Assessment of Application of Value Engineering in the Construction Industry and its Comparative Study with Conventional Method

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Abstract: Nowadays the construction industry is seeking to adopt recently made and workable method instead of the traditional method which lowers the cost and time and also raise the level of excellence and productiveness at the construction. In this growing world, it is necessary to have control over cost. The construction industry has considered being the second largest industry and having a high cost that taking a lot of system time or resources. Apart from this, Construction Industry is facing difficulties related to the shortage of material, labours, ideas, creativity, other resources etc. In such a situation, sometimes the construction industry using the poor-quality material, inadequate methods, and equipment's to complete the project and this may affect the structure in failure and causing other issues too. Instead of this, brainstorming should be done. One of the provident and estimable techniques used in the construction is value engineering (VE). Value engineering lower's excess cost and also enhances the quality of the product. This paper explores to identify the various parameters of VE used in construction projects through case studies and to analyze these parameters on the basis of quality, feasibility, demand and cost. The study also compares the conventional method with the alternative value engineered parameters.

Keywords **- Value Engineering, Construction Industry, Material Replacement, Cost, Quality.**

1. INTRODUCTION

In today's competitive world it is very difficult to complete the project within the specified time and cost. So, it is very important to plan and schedule the project to achieve the goals. Construction industry faces many difficulties like time overrun, cost overrun, delay in the project, loss in the project, poor management etc. The reason of such problems is due to unavailability of materials, shortage of labours, conflicts in the project, unawareness of creativity, higher rates, and lack of knowledge about the new technique adoption [1]. Here, it is very crucial to overcoming these difficulties and this can be done by applying the new and feasible technique. The various technologies have been used to surmount the problems and one of the effective techniques used to exclude the unnecessary cost in a construction project is value engineering (VE). VE is a cost-cutting tool used to diminish the cost of the project without upsetting the quality and value of the product. Value engineering was developed at General Electric C. during World War II and is widely used in industry and government organization such as defence, transportation, construction and health care [2]. The VE group looks for the greatest blend of scheduling, environmental awareness, execution, buildability, maintainability, safety, and cost consciousness [2]. Value Engineering is performed in a wide range to improve the overall efficiency and net profit without molochizing the quality, the value of the product and the level of customer satisfaction. In the construction industry, the goal of the project is to ensure the project is completing on time, within the intended expenditure. Reduction in the cost of construction is a consistent aspiration for the construction industry.

Industries have been going out of their way to minimize costs to save their financial resources, meet their budgetary limitations & reallocate this money to fund other projects. VE aims in achieving the best use of alternative, inexpensive material without compromising strength and quality, priced-off design, mass reduction, labour reduction, a new way of manufacturing, new ideas of construction and better understanding to achieve the identical quality and efficiency at low cost [3].

Ravish and Vinoth (2016) carried a case study of a residential building located in dhaliyur, Coimbatore. The overall cost for the construction of the building was 6, 61, 82,000.00 and duration was 11 months. The VE was applied to exposed walls, internal walls, windows, water tanks and sunshades, parking floor, terrace floor, plastering and painting and putty works and the feasible alternatives were adopted which saved in total 11,94,00.

Partheeban et al. (2017) stated that VE is a function-oriented technique that has proved to be an efficient management tool to obtain the enhanced design, cost of construction in various transportation fundaments. The paper presented a questionnaire survey to find out how effectively VE is adopted in construction and do the employees are aware of the concept of VE and its power. It was concluded that 20% of employees are not following a specific procedure for implementing VE and the remaining 80% following VE.

Rane (2016) stated that a cost-efficient solution is obtained by adopting the VE principle. Hence he presented a case study in which VE is applied to the shreenath enclave office complex and concluded that the value engineering method nobly aids the decision-making process to the designer, owner and the contractors. Successfully, this technique can be applied to a real construction project.

Patil and A.C.Attar presented an evaluation and selection techniques derived from value engineering principles for the door system. Sliding door alternative was selected as the best alternative, which saves cost up to 60-80% than the existing doors.

2. OBJECTIVES OF THE STUDY

1. To study and understand the phases involved in the value Engineering Job Plan.
2. To identify the various parameters of value Engineering used in construction projects.
3. To analyse the different parameters on the basis of:
   a. Quality
   b. Feasibility
   c. Demand
   d. Cost
4. To compare the conventional method with alternative value engineered parameters.
5. To give the advantages and disadvantages of both the traditional and VE method.
6. To analyse and compare the cost of the alternative method used in VE with the traditional method.

3. RESEARCH METHODOLOGY

It consists of two phases; the first phase includes literature study, data collection of the traditional method, from research papers, net, books, through contractors, a site in charge etc. The second phase consists of a collection of value engineering data from sites through a questionnaire, personal meetings, interviews, mail etc.
From the below methodology flowchart, it shows that the data of value engineering was collected through the case study. After the data collection, the analysis was done and comparative study was carried out

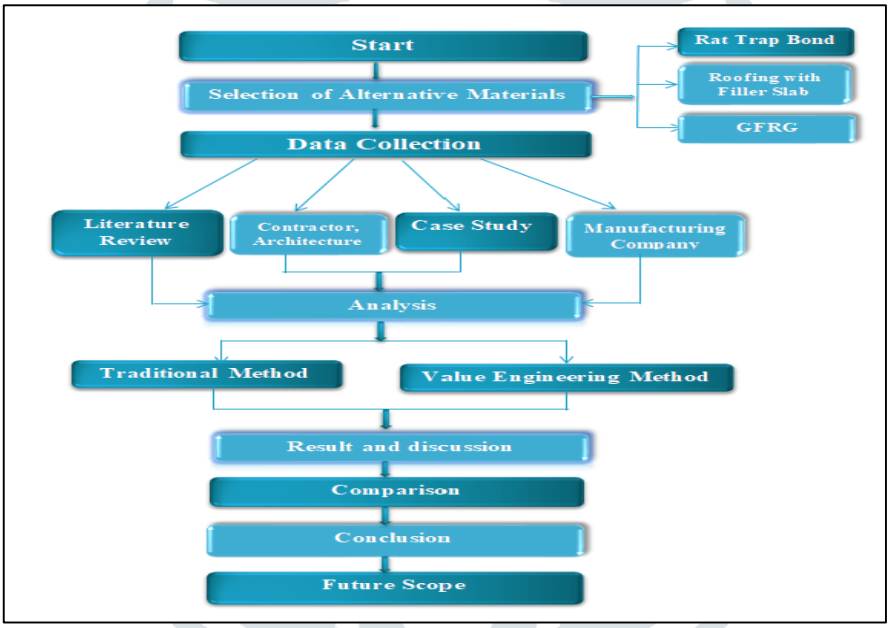

Figure 1. The Methodology Flow Chart

4. VE JOB PLAN ANALYSES

The value engineering job plan has modern eight phases depending on the VE application in the industry. Each phase has several tasks. These sequential phases have the highest level of project success. Step by step phases of a job plan is as below:

4.1. INFORMATION PHASE

In this first phase, a large amount of information regarding the project is gathered including project commitments and constraints. To minimize the losses in the project preliminary value analysis is carried out in this phase. The VE team participates to find the probable needs of the project.

4.2. FUNCTION ANALYSIS PHASE

This phase includes a detailed explanation of the function of every element of a project to direct a thorough understanding of what the project is supposed to furnish thoroughly [4].

4.3. CREATIVE PHASE

In this phase, the various alternative ideas are generated by the VE team related to the project benefits and cost reduction. The ideas are generated through brainstorming and association of creative proposals. The team needs good enough and a large number of ideas which can be screened in the further phase of the job plan.

4.4. EVALUATION PHASE

The value engineering group screened and ranks the thought that has been created in the creative phase. Those ideas found relevant and cost saving are selected and this idea shows the effective alternative for cost savings and better improvement in the work [4].

4.5. DEVELOPMENT PHASE

During this phase, the VE team researches the selected ideas and prepares sketches, designs, descriptions, and life-cycle cost estimations to allow decision makers to determine if the alternative should be implemented [5].

4.6. PRESENTATION PHASE

In this phase of the job plan, the best and feasible alternative is chosen and presented to the client for the final decision [4]

4.7. IMPLEMENTATION AND FOLLOW-UP PHASE

During this phase, management must assure that approved recommendations are converted into actions.

Parameters chosen as material replacements are:

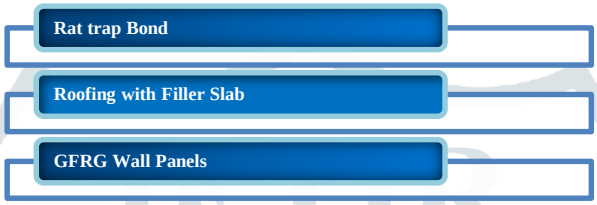

Figure 2. Flow Chart of Alternative Material

The above parameter had found through surveying at a different location in Maharashtra and through the internet and the data was collected from various sources.

5. DATA COLLECTION AND ANALYSIS

Data regarding value engineering parameters were collected from various sites by visiting, contacting the contractors, site engineers, supervisors, labours etc. After collecting the data, calculation of per Sq.m/Cubic meter of each parameter was done with the help of Microsoft Excel Worksheet and the mobile application has also been used for estimating the material known as a material estimator and material analysis v1.06. The calculated value then implemented for the plan of bungalow made in AutoCAD software and estimated the cost required for both the methods which helps to make the comparison between the two. After analyzing the data saving amount is calculated in percentage.

The estimation of the bungalow was also done so as to calculate the cost required after adopting this technique and suggest the relevant method to overcome the shortage of houses faced by the developing country like India. In this paper, the analysis with reference to material factor is only considered.

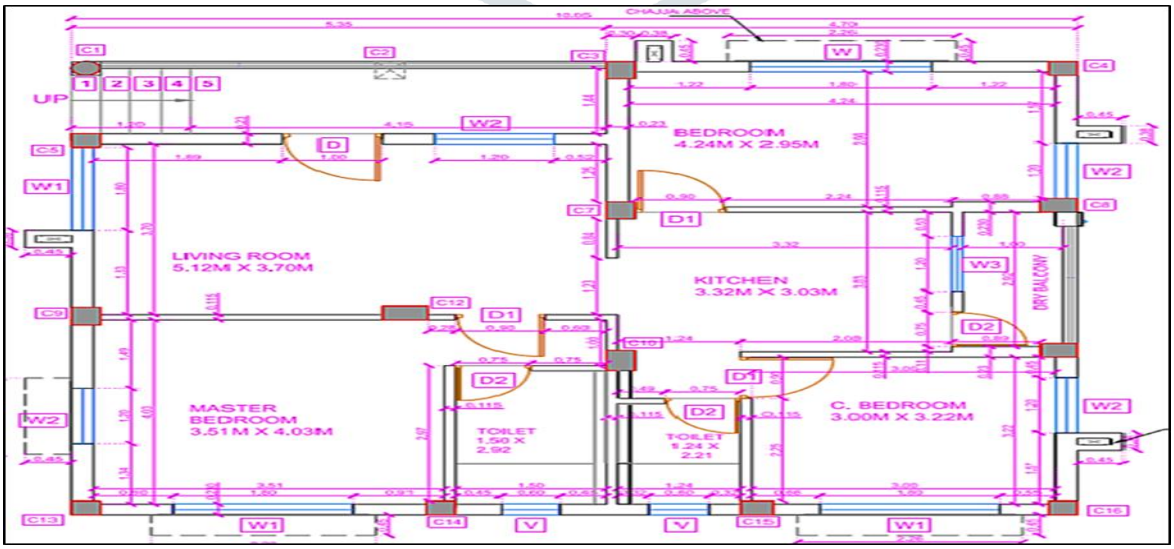

Figure 3. Plan of Bungalow

5.1 RATE ANALYSIS FOR RAT TRAP WALL, GFRG WALL PANELS, AND ROOFING WITH FILLER SLAB WITH CONVENTIONAL METHOD REQUIRED FOR 1 CUBIC METER.

Firstly, the three value engineered parameters have considered i.e. rat trap wall and roofing with filler slab (earthen pots) and GFRG wall panels. The rate analysis had carried out for 1 cubic meter for both the conventional and value engineering method and compared the result to find the feasible method amongst two.

Table 1: Details of material for per cubic meter required in Value Engineering Method

Sr No.	Material	Quantity	Units	Rate (Rs)	Amount (Rs)
1.	**Rat Trap Bond**				
	Bricks (Nos)	450	Nos	6	2700
	River sand	0.2592	m^3	1700	440.64
	Cement	1.1948	Bags	325	388.31
	Total				**3528.95**
2.	**Roofing with filler Slab (Earthen Pots)**				
	Cement	4.449	Bags	325	1445.925
	Sand	0.237	M^3	1700	402.9
	Aggregate	0.45	M^3	1000	450
	Pot	170	Nos	6	1020
	Steel	54	Kg	65	3510
	Binding wire	0.785	Kg	60	47.1
	Formwork	6.5	M^2	300	1950
	Total:				**8375.025**

Table 2: Comparison of GFRG Wall Panel and Brick Masonry Wall

Sr.No.	Description	GFRG wall	Brick Masonry Wall
1.	Size	1mx1mx0.12m	1mx1mx0.23m
2.	Bricks	-	400kg
3.	Cement	22.76kg	34kg
4.	Sand	28.30kg	172kg
5.	Quarry dust	77.83kg	
6.	Steel	1.232kg	

The above GFRG data has been collected from IIT Madras for per square meter and the cost comparison has done for 100-meter square area.

Table 3: Details of material for 1m3 required in the conventional Method are given as follows

Sr No.	Material	Quantity	Units	Rate (Rs)	Amount (Rs)
1.	**Standard Bricks**				
	Bricks	550	Nos	6	3300
	River sand	0.324	m^3	1700	550.8
	Cement	1.4935	Bags	325	485.3875
	Total				**4336.1875**
2.	**Conventional Slab**				
	Cement	8.24	Bags	325	2678
	Sand	0.4536	M^3	1700	771.12
	Aggregate	0.9072	M^3	1000	907.2
	Steel	84.78	Kg	65	5478.2
	Binding wire	0.785	Kg	60	47.1
	Formwork	6.5	M^2	300	1950
	Total:				**11831.62**

6. RESULT AND DISCUSSION

6.1 RAT TRAP BOND

Rat trap bond is laid in such a way that it creates a cavity in the wall. Fig shows the rat trap bond placed on edge forming the inner and outer face of the wall with cross bricks bridging the two faces. Rat trap bond is considered to be the cost-saving construction it has many advantages than only the cost saving.

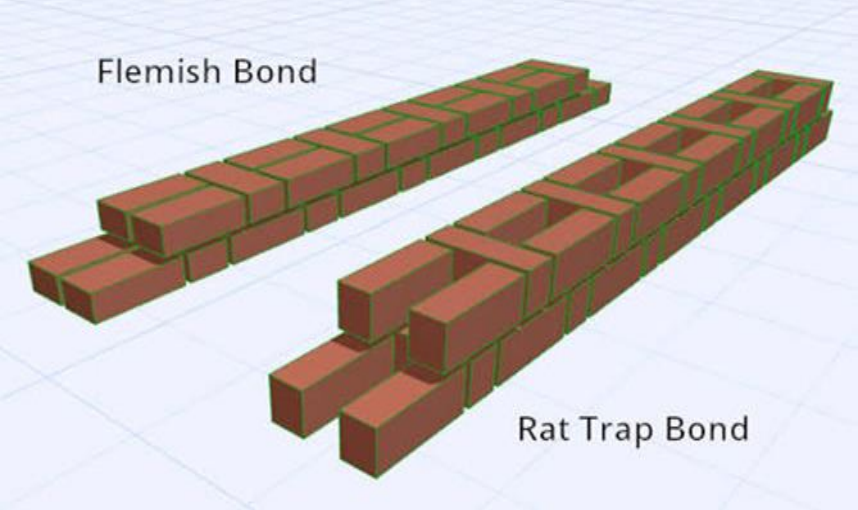

Figure 4. Rat Trap Bond
Source: https://goo.gl/images/9bu1Xi

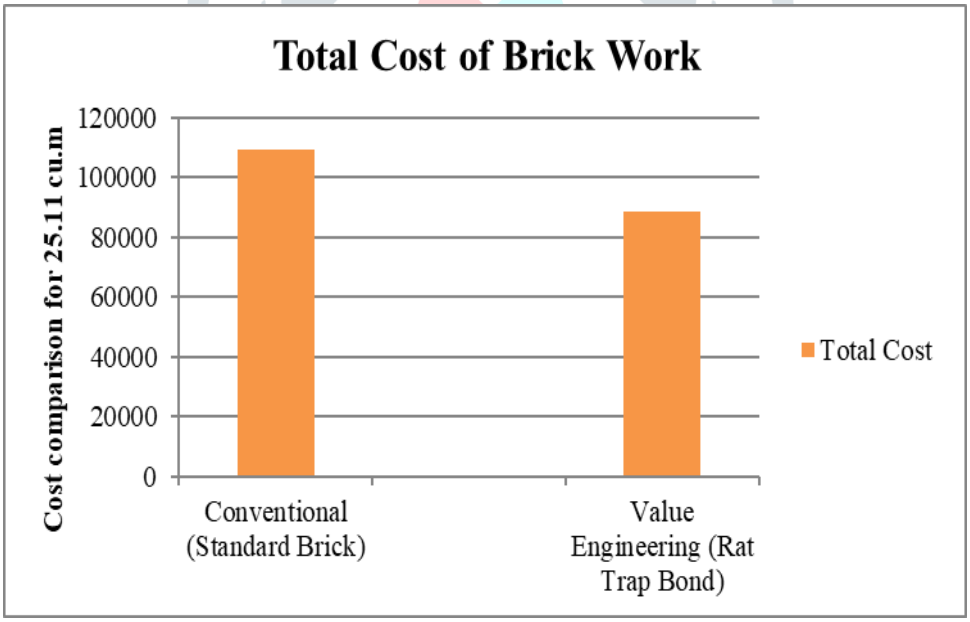

Figure 5. Cost Comparison of Rat Trap Brick Work

Figure 5 shows the cost comparison between the standard brick i.e. conventional method and rat trap bond i.e. value engineering method. The data was collected from the constructed building situated in Mahad, Raigad. This technique was used for 3 storey building and had saved the overall cost up to 20% said by the contractor of the building. In this method, the bricks are laid in a vertical position and formed the cavity which maintains the interiors cooler in summer and warmer in winter. In this report, a future bungalow plan had considered where this technique is going to be applied and the calculation for the same had carried out and concluded that 18.66% cost can be reduced without disturbing the quality and its strength

6.2. ROOFING WITH FILLER SLAB

Filler slabs are one of the cost-effective roofing systems in which filler material is placed to reduce the concrete volume in the tension zone where the concrete is not needed this construction technique reduces the self-weight of the slab hence saving in cost. The figure shows the air gap in between the pots makes it a good heat insulator and the ceiling looks attractive as well.

Figure 6. Roofing with Filler Slab

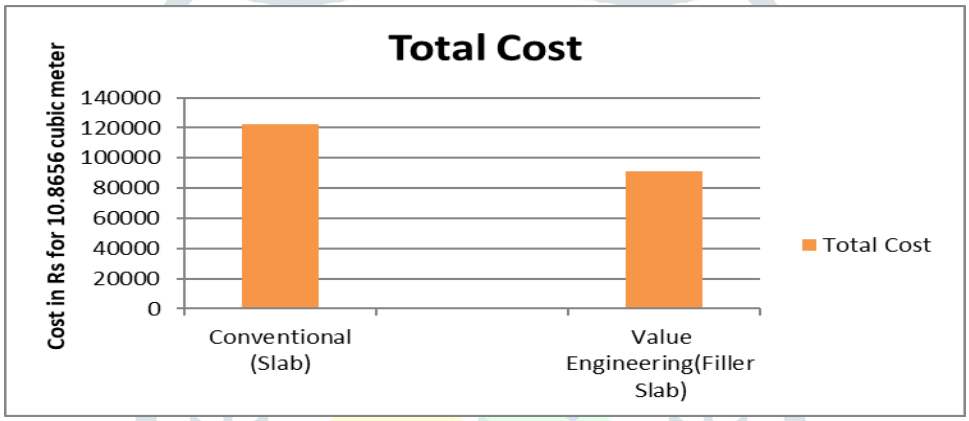

Figure 7. Cost Comparison of Conventional Slab with Roofing with Filler Slab

From the figure, it can be seen that about 25.58% cost can be reduced by adopting this technique. As the self-weight of the structure is reduced by reducing the concrete and steel it reduces the excess cost of the construction. The site is located in Roha, Raigad where this technique was successfully adopted and saved the project cost of about 30%

6.3. GFRG WALL PANEL

GFRG stands for Glass Fiber Reinforced Gypsum wall panels are one of the best alternative structural member used as a precast structure in the construction. Since 1990's this technology was used by the Australian's only as a wall construction and later professors from IIT Madras made research and found out this technology can be used for all the structural members such as wall, floors, and roofs in a building.

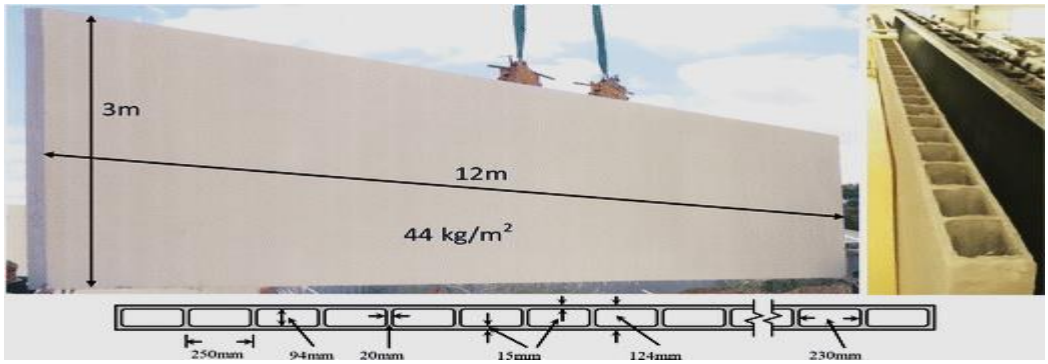

Figure 8. GFRG Wall Panel with its Sizes
Source: https://goo.gl/images/8tdNzB

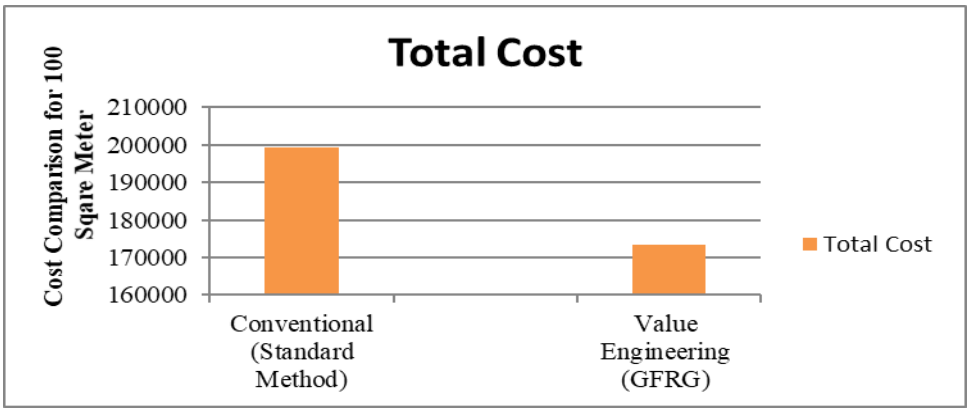

Figure 9. Cost Comparison of GFRG with Standard Brick

From the figure, it is clear that GFRG saves the cost compared to the standard method. GFRG is a new technology that has proved to be the cost saving, time-saving and saving in manpower by IIT Madras. The data was collected from IIT Madras to show the cost comparison and its advantages over the conventional method. The purpose of this parameter is to popularize the technique all over the world and to reduce the problems faced by the construction industry. The result is calculated by considering the labour and plastering charges. GFRG wall panel saves up to 13-14% with considering material and labour. Time comparison had not done in this research the construction with GFRG takes very less time compared to conventional method hence saving additional cost which takes construction project to save cost up to 30% and more.

6.4. PERCENT CALCULATION OF ALTERNATIVE PARAMETERS

From the figure, it is clear that alternative materials can save cost to some extent. If this technique is applied in the construction industry the economy will be achieved at the same time two parameters i.e. Rat Trap Wall and Roofing with Filler Slab technique are used in single construction more economy will be achieved and gives a better appearance to the structure.

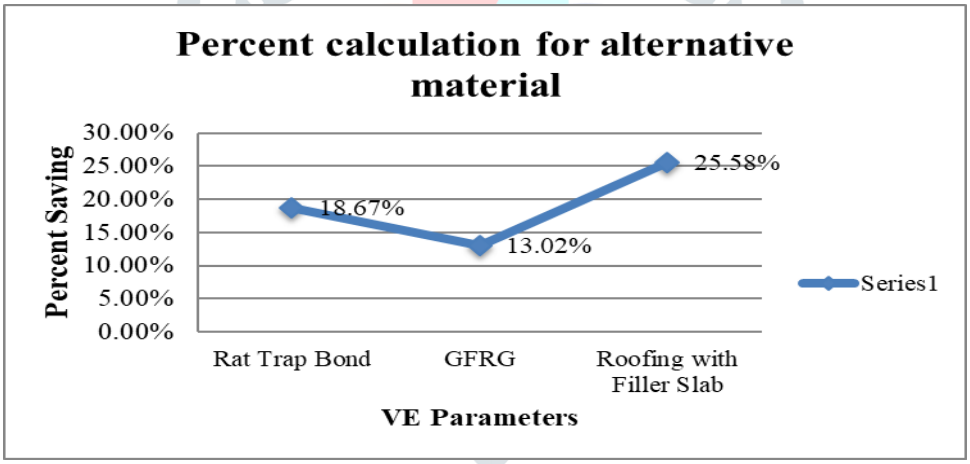

Figure 10. Percent Calculation of Value Engineered Parameters

6. CONCLUSION

In order to minimize the shortage of houses in India, a suitable and alternative technique should be adopted. Instead of constructing low-cost houses with the cheaper quality of material the best alternative technique should be used that eliminates the cost of construction about 20-25%.

Using Rat Trap Bond technique construction cost saves up to 19% without compromising its strength.

Roofing with filler slab is an alternative technology of slab construction in which the concrete volume can be reduced because at the tensile zone concrete is not needed and hence filler material can be used to reduce the wastage of concrete. This technique reduces the cost and self-weight of the structure. About 25.58% cost can be reduced.

Glass Fiber Reinforced Gypsum technique is a green product which is convenient and sustainable. Due to speedy construction, it saves the labour charges. The study shows that it saves the cost of about 13-14% and the technique has many advantages over the conventional method and it may save more cost when the time factor is also considered.

The above research has done for material and concluded that these parameters are relevant and save in cost when compared with the conventional method.

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