

# Cost-Effective Construction Technologies: A Review

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**Abstract**—For any construction work to be effective and efficient, the factors like quality, cost, services provided, etc. play key role. So, it is very important to adopt such constructive technologies which are beneficial to both the constructor and the user. Cost-effective construction technologies doesn't direct at using cheap materials of inferior quality and poor skills and technology. It points out at the adroit utilization of available resources, skill and technology and better management practices to optimize the project cost. In a developing country like India, where the majority of the population belongs to medium or less income earning group, cost effective construction technologies are a godsend.

## 1. INTRODUCTION

In developing countries like India, the development of the nation is usually measured by the growth of cities and the level of networking, even providing connectivity to the remotest place. Construction industry is just striving towards that and is growing rapidly throughout the nation. But the main concern is the economy. It is very important for a growing nation to cut out its inept expenses. Every country aims at lesser capital, greater revenue. About 20% of the nation's population are high-income earners. Since the majority of them belong to either low or medium income groups, it's become a difficult reality to afford a house at a reasonable price. At this point, cost-effective construction technologies come into the picture. It is a concept of reducing the cost of a construction project while delivering the same or even better performance. It doesn't indicate substandard quality work.

## 2. COST-EFFECTIVENESS CHARACTERIZATION

There are many elements which impact the efficacy of cost-effective construction technologies. Few of them which would make these technologies preferable are:

- Since most of the labors involved are low-skilled, technologies involved shouldn't be complex.
- Technologies should be modern.
- Deploying as far as possible renewable sources of energy and less energy consuming technologies which reduce the cost.

- It should be applicable to most type of buildings.
- Waste generated by these should be minimized reducing the waste management cost.
- Implementing smart materials which enhance the quality of building and also introducing innovative techniques which not only improve the building structurally but aesthetically also.
- With the increasing adverse effects of construction industry on environment, it's very important for these technologies to be environment-friendly.

## 3. COST-EFFECTIVE TECHNIQUES

### 3.1 Low cost Active and Passive energy saving technologies

Application of active and passive energy technologies [1] during operation and design phases of a project has provided better results in reduction of cost and energy.

Passive energy saving technologies involve –

- a. Use of 40mm thick polycarbonate curtain wall which has better insulation effect.
- b. Adjustable external shading preventing entry of sunlight during summer and allowing it to enter during winter. It reduces air conditioning costs.
- c. Green roofing which minimizes energy consumed for cooling during summer.
- d. Light concrete wall, natural ventilation, etc.

Active energy saving technologies includes-

- a. Free cooling technology which uses cold water and ground source for cooling.
- b. Modular ground source heat pump system uses an arrangement of 5 heat pumps along with 10 compressors, efficiently regulating the room temperature.
- c. Optimization of operation strategies and energy saving like providing ventilation for natural light and air, etc.

When a comparison between different sources of energy consumption was made, it revealed that air conditioning contributed for the highest energy consumption and ultra-low energy consumption buildings stood out in reducing the operating expenses and saving energy without compromise.

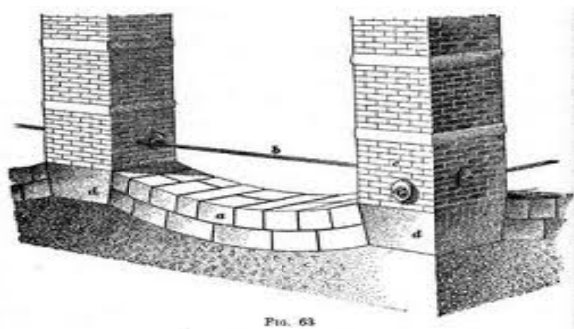
For better energy efficient buildings, the key is to have effective optimized operation and maintenance phase in a building.

### 3.2 Low cost housing technologies

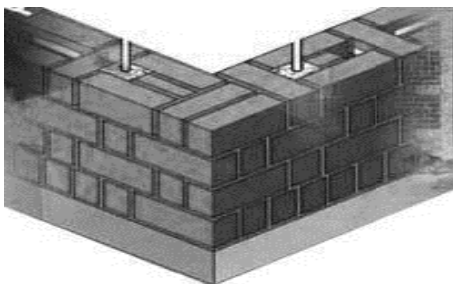
Housing costs have escalated so high recently that it has become so distant for the low and medium income earners. Low cost housing doesn't indicate utilization of cheap quality materials or substandard construction technology. It's the effective utilization of available resources-material or man power and more strategic construction technology.

The traditional techniques to the low costing ones in regards to foundation, walling, roofing and plastering could be updated. The results revealed that 26.11% and 22.68% of construction cost could be saved just in walling and roofing.

Arch foundation for walls can resist lateral stresses. Inverted arch is provided. It can reduce construction cost by 40% as depth of foundation is reduced. The only disadvantage is that its end piers have to be strengthened to avoid thrust to arch action acting towards pier junctions.



Rat trap bond technology can be used in walls. It is more effective in 1:2:12 lime mortar and 1:1.5:3 cement sand mortar. Along with this, stabilized mud blocks could be used. Rat trap bonds are more effective only till three floors in conjunction with brick columns. This technology reduces the total cost by 25% because of the reduction in mortar consumption due to lesser joints.



Concrete block walling is yet another concept of low cost housing technologies. Since burnt bricks consume large amount of energy, concrete blocks can be used in their stead. These consume less energy and also avail speedy construction. Plastering will not be needed in this case.

Adoption of Filler-slab technique. Slab is similar to a simply-supported beam, with its lower side in tension zone and the upper side will be subjected to compression. So, on the tensile zone of slab, not much concrete is required. In usual practice, RCC slab are provided. Concrete on the lower side of slab and the excess reinforcement adds on to the loads acting. Hence, this concrete can be reduced by low-cost, light-weight materials can be used. This saves up to 25% of the cost as 40% less steel and 30% less concrete is used.

### 3.3 Pre-fabricated technologies

Time and quantity of availability of materials are a major concern for any project. This instigates the adoption of pre-fabricated construction units. Pre-fabricated units don't require much time for their production and are very cost effective in mass-production. This results in faster construction and increased saving on the overall cost. They are more suitable for flooring and roofing.

### 3.4 Minimizing cost variance

Cost variance can be defined as the difference between the amount agreed upon by the contractor and the client and the actual amount spent by the end of the project. Cost variance can be minimized by adopting better management practices

Cost effectiveness analysis (CEA) is a tool for identifying minimal cost method for meeting a specific demand. It's a roadmap to quantify pros and cons of a technique.

### 3.5 Smart and Green materials

Concept of green and smart buildings is developing enormously in India. This design strategy highlights the extended lifespan, reduced operating and maintenance costs and aesthetics.

Though the initial investment costs users 3-5% more compared to the conventional properties, but it saves 25-30% on water and electricity consumption. So the investment would be recovered within five years of implementation of this technology. Few techniques are:

- Replacement of natural sand with finely powdered crystalline silica, obtained from waste limestone. There's not much compromise with the strength. Silica makes the structure more strong and durable.
- Fly-ash bricks can be used in place of clay bricks as a strengthening material. These are environment friendly and energy efficient.

- GGBS concrete and green cement can be used without negotiating the strength. Both are environment friendly as they are produced from waste obtained from factories and natural resources.
- Concrete can be designed provide thermal jacket for the building, preventing passage of heat or cold directly into the building.
- Natural materials can be incorporated into the cement like bagasse, straw and other natural fibers.[8]

### 3.6 Optimized material procurement [4]

Material procurement is one of the hectic tasks for a construction project. It is also major contributor of the total project cost. This stage also affects the quantity of waste generated. If materials are procured in excess, construction cost increases. Waste produced will also be more and hence increasing the waste management cost. A study on construction waste generated by UK's Building Research Establishment (BRE) revealed that upto £130 million profit could be gained by reducing waste by only 5%.

Use of recycled materials could be coined. But few researchers have argued that introduction of recycled materials has decreased the concrete's strength and few others say there were no improvements in the quality. So, recycling needs further advancements.

SMART Waste is a concept developed by the researchers conducted by BRE. It is an effective online tool for prediction of quantity of waste generated so as to devise counter procedures to abate waste.

Take-back scheme, acquiring waste efficient materials, reduced packaging, Just-in-time (JIT) delivery route and avoid over-ordering are few of the techniques for waste reduction.

## 4. CONCLUSION

Cost-effective construction technologies are no less than the cutting edge technologies. But in fact, they are more expedient in the nation's status quo. With developing economy and population alongside declining land availability and employment, these technologies are a boon. The government should employ these while setting out regulations for construction industry, which is beneficial to them as well as the citizens. Advanced research and developments in this sector are still needed.

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