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Dispute Resolution in Engineering Contracts

Urbanisation & Housing Environment in India

Confined Masonry Construction for India:
Prospects and Solutions for Improved Behaviour

Alternate and Emerging Building Materials and
Technologies for Sustainable Built Environment

Skill Development in Construction Sector

Concept of Smart Cities in India

Climate Change and the Built Environment

Seismic Vulnerability of Structures in Delhi

A Legacy of Heritage Resources Initiatives by
Defence Sector

HUDCO's Role in Provision of Affordable Housing

Challenges of Urban Mobility in South Asian Cities

Planning Concept of Teaching Hospital,
A Study of Nursing Units

***Focus on
Built Environment***

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Focus On
Built Environment

From Desk of Editor-in-chief

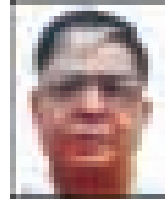
| | |
|--|---|
| Dispute Resolution in Engineering Contracts | 1 |
| Dr. Sudhir Krishna, | |
| Former Secretary, MoUD | |

| | |
|--|---|
| Urbanisation & Housing Environment in India | 5 |
| Arun Kumar Misra | |
| Former Secretary, HUPA | |

| | |
|--|----|
| Confined Masonry Construction for India: Prospects and Solutions for Improved Behaviour | 13 |
| Ajay Chourasia | |
| Principal Scientist, CSIR-Central Building Research Institute, (CBRI), Roorkee, | |
| S.K. Bhattacharyya | |
| Director, CSIR-Central Building Research Institute, (CBRI), Roorkee | |

| | |
|---|----|
| Alternate and Emerging Building Materials and Technologies for Sustainable Built Environment | 33 |
| Dr. Shailesh Kr. Agrawal | |
| Executive Director, BMTPC | |
| S. K. Gupta, | |
| Dy. Chief (TDE & IC) | |
| Dalip Kumar, | |
| Sr. Field officer (DCE), BMTPC | |

From Editor-in-Chief's Desk



Indian Buildings Congress was founded on September 1, 1992 and it was registered as a society on March 29, 1993. The vision of IBC is to build an environment which is conducive to good living, affordable, aesthetic, cost competitive, technology driven and capable of meeting the needs of Indian population. The objective of IBC is to promote and encourage the science and practice of conceiving, planning, designing, constructing, maintaining built environment standards, use of innovative and new materials, make suggestions to the Government in this field and to express opinion of members on matters related to built environment. In order to serve the society, IBC has to disseminate the knowledge about built environment.

2. In it's objective to disseminate knowledge, IBC has already published twenty two books. Besides, every year, it has been organizing two seminars on issues related with built environment. The seminar presentations are published and circulated. For information about IBC's activities, earlier news letters were published. Since last one year bimonthly magazine, "Built Environment" is being published giving news and information on built environment related subjects. Necessity was felt to publish articles on important issues related with built environment and the 1st edition of IBC Journal is an effort to fulfill this objective.

3. In the first edition of "IBC Journal" the focus is on built environment. We have included twelve papers in this inaugural issue.

- (i) "Dispute Resolution in Engineering Contracts is authored by Dr. Sudhir Krishna. He was Secretary, Ministry of Urban Development, Govt. of India and has wide rich experience at apex level of the Government. He feels that most important issue for completion of civil construction projects is Dispute Resolution between employer and contractor. He has suggested that conditions of contract should be reviewed and revised on the basis of experience gained in arbitration cases and judicial awards. His views are very valuable and will be helpful to engineering professionals for improving conditions of contract, ensuring expeditious disposal of disputes and in turn, early completion of projects.
- (ii) "Urbanization and Housing Environment in India" is authored by Shri Arun Kumar Misra, former Secretary Ministry of Housing and Poverty Alleviation, Govt. of India. He has wide experience in the field of Housing both at policy and implementation level. He has given an overview of urbanization and housing environment in India, covering policy planning, social aspects, regulatory aspects,

technological issues and human resources. Initiatives were taken to introduce several new schemes during his tenure as Secretary, HUPA. Our country is moving fast towards urbanization and unless proper environment is developed, smooth transformation will not be possible.

- (iii) “Confined Masonry Construction for India: Prospect and Solutions for Improved Behaviour” is authored by Shri Ajay Chourasia, Principal Scientist and Shri S.K. Bhattacharyya, Director, CBRI Roorkee. Under the leadership of Shri S.K. Bhattacharyya, CBRI is doing outstanding work and in this paper, both the authors have taken very important issues related to general public. Masonry can be unreinforced, reinforced or confined. Confined Masonry work is a structural system consisting of unreinforced masonry wall panels surrounded by lightly reinforced concrete. Authors have given advantages of confined masonry for structural safety during earthquakes.
- (iv) “Alternate and Emerging Building Materials and Technologies for Sustainable Built Environment” is authored by Dr. Shailesh Kumar Agrawal, Executive Director BMTPC, Ministry of HUPA Govt. of India, Shri S.K. Gupta, Deputy Chief and Shri Dalip Kumar, Sr. Field Officer, BMTPC. As is known, BMTPC is doing outstanding work to adopt new technologies. Authors have presented a practical and integrated approach for achievable targets on different issues such as use of local materials, energy efficient construction, quality control, R &D and regulatory measures to be taken. Our country has to move forward towards sustainable built environment. The knowledge of alternative building materials is very important.
- (v) “Skill Development in Construction Sector” is written by Shri K.B. Rajoria. I have been working in built environment sector for almost fifty years and taken initiatives for issues related to human resource development. This paper gives details of work done in “Skill Development” sector. Our workers are neither trained nor certified. They gain experience while working. Construction sector has not been able to show quality standards. Govt. of India has taken initiative in this field. Still lot more is to be done. A critical review has also been given.
- (vi) “Concept of Smart Cities in India” is authored by Shri Deepak Narayan, former Engineer-in-Chief, PWD, Delhi. He has practical experience and deep knowledge on different aspects of built environment. There are several papers to his credit. He has dealt with practical aspects for development of Smart Cities in our country. As we all know, ‘Smart Cities’ is a buzzword ever since now Government has taken over at centre. The author has explained that smart cities of India should take innovative approach. Our country must workout regional governance strategies, now infrastructure modeling and solution for urban challenges. Information Technology has to play important role for development and management of Smart Cities.

-
- (vii) "Climate change and the Built Environment" is authored by Shri K.K. Kapila, Chairman-cum- Managing Director, M/s ICT Pvt, Limited. He is a consultant of International repute and has presented issues related to survival of human races. He has dealt with different dimensions such as population, change of technology, conserving natural resources etc. Earth is becoming warmer and in changing landscape more of droughts, floods, fire, storms, etc will be experienced. Therefore, the author advocates sustainability to be considered for land use plan, transport modalities, building materials etc. New designs are to be evolved to reduce green house effect etc.
- (viii) "Seismic Vulnerability of Structures in Delhi" is authored by Shri A.K. Trivedi and Shri R.N. Dandekar with my assistance. Both the authors are outstanding engineers with more than forty years experience. They are former Addl. Director Generals of CPWD. Authors have felt it necessary to make us aware about seismic vulnerability of structures in Delhi. It is necessary that immediate attention is given by all concerned and they plan on short term and long term basis to make Delhi earthquake safe or face catastrophe. This article is an eye opener.
- (ix) "A legacy of Heritage Resources Initiatives by Defence Sector" is authored by Ms Upinder Kaur, Chief Architect, MES. She has conducted detailed study of heritage structures, which are still in use including I.M.A. Dehradun and Fort William Kolkata. MES has framed conservation policy and evolved techniques/ technologies, to restore heritage structures. In fact the strategy evolved by them should be made applicable for all heritage structures of our country.
- (x) "HUDCO's Role in Provision of Affordable Housing" authored by Shri Bhomik Jain Dy. Manager (P) HUDCO, gives comprehensive information about work done by HUDCO. Housing is basic human necessity. It is necessary that affordable housing for lower income group is planned and executed to avoid slums. He has explained about different schemes of HUDCO such as "Rent to Own" in private/corporate sector, individual borrowing as also Govt. Schemes like JnNURM etc. HUDCO has done outstanding work for housing sector and infrastructure sector.
- (xi) "Challenges of Urban Mobility in South Asian Cities" is authored by Shri A.K. Jain, former Commissioner (Planning) DDA. Shri Jain is an outstanding professional. Several books and articles on Urban Planning are to his credit. He has given a comprehensive review of urban transportation and dealt several issues such as integrity between public transport and urban planning, multi-mode transport planning, unified transport policy etc. He has also brought out administrative issues related to urban planning.

(xii) "Planning Concept of Teaching Hospitals: A Study of Nursing Units", is authored by Dr. Ashutosh Joshi, Associate professor IIT Roorkee. He has conducted case study of two hospitals, one in Srinagar and another in Allahabad. Both the hospitals were conceptualized, planned and constructed under different environments and phasing programmes. He has been able to evolve ideal conceptual relationship diagrammatically.

4. I would like to express my gratitude to Shri O.P. Goel, Founder President, IBC for his guidance. Due to his initiatives, IBC is a vibrant institution and serving the society for the cause of built environment. Shri S.P.S. Bakshi has been instrumental in making "IBC Journal", a reality and I am grateful to him for giving this opportunity. Members of the Editorial Board, Shri B.K. Chugh, Co-Editor-in-Chief as also Shri A.K. Trivedi, Shri P.S.Chadha and Shri Pradeep Mittal Editors have worked hard both for bi-monthly 'Built Environment' and 'IBC Journal'. I have no words to express my gratitude to them for their contribution. They deserve appreciation for the good work. I may be forgiven for shortcomings. Contribution of IBC Secretariat and particularly Shri Vasu Dev is gratefully acknowledged.

We will appreciate feedback from readers.

K.B. Rajoria
Editor-in-Chief

Dispute Resolution in Engineering Contracts

Dr. Sudhir Krishna

Former Secretary, Ministry of Urban Development, Govt. of India

Prologue

In engineering contracts, the importance of cordial professional relation between the contracting parties has been appreciated traditionally. The relation has, however, become subject to increasing stress owing to the fast evolving technological innovations and systems of communication. Globalization of the economy has further accentuated the possibility of disputes and its bitterness between the contracting parties. This is so, because the contracting entities come from differing social and professional culture and find it difficult to appreciate the position of the other party. Such environment enhances the bitterness of the disputes, which can be

mitigated greatly by arbitration. This is an important arrangement in moving forward any contract and enables faster resolution of disputes besides reducing the bitterness between the contractee and the contractor.

Dr. Sudhir Krishna who has a very wide and rich experience at the apex level in Administrative Services suggests that the experience of arbitration cases and the judicial awards should be used as a feedback for improving the contract documents.

- Editor -

Introduction

While disputes are inherent in any contract, the important issue is to have an acceptable, effective, efficient and transparent arrangement for resolution of disputes. The scope of arbitration covers disputes in contracts at very local levels as well as national and international contracts. The law on the subject has evolved very fast, both in the legislative forums as well in the forums of judicial interpretation.

As per generally accepted definition, arbitration is the process by which the parties to a dispute submit their differences to the judgment of an impartial person or group appointed by mutual consent or statutory provision. In India, the sys-

tem for arbitration was, till 1996, governed mainly by the Arbitration (Protocol and Convention) Act, 1937 (6 of 1937), the Arbitration Act, 1940 (10 of 1940) and the Foreign Awards (Recognition and Enforcement) Act, 1961 (30 of 1961). These named enactments were replaced by the Arbitration and Conciliation (Third) Ordinance, 1996 (Ordinance 27 of 1996), which in turn was replaced by the Arbitration and Conciliation Act, 1996 (Act 26 of 1996). The new Act is based on the Model Law adopted by the United Nations Commission on International Trade Laws (UNCITRAL) in 1985. The objectives of the Act, as stated in the Statement of Objects and Reasons for the Bill preceding the Act, were as follows:

- a. To comprehensively cover international commercial arbitration and conciliation as also domestic arbitration and conciliation;
- b. To minimise the supervisory role of courts in the arbitral process;
- c. To provide that every final arbitral award is enforced in the same manner as if it were the decree of a court.

Engineering Contracts

Arbitration is an important arrangement in moving forward any contract. However, it gets a special significance in respect of engineering contracts, in as much as engineering contracts usually aim at developing some basic infrastructure on which a much larger economic or social activity has to move. In respect of government contracts, the infrastructure created is for use in providing public good or service, of which the economic returns, including the opportunity costs, would normally be far in excess of the financial investments. For instance, a road is required to move the goods and passengers for the general public and possibly and, in some cases, even for country's security needs. Therefore, if the contractual dispute halts a road construction project, the delay would cause the general population to suffer, notwithstanding the legal outcome settling the financial or contractual liability on one or the other of the contracting parties.

In engineering contracts, the importance of cordial personal and professional relation between the contracting parties has been appreciated traditionally. The relation has, however, become subject to increasing stress owing to the fast evolving technological innovations and systems of communication of knowledge and information. The stress has further increased owing to larger values of the contracts, consequent upon scaling up of the economic activities, with major highways, huge buildings, metro rail projects etc.

Globalization of the economy has further accentuated the possibility of disputes and its bitterness between the contracting parties. This is so, because the contracting entities come from differing social and professional culture and find it difficult to appreciate the position of the other party. Such environment enhances the bitterness of the disputes, which can be mitigated greatly by arbitration.

Arbitration enables faster resolution of disputes and, in engineering contracts, allows the fruits of development to become available to the ultimate users or beneficiaries sooner. Another advantage of arbitration is that it reduces the bitterness in the relationship between the contractee and the contractor that creeps in following a contractual dispute.

Key Issues

The key issue, however, remains to make the arbitration laws more specific. Furthermore, arbitration laws have of necessity to be evolutionary in nature. The need of the hour is to make such evolution happen constantly, to enable the law catch up with the changing environment. Also, awareness about the benefits of arbitration needs to be spread, to facilitate all stakeholders.

The experience of arbitration should be used as a feedback for improving the contract documents. It could even lead to amendments in the extant procedures and, if need be, in the substantive laws too. It is desirable for the heads of the contracting organisations to hold periodic meetings with the arbitrators as well the contractors, to identify the issues, which commonly lead to disputes. This can be followed up with a formal analysis of the disputes and the arbitration awards. Such an approach can lead to better drafting of the future contract documents, leading to fewer disputes.

Court Judgements

It is also desirable to analyse the outcome of tests of arbitration awards in judicial courts, wherever the awards have been subject to such tests. This would lead to refinement of arbitration proceedings. It would also give greater acceptance of arbitration as practically the final mode for dispute resolution. Such analysis would also facilitate identification of loopholes or shortcomings in the contract documents that are liable to lead to disputes. In such cases, the contract documents can be revised, to reduce the chances of disputes in future contracts at least.

All in all, arbitration and conciliation proceedings deserve to be taken with utmost seriousness and be considered as a tool for better management of the projects in a healthy and progressive environment.



Urbanisation and Housing Environment in India

Arun Kumar Misra

Former Secretary, Ministry of Housing & Poverty Alleviation, Govt. of India

Prologue

The trend of global as well as India's urbanization and the consequent challenges including proliferation of slums and housing shortages has been portrayed in this article. An attempt has been made to explain the recent initiatives of Govt. of India by bringing out various policy/schemes for suitable urban development.

The author who has wide experience in the field of housing has tried to put forth the aspirations of real estate sector and initiatives of ministry during his tenure. The innovative technology for construction of low budget housing

through mass production is presented as a great business opportunity with a social cause in the new built environment. The manpower shortage and requirements of human resource and skill for building construction and real estate services is also sketched with relevant data.

A very comprehensive paper which would be of considerable interest not only to all civil engineers but also to the policy makers at the apex level.

- Editor -

Introduction

The world population is expected to increase by 2.3 billion, between 2011 and 2050 from existing 7.0 billion to 9.3 billion. During the same time span, the population living in urban areas is projected to increase by 2.6 billion, from existing 3.6 billion in 2011 to 6.3 billion in 2050. Thus, the urban areas of the world are expected to absorb all the population growth expected over the next four decades. As a result, the world rural population is projected to start decreasing in about a decade and 0.3 billion fewer rural inhabitants are likely to be there in 2050 than today. Furthermore, most of the population growth expected in urban areas will be concentrated in the cities and towns of the less developed regions. Asia, in particular, is projected to see its urban population increase by 1.4 billion, Africa by 0.9 billion, and Latin America and the Caribbean by 0.2 billion each. Population growth is therefore becoming largely an urban phenomenon mostly concentrated in the developing world.

Today, India has 377 million urban populations (31.7% of total population) and is inching towards 40% by 2030. The total numbers of Statutory and Census towns have grown from 5,161 in 2001 to 7,935 in 2011 with an increase of nearly 54%. In India, an urban area means agglomeration having population more than 5,000; density of at least 400 per sq.km (or 1,000 persons per sq. mile) and at least 75% of male population engaged in non-agricultural employment. If the globally adopted Agglomeration Index of population density of 150 people per sq.km 50,000 inhabitants and travel time to urban centre of 60 minutes is considered as the yardstick for urbanization, then India is already 52% urbanized.

Challenges Posed by Urbanisation

Although urbanisation is a driver of the economic growth, however, ever-growing urbanization has also posed enormous challenges for the planners, decision makers, architects, engineers, developers, project managers, construction workers, manufacturers of construction plant and machineries etc. Our cities face problems of land shortage, housing shortfall and severe stress on basic amenities and services. The capacity of our cities to safely dispose wastes and protect themselves against environmental hazards is much below optimum. These shortages and other planning failures have resulted in a particular type of scattering of housing and enterprises in peri-urban areas, green spaces and agricultural lands. This has created its own set of infrastructural challenges. Physical planning and public policy are yet to catch up with all these demands. For instance, the High Powered Expert Committee constituted by Government of India for assessing investment requirement has projected the capital investment requirement for Urban Infrastructure, Renewal and Re-development (including slums), and Capacity Building for the 20-year period from 2012-13 to 2031-32 at Rs. 35.75 lakh crore².

The social sustainability is also disturbed in the process of urbanization. As per the estimate of 2009-10, about 21% of the urban population is poor. Also 2011 census puts the slum population as about 18% of total urban population. As per our estimates, the housing shortage in India today is 18.78 million households out of which 95% is for Economically Weaker Sections (EWS) and Lower Income Group (LIG) categories as per Report of the Technical Group on urban housing shortage (TG-12) (2012-17) constituted by Ministry of Housing and Urban Poverty Alleviation. As per projections of McKinsey Global Institute, 38 million households will not be able to afford housing by 2030. These are the challenges that India needs to address on a priority basis and rightly so. 'Affordable Housing for All' to cater to the need of the growing urban population and to prevent proliferation of slums has been an objective of the National Urban Housing and Habitat Policy 2007, published by Ministry of Housing and Urban Poverty Alleviation, Govt. of India. The ultimate goal of the policy is to ensure sustainable development of all urban human settlements duly serviced by basic civic amenities for ensuring better quality of life for all urban citizens.

Importance of Housing and Real Estate Sector

The urbanization and growth of housing and real estate sector as a by-product is

very strongly correlated to the macro economy of a country. The Real Estate Sector is the second largest employer, next only to agriculture. Investments in this sector not only help expand the existing stock of housing units, but also improve the working and living conditions of citizens. It generates a significant share of employment as well. Owing to the significant forward and backward linkages of the housing and real estate sector, it has a strong multiplier effect on the overall economy.

According to estimates, housing ranks fourth in terms of the multiplier effect on the economy, ahead even of transport and agriculture in India. Performance of real estate sector has an effect on as many as 250 industries directly and indirectly ranging from steel, cement, paint etc. and a contributor of about 10% of GDP to the country's economy. However, India's real estate sector continues to struggle with manpower shortage. By 2022, Real Estate alone will need 30% of the human resources i.e. 24.98 million as projected by National Skill Development Corporation. So, affordable housing for the ever-increasing human resource, vital for urban growth is of utmost importance. In view of this technological innovations and thrust on building technologies in the Indian Housing and the Real Estate Sector is the need of the hour.

Interventions of Ministry of Housing & Urban Poverty Alleviation

Government of India has brought in various policy/programmes/schemes for sustainable urban development such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and the recently launched Rajiv Awas Yojana (or Rajiv Housing Scheme), Rajiv Rinn Yojana (or Rajiv Loan Scheme), Affordable Housing in Partnership Scheme and National Urban Livelihoods Mission with a total outlay of over Rs. 42,000 Crore in the next 4 years. The lessons learnt during implementation of these schemes/programmes in various parts of the country and continuous interactions with stakeholders like Association of Engineers, Associations of Real Estate Developers, Associations of Industries, legal and technical experts, policy makers and programme implementing agencies through seminars/workshops are used to gain new perspectives to bring in reforms.

The Real Estate Sector and its Aspirations

A key issue that acts as a deterrent to the participation of private real estate developers in the low-income group segments of affordable housing is the complex and unpredictable approval procedure. Considering the importance of the issue, a separate committee was set up by the Ministry and the findings have been submitted by the committee. A recommendation of the committee to develop an Automated Single-window Web-based Approval System is being explored very actively. The recommendations relevant to Ministry of Environment and Forest (MoFE) have already been referred to them for taking corrective action. The un-

equivocal demand of the Industry for having an online Single Window mechanism has been well taken and options for remedial measures are being seriously worked out. In parallel, a draft Affordable Housing Policy to provide necessary push to affordable housing in the country is also being prepared based on the recommendations of the Task Force on Affordable Housing.

Another very important regulatory issue that we are working on and is most relevant to Real Estate sector is Real Estate (Regulation and Development) Bill, 2003. The bill has been introduced in the Parliament recently which has been referred to a Standing Committee of Parliament. The bill intends to bring transparency in contractual obligations. It will ensure consumer protection and promotion of the Real Estate sector through effective regulation and introduction of speedy mechanism for adjudication of disputes. This is a pioneering legislation which shall instill standardization and professionalization in the sector thereby catalyzing domestic and foreign investments without adding another layer of approvals. The concerns of the industry have also been taken into account while formulating this comprehensive legislation.

We are aware that the Real Estate Sector today is facing various challenges like dried up domestic capital, inflation in input costs and shortage of skilled professionals etc. The Government of India has allowed Foreign Direct Investment (FDI) through automatic route in construction and development sector. In addition, External Commercial Borrowings (ECB) for affordable housing and slum rehabilitation projects has also been allowed.

With favourable demographic factors and increasing economic growth, India is rising as an important destination for businesses particularly for the services sector. Naturally, the country is becoming an attractive place for real-estate investors; given that requirement for real-estate is a function of expansion of business activities and trends in demographic growth. As the second most populous country on the globe and large gap in supply of housing, India therefore has massive requirements for housing and infrastructure.

As per the Department for Industrial Promotion and Policy, the Construction and Development Sector – for development of townships, housing, built-up infrastructure and construction-development related projects got Rs. 10,121 Crore (US\$ 22 billion) from April 2000 to April 2013 which is 11.30% of the net FDI inflow of equity (next only to Banking sector 19.16%). While ECB has been opened for Affordable Housing Projects finance with effect from December 2012, so far applications from 3 private developers and 3 HFCs have been received for a total of US\$ 804.20 million.

The other initiatives taken by Government of India in the recent past to fa-

facilitate greater flow of credit/funds to affordable housing segment include: creation of Credit Risk Guarantee Fund (CRGF), and Urban Housing Fund (UHF).

Need of Innovative Technology in the New Built Environment

The building construction costs have been increasing in the last decade at very fast pace. There is a need to adopt appropriate, cost-effective building materials and technologies for constructing affordable, strong, durable, functional and aesthetically pleasing houses. With the latest technological improvements and structural transformations, building technology is also changing rapidly. Technologies, which are environment friendly, ecologically appropriate and energy saving should be increasingly adopted for the future built environment.

It is important to focus on Green Building Technologies for sustainable development. A Green Building has to be designed, built, renovated, operated or re-used in such a manner that it protects the health of occupants, improves employee productivity; uses energy, water and other resources more efficiently as well as reduces the overall impact on the environment. Government of India through Building Materials and Technology Promotion Council (BMTPC) is propagating green technologies which are primarily based on prefabrication such as Panel building system Glass Fibre Reinforced Gypsum (GFRG)/ Rapidwall Building System etc. which are not only cost effective but are also eco-friendly. In order to popularize these and other local technologies, Government of India is trying to revive building centres and also getting the new technologies in the Standard Schedule of Rates (SoR) of the CPWD etc.

BMTPC has also been implementing Performance Appraisal Certification Scheme (PACs) for giving independent opinion of the fitness of new building technologies/systems as a third party certification for certifying the performance. BMTPC has issued PACs on three of the emerging technologies which are useful for mass housing namely Rapid Wall building System, Monolithic Construction using Plastic Formwork and Aluminium Formwork.

In addition to the above, BMTPC have identified five new technologies viz. Panel building system, Technology using expanded steel mesh panels, Polystyrene beads and alleviated concrete, Pre-stressed precast prefab technology using hollow core slab, beams, columns, solid walls, stairs, etc, Industrialized 3-S system using cellular light weight concrete slabs and precast columns, Precast concrete panels system using concrete, welded mesh and plates, polystyrene core. It is working on promoting these technologies through certification and inclusion of the same in SoR.

The real estate industry and the technological innovations in India are yet to evolve a perfect balance between affordable houses which are environmentally

sound and cost effective. It is imperative for the industry leaders to understand the feasibility of cost-effective construction technologies used worldwide for mass housing and work towards adoption of them to bring affordable housing stock to the market.

India needs robust growth of real estate sector for economic growth and to meet the demand of urbanization. Here, the private sector developers in real estate sector have a big role of play. Low budget housing, when subjected to mass production is not only a solution for cost-effective construction but also a great business opportunity with a social cause.

Preparing Skilled Work Force for the New Built-Environment

In terms of technical skills, we all know that there are numerous institutions for Architect and Engineers in India that produce a large number of technocrats specially Engineers, as given below.

Present Status of Skill : The total number of engineers in 2010 are approximately 7,93,321 nos, one engineer per 1000 people which indicates availability of sufficient technical work force. India has 348 universities and 17625 colleges of higher education and 15222 degree granting engineering colleges. However, the employability of engineers is only 25% for India, whereas it is 80% for Germany, UK or USA.

The deficiencies in various faculties of human resources in India have been brought out by a Study of Deptt. of Business Enterprises and Reliability Reforms, as shown below which is a matter of concern:-

Deficiency of Various Faculties of Human Resources

| | | | |
|--------------|-----|-----------------|-----|
| Mathematical | 14% | Problem Solving | 18% |
| Technical | 14% | English | 13% |
| Reliability | 33% | Team Work | 25% |
| Managerial | 26% | Leadership | 30% |

Accordingly, a Deloitte study has revealed that there are a lot of difficulties in attracting various categories of talents in India, which may be seen from the table below

Deficiency of Talents

| | | | |
|---------------------|-----|------------------|-----|
| Managers | 30% | Skill Production | 15% |
| R & D | 30% | Engineers | 23% |
| Sales and Marketing | 26% | | |

Shortage of Skilled Manpower

The construction sector has a significant bearing on productivity in Indian cities. In spite of the significant housing shortage, India's real estate sector continues to struggle with manpower shortage. In its report on the human resource and skill requirements for building construction and real estate services, the National Skill Development Corporation (NSDC) has projected that for 2022 the human resource and skill requirement will be 83.27 million people. Real Estate (Housing & Buildings) alone will need 30 per cent of the projected human resources (at 24.98 million); if the requirements of allied infrastructure such as electricity, irrigation, roads, bridges and railways is added, this goes up to nearly 87 per cent of the projected human resources (at 72.07 million). This reflects a huge requirement of skilled work force in general and for construction/real estate sector in particular.

Global Standard-Competing at Global Level

So, contrary to the popular view that China and India have an abundance of engineers, the above noted study shows that both countries may actually face severe shortages of what are described as dynamic engineers, as the vast majority of graduates from these countries have the qualities of transactional engineers. This is a further contributing factor to the low number of Chinese and Indian engineering graduates that can be deemed as globally competitive.

Dynamic engineers are described as being abstract thinkers with high levels of innovative and problem solving skills. These types of engineers work well in teams and possess strong interpersonal skills, and are trained to be globally competitive. In contrast, transactional engineers possess solid technical training, but not the experience or expertise to apply their knowledge to larger domains. Transactional engineers are typically responsible for routine tasks in the workplace, and are often produced by lower-tier universities, with a thinner curricula and weaker emphasis on research, group work, applied engineering and interdisciplinary thinking.

There is another noticeable aspect in National Sample Survey Organisation (NSSO) data which is of greater casualisation of labour among both males and females significantly rising from 32.1% (2004-05) to 36.2% (2009-10). The increased casualisation, up from 17.7% to 19.7% amongst the urban youth indicates in the same period that most of the new employment is of casual nature in urban areas. In the last eight to ten years, most of the job addition has occurred in the informal sector, but even within the formal sector a greater contractualisation of labour has taken place. As long as contractual labour is able to find continuous employment and has skill levels that can be flexibly adapted to changing situations, increase in casual labour trend may not be particularly bothersome, but if this category is unable to find decent work with decent remuneration on continuous basis, they will create similar pressures as the unemployed youth.

The share of agriculture in total youth employment has steadily declined from 55.4% (2004-05) to 49.6% (2009-10) while youth employment has increased in sectors like construction, including electricity, gas and water supply, 6.8% to 11.3%; transport, storage and communications from 4.8% to 5.6% and real estate etc. from 1.9% to 2.8% during the same period. This explains that the nature of new jobs is changing, clearly pointing towards specific skill requirements or specialization.

Conclusion

The Ministry of Housing and Urban Poverty Alleviation, Government of India, is committed to the development of Housing and Real Estate sector and keen to bring reform to the areas which are crucial for the development of housing and Real estate sector. Indian Buildings Congress being a professional organization having engineers with vast professional experience as members and working for Training/Capacity building in construction sector may be partners of our Ministry in playing crucial catalytic role in improving the built environment in our country. The need is to have a global perspective and a will to bring a paradigm shift in adopting construction technology and in creating business opportunity in a changed environment.

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Confined Masonry Construction for India: Prospects and Solutions for Improved Behaviour

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S.K. Bhattacharyya

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Prologue

Around 85% of existing building stock in India comprise of masonry structures which have poor record of performance in earthquakes. Very few experimental efforts have been made to seismically evaluate the technology in the country.

Shri S.K. Bhattacharyya who has done extensive work in the field of innovative technologies and his co-author have come forward with an alternative technology 'Confined Masonry (CM) Construction' that performs well in earthquake if built properly. The authors, through this paper have shown their efforts to analyse experimental data and performance of CM Building in major earthquakes world over and highlighted the comparison of performance of different types of masonry buildings, viz unreinforced, reinforced and confined

masonry tested on a full scale model with lateral displacement in the Indian context.

The paper also focuses on failure characteristics of CM with a suggestive actions to improve seismic resistance and compares with codal provision of selected countries for design and construction of CM buildings, as a guideline for formation of Indian Code under varying conditions of materials, data and architecture.

A very interesting and comprehensive paper from one who has been at the helm of it.

- Editor-

Introduction

Masonry still finds wide use in today's buildings, in low-to-medium rise construction, than any other material. The success of brick masonry, in particular, is mainly due to its durability, sustainability, fire resistance, acoustic and thermal insulation characteristics and relative simplicity of realisation. However, Unrein-

forced masonry (URM) buildings, have proven vulnerable in seismic events, with significant building damage and numbers of fatalities, world-over, including India. In addition, most of the masonry housing construction does not comply with codes and constructed without participation of trained engineering professionals. To increase the seismic resistance of masonry, different methods for reinforcing masonry have been attempted over the years, and led to the concept of reinforced masonry (RM) and confined masonry (CM) systems.

The issue of seismic performance and safety of existing masonry buildings is characterized by numerous uncertainties and in some cases real lack of codal provisions e.g. confined masonry, in India. This paper presents insight into the subject of confined masonry, analysing experimental data available in the literature and performance of CM buildings in major earthquakes, focusing failure characteristics with a suggestive actions to improve seismic resistance, and compares the codal provisions of selected countries for design and construction of CM buildings. It is expected that this paper stimulates researchers and code-developers of India in earthquake engineering community towards confined masonry as a structural system

Masonry Construction Scenario In India

Masonry construction is commonly adopted in India, both in rural and urban areas. Special characteristics of masonry construction are due to bias towards locally available material, limitations of construction skills, and constraints to construction activity. According to the Census of India in 2001 and 2011 (Housing data), the distribution of houses based on predominant materials of wall is shown in Table-1. As can be observed from the table that, in India, there were 249 and 304 million houses in the year 2001 and 2011 respectively, comprising around 85% masonry houses. Also there is decline in proportion of mud/unburnt bricks, wood, GI/metal sheet houses in 2011 as compared to 2001, with appreciable increased use of burnt clay units in masonry. Due to socio-economic constraints some of the buildings are with unburnt solid clay bricks or mud walls of 450-600mm thickness upto two storey as load bearing walls. Mostly, such houses do not have earthquake resistant features and become vulnerable even in small ground shaking. Past earthquakes have highlighted the inherent weaknesses of this type of construction and offer vivid demonstration of its vulnerability.

The wide band of variability in construction material, its mechanical properties, and workmanship exists across the country for masonry construction, which pose challenge to characterize the seismic behavior of such buildings in a quantifiable manner. For example bricks in Gangetic belt have elastic moduli in the range

of 1500 to 4000 MPa (compressive strength varies between 10 to 19 MPa) while bricks in South India have moduli in the range of 400 to 1000 MPa (compressive strength between 3 to 9 MPa). This must be compared with the strength of brick in the UK and US, which has average compressive strength of bricks as 100 and 75 MPa respectively.

The excessive use of cement based mortar (cement:sand, cement:stone dust:sand) have led gradual exclusion of lime mortar in recent construction. The mortar composition for masonry varies based on wall thickness, construction practice etc. Generally, cement-sand mortar of 1:6 proportion by volume is adopted for 220 mm thick masonry walls while richer mix of 1:4 is used for 115 mm thick non-load bearing (partition) walls. The mortar thickness in masonry ranges between 10-15 mm in masonry works. The masonry buildings are either founded on stone masonry, brick masonry stripped footing, plain concrete or in rare occasions of reinforced concrete for typically one to four storey buildings having 3-3.6 m storey height. The roof of such construction are either of wooden truss with GI sheets or clay tile or RCC slab, while floors are either of RCC slab, or wooden logs (as beam) with mud/RC floors, simply resting over walls. Further, majority of masonry construction is built by rules of thumb and traditions of construction technology that are handed down from one generation to the next. This has resulted in increasing vulnerable building stock in the country, and opening a large window for a promising masonry construction technology, confined masonry, which performs well in seismic events, if built properly.

Confined Masonry

Confined masonry is a structural system consisting of unreinforced masonry wall panels surrounded by lightly reinforced horizontal and vertical “confining” RC members. In some cases, the masonry units are staggered or “toothed” at tie column locations to create better interlock between the masonry and RC member. In confined masonry buildings, masonry walls are erected first and concrete in column is cast later in stages with a height of 1.0 m. The sequence of construction of confined masonry building is shown in Fig. 1. In India, generally building storey height is ranging between 3.0m-3.6m, and the door/window top levels are at 1.9m to 2.1m, with RCC slab as flooring/roofing system providing rigid diaphragm action. The RC diaphragm is adequately connected with tie-column, and to confine masonry in between lintel and roof level, it is preferred to provide tie beam at lintel level. The structural detail of typical CM building, as per EC8 requirements is shown in Fig.2 along with its view in Fig. 3.

Table-1: Houses by Material of Walls in India in 2001 and 2011*

| | Total census houses | Mud, Un-burnt brick units | | Wood | | GI, Metal, Asbestos Sheets | | Burnt Brick | | Stone | | Concrete | | Any other material | |
|-----------|---------------------|---------------------------|------|---------------|-----|----------------------------|-----|---------------|------|---------------|------|---------------|-----|--------------------|------|
| | | No. of Houses | % | No. of Houses | % | No. of Houses | % | No. of Houses | % | No. of Houses | % | No. of Houses | % | No. of Houses | % |
| Year 2001 | | | | | | | | | | | | | | | |
| Total | 249,095,869 | 73,799,162 | 29.6 | 3,196,992 | 1.3 | 1,998,678 | 0.8 | 111,891,629 | 44.9 | 25,481,817 | 10.2 | 6,540,338 | 2.6 | 26,187,253 | 10.5 |
| Rural | 177,537,513 | 65,807,212 | 37.1 | 2,363,200 | 1.3 | 876,677 | 0.5 | 62,715,919 | 35.3 | 20,347,899 | 11.5 | 2,253,979 | 1.3 | 23,172,627 | 13.1 |
| Urban | 71,558,356 | 7,991,950 | 11.2 | 833,792 | 1.2 | 1,122,001 | 1.6 | 49,175,710 | 68.7 | 5,133,918 | 7.2 | 4,286,359 | 6.0 | 3,014,626 | 4.2 |
| Year 2011 | | | | | | | | | | | | | | | |
| Total | 308,882,448 | 66,449,827 | 21.8 | 2,781,271 | 0.9 | 2,331,869 | 0.8 | 146,545,805 | 48.1 | 43,482,932 | 14.2 | 10,983,679 | 3.6 | 32,307,065 | 10.6 |
| Rural | 206,563,690 | 58,330,614 | 28.2 | 2,132,342 | 1.0 | 1,269,359 | 0.6 | 83,618,346 | 40.5 | 28,685,790 | 13.9 | 3,699,096 | 1.8 | 28,828,053 | 14.0 |
| Urban | 98,318,758 | 8,119,213 | 8.3 | 648,929 | 0.7 | 1,062,510 | 1.1 | 62,927,369 | 64.0 | 14,797,142 | 15.0 | 7,284,583 | 7.4 | 3,479,012 | 3.5 |

*Censuses of India 2001,2011 Housing Data

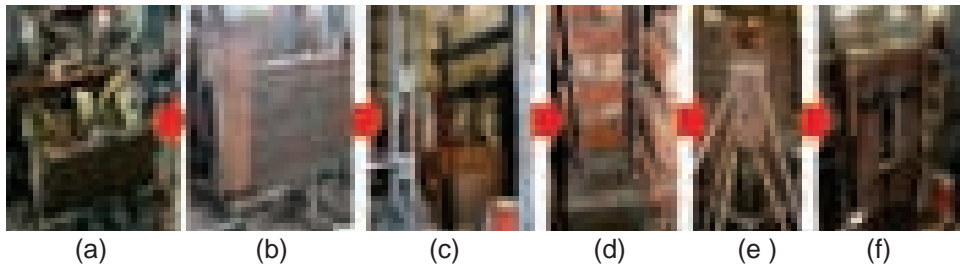


Fig. 1: Sequence of Construction of Confined Masonry Building

(a) construction of masonry wall with provision of reinforcement in tie column
 (b) providing shuttering on two faces of tie column (c) casting of tie column followed by subsequent masonry (d) provision of keys in concrete and masonry for better bonding of concrete with masonry (e) subsequent shutting of tie column (f) completed confined masonry model

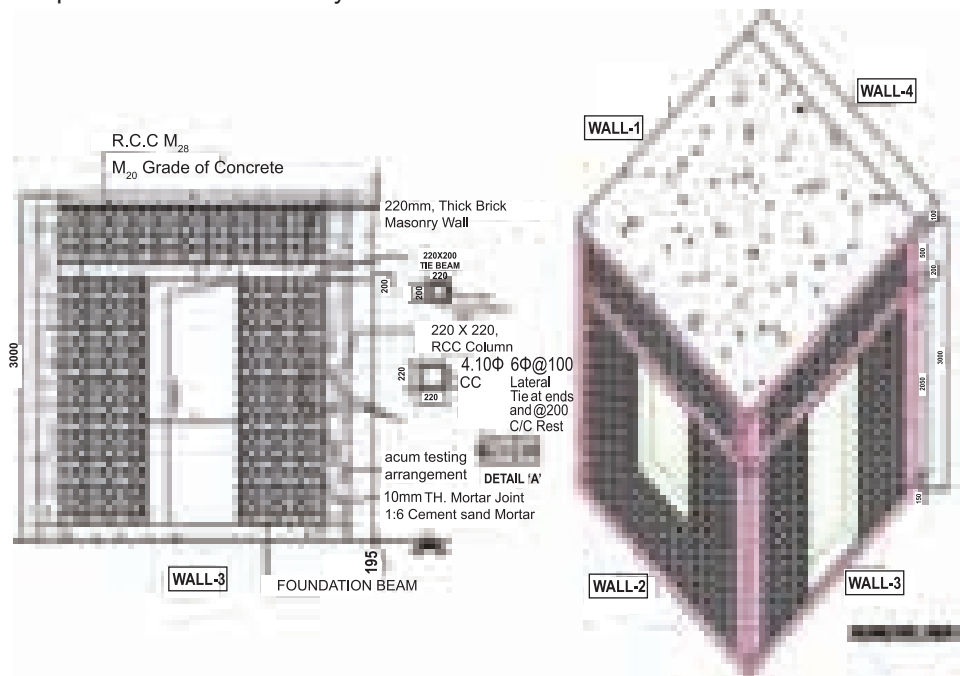


Fig. 2: Structural Details of Confined Masonry Building

Performance of Confined Masonry in Past Earthquakes

The confined masonry buildings generally performed satisfactorily in past earthquakes within the framework of seismic design philosophy. A few of the ma-



Fig. 3: View of Confined Masonry Building

for earthquakes around the world, demonstrating together with good and poor CM construction practices are: Colombia Earthquake (25 January 1999- $M_w=6.2$); Mexico Earthquake (30 September 1999- $M_w=7.5$); El Salvador Earthquake (13 January 2001- $M_w=7.6$); Colima, Mexico Earthquake (21 January 2001- $M_w=7.6$); Atico, Peru Earthquake (23 June 2001- $M_w=8.4$); Bam, Iran Earthquake (26 December 2003- $M_w=6.6$). The typical damage patterns observed are: shear failure of walls; shear and bending failure at ends of tie column; separation of tie column from walls; and inadequate wall densities in two orthogonal directions. The predominant reasons of failure in CM buildings are attributed to: missing / large spaced tie columns; inadequate anchorage of reinforcement of tie beam and column; largely spaced lateral ties in column; large aspect ratio of masonry panel; asymmetric distribution of walls in plan; poor workmanship and quality of materials used. None of the case of foundation failure of CM buildings has been reported. Nevertheless, confined masonry construction, if constructed properly, generally shown a good seismic performance and no significant damage during these earthquakes.

Experimental Tests on Confined Masonry

The behaviour of confined masonry walls under lateral cyclic loading have been widely evaluated by several researchers such as Tomazevic, M. et al. (1988, 1997, 2000, 2004, 2007, 2009); Wijaya, W., et al. (2011); Gouveia, J. et al. (2007); Yoshimura, K. et al. (1996, 2000, 2003, 2004); Zabala F. et al. (2004); Yanez F.

et al. (2004); Marinilli, A. (2004); Kumazawa, F. et al. (2000); Aguilar, G. et al (1996); Meli, R. (1973); and Umek A. (1971). The examples of full-scale test on shake-table are by Tomazevic, M. et al. (1996), Kazemi, M.T. et al (2010), while quasi-static test procedure was adopted by Agarwal, S.K. et al. (2007) for URM and RM models and Chourasia, A. et al. (2013, 2014) for CM model.

The review of experimental results and performance of CM buildings in past earthquake shows a complex global behaviour. The diverse behaviour of the reported results is mainly due to diagonal shear failure, however, in some cases flexure failure at initial stage within elastic limit has been noticed which may be attributed to low vertical loads. More interestingly it is observed that, in higher number of storey in CM buildings, deformation and damages are concentrated at first storey showing shear failure (Tomazevic, M., 2007). It is also noted that failure mechanism is strongly dependent on horizontal reinforcement ratio, leading to uniform distribution of cracks in masonry. In general, the brittle behaviour of hollow clay bricks /concrete block has been observed as compared to solid clay brick units. However, different CM buildings are of varying material and geometrical configuration, local tradition, and are not fully representative of Indian architecture. For this reason, a comprehensive masonry test programme was undertaken in Indian context at CSIR-CBRI, aiming to evaluate the seismic behaviour of indigenously built masonry buildings during earthquake. A full-scale test on one room size masonry model 3.01x3.01m in plan and 3.0m high, has been conducted under quasi-static cyclic lateral displacements of different types of construction practices prevalent. The three types of masonry buildings tested are in unreinforced masonry (URM), reinforced masonry (RM) and confined masonry (CM). The load-deflection envelope of different masonry models i.e. URM, RM and CM, is shown in Fig. 4. The overall observation shows major improvements in seismic performance of CM building over URM and RM. Some of the features are: increase in strength and ductility; enhancement in connections between walls; improvement in stability, integrity and containment of masonry walls; and higher energy dissipation capacity.



Fig. 4: Comparison of Average Lateral Load-Deformation Envelope for Different Masonry Systems

Table-2: Actions for Improving Seismic Resistance for Typical Damages in Confined Masonry

| Modes of Failure | Damage Characteristics | Influential Factors | Prevalent Circumstances | Approach for Improving Seismic Resistance |
|---|--|---|---|--|
| In-plane Structural failure modes Diagonal Shear Failure | Initiation of diagonal cracks in middle of wall and/or at opening corners. | Shear and tensile strength of masonry units. | Walls that are parallel to the direction of motion. | Increase shear and tensile strength of individual panel materials. |
| | | Brick-mortar bond strength. | | Increase masonry-mortar bond strength. |
| | Extension of initial diagonal crack along the principal diagonals through mortar joints and/or masonry units (smeared cracking), depending upon the relative strength/stiffness of the material. | Masonry unit compression strength and mortar shear/tensile strength | | Use higher compressive strength masonry units. |
| | | Tie column shear strength. | | |
| | | Tie column rebar anchorage. | Panels that are under the influence of significant lateral and vertical forces (first story walls). | Improve the tie column shear resistance. |
| | Crushing/cracking in tie column ends, leading to shear failure. | Axial load | | Adequate distributed confinement in panels. |
| | | Tie column-masonry wall interface shear capacity. | | |
| | Masonry crushing in middle of the panels or at corners; eventually splitting apart of wall along main diagonal. | Number of tie columns | Well-proportioned panels | Increase masonry wall-tie column interface shear transfer. |
| | | Tie column spacing. | | Provide sufficient wall density in both principal directions. |
| | | Wall density (length and thickness of the panels). | | Openings: minimize size/number, carefully locate, confine. |
| In-plane Structural failure modes Diagonal Shear Failure | Separation of masonry panels and tie columns their vertical interface. | Size and location of wall openings. | | Improve quality of construction and workmanship. |
| | | Workmanship. | | Provide wire reinforcement in the horizontal mortar. |

| In-plane Structural failure modes Diagonal Shear Failure | | | | |
|--|--|---|---|---|
| In-plane Bending Failure | Tension zone: Horizontal cracks in mortar joint at base of panel | Wall aspect ratio (walls with large panel heights and small panel lengths are susceptible). | Walls with high aspect ratios (bending behaviour dominates shear behaviour). | Construct panel with aspect ratios near 1. |
| | Compression zone: masonry crushing. | Masonry compression strength. Mortar tension strength. | This type of failure is not common for well-confined walls that are properly interconnected with tie columns. | Use high tensile capacity mortar & high compressive strength units. |
| | Horizontal bending cracks in tie column. | Tie column-masonry wall interface shear capacity. Vertical load (counteracts for tension stress from bending). | | Provide grooves at tie column and masonry interface Provide tie columns with sufficient longitudinal reinforcement. Provide connection dowel at tie column-masonry wall interface-400mm spaced vertically |
| | Horizontal cracks in mortar joints in panels and into tie columns. | Shear and tensile strength of mortar. Bond strength of masonry. Workmanship and construction quality. Vertical load (contributes to frictional resistance of joints) | | Use mortar with adequate shear resistance. Increase unit-mortar bond strength. |
| Sliding Shear Failure | | Workmanship and construction quality. | Walls that are under the effect of low axial loads but relatively high shear forces. | Provide panels with a sufficient number of tie columns of adequate shear strength. |
| | | Structural wall density. Tie column shear strength. | | Do not interrupt walls with large unconfined openings. |
| | | Number of tie columns. | | Improve quality of construction and workmanship. |
| out-of-plane structural failure modes | Vertical out-of-plane failure | Mortar tensile strength. | Perpendicular walls that to the direction of motion. | Use high tensile strength mortar. |
| | | Wall slenderness ratio (h/t). Distance between lateral supports. Stiffness of the bond beams. | High H/t (height/thickness) ratio of walls. Walls with closer spacing between floors/roof. | Decrease slenderness ratio of wall. Provide stiff bond beams that are properly connected to both panels and diaphragms. |
| | | Connections - wall to bond beam and bond beam to diaphragm | Walls with flexible roof bond beams. | Reduce the magnitude of force transferred vertically out-of-plane by reducing distance between intersecting walls. |
| | | Vertical loads | Upper story panels with lower vertical stress | |
| | Collapse of wall and subsequent collapse of roof/floor. | | | |

| Modes of Failure | Damage Characteristics | Influential Factors | Prevalent Circumstances | Approach for Improving Seismic Resistance |
|---------------------------------------|---|---|--|--|
| out-of-plane structural failure modes | Horizontal out-of-plane failure | Mortar tensile strength. | Walls that are perpendicular to the direction of motion. | Use mortar with high compressive and bond strength. |
| | | Tie column-masonry wall bond strength. | Walls with poor masonry-to-tie column connections. | Reduce the panel length-to-thickness ratio. |
| | Collapse of wall and subsequent collapse of roofs/floors if supports. | Wall length-to-thickness (L/t) ratio. | Long, thin walls. | |
| | | Connections (wall to tie column & tie column to intersecting wall). | Walls with flexible corner tie columns. | Provide stiff tie columns that are properly connected to both masonry panels and intersecting walls. |
| Diaphragm Failure Modes | Cracking / buckling of diaphragm panels. | Tie columns stiffness at corner wall intersections. | Walls with much less distance between intersecting walls. | |
| | | Type of diaphragm system. | Irregular buildings with large projections, recesses/cut-outs. | Regular walls in plan. |
| | Rotation of diaphragm panels. | Material strength and workmanship. | Buildings with heavy roof/floors. | Good workmanship and materials. |
| | | Building configuration and regularity. | Building with flexible diaphragms. | Adequate detailing of connections between diaphragm components. |
| Connection Failure Modes | Tie Column-Bond Beam | Adequate connections between different diaphragm components. | Building with long distance between lateral diaphragm supports. | |
| | | Strength, size and configuration of horizontal trusses for wood floor/roof. | Buildings with poor diaphragm connections. | Place lateral diaphragm supports at reasonable distance. |
| | | The distance between diaphragm lateral supports. | Buildings with wood plank diaphragms not reinforced with horizontal trusses. | Effective diaphragm system for transferring internal loads. |
| | | Rigidity of the flooring/roofing system. | | |
| | Wall-Tie Column | Shear resistance of tie columns. | Tie column-bond beam joints with improper detailing (Longitudinal rebars do not have adequate anchorage in tie beam / diaphragm. | Anchor longitudinal rebar of tie column into tie beam/diaphragm. |
| | | Reinforcement detailing. | | Closely spaced lateral ties in column at ends and in joints. |
| | | Workmanship. | | Reduce the distance between tie columns and increase wall density. |
| | | Capacity of Tie column-masonry wall at interface. | Panels with high H/t or L/t ratio, with too few tie columns. | Interlock tie column and masonry by toothing. |
| | Horizontal out-of-plane failure of the panel. | Spacing of tie columns. | Low quality mortar | Provide connections rebars across the wall-tie column interface. |
| | | Amount of force transferred by connection. | Inadequate bond between tie column and walls. | Increase wall density and reduce the distance between tie columns. |

| Connection Failure Modes | Diaphragm Wall | Cracking along the diaphragm-bond beam interface. | The magnitude of loads being transferred. | Large connections loads must be transferred. | Detail the connections between panels and diaphragms. | |
|--|--|---|---|--|---|---|
| | Partition Walls | In extreme cases, diaphragm can slide off the building. | Workmanship and connection detailing. | Improper connection detailing. | Keep story height and the distance between diaphragm lateral supports reasonable. | |
| | | Vertical out-of-plan failure of the masonry wall panel. | The distance between lateral diaphragm supports. | Excessive distance between lateral diaphragm supports. | Provide the building with sufficient wall density. | |
| | | Vertical out-of-plane behavior, horizontal cracking at the base, mid-height and top; if wall is not laterally connected at top. Horizontal cracking concentrated at wall base. | Walls not confined with tie-column and bond beams, with no vertical load. | Slender partition walls. | Connect partition walls adequately to their lateral supports. | |
| From horizontal out-of-plane behavior, vertical or stepped cracking at wall ends and mid-length. | Partition walls with improper connections to their lateral supports. | Reduce the distance between lateral supports/slenderness ratios. | | | | |
| Collapse of partition wall. | Partition walls with one free end. | Enhance bond with intersecting walls with dowel bar, toothing. | | | | |
| Non-Structural Failure Modes | Gable End Walls | Horizontal cracks from vertically out-of-plane bending. | Same as above, for partition walls. | Gable end walls not properly confined along borders. | Laterally connect top of gable end wall back to roof structure. | |
| | | Collapse of gable end wall. | | Long and high gable end walls. | Provide sloping bond beam on top of gables and extended tie columns upto sloping bond beam. | |
| | | Horizontal bending cracks from vertical out-of-plane behavior and collapse. | Confinement from bond beams and tie columns. | Heavy weight material used for gable end walls construction. | Replace gable end walls with lighter material. | |
| | Parapets | Horizontal bending cracks from vertical out-of-plane behavior and collapse. | Same as above, for gable end walls. | Tall and thin, unreinforced parapets constructed from heavy material. | Extended tie columns into parapet and cap (coping) with bond beam. | |
| | | | | Heavy covering with improper connections to their supporting roof /wall. | Limit the height of the parapets. | Replace masonry parapet with lighter materials. |
| | | | | | Use light weight roof coverings. | |
| | Roof Coverings | Detachment from the roof /wall. | Weight of cover materials. Connection detailing. | Heavy covering with improper connections to their supporting roof /wall. | Adequately connect roof covering to their supporting system. | |

The analyses of confined masonry experimental data and damages in past earthquakes have been carried out for understanding the behaviour and modes of failure. Table-2 is a compilation of the damage characteristics, failure mode, influential factors for the damage, and steps for improving the seismic resistance of confined masonry. It is expected that with these improvement in confined masonry construction practice, the risk of failure in seismic event further reduces. As confined masonry building construction uses the same materials and techniques, at only marginally high cost to that of URM with higher level of safety, there is ample opportunity to adopt this technology in India, as a feasible housing alternative.

Although the evolution of confined masonry is essentially through an informal process, it needs to be incorporated in formal construction by mean of codal requirements, design procedures (preferably simplistic approach), based on experimental evidences of Indian masonry and architecture, which is non-existence at present in the country.

Codal Comparison

Due to lack of masonry design practice, and limited experimental data of confined masonry, there are no codal provision in India and hence there are reservations in using the CM technology in the field. Internationally, good design rules are given by codes in South America (Colombia, Peru, and Mexico) and Europe (EuroCode EU-06,08). To formulate efficient design and construction guidelines / provisions of confined masonry in Indian standards, comparison of design criteria in various codes have been made. Table-3 compares the expressions to compute in-plane and out-of-plane resistance of wall to shear, flexure and compression. It has been noticed that, EU code estimates shear resistance as sum of the resistance contributed by masonry and the concrete of confining column, without consideration of resistance offered by reinforcement in tie-column. Similar is the case for axial and bending resistance, whereas Mexico code accounts for the resistance to bending given by reinforcement in confining elements.

Table-4 shows the comparison of computation of lateral strength of confining elements viz. compressive diagonal, tie-column, and bond-beam, by different codes. It has been noticed that, these parameters are estimated only by the codes of Colombia and Peru. The fact that crack control criteria is only suggested by Peruvian standard, it may be attributed that the other codes do not account for the contribution of tie-column and bond-beams in lateral resistance in CM building.

In Table-5, requirements of minimum sections of confining element and reinforcement are compared. Only Peruvian codes give the minimum section dimensions as a function of shear force, while other codes suggest minimum section size as 0.02 sqm. Similarly, codes of Colombia and Peru give minimum values of longitudinal reinforcement in tie-column as a function of lateral force, while other codes suggest minimum requirements of steel in confined elements.

In spite of the fact that specific national code regulations are essential for use of such constructions, the above comparison shall stimulate researchers and code-developers in India in earthquake engineering community to focus attention to confined masonry as a structural system and draw a road-map for the country.

Table 4: Comparison of Design of Confining Elements by Different Codes

| Confined Masonry Element | Country | | | |
|--------------------------|---------|---|--|-----------|
| | IS | Colombia | Peru | Mexico |
| Compressive strength | | $f_{cd} = \frac{f_c}{\gamma_c}$ $f_{cd} = 0.85 f_c$ | Compressive strength is conservatively assumed equal to that of concrete | 0.6 f_m |
| Reinforcement | | $\rho_{min} = \frac{f_{yk}}{f_{yk} + f_{cd}}$ | Reinforcement: $\frac{f_{yk}}{f_{yk} + f_{cd}}$ Stirrups: 1.0% Compressive: 0.5% | |
| Development | | $\rho_{min} = \frac{f_{yk}}{f_{yk} + f_{cd}}$ | $\rho_{min} = \frac{f_{yk}}{f_{yk} + f_{cd}}$ | |
| Crack control | | | $\rho_{min} = \frac{f_{yk}}{f_{yk} + f_{cd}}$ | |

Conclusion

The goal of the present paper is to develop a framework that provides the essential information to construct confined masonry buildings with good seismic resistance, considering the scenario of masonry buildings in India. To meet the objectives, extensive reported experimental data and damages of CM buildings in major earthquakes, are analysed to express its seismic behaviour and influential factors thereof. Also, the test results of full-scale single story different masonry buildings viz. URM, RM, CM, in Indian context, under quasi-static fashion have also been taken into account along with comparison of CM buildings design rules of selected countries, to give direction to draw Indian code. The conclusions drawn are:

- In the present masonry building scenario and its vulnerability in India, confined masonry shows much promise as a technology that performs well in earthquakes, if built properly.

Table 5: Comparison of Requirements of Confining Elements by Different Codes

| Sl. No. | Name of the Candidate | Roll No. | Grade | Subject | Score | Remarks |
|---------|-----------------------|----------|-------|---------|-------|---------|
| 1 | ABHIRAM K | 101 | 10 | Maths | 85 | |
| 2 | ADARSH K | 102 | 10 | Maths | 78 | |
| 3 | ADITHYAN K | 103 | 10 | Maths | 92 | |
| 4 | ADITHYAN K | 104 | 10 | Maths | 88 | |
| 5 | ADITHYAN K | 105 | 10 | Maths | 75 | |
| 6 | ADITHYAN K | 106 | 10 | Maths | 82 | |
| 7 | ADITHYAN K | 107 | 10 | Maths | 79 | |
| 8 | ADITHYAN K | 108 | 10 | Maths | 86 | |
| 9 | ADITHYAN K | 109 | 10 | Maths | 81 | |
| 10 | ADITHYAN K | 110 | 10 | Maths | 84 | |
| 11 | ADITHYAN K | 111 | 10 | Maths | 87 | |
| 12 | ADITHYAN K | 112 | 10 | Maths | 83 | |
| 13 | ADITHYAN K | 113 | 10 | Maths | 80 | |
| 14 | ADITHYAN K | 114 | 10 | Maths | 85 | |
| 15 | ADITHYAN K | 115 | 10 | Maths | 82 | |
| 16 | ADITHYAN K | 116 | 10 | Maths | 86 | |
| 17 | ADITHYAN K | 117 | 10 | Maths | 81 | |
| 18 | ADITHYAN K | 118 | 10 | Maths | 84 | |
| 19 | ADITHYAN K | 119 | 10 | Maths | 87 | |
| 20 | ADITHYAN K | 120 | 10 | Maths | 83 | |
| 21 | ADITHYAN K | 121 | 10 | Maths | 80 | |
| 22 | ADITHYAN K | 122 | 10 | Maths | 85 | |
| 23 | ADITHYAN K | 123 | 10 | Maths | 82 | |
| 24 | ADITHYAN K | 124 | 10 | Maths | 86 | |
| 25 | ADITHYAN K | 125 | 10 | Maths | 81 | |
| 26 | ADITHYAN K | 126 | 10 | Maths | 84 | |
| 27 | ADITHYAN K | 127 | 10 | Maths | 87 | |
| 28 | ADITHYAN K | 128 | 10 | Maths | 83 | |
| 29 | ADITHYAN K | 129 | 10 | Maths | 80 | |
| 30 | ADITHYAN K | 130 | 10 | Maths | 85 | |
| 31 | ADITHYAN K | 131 | 10 | Maths | 82 | |
| 32 | ADITHYAN K | 132 | 10 | Maths | 86 | |
| 33 | ADITHYAN K | 133 | 10 | Maths | 81 | |
| 34 | ADITHYAN K | 134 | 10 | Maths | 84 | |
| 35 | ADITHYAN K | 135 | 10 | Maths | 87 | |
| 36 | ADITHYAN K | 136 | 10 | Maths | 83 | |
| 37 | ADITHYAN K | 137 | 10 | Maths | 80 | |
| 38 | ADITHYAN K | 138 | 10 | Maths | 85 | |
| 39 | ADITHYAN K | 139 | 10 | Maths | 82 | |
| 40 | ADITHYAN K | 140 | 10 | Maths | 86 | |
| 41 | ADITHYAN K | 141 | 10 | Maths | 81 | |
| 42 | ADITHYAN K | 142 | 10 | Maths | 84 | |
| 43 | ADITHYAN K | 143 | 10 | Maths | 87 | |
| 44 | ADITHYAN K | 144 | 10 | Maths | 83 | |
| 45 | ADITHYAN K | 145 | 10 | Maths | 80 | |
| 46 | ADITHYAN K | 146 | 10 | Maths | 85 | |
| 47 | ADITHYAN K | 147 | 10 | Maths | 82 | |
| 48 | ADITHYAN K | 148 | 10 | Maths | 86 | |
| 49 | ADITHYAN K | 149 | 10 | Maths | 81 | |
| 50 | ADITHYAN K | 150 | 10 | Maths | 84 | |
| 51 | ADITHYAN K | 151 | 10 | Maths | 87 | |
| 52 | ADITHYAN K | 152 | 10 | Maths | 83 | |
| 53 | ADITHYAN K | 153 | 10 | Maths | 80 | |
| 54 | ADITHYAN K | 154 | 10 | Maths | 85 | |
| 55 | ADITHYAN K | 155 | 10 | Maths | 82 | |
| 56 | ADITHYAN K | 156 | 10 | Maths | 86 | |
| 57 | ADITHYAN K | 157 | 10 | Maths | 81 | |
| 58 | ADITHYAN K | 158 | 10 | Maths | 84 | |
| 59 | ADITHYAN K | 159 | 10 | Maths | 87 | |
| 60 | ADITHYAN K | 160 | 10 | Maths | 83 | |
| 61 | ADITHYAN K | 161 | 10 | Maths | 80 | |
| 62 | ADITHYAN K | 162 | 10 | Maths | 85 | |
| 63 | ADITHYAN K | 163 | 10 | Maths | 82 | |

- Confined masonry construction, if constructed properly, generally showed a good seismic performance and no significant damage during major earthquakes, worldwide.
- The failure mechanism of CM building under seismic actions is mainly due to diagonal shear failure. Flexural failure at initial stage within elastic limit occurs due to low vertical loads.
- In 3-5 storey CM buildings, deformation and damages are concentrated at first storey showing shear failure, hence calls for adequate checks for shear.
- CM buildings exhibited higher strength and ductility as compared to unreinforced and reinforced masonry buildings. The performance of Indian CM buildings over URM and RM in terms of strength showed about 3.42 and 2.63 times improvement respectively.
- The codal provisions applicable in South American and European countries having high seismicity, can be adopted as a guideline for formation of Indian codes. However, the same should be followed with a caution, especially in consideration to variation in Indian masonry material properties, experimental data in India and architecture. There is a need to check the capability of expressions for design of confining elements in predicting the Indian experimental response of confined masonry.

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Notations

European code

d = Diagonal length
 d_c = Transversal dimension of tie-column
 d_b = Transversal dimension of bond beam
 d_s = Diameter of the reinforcing steel
 t = Thickness of the masonry wall

Colombian code

A_{ci} = Total area of the transverse section of tie-columns
 A_e = Cross-section of the masonry wall
 A_{md} = Effective cross-section of the masonry wall
 A_{mv} = Cross-section of the masonry wall to determine shear strength
 A_s = Cross-sectional area of the longitudinal reinforcement of bond-beams
 A_{st} = Cross-sectional area of the longitudinal reinforcement
 M_n = Design bending moment of the confined masonry wall
 M_u = Ultimate bending moment of the confined masonry wall
 P_{nc} = Nominal compression load acting in tie-column, positive, N
 P_{nd} = Nominal compression load of the masonry
 P_{nt} = Nominal tension load acting in tie-column, negative, N
 P_u = Design compression load of the masonry wall, N
 P_{uc} = Design compression load acting in tie-column, positive, N
 P_{ut} = Design tension load acting in tie-column, negative, N
 Re = Coefficient that takes into account the slenderness of the elements under compression
 V_n = Design shear stress resisted by

the masonry, N
 V_{nc} = Nominal shear stress acting in the reinforcing concrete
 V_u = Maximum shear stress resisted by the masonry in ultimate limit state, N
 V_{uc} = Maximum shear stress resisted by the tie-column
 b = Thickness of the masonry wall, mm
 f'_c = Compressive strength of the concrete of confining elements
 f'_m = Compressive strength of masonry
 f_y = Yield stress of steel, MPa
 h' = Diagonal length, mm
 h_p = Height of confined masonry measured between bond-beams
 l_c = Length of confined masonry measured between tie-columns
 l_w = Total length of confined masonry
 t = Thickness of the masonry wall
 ϕ = Reduction strength coefficient

Peruvian Code

C_1 = Seismic coefficient
 F = Axial force in tie-columns produced by the bending moment
 L = Total length of confined masonry
 L_m = Total length of the highest confined masonry or $0.5L$
 M_e = Bending moment acting in confined masonry
 M_s = Distributed bending moment per unit length
 N_c = Number of tie-columns
 P_c = Sum of the gravitational loads
 P_g = Service gravitational load
 P_m = Maximum gravitational load
 T_s = Tension force
 U = Importance factor
 V_e = Shear force produced by moderate earthquake in the wall
 V_{et} = Shear force in the wall deter-

| | | | |
|---------------------|---|-----------|---|
| | mined in the elastic analysis | FE = | Coefficient of reduction that takes into account the slenderness and the eccentricity |
| V_m = | Shear strength of the confined masonry wall | FR = | Resistance factor |
| Z = | Zone factor | M_o = | Bending moment |
| a = | Critic dimension of the confined masonry panel | MR = | Bending moment applied to the plane of the wall |
| e = | Gross thickness of the wall | P = | Axial compressive load |
| f'_m = | Compressive strength of masonry | PR = | Design strength of the masonry wall to vertical load |
| h = | Height of confined masonry measured between bond-beams | P_u = | Design axial load |
| t = | Thickness of the masonry panel | Q = | Factor of seismic behaviour |
| v'_m = | Characteristic shear strength of masonry | $V_m R$ = | Design shear load of masonry, N |
| w = | Seismic load uniformly distributed | d = | Length between the reinforcement in tension and the concrete in compression. |
| \acute{a} = | Reduction factor of the shear strength due to slenderness effects | d' = | Length of confined masonry measured between longitudinal reinforcement of tie-columns |
| \tilde{a} = | Specific weight | f'_c = | Compressive strength of the concrete of confining elements |
| $\acute{o}m$ = | Maximum axial strength | f_m^* = | Compressive strength of masonry |
| Mexican Code | | f_y = | Yield stress of steel |
| A_s = | Cross-sectional area of the longitudinal reinforcement | h_c = | Total area of the transverse section of tie-columns |
| A_{sc} = | Cross-sectional area of stirrups in one layer | s = | Spacing of stirrups |
| AT = | Cross-section of the confined masonry wall | v_m = | Compressive diagonal strength of masonry |



Alternate and Emerging Building Materials and Technologies for Sustainable Built Environment

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Prologue

Housing is one of the basic needs (Roti, Kapra aur Makan) of mankind and at the top of the list of priority areas of the present Government who intends to raise 100 new smart cities to fulfill their agenda of election manifesto. As per the census report of 2011, urban population will continue to grow and likely to reach 470 million in 2021 and 700 million in 2041. Consequently our cities will face major shortage of housing stock particularly in the category of LIG and EWS, hence the necessity of new settlements and number of housing schemes like, JnNURM, RAY etc.

Massive constructions, consequent upon the above schemes require lot of construction materials and new tech-

nologies to conserve the materials with Sustainable Built Environment.

Dr. Shailesh Agrawal, a well known expert in the field of innovative building materials and technologies along with his co-authors assigned with the task of certification of new technologies by MoHUPA Govt. of India, have made effort in this paper to bring forth the various aspects of impact on land, water resources, forests and consumption of non-renewable resources in construction. Stress has been laid by them on waste management by life cycle approach and new technologies for mass housing including green buildings.

- Editor-

Introduction

Housing, one of the basic needs of the mankind is at the top of the list of priority areas of the Government. With annual growth rate of 2.7%, urban population in India rose to 286.1 million as per 2001 Census and more than 377 million consti-

tuting 31.16% of the total population as per 2011 Census of Government of India. It is projected that urban population will continue to grow and reach 470 million in 2021 and 700 million in 2041. With current pace of urbanization, our cities are facing major shortage of housing stock and also despite of best efforts by the Government, the gap between available housing stock and required is ever increasing. A Technical Committee constituted by Ministry of Housing & Urban Poverty Alleviation to assess housing shortage at the beginning of the 12th Plan, estimated the shortage at 18.78 million in 2012. Against this, about 18 million of shortage is for EWS and LIG categories. Out of the total shortage of 18.78 million, 14.99 million is on account of congestion factor, i.e. 14.99 million households live in congested houses requiring home improvement or new houses. The recommendations of the Technical Committee are that both housing improvement and new housing be included while addressing the housing shortage in the country. Housing and habitat related services for the urban poor and low income groups are estimated to cost a sum of about Rs.6,00,000 crores which requires proper planning, policy frame work and technical interventions to deal with the subject.

Realizing the challenge, the Government of India took several initiatives to create opportunities and provide enabling environment to overcome this housing shortage in most effective manner. The National Urban Housing and Habitat policy 2007 by the Ministry of Housing and Urban Poverty Alleviation, inter-alia, lays emphasis on using technology for modernizing the housing sector for enhancing energy and cost efficiency, productivity and quality specially to meet the housing needs of the poor. It encourages use of prefabricated factory made building components so as to achieve speed, cost effectiveness and better quality construction. Through ongoing Jawaharlal Nehru Urban Renewal Mission (JNNURM, Government of India's Scheme for slum renewal), and newly launched Rajiv Awas Yojna (RAY, Government of India's scheme for slum renewal & slum prevention), the central Government gives State Governments the opportunity to eradicate slum and create necessary housing stock and basic services for the urban poor. This gigantic task needs a review of our construction practices and study of emerging technologies so as to introduce best technologies and practices suiting our conditions for construction of housing stock in different parts of the country.

The National Housing & Habitat Policy, which calls for a "Housing Revolution" rightly stressed on the development of alternate and innovative construction materials and technologies and their wide application with special emphasis on protection of natural environment by stressing upon the use of locally available raw materials besides advocating reduction in use of scarce natural resources and planning them with renewable resources.

Massive construction activities associated with the development of habitat have numerous environmental impacts and unless tackled properly may create

ecological imbalance. In developing countries like India, materials producers and builders often use traditional, less energy efficient techniques or old fashioned highly polluting equipments. There is often a lack of knowledge about how to make production clean and energy efficient. Improvements might also be hindered by lack of capital, availability of indigenous equipments. Weak management, mind set both in material production and their use at construction sites might be other reasons for this status. Inadequate framework and enforcement mechanism to encourage designers and builders to adopt environment friendly technologies in construction and standards & building regulations also cause continued use of energy intensive materials and technologies.

Complex, highly dispersed and resource demanding nature of activities in the construction sector contributes to the loss of important natural resources and impose severe stress on the environment. Agricultural land is often lost through urbanization and extraction of raw materials. Forest timber being used for construction and as fuel for manufacturing building materials is depleting faster than it can be replaced by planting new trees or by natural growth. Many raw materials used in construction are limited resources in India. For example the reserves of some metal and mineral resource like limestone, fossil fuel are likely to be finished after few years, if the current rate of exploitation continues. The consumption of fossil fuel also contributes to increased air pollution and emission of greenhouse gases. Construction activities also contribute to the release of ozone depleting substances that damage the ozone layer.

This calls for a concerted, integrated approach for building eco habitat which alone can minimize the adverse impacts on the environment and reduce the consumption of natural resources over the building life.

Impact of Construction on Land, Water Resources and Forests

Degradation of Land

There is growing concern about increasing land dereliction, caused by extraction of sand, gravel and clay etc, which alternately reduces the land available for human settlements development.

Brick making activity alone consumes, at present, equivalent of 300 mm depth from 100,000 hectares (1000 sq. km) of fertile land, 22x10⁶ tonnes of coal and 10x10⁶ tonnes of biomass annually. With the available land area of 1.62x10⁶ sq km comprising of alluvial soils, black soil, red soil, laterite soil and desert soil, of which only alluvial, laterite and red soils are suitable for making bricks. Area under the soils suitable for brick making may not exceed 50% of the available land. Brick making activities to meet the present and future demand can result in consuming the 300 mm depth fertile top soil of available land in about 90 years (assuming

2.5% compounded growth rate). Similarly the pressure on raw materials like limestone to manufacture cement and energy requirement to produce these materials are required to be addressed.

Destruction of land can be avoided by applying more sustainable methods of quarrying, such as restoring agricultural land after clay winning.

Degradation of Coastal Areas and Water Resources

Construction activities can be detrimental to coasts and water resources, which can become critical in some areas. The extraction of sand and gravel from river beds and beaches can have serious environmental consequences, increasing soil erosion. In parts of India, removal of coral and shells from the coast to produce lime and cement is common, because of their high chemical purity. The use of coral as an aggregate or building stone is also common in parts of India. Logging practices also damage water resources. Heavy logging can cause increased rate of erosion, increased sediment loads that affect habitats for plant and river organism downstream. Debris from logging and saw milling can also increase the input into stream of organic materials, whose decomposition reduces the amount of oxygen in river water, jeopardizing the life of water animals. It is, therefore, necessary to strictly implement the coastal zonal regulations for all construction activities.

Deforestation

Forests are an important natural resources base, which play a crucial role in the conservation of watersheds, prevention of soil erosion and balancing the ecosystem. Forests are sources of domestic energy supply, such as wood for cooking and heating, and of fuel for brick and lime production in rural areas.

Inefficient commercial logging operations and the use of wood as fuel have resulted in deforestation in many regions. There is also increasing concern about the destruction of the tropical forest and the adverse impact of this on the environment. Managing the forest in a sustainable manner, so as to minimize the rate of deforestation, is, therefore, imperative and should be given highest priority.

The second consultation on the wood and wood products industry, organized by UNCHS (Habitat) and UNIDO in 1991, underscored the importance of greater utilization of wood on a sustainable basis, as a renewable source of indigenous building materials in housing construction. This includes commercially Less-accepted species (CLAS) and industrial tree plantation species (ITPS). If properly managed and exploited, these species can serve as abundant and renewable resource of building materials, which can be utilized by the vast majority of the population.

CLAS and ITPS are slowly showing their potential as raw materials in industrially processed wood products for construction in the country.

Consumption of Non-Renewable Resources in Construction

Non-renewable resources used in construction include fossil fuels, metals and minerals such as stone and clay. Supply of some of these may last only a few decades. Although more pockets of these resources are discovered, and new technology might extract more than is possible today, the rate at which the reserves of these resources are depleting means consumption must be controlled. Other preferable renewable resources must replace these traditional materials.

Use of Metallic Minerals

The construction industry is a major consumer of metals such as iron, aluminum zinc, copper etc. According to geological studies, the existing exploitable resources of metals are very different. The world's economically exploitable resources of some metals commonly used in construction are shown in Table-1 together with production pattern and life indices.

Table 1 : Annual Production, Reserves and Life Index of Some Metals

| Metal | Production/year (Million MT) | Resource (Million MT) | Life Index (Years) |
|-------------------|---|----------------------------------|-------------------------------|
| Bauxite/Aluminium | 104 | 23,000 | 222 |
| Copper | 9.3 | 310 | 33 |
| Iron | 930 | 150,000 | 161 |
| Lead | 3.4 | 63 | 18 |
| Nickel | 0.9 | 47 | 51 |
| Zinc | 7.1 | 140 | 20 |

Serious consideration, therefore, is needed to explore these metals in construction, to extend the life of existing reserves.

Use Of Energy In Construction

The construction sector is a major user of energy. Energy is required for manufacturing materials, for transport and for construction of buildings. Apart from this initial energy use, there is also need for energy to operate buildings.

Since energy is one of the most costly inputs to the construction industry and source of most of the polluting effects, improving energy efficiency is one of the most urgent tasks to be addressed. This calls for efficient use of energy intensive materials, greater use of low energy - intensive materials, improving the energy efficiency of production process, increasing the use of recycled and waste materials and applying low energy architectural design principles.

Embodied Energy in Buildings

The materials for habitat are traditionally classified under the following categories

- Cement and masonry materials;
- Metallic materials;
- Wood, natural fibers, polymers and elastomers;
- Glass and ceramic materials;
- Insulating, sealing, bonding, electrical and electronic materials; and
- Finishing and decorative materials

The embodied energy in buildings is defined as the total energy used at all stages of the production of these materials. These stages start with the extraction of raw materials, production of building materials and components, transportation, on-site construction and completion of the buildings.

Most of the embodied energy in buildings is related to the production of materials, while construction activities and transport account for a smaller proportion. On the basis of gross energy requirement for manufacturing a unit weight of building materials, these can be classified in three categories: low, medium and high energy content materials. Table 2 shows a classification of major building materials used in construction in terms of energy requirement for their production.

Table 2 : Comparative Energy Requirements of Building Materials

| Material | Primary Energy Requirement MJ/kg |
|-------------------------|-------------------------------------|
| Very high energy | |
| Aluminium | 200-250 |
| Plastics | 50-100 |
| Copper | 100+ |
| Stainless steel | 100 |
| High energy | |
| Steel | 20-60 |
| Lead, Zinc | 25+ |
| Glass | 12-25 |
| Cement | 5-8 |
| Plaster board | 8-10 |

Medium energy

| | |
|---------------------|---------|
| Lime | 3-5 |
| Clay bricks & tiles | 2-7 |
| Concrete | |
| In-situ | 0.8-1.5 |
| Blocks | 0.8-3.5 |
| Pre-cast | 1.5-8 |
| Sand-lime brick | 0.8-1.2 |
| Timber (sawn) | 0.1-5 |

Low energy

| | |
|----------------------------|------|
| Sand, aggregate | <0.5 |
| Fly ash, RHA, volcanic ash | <0.5 |
| Soil | <0.5 |
| Adobe | <0.2 |

Source: Building Materials in India : 50 Years - A Commemorative Volume published by Building Materials & Technology Promotion Council (BMTPC), New Delhi, India, 1998.

If medium and high energy materials such as ceramics and steel are used, typically 70% or more of the embodied energy comes from the manufacturing processes of these materials. The lower values in Table 2 correspond to more energy-efficient production. Amount of energy used to produce a unit weight of a high energy - content materials can be more than 100 times that needed for low energy-content materials. However, as the densities of building materials vary greatly and they are used in completely different ways, it is more pertinent to compare different types of building elements - such as roofs, walls etc - with similar performance. Comparative energy requirements for different roof and wall assemblies are given in Table 3, 4 & 5.

Table 3: Comparative Energy Requirements of Some Common Roofing Materials for Pitched Roofs

| Roofing material | Weight (kg/m ²) | Energy requirements MJ/kg (MJ/m ²) | |
|---|-----------------------------|---|-----|
| Corrugated aluminium sheet, 0.8 mm | 3.1 | 190 | 580 |
| Corrugated galvanized steel sheet, 0.4 mm | 4.4 | 60 | 270 |
| Ceramic roofing tiles ,12mm | 35 | 4 | 140 |
| Concrete roofing tiles, 12 mm | 45 | 1.3 | 60 |
| Micro concrete roofing tiles, 8 mm | 30 | 1.3 | 40 |

The calculations are based on average values from Table -2 (Tiles require more wood in the roof structure than sheets, but the energy requirement for the wood structure is of no significance compared to the roofing materials)

Table 4: Comparative Energy Requirements of Some Flat Roofs

| Roof Assembly | Weight (kg/m ²) | Energy requirement | |
|--|--------------------------------|--------------------|----------------------|
| | | MJ/kg | (MJ/m ²) |
| Reinforced concrete slab, 180 mm | | | |
| 180 mm concrete | 420 | 1.3 | 550 |
| Steel reinforcement (0.5% by vol.) | 7 | 40 | 280 |
| Total | 427 | 41.3 | 830 |
| Concrete slab with fillers, 180 mm | | | |
| Concrete, 40% by vol. | 170 | 1.3 | 220 |
| Steel reinforcement (0.5% by vol.) | 7 | 40 | 280 |
| Concrete hollow blocks, 60% | 110 | 1.3 | 140 |
| Total | 287 | 42.6 | 640 |
| Elements of autoclaved aerated concrete (AAC), 150 mm | | | |
| 150mm AAC elements (0.2%) | 90 | 4 | 360 |
| Steel reinforcements (0.2%) | 2 | 60 | 120 |
| Total | 92 | 64 | 480 |
| Timber roof, boarding on joists, 200 mm | | | |
| 25 mm timber boarding | 150 | 3 | 450 |
| 175x 50 mm timber joists | 5 | 3 | 15 |
| Total | 155 | 6 | 465 |
| Earth on branches and round timber joists, 350 mm | | | |
| 250 mm compacted earth | 450 | 0.1 | 45 |
| Branches, leaves, etc | 0 | 0 | 0 |
| Round timber joists | 5 | 0.5 | 2 |
| Total | 455 | 0.6 | 47 |

The calculations are based on average values from Table 2. Note that neither waterproofing nor ceiling plastering is included

Table 5: Comparative Energy Requirements of Some Common Walls

| Wall assembly | Weight (kg/m ²) | Energy requirement | |
|--|--------------------------------|--------------------|----------------------|
| | | (MJ/kg) | (MJ/m ²) |
| Solid clay brickwork 150 mm | | | |
| 120 mm solid clay brick | 150 | 4 | 600 |
| Lime/cement mortar | 50 | 0.7 | 35 |
| Total | 200 | 4.7 | 635 |
| Hollow clay brickwork, 180 mm | | | |
| 120 mm hollow clay bricks | 110 | 4 | 440 |
| Lime/cement mortar | 50 | 0.7 | 35 |
| Total | 160 | 4.7 | 475 |
| Hollow concrete block work 180 mm | | | |
| 150 mm hollow concrete blocks | 120 | 1.3 | 160 |
| Lime/cement mortar | 50 | 0.7 | 35 |

| | | | |
|---|-----|-----|-----|
| Total Brickwork of cement stabilized earth bricks, 180 mm | 170 | 2.0 | 195 |
| 150 mm compressed earth brick | 220 | 0.5 | 110 |
| Lime/cement mortar | 50 | 0.7 | 35 |
| Total Adobe block work plastered on both sides, 450 mm | 270 | 1.2 | 145 |
| 400 mm adobe plus earth mortar | 480 | 0.1 | 50 |
| 480 | | | |

Note : The calculations are based on average values from Table 2. Plastering is not included. A lime/ cement plaster applied internally and externally would add another 40 MJ/m²

Different types of construction systems can result in considerable difference in the total embodied energy requirements in a complete house system. Table - 6 shows a comparison of three houses using different materials.

Table 6: Comparative Energy Requirements for Three Single Storey Houses

| House type | Embodied Energy (MJ/m ²) |
|---|--------------------------------------|
| House made primarily with manufactured materials (Hollow brick walls, concrete frame and roof) | 1580 |
| House made partly with manufactured materials (Clay brick walls, concrete frame steel sheet roof) | 1310 |
| House built primarily with local materials (adobe walls, timber frame, steel sheet roof) | 590 |

(Source – UNCHS 1991)

Operational Energy in Buildings

A considerable amount of energy is used in buildings during their lifetime. This energy is required for heating, cooling, ventilation, lighting, cooking and other domestic activities. The energy use patterns inside buildings vary a great deal according to occupants' behavior, type of structure and location of buildings. In residential buildings, urban and rural patterns tend to be very different. Household income and climate have major influences both on the type of energy sources and end-use patterns.

In India, being a country of varying climate zones, energy sources and end use pattern differ considerably.

Although there is little information on how households use energy, the use of operational energy in buildings is increasing steadily. Many households, which previously endured a poor indoor climate, are installing equipment for active climatization as soon as they can afford it. This trend is especially obvious in urban households, which tend to have a better economy and a modern life style.

Architects and engineers have a crucial role to play in designing buildings to minimize energy use for active climatization and lighting. A good approach is to take advantage of natural means such as solar radiation and winds and use the building as a collector, storage and transfer mechanism. These so- called passive techniques might be so efficient that in some regions no energy will be needed for heating or cooling. The knowledge of passive techniques is well developed, but is unfortunately not yet effectively practiced.

Many existing buildings were never designed for active climatization through heating or air conditioning. The energy performance of such buildings can be improved significantly by increasing air tightness through sealing of windows and doors, and by adding thermal insulation materials to the building envelope. The additional cost of such measures is normally paid back in a few years.

Seen over a building's lifetime, the ratio between embodied and operational energy will vary considerably, depending on factors such as type of construction, climate and user behavior. For example, if a building is constructed with medium and high-energy materials and no heating or cooling is used, the portion of embodied energy will be very high. But if a building has high annual use of energy for heating and/or cooling, the portion of operational energy will be very high, especially if the building is badly adapted to the climate.

Use of Industrial and Agricultural Wastes in Production of Building Materials

A large number of industrial and agricultural wastes have found wide acceptance, as alternatives to clay, limestone and various other argillaceous and siliceous materials in the production of bricks, tiles, cement, concrete slab and ceramics. With considerable advantages of not only conservation of natural resources but also saving precious energy as some the wastes have their own intrinsic fuel value. The developing countries must be selective to adopt all such technologies in which industrial, mining and mineral wastes constitutes a raw material resources for building materials.

Table - 7 Indicates a list of well established industrial, mining and mineral wastes and by-products and their use in production of building materials as developed in India.

Table 7: Industrial, Mining, Mineral Wastes and their Application in Building Materials as Alternate to Traditional Materials and Natural Resources

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

Table - 8 gives energy saving in the manufacture of alternative building materials through use of industrial wastes.

Table 8 : Energy Saving Through Use of Industrial Wastes

| Sl. | Building material | Composition | Material compared | Energy saving(%) |
|-----|------------------------------------|--|--|------------------|
| 1. | Portland pozzolana cement | 75% OPC 25% Flyash | 100% OPC | 20 |
| 2. | Portland blast furnace slag cement | 60% OPC 40% B.F. Slag | 100% OPC | 30 |
| 3. | Masonry cement | 50% OPC 50% Tailings/waste chalk | 100% (Masonry cement (50% OPC + 50% Limestone) | 20 |
| 4. | Lime-pozzolana mixture | 25% Acetylene gas lime 75% Flyash | 25% Lime 75% Calcined brick | 75 |
| 5. | Calcium silicate brick | 90% FA Tailings 10% Lime (waste source) | Burnt clay brick | 40 |
| 6. | Burnt-brick | 75% clay 25% Flyash | Burnt clay brick | 15 |

Source: Building Materials in India : 50 Years - A Commemorative Volume, published by Building Materials & Technology Promotion Council (BMTPC), New Delhi, India, 1998.

Table 9 indicates resource and energy saving through use of important natural fibers and allied agro wastes and names of some well accepted commercially produced building boards and sheets made from them. This table also indicates the saving of timber and the binder used in the materials which get substituted by organic-fibers based composite sheets and panels.

Table 9 : Resource and Energy Saving Through use of Natural Fibers and Agro-wastes in Building Materials

| Sl. No. | Waste and source | Commercial product using natural fibre & agro-waste | Traditional resource fully or partly saved | Energy (%) |
|---------|------------------------------|---|--|------------|
| 1. | Coir fibre (coir industry) | Coir fibre-cement roofing sheet & panels | Asbestos | 10 |
| 2. | Rick husk (Rice mill) board | Rick-husk- cement building particle board timber | Resin (PF or UF) bonded | 20 |
| 3. | Ground nut hulls (Oil mills) | Ground nut- hull- cement building board | Resin-bonded particle board timber | 20 |
| 4. | Jute fibre (Jute mills) | Jute-fibre-polymer bonded panel; door and window | Timber, metal | 10 |
| 5. | Cotton waste (Textile mills) | Cotton-lint-cement bonded board | Gypsum, timber | 25 |

| | | | | |
|-----|-------------------------------------|--|---|-------|
| 6. | Bagasse (Sugar mills) | Bagasse-polymer- bonded boards | Timber fibres (in insulation board) | 30 |
| 7. | Corn cobs (Corn mill) | Corn cobs-cement bonded boards | Timber, polymer | 40 |
| 8. | Sisal fibre (Sisal plant) | Sisal fibre-polymer/ cement bonded roofing sheet, door, window | Asbestos fibre Timber | 20-25 |
| 9. | Rice straw & wheat straw (Farms) | Compressed and paper covered board | Timber Polymer | 40 |
| 10. | Banana fibre (Banana plant) | Banana fibre + cotton pulp/ paper pulp and polymer insulation boards | Timber Traditional light weight mineral viz. vermiculite or mica | 25 |

Source: Building Materials in India : 50 Years - A Commemorative Volume, published by Building Materials & Technology Promotion Council (BMTPC), New Delhi, India, 1998.

Use of agro-industrial wastes not only helps in tackling the environmental problems but at many instances actually improves the properties and durability of building materials.

Qualitative and quantitative assessment of the pollutants generated from industrial production of steel, cement, bricks, aggregates, composites using organic and inorganic chemicals indicate an alarming situation from environmental considerations. Coal being the main energy resource in India, for example, it is estimated that as much as 22 per cent of carbon dioxide emissions are attributable to the construction sector which consumes a variety of energy intensive materials. Scientific studies for in depth analysis of available technologies for change-over to alternative fuel sources in materials manufacturing that will reduce GHG emissions requires to be initiated. This is being increasingly realized through establishment of environmental regulatory mechanisms to ensure installation of pollution control systems which have already been developed and are commercially available in the country.

There appears to be a need to evolve an “Eco-Rating Tool” to guide the choice of materials that will maximize the efficiency of the critical resources. Reduction in embodied energy in materials and construction merits attention both by manufacturers of materials and design professionals. There is a need to direct efforts for promoting use of passive solar systems to achieve reduction in operational energy in buildings. The HVAC industry has been guilty of propagating a “one size fits all” concept in thermal comfort. It calls for evolving Energy-Consumption Indices for different types of buildings for varying cli-

matic conditions. Having standardized these indices, the policies and regulatory mechanisms will be needed to ensure that designs conform to these standards by proper selection of materials and processes.

Conservation of Water

Any human settlement requires sufficient source of water for daily and other needs. With the rising population and over exploitation of ground water resources, it is important to conserve water. Rain water harvesting is required to be incorporated in the building byelaws as mandatory requirement.

Under the slum renewal schemes of Ministry of Housing & Urban Poverty Alleviation also, it has been emphasized that State Governments should revise their bye-laws to make rain water harvesting mandatory in all buildings to come up in future and for adoption of water conservation measures including reuse of recycled water. Some states have already made mandatory provisions of rain water harvesting in their byelaws.

Waste Management

Integrated waste management is essential to ensure appropriate disposal and recycling of agricultural, municipal and industrial waste and preventing the indiscriminate abuse of precious land for dumping garbage. Besides reduction in waste and reuse for appropriate applications, segregation of waste at source and recycling of waste for building materials, fuel and manure or energy recovery should be promoted. Sustainable waste management practices are required for not only for municipal garbage but also for industrial refuse or bio-medical waste. The hazardous and toxic waste from health care establishments, comprising of infectious, bio-medical waste constitute a grave risk and should not be allowed to get mixed with other municipal waste.

Life Cycle Approach

The analysis of the impact of the construction industry on the environment is very complex. To assess how different materials and operations influence the environment over a longer period of time, it is worth considering a life cycle approach to materials and buildings.

Life Cycle Assessment of Products

To compare the environmental impact of different materials, life cycle studies of building materials are important. The goal should be to help designers and

users chose environmentally friendly materials. The approach, often called life cycle assessment or life cycle analysis (LCA), considers the entire lifetime of the products and their impact on the environment during that time. This includes the following phases: extraction and transport of raw materials, production, use, demolition and waste treatment.

The environmental impact of the products is evaluated within each phase. The environmental parameters that are considered normally include:

- Resource depletion: energy, materials, water etc.
- Human health: consequences of toxic emissions, impact on work environment, etc.
- Global and regional pollution: global warming, depletion of the ozone layer, acidification etc.
- Impact on animals and vegetation: biological diversity, etc

To evaluate a product, its different environmental impacts are scored, and the sum from all phases is added. One difficulty with LCAs is how to weigh different environmental impacts against each other. Existing LCA methods all have different points systems and a comparison between materials often turns out differently depending on the method.

Another problem with life cycle assessments is that no method considers the complete life cycle, which, of course, is linked to the complex nature of the task. It is also not always possible to obtain the necessary data, as they are often confidential.

Products achieving good ratings in life cycle assessments are based on renewable raw materials, produced with methods using low amounts of energy and having low pollution, are sound and non-hazardous for the users, etc. if there is a possibility to reuse or recycle the product when a building is demolished, or if the product can be used as fuel, this is considered positive and reduces the total environmental impact considerably.

Many industrial countries have developed so-called eco-labeling schemes to promote production of environmentally friendly products. Products that meet the requirements get the eco-label, which works as a “guarantee” to consumers that the particular product is environmentally sound. Gives the increasing awareness among consumers of the importance of protecting the environment, eco-labels have become important tools to market products.

Apart from being used to compare building materials, life cycle assessments have long been used by materials producers to improve their products. LCAs are performed to compare alternative production processes, to look into the possibilities of reducing inputs such as raw materials and energy, and to identify and reduce the wastes and polluting effects. In many cases, LCA is an excellent tool for material producers to make their products more environmentally friendly.

Life Cycle Studies of Entire Buildings

A limitation with product life cycle assessments is that they normally concentrate on the product itself, and do not include its influence on the energy use in the building during operation. Many thermal insulation materials, which are resource-consuming and would not be considered good options in most product life cycle assessments, may reduce energy use in buildings considerably.

Useful approaches when studying energy use in entire buildings are life-cycle cost or life-cycle energy analyses. Since energy use is largely linked to environmental impact, the life cycle energy use of buildings, taking into account both the embodied energy in the building and its operational energy requirement, can be considered a measure of a building's environmental friendliness.

Need for Integrated Approach for Green Buildings

In view of foregoing elaboration, it is important now to mainstream green building technologies for sustainable development. A green building is one, which encompasses the use of clean energy, renewable energy, efficient use of water, use of recycled or recyclable materials and provide healthy indoor air quality. It has to be designed, built, renovated, operated, or reused in an ecological and resource efficient manner. Green buildings are designed to meet certain objectives such as protecting occupants health: improving employee productivity: using energy, water and other resources more efficiently; and reducing the overall impact to the environment. This is possible if an integrated approach to building design, at initial stage itself, is followed which involves judicious use of application of:

- Efficient Green Materials and construction practices.
- Bio-climatic/ solar passive architectural principles.
- Efficient systems and equipments.
- Renewable sources of energy.
- Efficient waste and water management practices.

The range of 'green' design features is very diverse, with options that include energy efficient materials, passive solar considerations, structural and mechanical components. These all work together to create a building that is attractive and functional, saves utility costs over the life of the structure, and has minimal impact on the environment. The uses of active solar features such as photovoltaic and thermal panels, as well as reclaimed and recycled materials are increasingly becoming popular in green building construction.

A green building may cost more up front, but saves through lower operating costs over the life of the building. The green building approach applies a project life cycle cost analysis for determining the appropriate up - front expenditure. This analytical method calculates cost over the useful life of the assets. These and other cost savings can only be fully realized when they are incorporated at the projects conceptual design phase with the assistance of an integrated team.

Indian Initiatives for Green Building Technologies

Recently, in India, green building approach has drawn attention of many agencies both public and private like TERI (The Energy Research Institute), Pune Municipal Corporation, CII-Sohrabji Godrej Green Business Centre, etc. Many of these agencies have started their own certification process to rate a building on the degree of its greenness.

TERI's Green Building Rating System (TERI-GRIHA) evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period.

Pune Municipal Corporation is another example as the first urban local body in the country to take up implementation of Eco Housing Programme under technical assistance provided by the United States Agency for International Development (USAID). The assessment criteria which focus on resource conservation measures like site planning, total water management, energy conservation, eco-friendly and energy efficient building materials, renewable energy and solid waste management will help serve as a benchmark for Eco-Housing projects. Designed to serve as a performance assessment tool, the criteria help quantify the environmental achievement of a building and provide a meaningful differentiation of buildings in the market place.

CII-Sohrabji Godrej Green Business Centre in Hyderabad -- jointly promoted by the Confederation of Indian Industry, Pirojsha Godrej Foundation, Government of Andhra Pradesh and USAID - is the only building in the world to be awarded the 'platinum rating' under the LEED rating system of the US Green Building Council, making it 'the greenest building in the world.' This most environment-friendly building has been built under unique public private partnership as a demonstration building for the industry in India and other countries of the world to showcase use of water and energy efficient technologies and recycled materials.

Technologies For Mass Housing

BMTPC has been promoting cost-effective, environment-friendly, energy-efficient and disaster resistant technologies developed in India. With fast depleting natural resources; need for environment protection to protect greenhouse effect; need for bringing more speed, durability and quality in construction; it is prudent to widen the horizon to look for alternate cost effective technologies within and outside the country. BMTPC took an initiative to study/select emerging and alternate cost effective technologies suitable to Indian geo-climatic conditions and advocate these technologies to the State Govt. for their adoption in mass housing projects.

Through Global Expression of Interest BMTPC invited Construction System/Technology Developers/Providers for introducing emerging and alternate cost effective housing technologies. A Technology Advisory Group was constituted by BMTPC for identification, evaluation and selection of the suitable technologies/systems, comprising of eminent experts from Government, R & D laboratories of India, academic and private agencies.

Based on the information given by the technology providers for their respective technologies/systems with respect to material and structural details, status of evaluation, actual construction carried out in India or elsewhere and their performance, economic scale of construction, status of transfer of the technology to India, suitability for mass construction in urban areas, durability & speed of construction, cost effectiveness, innovation in technology, ease of working & adaptability in Indian condition, etc., the following technologies/systems have been identified as potential technologies for social mass housing and are being evaluated in detail for further adaptation: (Table 10)

Table 10: Potential Technologies for Mass Housing

| S. No. | Technology/System |
|--------|--|
| 1 | Panel building system using steel mesh, polystyrene core and chipping concrete (Evaluated through PACS by BMTPC) |
| 2 | Technology using expanded steel mesh panels, polystyrene beads & alleviated concrete |
| 3 | Pre-stressed precast prefab technology using hollow core slab, beams, columns, solid walls, stairs, etc. |
| 4 | Monolithic concrete system using plastic formwork (Evaluated through PACS by BMTPC) |
| 5 | Monolithic concrete construction using aluminium formwork (Evaluated through PACS by BMTPC) |
| 6 | Precast concrete panels system using concrete, welded mesh and plates, polystyrene core |
| 7 | Industrialized 3-S system using cellular light weight concrete slabs & precast columns (Evaluated through PACS by BMTPC) |
| 8 | GFRG/ Rapid wall Building System technology – Glass Fibre Reinforced Gypsum (GFRG) building panel of gypsum plaster, reinforced with glass fibres. (Evaluated through PACS by BMTPC) |
| 9 | Light Gauge Steel Frame Construction System – Nest |
| 10 | EPS Sandwiched Panel system (China) (Being evaluated through PACS BMTPC) |
| 11 | Factory made steel composite modular building system – Instacon (Evaluated through PACS by BMTPC) |
| 12 | Light gauge steel construction system (Being evaluated through PACS by BMTPC) |
| 13 | Light weight steel joist – composite flooring system Speed Floor (Being evaluated through PACS by BMTPC) |

Conclusion

As proposed in the Habitat Agenda adopted by Habitat II at Istanbul, a practical and integrated approach, based on achievable targets and realistic course of action formulated on the basis of understanding of prevailing situation is required.

- Based on the Global Plan of Action of the Habitat Agenda guidelines, actions are required to be formulated at national and state level on the following:
- Promotion of locally available, appropriate, affordable, safe, efficient and environmentally sound construction methods and technologies.
- Promotion of more energy efficient technology and alternative/renewable energy for human settlements, and reducing the negative impacts of the energy production and use on human health and on the environment.

- **Institutional support:** Institutional support should be provided in from of standards and quality control, with particular attention to energy efficiency, consumer safety and protection.

States can also provide tax incentives to promote green buildings. A green building credit can be awarded to tax payers who construct a building that meets certain requirements. The amount of tax credit awarded for a green building may be proportional to the size of the building and the extent that the building is green.

- **Research and Development:** Need to intensify and support research efforts to find substitutes for or optimize the use of non-renewable resources and to reduce their polluting effects, with special attention to recycling, reuse of waste materials and increased reforestation.
- **Exchange of information:** Promotion of information exchange and the flow of appropriate environmentally sound, affordable and assessable building technologies and facilitate the transfer of technology.
- **Regulatory Measures:** Encouragement and promotion of the application of low-energy, environmentally sound and safer manufacturing technologies backed by appropriate norms and effective regulatory measures.



Skill Development In Construction Sector

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Prologue

Workers in Construction are engaged in very important task of nation building. Construction sector which is second largest sector after agriculture is growing fast on account of growing demand of housing, particularly affordable housing for all sections of society. Skilled and unskilled workers form 93% of total employment for the construction sector. In olden days skilled workers were coming from generation to generation and trained in trade by their parents. Now, with the growing demand of skill workers in India and abroad, huge shortage is noticed. Skilled workers are leaving the country in search of lucrative employment elsewhere. Therefore, creating skilled workers and skill development at all levels is need of the day.

Workers are making all out efforts for training of workmen through National Skill Development Corporation of India, and organizations of State Governments. Their efforts will enhance the output of workers and the social status of the individuals besides improving the quality of construction works.

The author who has wide experience in the field of professional as well as workmen training both in Govt. as well as private sector through this paper has tried to put his view in this regard and attracted the attention of the authorities in the national interest.

- Editor-

The Govt. of India and the State Governments being aware of the situa-

Introduction

In our country, Construction Sector is the second largest sector after agriculture. It provides employment to 33 million people. The Compound Annual Growth Rate of construction sector is about 11%. It encompasses a number of flagship development programmes of the Government such as MGNREGA, Indira Awas, Prime Minister Gram Sadak Yojna, JnNURM, Ajeevika Scheme, PMKVY, RPL Scheme etc. The landscape of construction industry include, (a) Real Estate and Special Economic Zones which contribute about 24% and (b) Infrastructure which includes utilities, power, irrigation, urban infrastructure, transport, roadways, ports etc. and contribute about 76%. The break-up of employment is, (a) Engineers – 2.65%, (b) Technicians and Foremen – 1.85%, (c) Clerical Staff – 2.38% , (d) Skilled Workers

– 10.54% and (e) Workers – 82.50%. It will be observed that technicians and workers are about 95% of total employment in construction sector. Machine operators are also included in above categories.

Construction is largely an unorganized sector. Supervisors, workers and operators are employed by contractors – big and small, real estate developers, maintenance agencies etc. The employment is given by government agencies, contractors, developers, sub-contractors, labor-contractors, labor zamadars etc. Most of the persons in these categories are not regular employees. Depending on necessity for specific projects they are employed as requirements. For private construction, most of the workers especially unskilled ones are employed on day to day basis. Employers visit Workers Mandi located at specific locations in cities and take workers for day's jobs and keep them in the employment as required.

By and large, workers, supervisors and operators all work for construction under the supervision and control of site engineers. When they are employed for works, it is expected that they should have required skills and knowledge of their trades. They should be able to understand and appreciate task requirement and exhibit capability to execute it proficiently. They should be able to work with their own hands using requisite tools meant for their trade. Generally they should own their tools and not be dependent on the employer to make tools available to them. It is also expected that they must be efficient and should give required output. At times task on output basis is given to labor contractor and in turn to workers. It is also expected that they should have some educational background so that instruction of their trade could be understood by them. As far as possible they should be familiar with interface details about other trades. They must also be aware of safety requirements.

Ideally, a construction worker with some skill requirement should be trained in that skill and certified. In fact, in most of the developed countries, construction work is done only through trained and certified workers and not otherwise. In our country, we rarely find that workmen are trained and certified. Absence of any kind of training reduces their employability as also renders them as only unskilled at the entry level. Of course, once employed, through peer group interactions and learning one gains experience and after sometime with experience gained, a number of workers know their own job to a great extent. Other handicaps persist. They generally lack in educational requirements impeding their instructions receptivity to a large extent especially when the task involves reading and following written directions. By and large, workers are not aware of interface requirements of other trades. They are not found sensitized to take adequate and required safety measures. All these factors result in reduced productivity of the worker, both in terms of quantity as also quality. The output of Indian workers is very low compared to workers of developed countries, who are trained and certified.

After economic liberalization there has been a continuous growth in the construction and manufacturing sector throughout the country. The demand of con-

struction sector rising at phenomenal growth of 11% P.A is attracting more and more people both with rural and urban background. Because of lack of vocational training and skills, most of the work forces join as unskilled workers. They gradually develop their skills for different trades once they put in sufficient time on the job but due of absence of entry level skills, the output remains wanting with the consequence quality of the construction projects suffer. We do expect that our construction should be as per required quality standards. But with input from unskilled, unexperienced and untrained workers can we get required standards of quality? There is a strong public perception that overall quality of construction especially in the building sector is poor to less than desirable.

No one can deny that workers engaged in the construction sector are carrying out an important and noble task of nation building- be it in real estate projects, infrastructure projects or any other related development activities. It is for this very reason, workers in construction sector need to be taken care of, and this can be best done by training them in the skills of their respective trades. One of the pre-requisites of skill development is education. This education at primary, middle, or higher secondary level therefore apart from normal curriculum should also include courses which have vocational bias enhancing their employability once they enter the market. Subjects including one of the national language, mathematics, study of drawings, preliminary social sciences, ethics, yoga may be made part of their education. Such a work force when enters into job market will be highly amenable to receive job or trade related training and certification. Such a training of workmen will not only enhance the social status of workers but also raise the value of construction sector in the eyes of public at large. In Indian context whether it remains as a dream or will become reality, remains a moot point. If this country has to move from the category of developing country to developed country then the transformation of construction sector by way of educational input and skill development of workers must be considered as one of the pre-requisites for change.

Glorious Past

Hindu Art traditions which also includes Buddhist and Jain Art, has tradition of civil construction for more than two thousand years. Important artisan trade of that period include excavators, masons, carpenters, sculptures etc. Iron chisels and mallets were their main cutting tools. Artisans generally worked for lifetime on different projects and there were formal/ informal methods of training. The Hindu Art continued to flourish, in whole country from North to South and East to West. It will not be without much exaggeration that some structures created between 10th to 13th Centaury like Chnnakeshara Temple at Belur and Hrysoleshvara Temple at Halebid in Karnataka, have no parallel in the whole world with regard to fineness and detailing, which shows that skills of Indian artisans attained to highest standards during that period. The Hindu Art of course continued to flourish during fifteenth to eighteenth century, but not to the level of earlier period. It continued with the same tradition during nineteenth and twentieth century and will continue beyond. Swaminarain temples at Delhi and in foreign countries are testimony to continued tradi-

tion of artisans working for Hindu Art. Shastras provides information on technical and religious training of Artisans. Shastras lay down that Artist or Artisan should be considered as ritual practitioner and therefore must undergo rites of purification and mental preparation, in order to visualize sculpting forms and features correctly and appropriately. The suppression of personality of individual was considered essential to the success of the creative process. There are of course, some exceptions, in 12th Century in Karnataka, and in 18th -19th Century in Bengal, where structures show name of artists, family and place of origin.

Islamic Art traditions developed after invasion by Muslims during 10th and 11th Century. The energetic, pluralistic tradition of Muslim conquerors, absorbed new architectural principles and technical practices, brought a complete change in structural concept of structures. Qutub Minar at Delhi is testimony of Islamic Art by artisans who came to India with Muslim invasions. The plaster work and rubble stone work found way to India from Middle East and in-turn arches and tombs. These artisans found way toward South India, wherever the patronage could be found. Many structures are testimony of work done by Artisans of that period. It is worth to mention that two best examples of that period; Taj Mahal constructed in middle of 17th Century, is the finest example of Mughal Architecture. In style it combines Arabic, Persian, Ottoman, Turkish and Indian Architecture. Craftsmen employed in the construction included masons, stone cutter, inlayer, carver, painters, calligraphers, dome-builders etc. These craftsmen were drawn from the whole empire including Central Asian & Iran. About 20,000 craftsmen and other workers were employed in the construction of Taj Mahal. Gol Gumbad at Bijapur, constructed during the same period is shining example of structural ingenuity and skills of Deccani masons. In Gol Gumbad we find culmination of artisan skills of that period and till today it stands out as one of the finest architectural triumphs of the age. The dome spans the largest uninterrupted floor space in the world. The quality of brickwork and masonry work is unsurpassed. It was zenith of Islamic tradition. With the decline of Mughal power standard of building and monument construction gradually declined with a few notable exceptions like courts of Navabs' of Avadh in U.P. where one cannot fail to appreciate the craftsmanship of the building artisans.

Rajput and European Art and Traditions started developing from 18th Century onwards. Forts and palaces, at different places developed as a consequence of British influence. In this period there was remarkable fusion and synthesis of Local traditions with imported European values of forms and functions. Local traditions however kept themselves alive producing some very grand buildings of the time. Finest structure of that period is Umed Bhawan Palace of Jodhpur, designed by European Architect and constructed by Indian Artisans particularly stone cutters. It was a famine relief structure. Effect of British architecture is widely seen in urban centres developed during British period like Kolkata, Chennai and Mumbai. Victoria Terminus Railway Station at Mumbai is one of the finest examples of British architecture. Similarly development of Lutyens Delhi in 20th Century which includes Rashtrapati Bhawan, North & South Block, India Gate and Connaught Place, is yet

another an example of fusion of British architecture and contemporary craftsmanship of Indian Artisans, particularly from Rajasthan. For these projects, workmen were trained at project site. Except the prestigious construction, other civil construction till middle of 20th century by different agencies of Government was as per specific requirements and generally of average specifications. But by and large, even these structures are found to have been constructed with good quality standards. It may be noted that Artisans of this period like masons and carpenters were not fully dedicated to their trade, rather worked for construction only during lean periods of agriculture. Thus, though they were not fully employed in the profession, they were good at work mainly because of sustained tradition of pursuing same profession from one generation to another.

Post Independence

After India attained independence, there was many fold increase in developmental activities mainly by the Government agencies as a part of planned economic development. The construction works increased many fold in all fields including, roads, buildings, irrigation, dams, water supply, sanitation, railways, airfields etc. These were launched by different agencies of Central & State Governments. Important milestones of this planned economic development which lasted for about 30 years after independence can be seen in many mega projects and specific reference can be made of Bhakra Dam and Chandigarh city. On account of multiplication of construction activity, at one hand the demand of skilled workmen increased on the other side a number of skilled and experienced workers, went to Middle-East where oil industry created economic boom. This created a net shortage of skilled work force. Due to non-availability of adequate number of trained and experienced artisans, the quality standards of civil construction gradually deteriorated. Practically, no effort was made to train and certify skills of workmen. By the turn of 21st Century, overall quality standards of civil construction deteriorated.

Skill Development Scenario in 21st Century

21st century is the century of globalization and knowledge economy. This poses numerous challenges as well as new opportunities to developing economies like India. Indian labor force numbers to around 50 Crore by conservative estimate. Every year there is addition of around 1.2 crore people in the labor force. Lack of formal vocational education leads to both poor work output as well as low income level for the worker. Global flow of goods, services and knowhow create pressure on the economies to restructure as some industries decline and new opportunities arise in others. These forces in turn, create demands for re-skilling of those made redundant and for skills up-gradation and training for those employed. However with large population working in the unorganized sector, formalizing mechanism for skilling, re-skilling and up-gradation is challenging and massive task.

There is no authentic data on the employment of workers in unorganized sector but studies suggest that 93% of Indian work force is employed in unorganized or

informal sector which lacks any kind of skill development system. Out of this 12.5% undergo some kind of informal training. Barely 2-2.5% of unorganized work forces undergo formal skill development. Even in organized sectors only 11% work force is trained. It means that 85% of work force in unorganized sector does not imbibe any form of skill development, formal or informal. When compared with countries like South Korea (skilled work force 96%), Japan (80%), Germany (75%), UK (68%) the picture is found to be quite dismal. Various reasons attributable to low skill formation are (a) Dearth of formal vocational framework (b) High school dropout rate (c) Inadequate skill training capacity (d) Negative perception toward skilling (e) Lack of 'industry ready' skills even in professional courses.

At the beginning of 21st Century, a World Bank Report on, "Skill Development in India – The Vocational Education and Training System" brought out key constraints faced by the vocational education and training system as well as the potential options to address some of these constraints. Reforms proposed to be implemented include, (i) in initial phase by focusing on reforms that needed to be addressed in the very near future and (ii) in a medium-term phase consisting of interventions that could be implemented later on. It was necessary to develop a system where the Government plays a key role in policy development, standard settings, financing & monitoring and evaluation, while engaging greater competition and accountability by training providers. For reforms to succeed, close involvement of private sector at all levels was considered necessary. Reforms suggested regarding vocational education and skill development of workers are as follows.

- (a) The vocational education system is largely irrelevant to needs of the labour market and employment outcome. In first phase, the vocational education need not be expanded and system to be reformed to make it more demand responsive.
- (b) The management of vocational training system is fragmented and lacks basis for informal policy decisions. A clear demonstration is needed regarding functioning of DGE&T, NCVT & SCVT and effective coordination mechanism is to be developed. Significant involvement of employers in the decision making is necessary. Independent evaluation on quality of training is needed.
- (c) Improving effectiveness of Public Training Institutes is necessary as per market needs. The private sector is to be involved in management of institutions. Gradually, institutions are to be allowed greater autonomy. Short term courses to be developed on demand.
- (d) Excessive constraints and regulations on setting up private institutions should be removed.
- (e) The Government should develop a policy frame work which should outline how it plans to stimulate training for the informal sector. Such a frame work will allow the development of innovative ideas for public private partnership to encourage informal sector training and types of incentives and support services that will be provided to measure the productivity of informal sector. A policy framework is necessary to ensure coordination between different ministries, which are supporting informal sectors. Besides, involvement of NGOs is necessary for delivery of training.

Suggested reforms brought out above, very clearly established a need for complete change in the outlook of the Government with regard to issues related to skill development, which were neglected till the turn of century.

Initiatives by Govt. of India

Eleventh and Twelfth Five Year Plans – Realizing the urgency and importance of creating a frame work where the actor(pupil, workman) and the institutions (government, private, industries, NGOs) can be connected in a seamless manner for skill development, Government of India laid down the policy objectives in its Five year plans. The objective of Eleventh Plan was faster and inclusive growth. Initiatives taken during this plan resulted in substantial growth. The approach paper of Twelfth Plan mentions about advantages which can be derived at international level on account of demographic projection and India can enjoy demographic dividend. For 120 crore population, with median age of 29 years, demographic dividend is that more than 65% of this population will be in the working age group by 2021. On the flip side, 80% of this productive population will be less than class 12th standard of education. It is expected that world is likely to face shortage of 47 million skilled people because of ageing population of developed economies and India will have surplus of 56 million people by 2021. In today's knowledge based economy quality of work force has become more important than quantity. There is a serious gap between output of skill development institutions and industry requirement. Around 4 lakh engineering graduates join the work force every year but only 20% are readily employable. As per the estimate by 2020, the country is expected to face a shortage of 1.3 crore medium skilled workers, posing a big impediment to labor intensive sector. It is therefore possible to take advantage of demographic dividend only if quality education and skill training are given to new entrants to professions. Otherwise it will be a bad situation with unemployment and economic disaster. Rapid growth during 11th Plan experienced shortage of specific skills. Much more needed in skill development to complement the potential expansion in economic activity. Construction and infrastructure development are important components of these plans. Mechanism for providing training to unskilled workforce has to be strengthened. Besides, Construction Sector has to develop in orderly manner. All professionals, administrators and contractors in construction sector should take responsibility for imparting training to unskilled workforce.

National Skill Development Mission (NSDM) – The Government of India has set a target to impart necessary skills to 50 crore people by 2022, in line with its forecast of a significant requirement of skilled manpower over the next decade. 12th Five year plan which goes up to year 2017 has however set a modest target skilling of 8 crore people. This means that mission target of skilling 50 crore people by the year 2022 is too ambitious. Even by conservative estimate around 1.2 crore people join the work force every year. In contrast the country has total skill training capacity of only 43 lakh per year thereby depriving around 80 lakh entrants of the opportunity of formal skill development every year. Further net enrolment in vocational courses in India is around 55 lakh per year, while that in China it is 900 lakh. This shows that

our country faces a major challenge of imparting 'employable skills' to its growing force in the next decade. This also points toward massive efforts towards creating trainer in large number to reach out to source of skills (students, pupil) through government efforts as also by NGOs, industries and other interested private players.

Realizing the enormity of task in hand National Skill Development Mission was launched in Eleventh Plan and it brought paradigm shift in handling skill development programmes and put in place a Coordinated Action Plan for Skill Development. Three-tier institutional structure placed solid foundation for skills eco-system in the country. In Twelfth Plan gap in skill eco-system has been identified. Three agencies earlier set up in the year 2008 - Prime Minister's National Council on Skill development (PMNCSD), The National Skill Development Corporation Board (NSDCB) and the office of the Advisor to the PM on skill development has been recently replaced by single National Skill Development agency (NSDA) to streamline the function of policy planning. This agency will work to meet the increasing need for skilled population, in both the public and private sector. The agency will be responsible for coordinating with all central government ministries involved in skill development initiatives. It will also develop and monitor overarching framework for skill development, and anchor and operationalize the National Skills Qualification Framework (NSQF). National Skill Development Council (NSDC) will continue to work with private sector. NSDC has been assigned to develop ultra- low cost, high quality, innovative business model; foster private sector initiatives and to provide support services. So, setting up of NSDA, there will be broadly two major agencies, where the NSDA will monitor the NSDC's functioning. NSDA is an autonomous body which would coordinate and harmonize the skill development efforts of the Government and the private sector to achieve the skilling targets of the 12th Plan and beyond and to bridge the social, regional, gender and economic divide (i) by ensuring that the skilling needs of the disadvantaged and marginalized groups like SCs, STs, OBCs, minorities, women and disabled persons are taken care of through the various skill development programs and (ii) by taking affirmative action's as part of advocacy by the NSDA. The Central Ministries and NSDC will continue to implement schemes in their remit. The NSDA will anchor the National Skills Qualifications Framework (NSQF) and facilitate the setting up of professional certifying bodies in addition to the existing ones. For coordinated action plan, National Skill Development Corporation (NSDC) made significant progress and unorganized sectors have been identified. Skill formation has to take place in demand driven manner. Curriculum for Skill Development should be reoriented to meet demands of industry/ employer and align with self-employment opportunity. Accreditation and certification system has to be imposed. Emphasis to be given on high employment sectors for Skill Development Centre to develop. Vocational education at ITIs needs significant expansion. PPP Model to be introduced. Entry barriers for private players are to be removed. Aim should be to increase percentage of workforce which has received formal skills through vocational education and training from 12% to 25% at the end of Twelfth Plan. Thus, 80 million more people have to be imparted training in formal skills during 12th Plan period.

Mainstreaming vocational education-The National Skills Qualification Framework (NSQF): The gap between an industry ready workforce and the country's current skilling framework is widening at a rapid pace. Apart from majority of degree and diploma holders, approximately 20 crore students are the drop outs from higher secondary education system. They all need vocational education to become employable. Moreover there is no standardization of workers category, skill needs requirement and vocational courses curriculum. To streamline vocational education NSDA developed NSQF which will act as a central model responsible for regularizing the skill development agenda on all India basis. NSQF intends to be an all-encompassing framework, with a strong focus on vocationalization of school education. NSQF recognizes qualifications according to a series of levels of knowledge, skills and aptitude. These levels are defined in terms of learning outcomes which the learners must possess regardless of whether they acquired through formal, non-formal or informal learning. In that sense, the NSQF is a quality assurance framework. It is a nationally integrated education and competency based skill framework that will provide for multiple pathways, horizontal as well as vertical, both within vocational education and vocational training, general education and technical education. Thus, this framework links one level of learning to another higher level. This system will enable a person to acquire desired competency levels, transit to the job market and at an opportune time return for acquiring additional skill to further upgrade his competencies.

The key elements of the NSQF provide:

- (a) National principles for recognizing skill proficiency and competencies at different levels leading to international equivalency.
- (b) Multiple entry and exit between vocational education, skill training, general education, technical education and job markets.
- (c) Progression pathways defined within skill qualification framework.
- (d) Opportunities to promote lifelong learning and skill development.
- (e) Partnership with industry/ employers.
- (f) Transparent, accountable and credible mechanism for skill development across various sectors.
- (g) Increased potential for recognition of prior learning.

Central Government Ministries, other agencies and State Governments involved in Skill Development – In the Central government, around 20 Ministries were involved in skill development. These Ministries operated in one of two ways - through setting up their own training capacity in specific sectors (like Ministry of Labor and Employment, Ministry of Agriculture, Ministry of Health and family welfare etc) or through providing pre-trainee costs for specific target population (like Ministry of Rural development, Ministry of Women and Child Development etc). NSDA is the supervising authority. Thus, Seven Ministries are playing primary role. These are, (i) Labour & Employment, (ii) Human Resource Development, (iii) Micro, Small and Medium Enterprises, (iv) Women & Child Development, (v) Agriculture, (vi) Housing and Urban Poverty Alleviation and (vii) Rural Development. State Governments

have three-tier setup, (i) Council on Skill Development under Chief Minister, (ii) Empowered Committee under Chief Secretary for implementation, process and review, and (iii) State Skill Development Mission headed by Mission Director.

State Skill Development Mission: Most State governments have also set up State Skill Development Mission as nodal bodies to anchor the skill development agenda in the State. SSDMs are expected to play a significant role in escalating the pace of skilling, through identification of key sectors for skill development in the State, as well as coordinating with Central Ministries and State Line Departments, as well as industry and private training organizations. Each State has adopted a structure of SSDM that best suits the local environment and the State vision for skill development. While some States have elected to form the SSDM as a Society or Corporation under the Chief Secretary or Chief Minister, others have housed it under relevant Departments such as Labour, Human Resource Development or Planning. Many states are starting to set year-wise targets for skill development, specifying the state budgetary allocation, and complementing Government efforts by encouraging private investment

Non-Government Sector (NGS) – From a policy perspective, there has been a growing consensus that a public-private partnership is required to remove difficulties concerning filling the skill gap in growing work force. Non-Government Sector has to work with dedicated teams that know their area of operation and can reach out to unorganized sector. Private Sector is potential employer and Skill Gaps are to be defined. Demand to be ascertained and practical ground to be provided. Models should be developed for making Skill Development program financially viable. Cooperative Societies and Self Help Groups can lend significant contribution in this task.

National Skill Development Policy – It envisages target of skilling 500 million people by 2022. It will be possible only by massive efforts in the field of, (i) Policy Coordination and Coherences, (ii) Designing Skill Systems for high inclusivity, (iii) Overcome mismatch between demand and supply and (iv) Placement linked skill development (v) Building public perception about vocational training (vi) due consideration for aptitude based choices for skills learning. In India on job training is very low. It is 24-26% compared to China where it is 60-70%. In Japan and Germany it is 90-100%. Some change in thinking of Employers is necessary to increase on the job training.

Skill Development Initiative Scheme of Ministry of Labour

Background – Vocational training is a concurrent subject under the Constitution of India. At National level Directorate General Employment & Training (DGE&T), Ministry of Labour & Employment (MOLE), is the nodal body for formulating policies, laying down norms, standards, conducting trade tests and certification. It is the most comprehensive system in India. The institutional training to craftsmen is given through Industrial Training Institutes (ITIs). The educational qualification var-

ies from Class VIIth passed to Class XIIth passed and duration of training varies from six months to three years. For successful candidates National Trade Certificate is awarded by National Council of Vocational Training (NCVT). Besides, on the job training, i.e. apprenticeship training through industry is given under the Apprentices Act 1961, in industrial establishments. All India Trade Tests are conducted under the aegis of NCVT.

Concept of Skill Development Initiative on Modular Employable Skills (MES) was developed by DGE&T with close coordination of industry and State Governments. MES is "Minimum Skill Set", which is sufficient to get an employment. MES allows skills upgradation/ formation, multi-entry & exit, vertical and horizontal mobility and life long opportunity in flexible manner. The skill is to be assessed by Assessing Body mainly from the industry and organizations. NCVT issues certificate of skills acquired through informal means/ competency assessment. The Central Apprenticeship Council (a statutory body) and the National Council of Vocational Training (a non-statutory body), advise the Govt. of India on policies, procedures, standards & norms for vocational training schemes.

Skill Development Initiative Scheme (SDIS) – A majority of Indian Workforce does not possess marketable skills, which is an impediment in getting decent employment. Only 10% Indian labor force – 8% informally and 2% formally acquire vocational skills. There is acute shortage of availability of seats for training of workforce. The educational entry requirement and long duration of courses of the formal training systems are some of the impediments for a person of low education attainment to acquire skills for his livelihood. Thus, SDIS can cover unorganized sector. The scheme covers all those above the age of 14.

Features of Skill Development Initiative Scheme (SDIS) – Key features of the scheme are that demand driven short term training based on Modular Employable Skills (MES) are identified in consultation with the industry. The central government facilitates and promotes training while industry provides training. It has a flexible delivery mechanism and services of retired and guest faculty is being utilized. Courses are available for persons having completed studies up to fifth standard onwards. Public Private Partnership (PPP) envisaged in the form of active participation of industry/ private sector in every stage of design and implementation of the scheme.

Curriculum Development Process – Sector based employable skills are identified in consultation with the industry, employers', organizations, experts from ILO, World Bank, Central Govt./ State Governments Establishments etc. Training modules are identified corresponding to skill set/ competence. Modules in the Course Matrix are organized indicating vertical and horizontal mobility. Detailed curriculum developed by trade committees and after approval of NCVT, incorporated in the SDIS. The DGE&T has provided guidelines for the selection of Vocational Training Providers and guidelines for assessment. Besides, a list of MES courses has also been worked out by DGE&T. The revised list issued in September 2012, covers

72 sectors such as, Automotive Repair, Carpet, Khadi, Retail, Media, Brassware, Home Décor etc. Sector No. 25 is 'Construction' and covers 42 courses. Besides, there are number of courses related to construction, under other sectors (Annexure 1). The special feature of this listing is that each MES course has a code number. For example under 'Sector 25 Construction', Course Sl. No. 530 has MES course code "CON 106", for Assistant Bar-Bender & Steel Fixer. For this course, minimum educational qualification is 5th standard, duration of training is 300 hours and test fees amount to Rs.800/-. All the MES courses are also graded. First grade course code starts with 1, the second grade course code starts with 2 and third grade course code starts with 3. For example CON 101 is for Assistant Shuttering Carpenter & Scaffolder and minimum educational qualification is 5th Class. CON 201 is for System Shuttering Carpenter and minimum educational qualification for this MES courses is 5th Class plus CON 101.

Implementation – In order to maintain quality of training uniformity all over the country, instructional media packages, are developed by the National Instructional Media Institute (NIMI) Chennai and given in their website www.dget.gov.in/nimi. Besides, in order to maintain uniformity in quality of training, terminal competency assessment tools are prepared and placed on DGE&T website: www.dget.gov.in/nimi. In order to maintain uniformity in assessment, an Assessment Manual has been developed and put on the DGE&T website.

Initiatives for Imparting Training

National Skill Development Council (NSDC) was set up by Ministry of Finance, Govt. of India in August 2009. It is under Public Private Partnership Scheme of Govt. of India and it provides funds for skills and vocational training initiatives. Its mandate also includes quality assurance, information systems, train the trainers and establish academies, either directly or through partnership. The mission of skill development is headed by Advisor to Prime Minister and Chairman of NDSC.

Construction Skill Development Council of India (CSDCI) was constituted under the mandate NSDC to promote skill development. It is a non-profit making organization registered under Section 25, sub-section 1 Clause (a) of Company Act 1956. CSDCI aims to develop, establish, standardize and sustain industry competency frameworks, skills levels, occupational standards, create and delivery capacity, investment and skilling outcomes to meet expectation of industry. It has to be the apex body for ensuring the skills need of the construction industry. Its roles are, (i) create occupational standards and competency levels, (ii) issue guidelines and facilitate training and certification of trainers and assessors, (iii) plan skill development, (iv) accreditation and affiliation of training institutes, (v) national agency for assessment and certification of trainers, (vi) create and operate labour market information systems. It is promoted by industry having five divisions, (i) Standards & Research, (ii) Operations, (iii) Accreditation & Certification, (iv) LMIS-data base of workers and (v) Monitoring and Quality Audit. Six trades identified by CSDCI are,

(i) Helper-Mason, (ii) Helper Bar-bender, (iii) Helper Carpenter – Shuttering & Scaffolding level 1, (iv) Helper Construction Laboratory Technician level 1, (v) Assistant Scaffolder level II and (vi) Assistant Construction Laboratory Technician Level II. A number of providers and accredited testing centres have already been attached to CSDCI and training courses as also awareness workshops have also been conducted.

National Academy of Construction at Hyderabad (NAC) was established in 1998 by Govt. of Andhra Pradesh. It is an ISO 9001-2008 certified institute and it is vocational training provider as recognized by Govt. of India. Aim of NAC is to upgrade knowledge of skills of construction – covering engineers, contractors, managers, supervisors, architects and workers. Main activity of NAC is to upgrade employability standards of youth in the age group of 10 to 35 particularly those belonging to Below Poverty Line (BPL) category by providing 03 months vocational training in basic construction trades viz. Masonry, Bar-bending, Formwork, Carpentry, Electrical House Wiring, Plumbing & Sanitation, Welding, General Work Supervisor, Store-keeper etc. Its Construction Technicians Training Institute (CTTI) was established in 2002 for the training of unskilled workmen. It is working on Modular Employable Skills (MES) syllabus and there are three levels of skills in each category. Besides, trainings are organized for General Works Supervisor, Highway Works Supervisor, Land Surveyor, Store-keeper, Electrical House Wiring etc. NAC is a well established institution for skill development and only one of its kind in the country.

Construction Industry Development Council (CIDC) was set up by the Planning Commission of India with construction industry to initiate activities for development of Indian construction industry. It is working in several fields relating to construction including training of workmen and supervisors. CIDC has established 19 institutes throughout the country for training and certification of construction workers in various trades. Regular examinations are being held in these institutions and certificates are being awarded to successful candidates. CIDC is also running special programmes in North-Eastern Region of the country. CIDC is starting training of trainers, in construction industry.

Initiatives by Indian Buildings Congress – IBC made a modest beginning for training of workmen about three years back at Delhi. It is extending training activity at Bangalore, Agartala and Patna. IBC also provides tool kit to workmen. Members of IBC have donated tool kits for workmen. IBC intends to spread training activity in the whole country.

New Initiatives for Skill Development after May 2014

After May 2014 the new Government headed by Prime Minister Shri Narendra Modi took initiative to give more stress for skill development. In order to expedite and coordinate skill development, Skill Development Ministry has been formed and all training units of Ministry of Labour have been transferred to this Ministry. The National Skill Development Corporation and other organizations connected with

Skill Development have also been placed under the control of this Ministry. Besides, to expedite the skill development activities the Govt. of India has announced Pradhan Mantri Kaushal Vikas Yojana.

Pradhan Mantri Kaushal Vikas Yojana (PMKVY) is a flagship scheme of the Ministry of Skill Development and Entrepreneurship (MSDE) through National Skill Development Corporation (NSDC). The scheme aims to cover around 24 lakh persons. Skill training would be done based on National Skill Qualification Framework (NSQF) and industry led standards. Under the scheme, a monetary reward is given to the trainees on assessment and certification by third party assessment bodies. The scheme would train, assess and certify candidates across various job roles created by the SSC. In addition, the scheme also envisages to assess and certify the existing manpower across sectors for "Recognition of Prior Learning (RPL)". Average monetary reward would be around Rs. 8,000 per candidate for fresh training and Rs. 2,200 per candidate under Recognition of Prior Learning. Each stakeholder under the PMKVY Scheme has a critical role in mobilizing, motivating, counseling, training, assessment and reward distribution under the scheme.

The quality of training provided to each trainee will position them as employment ready for industry-recognized roles. The assessment by an independent third-party assessment agency will provide for standardization of skills and make them industry-ready.

As a major stakeholder in the scheme implementation, the Sector Skill Councils (SSC) are expected to –

- Finalize the Job Roles Qualification Packs (QPs)
 - ▶ Identification of job roles, QP National Occupational Standards (NOS) as assessment criteria, maximum marks for each QP-NQS and pass marks
 - ▶ Question banks related to identified QPs to be prepared and submitted to NSDC, PMKVY Project Management Unit (PMU) and Assessment Agencies (AAs)
- Affiliate Training Providers (TPs)
 - ▶ NSDC TPs are to be auto-affiliated in the sectors they are operating under NSDC
 - ▶ No affiliation fee to be charged by the SSCs
 - ▶ Every centre must be registered on Skill Development Management System (SDMS) and approved by SSC(s)
 - ▶ No subcontracting shall be allowed
 - ▶ Monitoring of the TPs
- Register Assessment Agencies (AA)
 - ▶ SSCs to ensure that the registered AAs are not affiliated as TPs with the same SSCs
 - ▶ All the documents pertaining to AA registration to be made available on SDMS

- ▶ All the assessors of AAs should be certified by the SSCs
- ▶ Monitoring of the AAs
- Allocate Targets to the TPs
 - ▶ SSCs to allocate targets to all the affiliated TPs as per their methodologies
 - ▶ Allocation to be made on quarterly basis based on the TP's performance
- Approve Assessment results
 - ▶ Assessment agencies to conduct assessment and upload result on SDMS. SSC to approve the final results in two steps
- Certify successful candidates
 - ▶ SSCs to certify the candidates after successful completion of the assessment and validation of identity of the candidate based on Aadhaar Authentication.
- Upload and approve data on SDMS for the steps above
- Create and operate a grievance redressal committee at the SSC to handle complaints and grievances of various stakeholders
- Submit the monitoring report of the scheme implementation on a monthly basis.

The SSC is expected to abide by the process manual for the PMKVY scheme as updated from time to time. Any deviation to the process manual would be dealt as per the consequence management system of the PMKVY scheme. The SSCs may be subject to audit for processes to assess their performance. The SSCs would be expected to coordinate and extend full support towards such requirements.

As the Scheme would process, there would be changes in the processes of the Scheme. SSCs would be required to accommodate these changes.

Central Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and Its Relevance to Skill Development

State Governments and U.T. Administrations are required to implement different provisions of this Act. These provisions include, (i) Roles to be notified, (ii) Welfare Board to be constituted, (iii) Implementation of cess collecting authority to be notified, (iv) State Advisory Committee to be constituted and (v) Schemes for implementation to be formed. States are required to keep record of (a) No. of workers registered with the Board, (b) Amount of Cess collected and (c) Amount of cess spent. In order to oversee the implementation, a Central Building and other Construction Workers Advisory Committee was formed by Ministry of Labor & Employment, Govt. of India. This committee is headed by Union Minister of Labour and Employment. Members include, Members of Parliament, top level officers of Ministry of Labour, Workers' representatives, employers' representa-

tive, representative of insurance sector and representative of the Institution of Engineers (I).

The implementation of various provisions of this Act is reviewed by this Advisory Committee from time to time and necessary directions are issued given to State Governments. It was noted by committee that as on 31.03.2013, by and large provisions of this Act which include notification of rules, constitution of Board, notification of cess collection authority, formation of State Advisory Committee and framing of implementation scheme has been done by most of the States and U.T. Administrations. The status of implementation as on 30.06.2011, is given in Annexure 2. It will be observed from Annexure that the cumulative total on all India basis is, (i) Registered workers with Welfare Boards - 74,64,328 Nos. , (ii) Amount of cess collected by Boards-Rs.5265.57 crores and (iii) Amount of cess spent by Boards - Rs.752.12 crores. The amount spent was about 14% of amount collected. While details of implementation by individual states can be seen from Annexure, it is important to note that huge funds collected for workers by State Governments and U.Ts remained utilized at that stage.

One of the more important point to note is that the Advisory Board considers Skill Development of Construction Workers as part of workers welfare activity. Therefore, State Governments and Union Territories can utilize part of welfare fund for skill development. Ministry of Labour in its circular dated 12/7/2013 to State Governments conveyed its decision regarding utilization of funds for skill development. They mentioned that the State Govt. should spent 20% of balance cess amount at the beginning of the financial year on activities related to the skill development.

The Government has already decided that 20% of the BOCW Cess funds would be utilized for skill development activities for construction workers and their family members. A large number of construction workers have acquired some skills informally through their work experience. However, these workers still require some formal training in order to obtain a national recognized certificate which will also improve their mobility in labour markets, in addition to increase in productivity and better wages. After in-depth consultation with the concerned expert agencies and construction industry, Ministry of Labour and Employment prepared a scheme for Recognition of Prior Learning (RPL) of construction workers. The Scheme was discussed in the State Labour Ministers' Conference held on 29th August, 2014.

The Scheme has been formally approved and has been communicated to all the stakeholders including the State Governments. Mainly, the Scheme provides for a pre-training assessment of the construction worker registered with BOCW,

fifteen day long gap training and final assessment leading to NCVT certification. The training is to be imparted at the construction site itself in order to minimize the disruption in construction work. The expenditure of training and assessment is to be borne from Cess funds which also include wage compensation to the construction worker at an hourly rate of 35 rupees during the period of classroom training and assessment. In order to ensure quality of training and assessment, a committee has been set up by the Ministry with representation of the states to empanel training providers and assessing bodies having good track record. The Scheme has evinced good interest from several states and construction industry.

Provisions in Government Contract Documents

Contracts for construction projects are between Employers such as Government/ Semi-Government organizations, developers, BOT operators, private entrepreneurs etc. and contractors. The contract is operated according to provisions of different clauses of the contract agreement. In the context of training and certification of workmen, technicians and supervisors, it was felt that in case Employer provides for employment of trained workmen in the contract, the contractor will be forced to employ trained and certified workmen. Therefore, this approach can help in expediting training and certification of workmen.

Some Employers are considering necessity for employing trained and certified workmen by incorporation of the same in a contract clause. A few provisions are detailed below.

(i) FIDIC Condition of Contract—The relevant provisions regarding Contractor's Superintendence (Para 6.8) and Contractors Personnel and Records (Para 6.9 and 6.10) are given in Annexure 3-1. Para 6.8 mentions about personnel employed at the level of professionals and Para 6.9 mentions about the workmen to be employed by Contractor. This Para states that Contractor's Personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. Besides, there is a provision which empowers Engineer to remove any of Contractor's Personnel who is not found suitable. Engineer is empowered to employ suitable replacements, Para 6.10 gives responsibility to Engineers to keep record of Contractor's Personnel etc.

These provisions of FIDIC Contract form clearly states that workmen to be employed by contractor should be qualified, skilled and experienced. In order to ensure that these workmen are qualified and skilled it is necessary that they must be trained and certified. In fact in developed countries workmen having required certificate regarding training only are employed. In countries like India, proper implementation of these provisions is not possible in foreseeable future because trained and certified workers are not available. The fact of the matter is that the Engineer cannot ensure proper implementation of these provisions.

(ii) CPWD Condition of Contract – Clause 19K is regarding employment of skilled/ semi-skilled workers (Annexure 3-2). This clause is meant for contracts having estimated cost exceeding Rs.5 crore. According to this clause, contractor is required to employ qualified and certified tradesmen. The institutes for certification of workmen mentioned in the clause includes CPWD Training Institutes, ITIs, NICMAR, CIDC and similar institutes recognized by Central/ State Governments. The clause further clarifies that number of such qualified tradesmen shall not be less than 20% in each trade. The contractor has to make available required information. The clause further provides that if the tradesmen are found to have inadequate skills, the contractor has to substitute with alternative worker, failing which compensation at specified rate is to be paid by contractor. Information made available indicates that this Clause has not been implemented in real sense.

(iii) MES Condition of Contract – The Clause 26 is regarding employment of qualified tradesmen (Annexure 3-3). As per this clause the contractor has to employ tradesmen who are qualified and certified by one of the institutes specified, in their respective trade. The clause further provides that the number of qualified tradesmen shall not be less than 25% of total tradesmen in each trade. The clause also provides that if tradesmen are found to have inadequate skills, the contractor has to replace such tradesmen. No information about implementation of this Clause is available.

By and large private employers such as developers, do not specify employment of skilled & certified workmen by the contractors. Similarly, private individuals while considering employment of workers, for their own construction projects, do not insist for skilled and certified workmen.

Issues

Manner of Employment of Workmen in Construction Sector is informal and project oriented. The project is awarded to contractor by the employer. The contractor employs workmen of different categories, as per specific requirement for different periods. This employment is generally through sub-contractors, labor contractors or petty contractors. At times, main contractor also employs workmen directly. Generally, the employment of workmen is casual and only for short period. The contractor is not interested to spend for welfare of workers i.e. their training and certification. The workmen is interested to get trained and certified but does not want to lose wages for getting trained. So, status does not change. There are exceptions like L&T. They ensure training and certification of their workmen. By and large workmen are not given opportunity to get training and certification.

Employers are either Govt. organizations or private construction agencies, real estate developers. They have very important role to play. For Govt. organizations, the objective is to get the project executed and completed. It is not their concern whether workmen are trained and certified or not. In view of policy of the Government regarding skill development, departments like CPWD and MES provided in their contract documents for employment of a particular percentage of workers having training and certification. The CPWD clause also provides for imposition of penalty for non-compliance. As regards implementation of these provisions, informal enquiries indicate that at times officers' in-charge are not aware of even existence of such clause what to talk of implementation. Non-compliance goes un-noticed. In fact, engineers of employer and even head of departments do not consider it as their responsibility to ensure employing trained and certified workmen. Besides, there is no infrastructure for organizing training program. Thus, on account of apathy and non-sensitivity by Employers, skill development of workers is not getting any impetus.

Day Workers are available for construction work at specific locations in cities and towns. Anybody in the vicinity, desirous for employing these workers, approaches them personally. Thereafter, take them to the work site and employ for one day or more, as required. These workmen, who earn their livelihood by getting employment on daily basis, have no desire for getting training and certified. They are self supported for their livelihood.

Organizations have different nomenclature for different categories of workmen. Ministry of labor has prepared an exhaustive list of categories, which by and large cover about 90% of workmen. Two important organizations i.e. Ministry of Transport and Central PWD have different nomenclature in their Schedules. State PWDs are having local variation in the nomenclature. The CSDCI has come up with different nomenclature. It is desirable to consider working out standard nomenclature for different categories of workmen and these should be adopted in different standards, schedules and specifications. We can consider adoption of DGE&T nomenclature for workmen, by all the agencies.

For Machine Operators much attention has not been paid. The civil construction is gradually moving towards mechanization. More and more machines for hoisting, mixing, fixing, transporting, cutting, consolidating, breaking etc. are being used. These machines are to be operated by skilled drivers and skilled mechanics are required for upkeep, maintenance and repair. It is necessary to evolve and workout standard categories of machine operators and work out their training requirements. The initiative for training and certification is to be taken both by construction organizations and machine manufacturers.

Laboratory Supervisors and Assistants are required for testing laboratories at construction project sites. These laboratories play a very important role for quality control. Most of the laboratory assistants are non-qualified. It is necessary that standard training courses are evolved for laboratory assistants and other workers connected with laboratories. For training of Laboratory Assistants, Indian Concrete Association has initiated some work. It is worth appreciation.

Surveyors with modern instrument are necessary for construction. Total station surveyor is required practically for all the projects. DGE&T has listed two categories of surveyors for training. But, the syllabus is outdated. It is necessary to revise the syllabus, as per modern trends of surveying and train surveyors as per revised syllabus. In fact, it is essential that DGE&T keep upgrading, modifying, deleting and adding course content on regular basis with a pulse on emerging technologies and construction practices.

Labor Departments in State Governments and U.Ts have important role to play. The Building and other Construction Workers Act 1996 is being implemented through State Governments and workmen welfare cess is collected by Labor Departments. The status reviewed by Advisory Committee of the Ministry of Labor & Employment a few years back showed that by and large funds of welfare cess remained under/un-utilized. It was agreed in principle that part of these funds can be utilized for skill development i.e. training and certification of workmen. Some Governments like Govt. of NCT of Delhi, took initiative in this regard but implementation has to reach to logical conclusion and training should start. It will also be desirable to develop a package of welfare of workmen at project site which should also include skill development.

On review of various provisions regarding employment of workmen, it is noted that FIDIC condition mentions that such workmen are to be employed who are appropriately qualified and skilled but it does not specify that workmen should be trained and certified. Thus contractor is therefore not obliged to employ certified workmen and suitability of workman is left to the discretion of Engineer. The CPWD provision specifies employment of 20% certified workmen and MES provision specifies employment of 25% certified workmen. For non-compliance, the CPWD provides for some compensation to be levied for employing such workers who do not have required skills. The MES provision does not mention about compensation. These provisions are a step forward but do not lead to any change in environment to ensure training and certification of workmen. At present adequate numbers of trained and certified workmen are not available in open market so one cannot expect contractor to employ even 20-25% of skilled force requirement as certified workmen. Besides, employment of a small percentage of certified workmen is not likely to bring about change in quality or productivity. Moreover, the MES provision does not specify compensation for non-compliance. Thus these

provisions have not brought any change in the environment and are not likely to bring about a change in future both in quality of work and productivity. If Employer is not serious, it is not expected that contractors will make efforts to implement these provisions. Thus change is not likely to happen with such provisions. Both employer and contractor are uncaring and insular as to the urgency of employing trained workmen at project. Unless demand is generated from the project site, workmen will not have any incentive for acquiring the training. Fresh thinking is required.

Training institutes run by Govt. departments generally impart training to executives. At times, training is also given to workmen employed directly by Government. But there is no provision for training of workmen of contractors. It will be desirable to extend training facility by these training institutes, for workmen of contractors. Besides, a number of branches can be opened for these training institutes by departments particularly at Zonal and Circle headquarters. The training facility, if available, can always be utilized by contractors. In fact, these institutes can extend training facilities to even private players. All officers of Chief Engineers/ Superintending Engineers should have attached Workmen Training Institute.

It is noted that developers deliver completed houses for purchase by the public. Most of these developers employ workmen through contractors. By and large these contractors employ untrained workers and there is no control on them to employ only trained and certified workmen. The Government authority for these developers like housing boards, development authorities etc. should exercise control and insist that only skilled and trained workers are employed. This provision can be made obligatory at approval of Plan stage. Besides, they should be directed to maintain record about employment of skilled workmen. Local bodies and Development Authorities can ensure employment of trained and certified workmen. One can expect change in the quality of work only when training and certification becomes a necessary condition for the employment.

Keeping pace with the global trend, there will be more emphasis toward using modern construction technology and practices with progressively reduced human intervention in deciding upon different elements of construction. This will necessitate trained work force, machine operators who can follow technical instructions and put them to practice. Quality of work output will therefore be directly linked to proficiency of workforce employed. The only way to do so is to employ qualified and certified workmen. But unfortunately such workmen are not available and Employers or contractors are not interested to train and certify these workmen because either it is not in their scope as in the context of implementation of government contract or contractors/builders/real estate developers do not want to invest on workmen's training as it affects their profitability. That is why in spite of

provisions the status has not much changed. It is also noted that skilled workers employment related provisions in the Government contract are covered under the clause which deals with the welfare of labor whereas the condition of employment of trained and certified workmen is directly related to quality and productivity. Therefore, provision for training and certification of workmen should not have been added under clause for welfare of workmen and instead a special condition should have been provided in the body of contract which governs rights and responsibility of contracting parties. The problem for employing trained and certified workmen can be solved to a great extent by imparting training at the project site. This should include skilled/ semi-skilled workmen as also technicians and supervisors. Thus it will be a proper approach, if training is given to workmen, while they work and within 03 months of getting employment at project site most of them can be given training and issued certificate after trade test. It will be necessary to review the list of those who are employed by the contractor and ascertain for whom the training can be imparted at project site. Other workmen, who are highly specialized, may also need training but organizing training for them at project site will be difficult. Therefore, ways and means will have to be found to train them at training institutes. Besides, for small contracts, where the period for employment of workmen is short, it may be difficult to organize training at the project site. It is felt that training at project site is possible for projects of reasonably good size and where period of construction is more than one year or more. For smaller projects alternative solutions are to be found such as grouping of projects in the vicinity or arranging training of workmen of small projects once in a week at some recognized training institute. For machine operators and workmen dealing with specialized materials, it will be desirable to organize training in coordination with manufacturers and suppliers. It should also be kept in mind that workmen at project site are already in their profession and their training is easy compared to fresh recruitments. Besides, they already have some professional skills. To ascertain their skills, gap analysis is necessary and they are to be trained only for the ascertained gap and then certificate can be awarded after trade test. Thus in real sense their training is a Refresher Course. Even otherwise, to certify workmen already in the profession, short term Refresher Course at training institute can be organized. To implement such training and certification in efficient manner, suitable provision in contract is necessary. This will cover the projects covered by the government departments. For private builders, developers etc very strict oversight by the municipal, development, labor and other controlling and approving authorities will be needed. For lax and departure there will have to be a suitable mechanism for carrying out punishment procedure.

Planning Commission documents talk of training 500 million people but surprisingly traditionally or informally acquired skills through actual work have been completely ignored for the purpose of calculating skill gaps or for skill development initiatives. It is not without reason that the informal sector values actual

skills more than any formally certified training. In view of the fact of vast number of work force falling under this category, it is essential that informal sector is more incentivized like above discussed on job training at site or through some other independent assessment mechanism. Certification can be issued after ascertaining their skill gaps. Any action in this regard will bring vast number of otherwise skilled workforce under formally recognized certification program. This will also boost growth in a widely disseminated manner as informal sector is geographically more distributed.

To Move Forward

Let us look back on Skill Development issues in a wider spectrum. After independence, our country executed mega and major construction projects under its Five Year Plans. Still, for almost half century the issue regarding training, trade test and certification of workers remained almost neglected. After turn of century some activities related with skill development started on the basis of report by an international body. It was followed by policy decisions, formation of organizations, documentation etc. particularly during Eleventh and Twelfth Plan (still continuing). But achievements were never publicized by Central or State Governments. In fact, no political party highlighted this issue of National importance.

At this juncture, it is necessary to bring this issue to the notice of politicians, administrators, professionals, press and electronic media as also public at large so that this issue is given due importance. It is also considered necessary to review achievements at Central and State level, so that public can be informed whether there is anything worthwhile achieved so far or not. Of course, the fact that achievements were not publicized or highlighted makes us believe that nothing worth mentioning has been achieved. Still, efforts can be made to ascertain facts. In case it is not possible to know realistic position, may be RTI or PIL can be initiated. It is recommended that Central Government as also State Governments should review the status on this issue & take action on priority. In fact extra efforts will be necessary to make good the short falls in skilled labor force. Besides, responsibility by way of instructions, orders, legislations etc. be given to employers, to ensure that employing trained and certified workers etc. is made obligatory. Moreover, adequate publicity be given in press and electronic media to make public aware of this national cause. Even professionals, organizations, trade unions, chamber of commerce etc. will have to play proactive role. Real skill development which will make country's productive young workforce a real asset for the various development field is the only way forward to take country into high growth trajectory.

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Annexure - 1

Skill Development Initiative Scheme (SDIS) based on Modular Employable Skills

List of MES Courses approved by NCVT – Construction and Other Trades related
to Construction

Six digit code is used for each MES course as per details given below:

From left side:

1st, 2nd and 3rd digits – Sector Code (Alpha Codes)

4th digit – Level Code (1 for level 1, 2 for level 2, 3 for level 3 and so on)

5th and 6th digits – Course serial number (separate series for courses at same level within each sector)

For Example CON 101

CON: Construction

1: Level One Course

01: Course Serial Number (Assistant Shuttering Carpenter and Scaffolding)

A. Construction

| S.No. | MES Course Code | Sector/Course | Minimum Education Qualification & MES Course | Duration Of Training (Hours) | Test Fees | Trg. Cost Cat. |
|-------|-----------------|---|--|------------------------------|-----------|----------------|
| CON | CONSTRUC TION | | Minimum age -14 years | | | |
| 1. | CON 101 | Assistant Shuttering Carpenter & Scaffolder | 5 th | 300 | 800/- | A |
| 2. | CON 202 | System Shuttering Carpenter | 5 th + CON 101 | 300 | 800/- | A |
| 3. | CON 203 | Conventional Shuttering Carpenter | 5 th + CON 101 | 300 | 800/- | A |
| 4. | CON 204 | Scaffolder | 5 th + CON 101 | 300 | 800/- | A |
| 5. | CON 205 | Building Carpenter | 5 th + CON 101 | 300 | 800/- | A |
| 6. | CON 106 | Assistant Bar Bender & Steel Fixer | 5 th | 300 | 800/- | A |
| 7. | CON 207 | Bar Bender | 5 th + CON 106 | 300 | 800/- | A |
| 8. | CON 10 8 | Assistant Mason | 5 th | 300 | 800/- | A |
| 9. | CON 209 | Mason | 5 th + CON 108 | 300 | 800/- | A |
| 10. | CON 210 | Tiler (Ceramic) | 5 th + CON 108 | 300 | 800/- | A |
| 11. | CON 111 | Assistant Plumber | 5 th | 300 | 800/- | A |
| 12. | CON 212 | Plumber | 5 th + CON 111 | 300 | 800/- | A |
| 13. | CON 113 | Assistant Works Supervisor | 8 th | 300 | 800/- | A |
| 14. | CON 114 | Assistant Storekeeper | 12 th | 200 | 800/- | A |
| 15. | CON 115 | Junior Land Surveyor | 10 th | 400 | 800/- | A |

| | | | | | | |
|-----|---------|--|---|-----|-------|---|
| 16. | CON 216 | Works Supervisor | 10 th + CON 113 | 300 | 800/- | A |
| 17. | CON 217 | Storekeeper | Graduate Degree if any discipline + CON 114 | 300 | 800/- | A |
| 18. | CON 218 | Senior Land Surveyor | 10 th + CON115 | 400 | 800/- | A |
| 19. | CON 119 | Junior Rural Road Layer | 5 th | 120 | 800/- | A |
| 20. | CON 120 | Assistant Highway Works Supervisor | Inter pass, ITI, GWS, III year diploma appeared | 300 | 800/- | A |
| 21. | CON 221 | Highway Works Supervisors | Inter pass, ITI, G WS, III year diploma appeared+ CON 120 | 300 | 800/- | A |
| 22. | CON 222 | 3D Design er Using Pro E | 10 th +ICT 101 | 200 | 800/- | A |
| 23. | CON 323 | 3D Advanced Design Using Pro E | 10 th +CON 222 | 200 | 800/- | A |
| 24. | CON 124 | Construction Electrician -I | 8 th | 300 | 800/- | A |
| 25. | CON 225 | Construction Electrician-II | 8 th + CON 124 | 150 | 800/- | A |
| 26. | CON 326 | Construction Electrician -III | 8 th +CON 225 | 300 | 800/- | A |
| 27. | CON 227 | Building Security System Mechanic | 8 th + ELC 101+ ICT 101 | 200 | 800/- | A |
| 28. | CON 128 | Rigger | Basic Reading & Writing | 200 | 800/- | A |
| 29. | CON 229 | Electrical Wireman | 8 th + ELE 101 | 200 | 800/- | A |
| 30. | CON 230 | Control Panel Assembler | 8 th + ELE 101+ FAB 109 | 200 | 800/- | A |
| 31. | CON 231 | Electrical Fitter | 8 th + ELE 101 | 200 | 800/- | A |
| 32. | CON 232 | Overhead Linesman | 8th + ELE 101+ CON 111 | 200 | 800/- | A |
| 33. | CON 233 | Cable Joiner (Power) | 8 th +ELE 101 + CON 111 | 200 | 800/- | A |
| 34. | CON 234 | Communication System Mechanic | 8 th +ELE 101+ELC 101 | 200 | 800/- | A |
| 35. | CON 235 | Refrigeration/ Air Conditioning/ Ventilation Mechanic (Electrical Control) | 8 th + ELE 101+ FAB 108 | 200 | 800/- | A |
| 36. | CON 236 | Fire Services Electrical Fitter | 8 th +ELE 101+ ELC 101 | 200 | 800/- | A |
| 37. | CON 437 | Construction Electrician -IV | 8 th +CON 326 | 200 | 800/- | A |
| 38. | CON 138 | Helper | 5 th +Able to read & write & 14 years of age | 90 | 500/- | A |
| 39. | CON 139 | Earth Work Excavator | Read & Write Local language | 150 | 500/- | A |
| 40. | CON 140 | Granite Stone Dresser T I | 5 th | 200 | 500/- | A |
| 41. | CON 241 | Granite Stone Dresser T II | 5 th + CON 140 | 120 | 500/- | A |
| 42. | CON 242 | Granolithic Flooring Mason | 5 th + CON 108 | 120 | 800/- | A |

B. Other Trades related to Construction

| S.No. | MES Course Code | Sector/Course | Minimum Education Qualification & MES Course | Duration Of Training (Hours) | Test Fees | Trg. Trade Cat. |
|-------|---------------------|--|--|------------------------------|-----------|-----------------|
| ELE | ELECTRICAL | | Minimum age-14 years | | | |
| | ELE101 | Basic Electrical Training | 5th | 120 | 800/- | A |
| | ELE203 | House Wiring | 8th+ ELE101 | 120 | 800/- | A |
| | | | | | | |
| ELC | ELECTRONICS | | Minimum age-14 years | | | |
| | ELC 101 | Basic Electronics (Repair & Maintenance of Power Supply, inverters and UPS | 8th | 120 | 800/- | A |
| | | | | | | |
| FAB | FABRICATION | | Minimum age-14 years | | | |
| | FAB101 | Basic Welding (Gas) | 8th | 120 | 800/- | A |
| | FAB102 | Basic Welding (Arc) | 8th | 120 | 800/- | A |
| | FAB103 | Gas Cutting | 8th | 120 | 800/- | A |
| | FAB204 | TIG Welding | 8th +FAB101 | 90 | 800/- | A |
| | FAB205 | MAG/ CO2 Welding | 8th +FAB102+103 | 90 | 800/- | A |
| | FAB206 | Fabrication Welding | 8th +FAB102+103 | 180 | 800/- | A |
| | FAB207 | Pipe welding (TIG & ARC) | 8th +FAB102+103 | 150 | 800/- | A |
| | FAB108 | Basic Fitting Work | 8 th | 180 | 800/- | A |
| | FAB109 | Basic Sheet Metal Work | 8 th | 180 | 800/- | A |
| | FAB210 | Structural Fabrication | 8th +FAB 103 | 150 | 800/- | A |
| | FAB211 | Pipe Fabrication | 8th +FAB 103 | 150 | 800/- | A |
| | | | | | | |
| MAM | MATERIAL MANAGEMENT | | Minimum age-14 years | | | |
| | MAN101 | Store Attendant | 8th | 180 | 800/- | B |
| | MAN102 | Material Handling | 8th | 160 | 800/- | B |
| | MAN103 | Finish Goods Keeper | 10th | 160 | 800/- | B |
| | MAN104 | Assistant Storekeeper | 12th | 300 | 800/- | B |
| | MAN205 | Storekeeper | 12th+ MAN104 | 300 | 800/- | B |
| | | | | | | |

| | | | | | | |
|------------|-------------------------------|--|--------------------------------------|-----|-------|---|
| PAI | PAINT | | Minimum age-14 years | | | |
| | PAI101 | Painter Assistant/helper | 5th | 90 | 800/- | A |
| | PAI202 | Wall Painter | 5th+ PAI 101 | 120 | 800/- | A |
| | PAI203 | Wood Painter | 5th+ PAI 101 | 180 | 800/- | A |
| | PAI204 | Metal Surface Painter | 5th+ PAI 101 | 150 | 800/- | A |
| | PAI205 | Spray Painter | 5th+ PAI 101 | 90 | 800/- | A |
| | PAI306 | Painter (Application, Testing, Handling and Storing) | 5th + Any one of MES Level II course | 120 | 800/- | A |
| | | | | | | |
| WOO | WOOD WORK | | Minimum age-14 years | | | |
| | WOO 101 | Basic Wood Work | 5th | 270 | 800/- | A |
| | WOO 202 | Wooden Furniture | 5 th + WOO 101 | 270 | 800/- | A |
| | | | | | | |
| RWH | RAIN WATER HARVESTING | | Minimum age-14 years | | | |
| | RWH 101 | Assistant Rain Water Harvester | 7th | 200 | 500/- | |
| | RWH 202 | Rain Water Harvester | 7th + RWH 101 | 200 | 500/- | |
| | | | | | | |
| EMS | ELECTRO-MECHANICAL | | Minimum age-14 years | | | |
| | EMS101 | Junior Assistant – Elevator Installation | 8th | 150 | 500/- | A |
| | EMS202 | Assistant Elevator Installer | 8th + EMS101 | 400 | 800/- | A |
| | EMS303 | Elevator Installer | 8th + EMS 202 | 450 | 800/- | A |
| | | | | | | |
| CE | CONSTRUCTION EQUIPMENT | | Minimum age-14 years | | | |
| | CEQ101 | Maintenance Mechanic Mining & Road Equipment | 10th | 500 | 800/- | |
| | | | | | | |

Annexture - 2

Status of implementation of Building and Other Construction Workers Welfare Cess Act., 1996, with regard to registration of workers, Cess Collected and Amount Spent as on 30.06.2011

| S.No. | Name of State Union Territory | Registered Workers with Board | Amount of cess collected in ₹cr. | Amount spent in ₹cr. |
|-------|-------------------------------|-------------------------------|----------------------------------|----------------------|
| 1. | Andhra Pradesh | 882070 | 472.00 | 12.78 |
| 2. | Arunachal Pradesh | 4298 | 12.03 | 2.49 |
| 3. | Assam | 3150 | 44.36 | 0.13 |
| 4. | Bihar | 18566 | 127.93 | 0.19 |
| 5. | Chhattisgarh | 62335 | 58.76 | 3.61 |
| 6. | Goa | 0 | 3.81 | 0 |
| 7. | Gujarat | 48971 | 190.22 | 0.41 |
| 8. | Haryana | 146667 | 419.8 | 6.36 |
| 9. | Himachal Pradesh | 633 | 51.22 | 0 |
| 10. | J&K | 0 | 0 | 0 |
| 11. | Jharkhand | 16285 | 21.09 | 0.11 |
| 12. | Karnataka | 140869 | 855.93 | 8.21 |
| 13. | Kerala | 1689789 | 509.29 | 375.65 |
| 14. | Madhya Pradesh | 1708574 | 527.31 | 119.33 |
| 15. | Maharashtra | 0 | 10.53 | 0 |
| 16. | Manipur | 0 | 0 | 0 |
| 17. | Meghalaya | 0 | 0 | 0 |
| 18. | Mizoram | 0 | 0 | 0 |
| 19. | Nagaland | 0 | 0 | 0 |
| 20. | Orissa | 60640 | 77.95 | 0.0066 |
| 21. | Punjab | 32839 | 150.31 | 2.1 |
| 22. | Rajasthan | 35119 | 114.5 | 0.31 |
| 23. | Sikkim | 0 | 0 | 0 |
| 24. | Tamil Nadu | 2115097 | 423.29 | 182.19 |
| 25. | Tripura | 8568 | 28.52 | 0.1 |
| 26. | Uttar Pradesh | 100060 | 172.81 | 0.2 |
| 27. | Uttarakhand | 755 | 8.32 | 0.01 |
| 28. | West Bengal | 313180 | 290.62 | 4.59 |
| 29. | Delhi | 41766 | 656.29 | 28.36 |
| 30. | A&N Island | 1080 | 7.4 | 0.03 |
| 31. | Chandigarh | 7562 | 9.73 | 0.33 |
| 32. | Dadra & Nagar Haveli | 0 | 0.17 | 0 |
| 33. | Daman & Diu | 0 | 0.73 | 0 |
| 34. | Lakshadweep | 0 | 0 | 0 |
| 35. | Puducherry | 25455 | 20.65 | 4.62 |
| | Total | 7464328 | 5265.57 | 752.1166 |

*Annexure - 3.1***International Federations Of Consulting Engineers**

Conditions of Contract

for

Construction For Building And Engineering Works
Designed By The Employer

Multilateral Development Bank Harmonized Edition
March 2006

Extract from General Conditions

| | | |
|-------------------------------------|-----|--|
| Contractor's Superintendence | 6.8 | <p>Throughout the execution of the Works, and as long thereafter as in necessary to fulfill the Contractor's obligation, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect and test the work.</p> <p>Superintendence shall be given by a sufficient number of persons having adequate knowledge of the language of communications (defined in Sub-Clause 1.4 [law and Language]) and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Works.</p> |
| Contractor's Personnel | 6.9 | <p>The Contractor's Personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. The Engineer may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representatives if applicable, who:</p> <ul style="list-style-type: none"> a) persists in any misconduct or lack of care, b) carries out duties incompetently or negligently, c) fails to conform with any provisions of the Contract, or d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment. <p>If appropriate, the Contractor shall then appoint (or cause to be appointed) a suitable replacement person.</p> |

| | | |
|--|------|---|
| Records of Contractor's Personnel and Equipment | 6.10 | The Contractor shall submit, to the Engineer, details showing the number of each class of Contractor's Personnel and of each type of Contractor's Equipment on the Site. Details shall be submitted each calendar month, in a form approved by the Engineer, until the Contractor has completed all work which is known to be outstanding at the completion date stated in the Taking-Over Certificate for the Works. |
|--|------|---|

*Annexure - 3.2***Provision in CPWD Contracts****CLAUSE 19K**

| | |
|--|---|
| Employment of skilled/ semi skilled workers | <p>The Contractor shall, at all stages of work, deploy skilled/ semi skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute/ Industrial Training Institute/ National Institute of Construction Management and Research (NICMAR)/ National Academy of Construction, CIDC or any similar reputed and recognized Institute managed/ certified by State/ Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled/ semi skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen alongwith requisite certificate from recognized institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs.100/- per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.</p> <p>Provided always, that the provisions of this clause shall not be applicable for works with estimated cost put to tender being less than Rs.5 crores.</p> |
|--|---|

*Annexure - 3.3***Provision in MES Contracts****26. Qualified Tradesmen**

26.1 In compliance with the Condition 26 of IAFW-2249 (General Conditions of Contracts) the contractor shall employ skilled / semi skilled tradesmen who are qualified and possessing certificate in particular trade from Industrial Training Institute (ITI) / National Institute of Construction Management and Research (NICMAR)/ National Academy of Construction (NAC), Hyderabad / Similar reputed and recognized Institutions by State / Central Government, to execute the works or their respective trade. The number of such qualified tradesmen shall not be less than 25% of total skilled /semi skilled tradesmen required in each trade. The contractor shall submit the list of such tradesmen along with requisite certificates to Garrison Engineer for verification and approval. Notwithstanding the approval of such tradesmen by GE, if the tradesmen are found to have inadequate skill to execute the work of their trades, leading to un-satisfactory workmanship, the Contractor shall remove such tradesmen within a week after written notice to this effect by the GE and shall engage other qualified tradesmen after prior approval of GE. GE's decision whether a particular tradesman possesses requisite qualification, skill and expertise commensurate with nature of work, shall be final and binding. No compensation whatsoever on this account shall be admissible.



Concept of Smart Cities in India

Deepak Narayan

Past President, IBC & Former E-in-C, PWD, Delhi

Prologue

Developing the infrastructure of cities require answers to various problems such as overcrowding population, budget, resource constraints, present inadequate infrastructure and need for continuous growth. This is probably answered adequately by the word “smart city” The cities of tomorrow which can integrate various services and build highly secure, intelligent and multimodal transportation while ensuring safety and security.

bodies and municipalities shall have to be augmented both technologically and financially. Smart cities shall have to cater for expanding the livelihood of people working both in formal sector as well as in informal sector. There will have to be an integrated system of governance with better coordination amongst the departments to implement such schemes according to the author who enjoys reputation among the renowned and practical technocrats.

“Smart City” has become a buzz-word ever since the Narendra Modi government took charge at the centre. Smart cities are expected to provide infrastructure such as water, sanitation, reliable utility services, health-care, education and create climate to attract investments. According to the author, such cities shall be predominantly guided by information /communication technology for which urban local

The need of the hour is for innovative regional governance strategies and new infrastructure financing models and provide the solution of urban challenges to create appropriate urban infrastructure and smart cities.

- Editor-

Introduction

Urbanization represents one of the most transformative processes of human civilization in terms of social and economic parameters. Cities have changed the development paradigms of entire nations and have laid the foundation of modern economies. The urban global tipping point was reached in 2007 when for the first time in history, over half of world's population of 3.3 billion was living in urban areas. It is estimated that 60% of the world's population will be urbanized by 2030. India is booming and urban development becomes increasingly more important. According to a United Nations report, India's population currently encompasses about 1.2 billion people and is expected to grow by another 300 million by 2030. With the cities generating two

thirds of the country's economic output, an increasing number of people are leaving rural areas to seek employment in cities. By 2030 it is predicted that 68 Indian cities will have more than one million inhabitants and six megacities more than ten million each.

Urban performance currently depends not only on the city's endowment of physical infrastructure, but also on the availability and quality of communication and social infrastructure facilities. It is against this background that the concept of the smart city has been introduced as a strategic device to encompass modern urban development factors in a common framework to highlight growing Importance of Information and Communication Technologies (ICTs) and social and environmental capital. The significance of the two assets – social and environmental capital itself goes a long way to distinguish smart cities from their counterparts, drawing a clear line between them and what goes under the name of smart cities.

In conjunction with the growth in urbanization and in service industries, these have intensified competition across cities for attracting economic activity. Investment decision is significantly guided by the assessment of comparative advantage offered by different cities and regions of the country. Thus the concept of urban competitiveness of cities is rapidly gaining importance. The growth of Indian cities has put a huge strain on infrastructure, including water shortage, power shortage, energy shortage, traffic problems, pollution, congestion and overcrowding. The poor are driven to city in search of employment where unfortunately poor basic services and acute lack of housing provision exist. Paucity of housing for poor and affordable housing in cities has made India a home of largest slum population in Asia. The city infrastructure is technologically outdated and highly inadequate even to meet the present needs of its residents. Apart from the problem of non availability of funds, there is inability of urban agencies and institutions to make available these basic services to their citizens.

In the last decade, urban development concerns have been given some attention, due to which need for urban reforms and policy level intervention has been felt. As a consequence several initiatives have been taken by the government, the important ones of which are as follows:-

- The 74th Constitutional Amendment Act (CAA) 1992 recognized Urban Local Bodies (ULBs) and instituted a framework to significantly enhance their efficiency and functional capacity. It devolved greater financial powers to the local government apart from according proper representation to weaker section and women in ULBs.
- Jawaharlal Nehru National Urban Renewal Mission (JNNURM) which is administered by the Ministry of Urban Development and Ministry of Poverty Alleviation and supports the local investment in urban development. The objective is to create economically productive, efficient, equitable and responsive cities. To qualify for the JNNURM funding, the proposal envisages, (a) City Development Plan defining vision of the city over next 20-25 years (b) Detailed project report enumerating the financial requirements and (c) Time schedule for implementation

of the project. As a consequence to JNNURM, the government has drafted various policies in the area of urban development such as National Urban Transport Policy (2006) and the National Urban Sanitation Policy (2008). However there are lots of challenges which remain to be addressed for their proper implementation.

Urban Challenges In India

The scale of urbanization in India is unprecedented. It is estimated that nearly 140 million of people will move to cities by 2020 and 700 million by 2050. Mumbai, Delhi and Kolkata are expected to emerge as three largest cities in the world. By 2020, it is expected that 68 cities shall have population more than one million. Not only will Indian cities be amongst the largest by 2050, they will also be amongst the most densely populated. The higher density population results in greater pressure on infrastructure. Limited flexibility in land use and lack of resources will continue to hinder infrastructure development.

India will continue to grow its existing towns and smaller cities in the future. A city cannot be wiped out and planned anew. The process of revitalizing our existing cities must be carried through without interrupting the existing services, or distributing the lives of the people. This poses significant implementation challenges on ground, and needs robust design and technologically well planned implementation of the city development. The initiatives should be a judicious combination of augmentation of services by improving the functioning of ULBs. The municipalities are excessively burdened with services and inadequately financed resulting in poor levels of service delivery. The existence of a large number of departments, agencies and personnel undertaking similar overlapping functions, leads to problems in implementation. There is need to properly streamline the administrative jurisdictions, separating out functions suitably in the best interest of one and all.

A city's own revenues are mostly dependant on octroi and property taxes, which are highly inadequate. There is need to augment the financial resources. In addition, capacity of persons and organizations building and, availability and training of engineering and skilled personnel are also required. The key areas of housing, water supply, sewerage and sanitation, electricity, transport, education, healthcare also need to be adequately addressed.

Sustainable Urbanization

For urbanization to be successful there are three goals that are needed to be achieved. The benefits have to be socially equitable, economically viable and environmentally sustainable. Economically viable solutions are those that are financially self sustaining. Significant investment is needed for capacity enhancement as well as new additions. For example in transport sector we need augmentation of roads as well as implementation of intelligent multi model transport system by participation both from public and private sector. With the scale of investments taken care of, effective governance is a top priority. Appropriate policies should provide an enabling environment for urbanization initiatives, duly based on the principles of enforceability, deferability

and transparency. Effective governance needs to be supplemented by viable business model to ensure efficiency in planning and implementation.

For sustainable urbanization social, economic and environmental well being of the city are of paramount importance. With existing current resources and governance challenges, the present efforts are constantly falling short of the expected goals. The magnitude of challenge makes it mandatory to look for solutions that are better, cheaper and quicker. It not only provides a solution to address the systematic inefficiencies inherent in India's urban service delivery machinery but also provides solutions that ensure environmental sustainability and social inclusiveness.

Concept of a Smart City

Internationally, a city can be defined as smart when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources is achieved through participatory action and engagement. The smart city concept essentially means efficiency, but efficiency needs to be based on intelligent management and integrated ICTs, and active citizen participation. This implies a new kind of governance, genuine citizen involvement in public policy. Smart cities can be identified along six axes or dimensions; these six axes connect with traditional regional and neoclassical theories of urban growth and development. In particular, the axes are based on theories of regional competitiveness, transport and ICT, economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

The concept of the smart city as the next stage in the process of urbanization has been quite fashionable in the policy arena in recent years, with the aim of drawing a distinction from the terms digital city or intelligent city. Its main focus is still on the role of ICT infrastructure, but much research has also been carried out on the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth. The European Union, in particular, has devoted constant efforts to devising a strategy for achieving urban growth in a smart sense for its metropolitan city-regions.

A smart city is taken to be one that takes advantage of the opportunities ICTs offer to increase local prosperity and competitiveness—an approach which implies integrated urban development based on multi-actor, multi-sector, and multi-level perspectives. This leads to an “underlying emphasis on business-led urban development”, creating business-friendly cities with the aim of attracting new business. The data shows that business-oriented cities are indeed among those with a satisfactory socio-economic performance. Local intelligence capacity is intrinsically linked to that of the knowledge-based economy where innovation and technology are main drivers of growth and the collective community intelligence which underlines capacity and networks as main drivers of a community's success. This requires a planning paradigm pertinent for urban-regional development and innovation management.

Government Policy Initiatives on Smart Cities

The centre has proposed a blueprint to define the key documents of 100 smart cities it plans to establish across the nation. The cities are one of the main promises made by Prime Minister Narendra Modi in run up to the Lok Sabha elections earlier this year. The centre has allocated Rs 1000 crores for each city which will be selected according to its population. Eight cities with more than four million people have been identified and they will have a satellite smart city. Further, five cities will be upgraded to a smart city. Seventeen capital cities also qualify for such development irrespective of their population. There will be at least ten other smart cities with tourist and religious significance. Here are the five main elements of the proposed smart cities identified by the Union Urban Development Ministry:-

- The smart cities should have 24 X 7 availability of high quality infrastructure services including water and power.
- A robust transport system with emphasis on efficient public transport system.
- As a part of social infrastructure, the cities should provide opportunities for jobs and livelihood of its inhabitants.
- Smart cities should have proper facilities for entertainment, health and education facilities.
- The smart cities should minimize waste by increasing recycling and reducing water consumption. Proper recycling of waste materials should be done in such cities.
- Reliable, adequate utility services shall be critical to smart city concept.

The Union Budget of 2014 laid out a much needed emphasis on infrastructure spending to speed up urbanization. The budget calls for a \$ 1.1 billion investment on creation of 100 smart cities and significant other investments towards ports, metros and airports. What is also very heartening to note is that there is strong focus on renewable energy like solar, with the government's announcement to create ultra-mega-solar projects. If the country has to successfully build the energy infrastructure, the only way it can do is by embracing sustainability and energy efficiency at the care of every single project that it pursues.

World over, there has been a rapid innovation where it comes to technologies and systems that go into making a building more energy efficient and environmentally friendly. From air conditioning systems that consume significantly less power and emit far less greenhouse gases, to elevators which can run on renewable energy sources, to fire safety systems that dramatically decrease the water consumption while delivering better performance, the timing is to use innovations that are available today. Not only do many of these technologies reduce the footprint of a building or infrastructure project, but they also pay for themselves over a period of time.

Govt. of India has allocated Rs 70.6 billion (USD 1.2 billion) for smart cities in the Budget 2014-15. India will also develop modern satellite towns around existing cities under the smart city programme. The important features of the plan for smart cities are as follows:

- PPP model to be used to upgrade infrastructure in 500 urban areas
- Develop over a long period of time (20 years), 2 smart cities in each of India's 29 states
- Delhi Mumbai Industrial Corporation Ltd to develop ten smart cities along 1500 km industrial corridor across six states with a total investment of USD 100 billion
- To develop 6 million electric and hybrid vehicles by 2020
- Develop metros, high speed rail and monorail projects
- Broadband connections to 175 million users by 2017
- Develop as a part of smart city project, seven big cities (Delhi, Mumbai, Kolkata, Chennai, Ahmadabad, Bangalore and Hyderabad) to focus on technical advancement
- Disaster risk mitigation in coastal villages
- India is expected to emerge as the world's third largest buildings market by 2020 including adequate increase in Intelligent Building Management Systems.

The Way Forward

To achieve smart and sustainable urbanization in the country the cities should be in a position to provide high quality infrastructure to the citizens. It is essential to let go the absolute approaches to financing, governance management and development of the cities. There is a need to empower the existing ULBs to execute the development and deliver the results. There is need to put in place technologically up-gradated system and procedures necessary for meeting the objectives of sustainable urbanization. Some of the important points in this regard are enumerated below for suggested implementation.

Strengthening the Urban Local Bodies

The ULBs are presenting weak and ineffective on account of lack of support from state governments, lack of finances, inadequate capabilities and inadequate devolution of powers and functions. In view of this there is a need of amending the 7th schedule to carve out a separate legislative list in the constitution – the fourth list beyond central, state and concurrent lists which may be called a “local list” reserving the subjects under 11th and 12th schedules for local bodies exclusively. This would institutionalize local bodies as the third arm of governance and help in constitution of ward committees, district planning committees and metropolitan planning committees. Many states have not transferred functions, funds and functionaries to ULBs.

To strengthen the ULBs it is considered essential that direction of states in constituting and granting of executive power be removed by suitably amending 73rd and 74th CAA. Further, the transfer of function under the 12th schedule should be made mandatory and functions should be handed over the ULBs to ensure speedy implementation.

Currently, administrative jurisdictions of multiple agencies are overlapping and leading to confusion, duplication of effort, lack of accountability and inaction. These call for effective co-ordination and mitigation mechanism.

Financing

Article 280 of 74th CAA needs to be suitably amended such that the Finance Commission may specify allocation of resources across the centre, state and local bodies. A share of goods and service tax of GST collected in a jurisdiction should be allocated to the respective local body. Ensuring sustainable financial independence for ULBs will be critical to true empowering of decision making and implementation.

A smart city may develop an investment and financing strategy such as accessing the bond market or structuring projects on PPP basics for leveraging additional resources from private sector. Other strategies may include user charges for facilities to be provided, land value based heavy/higher FSI charge and surcharge on stamp duty on sale transaction, property tax etc. and the contributions from the Government of India/ State/ULB's could be largely by way of viability gap funding (VGF).

Building Personnel Capabilities

These are need for each state to have a permanent state level cadre of municipal staff. This would enable sourcing of specialist and skilled capabilities in areas such as urban planning, financial management, engineering and infrastructure, project implementation, environment etc. This should lead to ULBs engaging full time staff with specialized skills within the organization of municipal set up. Experiences and competences could be shared across cities through inter municipal transfers. Centralized and unified selection process could further ensure proper qualification and quality of the recruited staff. The skills could be further upgraded through proper training.

Technology Up-gradation

Appropriate technology will act as a key enabler in ensuring sustainable urban development and living environment in urban areas. The initiatives of government in this direction include National Mission on Sustainable Habitat, National Urban Transport Policy and National Urban Sanitation Policy which could help in adopting sustainable urbanization framework.

Broadband and connectivity network extends basic and value added services to the citizens through internet. Ministry of Information Technology has started various initiatives to use IT to achieve citizen centricity, source orientation and transparency, with a landmark initiative for e-governance. Automation of the processes would enable proper co-ordination across different departments and lead to creation of a central data base for increased efficiency.

Public Private Partnership (PPPs)

PPPs have been recognized as a viable alternative for implementation of projects as an alternative mode of financing, which could partly solve the problems of ULBs. They ensure efficiency in urban development and infrastructure, while bringing in requisite finances to supplement the public funds. The initiatives taken by Governments of India to encourage PPPs include (i) establishment of PPP cell in the Department of Economics Affairs in the Ministry of Finance to administer various proposals and

co-ordinate activities to promote PPPs (ii) Setting of India Infrastructure Finance Company Ltd to provide long term finance to infrastructure projects (iii) Viability gap funding for projects which are not regarded as commercially viable (iv) preparing PPP toolkits and model concession agreements etc. However to encourage PPPs at municipal level, some additional initiatives will be needed to accelerate ongoing implementation of schemes.

The states need to take initiatives in creating suitable enabling environment with an aim to educate, facilitate and guide ULBs to attract private sector investment. The state should therefore set up PPP cells as a dedicated institution for urban sector projects, with authority for approval of PPP projects and other relevant functions.

The country is to have 100 smart cities that will be both greenfield and brownfield. The issues relating to land, and red tape, rules and regulations are to be addressed so that the private sector can be brought in, which could provide upto 90% of the investments. Government is taking steps to make easy financing available by making changes in rules for lending to banks, NBFCs and other financial institutions.

Future Development

Cities drive economic growth, increased investment and job creating for a very large number for people who are increasingly covering on them with the hope of security and better standard of living. For cities to be able to deliver true value, they need to be able to provide their inhabitants with the highest standard of living which ensuring sustained protection of the environment. Only cities which are able to reach this equilibrium will be capable of meeting today's changes and can look forward to a more smart and sustainable future.

The growth in our cities is largely organic in as much as that the urban centres are expanding and exploding economically, geographically and demographically rather than development of new planned cities from the scratch. The green field model is where urban area is developed abilities using state of art technologies. However for optimum development of smart cities, there is need for developing brown field cities which could complement the new greenfield smart cities.

India can cater to development of smart infrastructure and smart cities which could serve as a driver of growth which is socially inclusive and environmentally sustainable. There is a need for radical and proactive response to reinitialize some of the densest urban agglomeration in the country and also ensure the delivery of basic services to the less privileged who reside in such urban areas.

Considering the current scenario and the relevant opportunities in near future, it is necessary to act in a planned way both as a short term and long term strategy. It is important that urbanization and development of built environment be socially equitable, economically viable and environmentally sustainable. Different examples from across the world have proved that technology is the most important factor and key enabler to help achieve these goals at optimum cost in an efficient manner. It is now for our country to accept the challenge and make intelligent urbanization and smart cities a reality.



Climate Change And The Built Environment

K K. Kapila

CMD, ICT & Past President IBC

Prologue

Climate change is already beginning to transform life on earth. Around the globe, seasons are shifting, temperatures are climbing and sea levels are rising. If we do not act now, climate change will rapidly alter the lands and waters we all depend upon for survival, leaving our children and grandchildren with a very different world. This fact has been stressed by the author who is renowned for his opinions and in depth study on the subject.

Accordingly to the author, driving forces for climate changes are population growth, technology changes, institutional structures, and changes. India is likely to be hit hard by global warming and is already one of the most disaster-prone nations in the world. Buildings are the other major source of global demand for energy and materials that produce by-product greenhouse gases. Slowing the growth rate of greenhouse gas emissions and then reversing it is the key to addressing climate change and keeping global average temperature below 2°C above

pre-industrial levels. To accomplish this, architecture and building community should consider designing all new buildings, developments and major renovations to meet a fossil fuel, greenhouse gas-emitting, energy consumption performance standard of 60% below the regional (or country) average or median for that building type.

To mitigate the impacts of changing climate, author puts forth the desirability to use smart, appropriate design to meet with the complexity and social and economic importance of the built environment for predicted extreme events which are best tackled through legislation, codes and policy; and enabling communities to lead local renewal projects with a neighborhood-scale approach to ensure villages, towns and cities are fit for the future and create conditions for people to thrive.

- Editor-

Introduction

Climate Change – A Global Challenge

Life on earth is possible because of the warmth of the sun. While some of this incoming solar radiation bounces back into space, a small portion of it is trapped by the

delicate balance of gases that make up our atmosphere. Without this layer of insulation, earth would simply be another frozen rock hurtling through space. Carbon dioxide (CO₂) is the most important gas in this layer of insulation. Carbon is stored all over the planet — in plants, soil, the ocean, and even us. We release it into the atmosphere as carbon dioxide through activities such as burning fossil fuels (coal, oil and gas) and cutting down trees. As a result, today's atmosphere contains 42 per cent more carbon dioxide than it did before the industrial era. So much carbon dioxide and other greenhouse gases have been released that our planet's atmosphere is now like a thick, heat-trapping blanket. By disrupting the atmospheric balance that keeps the climate stable, we are now seeing extreme effects around the globe. It is like a thermostat that's gone haywire — it just doesn't work the way it should. The result is that the climate changes and it gets warmer. Extreme weather events also become more common.

The Kyoto Protocol covers six greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Of these six gases, three are of primary concern because they are closely associated to human activities. Carbon dioxide is the main contributor to climate change, especially through the burning of fossil fuels. Methane is produced naturally when vegetation is burned, digested or rotted without the presence of oxygen. Large amounts of methane are released by cattle farming, waste dumps, rice farming and the production of oil and gas. Nitrous oxide, released by chemical fertilizers and burning fossil fuels, has a global warming potential 310 times that of carbon dioxide. Global Warming is the increase of Earth's average surface temperature due to effect of greenhouse gases, such as carbon dioxide emissions from burning fossil fuels or from deforestation, which trap heat that would otherwise escape from Earth. This is a type of greenhouse effect. Global warming has already begun. Since 1900, the global average temperature has risen by 0.7 degrees Celsius, and the northern hemisphere is substantially warmer than at any point during the past 1,000 years.

Climate change is already beginning to transform life on earth. Around the globe, seasons are shifting, temperatures are climbing and sea levels are rising. And meanwhile, our planet must still supply us — and all living things — with air, water, food and safe places to live. If we don't act now, climate change will rapidly alter the lands and waters we all depend upon for survival, leaving our children and grandchildren with a very different world.

Some of the most dangerous consequences of climate change are higher temperature; changing landscape; risk to wildlife rising sea level, increased incidence of drought, flood and fire; storms and frequent storm damages; more heat related illness and disease; and economic loss.

Driving forces for climate changes are underlying in form of population growth, technology changes, institutional (political, market, cultural, social) structures, and changes. Land laws and markets affect land resources through how they impact on land management. There are typically nested interactions among these driving forces. Pressures from these driving forces have direct impacts on the environment. These include forest clearing for agricultural production, city growth on agricultural land, or

pollution of land, water and air from industrial, and other human activities. The state of the environment can be captured by assessing the stock of natural resources, changes in them or environmental quality indicators like, erosion levels, nutrient stocks, soil quality, pollution levels, changes in areas or quantities of carbon, and loss of species or habitats. Global warming due to greenhouse gas emissions causes changes in air and water temperatures, sea level rise, storms, floods and droughts.

Impact of Climate Change In India

Experts say India is likely to be hit hard by global warming. It is already one of the most disaster-prone nations in the world and many of its 1.2 billion people live in areas vulnerable to hazards such as floods, cyclones and droughts.

The U.N. Intergovernmental Panel on Climate Change (IPCC) lead authors said that India is likely to suffer losses in all major sectors of the economy including energy, transport, farming and tourism. Extreme weather may also harm infrastructure such as roads, ports and airports, disrupting delivery of goods and services. Freak weather patterns will not only affect agricultural output and food security, but will also lead to water shortages and trigger outbreaks of water and mosquito-borne diseases such as diarrhoea and malaria.

Here is some alarming data on environmental degradation in India:

- According to the figures released by Centre for Science and Environment out of the 180 cities monitored for air pollutants SO_2 , NO_2 particulate matter (PM10) only two towns in Kerala met the criteria of low pollution (50% below the standard). The number of critically polluted cities increased from 49 to 89 between 2005 and 2010.
- As per Central Pollution Control Board raw sewage and industrial waste has rendered water in more than half of India's 445 rivers unfit for drinking .Water from at least a quarter of the rivers surveyed can't even be used for bathing.
- The forest cover (24% of geographical area) which is already short of target of 33% set in 1988 and is declining and in 24% of forests there is 'inadequate' regeneration and in 10% there is no regeneration whatsoever.
- Per Capita availability of fresh water resources has fallen from 6042 cubic meters in 1947 to 1845 cubic meters in 2007.
- More than 147 million hectares of soil has become degraded, eroded and thus unproductive. About 5334 million tons of topsoil is lost annually.

All these environmental challenges are likely to be further aggravated due to climatic change.

Major Challenges Facing Cities and Urban Settlements

It is crucial to recognize that cities and urban residents are not just victims of cli-

mate change but also as part of the problem. If cities are part of the problem, that means they must also be focus of any solution. Immediate actions are required to make the cities more sustainable by revisiting the land-use plans, transport modalities, and building designs.

Cities can adapt to the impacts of climate change through effective urban management. Planning and land use controls prevent people from building in zones at risk of flooding and landslides (for example, restrictions on building within 50 year floodplains in South Africa). Guidelines and regulations, such as a decision issued by the ThuaThien Hue provincial authorities in Vietnam to encourage cyclone-resistant building practices, can increase resiliency of infrastructure and make economic sense.

However, many cities in least developed countries do not have much urban infrastructure assets that can be adapted. Therefore, adaptation cannot be disconnected from the need for local development. Both adaptation and mitigation strategies in urban areas require new and improved infrastructure and basic services. This provides cities in developed and developing countries with unique opportunities to redress existing deficiencies in housing, urban infrastructure and services and to create jobs and new opportunities to stimulate the urban economy.

The resolve with which some of the cities stuck to their climate action despite the current economic crisis is very reassuring. They remain convinced that climate change action makes economic sense. For example, increased energy efficiency is not only good for the climate but also makes sense for a city's budget. As former president Bill Clinton said: "For every 1 billion US dollars invested in the retrofitting of houses to increase their energy efficiency, 6000 jobs are created. This is six times bigger in impact than in average public investments. And what is more: savings in energy will payback for this investment in just over 7 years". In this context, it may be underlined that resilience of houses to natural hazards such as windstorms, floods and fires can be improved by revising building regulations and design standards. For example, revisions to design and construction standards have resulted in post-80s houses being more resilient to windstorms compared to pre-80s houses built in cyclonic regions of Australia.

According to the Global Land Tool Network developed by UN-HABITAT, the key priority areas that need to be focused on are – (i) land tenure reform, (ii) land rights records and registration, (iii) land use planning, (iv) regulation of land markets to enhance sustainable land use, (v) land management, administration and information, (vi) slum rehabilitation and resettlement, (vii) providing tenure security and slum rehabilitation, (viii) land law regulation and enforcement, (ix) payment for environmental services, (x) payment for resource dividends, (xi) participatory public works programs & productive safety nets, (xii) collective action for enhancement of environmental services, (xiii) integrated rural and urban development, and (xiv) rescue plans for areas threatened by sealevel rise and storm floods.

Built Environment and Climate Change

The human-generated gases derive in part from aspects of the built environment such as transportation systems and infrastructure, building construction and opera-

tion, and land-use planning. Transportation, the largest end-use consumer of energy, affects human health directly through air pollution and subsequent respiratory effects, as well as indirectly through physical activity behavior. Buildings contribute to climate change, influence transportation, and affect health through the materials utilized, decisions about sites, electricity and water usage, and landscape surroundings. Land use, forestry, and agriculture also contribute to climate change and affect health by increasing atmospheric levels of carbon dioxide, shaping the infrastructures for both transportation and buildings, and affecting access to green spaces. Vulnerable populations are disproportionately affected with regard to transportation, buildings, and land use, and are mostly at risk for experiencing the effects of climate change.

In other words, in planning and designing our buildings and infrastructure there is need to minimize emissions and develop resilience to a changing climate. A range of measures, like energy efficiency, renewable energy, low carbon heat generation and behavior change, can contribute to reducing carbon emissions.

Buildings are the major source of global demand for energy and materials that produce by-product greenhouse gases. Slowing the growth rate of greenhouse gas emissions and then reversing it is the key to addressing climate change and keeping global average temperature below 2°C above pre-industrial levels. To accomplish this, building community should consider the following – (i) all new buildings, developments and major renovations to be designed to meet a fossil fuel, greenhouse gas-emitting, energy consumption performance standard of 60% below the regional (or country) average or median for that building type, and (ii) at a minimum, an equal amount of existing building area to be renovated annually to meet a fossil fuel, greenhouse gas-emitting, energy consumption performance standard of 60% of the regional (or country) average or median for that building type.

Also, structural upgrading and the provision of building envelope protection against windborne debris (preventing the formation of a dominant opening that generates large internal pressure) are two strategies that will also reduce the vulnerability of houses, built in non-cyclonic regions. This is an adaptation strategy that would also be effective for any shift in cyclone boundaries or increases in wind loads that may result from climate change.

India-Built Environment Scenario

Ruthless unplanned growth is showing its disastrous consequences in the form of tsunamis, floods, glacier melting and so on. In India we have had the Mumbai's floods in 2005, Leh cloudburst in 2010, last year's Uttarakhand and now the Jammu & Kashmir floods. The devastation and natural fury indicates that nature responds adversely when human habitation crosses the saturation point especially in fragile ecologies. Overbuilding, artificial flattening of natural and sloped terrain, illegal constructions on riverbanks and flood prone areas are the bane of Indian cities. Experts point out deforestation, riverbank encroachments, degradation of lakes, siltation through river flow and obstruction in rivers by human activities and utter mismanagement of natural drainage as being the main reasons for Uttarakhand and Jammu & Kashmir tragedies.

It would be relevant in this context to mention that Scandinavian countries have developed lighter form of construction for their mountainous and riverside terrains; and there are countries where construction is forbidden in geologically unstable territories.

The Way Forward

The impacts of a changing climate can lead to global warming, flooding and disruption to power and water supplies if steps are not taken to improve the existing built environment in urban and rural areas. Hence, it is important to use smart, appropriate design so that new buildings and infrastructure can handle projected changes in temperature and rainfall.

The complexity and social and economic importance of the built environment requires focused governance to develop adaptation and hazard mitigation for community resilience to climate change and to predicted extreme events. Where issues of adaptation and hazard mitigation impact public safety, they are best tackled through legislation, codes and policy.

Enabling communities to lead local renewal projects with a neighborhood-scale approach is the most cost-effective way to ensure our villages, towns and cities are fit for the future and create the conditions for people to thrive. Through empowering community groups to come together to tackle issues of local priority, and to work in partnership with local authorities and businesses, multiple benefits can be delivered. Such upgrades to our physical infrastructure not only tackle climate change, they can also deliver reliable and efficient transport networks, improve health and well-being, secure a healthy natural environment, improve long-term housing supply, maximize employment opportunities, and make our communities safer and more cohesive. Further, education to improve the house-building process (regulation, design, construction, certification and maintenance) aimed at all parties (designer, builder, certifier, and owner) will enhance community resilience.

In sum, there are two options -

- Mitigation of climate change and slowing down global warming by reducing greenhouse emissions. The world has realized that mitigation is absolutely critical; and
- Adaptation to climatic change and responding to predicted impacts of climate change.

And, the future path lies in –

- Better environmental governance
- Shift from Western World's model of resource and energy intensive growth to a development model with emphasis on social welfare.
- Reducing greenhouse gas emissions and work with the global community to limit the rise in global temperature below 1.5 degrees °C, which can be done by cutting down the Greenhouse Gas Emissions by 40-70% of 2010 levels. Renewable energy deployment needs to be raised by 3-4 times of the present levels.
- Financing mechanism for green initiatives.



Seismic Vulnerability of Structures in Delhi

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Prologue

The recent earthquake of Nepal on April 25, 2015 of 7.9 intensity and the trend of aftershocks experienced, stimulate us to take up deep introspection of all possible parameters both of disaster management and disaster prevention in pan Indian scenario. The later should get focussed attention. In case of an earthquake of moderately severe intensity with epicentre closer to Delhi the prospects are highly grim and fearful for city of Delhi and the consequences may be more severe than one could foresee. It is to be noted that Delhi and surrounding NCR region lies in the Seismic zone IV and Earthquake of moderate to higher intensity will inflict severe damages and un-imaginable losses of property and human life. We essentially have to augment our preparedness and response mechanism to such situations initially on preven-

tion aspect and then on disaster management side. The response mechanism has to be well thought, clinically planned with short-term, mid-term and long-term strategy which will need closer supervision for reaching out to affected persons and their rehabilitation measures. This paper brings out status of preparedness and needs for action to be taken with special reference to government buildings in New Delhi from where most of the governmental business is conducted. In this paper short term and long term measures have been suggested to ensure safety of structures in Delhi, during and after earthquakes.

- Editor-

Introduction

During last few decades, our country has suffered losses on account of several major and minor earthquakes. Government has taken all out measures as per available resources and importance they assign to these calamities. It has gener-

ally been seen that monetary and help in kinds, pour from within the country and abroad for a few days. Thereafter, it dwindles as days pass on. It is also a fact that very little is done to rehabilitate and reconstruct the houses and properties lost by masses. The press and electronic media propagate the cause of human suffering, for a few days after the earthquake and does not persue on long term basis. In order to avoid or at least to minimise human suffering, it is necessary to workout short term and long term plan of action for Delhi. Thereafter, it must be implemented in coordinated manner. In this paper issues related to seismic vulnerability of buildings of different categories have been brought out, and immediate short term as also long term measures suggested. In fact, policy related issues brought out for Delhi are applicable for the whole country.

Earthquake Zoning and Recent Earthquakes in Delhi

Location in earthquake Zone

India is mainly divided into 4 seismic zones. There are zones 2,3, 4 and 5. Delhi lies in the very sensitive seismic zone 4 which also include Indo-Gangetic Basin, Jammu & Kashmir and Koyna region of Maharashtra. Areas under zones 4 include western and central Himalayas, Rann of Kutch and North East India which are even more vulnerable to massive earthquakes. In the list of five most earthquake prone cities in India, Delhi owns the third spot.

Zoning is done on the basis of the number of active fault line on the earth's surface which may or may not become the epicentre of an earthquake. The fault is formed as a result of a fracture in the earth's crust, which is rocky in nature. Main reason behind earthquakes in the Himalayas and adjoining areas has always been the friction between the Indian plate and the Eurasian plate. There is a movement along the fault lines which releases huge amount of energy thereby causing earthquakes.

Speaking of Delhi, the region is vulnerable to earthquake in particular because of its location. Delhi is situated on top of few active seismic fault lines. Moreover it's priority to the active seismic fault lines further worsens the situation. Fault lines close to Delhi are Mahendragarh fault line, Moradabad fault line, Delhi-Haridwar ridge zone and sohna fault line. Delhi is built as a mix of hard and soft soil. The lack of uniform soil structure will lead to a variation in the impact of an earthquake (www.skymetweather.com).

Recent Earthquakes

Following earthquakes during last ten years have given tremours in Delhi. After Nepal earthquake a number of buildings developed minor cracks.

It will be worth to note that Delhi has experienced more than one earthquake per year, during last ten years Ref. (earthquaketrack.com/in-07-delhi-recent). Be

| | | | | | | |
|--------|-----------------|---|----------------|-------------|---------------|----------------------|
| (i) | This year 2015 | - | 7.8 magnitude, | 15km depth, | Bharatpur | Nepal |
| (ii) | Three years ago | - | 4.1 magnitude, | 10km depth, | Beri, | Haryana |
| (iii) | Three years ago | - | 5.1 magnitude | 10km depth, | Rohtak, | Haryana |
| (iv) | Four years ago | - | 4.3 magnitude | 10km depth, | Delhi | - |
| (v) | Seven years ago | - | 3.8 magnitude | 10km depth, | Behat, | U.P. |
| (vi) | Eight years ago | - | 4.7 magnitude | 10km depth, | Gurgaon, | Haryana |
| (vii) | Eight years ago | - | 3.7 magnitude | 10km depth, | Nihtaur, | U.P. |
| (viii) | Eight years ago | - | 4.7 magnitude | 10km depth, | Chhata, | U.P. |
| (ix) | Nine years ago | - | 4.0 magnitude | 10km depth, | Govindpur, | Rajasthan |
| (x) | Nine years ago | - | 4.3 magnitude | 10km depth, | Rohtak, | Haryana |
| (xi) | Nine years ago | - | 3.9 magnitude | 10km depth, | Rohtak, | Haryana |
| (xii) | Ten years ago | - | 7.6 magnitude | 26km depth, | Mazaffarabad, | Pak occupied Kashmir |

sides, the epicentre of a number of earthquakes was around Delhi, including one in Delhi itself and one in Gurgaon.

Issues

The cities settlement pattern has never been viewed in relation to location and geological characteristics. Pockets with high rise buildings or ill – designed high –risk areas exist without specific consideration of earthquake resistance. Similarly, unplanned settlements with sub-standard structures are also prone to heavy damage even in moderate shaking. The central business district; namely Connaught Place, numerous District Centres and sprawling high risk group housing schemes are high in risk areas due to the vertical as well as plan configurations. The walled city area, the Trans-Jamuna area and scattered pockets of unplanned settlements also figure as high risk zone due to their substandard structures and high densities. Most of buildings in Delhi may not meet codal requirements on seismic resistance.

Luytens Zone and Other Important Structures

- (i) As we are discussing the capital therefore it is imperative to start with the Luytens Bungalow Zone (LBZ) of New Delhi. The Head of Government and all senior functionaries of Union of India reside in these Bungalows which predominantly have thick brick masonry walls (with lime mortar) and reinforced brick roof. These structures have outlived their economic life being more than 60 years old. Structural safety of these bungalows are highly suspect in eventuality of earthquake and may not survive modestly severe earthquake in Delhi with epicentre nearer to Delhi. There will be major structural damages to these single storey structures. Structural safety of these Bungalows need most immediate attention.

It is understood that a study was conducted by IIT Chennai on some of these bungalows and major strengthening measures were recommended. But however up-till now no sincere efforts have been made to implement these recommendations. This issue needs immediate attention by CPWD and the Ministry of Urban development, Govt. of India on highest priority.

Construction of appropriately designed bungalows with well decided importance factor is inevitable in the L B Z and deserves accelerated implementation in mission mode in the Luytens Bungalow Zone. Keeping in view practical aspect, this work should be taken in phased manner / in time bound manner.

- (ii) The Rashtrapati Bhavan has a mathematical geometrics and prima-facie appears to be safe to handle such contingencies except the north and south courts of Rastrapati Bhawan nevertheless it has to be assessed and certified. There will be an issue regarding availability of software to handle major calculations for structural safety in a masonry building admittedly, however assistance of IIT Madras may be taken whose experience in restoration of Angkor Wat in Combodia may come handy in this respect.

Post Uttarakhanda earthquake FRI building at Dehradun was damaged and assessment of that building was taken up by the Ministry of E&F. IIT Roorkee - Department of Earthquake Engineering was appointed consultant. Study report can be helpful for understanding about structural safety of Rashtrapati Bhavan. Further action can be taken, as required.

- (iii) Rail, Vayu, Udyog, Krishi, Nirman and Shastri bhawans etc were constructed prior to 2002 (i.e. prior to revision of Seismic Code). Therefore, the structural drawings of these Bhawans are to be located/ if the drawings are not available in archives then they are to be redrawn. Thereafter the structures are to be analysed using suitable software like ETABS Or STADD or similar type to evaluate their seismic preparedness condition and also evaluate if they need retrofitting and rehabilitation .

- (iv) AIIMS is the repository of knowledge in field of medical and allied sciences. Its infrastructure deserves to be safe and sound in most of contingencies (except when it is on the epicentre or a holocaust). The structural safety of the main

buildings of AIIMS should be evaluated as per revised Seismic code provisions and suitable retrofitting measures taken. In case preliminary study was already done in past, it can be examined and necessary follow up steps may be taken for retrofitting / rehabilitation. Structural drawings of all other buildings housing apex medical facilities need to be evaluated and remedial measures be taken on priority.

- (v) All barrack type structure in Safdarjung hospital and old blocks are suspect in case of earthquake and need professional evaluation on priority. It is felt that their demolition and generating new infrastructure is inevitable.
- (vi) Railway station at New Delhi-Paharganj side, Old Delhi Railway station, Delhi Cantt and other railway station in Delhi either with masonry structure or RCC frame work prior to 2002 need evaluation and certification including over bridges on railway stations. Similarly, All fire stations, police stations, water supply installations, Electrical installation.
- (vii) TV transmission tower at Pitampura Electrical transmission towers and other public works (overhead water tanks etc.) need careful evaluation and rehabilitation and retrofitting may be taken up wherever essential.

Government Buildings and Infrastructure

- (i) Residential Buildings by Central PWD, PWD Delhi, DDA, Municipal Corporation etc. were generally constructed by following relevant I.S.Codes for structural safety including earthquake requirements. Only Multistoried buildings constructed prior to year 2002 needs review of structural design for earthquake safety.
- (ii) Functional Buildings by Government Agencies are also required to be checked for structural safety, if constructed prior to 2002. Special care is required to be taken for Hospitals, Police Stations, Fire Stations, Power Houses, sub-station, water supply reservoirs etc. These are to be functional during emergency requirements for earthquakes. In Hospital it is necessary to design placing of furniture and equipments in such a manner that these are not disturbed during earthquakes. Schools and other educational institutes are to be safe and services to remain functional during earthquakes.
- (iii) Special care is necessary to review and revisit infrastructure meant for use by public, during earthquakes. Roads, drains, electrical overhead lines, water supply lines, sewer lines, telephone lines, etc. need special care so that these remain functional. In fact, proper functioning of emergency services depend on rebuilt infrastructure.

Heritage Structures and Old Buildings

- (i) Heritage structures like Red Fort, Qutab Minar, several other forts, temples, churches, mosques, gurudwaras etc need special attention. At times old struc-

tures are neglected and minor damages goes unnoticed. It is desirable to re-view, examine and recheck the structural safety of all the heritage structures.

- (ii) Old buildings in Chandni Chowk and other areas of old Delhi need special attention. In old structures, generally unscrupulous addition/alternations endanger structural safety. Even adjoining structure become unsafe by these alternations. A close watch by local bodies is necessary. Besides, local bodies should make a system of regular inspection of these buildings and order or carry out demolition if building is unsafe.
- (iii) Old buildings of urban villages within laldoras need special attention. Even additions and alterations in these buildings are not required to be approved by local bodies. Many unauthorized additions made in urban villages are unsafe and need specific attention and if required extra powers to take action.

Authorized Colonies and Buildings Constructed After Approval of Plans by Local Bodies

- (i) A number of colonies were developed by Government agencies, development authority, private builders, local bodies etc. In these colonies, it is expected that buildings are constructed or addition alterations are done after the plans are approved by local bodies. The first and foremost requirement is to ensure that no unauthorised structures or addition/alternation are done, in these localities.
- (ii) Buildings constructed with approved plans but without structural engineer's certification, need to be revisited and structural safety ensured by inspection. Special care is required for high rise buildings constructed in the past.
- (iii) Buildings constructed with backup of structural engineer are by and large considered safe as relevant codes must have been followed by incorporating earthquake requirements. In recent past building plans are approved by including parking area at ground level. At this level only columns are existing and there are no walls. Thus at ground level, there is less of rigidity and such structures are not considered safe, from earthquake resistance requirements. It is necessary that top structural engineers review this concept and give recommendations with regard to structural safety. If considered necessary, retrofitting should be done.

Buildings In Unauthorised Colonies, Urban Extensions, Slums and Resettlement Colonies

Hundreds of unauthorised colonies developed both on Government land and private land not approved for urban development. It was basically meant for agriculture. A good number of these colonies were regularized as per Government policy. Most of the houses in these colonies are non-engineered buildings. No approval of local bodies is taken and people construct unsafe buildings. Similarly, in urban extensions of villages, there is no control. There are resettlement colonies, developed during emergency for resettlement of un-

authorised occupants of land. There is practically no control of local bodies for construction even in these colonies. Besides, there are urban slums. All these areas have, buildings unsafe from normal structural considerations.

These building have very high probability of destruction and the damage which could be unprecedented. There is no system of checking structural safety of these structure. The Municipal corporations responsible for approving building plans are not geared adequately leave apart distinguishing themselves in the sphere of responsibilities assigned to them particularly for these colonies.

It is no doubt apprehended that any sincere effort in handling these problems as outlined in above paragraphs may evoke adverse social fallout, uncharitable political responses, nevertheless a beginning may be made to generate at least awareness may be created by amongst the local bodies, NGOs, mass media which may be helpful in long run.

In view of the fact that large number of seismically weak buildings existing in Delhi and NCR area, there is need to undertake retrofitting measures in large scale. But before undertaking such work in hand there is pressing need to train the engineers and administrators to adopt simple retrofitting methods for counter seismic vulnerability. Awareness of necessity of seismic retrofitting and carrying it out in engineering way to draw most benefit is highly essential so that public money is utilized in efficient manner. Local bodies should undertake such training programmes to take the message down to the public at large. It is estimated that cost of retrofitting is about 5-10 % of reconstruction cost. Such an amount can be spent by the owners for the safety of their own lives and lives of their kith and kins. But owners are generally unwilling to spend this sum also probably because of lack of awareness of ill effects of earthquake and also due to the fact that Earthquake occurs once in while. But it should not be forgotten that Earthquakes do not kill but it is buildings which kill people during earthquake.

Short Term Measures

It is suggested that for short term measures, the policy should be reviewed without delay and implementation should be completed in about three years period.

- (i) Aesthetic considerations in building design are no doubt pleasing and important in their own way but a robust structure has to be the back bone of all the buildings. In last few decades we have worked on misplaced priorities. More stress has been given to aesthetically pleasing elevations rather than structural safety and soundness. In our country by and large structural design and its evaluation has been pushed on back benches. Structural Engineer is forced to work as second in command to Architect. But in order to develop pleasing, safe and sound structures both have to work complimentary to each other. Architectural profession is controlled by Council of Architects created under the Act of Parliament. The engineering profession should also be raised to same level by enactment of Engineer's Bill.

- (ii) Structural reforms to enhance professional quality improvement and skill upgradation of design offices is required to be taken up on priority. Higher professional input to the engineers in the government and public sector and augmentation of training resources in the government sector for engineers is the need of the hour. Post graduate studies (M.Tech) in interrelated disciplines of engineering design like – Structures, Soil Mechanics, Reinforced Cement concrete and Steel structures, Pre-stressed concrete structures etc. should be made mandatory for engineering professionals working in this field. Sufficient number of seats should be allocated to / reserved for officers of engineering services in different IITs, NITs and engineering colleges of high repute. Engineering officers are to be encouraged to get proficiency in engineering design of structures with latest design concept like Base isolation technologies. Further after receiving training they should work in design offices and they should impart further training in these discipline There is need to alter altogether the attitude towards officers engaged in design offices-they should not be looked down as compared to field officers.
- (iii) Availability and learning of structural design software like STADD and ETABS in the Engineering Departments, offices will make design simple. There is tendency in Government offices to outsource design work. It should be discouraged. Capacity building to be done wherever required. It is noted with concern that design capability of Government officers has gradually gone down. This tendency should be stopped. Highly specialised design can, of course be outsourced with technology transfer arrangement.
- (iv) Provisions of “National Building Code 2005 – Direction and Administration” should be followed by all local bodies in Delhi. In fact these provisions are required to be enforced through out the country. This laxity is mother of all diseases. Specific provision to fix responsibility of structural designer should be made whether construction relates to public sector buildings are private sector building so that tendency of cutting corners may reduce.
- (v) National Academy of public works should be established at Delhi This will help in enhancing of technical excellence and thinking process of Engineers. This issue needs to be addressed on priority. In fact such training institutes of engineers in field of public works should be established in all the states. This will bring about may be targeting improvement of knowledge and skill of engineers. The faculties should be combination of field engineers, design engineers and teachers.

Long Term Measures

- (i) It is suggested that in order to sort-out issues related to urban development and safety of structures in urban areas, a policy and planning monitoring cell to be created under the supervision of the Ministry of Urban Development with representation from other concerned Ministries of State Governments. This Cell should coordinate for policy formulation for disaster prevention and mitigation of after effects of disaster due to the specific reasons mentioned here for

short, mid and long term measures. Besides, other related issues be looked after by this Cell. The activities of this Cell should be monitored by PMO.

- (ii) A very important activity which will have long term impact is skill upgradation programme of construction workers. Training programme for construction workers are required to be taken up in big way to include all workers in organised and un-organised sector. This training should include practical aspects like knowledge of water cement ratio, mix design and placing of reinforcements etc. There are many trades like masons, carpenters, fitters, barbenders, plumbers, electricians, machine operators and construction supervisors etc. where capacity building in this area is imperative. The Government has initiated training activity under Ministry of Skill Development. This is not enough and may not yield desired results. Government should make principal employees responsible for training. Only then contractors will ensure employing the trained and certified workers.
- (iii) It is necessary to redesign course content for graduate and diploma engineers in Civil and Structural Engineering. On review of syllabus of different institutions including IIT, It is noted that our graduates and diploma holders are not suitable for project management work as also design work. By and large, these engineers are not given hands on training for basic civil engineering activities. Our engineers can not demonstrate to a worker, the practical side of their trade. Similarly, hardly any knowledge is imparted regarding IS codes, standard specifications, schedules, tender documents etc. It will be necessary to critically examine the syllabus and inadequacies together with quantum of exposure to the budding civil engineers. It appears to be far from satisfactory at the present moment from the point of view of construction industry. Let IITs, NITs and other engineering institutes involve engineers with field experience to redesign the syllabus of civil engineering studies.
- (iv) Research and Master of Engineering programmes in our IITs, NITs and other Engineering Colleges seem to be of average level compared to their counterparts in developed countries. Many aspects of structural design of buildings and infrastructures are to be addressed in depth. For example we have to work on the prospects of base isolation and feasibility of its introduction in India as methodology for existing structure in order to make structures earthquake resistant and capable to remain functional even after tremours of high order. This technology is at nascent stage in our country but has immense potential. Such issues of developing cutting edge technology for Indian requirements is to be addressed by institutes in their research programme. Another field could be aerial survey. There may be large number of such options.
- (v) Regulatory mechanism in the construction Industry have to be addressed in depth. It is heartening to note that Real Estate Regulatory Bill is under consideration by the Government. It is necessary that Real Estate companies provide and make available their information in such a manner that no hidden costs are involved. Areas being projected should be as per standards and norms. Besides, it should be mandatory for the real estate companies to bring all structural drawings in public domain. No loan should be sanctioned by

banks till structural drawings duly certified by chartered Engineer are placed in public domain by the developers including the details of the structural designers. Since Low income group do not hold power to own costly houses they resort to non-engineered structures for their housing needs. Both situations are indicative of problem and not welcome.

- (vi) Role of local bodies – The issue of building bye laws has been addressed in the preceding paragraphs. The local self government is to be sensitised to ensure that structural drawings of buildings are prepared and approved before hand – This may require legislative/ administrative backing as well as technical strengthening of building section of municipalities and corporations. It is necessary that provisions of National Building Codes are made mandatory and local municipal bodies can elaborate details as per local reasons.
- (vii) Development of knowledge bank -The architectural , structural and services Drawing along with concept note on designs should be available in hard and soft copies for all public buildings irrespective of the fact whether they are in government sector or private sector. It is disturbing fact that structural drawings of public sector building are dumped to a place nobody knows their whereabouts once the building is completed and ready for occupation. Safety certificates by following proper method statement should be recorded and be available on line for all essential services infrastructure both in public and private sector. This should apply to all airports, hospitals, hotels, malls, stadiums, metro installations, Railway stations, Fire stations, flyover, grade separators, operational areas (both sensitive and non-sensitive) etc. in Delhi. A separate department or repository can be created for where one copy of documents and date of all public buildings should be available. The data should be stored using concept of cloud computing which will enable its retrieval whenever it is required.

Conclusion

The present status as also projections are not encouraging. Nevertheless the idea is not to generate a scare but to underline the present status and need for improvement. It is a dispassionate assessment as objectively as it could be done. It needs a review by all those concerned which will generate a clear policy. Thereafter, objective of short, mid and long term goals can be decided. It will definitely require an organised and purposeful thinking by all policy makers, planners, field engineers and Educational and Research persons. In fact the policy so developed should become part of our standard operating procedures in all sectors relating to infrastructures. Initiatives to be taken at Delhi for Delhi can give guidance for similar initiatives in others parts of the country.



A Legacy of Heritage Resources Initiatives by Defence Sector

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Prologue

Defence Sector is well known for its organized and systematic working and the same ethos are being carried over in the conservation process for their buildings. Keeping pace with modern trends and latest technologies, the complete process of new development / conservation of these assets is being dealt in a holistic manner

ber of magnificent heritage buildings belonging to defence department, some dating back to more than 200 years old in the country. Assets presently being put to various uses like offices, officers mess, hospital buildings and residential accommodation need to be kept in sound shape to preserve the country's heritage.

The author has rich experience in the architecture arena dealing with defence structures, old and new. She has very interestingly described the large num-

- Editor-

Introduction

The Cantonments were mostly established during British period (19th century) and their location was dependent upon the necessity to establish, maintain and consolidate the rule of foreign power. All these Cantonments were characterized by similar planning pattern, viz gridiron planning with central, tree lined thoroughfares also known as 'Mall Roads', large building plots with bungalows (size based on hierarchy) as the main housing type with Churches, cemeteries, barracks, clubs, golf courses in the vicinity. In certain instances the garrisons were raised within forts (eg Fort William at Kolkata) & residences for royal family (Sheesh Mahal Bharatpur) were also constructed within. After independence, these Cantonments were transferred to defence as the establishments were already functioning there and the legacy of these heritage/ royal residences & vintage buildings was handed over to the defence services.

Irrespective of the location, character of a Cantonment has not changed drastically over the years and Cantonment areas are still associated with well-maintained bungalows, low density houses, green and organized open spaces. While the char-

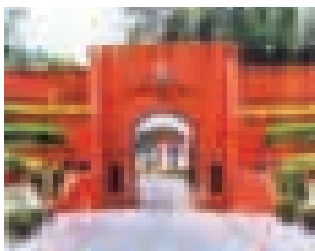
acter and skyline in a city undergoes change with expansion, the Cantonments have been able to retain their character. The noticeable difference in an expanding city and a Cantonment can be gauged by the fact that in cities, historical/ heritage buildings are being demolished to pave way for modern structures due to varying reasons like high maintenance cost, under utilization of prime land or structural safety, the defence services have taken the duty of preservation of these magnificent structures as a moral duty.

The historical/ heritage buildings in the cities are either in a dilapidated state or if conserved, are used only as a tourist attraction or museums, while in defence sector, all these buildings are being used for various purposes (after some modifications or additions, if reqd) and used as residences/ offices/ messes/ libraries. These heritage/ vintage buildings are seriously threatened by environmental agencies such as moisture, solar radiation, wind. Reaction of these agencies on building materials also brings a change in the form of discoloration, abrasion, cracks, stains and fungal growth over stone and growth of mosses, fungus, algae over timber & bricks. Hence maintenance of these heritage buildings needs to be on regular basis and requires a lot of efforts. There have been instances where the heritage buildings have been affected by nature's fury on account of floods or fire eg. Sun temple at Konark was affected by the floods due to heavy rainfall in Orissa in 2009 while the Military Hospital at Shimla was destroyed in a fire.

Army can also boast of maintaining some of the most invaluable treasures in the form of forts/ temples/ churches. What distinguishes these conservation initiatives is the adaptive use of building. Some of Conserved buildings are illustrated below.



Sudan Block NDA, Kharagwaslam



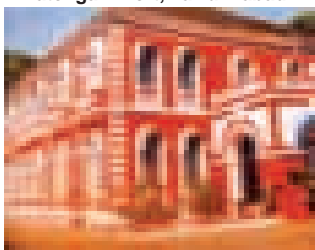
Fatehgarh Fort, Farrukhabad



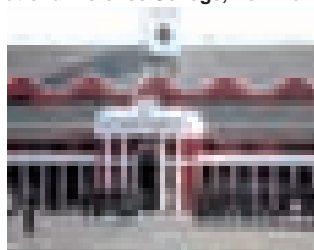
National Defence College, New Delhi



Ashwini Hospital, Mumbai



Building No P/1, Goa



IMA, Dehradun



Naval Dockyard, Mumbai



Ahmednagar Fort

Initiatives Undertaken

Army HQ had taken some initiatives in compilation/ documentation of few historical and vintage buildings in various commands. In 2007, funds were allotted for environment & ecological projects and a SOP wrt utilization of these funds was issued by the Army Head Quarters which dealt with maintenance/conservation of heritage & historical buildings. Documentation of certain buildings had been initiated & completed, though it has never been updated.

Few conscious efforts have already been taken at certain places for preservation of Heritage buildings under the custody of Forces for eg. Western Naval Command has already taken few measures for the Naval Dock yard and INS Angray, Ashwini Hospital (old block) amongst other heritage assets in their possession.

INHS Ashwini, Mumbai

The hospital started functioning in 1756 from barracks as King's Seamen Hospital for in-patients. In 1860 the octagonal building no. 3 (Hawa Mahal) was constructed as main ward of Bombay Marine Hospital. In 1899 the main block (building no. 1), was constructed and building no. 26 (officers ward) was added on. In 1996, work started on the construction of a new building, while restoring the Heritage buildings to their pristine glory. The new building site was adjacent to the existing hospital, and due to Herculean efforts of the hospital staff, patient care was never compromised while the construction of the buildings and the subsequent shift to the new buildings took place. While all patient care functions have shifted to the new complex, the administrative and support services are functioning from the existing heritage structure.



Fort William, Kolkata

Fort William was constructed after the battle of Plassey between the period 1758- 1781. Stretching for around 3 Km in north-south direction and spread over 71 hectares approx, it was designed as a star fort. It is built of brick and mortar in the shape of an irregular octagon with an area 5 km². Five of its sides face landward, and three towards the river and is surrounded by a dry moat 9 m deep and 15 m broad. The buildings are retained and readapted for various uses. eg St. Peter's Church which used to serve as a chaplaincy center for the British citizens of Kolkata is now a library for the troops of HQ Eastern Command.

In order to arrest the deterioration of these buildings and proper conservation/readaption in a better way, a Heritage Conservation Committee was set up in Eastern Command Kolkata in the year 2001. A Perspective Plan (FW) -2007-22 was approved by GOC-in C which not only identified the Heritage Assets within the Fort William Complex but also identified future growth within the Fort William complex. Restoration work was also carried out in one of the heritage building i.e. Kitchener's House.



Top Image of Fort William 1814

St. Peter's Anglican Church,

Fort William, Dalhousie Barrack

Efforts have been made to harmonize the character of New Head Quarter Building under construction in the complex with the overall architecture of Fort William Complex.

Topi Bungalow Jammu

This bungalow was constructed in the period 1894 – 97 for the inspecting officer for Kashmir Imperial Service Troops. Later in 1905 the Prince of Wales (later King George V) was also put up in this bldg. The bldg. has an influence of Gothic architecture and Scottish Renaissance style which is evident from the style of windows, conical roof, square stone ends. The building today is standing in all its glory and is being maintained and put to adaptive use by army.



Old Church Fategarh

This landmark of Fategarh Cantt overlooks the quarter Guard & training area. The church was built in the year 1819-1820. This church building has been used as a school (1863) and later converted to a hospital. The building is now as a church adjoining St Anthony's School, a pioneer education centre.



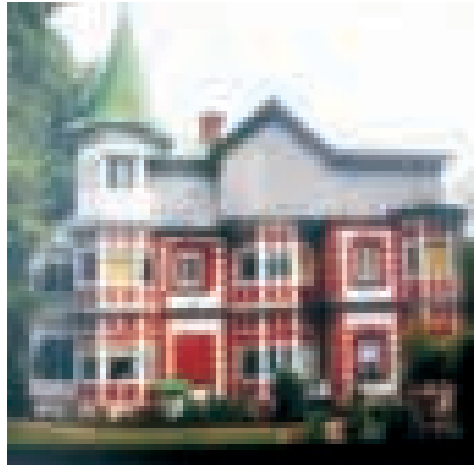
All Souls Church: Kanpur

This church of 1854 vintage is built in red stone brick and is surrounded by a spacious garden. The architectural values of the building are well preserved and is functional as a place of worship, though the tunnel believed to be an escape route for the British has been blocked and filled.



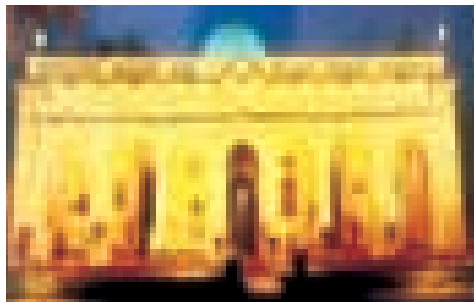
Chinar House, Srinagar

This iconic building was constructed in 1938 and later placed under the Cantonment authorities who were empowered to collect rent. The building was later transferred to central govt in 1956. This three storeyed building is on a wooden frame, using thin brick and sand construction bonded with cement. The central wooden staircase connects all the three floors while another wooden staircase in the rear is for emergency exit. The building today also stands in all its glory and is used as a residence.



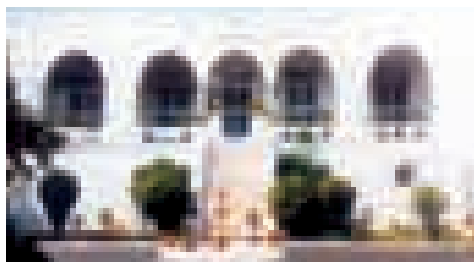
Brigadier General Dyer's House, Jalandhar

This house was used for Brigadier general dyer after assuming command of Jalandhar Brigade in March 1918. The house was later occupied by col WF Banbridge. Presently the building is readaptive used as Headquarters for Brigade.



Sheesh Mahal : Bharatpur

One of the luxurious buildings constructed in mid eighteenth century was the residence for queen and all members of royal family were born there. It is now used as a residence.



Itarana Palace, Alwar

Constructed in the period 1914-1917 this building has 76 rooms and is constructed in regal style. The ground floor was for servants, first floor for guests and the top floor was Maharaja's residence. The building is an amalgamation of French and German architecture. At present, it is used as an office and an Officers Institute.



Kharga House, Ambala

Ambala Cantonment was developed in 1825, though military significance of this cantt grew under Maharaja Ranjit Singh's period. This house was constructed during the period 1908-1909 for single officers. Modifications have been carried out over the years in consonance with the architectural style of construction



In absence of any standard procedure for initiating the conservations/maintenance works for these buildings, the recommendations of the station Commander. The works initiated are at times works initiated are at times struck up in bureaucracy hurdles which delays the process of conservations. Conservation Policy on heritage buildings is now being formulated to safeguard the Heritage Resources with Armed forces along with proper documentation. The advantages of this policy are as under:

- ▶ To initiate 'Conservation Process" to safeguard the Heritage Resources with defence.
- ▶ To initiate "Documentation Process" by preparing an "Inventory".
- ▶ To re-orient the thought process in r/o maintenance/ preservation/ Addition & Alteration and new develop ment in Heritage Zone.
- ▶ To explore suitable restoration techniques with a list experts in the field of conservation.

Guidelines for Conservation of Heritage resources are also being finalized in order to regulate construction activities in Heritage precincts , guide adaptive use/ reuse of buildings, generate awareness on heritage conservation to local staff and general public, which need to be read in conjunction with the conservation policy.

Scope of Conservation Policy

The Conservation policy shall be applicable for Heritage Buildings (Buildings, artifacts, structures), Heritage precinct (Precincts, environmentally significant areas) and Natural features (Natural feature of environmental significance or scenic beauty) in the custody of Armed Forces.

The Conservation may include only maintenance, preservation, restoration, re-construction, re-appropriation or be a combination of one or more. The responsibility for the conservation process at various levels is as below:

| | |
|---------------|--|
| Army HQ – | <p>(i) To recommend release of repair/ Maintenance funds for works forwarded by Command after ensuring adherence to ‘Conservation Plan’ of Military Stations (to be developed along with Zonal plans in case Heritage Buildings/Precincts/Natural Features exist in the station.</p> <p>(ii) Develop Conservation Plan along with Zonal Plans (in case Heritage Buildings/ Precincts/ Natural Features exist in the station)</p> |
| HQ Commands - | Identification & listing of heritage buildings / Precincts. Develop Conservation Plan alongwith Zonal Plans. |
| CE Zone - | Responsibility of carrying out conservation works and getting works sanctioned as per DWP |
| CWE/ GE- | Execution of works as enumerated below: |
| | <ul style="list-style-type: none"> • Regular repair and maintenance through term contracts/ special contracts • As major works when involving structural reconstruction/ restoration. • As special repair works when involving specialized repair/replacement/materials/ preservative treatments involved • As minor works if on small scale |

Conservation Policy

- i) An identification of area of 100 meter around the Heritage Buildings may be declared as “Protected / Heritage Zone” to avoid any New Construction and be marked in the “Conservation Plan” as laid out in the Act 2010 thro’ amendments by ASI.
- ii) Fixing of “Plaque” (preferably of stone) on each building with brief description of historical background & date of construction.
- iii) No Permission to alter the original façade & obstruction of the vista of Heritage Buildings for Gde-I Building.
- iv) Preparation of “Conservation Plan” at the time of preparation / Revision of Zonal / Master Plan of such Mil Stns / Cantt where enlisted Heritage Buildings exists.
- v) All the buildings with historical background and of Architectural Merit within Mil Stns / Cantt be ‘identified’ and be ‘graded’ according to their merit.

- vi) An “Inventory” to be prepared station wise with the enlisted buildings / structures with photographs / drawings / historical background / architectural Merit.
- vii) Update of “Inventory” of Heritage Building periodically (after physical inspection) at least once in 3years to monitor document changes so as to support the conservation process.
- viii) Creating ‘Conservation Cell’ as enumerated in para 16 to monitor activities (restoration/re-adaptation) to ensure least damage to buildings.
- ix) Formation of “Approving Auth” at Army HQ / Comd HQ for the recommendation given by Conservation Cell.
- x) Works of Conservation to be included in DWP and a prior ‘go-ahead sanction’ may be required due to its specific nature.
- xi) Widening of the existing roads under the Master Plan of the City or Town / Zonal Development Plan or in the Layout Plan shall be carried out considering the existing heritage buildings (even if they are not included in a Heritage Precinct) or which may affect listed natural features areas.
- xii) Special budget allocation required to handle the restoration / preservation / maintenance / conservation of listed buildings of Heritage value, as maintenance fund available for routine work is too less as projected. Adoption of modern conservation techniques based on scientific development for better maintenance.
- xiii) The process of restoration/preservation/conservation is a highly specialized job and needs proper attention. Any intervention must be governed on a scientific basis by a body of experienced technical experts, such as Archaeologist, Engineers, Conservation Architects, Conservation Artisans, Craftsman etc.
- xiv) For any special type of repair/ maintenance for which expertise is not available within MES, outsourcing may be explored from any other agencies like Archeological Survey of India or INTACH.
- xv) Uniformity to be maintained for the ‘Colour scheme on wall surfaces, wooden surfaces and metal surfaces for the buildings of historical natures.

Conservation Plan

To guide the growth of a Station and stop haphazard growth, Zonal plans for the Stations are finalized and approved by higher authorities for adherence. Stations

where heritage buildings exist and a specific architectural style/character is predominant, efforts should be taken to preserve the heritage status of these Cants/Mil Stns. This can be done by preparing / finalizing 'Conservation Plan' at DCP/CPT as an Appx to Zonal Plan/Master Plans. This plan shall recommend the specific guidelines for the old structures, new construction, retention and demolition, landscape traffic planning etc for that particular Cantt/Mil Stn approved as part of Zonal Plan Board.

Area Planning / Urban Design

- i) The "Conservation Plan" approved by the competent auth to be adhered to for any kind of intervention in the protected /Heritage zone in all Mil stns/Cantt. No new construction / demolition / modification / addn / altn to be carried out within the Heritage Zone / Building without the prior permission of "Conservation Cell".
- ii) Uniformity to be maintained for the colour, size, designs & material for Name Plates, Sign Boards, Hoardings, Road Signs , railings, gates, compound wall etc. within the Heritage Zone.
- iii) A comprehensive drainage plan requires to avoid water-logging in and around Heritage bldg to protect the foundation /structure and to maintain the clean ambience of Heritage zone.
- iv) Due consideration to be given to external illumination/effect lighting so as to enhance aesthetic value of total environment.

Old Buildings

- i) All buildings of historical importance / Architectural Merit to be identified and graded.
- ii) Historical evidence or artifacts must not be destroyed or falsified or removed from these buildings. All the architectural features must be identified and to be preserved in its original state as far as possible.
- iii) No alterations of facades of the graded buildings be permitted. The facades be maintained through regular maintenance with only repair/ re plastering, repainting etc.
- iv) Structural repair work whenever required should form an integral part of the whole structural system on the basis of the structural capacity of the buildings.
- v) Original utility of the plan may be restored wherever possible. Any changes

in interiors should take in consideration interior features of historical nature or of Architectural merit,(eg verandah, structural arch or architectural arch, ventilators for the top light, lofty ceiling, arched doorways/ windows or lofty doors).

- vi) Replacement of original building material are not generally recommended. But, in case, if it is felt necessary it should be replaced by the matching material and such replacement got to be approved by "Conservation Cell".

It is very important aspect to take into consideration of light and ventilation, while renovating the interiors specially in case of old buildings to avoid dampness, which is a major cause for damage of the structure.

New Constructions

- i) No new construction, demolition or modification will be allowed within the Heritage Area, which would adversely affect not only the main buildings but also the surrounding area for eg obstructing the vista, polluting the environment, choking of surface drainage etc.
 - ii) Any 'new construction' within the conservation area or any addn/altn to the buildings of historical value, whether exterior or interior should harmonize with the Architectural Style of that area and got to be approved by "Conservation Cell".
 - iii) New bldgs being planned within the conservation area will follow the basic planning norms and get the drawings approved by the "Conservation Cell".
- The new buildings to conform to the height of existing buildings in the vicinity.
 - Street pattern should not be disrupted and alignment of buildings to be catered for in design.

Electrical /Mechanical (E&M) Installation

- i) Any E/M installation like transformer, sub-stn, pump house, feeder box that may pollute or degrade the aesthetic value of heritage building/ zone should be avoided.
- ii) Fixing of security light directly on the heritage building should be avoided. A proper external illumination plan with effect lighting to enhance the environment of heritage zone may be adopted.
- iii) A well thought/ designed INTERNAL E/M layout approved by Conservation Cell to be carried out in any heritage building before any intervention. All electrical / telecom cable may be laid underground in heritage zone.

Landscape Planning

To enhance the environment quality of heritage zone, it is vital to have well planned landscape design. The landscape plan should ensure the following:

- i) Emphasize the visual axis/vista
- ii) Uniformity in street furniture design like, garden chairs, park railings, gates, street lights, sign boards / hoardings, road signs, jail, curb wall, illuminated signboards etc.

Conclusion

Indian Army is the custodian of largest real estate as cantonments and military stations and can boast of preserving the precious heritage in the form of forts, buildings, temples, churches, gurudwaras and cemeteries. Keeping all these buildings in good shape is herculean task taking into cognizance the diversity in architectural style of these buildings which is a hybrid of diverse elements of Hindu and Mughal architecture laced with gothic feature like Cusped arches, Domes, Spires, Minarets and Stained glass. Conservation of these buildings needs lots of efforts alongwith the added challenge of re-adaption of these buildings.

Defence is well known for its organized and systematic working and the same ethos are being carried over in the conservation process for these buildings. Using the guidelines to streamline the process along with organisation's space with modern trends and latest technologies will result in better development / conservation of these assets and keep them in pristine glory.

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HUDCO's Role in Provision of Affordable Housing

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Prologue

Housing and Urban Development Corporation Ltd., (HUDCO) is a well known name among the public sector enterprises of Government of India who is on the mission of promoting sustainable habitat development to enhance quality of life. It has emerged as the leading national techno-financing institution with the major objective of financing/encouraging the housing activity in country and alleviating housing shortage for all groups in rural and urban areas with emphasis to cater to the needs of economically weaker sections and lower income groups of the society and also the development of infrastructure in human settlements.

HUDCO has launched number of schemes like 'Rent to Own' housing through private /corporate sector and joint sector and also funding to individual borrowers for meeting their housing requirements, besides supporting in implementation of major programmes of Govt. of India, like JnNURM, SJSRY, RAY, VAMBAY etc.

The author who has considerable expertise in the field of affordable housing, through this paper has made efforts to apprise about the activities, various achievements and challenges before his organization.

- Editor

Introduction

The urban population of India has increased six-fold in six decades, from 62.4 million in 1951 to 377.1 million in 2011. This accounts for over 31 per cent of the country's total population of 1.21 billion in 2011. The number of million plus cities has also increased from 35 in 2001 to 53 in 2011. The million plus cities account for 43% of the urban population in 2011, indicating the huge geographical shift from rural hinterlands to urban centres. Projections indicate that by 2039, urban population will reach 50 percent of the total population. Urbanisation is assessed to be positively associated with socio-economic development with a higher level of productivity as well as agglomeration economies. Notwithstanding these benefits, urbanisation has also brought in some complex challenges for the policy makers and city planners such as inequity, poverty, slums and pressure on limited urban basic amenities like water supply, sanitation facilities, roads, drains, etc.

Magnitude of Housing & Urban Services Challenges

The Report of the Technical Group on Urban Housing Shortage (2012-17) of the Ministry of Housing & Urban Poverty Alleviation, Government of India has assessed the housing shortage at the beginning of the 12th Plan period (i.e. 2012) to be of the order of 18.78 million. Significantly, 95.62% of the shortage is assessed to pertain to the Economically Weaker Sections (EWS) and Low Income Groups (LIG) and 4.38% that of Middle Income Group (MIG) and above. The funds requirement for addressing urban housing shortage of 18.78 million works out to be around Rs. 10 lakh crore. In addition to the urban housing shortages in the country, the rural housing shortage is also assessed to be significant. According to the estimation of the Working Group on Rural Housing for the 12th Plan period, the total rural housing shortage in the country in 2012 was around 40 million dwelling units, and 90 per cent of this shortage pertains to the BPL families.

In regard to urban infrastructure, as per the High Powered Expert Committee (HPEC) Report for estimating the investment requirement for urban infrastructure services, the investment requirement for urban infrastructure over the 20 year period (2010-30) is estimated at Rs. 39.2 lakh crore at 2009-10 prices. Out of the total estimated investment, Rs. 17.3 lakh crore (or 44 per cent) is accounted for by urban roads. Sectors delivering urban services such as water supply, sewerage, solid waste management and storm water drains will need Rs. 8 lakh crore (or 20 per cent). The Committee has made explicit provision of Rs. 4 lakh crore towards investment in renewal and redevelopment including slums. Given the scarcity of financial resources, this poses a serious challenge to accommodate increasing urban population under a desirable standard of livelihood and sustainable habitat.

Further, the slum population of the country which was estimated to be 75 million in 2001 would have increased to around 97 million by 2013, as per the Dr. Pronab Sen Committee Report on Slum Statistics/Census. As part of the growth process, the poor will continue to move to urban areas that offer a better level of employment opportunities and stay in slums unless they gain access to suitable accommodation and related basic services.

HUDCO's Support for Social Housing Delivery

The Govt. of India had set up Housing and Urban Development Corporation Ltd. (HUDCO) as a fully owned public sector enterprise in 1970, in order to effectively address the housing and urban development requirements in the country. HUDCO today has emerged as the leading national techno-financing institution with the major objective of financing/encouraging the housing activity in the country and alleviating housing shortage for all groups in rural and urban areas with emphasis to

cater to the needs of economically weaker sections and lower income groups of the society and also the development of infrastructure in human settlements. With its corporate vision of being among the world's leading knowledge hubs and financial facilitating organizations for habitat development, HUDCO is on the mission of promoting sustainable habitat development to enhance quality of life. HUDCO offers support for a variety of housing options that include: Housing projects both in urban and rural areas for all sections of the society taken up by State Governments, Housing Boards/Corporations/agencies, Parastatal Institutions, Development Authorities, etc.; Housing projects for employees by State Governments/public Institutions; Land acquisition projects for Housing; Housing Projects under JNNURM for meeting the State/ULB contribution (Viability Gap Funding); Employee housing through the recently launched 'Rent-to-Own' scheme of HUDCO; housing through private/corporate sector and joint sector, and also funding to individual borrowers for meeting their housing requirements.

Till October 2013, cumulatively, HUDCO has sanctioned 14,840 schemes with a loan component of Rs. 43,188 crore for housing projects in the country. HUDCO is the largest facilitator of housing for the weaker sections in the country. There is a significant social orientation in its housing operations. HUDCO offers a relatively lesser interest rate for the EWS and LIG categories, offers a higher extent of unit cost as loan, and permits a relatively longer repayment period for these groups. HUDCO, since its inception, has contributed very significantly to the housing sector with its support for over 15.92 million housing units, of which about 14.74 million units are for the EWS/LIG beneficiaries alone. Of this total, about 6 million units are in urban areas and about 9.92 million units are in rural areas. Its facilitatory social orientation in housing operations has resulted in about 92.6% of the dwelling units supported by HUDCO benefiting the EWS & LIG groups. Of the total, nearly 4 million houses have been in the disaster affected areas.

Towards increased lending for Social Housing, HUDCO has undertaken many facilitatory initiatives in the recent past covering revision of income ceilings of various categories of beneficiaries, revisions in unit cost and unit loan ceilings for various income groups in relation to their affordability, waiver of application fee as well as front-end-fee for EWS & LIG category projects from Govt./public sector borrowers, removal of cost ceiling for JNNURM related housing projects (under BSUP & IHSDP) in view of the grant component, and levy of extremely competitive interest rate (of 8.5% to 9%) for EWS/LIG, etc.

HUDCO's Support for Urban Infrastructure & Services Delivery

In addition to housing sector, HUDCO also extends a major thrust on infrastructure development in human settlements, towards improving the quality of life

of citizens at large, by augmenting/providing basic community facilities and infrastructure services. HUDCO opened its exclusive Urban Infrastructure window in 1989-90, with a view to channelize funds to the urban infrastructure development in cities and towns. HUDCO's support for a variety of urban infrastructure schemes include: utility infrastructure covering water Housing, sewerage, drainage, sanitation, solid waste management, roads, etc.; social infrastructure such as health, educational and recreational infrastructure; economic, commercial and emerging sector infrastructure projects like highways, commercial and market complexes, power, IT Parks, ICE Component related projects, special industrial projects, etc. A significant support to the State agencies and Urban Local Bodies is also being provided for meeting the viability gap requirement for infrastructure Projects under JnNURM programme.

HUDCO, till October 2013, cumulatively, has sanctioned 1734 schemes with a loan component of Rs. 85,482 crore for infrastructure projects in the country which has helped in improving the quality of life of the citizens to a large extent, making the cities self-contained in the utility, social, economic/commercial infrastructure and thus improving their livability. HUDCO's cumulative support includes about 450 water supply projects, 70 sewerage projects, 21 drainage projects, 21 solid waste management projects, 351 social infrastructure projects, 257 transport infrastructure projects and over 360 economic and commercial infrastructure projects.

Technology Advocacy, Consultancy and Capacity Building Assistance by HUDCO

Towards promoting use of building materials and technologies which are cost effective, environment friendly, ecologically appropriate, aesthetically pleasing and economically affordable, HUDCO has promoted 665 Building Centres (Nirmithi Kendras) at grass-root level, of which 392 are fully functional. These Building Centres have so far trained more than 3 lakh artisans in use of various cost effective building materials and technologies and have also played a vital role in awareness creation, disaster mitigation and reconstruction activity during natural calamities.

HUDCO's consultancy assistance cover a wide variety of architectural, planning and engineering fields such as housing designs, development plans, master plans, heritage protection/preservation plans, city development plans, feasibility studies, engineering and environmental consultancy, etc. So far, HUDCO has provided consultancy support for over 300 projects, in addition to taking up preparation of master plans for 10 cities.

Towards improving the capacity of the Urban Local Bodies and Public Institutions for taking up major housing and urban development programmes for the welfare of the citizens and also promoting themselves as viable and sustainable

entities in the long run, HUDCO through its Human Settlement Management Institute (HSMI) extends capacity building support in the field of housing and urban development. HSMI has so far organised a total of 261 capacity building programmes by training over 38,000 municipal managers and technical professionals in India. HSMI incorporates four thematic Centres on Urban Poverty, Slums and Livelihoods, Sustainable Habitat, Project Development and Management, and on Affordable Housing.

HUDCO's Support in Implementation of Major Programmes of Govt. of India

As a techno-financing Institution, with a multi-disciplinary workforce, HUDCO has been assisting the Government of India in implementation of its major programmes in the country. HUDCO was associated in a significant manner in the implementation and monitoring of various Government of India's programmes such as the Two Million Housing Programme, Night Shelters, Swarna Jayanti Shahari Rozgar Yojana (SJSRY) for training component, National Slum Development Programme (NSDP), Valmiki Ambedkar Awas Yojana (VAMBAY), JNNURM (Jawaharlal Nehru National Urban Renewal Mission), Interest Subsidy Scheme for Housing the Urban Poor (ISHUP), Affordable Housing in Partnership Scheme, etc. As part of the JNNURM programme, besides undertaking appraisal, monitoring, capacity building and supporting the agencies through preparation of CDPs and DPRs, HUDCO has also sanctioned Viability Gap Funding (VGF) to State Governments/Urban Local Bodies. So far a loan assistance of Rs. 3069 crore has been sanctioned under the programme for meeting the requirement of 5,67,253 dwelling units under BSUP & IHSDP; and Rs. 3023 crore has been sanctioned for infrastructure projects under the Urban Infrastructure & Governance (UIG) component. HUDCO is a Nodal Agency as well as a Prime Lending Institution (PLI) for the scheme of Interest Subsidy for Housing the Urban Poor (ISHUP). HUDCO is also taking a lead role in implementing the Government of India's flagship programme for creating slum-free cities – 'Rajiv Awas Yojana' (RAY) with preparation of Slum Free City Plan reports, appraisal, monitoring, and Viability Gap Funding of the scheme projects in addition to undertaking capacity building programmes.

Innovative Financing Methods by HUDCO

While providing loan assistance to the borrowing Institutions for housing and infrastructure projects, HUDCO has endeavoured to facilitate the Institutions for sustainability of the projects. A significant emphasis is laid on critical aspects of long term sustainability such as cost recovery, incorporation of user pay instruments towards at least part recovery of the investment, incorporating cross-subsidisation opportunities to increase the coverage of population, opportunities for public-private participation, opportunities for un-bundling of complex projects for

systematic implementation of the projects, etc. Innovative mechanisms of funding have been adopted in respect of major projects in the recent past both in respect of housing and urban infrastructure areas. Loan assistance for the mega housing project of the Government of Rajasthan under its Mukhyamantri Gramin BPL Awas Yojana being implemented through the District Panchayats, and sanction of similar scheme for the Urban Local Bodies for BPL households under the programme of Mukhyamantri Shahari BPL Awas Yojana in Rajasthan are based on innovative financing mechanisms involving the implementing Institutions as well as the State Government.

In respect of infrastructure projects as well, HUDCO has adopted innovative methods of funding. In Punjab, HUDCO has extended two major loans for infrastructure provision & Improvement in Urban Local Bodies, based on utilising the Punjab Municipal Infrastructure Development Fund (PMIDF) and the Punjab Municipal Fund (PMF) in which, based on State Acts, a certain proportion of the Value Added Tax (VAT) accrues annually, which is used for repayments over the loan period, through an agreed escrow mechanism. HUDCO has also funded many proposals of bus fleet augmentation in many States by State Transport corporations, based on escrow of daily receivables towards repayment requirement. In the State of Madhya Pradesh, HUDCO has extended major loan assistance for water supply and infrastructure development projects in Urban Local Bodies, based on major repayment component coming from the State through utilisation of the ULB share of certain taxes/grants/subsidy.

New and Innovative Products by HUDCO

HUDCO has been striving to make 'Housing for All' a reality. Towards improving access to housing for all sections of the society, especially at the lower rungs of the society, HUDCO has introduced two innovative products, namely, Rent-to-Own Scheme and HUDCO Nav Nagar Yojana (HuNNY). The unique features of these two schemes are given below:

- 'Rent-to-Own' Scheme: One of the sections of the society which finds it very difficult to own a house in the career span is the salaried public government sector employees, especially at the lower rung. Towards improving access to housing for this section of the society, HUDCO introduced the 'Rent-to-Own' Scheme on 25th April, 2013 on the occasion of HUDCO Annual Day. It is a 'rental-cum-ownership' scheme which is designed to facilitate an agency to initially avail loan from HUDCO on behalf of its identified employees for the scheme and would allot the houses to its employees initially on rental basis. The employee would become the 'owner' of the house as and when the full cost of the house is paid to the Agency. This would help the Agency to improve the satisfaction level of employees.

- **Hudco Nav Nagar Yojana (HuNNY) Scheme:** HUDCO, as a pioneering techno-financial institution in the housing and urban development sector, proposes to facilitate the Urban Local Bodies (ULBs) and other Government Agencies in developing integrated townships/layouts/colonies, to meet the increasing requirement of planned housing for its citizens. Introduced on 15th August, 2013, HuNNY offers a comprehensive solution to the growing cities/towns from 'Planning to Financing' the sustainable habitats. Under the Scheme, HUDCO would provide technical and financial support for developing potential sites as planned urban extensions to meet the requirements of the ever growing population. The programme operates at three stages: advisory service on conceptualization and feasibility of the proposed development; consultancy assistance on fee basis for architectural and engineering designs; and providing funds required for development of sites and services as well as housing, including land acquisition.

Major Initiatives During the Year 2012-13

Apart from the two new products mentioned above, HUDCO has taken many new initiatives during the year 2012-13, to expand its reach and enhance its contribution in the development of affordable housing and sustainable habitats. The important initiatives are as follows:-

Macro Finance for Housing

HUDCO has agreed in principle for an equity investment of Rs.1 crore in the proposed new Housing Finance Company – SEWA Grih Rin (SGR), promoted by SEWA, a reputed NGO. SEWA is currently having 1.34 million women as its members and promoting the cause of poor and self-employed women in slums and squatter settlements. Through the proposed equity participation, HUDCO would ensure financial inclusion of the women members of SEWA, who have so far been denied the benefit of home loans through the formal lending mechanism.

Partnering Delhi-Mumbai Industrial Corridor

HUDCO has subscribed to 19.90% (Rs.19.9 crore) of the equity capital of Delhi Mumbai Industrial Corridor Development Corporation Ltd. (DMICDC). By utilizing the high capacity western dedicated railway freight corridor as the backbone, DMICDC has a vision to develop seven Industrial cities (in phase-I) along Delhi Mumbai Corridor, which can compete with the best manufacturing and investment destinations in the world. HUDCO would also assist the State Governments along the Corridor by financing land acquisitions, new township development and related infrastructure projects.

Venture Capital

HUDCO has approved a subscription of Rs.25 crore in Venture Capital Fund being established by the National Innovation Council. The Fund will invest in the enterprises involved in the housing and urban development sector including start-ups as well as emerging and growing ventures that needs support to scale-up potentially successful solutions and business models allowing them to maximize their social impact in the Habitat Sector.

Infrastructure Debt Fund

HUDCO has approved subscription of up to Rs.50 crore to the Units of Infrastructure Debt Fund (IDF) launched by India Infrastructure Financing Corporation Ltd (IIFCL) through mutual fund route. The IDF will mainly undertake investment in debt securities or securitized debt instruments of infrastructure companies. As a Strategic Investor, HUDCO will contribute towards catalyzing capital formation for infrastructure development in the country.

Participation in UN-Habitat Exhibition

HUDCO participated in the UN-Habitat exhibition during the Governing Council meeting of UN-Habitat in April, 2013.

HUDCO Design Awards

Launched in 2012, to encourage architects, town planners and engineers, 'HUDCO design awards' give recognition and encourage innovative ideas that make cities inclusive, beautiful and environmentally sustainable. This shall be a regular feature henceforth.

Conclusion

In the light of the significant deficit in the housing and urban service delivery in the country and the need for massive efforts to achieve the objective of affordable housing and provision of urban basic services for all, HUDCO is fully geared up to take up the challenge of greater social housing delivery as well as the provision of urban infrastructure services in the country.



Challenges of Urban Mobility in South Asian Cities

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Prologue

This article explains about the public transport system in Asian Cities and various challenges before them. It is only a fraction of the total number of cities / towns in India which have formal/regular transport system. These too are struggling to survive and dependent upon Govt. subsidies. Complete privatization of public transport may not work by itself and its affordability is a big question, making the system non-viable in terms of safety of passengers, affordable fares and welfare of operators including the staff.

In this article, Shri A.K. Jain who has a wide experience of planning of Delhi has tried to bring out his views about a series of complementary actions towards enhancing the potential of public transport. Integrity between transport and urban planning, along with transport demand management, transport mode and technology choice are crucial factors in transport facility.

- Editor

Introduction

Existing public transportation systems in South Asian cities face several challenges. In the cities where majority of the public transport users are poor, women and children mobility helps them to access to employment, education, healthcare and other basic amenities. As such public transit systems need to not only sustainable but also inclusive. However, the provision of public transport system is limited, e.g. only 100 odd large cities out of 7936 cities and towns in India have a formal transport system. Wherever provided, the public transport agencies are struggling to survive and are dependent upon by huge government subsidies. With the growing economies of the cities in South Asia, it is a major challenge to facilitate a shift from cars and motorcycles to public transport. Public transport is also linked with feeder services, parking facilities, financial resources, dedicated corridors and network capacity. Although solutions like underground metro is long range and expensive, innovative models can be developed engaging property development, central/state government and local bodies sharing of investments, soft loans, public private partnership and formation of special purpose vehicle, as has been done in Delhi

and Mumbai. However, as the examples of Karachi and some other cities indicate, complete privatization of public transport may not work by itself and its affordability is a big question. Such efforts have ended up being non-viable in terms of safety of passengers, affordable fares and welfare of workers/operators (as in Karachi and Kabul).

Some of the cities in India e.g. Delhi, Mumbai, Ahmedabad, Nashik, Rajkot, Vishakhapatnam, etc. have embarked upon Bus Rapid System (also called integrated transit corridor) for improving public transport. The experience indicates several challenges. Improving the vehicle efficiency and transit operations (consistent dwell times and driving practices, regular dispatch, control of the bus intervals along the route), improving fuel efficiency and quality, fleet management systems, using GIS and online supervision as to make public transit operations sustainable and reliable. Establishing a relationship of the public transport system with other modes, such as 2 wheelers, cars, informal transport and NMTs is another challenge. The public transport system, also needs a well developed road infrastructure, terminals, workshops, depots and parking space which can not be overlooked.

Trends and Conditions

The core of many South Asian cities are still walkable (e.g. Delhi, Mumbai, Jaipur, Agra, Lahore, Karachi, Dhaka, Colombo, Kathmandu), which makes it possible for the average citizen to save cost and time on vehicular transport for day to day activities. Street life, public places, pedestrianisation are special features of South Asian cities which make them dynamic and vibrant.

With the passage of time, the cities have adopted low density and single-use zoning. Urban sprawl and the separation of land use from transportation planning generated higher volumes of vehicular transport, longer trips, higher consumption of fuels and rising levels of congestion, emissions, pollution and road accidents. These have made the cities unsustainable. However, a few attempts have been made towards integrated land use and transport planning and the examples of Islamabad (Pakistan), Dhaka (Bangladesh), New Mumbai and New Delhi can be cited.



Concept Plan of New Mumbai

Planned in early 1970s by Charles Correa the spatial configuration of New Bombay is derived from its traffic and transport structure, comprising road-cum-rail corridors. These are the backbone of a series of new cities which are planned and served by public transport. The central business districts have been planned at the junction of three linear rail spines and regional road transport networks. The plan seeks to use rail network for reducing traffic load on the roads and to achieve better environmental and economic sustainability

The Master Plan for Delhi 2021 envisages the restructuring of about 500m belt along the metro corridors, highways and transport nodes with incentives of higher Floor Area Ratio and mixed land use. The concept of linear 'facility corridors' all along metro/ public transport networks envisages high intensity development of work centres, educational, healthcare and other public facilities so as to strengthen the relationship with mobility (public transport), pedestrians, cycles, etc. It aims at dispersal of traffic towards achieving a sustainable volume/ capacity ratio. The Plan encourages compact, dense and smart growth and projects the concepts of 'synergy between public transport corridors and land use,' 'urban restructuring along major arterials' and 'metro network,' 'influence zone' 'densification' and 'mixed land use'. The experience of Delhi indicates that a speedy, comfortable and affordable public transport can attract private motorised users to public transport. Central Road Research Institute (CRRI) surveys (2009) estimated that about 29,000 car owners and 28,000 two wheelers/three wheeler commuters shifted to metro during 2009. The shift was attributed to traffic jams (23 per cent), parking problem (5 per cent), speed (17 per cent) and 24 per cent for safer, comfortable journey. On the other hand, there is also a shift of about 200,000 to 300,000 commuters per year from public to private transport, which points towards enhancing the potential of public transport by linking it with land use, along with a series of complimentary actions, as given below:

- Preparation and operationalization of an integrated and complementary multi-modal transportation plan comprising the road, rail and metro networks, so that work centres/residences are within a walkable distance.
- The multimodal system has to be integrated with facilities for pedestrians, bicyclists, disabled persons and Intelligent Transport System enabled taxis and three-wheeler scooter rickshaws.
- Optimal development of the existing road network by removing impediments to the smooth and safe flow of buses and non-motorized transport.
- Expansion and restructuring of the existing road, rail and metro network and creating alternative networks to promote use of public transport.
- Integration between the bus, rail and metro-system to provide seamless multi-modal transport, through the provision of additional stations, park and ride facilities and introduction of single multi-modal ticketing. The multimodal public transport system to be based on comparative cost-effectiveness analysis for the judicious use of public funds.

- Planning and development of goods transport and transport terminals (air, railways, container depots, freight complexes, warehousing and wholesale markets) and influence areas around them to be based on the principle of decentralization in a regional framework and towards the urban periphery, linked with railways, highways and metro network, together with feeder services.
- Development of a comprehensive parking policy including measures for linking new vehicle registration with owner parking facilities
- Bicycle/cycle-rickshaw to be promoted for short and medium trip lengths, together with enhanced facilities for pedestrians with street furniture, signage and landscaping.
- A major consideration in mobility planning and space design is that people with disability, older persons and people in wheel chairs could move safely in the city. This requires that:
 - o Paths and pavements shall be flat, uniform, slip-free and free from obstacles.
 - o Orientation points and guide routes may be provided for visually disabled people.
 - o Information and warning signs must be understandable, clear and well lit.
 - o Provisions for the physically challenged should be made to overcome curb height, rain water gratings and other barriers. Parking spaces close to the entrance should be reserved for physically challenged. Public transport shall be designed for easy access by wheelchair users.
- Exclusive parking bays to be provided near major intersections for parking of mobile repair vans, Police Control Room/Vans, ambulances, cranes, fire tenders and other public utility vehicles.
- Safety of road users shall be a prime consideration while planning transport infrastructure. The aspects of licensing, registration and training of transport operators/drivers are important elements in traffic safety. Appropriate road signage and markings help in traffic safety.

The sustainability of surface transport system is constrained by three distinct sets of factors. These are:

- physical (e.g., conversion of agriculture/forest for urban use and transport network, environmental impacts, periodic flooding, poor soil condition, siltation and erosion of rivers, etc.);
- low investments in public transport systems; and
- inadequate institutional framework (number of ministries, transport sector agencies and lack of co-ordination and autonomy of transport organisations).

The environmental dimension of transport projects often remains disjointed. In

practice it means vehicle and fuel centric environmental controls, such as checking of 'pollution, control certificate' of vehicles and fuels. In most of the cities there is hardly a comprehensive and legally enforceable system to evaluate and obviate the impacts of urban growth and transportation infrastructure projects (like expressways, flyovers, etc.). The production and ownership of private motorized vehicles are being promoted with government support by the automobile industry, media and aggressive marketing, as well as due to poor alternatives to travel and transport goods. Overemphasis upon transportation hardware such as more and wider roads, grade separators, fuels, engine efficiency and reduction of energy use, have marginalized the software of environmental sustainability of transport, such as promoting walkable city, mixed land use, higher density, compact and smart growth, which reduce the demand to travel. Planning interventions and non-invasive, non-structural solutions such as promoting transport and land use integrity and a walkable city structure are hardly adopted in practice. Popular solutions like widening of roads, construction of flyovers/grade separators and mega transport terminals are pursued by transport organizations and political leadership, who consider these as a matter of prestige and professional achievement. However, these often prove to be short term and sometimes even worsen the situation.

Integrity between transport and urban planning, along with transport demand management, transportation mode and technology choice are crucial factors in transport sustainability. It implies a change in perspective as public transport and NMTs are usually seen as the mode for the not so well off section of the community, who cannot afford to own/use personal transport. To change this perception public transport and NMTs have to be reinvented as in the case of Dhaka where Volvo buses were introduced. Luxury air-conditioned buses have also been introduced for city transport in some Indian cities, such as Delhi, Mumbai and Bangalore, etc., which helped in changing the perceptions of public transport. In Agra, state of the art designer rickshaws made them prestigious for the users besides being more efficient, less polluting and more comfortable.

Apart from aspects like reliability, frequency, inter-modal integration and single ticketing systems, the quality of public transport would need to be significantly upgraded, inter-alia, keeping in view the elements of clean and non-carbon (green) fuels and traffic calming. This way a reduction in use of fossil fuels and resulting pollution control is linked with public transport sustainability, efficiency and performance. Some cities in India (Indore, Ahmadabad, Delhi, etc.) have recently adopted Clean Development Mechanism protocols, performance standards and IT based traffic management and passenger information systems for public transport, which can be evaluated and adapted more widely.

With growing transport and mobility demand, urban transport institutions in South Asian countries face numerous challenges, such as:

- being under-resourced and lacking in overall capacity to plan, execute, maintain and deliver affordable and sustainable transport;
- fragmented policy formulation and implementation, lack of co-operation among multiple ministries and transport agencies;

- lack of finances for transport infrastructure and urban public transport, which require institutional/governmental support, concessions/subsidies, etc.;
- the institutional and procedural constraints that impede efficient delivery of transport infrastructure and services;
- lack of a unified legal and enforcement framework;
- lack of financial procedures, accounting and audit systems;
- lack of comprehensive information systems, disclosure and public participation, leading to corruption.

Most of the organized institutions are created and geared to deal with formal traffic and transport and the informal modes and NMTs are left to fend for themselves, although they normally constitute half of the total trips. In most of the cities (except metropolitan centres), there are no integrated mobility and accessibility plans. Traffic and transport planning is often piecemeal, ad hoc and is left to traffic police and regional transport offices. The continuance of the vertical command structure leaves out the scope of horizontalization among the transport infrastructure providers, operators and regulatory bodies, (traffic police, etc.).

It is being increasingly realized that the gap between planning and implementation can not be bridged without the institutional reorganization, capacity building and streamlining of the procedures, including review of overall mandates, roles, and functions of existing institutions. As such the establishment of a citywide unified urban transport agency, which also recognizes and promotes the NMTs and non-transport (walking, e-governance, etc) has been initiated in Delhi, Bangalore, Hyderabad and some other cities. A major task of unified transport agency is to promote a more professional approach to transport planning. Its other priorities are streamlining of public-private partnership procedures, updating legal framework, driving license and safety procedures, working out norms and standard operating procedures. As urban mobility concern every citizen, the Unified Transport Agency provides a platform for online and personal participation of citizen groups, media, education and training institutions in the development of public oriented policies, plans, priorities and services. The States/city governments in India are increasingly adopting disclosure policy and accounting procedures to achieve better value of public funds. However, the process of social audit of urban transport projects to ensure creation of an equitable gender sensitive, accessible mobility is still missing, and the concerns specific to South Asian cities such as protecting women's dignity in public transport, role of NMTs, traffic calming, etc. are not given due importance. A composite governance framework needs to be evolved putting together bits and pieces.

To improve the delivery and reduce the risk of corruption, few institutional and governance reforms, such as right to information, social audits, road public expenditure reviews, anti-graft initiatives and project specific fiduciary management measures have been effective. These can be clustered into national policies and reforms, such as, procurement, third party monitoring, road users' voice in agency performance monitoring, civil society involvement, optimizing value for money, etc for a more affordable, safer and sustainable delivery of transport infrastructure and services.



Planning Concepts of Teaching Hospitals : A Study of Nursing Units

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Prologue

The paper highlights the planning concepts for a teaching hospital of 200 plus beds. As a part of the process to understand the existing schemes in India, two case studies have been taken up in this research paper. The selection of the case studies are done in a manner to have a complete overview of the planning concepts. One of the finest examples in hospital planning, Sher-e-Kashmir, Institute of Medical Sciences at Srinagar, forms the first case study and the second focus is on the development of a modern hospital Indira Gandhi Bhawan for Kamala Nehru Memorial Hospital at Allahabad.

Both these campuses impart education in the field of medical sciences. On one hand Sher-e-Kashmir presents the latest technological in-

terpretation of the problem, based on British Planning Styles. It exhibits one of the ideal circulation patterns and layouts. The initial construction period of the Institute was from 1975 to 1987, however additions are still being made. Whereas the Indira Gandhi Bhawan designed in KNMH campus is planned to function as a modern block in an old hospital campus, designed as podium and tower concept.

The paper presents an ideal relationship between various departments in a multi-level hospital and guidance for those providing consultancy in planning of the hospital services.

- Editor-

Introduction

One of the first examples of modern hospital planning in India can be seen at Sher-e-Kashmir, Institute of Medical Sciences. This is a 600-bed referral hospital, located on a 72-acre plot at Soura; just outside Srinagar city. The institute is planned almost as a self-sufficient township, including the hospital complex, hostels for nursing staff and junior doctors, and housing for doctors and essential personnel. The polyclinic can handle upto 1200 patients every day. It was conceived in 1973. The total cost of the project was Rs. 15.4 Crore and the period of construction from 1975 to 1987.

Kamala Nehru Memorial Hospital is an edifice of service to humanity. Over a span of 46 years it has provided succour to the poor, downtrodden, under-privileged

suffering people of Allahabad city and its neighboring areas, as also to a large number of difficult cases coming from the neighboring states of Bihar, Madhya Pradesh and West Bengal. The nucleus of KNMH was laid by Smt. Kamala Nehru in 1931 as a Congress dispensary in Swaraj Bhawan. The institution which initially was only a fledgling 40 bedded obstetrics and gynecological hospital, has constantly grown from strength to strength. Today, it is a 301-bedded hospital catering to the medical needs of women and infants. KNMH is a composite hospital to render maternal and child health care with facilities for radiology, pathology and cancer treatment. The hospital is affiliated with Motilal Nehru Medical College for purpose of teaching of undergraduates and post-graduates. Adjacent to the hospital is the Sarojini Naidu Children Hospital, which was constructed by the KNMH Society.

To help maintain the service standards of the institution the new Indira Gandhi block is conceived, with a definite view that the new block would: -

- Blend harmoniously in the campus.
- Would be aptly supported by the various diagnostic and other junctions **housed** elsewhere in the campus.
- While incorporating the latest technologies it would retain the 'service philosophy' of the Institution.

PLANNING CONCEPTS

An attempt is made to integrate the functional needs of all sections – patients, staff, service utilities and referral specialties. The planning style is based on a time tested British System which has been modified to suit Indian conditions. Maximum care has been taken to segregate and control circulation patterns of patients, visitors, medical staff and service personnel. Circulation routes for different types of users meet only at controlled points. Visitors move past the reception into a separate circulation pattern which does not interfere with the working of the medical and service staff.

A separate service zone is provided to take all medical and other items from the kitchen, laundry, CSSD, etc. through a clearly defined corridor to service connected to the wards under the control of the nursing station. This has been done to keep the working of the OPD and referral areas separate.

In Sher-e-Kashmir there is a compromise between the two distinct philosophies of hospital planning i.e. either to have tower blocks or to have low rise development. In the first case the cost of services are always high compared to the second type of traffic (where it was expected that more floating population would be) like the polyclinics and referral clinics are purposely restricted to only 2 levels. This is convenient to the outpatients. The ancillary service areas are comparatively higher and forms block of 5 levels.

The patient care area or the ward area and all the ancillary departments and the outpatient department are joined together by a 'spine', which forms the major

traffic link. The spine is of 'T'-shape and helps to link all the activities together (Fig.1).

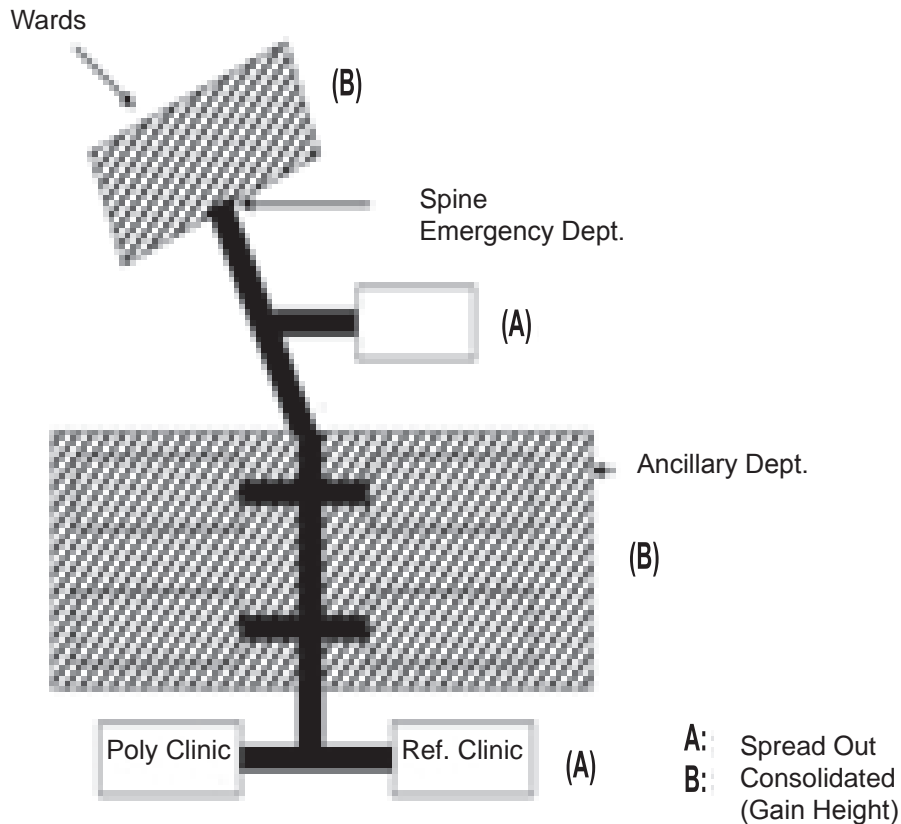


Fig. 1 Lay Out of Sher-e-Kashmir Hospital

In Kamala Nehru Memorial Hospital, Indira Gandhi Block the planning style is based on 'the podium and tower' or the 'match box on muffin style'. In this particular hospital building the podium is the 'specialist base' consisting of entrance, waiting, doctors cabins, examination rooms, operation theatre department, recovery rooms and Intensive-care unit. The outpatient department is housed in a separate block, which is an old building, remodeled to suit the present day medical needs of the patients.

The tower block consists of wards, both general wards and private wards. The service block is placed in the rear of the building. Segregation in the routes of visitors, patients, medical staff and supplies has been done with great care. A separate service zone is provided to take all the medical and other items from the service block to the hospital.

The outpatient department, ancillary departments and the services are housed in four separate buildings joined together by a 'link'. There is a 'T' shaped internal corridor, which runs right across the hospital. There are different zones which restricts the entry of non-medical staff to the critical areas. In the core of the hospital, care has been taken in segregating the movement of visitors from the hospital staff by providing different vertical hoists for them (Fig.2).

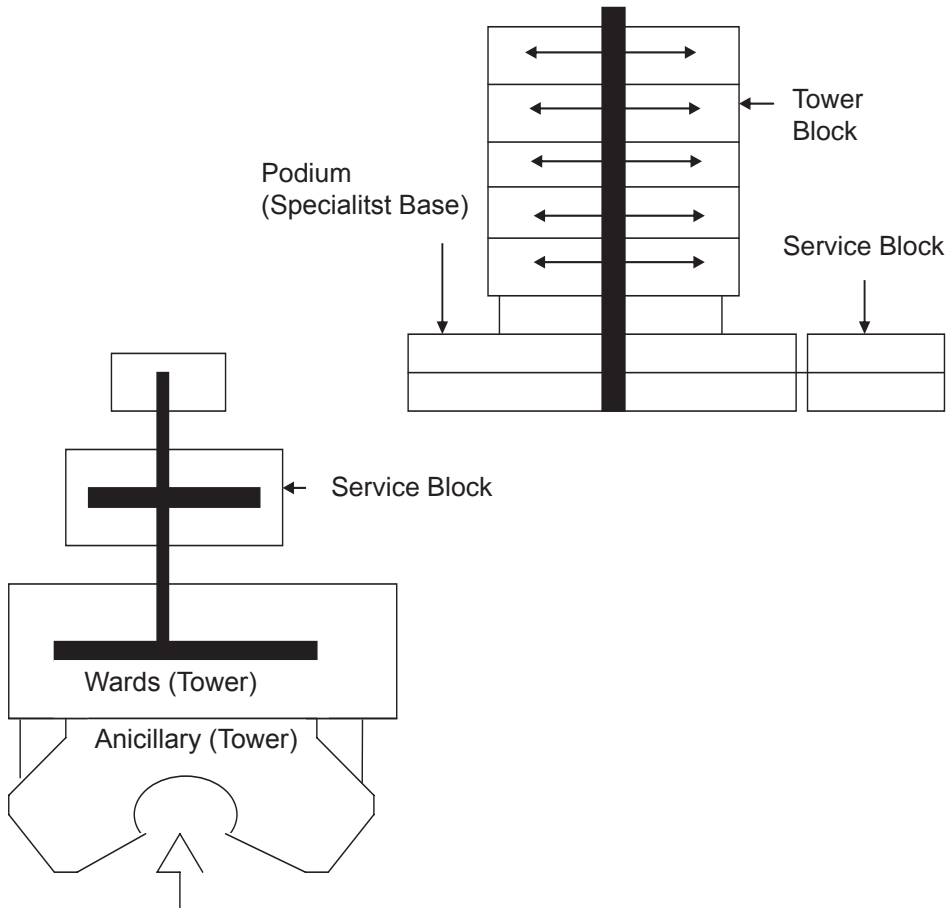


Fig.2 Indira Gandhi Block-Details

Relationship Between Different Departments

In Sher-e-Kashmir, Institute of Medical Sciences, Srinagar the sequence of departments (Fig.3) are in such a manner that the polyclinics and referral clinics together form the outpatients department. The polyclinics are spread out in three building blocks, the referral clinics on the other hand are housed in two blocks. All these different blocks are of two storeys.

The outpatient department is followed by the ancillary departments which consist of: -

- Physio Therapy;
- Nuclear Medicine;
- Radio Diagnostic;
- Radio therapy;
- Operation Theatre Department.

The emergency has a separate entry and has operation-theatre department and Intensive-Care-Unit on its upper floor.

The student facilities like the library, museum and laboratories are placed along with the ancillary departments and are located between the polyclinics/referral clinics and the wards.

- The ward block consists of two parts:
- General wards.
- Paying wards.

The general ward block is of eight storeys and the paying ward block is of six storeys. The entry for the ward block is separate and independent.

This is followed by the services department which consists of: -

- Kitchen;
- C.S.S.D;
- Laundry;
- Boiler house;
- A.C. Plant / Sub Station.

Between the ancillary departments and the services is placed the staff canteen.

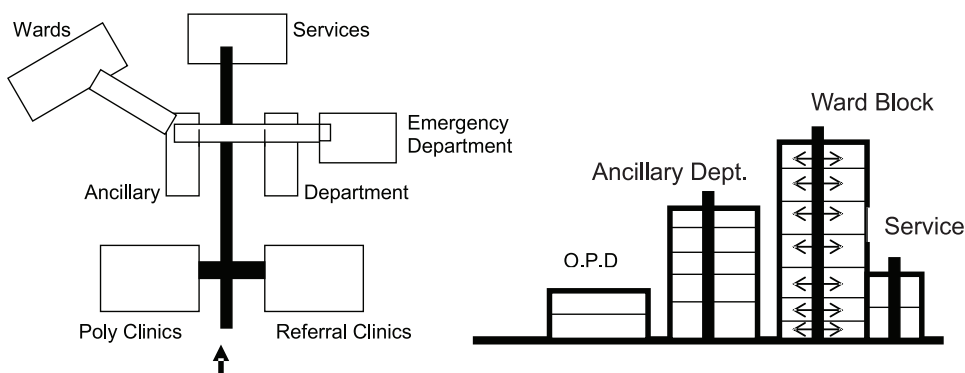


Fig. 3 Sequence of Departments – IMS Srinagar

In KNMH, Indira Gandhi block the outpatient department forms the first building block, this is easily accessible from the main road (Fig.4).

The ancillary departments and the emergency department are housed in the central portion of the main building. The patient care area or the wards form the tower block with the private rooms in third and fourth floor levels and general wards in the forth, sixth and seventh floor levels. The operation theatre department is in the first floor along with the doctors, cabins and recovery rooms. The front portion of the first level of the podium housed the Intensive Care Unit. There is a direct link between the C.S.S.D. and the operation theatres. The service block is behind the ward block and consists of C.S.S.D; Kitchen; Sub-Station; Laundry; A.C. Plant;

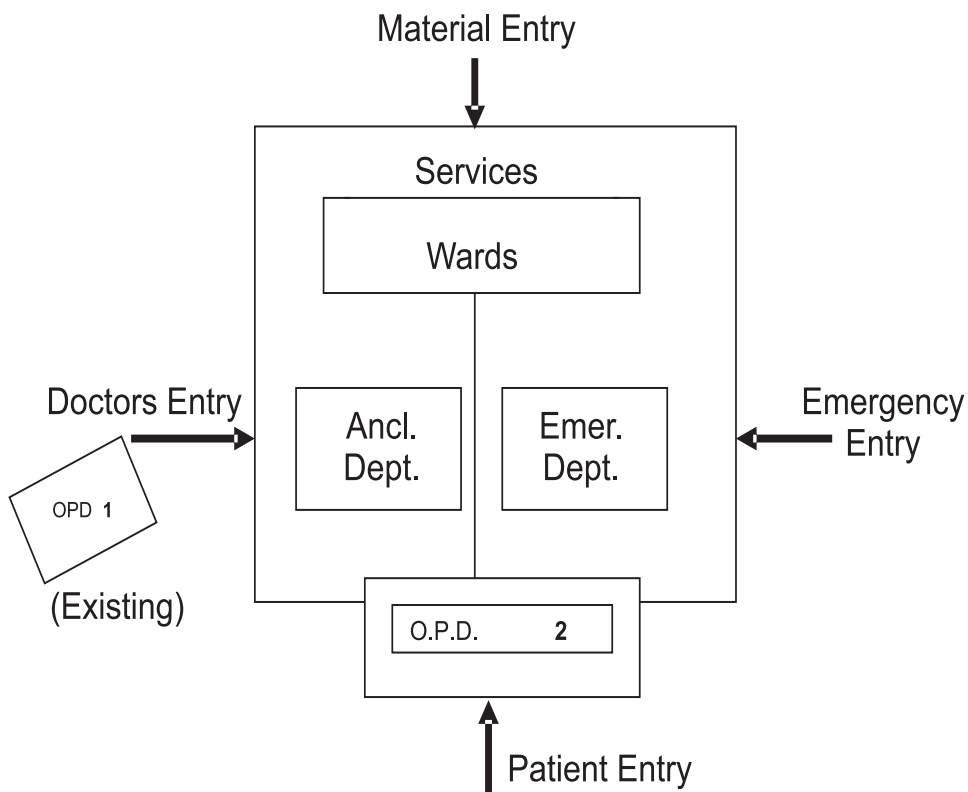


Fig. 4 Relationship between Different Departments - KNMH

Structural Grid of The Nursing Unit

The ward block of Sher-e-Kashmir is designed on a structural module (Fig.5). The grid is 6m in one direction and a combination of 7.2m and 5m along the other. The corridor width is kept as 2.7m. The 7.2m grid accommodates the major part of the beds and the 5.0m grid is mostly used for the supporting facilities.

The grid is a result of functional placement of beds. The building has a frame structure allowing for flexibility of service distribution, Sub-division of space and the possibility for future growth.



Fig. 5 Structural Grid of Ward

In the KNMH, Indira Gandhi Block, a structural grid of 6.6m is used. A corridor of 3.3m width is given in between the two rows of general wards. A general ward is thus of 6.6m x 6.6m and accommodates six beds in it. The fire escapes provided at the two ends of the nursing unit are placed in a 3.3m grid. In all, 12 bays of 6.6m in length and two and one half bays of 6.6m in width house one nursing unit of 60 beds.

Ward Planning

In the Sher-e-Kashmir, Institute of Medical Sciences, Srinagar a 'T' shaped ward unit has been designed which satisfies medical, nursing and social criteria of patient care, optionally. The circle drawn with a radius of 12.0m (40 feet) from the nursing station to indicate the relative distances the nurses have to cover to discharge their duties. Thus the ward has 33 bed 'T' shaped nursing unit, and is essentially a modified unilateral ward having 24 intermediate and ambulatory beds facing South West and over looking Achare Lake, which is the most favorable orientation in the given setting.

The nursing station is centrally located with stand-by services behind the station. The vital space on either side of the station is utilized to accommodate two four-bedded bays for critically ill patients. One additional bed is provided within the station for isolation of a potentially hazardous, potentially susceptible or a terminally ill patient.

The intermediate and self-care bays are separate by low partitions to facilitate visual reciprocity between the patients and the nursing staff. The bays for the critically ill are fully partitioned with a glass window towards the nursing station. These bays in addition have bedside oxygen, vacuum, compressed and central monitoring facilities for critical patients are available in specialty wards where considered necessary. A flat plate slab has been provided which eliminates beams and provides a clear ceiling with no obstructions that can collect dust.

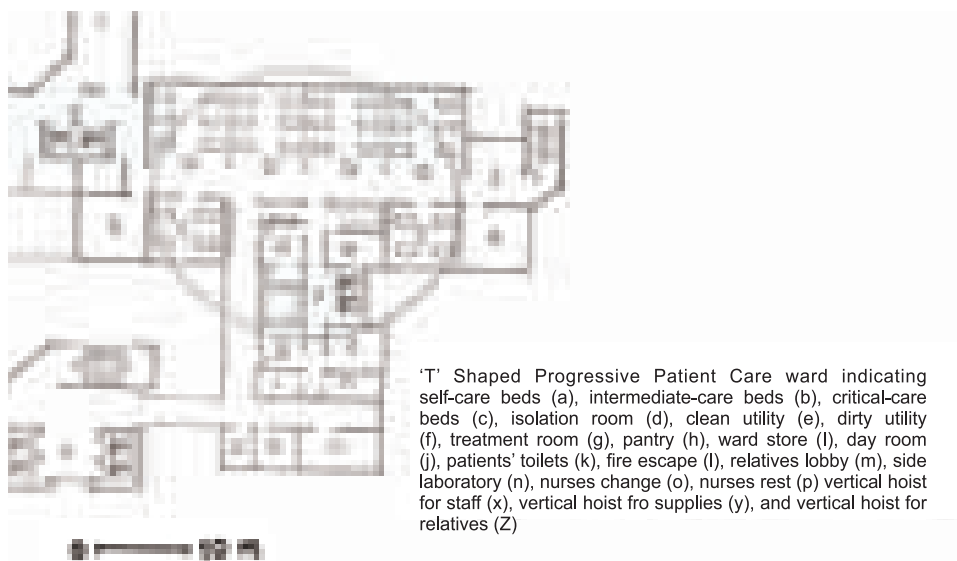


Fig. 6 Indira Gandhi Block –Ward

In KNMH, Indira Gandhi Block, there are ten wards of six beds each (Fig.6.), thus having sixty beds per floor. The nursing station is such located that the stand-by services are behind the station. This include clean utility room and dirty utility room and medication closet.

The treatment room is also near the patient rooms thus making it convenient for the in-patients. The wards have glass partitions towards the inner-corridor, to make the patients visible from the nurse's station. Areas on either side of the station are utilized to accommodate critically ill patients and for utility areas. If we draw a circle with a radius of 12.0m (40 feet) from the nursing station then the supporting areas and all the critically ill patient beds come inside, this area. This circle shows the relative distances the nursing staff covers during patient care.

The ward has an arrangement of patient rooms on either side of the corridor. The ancillary services are placed towards the centre of the unit and are pushed towards the link, which joins the service block to the nursing unit. This type of arrangement establishes a direct link between services, supporting facilities and nursing staff and helps to perform the nursing unit more efficiently.

Placement of Wards In Relation To The Hospital

In Sher-e-Kashmir, the ward block has been placed at an angle of 45° [Fig. 7(a)] with a twin connection to the Hospital and Services Block. This ward block has a separate entry for the visitors and is linked to the main ancillary departments, this route is taken by the doctors and the other medical staff. Besides the wards are placed the services (C.S.S.D., Kitchen, Laundry, etc.), these are brought in by the help of a link joining these two departments. One of the main reasons for the location of wards was the Achare Lake. Twenty-four intermediate and beds face southwest and overlook the lake. This was the most favorable orientation in the given setting.

In KNMH, Indira Gandhi Block, the wards are housed in the tower block [Fig.7(b)] The doctor's cabins are in the ground floor level and the first floor level and are connected to the patient area by the help of the vertical hoist. The area below the wards house ancillary departments.

The service block behind the ward area is connected by a link. This helps the supplies food from the C.S.S.D. and kitchen to be brought into the hospital. As the hospital is an addition done on the existing campus, therefore the scheme came up on a restricted site. Tower on a podium concept was thus formed wards formed the central core of the scheme as they needed connection with the ancillary departments and the services.

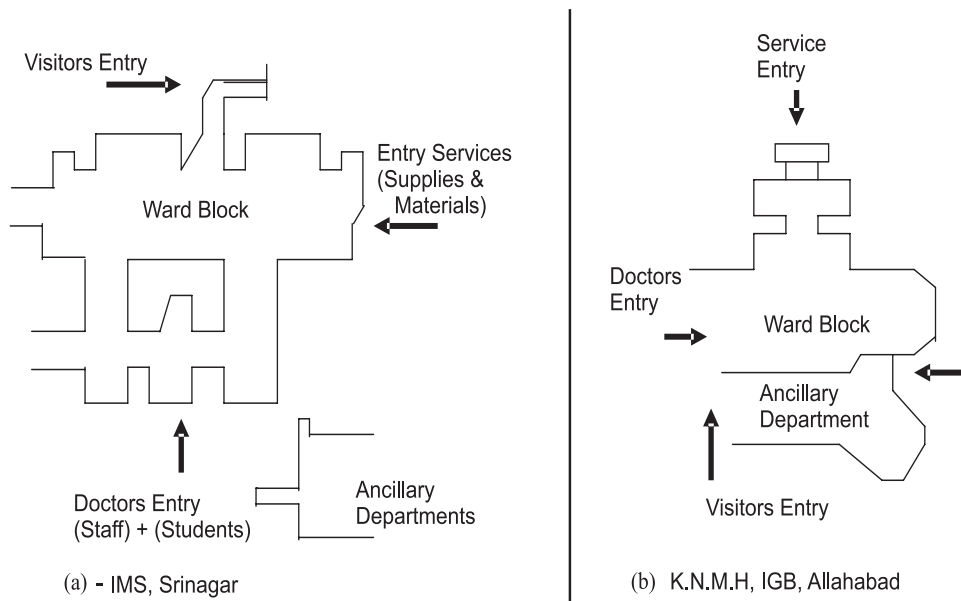


Fig. 7 Placement of Wards

Movement Of Visitors, Patients, Doctors And Supplies

In Sher-e-Kashmir care has been taken to segregate the traffic flow of staff/patients, that of visitors and the supplies. The vertical hoist for visitors (A) opens in the lobby and leads them directly to the patient rooms. The vertical hoist for staff (C) brings the doctors through a separate corridor to the ward area. This corridor is also joined to the paying ward section. The supplies are brought by the vertical hoist (B) and open directly into the ancillary area (Fig.8). The supporting facilities in the hospital are placed in a separate block, which is connected to the service block.

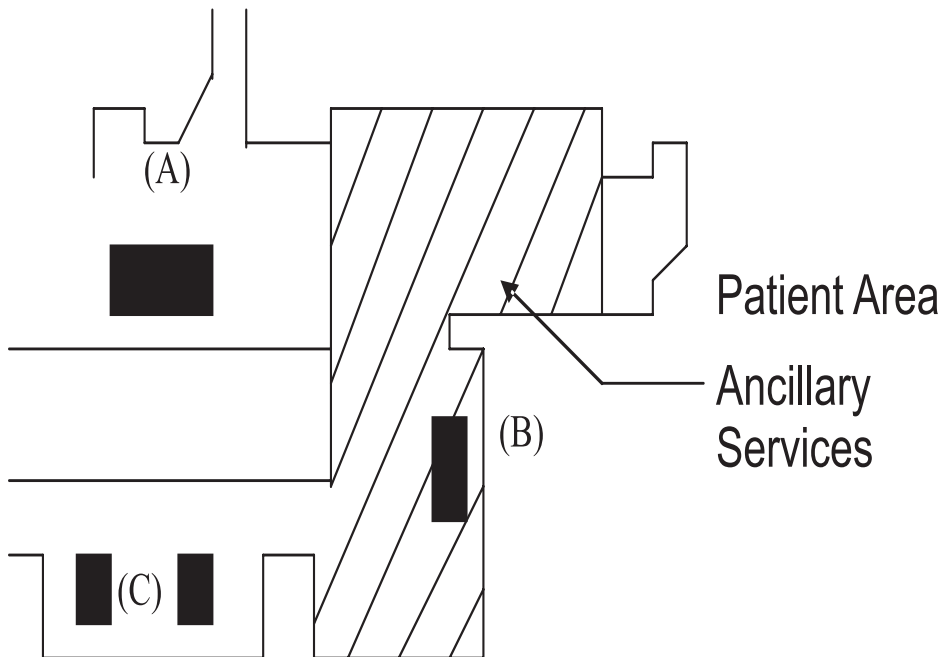


Fig. 8 Location of Vertical Hoists – IMS Srinagar

In the KNMH, IGB the vertical hoists for the staff (C) are pushed in the centre, making the entry of the doctors to the patients area a direct one. The vertical hoists for the visitors (A) are in the front of the ward block and does not disturb the working of the hospital. The supplies are brought in from the service block by the vertical hoist (B), these include food from the kitchen and supplies from the C.S.S.D.

The supporting facilities in the hospital lie between the patient area and the service block. The vertical hoist for doctors (C) will take the doctors directly from the operation theatre floor and doctors cabins/examination rooms to the wards (Fig.9). Fig. 10 and 11 show the details of wards in the two hospitals.

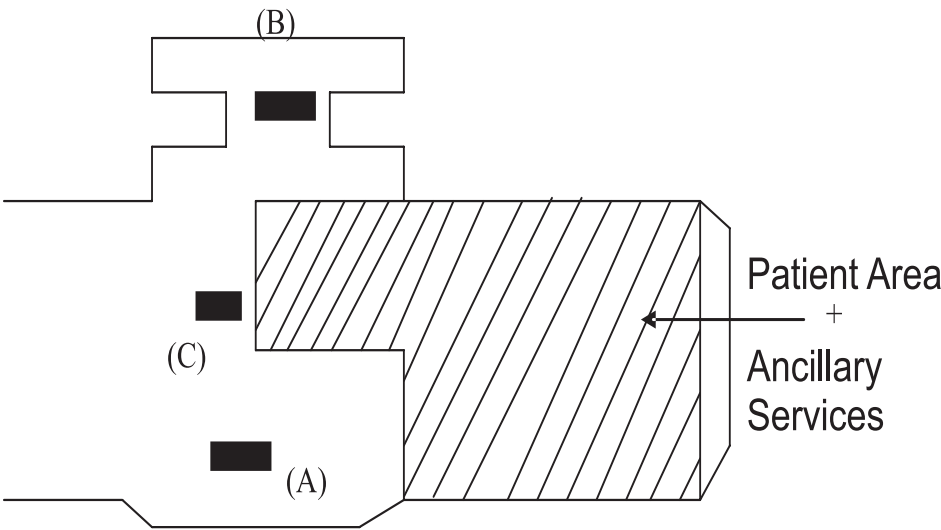


Fig. 9 Location of Hoists – IGB Allahabad

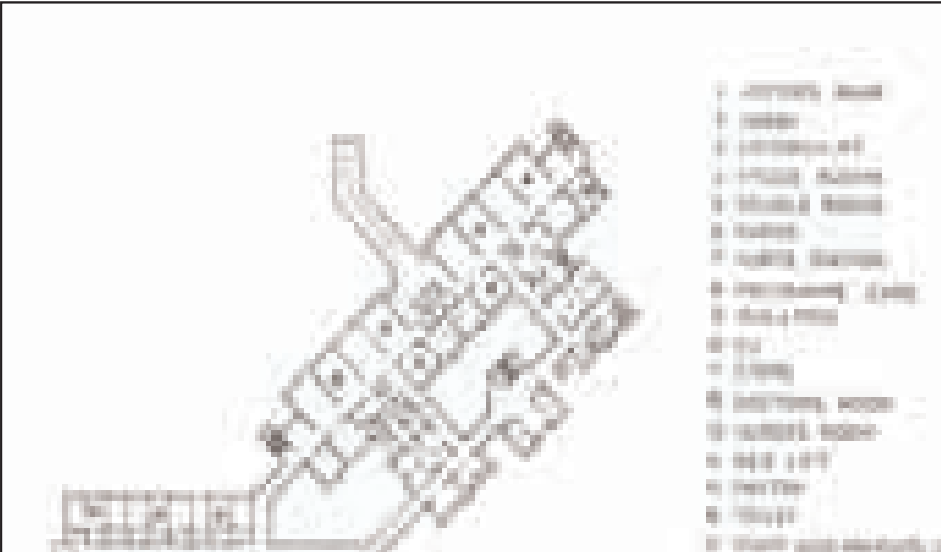


Fig. 10 Typical Ward Floor Plan – IMS Srinagar

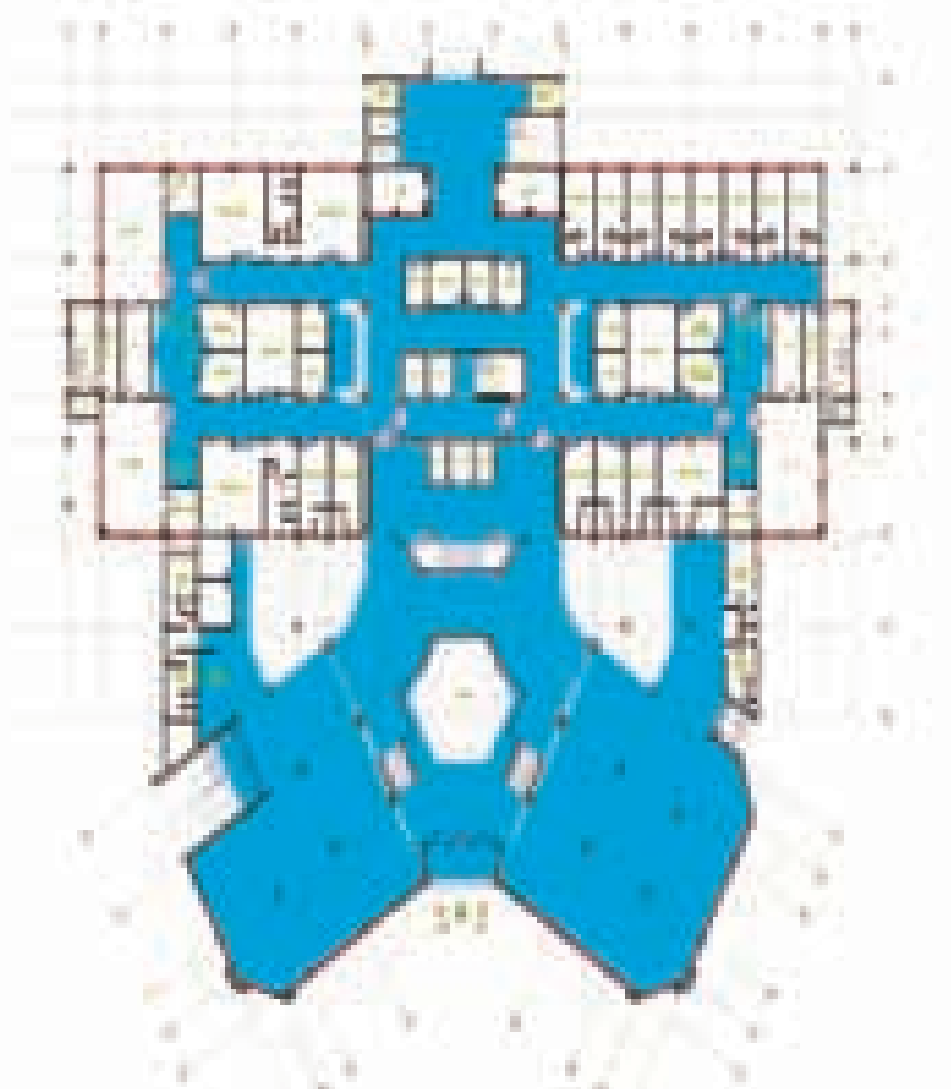


Fig. 11 Ground Floor Plan – IGB in KNMH Allahabad

Conclusion

Effort has been made to combine all the departments that are to be housed in a Hospital. The ideal conceptual relationship can be diagrammatically represented in (Fig. 12).

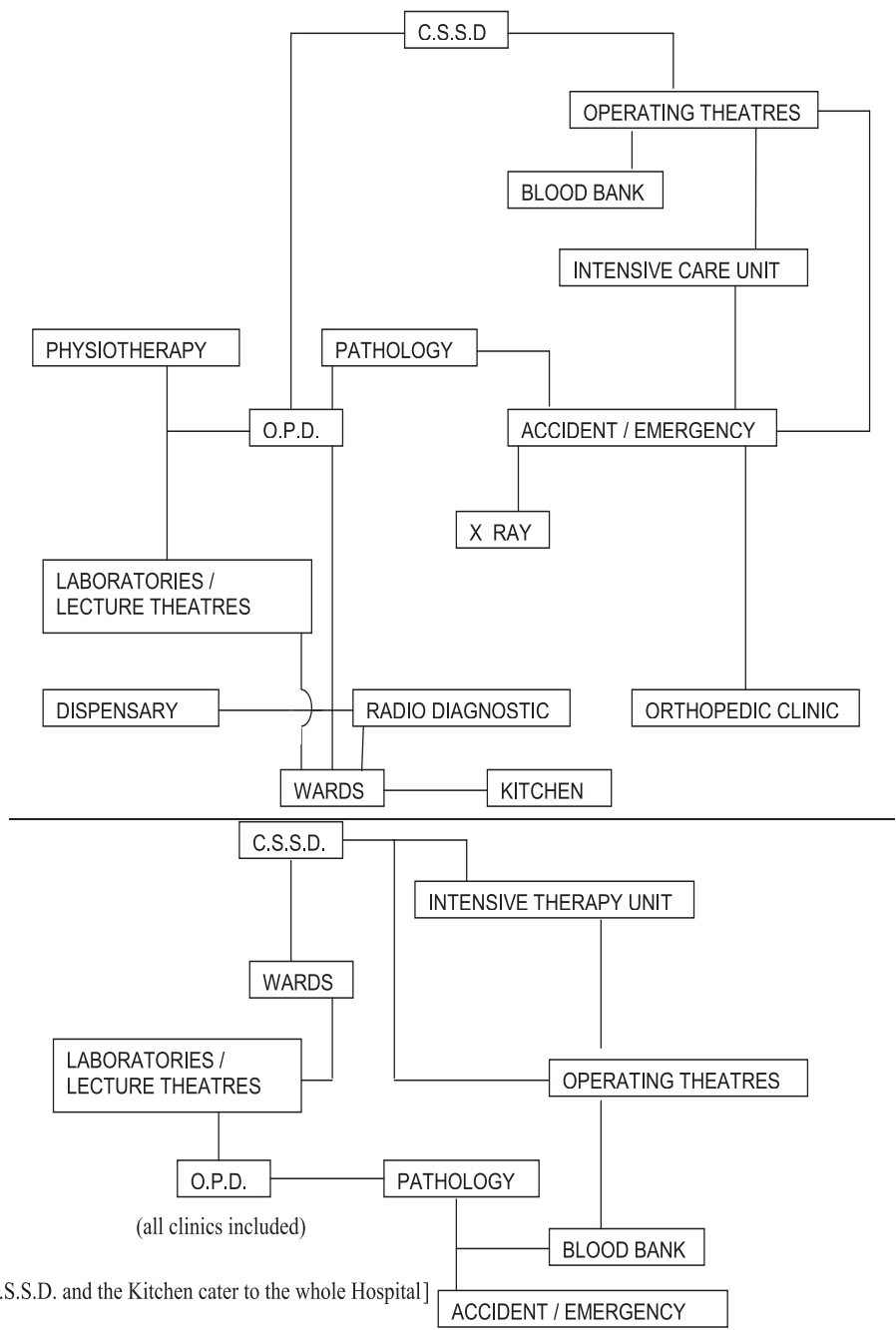


Fig. 12 Conceptual Relationship of different Departments in a Hospital

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