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An Appraisal of Cost Reduction of Houses

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Abstract:
Good housing is a need to every human-being. In today's economic scenario, the incomes and expectations in the wake of rapid urbanization have created a crying demand for cheaper, energy-efficient and ecofriendly houses with cost effective technology and skill acquisition. This paper tells about some alternative housing methods and materials comparing the cost reduction over conventional methods without sacrificing the strength and performance.

Keywords: Cost-effective, conventional, economic, housing, strength

I. INTRODUCTION

Essential requirement to human existence is a HOME next only to food and clothing. Adequate shelter for all people is one of the pressing challenges faced by India, because of the growing population day by day. The dream of owning a house particularly for low income and below poverty line families is becoming a difficult reality. Hence, we need a solution that is fast, easy to build, fulfils the needs of conventional houses, cost effective, innovative, energy efficient and eco-friendly. This will enable each and every one to construct his/her own dream house at affordable cost keeping various factors such as stability, safety, durability of structure as well as overall mental satisfaction at top priority. To meet the aim of our country, we definitely need some immediate plans regarding cost effective materials and appropriate technologies in construction.

II. HOUSE COMPONENTS AND COST

A house can be broadly divided in two parts: - (i) Sub-structure (ii) Super-structure. The portion of the house below the surrounding ground is known as sub-structure and the portion above the ground is termed as super-structure. The components of a house can be broadly summarized as Foundation, Plinth, Walls, Floors, Openings (doors/windows/ventilators), Roof, Finishes, Services etc. House construction cost comprises two things: - (i) Building material cost (60% to 65% of the whole cost), (ii) Labor cost (35% to 40% of the whole cost). Cost of sub-structure which includes foundation and plinth is about 18% to 20% of the whole cost and cost of super structure contributes about 80% to 90% of the whole cost. Cost of reduction of the house can be achieved by reducing the quantity of materials through an improved design and by selection of more efficient materials and also the reduced labor cost through proper time schedule of work.

III. COST REDUCTION BY PROPER PLANNING

Cost of reduction varies depending upon the nature of the house to be constructed, budget of the owner, geographical location where the house to be constructed, availability of the building material, good construction management practices etc. However, it is necessary that good planning and designing methods should be adopted by utilizing the services of an experienced engineer/architect for supervising the work. The more planning goes into a house extensively, the less the actual construction will cost. In plans, too much height and unwanted, wasteful spaces like passages, corridors, stairs, access verandahs etc. should be avoided. Vaastu concepts should be considered before starting the work to avoid demolition and extra cost for correction in future. Local climate should be analyzed and wind directions should be properly utilized to reduce the power consumption and to prevent unnecessary heat absorption. Land gradients, contours, natural existing features etc. should be used to the optimum level for the best design. Preparation of good plan can reduce the cost of rooms and boundary wall to great extent. For example, the boundary wall length will be shorter for a square plot compared to a rectangular or triangular plot of same area. So, by planning a square room, the cost of brick work, plastering, wall base and paint will be automatically less. Plentifully available local materials should be encouraged to be extensively used in construction rather than importing building materials from other places to save the transportation cost. Every component of the house should be pre-planned and the design procedure should be rationalized for reducing the size of the component in the building.

IV. COST REDUCTION BY EFFICIENT BUILDING MATERIALS IN DIFFERENT COMPONENTS

Selection of materials for different components of house depends upon several factors such as:- (i)locally available (ii)re-used (iii) low embodied energy (iv)biodegradable (v)pollution preventing (vi)non-toxic (vii)salvaged (viii)energy efficient (ix)recyclable. Eye-catching and unjustifiable materials should be avoided, which are invariably an extra expense. First of all, eco friendly building materials should be selected which also enhances the sustainable design principle. Each stage of building should be such that they help in conserving energy. In the last stage which is disposal stage, the materials should be recycled or reused. ½

1. Foundation

Normally, the foundation cost comes to about 10% to 15% of the total cost of the building. It is recommended to adopt a foundation depth of 2 ft. for normal soil like gravely soil, red soil etc. In case of black-cotton or other soil, under ream pile foundation should be adopted to save about 20% to 25% in cost over conventional method of construction. Spread foundation should be replaced by inverted arch foundation to reduce the cost by 40%, but the end piers have to be specially strengthened by buttresses so as to avoid the thrust to arch action tending to rapture the piers junction. Random rubble masonry in mud/cement mortar can be placed in excavation over thick sand bed. Lean cement concrete mix (1:8:16) may be used for base with over burnt brick masonry in cement mortar (1:6) or cement lime mortar (1:2:12) in footings. Soil stabilized foundation may also be considered as an alternative, in which, foundation is laid at a depth of 2´6´´ from ground level and base of the foundation is compacted with a mechanical compactor to give a density of 90% of maximum dry density. The foundation is filled up to the ground level in three equal layers with 3% cement-soil mixture and is compacted upto 95% of maximum dry density.

2. Plinth

Normally, a height of 1ft. to 1½ ft. above ground level is recommended for plinth and may be constructed with cement mortar (1:6). Conventionally used 4´´ to 6´´ plinth slab can be replaced by bricks on edge, by which the cost can be reduced upto 35% to 40%. Soap, petroleum, oils, fatty acid compounds etc. can be mixed with 1:6:12 cement lime mortar and used as damp proof course in plinth.

3. Walls

Rat-trap bonded wall in 1:2:12 cement lime mortar or 1:1½:3 cement sand mortar, a cavity wall construction can be adopted in place of traditional English or Flemish bond masonry in 1:6 cement mortar to reduce the number of bricks from 350 to 280 per cubic meter of masonry along with the reducing mortar consumption due to less number of joints. 25% material cost and 15% masonry cost reduction is achieved by this with aesthetically pleasing wall surface. Stabilized compressed earth blocks with 4% cement or lime in stabilized mud mortar or a hollow concrete block, which consumes about 1/3rd of the energy of the burnt bricks in its production when used in walling of thickness 15 cm can save upto 10% to 25% of the total cost as plastering can be avoided for this. Another alternative is to use energy efficient Fal-G sand blocks manufactured by hand operated machine with soil and 5% cement, by which 15% to 20% economy can be achieved over conventional method of construction.

4. Lintels

Traditional lintels which are costly can be replaced by flat, segmental arches for small spans and the bricks used in arches may be clay red mud burnt bricks, which are produced from alumina red mud or bauxite, an industrial waste of aluminum producing plants in combination with clay. It solves the problem of disposal of bricks due to pleasing hue of color and saves about 30% to 40% cost. Pre-cast thin lintels with sand stone chajjas can be an alternative also.

5. Roof

Traditional R.C.C. roof slabs can be substituted by Filler slab technique, where bottom half (tension) concrete is replaced by filler materials such as roofing tile, bricks, cellular concrete blocks etc. The structure requires less steel and cement and it is also a good heat insulator. By reducing the quantity and weight of the material, the roof becomes less expensive, but retains the strength of conventional slab. Filler slabs also provide aesthetically pleasing patterned ceilings and cost reduction is happened to be 20% to 25% by using this technique. Another method is to construct Jack arch roof, in which an arcadecan be created at the interior surface of the roof with a series of small segmental arches by using compressed earth blocks, bricks or cheaper pre-cast concrete blocks with rolled steel joists or R.C.C. joists. Care is taken to keep the rise of the arches not more than 1/12th of the span. Ferro-cement channels also provide an economic solution to R.C.C. slab by providing 30% to 40% cost reduction without compromising the strength. Again, these being precast, constructions are speedy, economical due to avoidance of shuttering and facilitate quality control. Upgraded thatched roof on appropriate frame-work, bamboo reinforced concrete, burnt clay tube roofing in vault form or precast R.C.C. cored/channel units in M15 concrete may be alternate solutions for low cost roofing, which can save cost upto 25% to 40%.

6. Doors / Windows

Use of brick jail in place of regular windows can help cost reduction as well as climatic considerations. It is found that 1 ft^2 of a normal conventional window costs about 10 times more than the brick jail of same area. Again, due to use of this, diffusing of light occurs and glare is avoided naturally. Extensively, it can be used in parapet wall, boundary wall and ventilators. Ferro cement chajjas, precast R.C.C. frames with wood insert, resin bonded saw dust frame, PVC frame or fiber reinforced plastic frame can be used as cost effective door/window frames, by which cost can be reduced upto 30% to 40%. Similarly, for shutters medium density fiber boards, cement bonded particle board, red mud polymer boards, plantation timber styles with rice husk board inserts or Ferro cement / PVC can be used for reducing the cost by 25%.

V. SCENARIO IN INDIA

i) Renowned British Born Architect Laurie Baker (1917-2007) is generously known for his limitless contributions towards low cost housing with sustainable technologies adopted with care and creativity. He had constructed his house "Hamlet" in Trivandrum along the slope of a rocky hill with all materials in natural form and with limited access to water, which shows the truthfulness of the materials.

ii) To cater to the housing demand in India, Tata Blue Scope Steel is supplying affordable conventional housing by using Light Gauge Structure (LGS) along with ZINCALUME steel and COLORBOND steel within a very short span of time. This steel is increasing its familiarity and demand due to its various properties like durability, design flexibility, termite resistance, corrosion resistance, fire resistance, high strength, light weight, thermally efficient, earth quake resistance etc.

iii) IIT, Madras has developed a method for cost reduction of houses using Glass Fiber Reinforced Gypsum (GFRG) panels for the entire building system including floor, roof, staircases etc.,

thus significantly reducing the consumption of reinforced cement concrete. GFRG panels are also increasing the speed of construction, providing less built–up area for the same carpet area and recycling the industrial waste gypsum. As the panels weigh only 43 kg/m^2, the building load is also reduced which contributes to saving in foundation. Also, the panels does not need plastering, for which, finishing cost at the same time is reduced.

iv) Several Research and Development bodies in India which are developing cost effective building materials and construction technologies are Central Building Research Institute (CBRI), Structural Engineering Research Center (SERC), Center of Application of Science and Technology to Rural Ares (CASTRA), Regional Research Laboratory (RRL), National Environmental Research Institute (NEERI) etc.

VI. COMPARISON WITH AN EXAMPLE

Let a room has to be constructed with data :- (a) Carpet area - 36m^2 (b) Floor to ceiling height – 3m (c) One door of size (1.1m x 2.1m) (d) One window of size (2m x 1.3m). Two geometrical sizes (6m x 6m) and (9m x 4m) having 36m^2 area are selected for room. The square room is preferred design-wise as it has less perimeter (24m) compared to rectangular size (26m) due to which, the cost will be reduced because of less wall. The cost of different components when compared to a conventional house is as follows (Table I):-

Table.1. Comparison cost table

S. N	Conventional Technique				Cost Reduction Technique				Remark
	Particulars of items	**Quantity**	**Rate (Rs)**	**Cost (Rs)**	**Particulars of items**	**Quantity**	**Rate (Rs)**	**Cost (Rs)**	
1	Earthwork in excavation foundation trenches of (90cm x90cm) for 23 cm wall	20.19m^3	147	2968	Earthwork in excavation foundation trenches (80cm x 80cm) for 15 cm wall	15.74 m^3	147	2314	Reduction in foundation cost 29%
2	Earth work in filling in foundation trench and plinth at 60 cm from G.L.	19.52 m^3	102	1991	Earthwork in filling in foundation trench and plinth at 30 cm from G.L.	10.32 m^3	102	1053	
3	Cement conc, (1:4:8) in foundation upto depth 30 cm	6.72 m^3	3921	26349	Providing & laying Soil cement stabilized foundation	15.74 m^3	430	6768	
4	First class brick work (1:4) in foundation & plinth	12.45 m^3	4848	60358	Cement conc. Blocks (10x15x20cm) in cement lime mortar (1:2:12) in foundation & plinth	2510 No.	22	55220	
5	4 cm th. D.P.C. (1:2:4) with stone chips including waterproofing compound	5.48 m^2	221	1211	Providing & laying 2´´ th. D.P.C. (1:2:3) conc. With polythene sheet	3.52 m^2	269	947	Reduction in DPCcost 22%
6	First class brick work in (1:6) cement mortar in wall in super structure	16.06 m^3	5210	83673	Providing & laying (10x15x20cm) cement conc, blocks in (1:2:12) cement lime mortar in wall in super structure	2066 No.	22	45452	Reduction in super structure wall cost 46%
7	R.C.C. work (1:2:4) in lintel & roof excluding reinforcement but including shuttering	4.26 m^3	5925	25240	Filler slab technique in lintel & roof slab excluding reinforcement but including shuttering	4.02 m^3	4915	19758	Reduction in lintel & roof cost 31%
8	Tor steel reinforcement including cutting, bending & placing in position in binding	268 kg	67	17956	Tor steel reinforcement including cutting, bending & placing in position in binding	150 kg	67	10050	

9	10cm th. Lime terracing on roof thoroughly beaten & cured including top finishing	38.8 m^2	410	15908	Conglomerate terracing with lime conc. topping	37.8 m^2	186	7031	Reduction in roof terracing cost 55%
10	6mm th. Terrazzo flooring (1:11/2) over 20mm cement conc. (1:2:4)	36 m^2	560	20160	Precast conc. Block flooring with (1:6:12) cement lime screed	36 m^2	186	6696	Reduction in flooring cost 66%
11	Sal wood work in door & window frame including fitting	0.12 m^3	73331	8800	Precast R.C.C. door frame	0.13 m^3	11250	1462	Reduction in door/window cost 80%
12	35mm Teak wood panel shutters for door/ window including fitting	4.28 m^2	2664	11402	Ferro-cement door/window shutters with fitting	4.28 m^2	570	2440	
Total Cost				276016	Total Cost			159191	Gross cost reduction per sq.m 38%
Total Built-up Area - 41.73 m^2					Total Built-up Area - 38.81 m2				
Construction cost / m2 - Rs 6614					Construction cost / m2 - Rs 4102				

VII. CONCLUSION

No one wants to pay more than necessary when building a home, but, only the expert knows how to save money on construction. Managing the response to the over increasing housing need of Indian population has long been a problem for its Government. Urbanization has resulted in people increasingly living in slums and squatter settlements. Currently, there is a wide gap between the demand and supply of affordable housing. So, our awareness drive has to take place to adopt the alternative options available in construction industry, which helps in reducing the cost of construction without sacrificing the strength, performance and life of structure.

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