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Cost Effectiveness of using Low Cost Housing Technologies in Construction

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Abstract

Adequate shelter for all people is one of the pressing challenges faced by the developing countries. India is currently facing a shortage of about 17.6 million houses. The dream of owning a house particularly for low-income and middle-income families is becoming a difficult reality. Hence, it has become a necessity to adopt cost effective, innovative and environment-friendly housing technologies for the construction of houses and buildings for enabling the common people to construct houses at affordable cost. This paper compares construction cost for the traditional and low cost housing technologies. Case studies in India are used for the investigation. Construction methods of foundation, walling, roofing and lintel are compared. Strength and durability of the structure, stability, safety and mental satisfaction are factors that assume top priority during cost reduction. It is found that about 26.11% and 22.68% of the construction cost can be saved by using low cost housing technologies in comparison with the traditional construction methods in the case studies for walling and roofing respectively. This proves that using low cost housing technologies is a cost effective construction approach for the industry.

KEYWORDS: Low cost housing technology, cost, effectiveness, construction, India.

1. INTRODUCTION

Low cost housing can be considered affordable for low- and moderate-income earners if household can acquire a housing unit (owned or rented) for an amount up to 30 percent of its household income (Miles, 2000). In developing countries such as India, only 20% of the population are high-income earners, who are able to afford normal housing units. The low-income groups in developing countries are generally unable to access the housing market. Cost effective housing is a relative concept and has more to do with budgeting and seeks to reduce construction cost through better management, appropriate use of local materials, skills and technology but without sacrificing the performance and structure life (Tiwari *et al.*, 1999). It should be noted that low cost housings are not houses which constructed by cheap building materials of substandard quality. A low cost house is designed and constructed as any other house with regard to foundation, structure and strength. The reduction in cost is achieved through effective utilization

of locally available building materials and techniques that are durable, economical, accepted by users and not requiring costly maintenance (Miles, 2000). Economy is also achieved by postponing finishing and implementing low cost housing technologies in phases. High efficiency of workers, minimize waste in design and apply good management practices, can also be achieved.

Low cost housing is a new concept which deals with effective budgeting and following of techniques which help reducing construction cost through the use of locally available materials along with improved skills and technologies without sacrificing the strength, performance and life of the structure (Kumar, 1999; Civil Engineering Portal, 2008). Low cost housing technologies aim to cut down construction cost by using alternatives to the conventional methods and inputs. It is about the usage of local and indigenous building materials, local skills, energy saver and environment-friendly options.

2. THE TRADITIONAL CONSTRUCTION METHODS

The traditional construction methods are used in the case study. The detail procedures of each step used for the case study are as follow:

- **Foundation:** Foundation is the lowest part of the structure which is provided to distribute loads to the soil thus providing base for the super-structure. Excavation work is first carried out, then earth-work is filled with available earth and ends with watering and compaction in a 6” thick layer.
- **Cement concrete:** Plain cement concrete is used to form a leveled surface on the excavated soil. The volumetric concrete mix proportion of 1:4:8 (cement: sand: aggregate), with a 6” thick layer for masonry foundation and column footings is used. Plain cement concrete is finished on the excavated soil strata and mixed by manual process.
- **Wall construction:** Size stone masonry for foundation is constructed for outer walls and burnt brick masonry of a 9” thick layer for main walls and a 4 ½” thick layer for all internal walls. Good quality table-moulded bricks are used for the construction.
- **Reinforced cement concrete slab and beam:** The normal procedure to cast reinforced cement concrete slab is to make shuttering and provide reinforcement and concreting. Good steel or plywood formwork is used, with proper cover blocks between bars. Both aggregate and sand used are clean, with aggregate being ¾” graded. After the concrete is poured, it is properly consolidated.
- **Plastering:** Plastering is used for the ceiling, inside and outside walls. Joints are raked before plastering and proper curing is ensured.
- **Flooring:** For the flooring purpose, the earth is properly filled and consolidated in the ratio of 1:4:8 (cement: sand: aggregate) concrete.
- **Plumbing:** Good quality plumbing materials are used and passed hydraulic test before using it.
- **Painting and finishing:** Before the painting process, surface is prepared with putty and primer and a ready-made paint is used.

3. LOW COST CONSTRUCTION TECHNOLOGIES

It is found that cost-effective and alternative construction technologies, which apart from reducing construction cost by the reduction of quantity of building materials through improved and innovative techniques, can play a great role in providing better housing methods and protecting the environment. It should be noted that cost-effective construction technologies do not compromise with safety and security of the buildings and mostly follow the prevailing building codes. The detail procedures of each step used for the case study are as follow:

- Foundation: Arch foundation is used in which walls are supported on the brick or stone masonry. For the construction of the foundation, the use of available materials such as brick or concrete blocks can be made to resist lateral forces buttresses at the corner.
- Walling: Rat trap bond technology is used in the case study. It is an alternative brick bonding system for English and Flemish Bond. The reduced number of joints can reduce mortar consumption. No plastering of the outside face is required and the wall usually is quite aesthetically pleasing and air gaps created within the wall help making the house thermally comfortable. In summer, the temperature inside the house is usually at least 5 degrees lower than the outside ambient temperature and vice versa in winter.
- Roofing: A filler slab roofing system is used which based on the principle that for roofs which are simply supported, the upper part of the slab is subjected to compressive forces and the lower part of the slab experience tensile forces. Concrete is very good in withstanding compressive forces and steel bears the load due to tensile forces. Thus the low tensile region of the slab does not need any concrete except for holding steel reinforcements together.
- Flooring: Flooring is generally made of terracotta tiles or color oxides. Bedding is made out of broken brick bats. Various patterns and designs are used, depending on shape, size of tiles, span of flooring, and client's personal preference.
- Plastering: Plastering can be avoided on the walls, frequent expenditure on finishes and its maintenance is avoided. Properly protected brick wall will never lose its color or finish.
- Doors and windows: As door and window frames are responsible for almost half the cost of timber used, avoiding frames can considerably reduce timber cost. Door planks are screwed together with strap iron hinges to form doors, and this can be carried by 'holdfast' carried into the wall. The simplest and cost effective door can be made of vertical planks held together with horizontal or diagonal battens. A simplest frameless window consists of a vertical plank of about 9" wide set into two holes, one at the top and one at the bottom. This forms a simple pivotal window. Wide span windows can be partially framed and fixed to walls or can have rows of pivotal planks

4. COST EFFECTIVENESS OF USING LOW COST HOUSING TECHNOLOGIES

The construction methods of walling and roofing are selected for the detail cost analysis based on available resources from the interviews. Table 1 and Table 2 summarise the cost analysis of the traditional construction methods and the low cost housing technologies in the case studies for walling and roofing respectively. It is found that about 26.11% and 22.68% of the construction cost, including material and labour cost, can be saved by using the low cost housing technologies in comparison with the traditional construction methods for walling and roofing respectively.

Suggestion for reducing construction cost in this paper is of general nature and it varies depending upon the nature of the building to be constructed and budget of the owner. However, it is necessary that good planning and design methods shall be adopted by utilizing the services of an experienced engineer or an architect for supervising the work, thereby achieving overall cost effectiveness.

5. CONCLUSION

The dream of owning a house particularly for low-income and middle-income families is becoming a difficult reality. It is necessary to adopt cost effective, innovative and environment-friendly housing technologies for the construction. This paper examined the cost effectiveness of using low cost housing technologies in comparison with the traditional construction methods. Two case studies in India were conducted. It was found that about 26.11% and 22.68% of the construction cost, including material and

labour cost, can be saved by using the low cost housing technologies in comparison with the traditional construction methods for walling and roofing respectively. This proves the benefits and the trends for implementing low cost housing technologies in the industry.

Table 1: Cost analysis of the traditional construction methods and the low cost housing technologies used in the case studies for 1m³ of walling (Works Department, 2002)

No	Item	Unit	Rate (US\$)	Conventional brickwork		Rat-trap bonded brickwork	
				Quantity	Amount (US\$)	Quantity	Amount(US\$)
Materials							
1	Bricks	No	0.02	350.00	7.00	284.00	5.68
2	Sand	m ³	0.32	0.28	0.09	0.17	0.05
3	Cement (10kg bag)	No	6.17	0.67	4.13	0.40	2.47
Labour							
1	Mason (highly skilled)	No	1.70	0.35	0.60	0.35	0.60
2	Mason (2 nd class)	No	1.49	1.05	1.56	0.80	1.19
3	Unskilled labour	No	1.06	2.96	3.14	1.96	2.08
Add 2% tools and plant charges					0.34		0.25
Add for scaffolding- superstructure: 0.42/m ³					0.42		0.42
Total (per m³)					17.71		13.08
Savings					26.11%		

Table 2: Cost analysis of the traditional construction methods and the low cost housing technologies used in the case studies for 1m³ of roofing (Works Department, 2002)

No	Item	Unit	Rate (US\$)	Conventional slab		Filler slab	
				Quantity	Amount (US\$)	Quantity	Amount(US\$)
Materials							
1	Concrete, including labour	m ³	38.6	1.00	38.6	0.80	30.88
2	Reinforcement	ton	36.12	0.80	28.89	0.38	13.72
3	Steel cutting, bending	ton	3.87	0.80	3.09	0.38	1.47
4	Mangalore tiles	No	0.06	N/A	N/A	65.00	4.14
Labour							
1	Mason (2 nd class)	No	1.49	N/A	N/A	0.20	0.30
2	Unskilled labour	No	1.06	N/A	N/A	0.80	0.85
Add 2% tools and plant charges					0.11		0.11
Total (per m³)					84.32		65.20
Savings					22.68%		

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