2009

Training Programme for Masons at Vidisha, Madhya Pradesh, July 2009

Quality, Durability, Performance and Service Life of Building Materials

*Dr. J.S. Chauhan**

Introduction

In developing countries like India, building materials account for upto 70 percent of the cost of construction and accordingly great importance is attached to their quality, durability, performance and service life.

Soon after Independence, in the wake of successive Five Year Plan Programmes of National Development, large-scale construction activities have been taken up in the country, placing heavy demand on different types of building materials. As augmentation of production of building materials has not kept pace with large-scale demand, non-availability of building materials, of required type and quality, has hampered many a construction projects. Moreover, it has not been possible to insist on supply of building materials of good quality and often there has been no choice but to use the available materials.

Quality of Building Materials

On the other hand more exacting demand, as regards quality and performance of building materials is being made to meet the modern requirements of construction of different types. Efforts have, therefore, been directed towards standardisation of building materials and the Indian Standards Institution has so far brought out more than 400 specifications on different types of building materials. It is obligatory for all construction departments, housing boards, etc, to insist on the use of good quality materials as per the IS Specifications. However, generally speaking, it has not been possible to insist on these standards, due to non-availability of IS certified building materials and product and general scarcity of building materials of different types.

Bricks

Burnt clay bricks, which are the mainstay of construction in many parts of the country, are not available as per Indian Standard Specifications. Reasons often cited by the manufacturers are that, besides the difficulty in procuring suitable soils for brick making, good quality coal is also not available for burning the bricks. Further to conform to modular coordination in building industry the IS has recommended production and use of standard modular size bricks of 19 cm x 9 cm x 9 cm which results in economy. However, as yet, no major breakthrough has been achieved in this direction.

Classification

Brick is the sought-after building materials, and is widely manufactured and used locally. The clays available in river basins, water tanks and coastal areas are plastic in nature for proper moulding, drying and burning of bricks and tiles. The clays less plastic or expansive, gritty or sandy require addition of plastic clay or some non-plastic material like sand, stone dust or flyash. Clay-fly ash bricks have the advantages of saving clay and fuel.

The future trends in brick making go in three directions : (a) to reduce the weight by making perforated or hollow bricks and consequently reduce the consumption of clay and fuel, (b) to improve thermal efficiency of brick made of sand and (c) to produce bricks made of sand and lime or fly ash sand-lime to stabilised soil bricks by pressing and / or steam curing, requiring much less energy than in burnt-clay bricks.

* Prof. & Head of Civil Engg. Deptt., S.A.T.I. (Engg. College), Vidisha (M.P.) - 464001 INDIA
E-mail : jsccivil@rediffmail.com

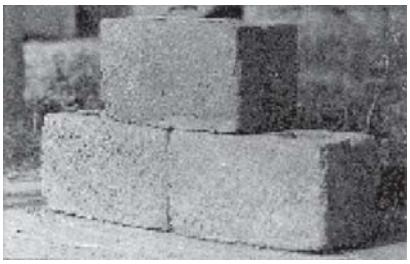
Perforated bricks show as good compressive strength as solid bricks and are used for load bearing structures. Hollow bricks with over 30% hollow space, are mainly used for non-load bearing walls and partitions. Burnt clay flooring, terracing tiles, glazed/ non-glazed ceramic tiles are produced extensively in different shapes, sizes and designs.

Burnt - clay bricks

- **Colour** : generally blood-red or brown. Shape : should be regular with sharp edges which is better achieved in machine made bricks.
- **Dimensions** (as per IS specifications) :
- **Modular** : length 190 mm, width 90 mm, height 90 or 40 mm, Dimensions : length 210 mm, width 110 mm, height 70 mm.
- Locally manufactured bricks have different dimensions in various states.

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



Solid Concrete Blocks

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.

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 achieved 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 Blocks

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.

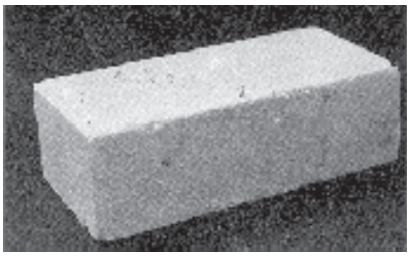
This product has a higher strength in addition to a number of other advantages as they are uniform in size, shape and surface as well as low coefficient of variations in strength. Thus the thickness of the walls can be smaller and the walls do not require plastering on both sides.

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 prerequisite 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.



Calcium Silicate Bricks

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 the durability of buildings and structure is not jeopardised.

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 regard.

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, electro-magnetic agents, chemical agents & biological agents.

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

- Weather factors – radiation, temperature, water, normal air constituents, air contaminates, freeze-thaw and wind.
- Biological factors – micro-organisms, fungi and bacteria.
- Stress factors – sustained periodic and random stresses and physical action of water such as rain, hail, sleet, snow, etc.
- Incompatibility factor – chemical and physical.
- 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.

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.

Service Life

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

- Specifications of materials and construction techniques adopted;
- The extent of satisfactory maintenance and repair work undertaken periodically;
- 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.

...contd. on page 45

A Pro Common Man Housing Development Strategy

*Abhaya Adlakha**

Home and Shelter: The **home** has been defined by the Webster's third new international dictionary as "the house and grounds with their appurtenances habitually occupied by a family; a social unit formed by a family living together in a dwelling; the family environment in which one is emotionally attached". **Shelter** is defined as a means of cover or place of protection (as from injury, exposure, observation, attack, pursuit, danger or annoyance) and appears to have originated from shell. **House** is defined as structure intended or used for human habitation.

A housing process comprises of the following resources:

a) Infrastructure
b) Land
c) Finance
d) Building materials
e) Labour

Land is the basic ingredient of housing, it is necessary to adopt alternatives to large scale land acquisition and revise the concepts of land tenure and building regulations. In order to harness public and private sector resource, a new system of land assembly and development should be incorporated in planning and legal framework. The cost of community facilities and service provision is to be met by the contribution to be levied by the development authorities in a proportionate manner to the ratio related to housing area.

Often economic policies, plans and programmes tend to deal only with the basic needs of earning, food and clothing where the human being is perceived not very different from the animal. However, the human needs are much more than survival. These are comprised of freedom and protection, dignity and self-respect, continuity and growth, variety and adventure, entertainment and recreation, beliefs and values, feeling of a purpose of life, community and relationships, mobility, physical well-being and health, mental peace/security and privacy and urge for information and learning. So far the need of shelter, although a basic resource, has been given secondary importance in the life cycle.

The goal of the National Urban Housing and Habitat Policy, 2007 is to ensure sustainable development of human settlements covering shelter, environment and urban infrastructure, which would enable a better quality of life to all its citizens with the involvement of all stakeholders. The policy lays a special emphasis on provision of social housing for the EWS/LIG so that they are fully integrated in the urban landscape and the towns/cities become truly inclusive of all segments. The focus of the policy is on sustainable development of habitat with a view to ensure equitable supply of land, shelter and services at affordable prices. This requires a multi pronged approach and several reforms to accelerate the pace of development of housing and related infrastructure, and to create adequate and affordable housing stock, both on rental and ownership basis.

It has been observed that the practice of prescribing FAR/Density norms without distinguishing between housing categories in terms of plinth area, can result in making smaller size of housing unaffordable (as land use for dwelling unit is higher than larger size units). The norms should be changed to provide options to provide more density in G+3 or 4 storeyed walk up structures. A fixed density leads to under utilization of FAR. In every housing scheme, at last 10 per cent of the sale-

* Adlakha Associates Pvt. Ltd., New Delhi, E-mail: info@adlakhaassociates.com

able net residential land should be reserved for EWS housing and even spread in different parts of the city instead of concentrating them at one place.

In order to provide quality and cost effective housing and shelter especially to the vulnerable group and the poor, there is a need to modernize the housing technology and to increase efficiency, productivity, energy efficiency and quality.

In spite of the fact that technological innovations have permeated in almost every field in case of housing, we are still adopting conventional means involving wastages and delays. Low productivity, high costs, long building cycles, non-standardization and poor quality are the main challenges of building and housing. At present a large proportion of housing activity in our country is carried out by employing local or migrated man- resources. In the present technological era traditional methods need to be mechanized, even if not fully.

Thus, to tackle the problem it is necessary to evolve an integrated 'systems' approach in planning, design and development of housing.

Close coordination and consistency, between design, production and management of buildings are indispensible prerequisites of the 'systems' approach. In order to develop a common approach, modular coordination and standardization are essential. Standardization and modular coordination are the basic tools and language of systems building, which would lead to partial prefabrication.

(View of housing at Baprola using precast RC joists roofing and other ferrocement elements)
Example of system based housing under JNNURM

Modular coordination, if properly applied to housing and building, would reduce the costs through greater efficiency in the use of labour and less wastage of construction materials. Standard types and the use of modular materials would make large scale production possible and also bring down prices, besides availing of quality products.

Innovative building systems and techniques, combined with traditional materials have been tried and found successful. Various options have also been evolved incorporating 'prefabricated components'. Complete industrialized prefabrication is being advocated. We as consultants for DSIIDC have adopted partial prefabrication system for Rajiv Awaas Yojna in construction of thousands of houses at Bawana, Narela, Baprola in Delhi.

*****

... from page 43

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.

*****

Requirements of Building Materials for Earthquake Resistant Buildings

*Dr. Shailesh Kr. Agrawal**
*J.K.Prasad***

With 59 percent of land areas exposed to earthquake hazard, 8 percent to cyclone, 5 percent to flood, considerable areas to landslide, coastal areas, especially eastern coast to Tsunami; the housing stock of the country are vulnerable to natural disasters of varying degrees.

During the last decade and half, we have witnessed earthquakes of damaging effects in different characteristic earthquake sources i.e. continental collision boundary (Himalaya); subduction zone (Andaman & Nicobar)' ancient rift (Narmada, Kutch); non rifted zone (peninsular shield) and reservoir triggered (Koyana). Earthquakes of Killari (Latur) 1993, Jabalpur 1998, Chamoli 1999, Bhuj 2001, Andaman- Sumatra 2004 and Muzaffarabad 2005 have revealed that human and property losses are mainly due to collapse of very large vulnerable building stock in the region.

Post Disaster studies, especially after Bhuj earthquake, have given the engineering community - both architects and structural engineers number of important lessons to be adequately addressed so as to mitigate the effect of such hazards in future. Existence of non-engineered buildings, no doubt, has been one of the major cause of collapse of buildings in most of the affected regions but poor quality of construction materials was also observed to be an important cause of failure of RC structures specially in Ahmedabad area, which is about 300km away from the source of the earthquake. Indian Standard Codes for Earthquake Resistant Design & Construction prescribes, besides other things, use of proper quality of building materials in a proper way. It is important to follow the provisions of the codes in a sincere way in construction of buildings for mitigating the effect of such hazards in future.

"A house saved is a house constructed". Therefore, it is necessary to carry out seismic analysis of existing buildings to make them safe against earthquake forces using established seismic retrofitting techniques. For retrofitting a number of innovative materials are used which should be of proper specification and should be used in a proper way.

Basic of Earthquake Resistant Buildings

To make an earthquake proof building that will not get damaged during rare or strong earthquakes is not economical. Instead engineers attempt to make buildings earthquake resistant; such buildings resist the effects of ground shaking, although they may get damaged severely but would not collapse during the strong earthquake. Thus safety of people and contents is assured in earthquake resistant buildings and thereby a disaster avoided. **This is the major philosophy of seismic design all over the world.**

Earthquake resistant design of buildings is concerned about ensuring that the damage in buildings during earthquakes are of the acceptable variety and also that they occur at right places and in right amount.

The main task is to identify acceptable forms of damage and desirable building behaviour during earthquakes. Earthquake resistant buildings are required to have the ability to sway back and forth during an earthquake and to withstand earthquake effects with some damage, but without collapse. For this the structure, particularly their main elements, need to be built with ductility in them. To achieve the required performance it is also important to have right selection of building

* Executive Director, Building Materials & Technology Promotion Council (BMTPC), New Delhi
** Chief (Building Materials), BMTPC, New Delhi

materials and techniques.

The structural elements such as walls, beams and columns which bears only vertical loads before earthquake have to carry horizontal bending and shearing effects as well during earthquake. When the bending tension due to earthquake exceeds the vertical compression, net tensile stress will occur. If the building material is weak in tension, such as brick or stone masonry, cracking occurs which reduces the effective area for resisting bending moment, as shown in Fig.1.

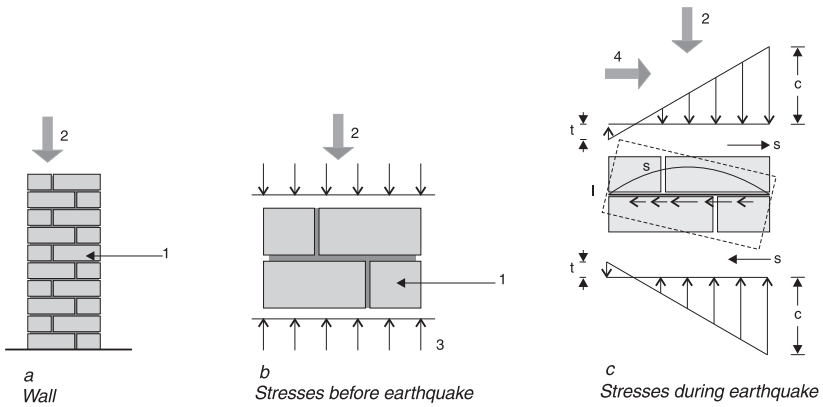


Fig.1
Stress condition in a wall element

It follows that the following properties and parameters are most important from the point of view of the seismic design.

- Building material properties
  - Strength in compression, tension and shear, including dynamic effects
  - Unit weight
  - Modulus of elasticity
- Dynamic characteristics of the building system, including periods, modes and damping.
- Load-deflection characteristics of building components.

Feedback from Damage Studies

An important aspect of post earthquake study is the realization of the important role that the quality of construction plays. Earthquakes are no respecters of theories. Many instances of poor quality construction are invariably exposed in damaged buildings. Badly placed reinforcement, poor quality of concrete, incorrect practice of masonry, incomplete grouting have been observed to be some of the causes of failure of structures during earthquakes.

Various post disaster studies of Gujarat earthquake, brought out among other deficiencies, use of poor quality of construction materials and corrosion of reinforcement as major causes of failures of RC structures.

There are numerous instances in which faulty construction practices and lack of quality control contributed to the damage of structures. The cement-sand ratio was dangerously high. Recycled steel were also observed to be used as reinforcement. Many buildings are damaged due to spalling of concrete by the corrosion of embedded reinforcing bars. The corrosion, inter-alia, is related to insufficient cover, poor concrete placement and porous concrete. Use of salty water for concrete mix was also reported to be used at many places.

In masonry building, failures have been mainly due to:

- Heavy weight and very stiff buildings, attracting large seismic erection force.
- Very low tensile strength, low shear strength particularly with poor mortar.
- Use of substandard materials and bad construction practices as well as unfilled joints between bricks, improper bonding between walls and right angles etc.

All these emphasized that buildings should be properly designed and constructed to behave as Earthquake Resistant Structures.

Building Materials For Seismic Resistant Buildings

In India, most non-urban buildings are made in masonry. In plain areas masonry is generally made of burnt clay bricks and cement mortar. However, in hilly areas, stone masonry with mud mortar is most common. Masonry buildings can carry loads that cause compression but can hardly take load in tension. These are brittle and one of the most vulnerable of the entire building stock under strong earthquake shaking. It is, therefore, very important to use right quality of materials and introduce necessary earthquake

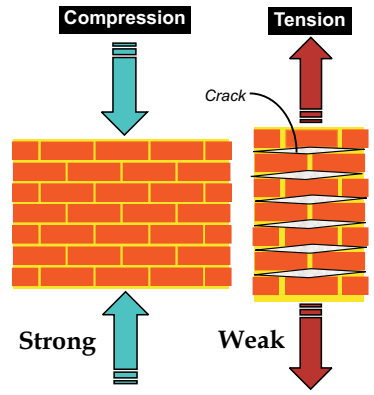


Fig.2 : Masonry is strong in compression but weak in tension.

resistant features to achieve the objective.

IS 4326: 1993 Code of Practice for Earthquake Resistant Design and Construction of Buildings prescribes the requirements of materials to be used in earthquake resistance construction.

Stone Masonry

Wherever stones are available in abundance, stone masonry are used for house construction. These are most vulnerable against earthquake forces unless they are used in a proper way with necessary earthquake resistant features. Stone masonry and half dressed stone buildings have suffered extensive damage and complete collapse during past earthquakes having intensities of MSK VII and more.

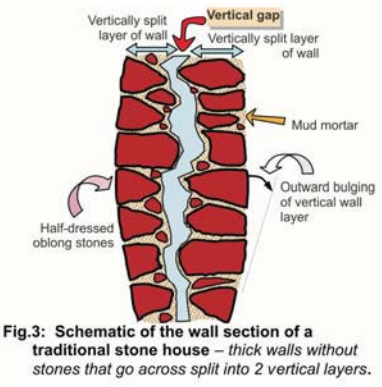


Fig.3: Schematic of the wall section of a traditional stone house – *thick walls without stones that go across split into 2 vertical layers.*

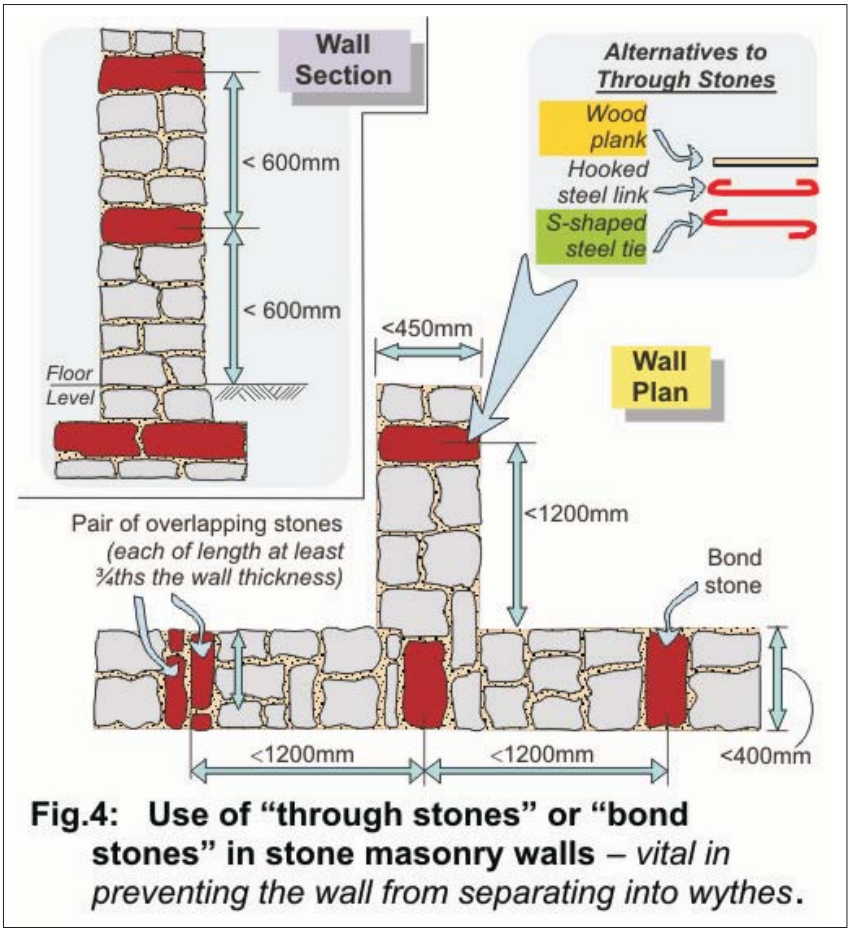


Fig.4: Use of "through stones" or "bond stones" in stone masonry walls – *vital in preventing the wall from separating into wythes.*

As per IS 4326 Squared stone masonry, stone block masonry as specified in IS 1597(part 2): 1992 of adequate strength, may be used.

Brick & Block Masonry

Besides slenderness ratio of the wall (height or length / thickness), eccentricity of vertical load, percentage of openings affecting the performance of masonry, earthquake performance of a masonry wall is very sensitive to the properties of its constituents namely masonry unit and mortar. The property of these materials vary across India due to variation in raw materials and construction methods. The masonry units used may be;

i) Burnt Clay Bricks conforming to IS 1077:1992 - Important Properties - to- check are Compressive Strength, water absorption, efflorence.

ii) Hollow & Solid Concrete Block - conforming to IS 2185(Part I)- having a crushing strength not less than 3.5 Mpa is also recommended.

Mortar for Masonry

Quality of mortar used for brick masonry is very important. Various mortars are used for masonry e.g. mud, cement-sand or cement - sand - lime. Of these, mud mortar is the weakest; it crushes easily. When dry flows outwards and has very low earthquake resistant property. Cement - sand mortar with lime is most suitable. This mortar mix provides excellent workability for laying bricks, stretches without crum-

bling at low earthquake shaking and bonds well with bricks. The earthquake response of masonry walls depend on the relative strength of bricks and mortar. Bricks must be stronger than mortar.

The tensile and shearing strengths of masonry mainly depend upon the bond or adhesion at the contact surface between the masonry unit and the mortar and, in general, their values are only a small percentage of the crushing strength.

Richer is a mortar in cement or lime content, higher is the percentage of tensile and shearing strength in relation to the crushing strength. Tests carried out on brick-couplets using hand made bricks in cement mortar give the typical values as shown in Table-1.

Brick couplet tests under combined tension shear and compression shear stresses show that the shearing strength decreases when acting with tension and increases when acting with compression. Fig.5 below shows the combined strengths:

The tensile strength of masonry is not generally relied upon for design purposes under normal loads and the area subjected to tension is assumed cracked. Under seismic conditions, it is recommended that the permissible tensile and shear stresses on the area of horizontal mortar bed joint in masonry may be adopted as given in Table-2.

The modulus of elasticity of masonry very much depends upon the density and stiffness of masonry unit, besides the mortar mix. For brickwork the values are of the order of 2000 MPa for cement-sand mortar in 1:6 proportion. The mass density of masonry mainly depends on the type of masonry unit. For example, brickwork will have a mass density of about 1900 kg/m^3 and dressed stone masonry 2400 kg/m^3

Excessive thickness is not desirable A 10 mm thick mortar layer is generally preferred. As per IS 4326, based on the building categories recommended mortar mix are as follows:

Table 1: Typical Strengths of Masonry

Mortar Mix		Tensile strength,	Shearing strength,	Compressive strength in MPa corresponding to crushing strength of masonry unit			
Cement	Sand	MPa	MPa	3.5	7.0	10.5	14.0
1	12	0.04	0.22	1.5	2.4	3.3	3.9
1	6	0.25	0.39	2.1	3.3	5.1	6.0
1	3	0.71	1.04	2.4	3.3	6.3	7.5

Table 2: Typical Permissible Stresses

Mortar mix or equivalent			Permissible Stresses		Compression for strength of unit, MPa			
Cement	Lime	Sand	Tension MPa	Shear MPa	3.5	7.0	10.5	14.0
1	-	6	0.05	0.08	0.35	0.55	0.85	1.00
1	1	6	0.13	0.20	0.35	0.70	1.00	1.10
1	-	3	0.13	0.20	0.35	0.70	1.05	1.25

Category of construction	Proportion of cement – lime-sand
A	M_2 (cement –sand 1:6) or M_3 (lime –cinder 1:3) or richer
B,C	M_2 (cement-lime-sand 1:2:9) or cement sand 1:6) or richer
D,E	H_2 (cement sand 1:4) or M_1 (cement –lime, sand 1:1:6) or richer

Building categories are defined based on important factors as follows:

Important Factor	Seismic Zone II	III	IV	V
1.0	B	C	D	E
1.5	C	D	E	F

Residential buildings has important factor as 1.0, where as important service and community buildings, such as hospitals, schools, monumental structures, emergency buildings like telephone exchange, television station, ratio station, railway station, fire station buildings, large community halls like cinema, assembly halls & subway power stations have important factor 1.5.

Reinforced Concrete Construction

The two important materials used in any RC structures are Concrete & Steel reinforcement. Cement concrete is the most widely used construction materials. It is one of the seemingly simple but actually a complex materials. Improper quality of concrete, inadequate concrete cover are major causes of distress in such structures. Distressed structures are highly vulnerable during earthquakes.

Table 3: Minimum cement content, maximum water-cement ratio and minimum grade of concrete for different exposures with normal weight aggregates of 20 mm nominal maximum size

Exposure conditions	Plain concrete			Reinforced concrete		
	Minimum cement content, kg/m³	Maximum free water-cement ratio	Minimum grade of concrete	Minimum cement content, kg/m³	Maximum free water-cement ratio	Minimum grade of concrete
Mild	220	0.60	-	300	0.55	M 20
Moderate	240	0.60	M 15	300	0.50	M 25
Severe	250	0.50	M 20	320	0.45	M 30
Very severe	260	0.45	M 20	340	0.45	M 35
Extreme	280	0.45	M 25	360	0.40	M 40

Source: Table 5 of IS 456 : 2000

Note: (i) Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in clause 5.2 of IS 456. The additions such as flyash or ground granulated blastfurnace slag may be taken into account in the concrete composition with respect to the cement content and w-c ratio if the suitability is established and as long as the maximum amount taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part I) and IS 455, respectively.

(ii) Minimum grade for plain concrete under mild exposure condition is not specified.

Specification of concrete is governed by IS 456:2000. Code of Practice for Plain and Reinforced Concrete. From durability point of view four 'Cs' i.e. Constituent, Compaction, Curing and Cover are important for quality of concrete.

With the availability of OPC of different grades , Portland pozzolana cement, Portland slag cement and specialized cements like Sulphate resistant cement, Super sulphate cement etc., supplementary cementitious materials like flyash, granulated blastfurnace slag; it is utmost important to judiciously select the materials as per requirements and use only design mix concrete to achieve the desired properties of concrete. Cement, being a hydraulic material, gains strength in contact of water only. However, an optimum quantity of water is required for the chemical reaction and achieving durability. Any excess water is detrimental to the quality of concrete in terms of strength and durability.

From durability point of view a minimum grade of concrete is also required.

Minimum quantities of cement, min. grade of concrete and maximum w/c ratio based on exposure condition as prescribed in IS 456 are given in Table-3.

Making Good Concrete

Proper selection of ingredients of cement, mix design, batching, transportation, placing, compaction, curing, reinforcement are necessary for making good concrete.

Concrete Cover

To save the reinforcement from corrosion effect, apart from proper grade and quality of concrete, adequate cover as per Table-4 is also important.

The mass density of RC is about 2400 kg/m3 and modulus of elasticity is variously related with the concrete strength. Since the stress-strain characteristics are non-liner, the value of modulus of elasticity is ambiguous. Similarly, the allowable stresses are differently specified by codes of practice in relation to Fc. Each country has its own standards for allowable stresses and load factors which may be referred to in this regard. A factor of safety of about 3 is used in determining the allowable stress in axial compression relative to the 28 day cube strength. Under seismic condition these allowable values may be increased by 33.33 percent and the load factors may be decreased by 25 percent unless specified otherwise in national standards.

It is important to know that the tensile strength of concrete is only about one-tenth of the compressive strength. The diagonal tension caused by seismic shear forces, if not thoroughly protected by well designed stirrups or ties, can lead to wide cracking and failure.

Table 4: Nominal cover to meet durability requirements

Exposure	Nominal cover, less than, mm
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Source: Table 16, IS 456 : 2000

Note: (i) For main reinforcement up to 12-mm diameter bar for mild exposure conditions, nominal cover may be reduced by 5 mm.

(ii) For exposure conditions of "severe" and "very severe", cover may be reduced by 5 mm, where concrete grade is M35 and above.

(iii) Unless specified otherwise actual concrete cover should not deviate from the required nominal cover by + 10 mm.

Concrete is a brittle material and weak against impact shock and vibrations. Ductility is imparted to it by the reinforcing steel only. The compressive strength as well as straining capacity can be greatly increased by using closely spaced lateral stirrup ties or spiral reinforcement. This is an important characteristic for improving the earthquake resistance of reinforced concrete columns and frames.

Steel Reinforcement

An earthquake resistant building is designed for adequate stiffness and good ductility IS13920:1993. Code of practice for ductile detailing of reinforcement concrete structures subjected to seismic forces prescribes use of Steel reinforcement of grade Fe 415 or less. However, high strength deformed steel bars produced by thermo-mechanical treatment process of grade Fe 500 or Fe 550, having elongation more than 14.5% and conforming to other requirements of IS 1786 may also be used for reinforcement. Force vs elongation curve is shown in Fig.6. IS 1786 has recently been revised. As per the revised Standard elongation for different grades are given in Table-4A.

Any of the above steel could be used as per the provision of the standard. Some manufactures like Tata Steel, SAIL have developed reinforcement with corrosion resistant properties by introducing Micro alloying elements like Cr. Cu. Ni. Mo and P. either individually or in combination. However, in such case total content of these elements shall not be less than 0.40%, when P is used, it shall not exceed 0.12% and when used beyond the limit, the carbon shall be restricted to a maximum of 0.15%. Manufacturers should try to develop through R&D CRS bars with adequate strength and elongation of more than 14.5%.

Geometry of any deformed bars, i.e. longitudinal and transverse ribs are important from the point of view of bond strength. For any new pattern, not established through testing, it is important to get the pullout tested in addition to satisfactory conformance to the geometrical requirements prescribed in the standard.

Table – 4A:

	Fe415	Fe415D	Fe500D	550D
0.2%proof stress/ Yield stress, Min. N/mm^2	415.0	415.0	500.0	550.0
Elongation percent Min. on length 5.65 $\sqrt{A}$, where A is the cross-sectional area of the test priece	14.5	18.0	16.0	14.5

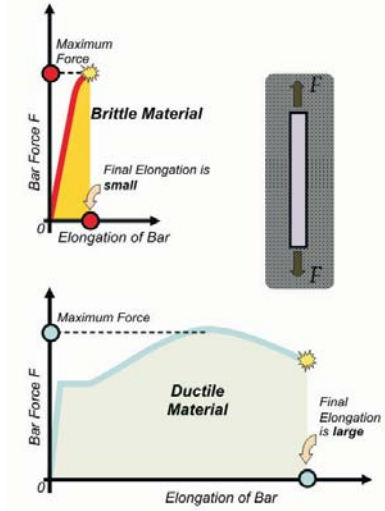


Fig.6: Tension Test on Materials – *ductile versus brittle materials.*

For ductile detailing provision given in IS 13920:1993 should be followed.

Wood

Wood has higher strength per unit weight and is therefore, very suitable for earthquake resistant construction. Although timber is seismically suitable, use of timber is declining in building construction even where it used to be prevalent due to ecological concern. Its use may only be encouraged where it's still

abundantly available or in unavoidable situations only.

In view of its lightness, very easy workability like cutting and nailing and safe transportability, timber makes an excellent material for post-earthquake relief and rehabilitation construction.

Structural properties of wood

There are large varieties of timbers in use in various countries. Strength properties of wood depend on the following:

- Wood specy
- Direction of loading relative to grain of wood
- Defects like knots, checks, cracks, splits, shakes and wanes
- Moisture content or seasoning
- Sapwood, pith, wood from dead tress and dried wood conditions
- Location of use, viz inside protected, outside, alternate wetting and drying.

The permissible stresses must be determined taking all these factors into account. Typical basic stresses for timbers given in IS 883:1992. Code of practice for design of structural timber in buildings (forth revision) is given in Table-5.

Bamboo

Whereas use of wood is restricted due to ecological reason, availability of bamboo in the country especially in North Eastern Region is in abundance. Dendrocalamus strictus and Bamusa arundnancea are two principle economic species of which the farmer occupies the largest area and is most common owing to the vast expanse and suitability as a raw material for industrial use. Being lighter in weight and having very strong fibres, is an excellent building material for seismic regions.

More than 100 species of bamboo are native to India and a few of them are solid but some of them are hollow in structure. Out of these species, 16 found suitable for structural applications and classified into three groups are as given in Table-6. National Building Code 2005 gives physical and mechanical properties of Indian bamboo.

Table-5 : Typical basic stresses for timbers

Types of stress	*Location*	*Permissible stress, MPa*		
		Group A	*Group B*	*Group C*
(i) Bending and tension along grain	inside	18	12	8
	outside	15	10	7
	wet	12	8	6
(ii) Shear in beams	all	1.2	0.9	0.6
shear along grains	all	1.7	1.3	0.9
(iii) Compression parallel to grain	inside	12	7	6
	outside	11	6	6
	wet	9	6	5
(iv) Compression perpendicular to grain	inside	6	2.2	2.2
	outside	5	1.8	1.7
	wet	4	1.5	1.4

* Based on Indian Standard IS:883.

Note: Group A, B and C are classified according to Young's modulus of elasticity as follows:

group A more than 12,600 MPa.

group B more than 9,800 to 12,600 MPa.

group C 5,600 to 9,800 MPa.

Moisture Content in Bamboo

With decrease of moisture content, the strength of bamboo increases exponentially and bamboo has a intersection point (Fibre saturation point) at around 25% moisture content depending upon the species. A typical moisture content relationship is shown in Fig.7.

Grading of Structural Bamboo

Grading of bamboo is done on the basis of characteristics importance for structural utilization as under:

- Diameter and length of column
- Taper of column
- Strengthness of column
- Inner nodal length
- Wall thickness
- Density and strength
- Durability and seasoning

One or combination of 2 or 3 characteristics form the basis of grading.

Durability & Treatability

The natural durability of bamboo is low and varies between 12 months and 36 months depending upon the species and climatic condition.

Bamboos get destroyed in about one or two years when used in the open and in contact with ground. While a service life

Table-6:

	Modules of Rupture (R) N/mm²	Modules of Elasticity (E) in bending 10^3 N/mm²
Group A	R > 70	E > 9
Group B	70 e" R^1 > 50	9 e" E > 6
Group C	50 e" R^1 > 30	6 e" E > 3

Bamboo species may be identified using suitable methods.

of two to give years can be expected from bamboo when used under cover and not in contact with ground. The mechanical strength of bamboo deteriorates rapidly with the onset of fungal decay in the scleranctymatous fibres. With proper preservative treatment, durability properties of bamboo, however, could be improved. Bamboo behaves differently from wood during treatment with preservative. Normal preservative treatment does not work in case of bamboo, in dry condition and therefore, treatment is best carried out in green condition. IS 9096: 2006 Code of Practice for Preservation of Bamboo for structural purposes cover types of preservation, treatment procedure for structural purposes.

One of the effective process of treatment is Boucherie process. In this process, water borne preservative is applied to end surface of green bamboo through a suitable chamber and forced through the bamboo by hydrostatic or other process. Treated bamboo have shown varied durability depending upon actual location of use. The performance in partially exposed and under covered conditions is better.

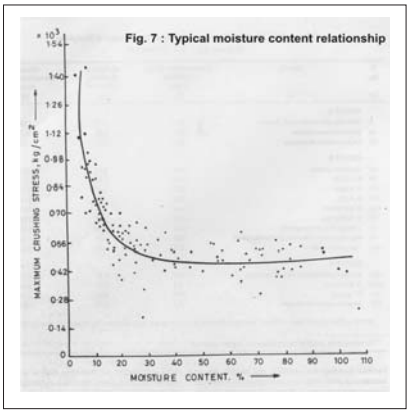


Fig. 7 : Typical moisture content relationship

Solid bamboo or bamboos whose wall thickness is comparatively more and bamboos which generally known as male bamboos having nodes very closer and growing on ridges are often considered good for structural purposes.

National Building Code 2005 gives details of design of bamboo structure including different techniques of joints, which should be referred to while designing any bamboo structure.

Retrofitting Materials

For mitigating affects of earthquake hazards, it is not only important to construct new houses with all necessary provisions for earthquake resistance, it is equally important to make the existing vulnerable houses safe by repairing and retrofitting. Considerable research has taken place in the field of repair and retrofitting materials and a large variety suitable to different applications and working conditions is available. Information about these materials are necessary for engineers involved for designing repairing and retrofitting scheme.

A brief description of different materials available is given below:

Cement Grout

It is a mixture of water, cement and optional materials like sand, water reducing admixtures, expansion agent and pozzolans. The water to cement ratio is around 0.5. Fine sand is used to avoid segregation. The desirable properties of grout are as follows.

- Fluidity
- Minimum segregation
- Low shrinkage
- Adequate strength after hardening
- Good bond with the substrate
- No detrimental compound
- Durable

Other Types of Grouting used are:

- **Injection Grouts:** Flowable plastic materials which can be injected into a structural member under pressure.
- **Gas fusing Grouts**: Contains same ingredients (usually aluminum and carbon powder) which reacts with cement liquor to generate gas bubbles. The gas expands the grout to compensate shrinkage.
- **Sulphoaluminate Grouts**: In these grout either shrinkage compensating cement or anhydrous sulfoaluminate expansive additive is used with Portland cement.
- **Fibre Reinforced Grout**: Polypropylene steel or glass fibres may be used in Portland cement or shrinkage compensating mortar to provide improved flexural strength, impart resistance

and ductility.

- **Polymer Grout**: The Polymer resin grouts are most commonly used in concrete. The commonly used polymers are polyester, epoxy, vinyl, ester, polyurethane and aughi. Out of these, epoxy is most popular.
- **Epoxy Resins** are used for the following purposes.
  - To bond plastic concrete to a hardened concrete surface
  - To bond two rigid materials
  - For patch work
  - For applying a coating over concrete surface to give colour, resistance to penetration of water and chemicals and resistance to abrasion.

  Epoxy resins are excellent binding agents. The low viscosity resins can be injected into small cracks. The higher viscosity resins are used a scoating and for filling larger opening or hales.
- **Epoxy Mortar**: It is made using epoxy resin, sand, cement and water. The resin is added as an additional binder. It has high compressive strength, high tensile strength and low modulus of elasticity. The polymer particles join and form chain link reinforcement, increasing the tensile strength of the mortar. There is greater plasticity and reduction in shrinkage stress.

Cementitious mortars such as gypsum cement mortar have limited use for structural purposes and are intended for architectural hand/trowel applications. The use of various types of mortars is given in Table-7.

Shortcrete

Shotcrete is a method in which compressed air forces mortar or concrete through a nozzle to be sprayed on a surface of building component such as a wall, at a high velocity. The materials used in shotcrete are generally same as those used for conventional concrete. The reinforcement provided is welded wire fabric or deformed bars tacked on the existing surface.

Shotcrete is applied using either wet or dry process. The wet mix consists of cement and aggregate premixed with water and the pump pushes the mixture through the hose and a nozzle. Compressed air is used at the nozzle to increase the velocity of application. In the dry mix process, compressed air propels premixed mortar and damp aggregate, and at the nozzle end, water is added through a separate hose, the dry mix and water are projected on to the surface through second hose, in most cases, shorcrete can be applied in a single application for the required thickness. It is a versatile technique as it can also be applied to curved or irregular surfaces. Its strength after application and its good physical characteristics make it ideal for strengthening weak members.

Micro-concrete

Based on hydraulic binders, these ready-made formulations are tailored to produce concrete which is flowable and free of shrinkage. They are applied in complicated locations and in thin sections such as concrete jackets.

Fibre-reinforced Concrete

Fibre-reinforced concrete has better tensile strength as compared to conventional concrete. They also have improved ductility (energy absorption capacity) and durability. They are being increasingly used for structural strengthening.

Fibre-reinforced Polymers

The fibre-reinforced polymer (FRP) composites are made up of a polymer matrix and fibres. The fibers can be of glass or carbon. They possess high strength -to-weight ratios, high fatigue strength, high wear resistance, vibration absorption capacity, dimensional stability, high thermal and chemical stability and corrosion resistance. They are manufactured in long lengths by the pultrusion process. FRP wraps can be used to strengthen structural members.

Ferro-cement

Ferro-cement is constructed of cement mortar reinforced with closely spaced layers of small diameter wire mesh. The mesh may be made of steel or other suitable material. The mortar should be compatible with the opening size and weight of the mesh. The mortar may contain discontinuous fibres. The use of ferro-cement can be economical even for non-engineered buildings.

Table-7: Applications of mortars

S.N.	Defect	Type of mortar	Properties
1.	Minor surface defect	Polymer modified cementitous mortar	• Gives a fair surface. • Good water proofing. • Resists acids and gases. • Water proof and anticarbonation finish. • Good resistance to pollytion. • Binds powdery surface. • Evens applied elastic compound. • Eases at low temperatures. • High strength. • Can be compacted in layers. • Can be applied up to 100 mm thick without sag. • Easy to mould
2.	Surface cavities and honey-combed concrete	Highly adhesive, thixotropic mortar	
3.	Powdery surface	A two component surface stabilizer	
4.	Non-structural cracks	Non-shrinking polymer filler	
5.	Minor voids of approximate size 100mm x100mm x50 mm	Rapid curing polymer modified cementitious mortar	
6.	Major voids of approximate size 200mm x 200mm x150 mm	Heavy duty thixotropic fiberreinforced polymer modified cementitious mortar	
Other uses			
7.	Surface protection	Resin rich water based co-polymer	• Highly resistant to diffusion. • Self cleaning. • Resistant to fungal attack. • High penetration into porous concrete creating enhanced adhesion. • High penetration. • React chemically to generate passivity of steel.
8.	Surface barrier	Water based co-polymer	
9.	Bonding agent	Polymer modifier cementitious surface impregnant	
10.	Protection of steel reinforcement	Two component system of cementitious powder and polymer	

References:

1. Guidelines for Earthquake Resistant Non-Engineered Construction, International Association for Earthquake Engineering, Japan.
2. Hand Book on Seismic Retrofitting of Buildings, Central Public Works Department, New Delhi; Indian Building Congress, New Delhi; Indian Institute of Technology, Madras.
3. IITK-BMTPC Earthquake Tips, Building Materials & Technology Promotion Council, New Delhi.
4. Cement User's Guide, The Associated Cement Companies Ltd.
5. Proceedings of Training Course on Earthquake Resistant Design and Construction of Buildings - IIT Roorkee and BMTPC 2006.
6. IS 4326:1993 Code of Practice for Earthquake Resistant Design and Construction of Building, Bureau of Indian Standards.
7. IS 456 : 2000 Code of Practice for Plain & Reinforced Concrete
8. IS 13920: 1993 Code of Practice for Ductile Detailing of reinforced concrete structures subjected to seismic forces, Bureau of Indian Standards
9. IS 1786 : 2008 Specification for High Strength deformed bars and wires for concrete reinforcement, Bureau of Indian Standards,
10. National Building Code-2003, Bureau of Indian Standards.
11. IS 2185(Part-1): 2005 Specification for Concrete Masonry Unit - Part 1 : Hollow & Solid concrete blocks, Bureau of Indian Standards
12. IS 2185(Part-2): 1983 Specification for Concrete Masonry Unit - Part 2 : Hollow & Solid light weight concrete blocks, Bureau of Indian Standards
13. IS 2185(Part-3): 1984 Specification for Concrete Masonry Unit - Part 3 : Autoclaved cellular aerated concrete blocks, Bureau of Indian Standards
14. IS 2185(Part-4): 2008 Specification for Concrete Masonry Unit - Part 4 : Preformed Foam cellular concrete blocks, Bureau of Indian Standards

*****

Low Cost Precast Ferrocement House for Slum Development

*P.C. Sharma**

Shelter is one of the basic needs of man and yet an unsolved problem in the developing countries like India, where a large number of people are living in slums or unsuitable & unhygienic residential conditions. Not only for housing but also a large number of medium and small size buildings are required to accommodate schools, dispensaries, godowns etc. in rural and semi-urban areas. With the fast rising cost of materials and labour needed for construction of these basic and infrastructural facilities, it has become necessary to use cost lowering technologies, which can also be implemented easily without the need of much machinery, electricity & can reduce construction time.

A considerable portion of construction cost of a building spent on the roofing and walling system, which involve aesthetics, strength and resistance to natural hazards & climatic conditions such as temperature, ultraviolet rays from sun, rain, earthquakes and wind. Cost effectiveness, strength and durability are three essential requirements for selection and acceptance of a structural system for any construction project.

Providing safe and comfortable but lower cost shelters to the large population living in slums or in backward rural habitations, is a challenge to day. Sincere efforts of Govt. agencies have not shown effective impact due to rising cost of materials an manpower and time taken in construction using traditional Techniques. Ferro-cement is a material which has been successfully used for various types of structural construction ranging from Boats to shells of fairly large size.

What is Ferrocement?

Ferrocement is a thin walled, versatile high strength cement based composite material made up of cement mortar and several layers of wire mesh or similar small diameter steel mesh closely bound together to create a stiff structural performance. The mortar/ micro concrete is a mixture of cement and natural sand (or crusher dust of selected grade) and a few selected concrete admixtures such as poresealing compounds, mild plasticizers and bond improving chemicals. The desired compressive strength of matrix used is generally above 25 N/mm^2 at 28 days. Mix ratio recommended is 1:2 (Cement : Sand) with water cement ratio at 0.40 by weight.

Materials Constituents Used

Cement - Ordinary Portland Cement 43 grade – conforming to IS: 269-1976

Sand - Clean medium River Sand, Stone crusher dust with grain size passing 2.36 mm, fineness modulus 2.4 mixed in ratio of 20:80- Mixed Sand.

Water For Mixing and Curing - normal drinking water from municipal water supply.

Admixtures - For obtaining better bond between cement matrix, the meshes and skeletal reinforcement, it is advicable to use bond improving admixtures and admixtures which improve workability and water proofing property.

Ferrocement can be called as earlier version of Reinforced cement concrete (known as Fericement) is a suitable and time Tested durable cement composite. This can be used for producing precast roofs, walls, truss members, door shutters, drainage units, septic tanks, soaking pits, super structures for Low cost sanitation units. All of these components are needed for slum improvement

* Retd. Head Material Sciences, Structural Engg. Research Centre Ghaziabad & Chief Editor, New Building Materials and Construction World

constructions in major cities and also for EWS houses in rural areas.

Ferrocement members are thin, hence lighter in weight but are capable of taking large amount of tension without cracking, can be cost into any shape using simple masonry forms or even without any formwork. It has high strength to weight Ratio when compared to RCC. It requires very less or no maintenance when compared to metal structures and no solar or heat effect and strength loss as in case of plastics.

Ferrocement for Casting of Precast Components for Low Cost Housing

Ferrocement, the earlier version of RCC (known as FERICEMENT) is a suitable and durable cement based composite which is a time tested Technology for Producing Precast Components for Low Cost Housing. This technique consist of embedding number of thin woven wire mesh layers in a well mixed and designed rich cement and sand mortar / micro concrete. Thin structures capable of taking large amount of tension without cracking, can be cast in to any desired shapes. Even complex shapes, as thin as 10 mm, can be fabricated. It has high strength to weight ratio, when compared to RCC, requires very little or Zero maintenance when compared to metal structures. It is many times stronger and durable than timber.

Some of the merits as structural construction material are:-

- Local availability of materials
- Works cab be carried out by local technicians (Masons, Smiths, Helpers)
- No Need For Heavy Equipment / Machinery
- Highly durable
- Light, Highly water Resistant / impermeable
- Community involvement in production & erection.

The durability aspect of this composite material can be indicated by quoting few examples:-

1. Large number of Ferrocement Boats produced in early Nineteenth Century were afloat in Pelican Pond of a European 200 for more than 100 years.
2. Ferrocement water storage tanks – 10 mm thick 2500 lit. capacity erected in 1974bv in CSIR Madras complex Adiyar are still in good shape inspite of being uncoated with any paint. Underground bin (2.5m^3 capacity) placed in a water reservoir at SERC Roorkee campus was under observation from 1973 to year 2000 and did not show any leakage or deterioration.

Considering cost effectiveness, durability, strength, ease in production and possibilities of involving user/beneficiaries in production and erection, Ferrocement was considered a substitute to current construction materials used for Low cost housing. Structural Engg. Research Centre Roorkee and Ghaziabad carried out extensive lab and field investigation between 1970 to 2000 and developed environment friendly systems for producing precast wall and Roof elements.

The Roofing Technology popularly known as segmental shell construction has been successfully used on commercial basis for the cycle shed roof in parliament complex at New Delhi, For Rural housing project by Rural Housing Board U.P., Nainital Club annexe Building, Annapara Thermal Power Project, large number of Godown & factory sheds in Punjab. These are some or the examples which have completed an age of more than 25 years without any maintenance need. SERC (G) developed a unique two leaf wall panel system fig. 1, buildings upto 4 stories and a Lab Building (Testing Machine Annexe) was constructed using this system in 1970's. the System has behaved well in the past almost 40 years without maintenance. Fig. 2 shows details of this wall panel roofing system for a two room house. This system can be modified to suit the requirement of slum development projects. All the panels are precast and the joint column is only cast insitu portion.

Fig. 2 also presents details for a house which was designed and provided for Koyna Earthquake victims rehabilitation scheme by SERC (G). The wall panels, Fig.2 are precast on ground in horizontal position over masonry moulds made using bricks and soil deposited in desired shape. These are low cost, easy to fabricate moulds. Designed Reinforcement is placed and units are cost manually and vibrated using specially developed vibration system. The reinforcement contain 4 mm wire, 6 & 8 mm bars and

Hot dip galvanized square woven wire mesh Fig. 4. The matrix is M-25 grade microconcrete / mortar produced using OPC 43 gd. Zone II sand, Liquid water proofing compound and mild plasticizer to keep the matrix workable at 0.4 water cement Ratio. Fig. 3 also show the dimensions & type wall panels i.e. the normal panel, window panel and door panel.

A prototype Room constructed in 1992 using such panels was constructed near the Material Science Lab (of earlier SERC (G)) Now a portion of HRDC (CSIR). The Foundations (Fig. 4 & 5) are traditional and have a lock in erection F.C. channel at the top position. Wall panel joints (Fig. 6) have been designed using Bolting Technique to make sure total dry construction at site. These have been designed keeping earthquake resistant features. The cost of such wall system comes to almost at par with 115 mm brick wall plastered on both faces.

A technique for making these panels comfortable during peak heat a lining technique (anchored to F.C. surface) has been developed. This can be easily added by residents as it has been derived from a traditional abode wall lining technique.

The roof of the house is Ferrocement segmental shell roof made with light in weight, easy to produce units cast over masonry or soil deposit moulds. A unique pointing technique developed at SERC by providing joints wire mesh laps mortared at site, has been used (Fig. 7).

The cost of such roof comes to almost at par with standard 20 gage G.1. Corrugated sheet supported over pipes but with benefits of much Better Thermal Comfort and Life Span of Roof.

The system can be tailor made for any selected plan of house for Slum Development or Low Cost Housing Scheme and savings in time and expenditure can be obtained.

*****

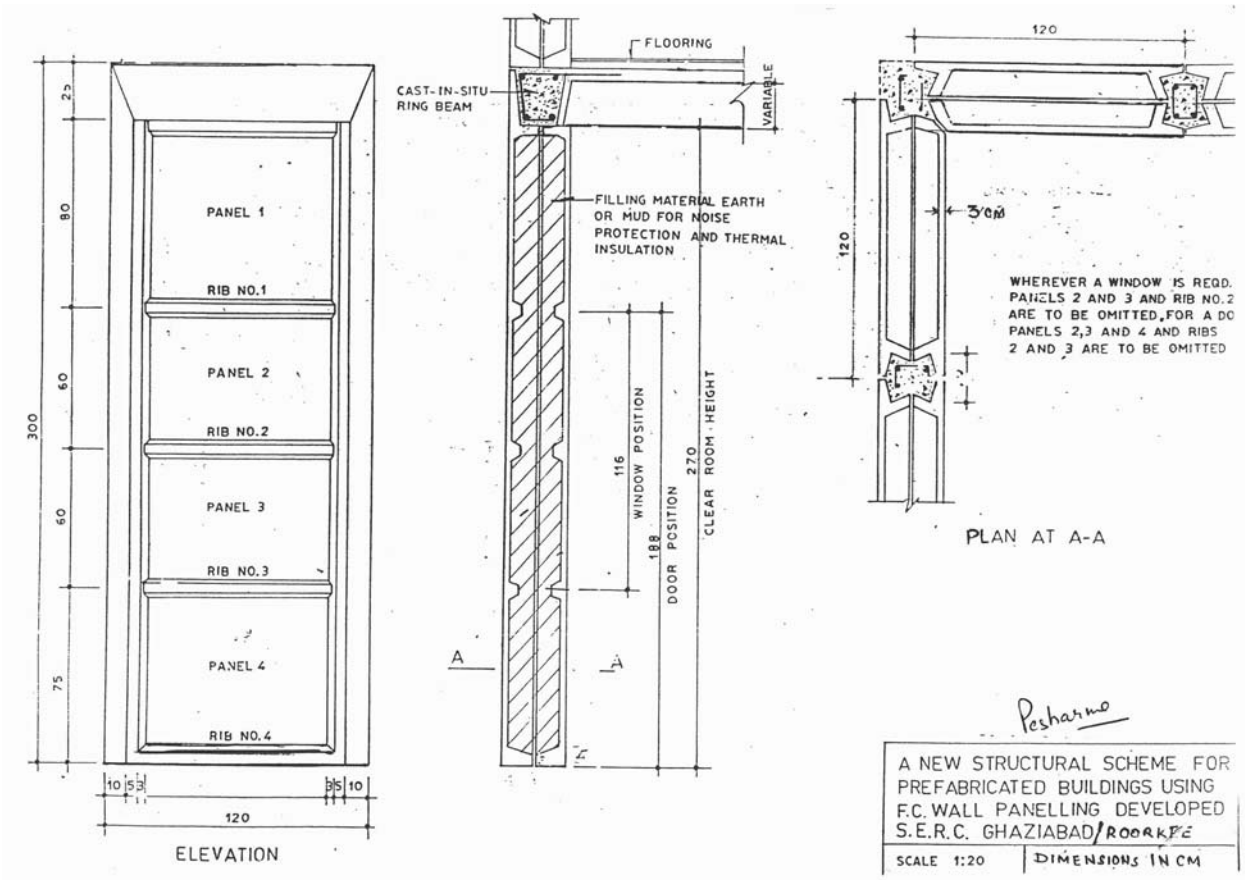


FIG.1 : VERTICAL SECTION OF WALL ASSAMBLED

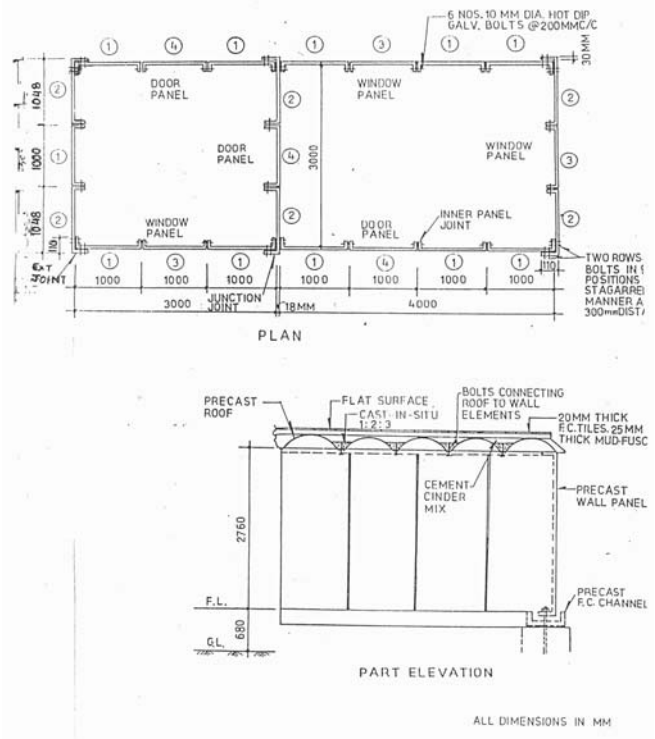


FIG.2 : PRECAST F.C.ROOFING AND WALLING UNITS

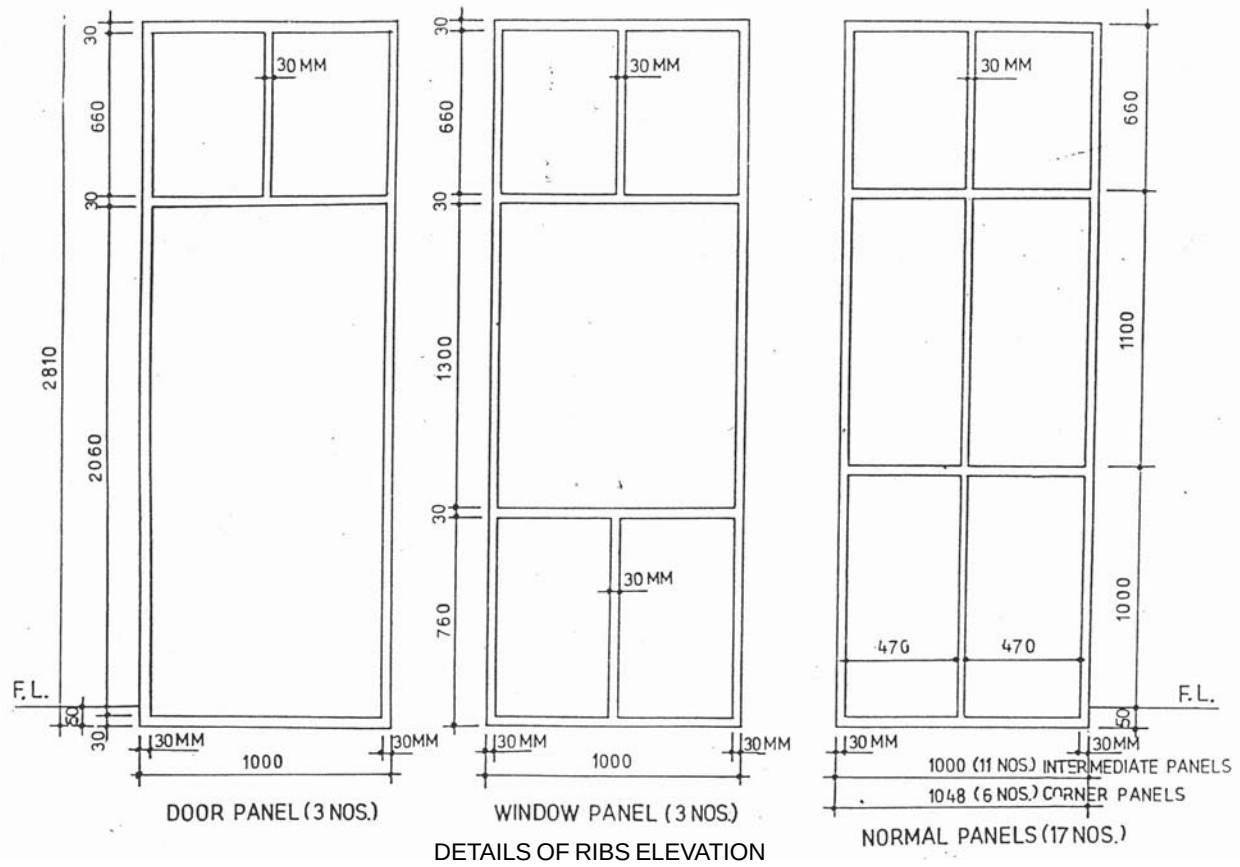


FIG.3 : DIFFERENT TYPES OF WALL F.C.ELEMENTS

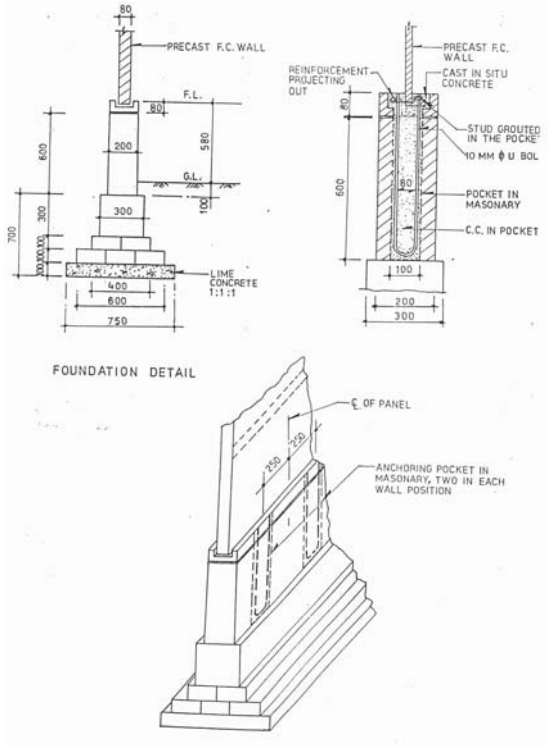


FIG.4 : DETAILS OF FOUNDATION

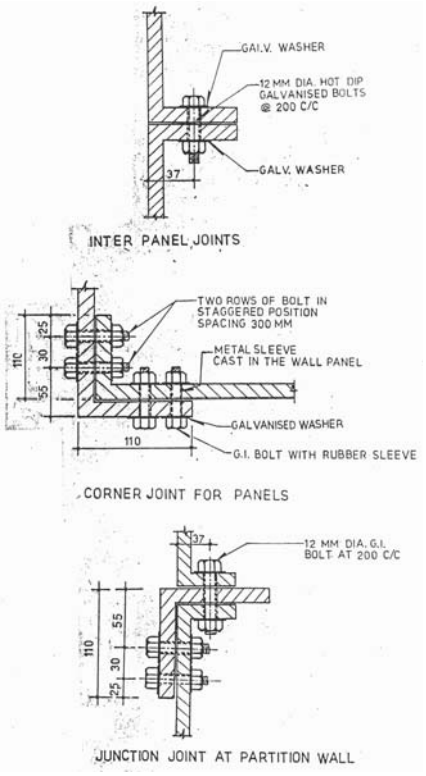


FIG.6 : DETAILS OF JOINTS

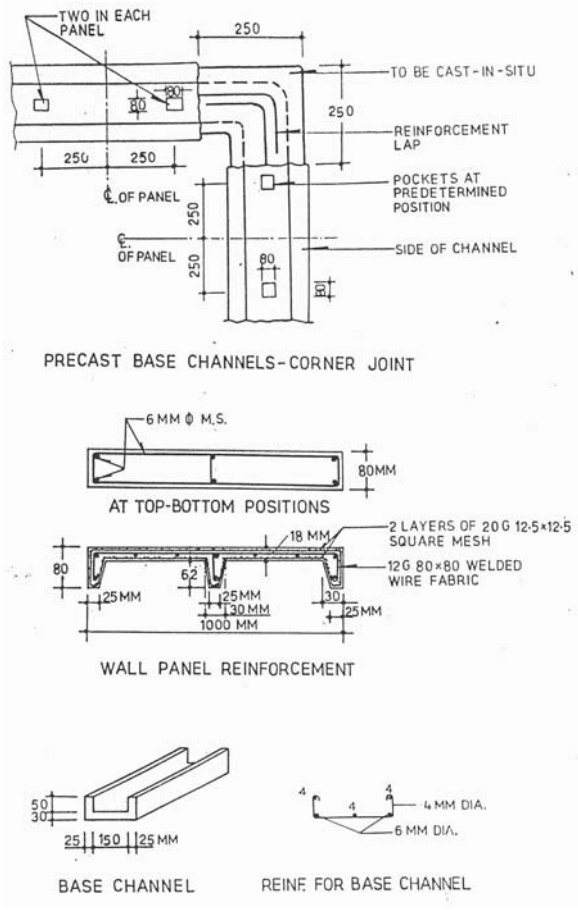


FIG.5 : REINFORCEMENT FOR BASE CHANNEL AND WALL PANEL ELEMENTS

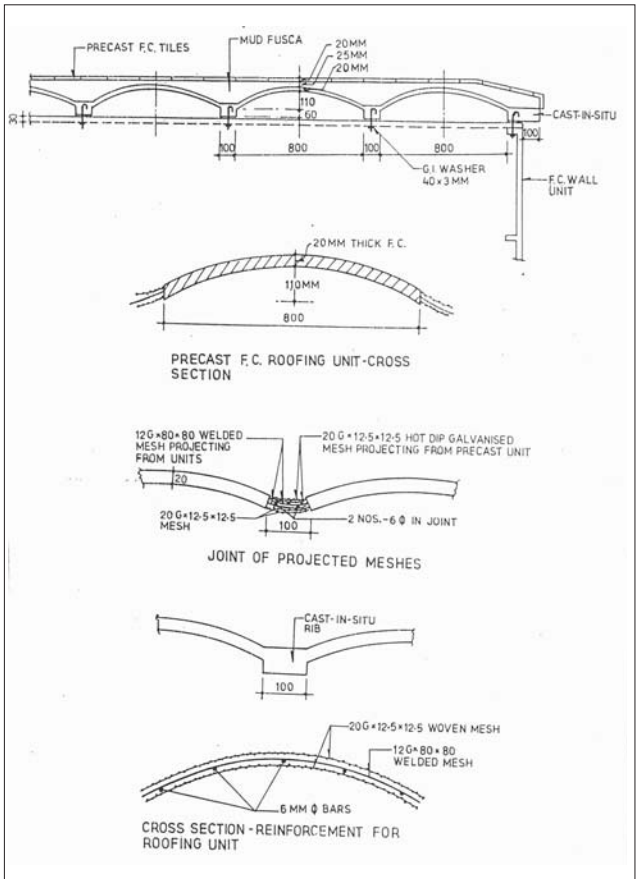


FIG.7 : F.C.ROOFING UNIT FOR F.C. HOUSE

Release of Publications of BMTPC

Kumari Selja, Hon'ble Minister releasing the publications of BMTPC during Foundation Laying Ceremony of Construction of Demonstration Houses at Bitna Road, Pinjore, Distt. Panchkula, Haryana on 28th February, 2009

User's Manual for Production of Cost-Effective, Environment-Friendly and Energy-Efficient Building Components

Brochure on Dissemination of Information through Demonstration Construction using Cost Effective and Disaster Resistant Technologies

Booklets on Aam Aadmi Series on House Building Digest (Series 1 to 3)

भूकंपरोधी डिजाइन और निर्माण

*डा. शैलेश कुमार अग्रवाल**
*अरुण कुमार तिवारी***

भूकंप के दौरान मानवजीवन की अपूर्णीय क्षति इसलिए होती है क्योंकि जो भवन बनाए जाते हैं वे भूकंप को झेलने में असफल रहते हैं और गिर जाते हैं। भूकंप के कारण आर्थिक हानि और जनजीवन की अव्यवस्था भी भवनों तथा मानव निर्मित ढांचों के विफल होने के कारण होती है। इसलिए भूकंप जोखिमों को कम करने के लिए भूकंप रोधी डिजाइन और निर्माण, सबसे पहला और अहम उपाय है। भूकंप इंजीनियरी में अग्रणी "हाउसनर" के अनुसार बड़ी भूकंपीय आपदा के प्रमुख घटकों में तीव्र भूकंप, उत्पत्ति भ्रंश (केन्द्र) से दूरी और सबसे महत्वपूर्ण ऐसे भवन जो भूकंपरोधी नहीं है आदि शामिल हैं। भारत, जो एक भूकंप प्रवण देश है, में ज्यादातर मकान ऐसे हैं जिनमें कोई विशेष भूकंप रोधी उपाय नहीं किए जाते हैं। इसलिए भारतीय शहर भूकंपीय आपदा के आसान शिकार बन जाते हैं और पिछले एक दशक में आए सभी भूकंपों से यह बात प्रमाणित हो चुकी है। हाल ही में 26 जनवरी, 2001 में भुज में आया भूकंप इसका ताजा उदाहरण है जिसमें व्यावसायिक इंजीनियरों द्वारा डिजाइन किए गए आरसी भवन भी मीजा-भूकंपीय क्षेत्र से 300 किमी की दूरी पर होने के बावजूद गिर गए।

भूकंपीय क्षेत्रों में भवन तब तक गिरते रहेंगे या अनिश्चित रुप से क्षतिग्रस्त होते रहेंगे जब तक उन्हें भावी भूकंपों से होने वाले संभावित भू-कंपनों को झेलने के लिए डिजाइन नहीं किया जाता और साथ ही अपेक्षित स्तर की भूकंपीय सुरक्षा कैसे हासिल की जाए इसके बारे में इंजीनियरों के मार्गदर्शन के लिए पर्याप्त जानकारी और मानकों की जरुरत है। भूकंपक्षम निर्माण मात्र केवल भूकंपीय भार झेलने के लिए बने ढांचे का डिजाइन नहीं है बल्कि यह एक संपूर्ण दर्शन है जिसमें वास्तुकीय आयोजना से लेकर संरचनात्मक डिजाइन और फिर वास्तविक निर्माण और गुणता नियंत्रण तक भूकंप की धारणा को ध्यान में रखना होता है। सामान्य दृष्टिकोण से किसी भी इंजीनियरी डिजाइन में मूलत: प्रत्याशित बलों को परिभाषित किया जाता है और इनके लिए उचित अवयव/खण्डों तथा उनके संयोजन (कनैक्शन) की व्यवस्था की जाती है। भूकंप रोधी डिजाइन में समस्या कुछ जटिल सी है क्योंकि भूकंप भारों, संरचनात्मक अवयवों और अन्य की क्षमताओं के संबंध में अनिश्चितता रहती है और इसके साथ ही ऐसा ढांचा बनाना संभव नहीं है जिसे तीव्रतम भूकंप के दौरान भी कोई क्षति न पहुंचे। इस प्रकार भूकंपीय डिजाइन में हम भूकंप डिजाइन बलों के अंतर्गत क्षतियों को ज्यादा जोखिम लेते हैं बजाय अन्य तुलनात्मक बड़े भारों जैसे कि अधिकतम चल भार या वायु भार। इसलिए भूकंपीय डिजाइन दर्शन स्वीकार्य जोखिम की अवधारणा पर आधारित है। इसके उद्देश्य इस प्रकार हैं:

क) ढांचों के जीवनकाल के दौरान अकसर बार बार आने वाले छोटे भूकंपों का बिना किसी क्षति के प्रतिरोध करना;
ख) बिना संरचानात्मक क्षति के लेकिन कुछ गैर संरचनात्मक क्षति पहुंचाने वाले मध्यम भूकंपों का प्रतिरोध करना, मध्य तीव्रता वाले भूकंप कभी कभी किसी संरचना के जीवन काल में कम से कम एकबार आ सकते हैं;
ग) भवनों के संरचनात्मक ढांचे या उसके अवयवों में बिना किसी बड़ी विफलता के बड़े या तीव्र भूकंपों का प्रतिरोध करना और जीवन सुरक्षा को बनाए रखना (कोई निपात नहीं), बड़े भूकंप बहुत विरले ही आते हैं और किसी संरचना के जीवन काल में कदाचित न आएं।

सरल शब्दों में भूकंपीय रोधी डिजाइन का दर्शन यह है कि विरले प्रकार के भूकंपों की स्थिति में संरचनाओं के जीवनघाती निपात की रोकथाम की जाए और ऐसी घटना के दौरान केवल मरम्मत योग्य या मरम्मत न होने योग्य क्षति ही हो।

विश्वसनीय भूकंप रोधकता कैसे हासिल करें ?

विश्वसनीय भूकंप रोधकता के लिए संरचना डिजाइन के कुछ सिद्धांतों का पालन करने की जरुरत है।

* कार्यकारी निदेशक, ** उप प्रमुख (एस.पी.डी. एवं प्रशासन), बी.एम.टी.पी.सी.

सरलता और सममिति: पिछले अनुभवों से लगातार यह प्रमाणित हुआ है कि सरल संरचनाएं जिनकी योजना सममित होती है वे भूकंप के दौरान बेहतर टिकते हैं बजाए जटिल और असममित संरचनाओं के। भूकंपीय भार के अंतर्गत जटिल संरचनाओं की बजाए सरल संरचनाओं के व्यवहार को आसानी से समझा जा सकता है। चित्र 1 में कुछ प्रारुप दिखाएं गए हैं जिसे भूकंप रोधी निर्माण में अपनाया जाना चाहिए । सममिति की कमी से ऐंठन बढ़ती है जिनका आकलन करना कठिन होता है और यह बहुत विध्वंसकारी हो सकता है । भवनों के फैकेड में डीप री इन्ट्रैन्ट कोने बनाने से भवन सरल प्ररुपों की तुलना में ज्यादा नाजुक हो जाते हैं। H ,T , और Y आकार की योजना वाले भवन भूकंपों में अकसर बुरी तरह क्षतिग्रस्त हुए हैं ।

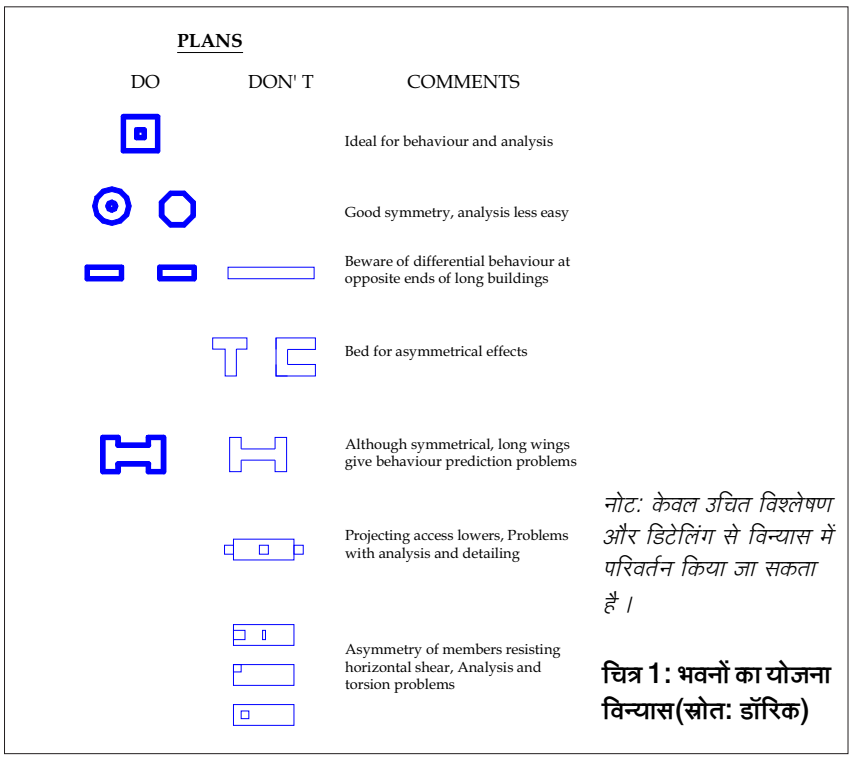
प्लान की लंबाई: जो संरचनाएं लंबी होती है उन पर छोटी संरचनाओं की अपेक्षा भू संचलन और मृदा स्थिति का ज्यादा अलग अलग प्रभाव पड़ता है । ये अंतर आउट आफ फेज भूकंप गति या अलग अलग भूंगर्भीय दशाओं के कारण होता है। नींव की किस्म अर्थात सतत या विलगित के आधार पर भी प्लान की लंबाई के कारण संरचना पर दबाव या खिंचाव बल पड़ते हैं। सामान्यत: संचलन अंतर रखा जाना चाहिए ताकि विभेदी संचलन हो सके या डिजाइन में इस प्रकार के प्रभाव के लिए व्यवस्था होनी चाहिए । जहां आयोजना कारणों से लंबे भवनों की जरुरत हो तो उसे कम लंबाई की अलग अलग संरचनाओं के रुप में उप विभाजित करके उनके बीच संचलन अंतर छोड़कर बनाया जा सकता है ताकि यह बेहतर ढंग से कार्य कर सके।

उद्विक्षेप(एलिवेशन) में आकृति: क्षैतिज विरुपण को सीमित करने के लिए भवन तनुता (स्लैण्डरनेस) को प्रतिबंधित किया जाना चाहिए। ऊँचाई से चौड़ाई की सीमा 3 या 4 संस्तुत की जाती है किसी अच्छे डिजाइन में इसे बढ़ाया जा सकता है । तनु भवनों में उच्च स्तम्भ बल होते हैं और नींव का स्थायित्व पाना कठिन होता है । चित्र 2 में उद्विक्षेप आकृतियों के लिए सरल नियम दिए गए हैं ।

सामर्थ्य और दृढ़ता का एकसमान तथा सतत वितरण: अनुभवों से पता चलता है कि भूंकप के दौरान संरचना के बने रहने की अधिकतम संभावना होती है बशर्ते कि:

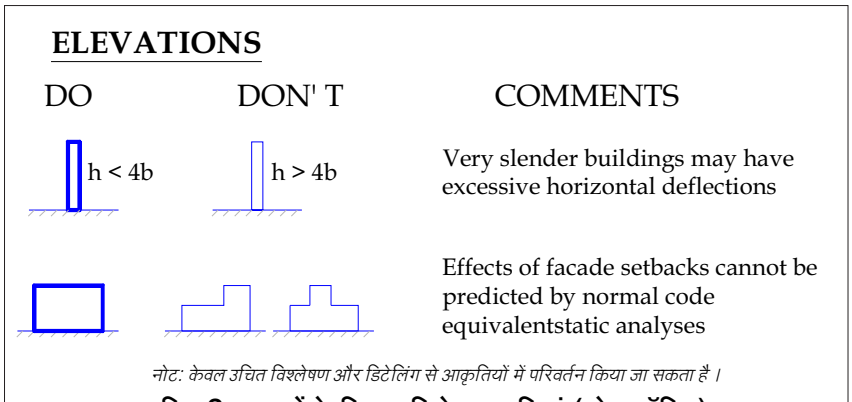
- भार धारक अवयव एकसमान रुप से वितरित हों
- सभी स्तंभ और दीवारें छत से लेकर नींव तक बिना किसी ऑफसेट के हों (चित्र 3)
- सभी धरने ऑफसेट रहित हों ।
- स्तंभ और धरने समक्षीय हों (चित्र 4)
- प्रबलित कंक्रीट स्तंभ और धरने लगभग समान चौड़ाई की।
- कोई भी प्रमुख अवयव अकस्मात ही खण्ड से अलग न हो ।
- संरचना जितना संभव हो उतना सतत (अपेक्षाधिक) और एकाश्मी हो ।

उपर्युक्त संकल्पनाएं अनिवार्य नहीं हैं लेकिन ये पूर्णत: प्रमाणित है । सततता (रिडन्डेंसी) की संकल्पना एक महत्वपूर्ण पहलू है और इसकी उपेक्षा नहीं की जानी चाहिए। बिना सततता घटक वाली प्रणाली में प्रत्येक एकल घटक को कार्यात्मक रहना चाहिए ताकि संरचना की समग्र एकांगता सुनिश्चित हो सके। तथापि, उच्च सततता (रिडन्डेंसी) वाले भवनों में अनेक अवयवों के विफल हो जाने पर भी कदाचित भवन ध्वस्त न हो। भूकंप गति और संरचनात्मक अवयवों के व्यवहारों की अप्रत्याशित प्रकृति को देखते हुए संरचना का डिजाइन इस प्रकार होना चाहिए कि यदि एक घटक विफल भी हो जाता है तो दूसरा उप घटक उसका भार उठा सके ।



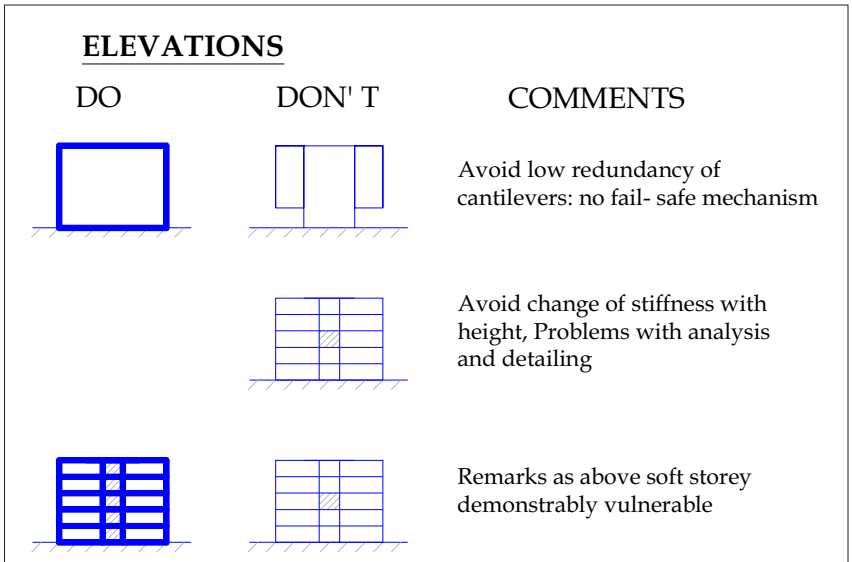
नोट: केवल उचित विश्लेषण और डिटेलिंग से विन्यास में परिवर्तन किया जा सकता है ।

चित्र 1: भवनों का योजना विन्यास(स्रोत: डॉरिक)

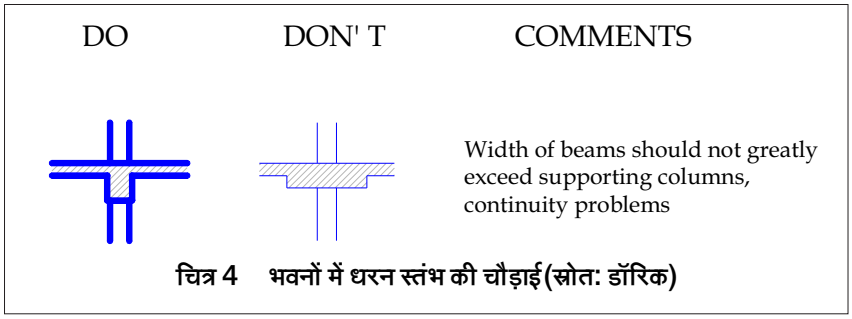


नोट: केवल उचित विश्लेषण और डिटेलिंग से आकृतियों में परिवर्तन किया जा सकता है ।

चित्र 2: भवनों के लिए उद्विक्षेप आकृतियां (स्रोत: डॉरिक)



चित्र 3: उर्ध्वाधर विन्यास (स्रोत: डॉरिक)



चित्र 4 भवनों में धरन स्तंभ की चौड़ाई (स्रोत: डॉरिक)

एक विशिष्ट किस्म की असततता जिसका उल्लेख किया जाना आवश्यक है वह नाजुक तल संकल्पना (सॉफ्ट स्टोरी कंसेप्ट) है । बहु मंजिला धंचे वाली इमारतों में सामान्यत: रिहायशी ऊपरी मंजिलों में अनुप्रस्थ दीवारें या ढांचा इनफिलिंग मुहैया की जाती है लेकिन भूतल पर इन्हें पूर्णत: हटा या आंशिक रुप से हटा दिया जाता है ताकि खुला व्यावसायिक स्थल या पार्किंग स्थान बनाया जा सके । इससे भूतल एक कमजोर तल बन जाता है । जिसे सामान्यत: सॉफ्ट स्टोरी के रुप में जाना जाता है । दुनिया में आए पिछले भूकंपों के दौरान अधिकांश आरसी ऊंचे भवनों की विनाशकारी विफलता का यह एक कारण रहा है ।

नींव: भूकंपरोधी निर्माणों में सामान्यत: नीवों की उपेक्षा की जाती है जबकि किसी भी अधिसंरचना के समग्र भूकंपीय निष्पादन पर नींव का बहुत अधिक प्रभाव पड़ता है । नीवों को जितना संभव हो, विशेषकर बड़ी इमारतों के लिए, समान रुप से साधारण बनाना चाहिए । पूरी इमारत के लिए केवल एक किस्म की नींव का प्रयोग किया जाना चाहिए । अलग स्तंभ या दीवार नीवों को इस प्रकार संयोजित किया जाए ताकि वे एकीकृत इकाई के रुप में कार्य करें जो कि संरचना को भूकंप रोधी बनाने के संबंध में बुनियादी नियम है । नीवों में उर्ध्वाधर भार लगभग एकसमान रुप में होना चाहिए।

सारांश

इस लेख का आशय समग्र रुप से यह समझना है कि भूकंप रोधी डिजाइन और निर्माण क्या है? भूकंप रोधी डिजाइन का दर्शन अलग और जटिल है क्योंकि भूकंप भारों से लेकर अप्रत्यास्थ संरचना व्यवहार, सामग्री विशेषताएं, संरचना की मॉडलिंग आदि तक सभी स्तरों में भिन्न भिन्न अनिश्चितताएं रहती है । तथापि, पिछले 30 वर्षों में काफी प्रगति हुई है और भूकंप इंजीनियरी उस अवस्था में पहुंच गई है जहां ऐसी सुरक्षित संरचनाएं बनाई जा रही हैं जो तीव्र भूकंपनों में टिकी रह सकती हैं । भारत में 2001 में आए भुज के भूकंप से ही इस बारे में इंजीनियरों में जागरुकता आई है । तथापि, ऐसा लगता है कि समय के साथ इस दिशा में रफ्तार कम हुई है । भारत ऐसा देश है जिसमें बार-बार भूकंप आते रहते हैं और हमारी संरचनाओं को क्षति पहुंचाते हैं क्योंकि मौजूदा इमारतों में भूकंपरोधी उपाय कार्यान्वित नहीं किए गए हैं । ऐसा व्यावसायिक इंजीनियरों की इस विषय के संबंध में अज्ञानता के कारण

हैं । भूकंप रोधी डिजाइन और निर्माण के क्षेत्र में कार्यरत इंजीनियरों और कारीगरों को प्रशिक्षित करने के लिए राष्ट्रीय स्तर पर एक कार्यनीति (स्ट्रैटजी) तत्काल बनाने की जरुरत है । भारत के पास अलग अलग संरचनाओं के लिए काफी भूकंप संहिताएं (कोड) हैं और काफी उन्नत प्रणाली भी है तथापि, उन्हें सही ढंग से डिजाइन में कार्यान्वित करने से पूर्व इंजीनियरों को महत्वपूर्ण प्रशिक्षण और सहायक सामग्री उपलब्ध कराने की जरुरत है । इंजीनियर के रुप में हमें यह सुनिश्चित करना चाहिए कि नया निर्माण भूकंप रोधी हो और मौजूदा कमजोर संरचनाओं को भूंकपरोधी बनाने की समस्या का भी समाधान हों ।

संदर्भ

1. अग्रवाल, शैलेश कुमार, स्ट्रांग मोशन ऐरे एज रेस्पांस आफ लेयर्ड इलास्टिक मीडियम, पीएच.डी. थीसिस, डिपार्टमेंट ऑफ अर्थक्वेक इंजीनियरिंग, इंडियन इंस्टीट्यूट ऑफ टेक्नोलॉजी (फॉरमली यूनिवर्सिटी ऑफ रुड़की), रुड़की, 2002
2. डॉरिक डी.जे., अर्थक्वेक रेजिस्टेंट डिजाइन फॉर इंजीनियर्स एण्ड आर्किटेक्ट (दूसरा संस्करण) जॉन विले एण्ड संस लि, किचेस्टर, 1987
3. अर्थक्वेक स्पेक्ट्रा, 2001 भुज, इंडिया अर्थक्वेक रिकनैन्सां रिपोर्ट, सप्लीमेंट ए टु वाल्यूम 18, 2002
4. जैन, एस.के.मूर्ति, सी.वी.आर., सीस्मिक डिजाइन ऑफ रीइन्फोर्स्ड कंक्रीट बिल्डिंग्स, शॉर्ट कोर्स, कंटीन्यूइंग एड्यूकेसन प्रोग्राम, इंडियन इंस्टीट्यूट आफ टेक्टनालॉजी, कानपुर, 2001

****

Capacity Building Programme for SAARC Countries

An Inter-Ministerial meeting was held in the Ministry of Statistics & Programme Implementation (MoSPI) in September regarding formulation of projects for SAARC countries. The Secretary, MoSPI desired that a detailed project proposal may be submitted by BMTPC. Accordingly, BMTPC prepared a proposal for "Capacity Building on Performance based Design & Retrofitting of Buildings against Earthquakes for SAARC Countries" and submitted to the Ministry of HUPA for onward submission to Ministry of Statistics & Programme Implementation. The Capacity Building Programme on "Performance Based Design and Retrofitting of Buildings against Earthquakes" under SAARC Social Charter was organized in New Delhi during 20th - 24th October, 2008.

Nominations were invited from SAARC countries through Ministry of External Affairs, Govt. of India and the participants from Afghanistan, Bhutan, Bangladesh, Maldives, Sri Lanka and India participated in the Capacity Building Programme. Faculty included National Seismic Advisor, Ministry of Home Affairs, earthquake experts from IIT Kanpur, Roorkee, Madras, Mumbai and Delhi, senior officials from GSI, IMD, DTTDC and BMTPC. Certificate of participation were distributed by Joint Secretary (Housing), MoHUPA and Joint Secretary (SAARC), MEA, Govt. of India. Most of the participants found the programme quite useful and expressed their interest for organization of such type of Programmes in their country.

Demonstration Construction using Cost Effective and Disaster Resistant Technologies

The Council is construct ing demonstration houses in various regions of the country to showcase the efficacy of the innovative and cost effective building materials and disaster resistant construction technologies. Accordingly, BMTPC is constructing 24 Demonstration Houses at Amethi, Sultanpur, UP with infrastructure facilities. This demonstration project focus at promoting innovative technologies in the region. The work for construction of the project has already been started and the work has reached upto plinth level in some of the DUs. Some of the technologies being used in the project are rat trap bond in bricks for walling, prefabricated filler slab for roofing and intermediate floors, RCC door/window frames, precast sunshades, staircases, lintels etc. The estimated cost of construction of Rs.510/- per sq.ft.

Construction of Demonstration Houses at Amethi, Sultanpur, UP in progress

The land for construction of 24 demonstration houses and establishment of a Technology Demonstration-cum-Production Centre has been identified and handed over at Bitna Road, Pinjore, Distt.Panchkula, Haryana by the State Government. The Foundation Stone was laid by Kumari Selja, Hon'ble Minister of State (Independent Charge) for Housing & Urban Poverty Alleviation on 28th February, 2009. Based on the drawings, estimates have been prepared for the projects. The work of construction of Demonstration Housing including Community Centre & Meditation Hall has been awarded. The work is likely to start very soon. The plinth area of each dwelling unit is 400 sq.ft. The cost of construction works out of be Rs.650/- per sq.ft. The technology proposed to be used in the housing project are rat trop bond in bricks, RCC filler slab, precast concrete door/window frames, ferrocement, stair case, solid concrete blocks, ferrocement roofing channels etc.

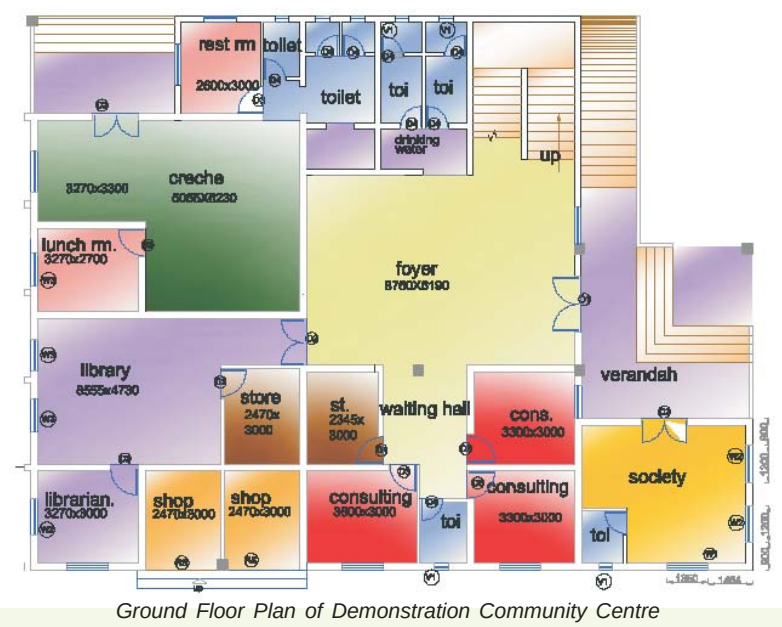
The Council has initiated construction of 24 demonstration houses at village Devanandpur, Rae Bareli, Uttar Pradesh with Infrastructure Development such as Site leveling, Landscaping-horticulture, Water supply lines, Sewerage disposal, twin leach pit, Storm water drains, WBM road, Interlocking tiles paving, Boundary wall, External electrification, Rain water harvesting, etc. The land has been handed over by the District Administration. The detailed drawings and estimates have been prepared and the construction work has been awarded. The technology proposed to be used are Burnt Clay bricks in Rat Trap Bond, Reinforced Cement Concrete Filler Slab with bricks, Pre-cast RCC door/window frames in place of traditional frames to achieve cost effectiveness, Wood substitute Flush shutters for doors, Paneled door shutters for windows, Prefabricated staircases and sunshades, PPR for sanitary fittings, etc. The super plinth area of the each DU is 41.28 sqm.

and the estimated cost of construction is Rs.600/- per sq.ft.

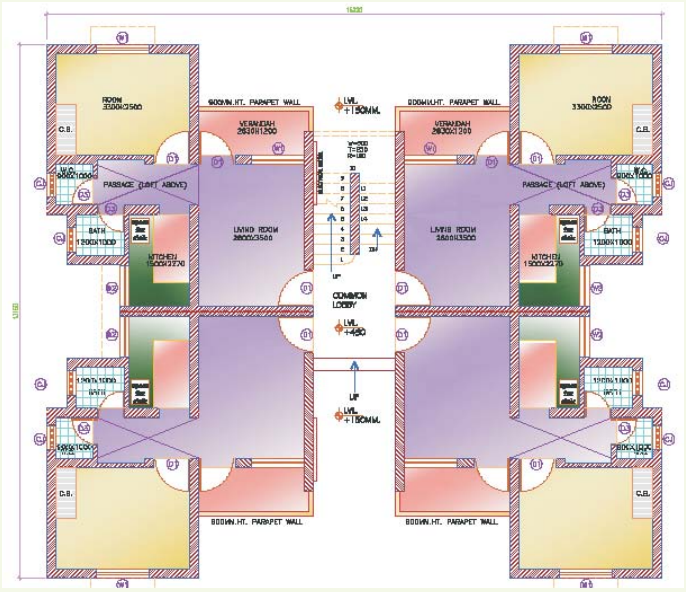
The Council has undertaken a project jointly with Durg Municipal Corporation for construction of 72 Demonstration Housing using innovative housing technologies at Durg for Safi Karamchari on cost sharing basis. The land for construction of demonstration houses for Safai Karamchari at Durg has been identified by Durg Municipal Corporation. After completion of drawings and estimates, the work on the project has been started. The technologies being used are flyash bricks for walling, RCC filler slab, precast concrete door/window frames etc. The estimated cost of construction of Rs.404/- per sq.ft.

The Council has also undertaken a project jointly with Madhya Pradesh Housing Board for construction of 24 demonstration houses at Bhopal. The land for project has been identified by MP Housing Board. During the visit to the site, the land for construction of demonstration houses has been found suitable. The drawings and estimates based on cost effective technologies has been prepared and the work has been initiated. The special feature includes use of cost effective technologies such as concrete blocks for walling, RCC door/window frames, RCC filler slabs, etc. The estimated cost of construction of Rs.520/- per sq.ft.

The Council received a request from State Govt. of Haryana for construction of a public building using cost effective technologies with a twin objective of demonstration as well as socially useful asset for use by the community at large. The State Govt. has also identified the suitable land in Village Khojkipur-Naggal. The Foundation Stone laying ceremony for construction of Demonstration Community Centre was held on 10th January 2009 at Village Khojikipur, Naggal, Ambala, Haryana. The Foundation Stone was laid by the Hon'ble Minister of State (I/C) for Housing & Urban Poverty Alleviation, GoI. Senior officers from Government of Haryana, District Admn. & Panchayat also participated in the event. The Community Building will have facilities like community hall, dispensary, crèche, library, green room, office etc. The Community Building will also showcase the innovative construction materials &



Ground Floor Plan of Demonstration Community Centre at Village Khojkipur-Naggal, Ambala, Haryana



Ground Floor Plan of Demonstration Housing Project at at Bitna Road, Pinjore, Distt.Panchkula, Haryana

Donstruction of Community Centre at Village Khojikipur, Naggal, Ambala, Haryana in progress

technologies for replication at the local level. The construction of Demonstration Community Centre has reached above plinth level. Special features includes use of rat trap bond in bricks; interlocking type compressed earth blocks; flyash bricks; modular bricks for walling; RCC planks and joists; prefabricated panels; prefab brick arch panels; RCC filler slab; doubly curved shell for roofing; precast concrete door/window frames; precast sunshades, lintels, staircases, etc. The estimated cost of construction of Rs.650/- per sq.ft.

The Council earlier completed construction of Demonstration Housing using cost-effective and disaster resistant technologies at Nagpur (Maharashtra – 70 houses), Dehradun (Uttarakhand – 100 houses), Kudalu (Karnataka – 70 houses), Trichi (Tamil Nadu – 100 houes) and Bilaspur (Chhattisgarh – 100 houses) under VAMBAY and handed over to the respective State Governments.

The Council is undertaking the construction of model Informal Markets in Gumla, Jharkhand and Vishakhapatnam, Andhra Pradesh. The necessary infrastructure such as water supply, electricity and other public amenities required in the premises will be provided by the State authorities. The sites have been chosen to cater to many urban slum dwellers as well as inhabitants of nearby villages who are in the trading of handmade petty items, agriculture, forests products etc. The Informal Market will have platform for trading on time sharing basis, health centre, workstations for women, reading rooms, crèche, etc. The informal market at Gumla is being implemented through Gumla Municipal Corporation and informal market at Vishakhapatnam through Greater Vishakhapatnam Municipal Corporation. The work on construction of Informal Market at Visshakhapatnam has already been started.

Foundation Stone Laying Ceremony

for construction of Demonstration Community Centre at
Village Khojkipur-Naggal, Ambala, Haryana on 10th January, 2009

Foundation Stone Laying Ceremony

for construction of 24 demonstration houses and establishment of a
Technology Demonstration-cum-Production Centre at Bitna Road,
Pinjore, Distt.Panchkula, Haryana on 28th February, 2009

Bamboo as a Material for Housing and Buildings - BMTPC's Initiatives

*Dr.Shailesh Kr.Agrawal**
*Sharad Kumar Gupta***

Background

Wood has been used for centuries as a common material in construction of buildings and other structures. Similarly, bamboo has also a long and well established tradition for being used as a construction material throughout the tropical and sub-tropical regions of the world.

In the modern context when forest cover is fast depleting and availability of wood is increasingly becoming scarce, the research and development undertaken in past few decades has established and amply demonstrated that bamboo could be a viable substitute of wood and several other traditional materials for housing and building construction sector and several infrastructure works. Its use through industrial processing has shown a high potential for production of composite materials and components which are cost-effective and can be successfully utilized for structural and non-structural applications in construction of housing and buildings.

Main characteristic features, which make bamboo as a potential building material, are its high tensile strength and very good weight to strength ratio. The strength-weight ratio of bamboo also supports its use as a highly resilient material against forces created by high velocity winds and earthquakes. Above all bamboo is renewable raw material resource from agro-forestry and if properly treated and industrially processed, components made by bamboo can have a reasonable life of 30 to 40 years. The natural durability of bamboo varies according to species and the types of treatments. Varied uses and applications in building construction have established bamboo as an environment-friendly, energy-efficient and cost-effective construction material. The commonly used species in construction are Bambusa balcooa, Bambusa bambos, Bambusa tulda, Dendrocalamus giganteous, Dendrocalamus hamiltonii, Dendrocalamus asper, etc.

Bamboo, a highly versatile resource and widely available, is being used as an engineering material for construction of houses and other buildings. A number of small and medium

World-wide availability of Bamboo

(Number of bamboo species and coverage by country, in Asia)

Country/area	Number of species	Area (million hectares)
Bangladesh	33	0.6
China	300	2.9 (only 'Moso')
India	136	9.6
Indonesia	35	0.1
Japan	95	0.12
Malaysia	44	0.3
Myanmar	90	2.2
Papua new guinea	26	N/A
Philippines	55	N/A
Sri lanka	14	N/A
Taiwan	40	0.18
Thailand	60	0.81

* Executive Director, Building Materials & Technology Promotion Council (BMTPC), New Delhi
** Dy.Chief - TDE&IC, BMTPC, New Delhi,
This Paper was published during the VIII World Bamboo Congress held in Bangkok, Thailand in September, 2009.

sized demonstration structures have already been constructed during past few years. These have shown very good performance in different climates. In order to propagate use of bamboo in housing and building construction for wider application, awareness and confidence building amongst professionals and householders is required. This calls for organized actions on prototyping, demonstration, standardization aimed at improving acceptance levels and promoting appropriate construction practices.

Over twenty million tones of bamboo are harvested each year, with almost three fifths of it in India and China. An estimated 25 million people all over the world depend on or use bamboo materials. The table above indicates the distribution of bamboo in Asia. It is also serves to highlight the potential dominance of India with its vast resources and reserves of bamboo in future economic activity and trade.

In India, 28% of area and 66% of growing stock of bamboo in NE region and 20% of area and 12% of growing stock in MP & Chattisgarh.

The housing and building construction industry is one of the largest consumers for natural mineral resources and forests. It is increasingly realised that innovative building materials and construction technologies which offer potential for environmental protection, employment generation, economy in construction and energy conservation need to be encouraged as best options to meet the rising demand of housing. Whole of north-east is prone to earthquakes and falls under Seismic Zone V. BMTPC lays emphasis on promoting design and construction of disaster resistant technologies for housing. Construction techniques using bamboo as main material have been found very suitable for earthquake resistant housing. With the constant rise in the cost of traditional building materials and with the poor affordability of large segments of our population the cost of an adequate house is increasingly going beyond the affordable limits of more than 30-35% of our population lying in the lower income segments. This calls for wide spread technology dissemination of cost effective building materials and construction techniques.

Bamboo as a Building and Construction Material

Bamboo is structurally stronger than steel. At the same time, it is light-weight, easily workable, and has vibration damping and heat insulation properties. Structurally, bamboo can find application in three main types of structures: scaffolding, housing, and roads.

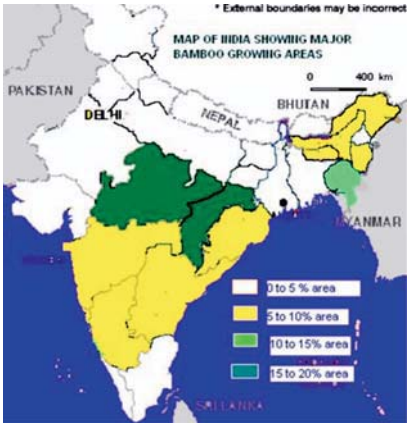
Scaffolding

Bamboo is being used for scaffolding in most of the countries where it grows. In fact, despite construction becoming high-rise, bamboo has continued to hold advantages over other materials such as steel, which has entered the scaffolding market recently. Steel scaffolding is available as an industrial product of standardized dimensions that make it quick to erect and dismantle. Moreover, steel can be used at least 50 times more than bamboo, which can be used five to ten times at most depending upon the load of the construction. In this respect, bamboo scaffolding needs some technical upgrading.

However, bamboo is a preferred scaffolding material be-

Availability of Bamboo in India

S.No.	State/region	Area %	Growing stock %
1	North East	28.0	66
2	Madhya Pradesh	20.3	12
3	Maharashtra	9.9	5
4	Orissa	8.7	7
5	Andhra Pradesh	7.4	2
6	Karnataka	5.5	3
7	Others	20.2	5



cause its flexibility in the variety of lengths that it can be cut into, the lower investments that contractors need to make in the scaffolding stocks (bamboo costs just 6 per cent of the price of steel for similar quantity of scaffolding) and the ease with which it can be set up and dismantled. It is the preferred scaffolding option even in developed countries such as Hong Kong and continues to be used for the majority of high-rise buildings in these countries

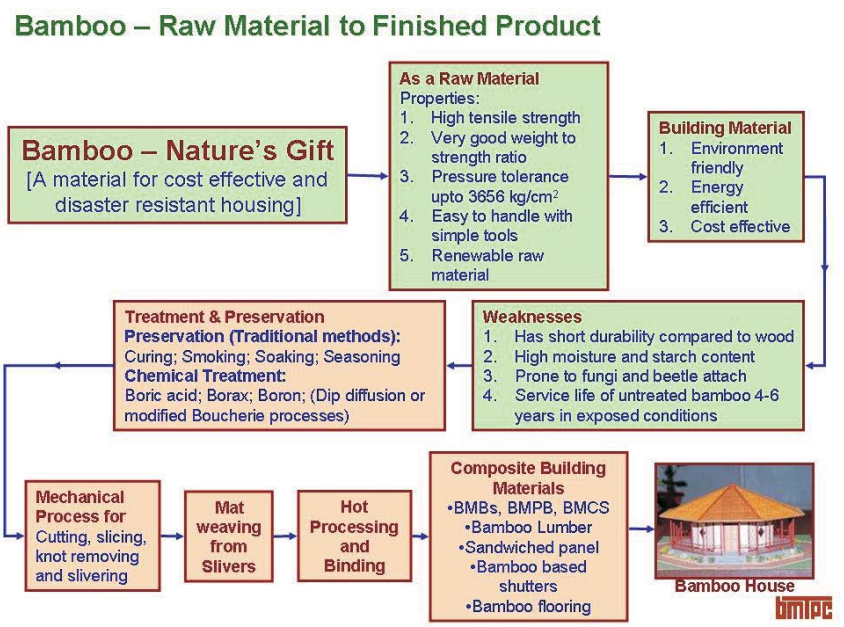
In India too the usage of bamboo for the purpose of scaffolding is on the higher side. There is virtually no value addition on the raw bamboo used for scaffolding purposes.

Bamboo - a Housing material

In a structural application, bamboo rounds are used to create roof support systems. These systems include a prefabricated triangular truss comprising units eight metres long. A truss can be carried by four people, and deflects only 2.5 cm along its entire length. It is covered with bamboo boards, lath and plaster to create a waterproof roof. This system utilises bamboo rafters with bamboo boards, which are plastered on both sides, and fired clay tiles are used to waterproof.

Floor

Bamboo flooring and bamboo board are newly developed interior designing material made using modern scientific methods from superior quality bamboo. Bamboo flooring is an attractive alternative to wood or laminate flooring.



Bamboo with a wall thickness of culm of at least 11 mm is suitable for making floorboards. The process of making bamboo strip flooring consists of the following steps:

- Hollow bamboo of a minimum thickness of 11 mm is sliced into strips.
- These strips are milled to a thickness of 7 mm. They are then boiled to remove the starch and treated for anti-moth, anti-mildew, etc.
- The strips are then dried and carbonised (if required).
- The dried strips are now milled to 5 mm thickness.
- These strips are now glued and laminated into solid boards under high pressure, which are then milled into standard strip flooring profiles.

The machinery and equipment required for manufacturing bamboo flooring can be imported from Taiwan, though some is available locally as well.

Floors can be made out of flattened bamboo, woven bamboo mats or split bamboo.

As reinforcement:

There are four categories in which the use of bamboo has been made:

1. Bamboo fibres in cement mortar for roofing sheets
2. Split bamboo as reinforcing bars in concrete
3. Bamboo as a form work for concrete
4. Bamboo as a soil reinforcement

For Roofing:

Bamboo Mat Corrugated Roofing Sheet has been developed by BMTPC in close collaboration with Indian Plywood Research and Training Institute (IPIRTI) Bangalore, India. It is made from woven bamboo mats.

For Walls:

Woven bamboo mats are used to make walls in countries such as Bangladesh and India. Vertical whole or halved culms and flattened bamboo strips are also used for making walls. Walls can be made with bamboo as a minor component and mud as a major one.

For Doors and windows:

Bamboo can be fashioned artistically to make doors and windows.

BMTPC's Initiatives in Promotion of Bamboo in Housing & Buildings

The Building Materials & Technology Promotion Council (BMTPC) under the Ministry of Housing & Urban Poverty Alleviation, Govt. of India is actively involved in development of bamboo based technologies and to promote these technologies in the North-Eastern Region including other bamboo growing areas, by encouraging commercial production of bamboo based products, construction of demonstration houses and setting up of Bamboo Mat Production Centres for processing of bamboo, etc.

Bamboo Mat Corrugated Roofing Sheets

The BMTPC in collaboration with Indian Plywood Industries Research & Training Institute (IPIRTI), Bangalore, have developed a technology for manufacturing of Bamboo Mat Corrugated Sheet (BMCS) which is durable, strong, water-proof, and decay-insect-fire resistant. The commercial production has been started at Byrnihat, Meghalaya. The product has been accepted by the consumers and is becoming increasing popular as a roofing option in the north east part of the country. It is estimated that in full capacity this unit will generate livelihood for nearly 7000 women/men (through mat weaving) in rural regions where bamboo is abundantly grown.

Bamboo Mat Corrugated Ridge Cap

BMTPC in collaboration with IPIRTI, Bangalore, has also developed a technology for manufacturing of Bamboo Mat Corrugated Ridge Cap for roofing. The Technology is ready for commercialization.

Construction of Demonstration Structures

BMTPC has constructed 24 demonstration structures in Mizoram, Tripura, Nagaland and Meghalaya using bamboo based technologies. These include Houses, OPD buildings, Library buildings, Picnic huts, Schools, etc. The cost of construction using conventional technologies in these areas is around Rs. 800/- per sq ft. This is considerably reduced using bamboo based technologies and the cost of construction achieved is Rs.315 to Rs.622 per sq.ft. for different types of structures. The specifications used are:

(a) Treated bamboo columns and beams,
(b) Ferrocement walls on bamboo grid reinforcement,
(c) Treated bamboo trusses, rafters and purlins,
(d) Bamboo mat board in wooden frames for door shutters,
(e) Bamboo Mat Corrugated Roofing Sheets,
(f) IPS flooring, etc.

Development of Technology for Construction of Two Storey Bamboo Housing System

A technology for construction of two storey bamboo housing system has been developed and a demonstration house has been constructed at the campus of IPIRTI Bangalore. At each stage of house construction various elements were tested and models of such elements were made before the actual construction was carried out.

Design and Development of Pre-fabricated Modular Housing System

BMTPC has undertaken Design and Development of pre-fabricated modular housing system using bamboo and bamboo based composites in collaboration with IPIRTI, Bangloare. A model design of pre-fab double walled bamboo composite house attached bath and kitchen having size 20' x 24' x 8' was developed. This system will enable application of bamboo composite building materials in pre-fabricated houses. These types of houses can be constructed quite quickly for immediate and long term rehabilitation for post disaster relief.

Bamboo Mat Production Centres

BMTPC alongwith Cane & Bamboo Technology Centre (CBTC) in cooperation with State Governments, is establishing Bamboo Mat Production Centres in the States of Assam, Tripura, Mizoram, Meghalaya and Kerala. The main objectives of Bamboo Mat Production Centres are to provide uninterrupted supply of bamboo mats to the manufacturing units of bamboo based building components for increasing the productivity, quality, to provide training in mat production process and to create employment opportunities. The Council has established such Bamboo Mat Production Centres in Tripura, Mizoram, Meghalaya and Kerala.

BMTPC and CBTC are also providing training on bamboo mat production to the artisans from each Bamboo Mat Production Centres. The production capacity of each production centre will be 300 mat per day. It is estimated that the each Centre will be able to produce the mat at the rate of Rs.35 per mat and would be able to sell at the rate of Rs.45 per mat. This provides employment generation of nearly 150 women/men per day i.e. 45,000 women/men days per year per Centre. Besides the above, the Centres can also generate income by supplying bamboo sticks made out of bamboo waste, to the artisans for making handicraft items. The mats produced by Bamboo Mat Production Centres are likely to utilized by various manufacturers who are producing Bamboo Mat Corrugated Roofing Sheets and Bamboo Mat Boards.

Bamboo - More Than An Alternative

Bamboo has so far not been regarded as a substitute for wood. An analytical look at the applications for which wood is being used and the usage of bamboo indicates that it is possible to use bamboo for all the applications for which wood is being used. The usage of bamboo has in fact been established conclusively for categories that consume larger volumes of wood, namely, paper pulp, plywood, construction and furniture.

There are preconceived notions about the technical capability of bamboo. These have hindered the adoption of bamboo as a wood substitute. The wood industry is not able to visualize bamboo as a process-friendly material that can peeled. It also considers bamboo to be susceptible to fire, water and termites.

The Bamboo, if used efficiently, shall lead to the following in the interest of the nation and masses:

- Enterprise Development
- Training for skill upgradation
- Employment generation
- Conservation of forest timber
- Bulk utilization of bamboo.

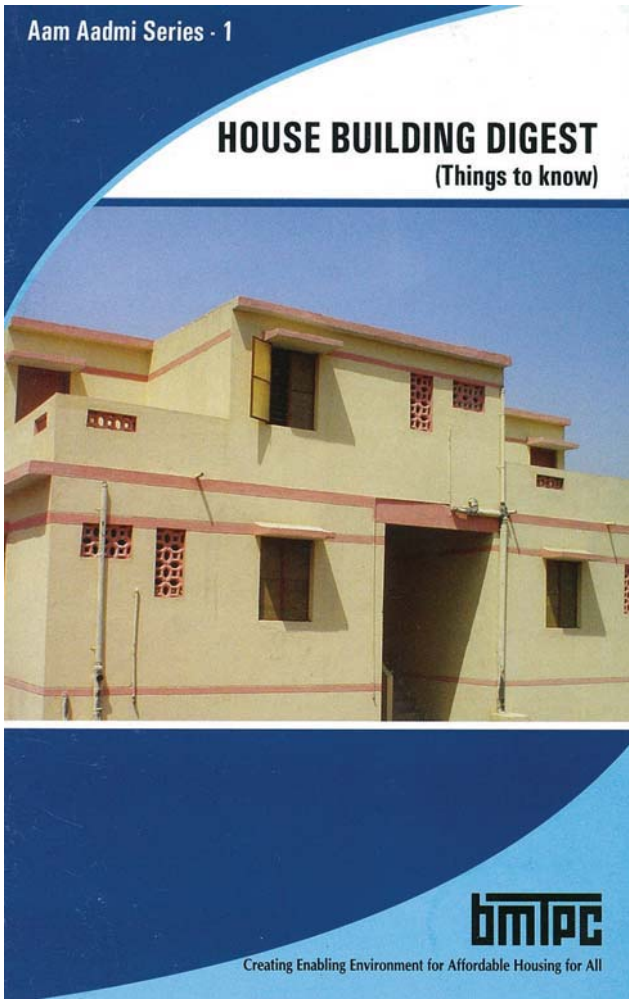
Know Your House Construction – Aam Admi Series

Since its inception in 1990 the Building Materials and Technology Promotion Council (BMTPC) has been engaged in the process of propagating new and innovative methods of construction including new building materials and construction technologies. One of the ways to achieve this objective has been to bring out popular publications on various technical issues. The themes of the publications ranged from hardcore technical, both instructional and informative, to common topical subjects on housing technologies and building materials for widespread understanding of the subject by the common people.

A quick review of the publications brought out in the past by the Council brought out that there is a need of bringing out publications for the common man, which would help the common man in familiarizing himself with the processes involved in house construction as well as the basic construction systems and methods. It was also felt that the publications should be of help in improving upon the quality of construction besides identifying areas of cost reduction.

BMTPC has accordingly made an attempt to bring out an informative series on construction of a house by an individual which has been named as 'Aam Admi Series'. In the series it is endeavored to highlight the processes involved in the construction of a house as also the salient features of each element of the house say foundations, superstructure, finishing etc. For the benefit of the common man the language used in these publications is lucid and simple to comprehend. Further the technical issues have been explained in a manner which can be understood by the Aam Admi. These publications also include typical sketches and photographs of different elements of the house for facilitating a better understanding of the construction process.

During the past nine months seven publications of the series have been brought out both in Hindi & English. A brief on the series is as under:-



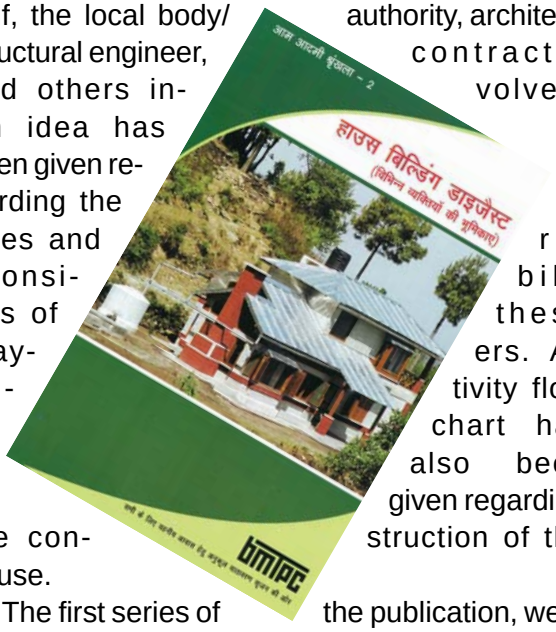
1. Things to Know

In this publication the basic issues involved in the construction of a house have been highlighted. It brings out various activities involved in the construction of a house, including the architectural design, structural design, construction costs, planning and construction time, supervision of works. Some of the issues that the house owner should check himself have been highlighted in the publication.

2. Roles of Different Players

The second series of the publication deals with the roles that different agencies and individuals

have to perform during the construction of the house. These include the house owner himself, the local body/ authority, architect, structural engineer, contractor and others involved. An idea has been given regarding the roles and responsibilities of these players. An activity flow chart has also been given regarding the construction of the house.



The first series of the publication, were released by the then Minister of State for Housing, Kumari Selja at Ambala.

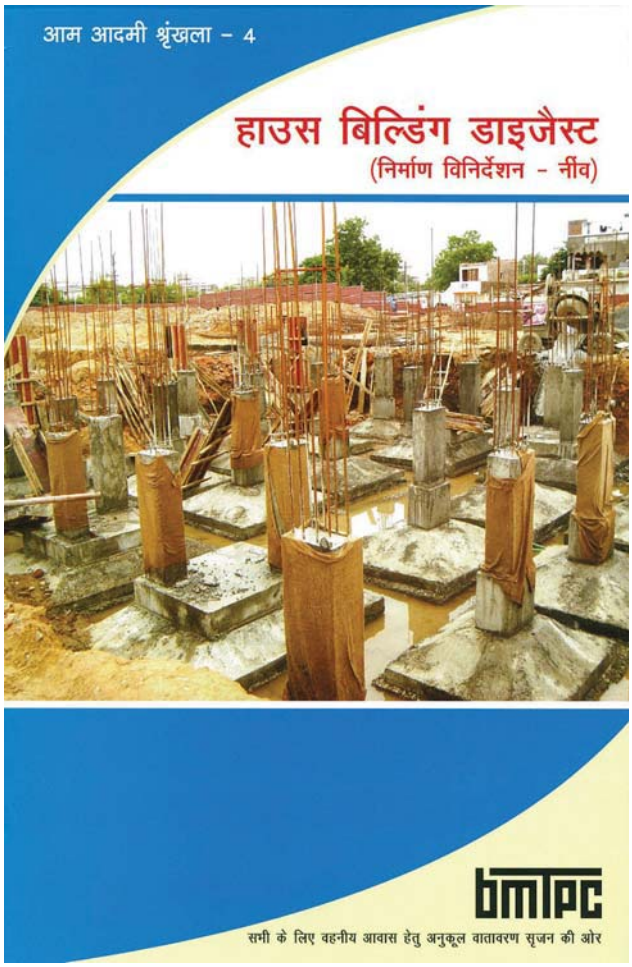
3. Procedures and Terminologies

The series has two parts the first dealing with the procedures of house construction as well as the document required therefore and the second dealing with the common terminologies associated with house construction. Issues regarding Building-Bye-laws, Steps in house construction, Building permits, sanctions, various certificates required etc have been dealt in the first part.

The second parts explains some of the commogies like mon terminolodwelling unit, plinth level, carpet areas, super-built area, foundation, superstructure, specifications, estimated etc.

4. Construction Specification – Foundations

In this series various issues involved in the construction of a house have been brought out. It explains about the various types of foundations which can be provided in construction of a house. These include the brick foundation, concrete foundation, raft foundation, pile foundation, foundations along a property line etc. It also deals briefly with the anti termite treatment which has to be carried out during the construction of the foundation. Some *do's and don'ts* for the construction of a foundation have also been highlighted.

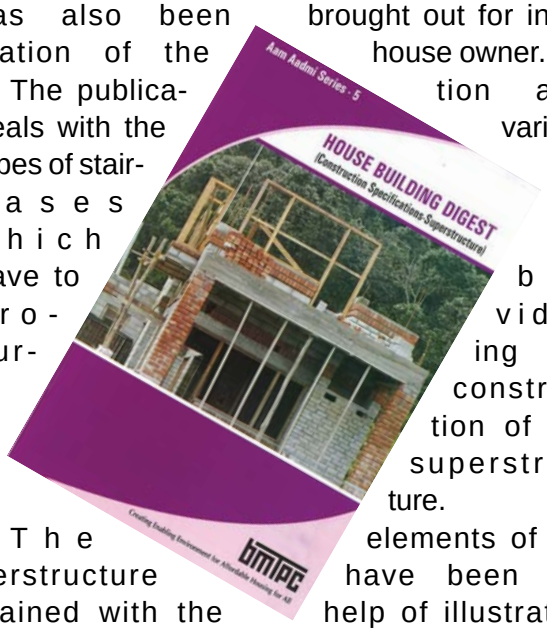


5. Construction Specification – Superstructure

The publication deals with the various modes in which a superstructure can be provided for the house. It highlights about the brick load bearing construction, the type of bricks, types of mortars used, bonds in brickwork, the element of workmanship involved etc. RCC framed construction, which is also used in the construction of a house has also been explained in the booklet. In this section the typical dimensions of beams, columns, floor and roof slabs etc have been indicated. The method of construction of RCC frame

has also been brought out for information of the house owner.

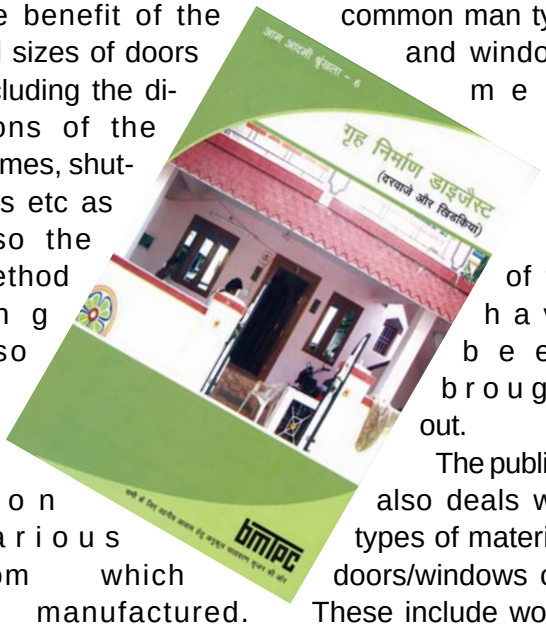
The publication also deals with the various types of staircases which have to be provided during the construction of the superstructure.



The elements of superstructure have been explained with the help of illustrative sketches.

6. Doors and Windows

Door and Windows are an important element of a house which improves upon the general appearance. Further, they may cost between 15% to 20% of the cost of civil works, during the construction of the house. The publication accordingly deals with various types of doors and windows which can be provided in a house. For the benefit of the common man typical sizes of doors and windows including the dimensions of the frames, shutters etc as also the method of fixing have also been brought out.



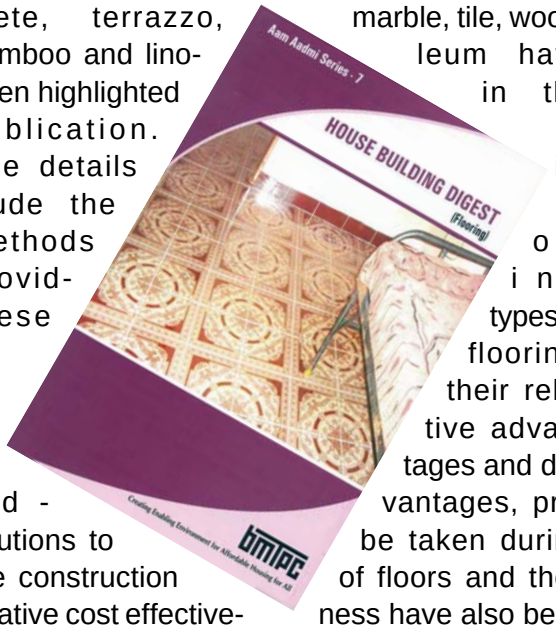
The publication also deals with various types of materials from which doors/windows can be manufactured. These include wood, boards, glass, steel, PVC, fiberglass, Fiber Reinforced Plastics, Aluminum and Bamboo-Jute composite. Doors like the Batten and Ledged, paneled and glazed as also single shutter, double shutter sliding doors etc have also been dealt in the publication. A few tips have also been given on the criteria for selection of these elements.

The text has been substantiated with photographs and sketches

7. Flooring

The main theme of the publication is that a proper flooring will give good appearance and performance and would also be cost effective. With this theme in view the publication brings out various types of flooring that could be effectively adopted in the house. The effectiveness has been highlighted from considerations of the room it is being provided, considerations of location – interior or exterior, considerations of local availability of material etc.

Some of the most commonly method of flooring like those made in mud, bricks, stone, concrete, terrazzo, marble, tile, wood, bamboo and linoleum have been highlighted in the publication. The details include the methods of providing these types of flooring, their relative advantages and disadvantages, precautions to be taken during the construction of floors and their relative cost effectiveness have also been brought out. The issue regarding maintenance of floors have also been including in the publication.



Photographs of typical floors and sketches also form a pert of the publication.

The above seven publications have also been simultaneously brought out in Hindi. They have been distributed at various seminars and other important functions and have become quite popular.

Further publications of the 'Aam Admi Series' series are being finalized by the Council and will be brought out on a continual basis.

Capacity Building of Construction Professionals

BMTPC - DR. FIXIT INSTITUTE TRAINING SERIES 2009-10
Training Programme on Building Maintenance and General Repairs, Bhopal, 24-25 September, 2009

Training Programme on Cost Effective Building Materials and Housing Technologies, Basti, Uttar Pradesh
17-19 November, 2008

Training Programme on Production of Compressed Earth Blocks and
Ferrocement & Prefab Technologies, Kanyakumari, Kerala

Role of BMTPC as Monitoring Agency under Basic Services to Urban Poor Sub-component of JNNURM

Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a flagship programme launched by Govt. of India in December, 2005 has made significant impact in terms of improving the overall urban infrastructure scenario and providing basic services to urban poor in selected mission cities and other medium and small towns of India.

Ministry of Housing and Urban Poverty Alleviation (MoHUPA) is nodal agency for sanctioning and monitoring of projects under Basic Services to Urban Poor sub-component of JNNURM. The basic services to urban poor sub component includes projects under Basic Services to Urban Poor (BSUP) from selected mission cities and Integrated Housing & Slum Development Programme (IHSDP) from medium & small towns. The provision of basic services to urban poor includes security of tenure at affordable prices, improved housing, water supply, sanitation and ensuring delivery through convergence of other already existing universal services of the Government for education health and social security. Upto mid September, 2009 a total of 462 projects under BSUP and 842 projects under IHSDP have been sanctioned from 63 mission cities and 761 medium and small towns respectively.

Presently, the Mission is well ahead of its mid term phase and most of the projects are in initial stages to advance stages barring a few mission cities/ towns where projects have not started on ground. The fact need not be overemphasized that proper monitoring has a vital role to play for success of any scheme. Keeping this in view, the Ministry has been strongly advocating for four tier monitoring system for all the ongoing BSUP and IHSDP projects with particular reference to quality aspects.

BMTPC, a technical organization under the aegis of MoHUPA, GoI, has been designated as Central Monitoring Agency for all BSUP & IHSDP projects being implemented all over the country. This is in addition to its role as Appraisal Agency for BSUP projects mainly from selected cities and IHSDP projects to a limited extent.

As monitoring agency the Council has been assigned specific tasks, some of the main tasks include:

a) Regular site visits to ongoing BSUP & IHSDP projects

The Council has laid particular emphasis on visits to various BSUP and IHSDP projects in mission cities and towns. In 15 months time during July 2008 to September 09, a total 7500 crore worth BSUP & IHSDP projects have been physically inspected which include 81 BSUP projects and 54 IHSDP projects from 25 mission cities and 54 towns respectively. The visit to other mission cities has so far not been made primarily due to non-execution of the sanctioned projects on ground. The projects in 5 mission cities and 10 towns have been inspected twice as per the various requirements of the ministry such as facilitating release of subsequent installments, attending to complaint with regard to quality aspects of project etc.

Based on specific observations made and details gathered from State implementing agencies, the monitoring reports are prepared and submitted to the Ministry, which primarily includes:

- Assessment of physical progress of housing and infrastructure component viz. a viz. financial progress of the project in order to ascertain whether physical progress is commensurate with financial progress.
- Mobilization and utilization of matching financial share by State Govt. & Urban local body (ULB).
- Fund flow statement from GoI & various other state sources to ULB.
- Time and cost overrun in projects

- Implementation related issues if any
- Any deviation from the sanctioned parameters
- Quality control aspects based on Test results/ data/ quality control mechanism available at site and overall workmanship of construction.
- Progress on key reforms

b. The Desk Appraisal & MIS Job under JNNURM Cell

BMTPC's JNNURM Cell has been created comprising of BMTPC Officials and professionals with IT & social background. The Cell's primary job includes coordination with State agencies and receiving details of all BSUP and IHSDP projects sanctioned and under implementation throughout the country in both electronic and print form. The project details furnished by State agencies as per the specified formats are further analyzed to assess/evaluate the various aspects of progress of the project.

Further, web based software has also been designed to capture online information with regard to physical and financial progress of projects. The professionals from JNNURM Cell have been involved in maintenance of this software & in capacity building programmes conducted for smooth implementation of this e-tracking system in various states.

c. Quality Control Aspects & Guideline

The quality aspects of the projects are accorded very high

Moniotoring of IHSDP Project at Bali, Rajasthan

Moniotoring of IHSDP Project at Pali, Rajasthan

Moniotoring of IHSDP Project at Kanti, Bihar


Moniotoring of BSUP Project on Rehabilitation of Slums in Asansol, West Bengal


Moniotoring of BSUP Project for Integrated Development of Kanshi Ram Taj Nagari Phase II, Agra, Uttar Pradesh


Moniotoring of BSUP Project for Integrated Development of Kanshi Ram Kalindi Vihar I & II

priority among monitorable parameters. This aspect of quality assurance has time and again been emphasized by MoHUPA. Towards this there is a proposal to induct faculties/ Scientists from Academic/ Research & Development organizations of excellence in the monitoring team and make regular visits to all the ongoing projects with special focus on quality of projects.

Further, BMTPC has been entrusted by the Ministry with the responsibility to develop Quality Control Guidelines particularly for BSUP & IHSDP projects. The same is under finalization in consultation with all the stakeholders. The guideline once finalized shall be circulated to various state agencies and would in turn help in improving the quality of projects.

With concerted effort of all the stakeholders, it is strongly felt that the mission would achieve its primary objective of integrated development of basic services to urban poor in cities and towns covered, which would be a giant leap towards making the country slum free.

Consultative Meet on "Manual for Quality Assurance of BSUP / IHSDP Projects under JNNURM

BMTPC has been entrusted as the Central Monitoring Agency by Ministry of Housing and Urban Poverty Alleviation, Govt. of India for BSUP and IHSDP projects under JNNURM. To facilitate the State Govt/ULBs/Implementing agencies, follow proper quality assurance plan during execution of BSUP/ IHSDP projects, Ministry of HUPA had desired that a Quality Assurance Manual may be prepared. Accordingly, a one day Consultative Meet on "Manual for Quality Assurance of BSUP/ IHSDP Projects under JNNURM" was organized on 17th June 2009 at New Delhi which was attended by senior technical officers from States and ULBs/implementing agencies dealing with Quality control/assurance of JNNURM projects, experts from organizations like CPWD, IIT, CBRI, NBCC, RITES, NCCBM, HUDCO etc and other technical organizations/institutions/industry.

After the presentation on draft Manual prepared by BMTPC, detailed discussion was held on all aspects of the quality manual covering the scope, applicability based on size and type of project etc. Due to prevailing local practices, norms and site conditions, it may not be practical to formulate a document which is applicable in all the States, therefore, there is need to formulate the document in the form of Guidelines which could cover all major Checks and Controls for Quality Assurance with flexibility of modification for local conditions.

It was agreed that based on the Draft Manual prepared by BMTPC, a suitable document in the form of the Guidelines incorporating CPWD specifications & BIS Standards may be prepared for which a small Technical Group was constituted to study the draft manual in detail and suggest suitable modifications before its submission to the Mission Directorate, JNNURM, MoHUPA, Govt. of India. The meeting of the technical Group has been held and the Guidelines are being finalized for final submission.

Performance Appraisal Certification Scheme - An effective Tool for Transfer of Innovative Technologies

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

The PACs for the following products have been issued:

1. Finger Jointed Solid Wooden Door:

Finger Jointed Solid Wooden doors manufactured by M/s Riya Enterprises, Gujarat are made of timber obtained from plantation forests of New Zealand.The components of door shutter such as stiles, rails, mullions and panels are made from finger jointed edge glued defect free timber pieces and from same species of wood. These light duty doors are suitable for internal locations. These doors are available in different shapes, sizes & shades.

2. Plastocrete Panel:

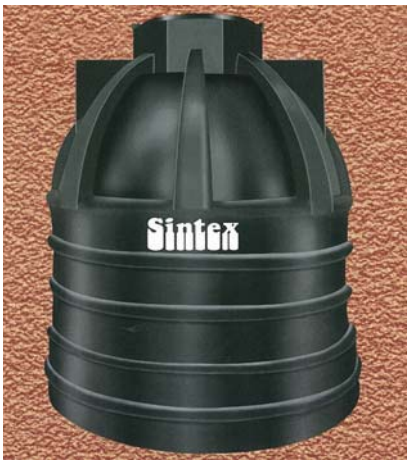
Plastocrete panels manufactured by M/s Sintex Industries, Gujarat consist of outside plastocrete wall and inside wall of various materials such as PVC hollow sections, PUF panels attached PVC layer, AC Sheet and also plastocrete. These are light weight, easy to install with simple tools & require low labour. These panels are suitable for construction of school buildings, site office, security cabins, housing, modular toilets, hospitals etc.

3. 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.

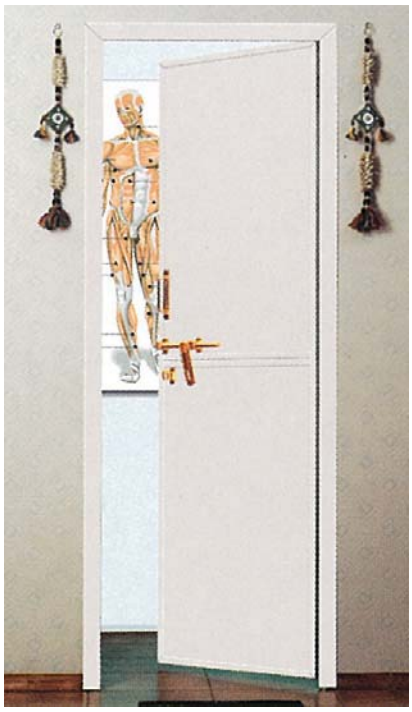
4. Underground Water Storage (Sump) and Septic Tanks:

Underground Water Storage Tank (Sump) and Septic tank manufactured by M/s Sintex Industries, Gujarat are one piece moulded tanks made of polyethylene. These are non-porous and does not allow contamination of water kept in the tank. These underground tanks are suitable for houses, school, hospitals, offices etc.



5. Endura Door:

Endura doors manufactured by M/s Sintex Industries, Gujarat are made by combining hot pressed moulded 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.

6. 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.

7. 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.

8. 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.

9. 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.

The applications for issue of PACs for the following products are under process:

1. **HDPE Cover Blocks**: HDPE Cover Blocks manufactured by M/s Right Vision, Delhi are made of High Density Polyethylene. These blocks are used I 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 sizes and shapes.

2. **Heat Proof Mosaic Tiles**: These tiles manufactured by M/s Ishaan Industries, Gujarat are made of white & grey cement, minerals, stones of different and additives. These tiles reduce the heat transmitted into the building and proved a cooler interior. These are used for external locations on the roof/ terrace of buildings.
3. **Dispersible Polymer Powder**: Dispersible Polymer powder manufactured by M/s Wacker Chermie, Mumbai is a polymer powder of vinyl acetate & ethylene. This is dispersible in water and has good saponification resistance. Its applications are not only for blending with inorganic binders but also as binder for synthetic resin bound systems.
4. **Low Cost Binder**: Low Cost Binder manufactured by M/s S.L.Surana, Udaipur is made from recycling marble slurry waste. This can be used in place of cement and lime for masonry and plaster in buildings.
5. **Prepolymerised Wetmix Self Curing Material**: This product manufactured by M/s Green Build Products, Pune is a binder made of filler materials collected from graded wastage. This material is used in place of cement and sand for masonry and plaster works. This is self curing, saves time and needs less labour.
6. **Tejas Ecosafe Panel**: Tejas Ecosafe Panels manufactured by M/s Tejas Foundations, Chennai are made from EPS Granules and Galvanised wire. These panels can be used as replacement for bricks and hollow blocks. These are suitable for areas prone to typhoons, tornadoes, cyclones and earthquakes. These panels save time and cost due to simplicity in assembling.
7. **Deep Penetrating Sealer**: Deep Penetrating Sealer manufactured by M/s Polyflex, Mumbai is a non-toxic, non-flammable, odorless, clear water soluble liquid compound. It is inorganic and based on natural minerals. This can be used on walls & floors for waterproofing and preserving concrete etc.
8. **Veneer Laminated Lumber**: Veneer Laminated Lumber manufactured by M/s Sahan Flush Doors, Tanjavur is made from rubber wood and is used for making doors, windows and ventilator shutters/ frames. This is suitable for use in rails and stiles of panel doors & windows. The doors and windows are available in various sizes, shapes and shades.

Builders and Architects Should Focus on "Safe And Smart" High Rise Buildings And Work On Reducing Cost Of High Rise Construction - S.Jaipal Reddy

Management and Communication Press Release, Wed, 23 Sep 2009

Union Urban Development Minister S. Jaipal Reddy today urged the construction industry to focus on futuristic 'Safe and smart' high rise buildings as need for construction of high rise buildings in metro cities will increase due to soaring land prices and growing global trend for accommodating various activities under one roof.

Minister while inaugurating the three day National seminar on 'Recent Trends in High Rise Buildings' organised by the Indian Builders Congress (IBC) said "the construction industry should use latest green technologies, including environment friendly building materials, high tech sensors for conserving energy and water, and water recycling and ample parking and open spaces while construction of safe and smart high rise buildings".

"High rise buildings for residential purposes is being seen as a major answer to urban housing problem not only in four metropolitan cities but also in other cities like Chandigarh, Bhubaneshwar, Agra and Jaipur. But how far this is tenable, in the context of conditions prevailing in our country must be studied in depth before adopting high rise buildings" Mr Reddy said.

"For structural and social safety in high rise buildings as well as providing essential services such as lifts, elevators, fire safety devices, the initial investment of capital is very high followed by heavy recurring costs for maintenance. The building experts should find ways and means to reduce both the construction as well as maintenance cost in high rise buildings" the Minister added.

"Migration of the people to the Urban Areas is on constant increase due to enhanced employment opportunities. This has resulted in increase in land cost and desire of the people to reside near the heart of towns are some of the various factors which have given rise to construction of high-rise buildings. High rise development has come in vogue not only in mega cities like Mumbai, Delhi, Kolkata and Chennai but also in large towns like Chandigarh, Bhubaneshwar, Bangalore and Hyderabad" said Mr.M.Ramachandran, Secretary, Urban Dvelopment, while speaking on the occasion.

Display of BMTPC's Activities at various exhibitions...

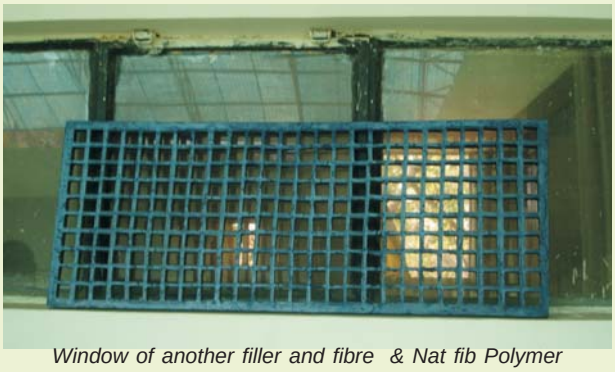
New Technology...

Light weight Core for panel for partition, door, window, manhole covers & road dividers

A new design and natural fibre reinforced composite material based core is developed at lab level for making partitions, door, instant housing panels, panels for instant toilet, doors, windows, drainage covers, manhole covers, road dividers, gratings and fencings. These partition panels, doors, instant housing panels, panels for instant toilet, doors, windows, drainage covers, manhole covers, road dividers, gratings and railings can be made by using local natural fibres and a polymer. This new design core use renewable, natural and degradable natural fibres such as jute, sisal and bamboo etc . It can be processed and produced at local level by any small scale cottage industry /medium level industry.

Window from Light wt Natural fibre Polymer composite core

Drainage cover from Light wt Nat fibre Polymer composite core

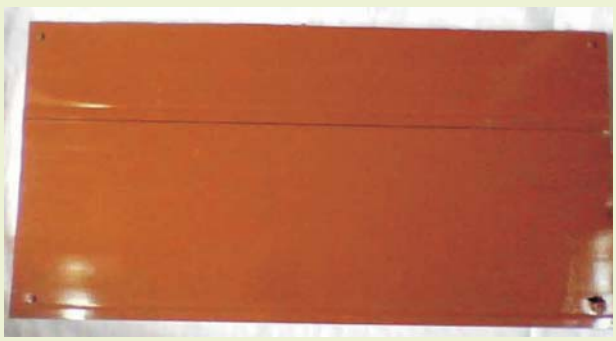


Window of another filler and fibre & Nat fib Polymer composite core

Industrial drainage cover from Light wt Nat fib Polymer composite

Different Colour / filler added core

PVC surface covered housing panel from Light wt Nat fib Polymer composite



Light wt. Door / panel for housing /instant housing from Light wt Natural fibre Polymer composite Core (NC)

New Technology...

Rice Husk and Bagasse filled Polymeric Light weight Foamed Sheets

Processes has been optimized for making Rice Husk and Bagasse filled Polymeric Light weight Foamed Sheets and are depicted in the figs 1a-d below. These sheets are some typical examples of the foamed sheets made by using rice husk or bagasse and different polymers such as PVC/PP and some additives .All the sheets made by using polymers and fillers can be easily cut by using ordinary carpenter saw and gives smooth surface, which is visible in the cut sections .

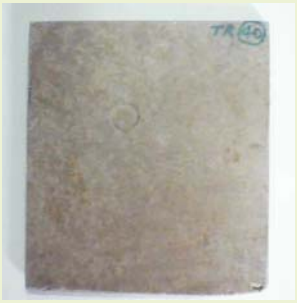


Fig 1a shows the foamed sheet made by Rice husk and polymer (TR40)

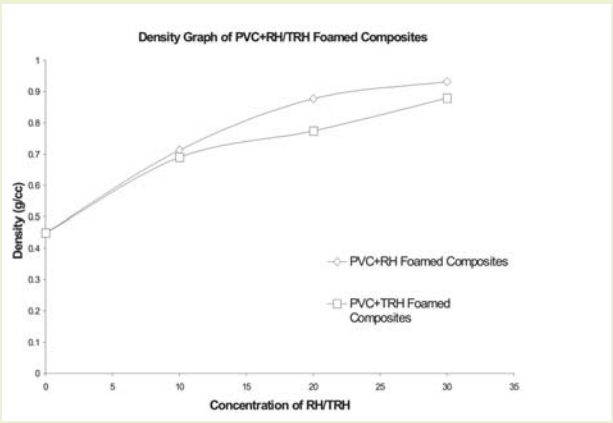
Fig 1bshows the sheet made by treated Bagasse and polymer (TR35)

Fig 1c shows the foamed sheet made by rice husk and polymer (TR26)

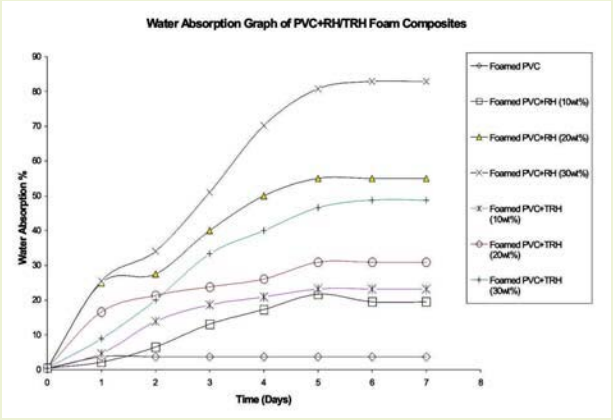
Fig1 d shows the foamed sheet made by Treated RHand another polymer(TR29)

Typical data for one sample only

Fig 2a 2b shows the variation of density and moisture absorption with concentration of rice husk powder in PVC Foam composite .



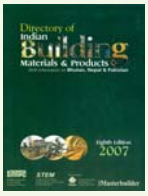
Fig[2a] Variation of density with concentration



F ig [2b] Variation of moisture with concentration

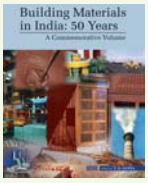
For further information, contact:
Dr Anil K Gupta, Director or
Dr. Navin Chand, Scientist G,
Head, Polymer and Fiber Composite Group
Advanced Materials and Processes Research Institute,
Near Habibganj Naka,Bhopal-462064;
Tel: 91- 0755- 2417511
E-mail: navinchand15@yahoo.co.in

Priced Publications of BMTPC



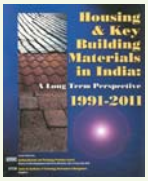
DIRECTORY OF INDIAN BUILDING MATERIALS & PRODUCTS (with information on Nepal, Bhutan & Pakistan) 2007
550 pages, Rs. 1000 + 200 postage

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



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

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



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

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

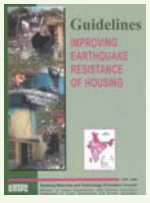
INSTRUCTION MANUAL FOR APPROPRIATE BUILDING SYSTEMS
64 pages, Rs. 150 + 75 postage

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

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

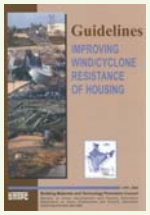
GUIDELINES FOR DAMAGE ASSESSMENT AND POST EARTHQUAKE ACTION
(Two Parts)
- Rs. 250 + 75 postage and packing for each part

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

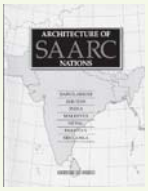


GUIDELINES FOR IMPROVING EARTHQUAKE RESISTANCE OF HOUSING - 76 pages, Rs. 350 + 75 postage

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



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



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

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

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

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 7)
22. Brochure on Dissemination of Information, Demonstration Construction using Cost Effective and Disaster Resistant Technologies".

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

Films Produced by BMTPC

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

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

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

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

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

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

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

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

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

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

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

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

Published by:
BMTPC, New Delhi
For Further Details write or contact:
The Executive Director
Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Core-5A, First Floor, India Habitat Centre,
Lodhi Road, New Delhi - 110 003
Tel.: 91-11-2463 8096
Fax: 91-11-2464 2849
E-mail: bmtpc@del2.vsnl.net.in
info@bmtpc.org
Website: www.bmtpc.org

PLANNING OUR URBAN FUTURE

World Habitat Day | 5 October 2009

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."

bmtpc