A Study on the Effect of Value Engineering Practices in Construction Projects

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Abstract- **In construction industry, increased innovation techniques aims in reducing the cost of construction work with either increasing or decreasing the quality of the construction with an affordable housing techniques. In the current scenario, construction industry replaces the implementation of conventional construction process by various new and innovative techniques in the construction field. These new construction techniques are developed mainly to increase the quality of work and to ease the work throughout the completion of the project. For a project to be successful, the most important factor is the cost and quality of the project which needs to be enhanced in the forthcoming years. Value Engineering (VE) is a process for achieving the optimal result through a functional approach. VE continues its journey with deep impact on the world by increasing the performance of all techniques in all fields by eliminating the unwanted cost.**

This project work provide the necessary information on reduction of cost in construction project at the same time increase in quality comparison with respect to the concept of value engineering by the concreting work. To identify the best quality of the concrete mortar with proper supervising with respect to minimum of cost as possible. This identification of best concreting is to be worked out in the phase I project by estimating the structural building individually using the method of Site Mix Concrete (SMC) and Ready Mix Concrete (RMC).SMC is a traditional concreting method widely suitable for small projects and RMC is the fastest concreting technique which reduces the labour cost and also maintains the quality of mortar. Finally the comparison table is formed to choose the effective concreting technique.

Index Terms- **Concreting, Cost and Quality, Performance, Value Engineering, Cost Estimation, Comparison of Construction Methods.**

1. INTRODUCTION

The construction sector is one of the largest sector for employers in the country. This construction sector also recorded the highest growth rate in generation of jobs in the last decades, doubling its share in total employment. Value Engineering(VE) is an exercise that involves in various project as a team. It is about taking a wider view and looking at the selection of materials, plant, equipment and processes to see if a more cost-effective solution exists that will achieve the same project objectives.

Value Engineering techniques improving the effectiveness of construction work that has been conventionally performed as it questions and probes into the plan, design, purpose, method of manufacture, etc., of the product with a view to identifying and eliminating unnecessary costs without adversely affecting quality, efficiency and other customer features.

1.1 Need for Study

The high cost of operation has been identified as one of the major problems that not only affect the construction industry directly but also the overall economy indirectly, as high input and process costs are reflected in high cost of infrastructure, which in turn translates into higher user charges and to improve the value of the construction elements by increasing its performance and bring suggestion to adopt the qualitative technique in construction field.

An important factor in cost and quality overruns has been the lack of proper project preparation. Details are often ignored at the preparatory stage, leading to problems later on. Project planning needs to be strengthened through adequate field investigation, data collection and analysis.

1.2 Objectives

The main objective of the project is to provide all essential functions at a lowest cost and it also includes:

- To study the feasible alternative materials and techniques that can improve the value of the structure and environment.
- To understand and compare the cost saving factors attained after conducting value engineering study with the conventional one.
- Compare the total cost of the project with the ongoing constructional projects.

1.3 Nature and Scope of Work

The scope of the research is mainly focus on literature review and the collection of data from the construction site which includes plan and cost estimation to compare the various methods and its effective performance in construction projects.

In this project, an effort has been made for the following:

- Use of alternative methods in construction industry.
- Use of Energy efficient and eco-friendly techniques in practical environment.

2. METHODOLOGY

The desired objective can be obtained by sequencing the flow of work into a typical methodology. Figure 2.1 represents the methodology adopted for successful completion of the project.

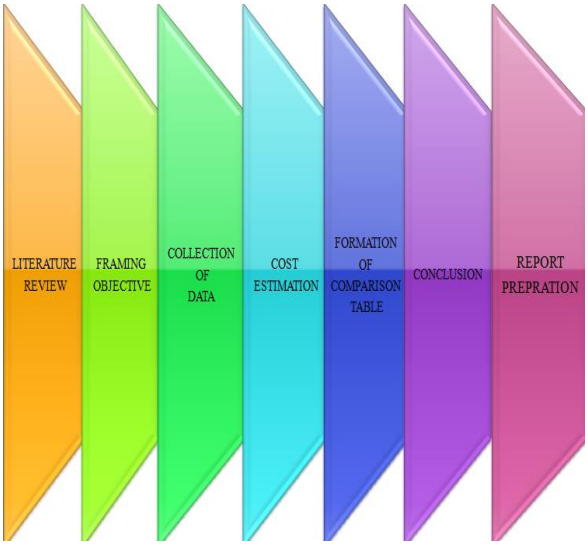

Figure 2.1: Methodology Flow Chart

3. DATA COLLECTION

Concrete is a composite or binding material which consists of a binding medium within the embedded particles or fragments of aggregates in the combination of fine aggregates and coarse aggregates in Portland-cement concrete to form the binder, which is a mixture of a Portland-cement and water, with or without admixtures.

3.1 CONCRETING

The experienced person in the construction of formwork, preferably a tradesman, should always be standing by when the concrete is being placed. He should have a supply of suitable materials such as props, bolts etc. to handle dangerous situations. Grout loss is an indication that joints were not tight or some movements have occurred during placing. Similarly, wedges should be regularly checked and tightened. After concreting ,all split concrete or grout leakage should be cleaned or diluted with spray water immediately to make striking and cleaning easier especially with steel formwork. Check cracking, excessive deflection, level and plumb and any movement. Concrete should be deposited at, or as near as possible to, it's final position.

3.2 CONCRETING METHODS

- Site Mix Concrete(SMC)
- Ready Mix Concrete(RMC)

3.2.1 SITE MIX CONCRETE

The site mixing is also known as hand mixing concrete. It is adopted for small works and where the quantity of concrete used is small. Proper mixing of concrete ingredient is very much necessary as it affects the quality of concrete in its fresh state as well as in hardened state. A concrete is said to be well mixed if it fulfills the following requirements.

- Concrete mix should be uniform in colour.
- Concrete should achieve proper consistency for which it is designed.
- Complete blending of all concrete ingredients.
- Cement paste should cover all the surface of the aggregate.

3.2.1.1 THE MANUFACTURING PROCESS OF SMC

Step 1: Implementing the product received

Receiving the facilities for aggregates make it possible for trucks to unload their goods directly into a hopper (large funnel-like device) which feeds the product through a conveyor belt. The cement is delivered by tanker trucks that unload their cargo in silos via pneumatic pipes under compressed air pressure.

Step 2: Storage of aggregates

Aggregates are stored in hoopers, in silos, or on the ground. The aggregates can be stored for several days at the batch plant without any loss.

Step 3: Adjuvants (additives)

Admixtures or additives are added at the time of manufacturing to obtain fluidity, and to accelerate or delay setting time.

Step 4: Storage of cement

The composite material is stored in silos equipped with a dust collection venting system. There are as many silos as there are types of cement.

Step 5: Mixing

The mixer blends the cement, sand, gravel and adjuvant supplied by the PLC (Programmable Logic Controller).A mixer must contain up to 3 m3. The time and the quality of the mixing are important factors so as to produce a good product. They are controlled by a programme.

Step 6: Control Station

The batch plants are all equipped with PLC's to automate control production. They allow for better selection with rigorous standards, of a formulation adapted to the concrete ordered by clients, and according to the dosage in water corresponding to the hygrometry of aggregates. Cement, sand, gravel, water and adjuvants are dosaged (measured) and weighed with extreme precision.

Step 7: Delivery

The fresh concrete is brought to the site via mixer-trucks for delivery of the required quantity of concrete with a capacity of 6 to 8 m3, in which it is generally mixed before delivery to clients. Delivery logistics constitute an essential part of the process because of cement's setting time which is limited.

3.2.2 READY MIX CONRETE

Ready mix concrete is a tailor-made concrete which improves durability and sustainability. Instead of purchasing the raw materials by individuals and experimenting every time with handling and proportioning, it would be far better idea to entrust all these activities to some expert supplier who is having a professional acumen. In India, concrete has traditionally been produced on site with the primitive equipments and use of large labour force. Ready mixed concrete involving a high degree of mechanization and automation. A typical RMC plant consists of silos and bins for the storage of cement and aggregates respectively, weigh batchers for proportioning different ingredients of concrete, high efficiency mixer for thorough mixing of ingredients, and a computerized system controlling the entire production process. The quality of the resulting concrete is much superior to site-mixed concrete. Ready mixed concrete is the concrete which is delivered in the ready-to-use manner. Ready-mix concrete is concrete that is manufactured in a batch plant, according to a set engineered mix design.

3.2.2.1THE MANUFACTURE PROCESS OF RMC

Raw materials used to produce concrete are as follows:

1) AGGREGATES

The required amount of aggregates are obtained from various quarries and from nearest aggregate banks. About 60% to 75% of ready-mix concrete's volume is made roughly.

2) ADDITIVES

Additives are added to the ready-mix concrete before or during preparation which are the solid or liquid chemical substances. The utilization of additives improves the durability of the hardened concrete or otherwise these additives reduces the presence of water in an effort to shorten setting times.

3) WATER

When water comes into contact with the cement,the concrete sets in its state due to chemical reaction which take place in the concrete mortar.

4) CEMENT

Cement is a binding material which plays a vital role in concrete mix. Cement is the ingredient that gives concrete in its resistance. Although types II and IV are also employed, the most widely used cements are gray Portland type I and Pozzolana Portland type C-2.

5) CONCRETE MIXING

To produce a uniform mass of concrete, the different components come together at the mixing phase. From the moment that the material and water is poured

into the cement mixer, the mixing time gets registered, and it starts rotating.

6) TRANSPORTING

The cement mixer never stops revolving at a speed of two to six rotations per minute during the concrete transportation to the construction site.

3.3 QUALITY TESTS OF CONCRETE

At the construction site, the quality of the concrete should be determined at each stage by using the various quality tests of concrete. There are six common quality tests on concrete before and after completion of casting of concrete on site are as follows:

- Slump test before leaving the batching plant and on arrival on site
- Compressive strength test
- Water Permeability test
- Rapid Chloride Ion Penetration Test
- Water Absorption Test
- Initial Surface Absorption Test

3.4 IDENTIFICATION OF FACTORS

The factors such as the materials used for concrete, concrete mix design, properties of concrete, quantity of concrete, quality of concrete are as follows briefly.

3.4.1FACTORS AFFECTING THE SELECTION OF MATERIALS

- The structural requirements of the concrete
- The environment to which the structure will be exposed
- The job site conditions, especially the methods of concrete production, transport, placement, compaction and finishing
- The characteristics of the available raw materials

3.4.2 FACTORS AFFECTING THE CONCRETE MIX DESIGN

In order to achieve a defined workability, strength and durability of concrete, the concrete mixes are designed AS per requirements. The various factors affecting the choice of concrete mix design are as follows:

- Compressive strength of concrete
- Workability of concrete
- Durability of concrete
- Maximum nominal size of aggregate
- Grading and type of aggregate
- Quality Control at site

3.4.3 FACTORS AFFECTING COST OF CONCRETE

For undertaking any construction project, it is much difficult for most of the clients to budgeting the cost particularly availing the materials and performing the concreting activity.. There are two major factors which affecting the price of the concrete in construction industry. first is the quantity of concrete and the second is quality of concrete .

Quantity:

The quantity of concrete estimation depends mainly on the area to be covered by using concrete. We need to calculate the cost of the concrete by finding out the volume of the concrete, though we expressing the cost of concrete is per yard or per square foot. Commonly most of the houses are shaped like rectangles or squares and volume is the product of area and thickness. So, we need to calculate the surface area or a gap to be covered by using the concrete with the required thickness of concrete. So, volume of concrete is: L x B x Thickness. the length and breadth of the area to be covered with concrete should be measured at first and multiply the resultant quantity with the thickness of concrete to accomplish the required amount of concrete quantity. The thickness of concrete varies with application. For example, the thickness of concrete used for floors varies that the concrete used for driveways or roads.

Quality:

The quality of concrete mainly includes the specifications of construction materials like cement, sand, crushed stone and water used for making concrete. The mix ratio carried out on the basis of these ingredients affects the quality of the concrete directly. Hence the cost and application of concrete price leads to maximum price. The concrete used for various purposes such as decorating, pavement concreting etc., the cost would be different while it affects the quality too. There are a few kinds of concretes are as follows each concrete requires the basic four ingredients in a definite ratio.

- Decorative Concrete
- Stamped Concrete
- Stained Concrete
- Concrete Driveway
- Concrete Patio

Therefore, other than the cost of concrete we will need to add additional expenses like levelling the concreting surface, pavement grading, concrete forms and the reinforcements wherever required towards which finishing the concreting work to estimate the final cost of concreting. Before making any decision, it is worthwhile to compare the various applications and methods to avail the best quality of the construction buildings.

4. COST ANALYSIS

The residential building is about 1720 square feet with ground floor and first floor. This building is north facing to avail the natural lights and other natural benefits. This building consists of ground floor and first floor. It consists of several rooms, such as portico, verandah, kitchen room, foyer, stair room, bedroom, bathroom etc.

The concreting cost is going to be compared by individual estimation of ready mix concreting and site mix concreting. This comparison includes concreting work with respect to two different concreting methods. This comparison is made to increase the concreting quality and the performance of building by reducing the concreting cost included to construct the building.

4.1 COST ESTIMATION OF THE RESIDENTIAL BUILDING – SITE MIX CONCRETE

The detailed cost estimation of the G+1 Residential Building for the Site Mix Concrete (SMC) is tabulated in the Table 4.1.

Final Cost Estimation Of Smc	
Total Concrete Required For G.F And F.F	1980.31cft
Steel Cost	Rs.1,47,025/-
Material Cost	Rs. 2,44,720/-
Total Labour Cost In Smc	Rs. 23,250/-
Grand Total Of Smc	Rs.4,14,995/-

Table 4.1: Final Cost Estimation Of SMC

4.2 COST ESTIMATION OF THE RESIDENTIAL BUILDING – READY MIX CONCRETE

The detailed cost estimation of the G+1 Residential Building for the Ready Mix Concrete (RMC) is tabulated in the Table 4.2.

Total Concrete Required For G.F And F.F	1980.31cft
Total Concrete Required In Cubic Meter	56 Cu.M
Price Of Concrete Per Cubic Meter In Rmc	Rs.4500/ Cu.M
Grand Total	Rs.2,52,000/-
Steel Cost	Rs.1,47,025/-
Final Cost Price Of Rmc	Rs.3,99,025/-

Table 4.2: Final Cost Estimation Of RMC

4.3 SITE MIX CONCRETE VS READY MIX CONCRETE

The difference between the Site Mix Concrete and the Ready Mix Concrete according to the factors which affects the quality of the concreting work is compared and tabulated in the Table 5.3.

FACTORS	HAND/MANUAL/SITE MIX CONCRETE	READY MIX CONCRETE
Concrete Consistency	Fairly difficult to achieve consistency since it is manually mixed at the site.	Concrete mortar is consistent since it is computerized machine produced.
Manpower Requirement	Requires more labor force both skilled and unskilled for mixing the mortar and shifting it, laying and compacting.	Skilled labor required only to lay and compact the concrete as per the design
Concrete Mortar Mix Ratio	Respective structural Engineer /Architect will provide the details of Concrete Grade whether it is M20, M25, M30 etc. and the thickness of the concrete mould.	Respective structural Engineer / Architect will provide the details of Concrete Grade whether it is M20, M25, M30 etc., and the thickness of the concrete mould.
Material Management	Requires proper estimation the material sand availability at the site ahead of schedule. Material procurement not a concern but proper concrete estimation needs to do.	However, the RMC agency should confirm the materials used in the mortar which may include Fly ash, GGBS, Chemicals etc.
Time Spent	Requires approximately 50% more time compared to RMC.	Requires approximately 50% less time compared to Site Mix.
Site Condition	Requires enough space to accommodate	Requires a road width of

	materials and site mix machinery.	minimum 30 feet for smooth maneuvering of the RM vehicle.
Quality	Monitoring the concrete mortar mix ratio through the process is critical.	Owner should obtain the cube test report from the RMC Company.
Quality Control On Raw Materials	Quality consistent materials are very critical to achieve the concrete compression strength required.	Choose certified RMC suppliers who manufacture according to IS standards and will provide cube test reports.
Laboratory Test Results For Concrete	Normally not tested for site mixes. The owner can opt for cube testing by any third party testing laboratories.	Testing to be done by RMC manufacturer and no additional charges are levied.
Pricing	Site mix is generally costly and risky when compared to RMC.	RMC is less costly when compared to site mix and it is very effective.

Table 5.3: Comparison Table

5. CONCLUSION

The study was focused on minimizing the construction cost by using fastest and qualitative concreting method of Ready Mix Concrete. The demand for building materials had been continuously raising, therefore the alternative construction techniques are selected without making any compensation in its quality. Cost analysis is made for the construction project and compared with the current projects. By using Site mix concrete, the total cost for concreting comes around **Rs.3,99,025/-**, whereas by using Ready mix concrete, the total cost for concreting comes around **Rs.4,14,995/-**.Hence, the cost of the G+1 Residential Building is reduced up to 3% by utililizing the Ready Mix Concreting techniques for effective construction of buildings.

Meanwhile, Quality assured concrete, high speed of construction, Reduction in cement consumption by 10 – 12 %, Timely delivery of concreting and its Durability can be achieved with enhancing the quality of concrete by adopting Ready Mix Concrete. This approach can be very useful to owners, site engineers, labours, contractors and clients, which is more eco-friendly and less maintenance. So owners can save the cost and gets more profits in constructional projects with achieving the high quality benefits.

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