16th WEDC Conference
Infrastructure for low-income communities
Hyderabad, India 1990

Housing costs and appropriate building materials

P C Shah, Prof M M Tamakuwala, Prof N C Shah and C M Desai

ABSTRACT
Now a days, low cost housing has become a crying need in almost all developing countries. Increase in population, industrialisation and consequent urbanization, migration of more low income people to cities, increase in cost of construction materials etc. are the factors that contribute to this very situation. Different efforts are being made by all developing countries to tackle the problem in different ways. The planning, design, research and construction of low cost houses for developing countries are taking place according to the needs and performance requirements of the occupants. Of course, it changes from place to place and country to country, according to administration, resources of finance, availability of technical talents, construction materials, social condition of people etc. etc.

This paper riview the recent research on suitable low cost modern materials for environmental design of buildings.

INTRODUCTION

Nearly 80% of India's population live in villages and 20% live in urban settlements scattered all over the country in very poor and substandard conditions full of deficiencies of decent living. The National Building Organisation has estimated the shortage of housing in India as 15.6 millions dwelling units, 11.8 million in rural areas and 3.8 million in urban areas which will swell to 50 million dwellings by the year 2000. According to the report of the working group on Housing, about 80% of the rural people are living in Kutcha Structures with mud flooring, walls and roof built of grass reed and thatch. About 2% live in Pucca Houses with plastered flooring, brick walls and concrete/tile roofing.

The problem of housing has reached staggering proportions and the existing backlog is compounding year after year. Housing of masses, particularly in the developing countries, because of accumulated shortage, shrinkage of conventional materials of construction, high cost of prevailing techniques and the demand for more comfortable accommodation, has placed on the community of professional engineers, builders and manufacturers the obligation to invent more economical and acceptable materials for building construction as it accounts for 65% to 75% of the construction cost. We should be able to evolve suitable technology to bring into use locally available building materials that are within the easy reach of the common man and especially the Economically Weaker sections. The common man should be able to put up his house under self-help programme without much of skilled labour and machinery for erection.

BUILDING COST AND ECONOMY

Construction is an integral part of all development activities. It accounts for more than 50% of the total national plan outlay. Half of the expenditure on various types of construction is spent on building and housing construction. Therefore, for achieving optimum utilization of scarce capital investment in building, cost reduction is of vital importance to national economy.

The cost of building construction has been rising steeply due to inflation, which has resulted in heavy burden on economy. For the evolution of a low-cost house a breakdown of the cost of the materials and labour of an average house is important. An analysis of cost, based on several housing scheme is given in Table-1.

TABLE-1:BREAKDOWN OF THE COST OF AN AVERAGE HOUSE.

Sr.No.	Details	Percent(%)
1.	Materials	55
2.	Labour	15
3.	Land	20
4.	Architects fees, overhead charges & constructor's profit	10
	Total	100

The first two items of Table-1 form the bulk of the cost of a house, and therefore require our serious consideration for the purpose of reducing the cost

of construction. It will be further seen from Table-2 that from the percentage cost of the major items of a conventional type of house that the three main items, responsible for over 70% of the total expenditure, are the walls, the roof and the doors and windows. It is therefore quite clear that the reduction in cost

TABLE-2 PERCENTAGE COST OF THE MAJOR ITEMS OF A CONVENTIONAL HOUSE

Items	Percent(%)
1. Foundation	6.0
2. Basement & Plinth masonary	10.0
3. Superstructure masonary	18.1
4. Doors, windows etc.	23.5
5. Lintels,Sills,Sunshades, Column etc.	4.5
6. Floors & Roof	17.8
7. Stairs	2.0
8. Flooring	5.8
9. Plaster & Finishes	9.3
10. Sundries	3.0
	100.0

of any dwelling unit would largely depend on economical use of building materials and use of locally available materials in preference to scarce and costly materials.

In the name of durability, the relatively affluent section of the rural population has of late started using to a great extent cement and steel, many items out of proportion. As a nation starving for its development it should be our policy to see that use of cement and steel where it can be substituted should be discouraged so that the pace of development of the nation does not get retarded for lack of cement and steel. It is to this end, apart from the cost reduction, necessary, to encourage the use of traditional materials or materials which require smaller financial and infrastructural resources and are labour intensive.

Shortage of building materials is another factor which the nation faces often. The Government is very much concerned with the housing shortages particularly for the Economically Weaker Section (EWS) of the society and if the benefits of the independence and prosperity are to reach the poorest of poor, it is solemn duty of engineers to look for material substitution and to play a leading role in conserving scarce materials.

ROLE OF BUILDING MATERIALS IN COST REDUCTION

The use of traditional building materials and construction practices has become rather costly and not very advantageous on account of one or more of the reasons viz:(i) Heavy increase in the price of materials, (ii) Lack of economy in structural design, (iii) Slow and laborious process of construction & (iv) Lack of durability, expensive maintenance.

The three items of house construction in which it is possible to effect substantial economy by adopting alternative forms of construction are the walls, the roof and the doors and windows. These three items in a traditional house account for more than 70% of the total expenditure on it. Therefore, while selecting building materials for house construction, as far as possible locally available materials which are cheap and do not require transportation should be used. The use of clay with good binding property and lime can be tried in place of scarce cement. For steel replacement, the use of bamboo because of its good tensile property has resulted in a major cost reduction.

Low Cost Construction Materials:

Ferrocement:The name 'Ferrocement' implies the combination of ferrous products with cement and can be considered as a special form of reinforced concrete. The greatest factors leading to the acceptence of ferrocement are:(i) It's basic raw materials are readily available in our country.

(ii) It can be prefabricated into any desired shape and adopted to environmental and traditional customs of the country.

(iii) The skills for ferrocement construction can be acquired easily.

(iv) Heavy plants and machinery are not required for ferrocement construction.

(v) No maintenance is required.

(vi) It can be repaired easily.

(vii) It is suitable for mass production and construction on self-help basis.

(viii) Septic tanks for ferrocement offer the best sewage disposal system.

Rice Husk Ash Cement (RHAC): Rice husk cement is made by mixing lime with the ash produced by burning rice husk.The ash has a high silica content together with a little carbon. Under suitable burning conditions, the structure of silica is finely divided and amorphous. Under this conditions it can undergo chemical reaction with lime to form a stable compound - calcium-silicate, which is a type of cement.

The cost of raw materials for the production of RHA cement is low. Rice husk is largely wasted and an alternative to the unwanted dumping or burning would be advantageous, specially if a useful

product could be made. Though more RHA cement is used, but even so, the price would be only about 70% of that of ordinary portland cement (OPC).

Mud:Mud is used as one of the cheapest mortars in brick work under suitable conditions. Sometimes animal dung and waste mineral oil or bituminous compounds are added to mud in order to make erosion resisting mortar upto some extent. (CBRI).

Wall Construction:

Rowlock bond Brickwork: In superstru--cture brickwork 1 cum. of single brick thick wall requires 425 bricks for English bond whereas only 290 bricks per cum. are required in rowlock bond. Hence a saving of 32 percent in the quantity of brickwork can be achieved.

1. Saving of Mortar: Only 0.13 cum.of mortar is required per cum. of rowlock bond brickwork compared to 0.25 cum. required for English bond, thereby resulting in a saving of 48% in the quantity of mortar.

2. Saving in Plastering: As both the faces of rowlock bond brickwork can be kept in plumb and as such 15 mm thick plastering can be replaced by 12 mm thick plastering. This results in a saving of 16 percent of the quantity of mortar.

3. Saving in Foundation and Earthwork: As in Rowlock bond brickwork load tran--sferred to the foundation is reduced by 25% compared to English bond, the loading in the base gets reduced by 13% which enables in reduction of foundation width and consequent reduction in qua--ntity of PCC and earthwork in case of load bearing structure.

Stone Work:Instead of brickwork which need plastering and pointing on eitherside and is also energy consuming (bricks entail the burning process, coal, cement) houses can be made of stone-slabs, where stones are locally available. Numbers of joints are reduced. Stone is not plastered but it is exposed. There is hardly 10% energy consumption and thus a 40% cost reduction.

In Karnataka Hasan Project for low cost housing has totally followed above techni--que. It is accepted by HUDCO-Karnataka. In this project stone slabs were used. Granite stones which are durable and rugged, costs Rs.48.40 per Sq.m. and in large scale it costs only Rs.37.65 per Sq.m.

Flooring/Roofing:

Theconventional method of flooring/roofing are more expensive, time consuming and involve a lot of shuttering in the form of labour and material. The shuttering in the form of labour and material. The shuttering used is susceptible to damage and it's availability in bulk is progressively getting reduced in the market with increasing construction. To reduce the cost labour intensive schemes should be preferred.

Brick-flooring (plastered) can be used as it is cheaper than conventional methods of flooring. After preparing the subgrade bricks are laid on 12mm thick mortar bed on their edge in such a manner that all the joints are full of mortar. Before plastering the joints are raked to a depth of about 15mm. It is then flushed with cement slurry. It is durable and hard, easily repai--rable and cheaper than cement concrete, tiled flooring and wooden.

Broken bricks and over-burnt bricks which are cheaply available can be also used in making floors. First the subgrade is prepared by ramming and levelling. Broken bricks of size 20-30 mm are mixed with loan cement mortar and laid on 10-12 mm thick mortar bed and rammed. It is then plastered and flushed with rich cement slurry. It is very cheap depending upon availa--bility. It is hard, durable and easily repairable.

CBRI has proposed many alternatives to flooring/roofing for mass housing. Some of them are as follows:

(i) Precast R.C.C. Planks and Joists for Floors/Roofs: Precast planks and joists scheme results in a saving of 25-30 percent in concrete, 30-50 percent in reinforcement and 25-30 percent in overall cost. More than 20,000 houses have been constructed in different parts using this technique.

(ii) Prefab Brick Panels and Joists for Floors/Roofs: This technique is ideally suited for construction of semi-permanent and permanent houses in rural and semi-urban area. This scheme results in saving of 25-30 percent in concrete, 30-40 percent in reinforcement and 25-35 percent in overall cost.

Doors and Windows:

Use of readymade doors and windows with cheap treated wood is found eco--nomical and reduces time of execution and reduction in cost. Steel windows are found cheaper than wooden windows. But for low cost houses cement/brick jally can be substituted provided the climatic conditions are suitable. Instead of wooden shutters ferrocement shutters

have also been tried as substitute. The shutters have been made both in double and single leaf configuration and are giving satisfactory services. The cost of these shutter is also equivalent to seasoned country-wood shutter.

Precast reinforced concrete frames are now becoming increasingly popular espe--cially for low cost houses. They are durable fire-proof and are not affected by white ants and weather conditions, they also do not require periodical maintenance. Such frame can be made of any design in simple moulds and can be economically mass-produced.

Sanitary Units:

Plastics are most versatile among the new building materials and are bound to play a very important role in reducing overall cost of housing. Plastic pipes for water supply, replacement of copper fitting with PVC syphon for automatic urinals, complete replacement of chromium plated flushing system for urinals with PVC piping system, use of plastic water storage overhead tanks in place of conventional RCC, AC, GI tanks, devel--opment and use of FRP squatting pans and traps for hand pourflush latrins etc. has gained importance.

Installation of plastic pipes instead of metal pipes for water supply including plumbing causes 20 percent to 40 percent saving in cost. The use of plastic bib cock has also grown to the extent that at present over one million bib cocks are produced thus saving about 250 tonnes of brass every year inspite of their being about 1/5th in cost as compared to brass taps. The introduction of plastic overhead water storage tanks has installed confidence among the users as these do not corrode. GRP squatting pans are being used in place of ceramics because of their low cost (about 30 percent less) and satisfactory performance.

In addition, energy required for the pro--duction of plastic products is 30 percent to 70 percent less than the energy required for production of their conven--tional counter parts.

TABLE-3:LATEST PRICE LIST FOR PVC AND G.I. PIPES

Diameter mm	Cost of PVC Pipes (Rs.)	Cost of GI Pipes (Rs.)
20	4.55	24.50
25	6.00	34.00
32	9.50	42.00

PVC flush pipes and bends 40mm in dia--meter costs Rs.15.00 whereas G.I. pipes costs Rs.54.00.

CONCLUSION:

Various alternative building materials which has been discussed in this paper for lowering the overall cost of constr--uction have the following advantages:

(i) R.H.A. cement can be one of the cheapest construction material as rice production is very high.

(ii) Rowlock bond makes saving in terms of money and material. If stones are locally available,they can be used beneficially.

(iii) Cement/brick jelly can be effect--ively used instead of conventional doors and windows.

(iv) PVC sanitary components has gained popularity due to it's various advantages over conventional units.

Some new areas of research in building materials that meant attention are super--plasticizers, polymer concrete, composite panels, fibre reinforced concrete, light weight metal alloys, anti-corrosive treat--ments and durability of building materials. The tools of modern science & technology have so far been applied very little to improve the performance of agro-forest materials which are used by milions of our people in rural areas. A lot more needs to be done by providing decent and inexpensive shelters for masses using renewable plant based materials and agro-industrial wastes by developing durable, low-cost and low-energy building materials.

REFERENCES

1. Proceedings of All India Seminar on 'Construction Management' held at Madurai, India, 1979.

2. Proceedings of International conferen--ce on 'Low Cost Housing for Developing Countries', 1984.

3. 'Low Cost Concrete Houses' published by the Concrete Association of India, Bombay (India).

4. 'Lectures on Housing' by SHAMSHER PRAKASH, published by CBRI Roorkee (India), 1985.

5. 'Voluntary Agencies & Housing' by MADHAV ACHWAL, published by UNICEF,1979.

6. Special Issue on 'Construction Manage--ment' published by Civil Engineering Division, The Institution of Engineers (India), 1988.