World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:6, No:3, 2012

Adoption of Appropriate and Cost Effective Technologies in Housing: Indian Experience

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***Abstract*—**Construction cost in India is increasing at around 50 per cent over the average inflation levels. It have registered increase of up to 15 per cent every year, primarily due to cost of basic building materials such as steel, cement, bricks, timber and other inputs as well as cost of labour. As a result, the cost of construction using conventional building materials and construction is becoming beyond the affordable limits particularly for low-income groups of population as well as a large cross section of the middle - income groups. Therefore, there is a need to adopt cost-effective construction methods either by up-gradation of traditional technologies using local resources or applying modern construction materials and techniques with efficient inputs leading to economic solutions. This has become the most relevant aspect in the context of the large volume of housing to be constructed in both rural and urban areas and the consideration of limitations in the availability of resources such as building materials and finance. This paper makes an overview of the housing status in India and adoption of appropriate and cost effective technologies in the country.

***Keywords*—**Appropriate, Cost Effective, Ekra, Five year plan, Poverty

Open Science Index, Economics and Management Engineering Vol:6, No:3, 2012 publications.waset.org/1017/pdf

I. Introduction

HOUSING is one of the prime necessities of human life, next only to food and clothing. The provision of suitable and adequate shelter to live under is of vital importance to one's life. There is acute shortage of housing in India and this problem is aggravating as time is passing due to rapid growth in population. National housing scenario reflects estimated shortage of 24.7 million houses for 67.4 million households at the end of tenth five year plan (31st March, 2007). Out of the total shortage estimated 99% pertains to economically weaker sections (EWS) & lower income grade (LIG) sectors. However, during eleventh five year plan (1st April 2007 to 31st March 2012) total housing requirement will be to the tune of 26.53 million units for 75.01 million households[5]. The burgeoning annual growth rate in the country which presently stands at 2.7% has been responsible for throwing the already appalling housing situation in the country out of gear[2].

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Approximately one Australia with a population of 20 million people is being added to the Indian population annually. With the growth of population and urbanization, the problem of providing shelter to the poor is bound to aggravate further in the coming years. In the present situation planners and engineers have to device ways and means to reduce the construction costs by using locally available materials and appropriate technologies. The local conditions and local needs should be looked in to and local labour should be involved in the construction.

II. Housing Problem

Non-affordability of housing by economically weaker sections of society and low income families in urban areas is directly linked with the magnitude of urban poverty. Poverty in India has declined from 320.3 million in 1993-94 to 301.7 million in 2004-05. While there has been a decline of 18 million persons in the total numbers of the poor in India, the national sample survey organization (NSSO) reports that the number of the urban poor has risen by 4.4 million persons during the same period. One fourth of the country's total urban population, numbering 80.7 million persons is below the poverty line[1]. The urban poor constitute 26.7% of the total poor in the country. The fact that the number of urban poor has risen is in stark contrast with rural poverty, where both the total number of rural poor and its incidence vis-à-vis the rural population has fallen. The urban poor have limited access to basic services. According to the 2001 census, there is a 9% deficiency in drinking water, 26% in toilets and 23% in drainage. It is quite understandable that most of this shortage pertains to slums [2].

III. Adoption of Sustainable Technologies

Realizing the gravity of the situation, Sustainable low cost housing technologies which could provide houses to masses at affordable cost assumes greater significance. The present strains on Indian economy and the ever-growing demand for housing, call for adoption of appropriate building technology which could achieve utmost economy and speed in construction. These are developed by the various research and development bodies in the country, namely;

1) Central Building Research Institute (CBRI),
2) Structural Engineering Research Centre (SERC),
3) Centre for Application of Science and Technology to Rural Areas (CASTRA),
4) Regional Research Laboratories (RRL),
5) National Environmental Engineering Research

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Further, several state governments, Building Centers and Building Materials & Technology Promotion Council (BMTPC) have been playing stellar roles in evolving and promoting low cost housing technology which has helped to solve the problem of housing to masses through provision of house at affordable prices by adopting appropriate and cost effective technologies . As a result of a number innovations have been made in the field of low cost housing technology, it is now possible to achieve an overall saving to the extent of 10% to 30% [3]in the total cost of construction compared to the cost of traditional houses. Various technologies adopted are mentioned below;

A. Walling materials

The designs for housing units ranges from single to multi-storied, depending on the local situation (rural, urban and metropolitan) and the needs of target groups and the pressure on land.

The materials used for walling can consist of

1) Mud
2) Sun-dried bricks
3) Rammed earth
4) Stabilized soil blocks
5) Kiln-burnt bricks
6) Laterite/stone
7) Timber/bamboo
8) Stone block masonry
9) Precast/factory-made walling units using light weight cellular concrete
10) Concrete hollow blocks
11) Ferro-cement

Mud, sun-dried bricks and rammed earth are used extensively in many regions depending on the availability and quality of existing soils. Stabilization of soil is done by stabilizers like cement, lime, asphalt, and molasses. Laterite masonry blocks are available in Southern part of the country. Stone masonry using dress stone and rubble is used in many places. With the strength of kiln-burnt bricks being of the order of 40 to 200 kg/sq.cm in Indo-Gangetic plain (Haryana, Uttar Pradesh, Bilhar and Bengal) it is possible to use single brick load-bearing walls of up to five storeys. Half brick thick zig-zag pattern load bearing walls are used in many housing projects of Uttar Pradesh. Adoption of "Modular" bricks can also effect savings in the use of brick and mortar[4].

Another very innovative area where cost reduction can be achieved is in the use of economical and innovative bonding systems using, for example, "rat trap bond" as against "English and/or Flemish bond". Over 25 per cent saving in bricks and mortar is achieved with proven structural strength and better thermal efficiency. The technology has not only proved to be useful and economical but also has resulted in aesthetical housing options. Stone-block masonry is an R & D contribution using stone blocks and lime/cement mortar, made by semi-skilled labour. Its use is effectively demonstrated in many low-cost housing projects in India.

In the North-eastern region, which is a seismically active region, the conventional system of timber, bamboo, mat-based wall system called "Ekra" walling is a traditionally popular and structurally sound walling system. With appropriate R & D inputs, it is possible to give plaster over cladding material with stretched wiremesh and appropriate frames of timber or reinforced cement concrete (RCC).

Factory made cellular concrete wall panels have been used at Madras, Pune, Bombay, Ahmedabad and Delhi. In situations where it is not possible to have access to masonry building blocks made of local materials, recourse has to be taken to manufacture masonry blocks. This could cover aerated light weight concrete blocks and hollow concrete masonry blocks. Flyash which is a waste emanating from thermal power plants can be utilized with advantage for either flyash-based bricks or aerated light weight blocks. There are many modes of application of flyash using various technologies developed at CBRI and other research institutions in the country. The hollow concrete block masonry can be used both as structural/non-structural elements. Large prefabricated panel units have been used in mass construction schemes. However, its application in the country has been limited mainly due to the limitations in lifting/erecting equipments as well as weaknesses in joints of wall to wall and roof to wall interaction locations.

Hollow concrete block masonry has been able to make a major impact primarily because of the poor quality of burnt brick and also high cost of the local fuels namely timber and coal for burning kilns. Even houses constructed by co-operative societies, private builders are taking recourse to use hollow concrete block masonry for walling. Many of the building centers countrywide are also able to contribute to the increased use of hollow concrete blocks as willing material.

B. Roofing materials

Reinforced cement concrete rooting slabs are predominantly used in many housing projects more so in the urban context. But the use of the many economic alternatives can play a major role in large housing projects.

The various alternative systems that can he used are:

1) Clay/micro-concrete tiled roofing
2) Stone roofing with distributors
3) Corrugated sheet: galvanized iron (GI) and asphaltic
4) Prefabricated brick panel
5) 'L'panel roofing
6) Plank and Joist system
7) Filler slab roofing with various filler material
8) Clay tile - RCC batten root
9) Precast cellular concrete roofing unit
10) RCC channel units
11) Precast joist and hollow block construction
12) Precast RCC solid planks/joists
13) Funicular shells over edge beams
14) Precast plate floors
15) Ferrocement roofing elements
16) Filler slab roofing with various filler material

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Using prefabricated roofing elements, large-scale housing projects can be constructed economically. There are many successful applications of these systems in different parts of the country. By making use of these technologies approximately 10 to 30 percent cost saving can be achieved.

C. Doors and windows

Timber is used for door and window frames and shutters and also for structural and non-structural walling and roofing units in different parts of the country. With a view to effect the economic use of timber and also conserve the primary species of timber, use of secondary species of timber has been resorted to by giving appropriate seasoning and chemical treatment before use. However, time has come to look for alternatives to timber. The use of steel shaped frames as well as precast concrete and magnesium oxychloride cement door and window frames is becoming increasingly popular. Precast concrete door/window frames are competitive in cost and function and do not need repetitive maintenance.

The precast concrete door and window frames have got considerable acceptance both by the public and private house builders. The use of precast door and window frames as well as ferrocement shutters are also gaining considerable momentum in the housing scenario in the country. With regard to door shutters, the use of alternatives like cement bonded particle boards; bamboo boards are becoming popular in many regions.

D. Other elements

The scope for the use of precast elements is coming into sharp focus for areas of application such as:

1) Thin precast lintels
2) Thin ferrocement precast shelves
3) Ferrocement based sanitation units/cladding
4) Ferrocement water tanks
5) Precast well rings for water wells
6) Precast sanitation unit rings
7) Precast septic tanks
8) Ferrocement bio-gas units
9) Precast tree guard
10) Precast poles for street lighting
11) Precast posts for boundary walls

The use of ferrocement water tank has become very popular in the last two decade in India. Use of precast well rings for water well has also caught up because of their popularity and the fact that they are manufactured by private sector outlets as well as through the building centers. The sanitation schemes using twin pits is also giving rise to the manufacture of the rings for sanitation. The precast poles for the street lighting have become increasingly popular for the land development as well as electricity boards due to scarcity of timber poles and also the exorbitant cost of the same. Even metallic telephone poles are being often replaced with precast concrete poles. Precast shelves and tree guards are also gaining popularity because of good aesthetic appearance and low cost.

IV. Conclusion

There is an array of technology options available for various elements of building construction, leading to cost-effectiveness and at the same time not affecting the performance characteristics expected from a decent house. It is desirable to have increased understanding of the various materials and technology options, its structural and functional characteristics and efficiencies and more importantly the methodologies for implementation. Series of follow-up measures to enable application of the same would need to be taken. These would cover work related to regulatory measures, organizational development needs and also technology transfer mechanisms evolved. This would play a major role in ensuring the adoption of appropriate and cost-effective technologies in housing and building construction scene, which is one of the vital inputs to make affordable and acceptable housing a reality for the vast majority of low-income people in the Country.

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