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A Cost Effective Assessment of Aganwadi Building through Value Engineering Methodology

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Abstract— Saving money and, at the same time, providing better value is a concept that everyone support. The benefits of spreading our investment rupees, building more for less money, increasing efficiency and cutting down our dependency on energy-intensive building and plant facilities need to be recognized today and pursued in the future.

Government agencies commonly funding the Construction projects that improve our Infrastructure system, Transportation system, Educational system and many other Government buildings which fulfil the basic needs of the society by spending millions of money. So systematic study of this projects are required as it leads to reduction in the overall cost and saving the money of the Government that can be utilized for the betterment of other works in state as well as in the nation. This can be effectively achieved with the use of Value engineering theories and methods in the relevant construction projects. Value engineering is an organized, creative, cost search technique for analyzing the function of a product, service, or system with the purpose of achieving the required functions at the lowest possible overall cost consistent with all the requirements that comprise its value, such as performance, quality, reliability, and appearance.

Keywords- Value Engineering, VE Job Plan, Decision Matrix, Functional Analysis, Cost Effectiveness, Creativity, Quality, Performance

I. INTRODUCTION

In current era, there is a great need for assessment of the existing approaches of construction of Government projects which involves millions of money spent every year. Value Engineering concepts is the best solution, which can provide cost effective solution.

Government agencies commonly funding the Construction projects that improve our Infrastructure system, Transportation system, Educational system and many other Government buildings which fulfil the basic needs of the society by spending millions of money.

So systematic study of this projects are required as it leads to reduction in the overall cost and saving the money of the Government that can be utilized for the betterment of other works in state as well as in the nation. This can be effectively achieved with the use of Value engineering theories and methods in the relevant construction projects.

Hence in this research study, Aganwadi Building" is to be studied systematically in all respect i.e. design, materials used, to improve function served by each that leads to reduction in overall cost and its feasibility study is to be carried out. The cost of each Aganwadi building is 5, 50,000/- Rs. Annual budget of last two financial years for the construction of Aganwadi building is graphically represented in Table -1.

Table – 1 : Year wise Budget

Sr No	Financial Year	Budget (in crore)
1.	2011-2012	100.00
2.	2012-2013	511.91

II. VE Job Plan

1. *INFORMATION PHASE – COST MODEL*

Objective : **To Secure all and Complete Information.**

To gather Facts from the best sources.

To ensure accuracy of Information, Check, Recheck & update all data.

Project: Construction of Aganwadi Building

Table- 2 Information Phase: Cost Model

Sr. No.	Description	Percentage of Total	Cost
1.	Excavation & Filling	1.10	6059.16
2.	P.C.C Work	5.68	31242.33
3.	Brick Work	29.54	162489.83
4.	R.C.C Work	18.14	99768.24
5.	Plaster Work	6.67	36707.44
6.	Flooring Work	8.64	47493.66
7.	Colour Work	1.67	9163.73
8.	China Mosaic Work	6.17	33908.73
9.	Door/Window Work	9.82	54010.8
10.	Plumbing Work	8.79	48351.69
11.	Electrical Work	2.45	13500
12.	Material Testing Work	1.33	7300
	Total	**100.00**	**5,50,000.00**

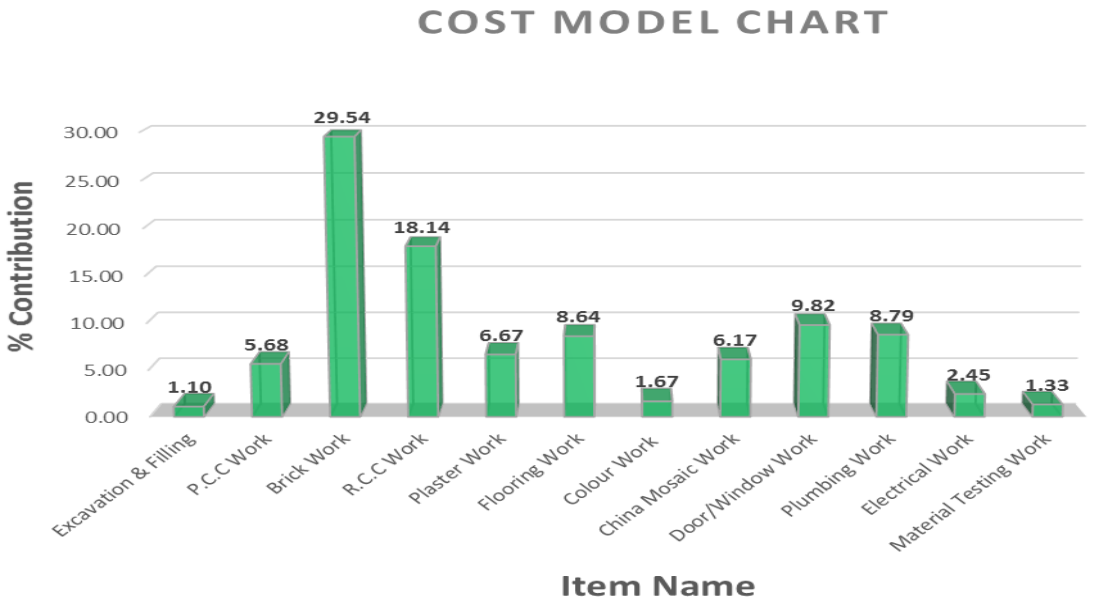


Fig. 1 Item wise Contribution (in %)

2. *FUNCTIONAL ANALYSIS*

Objective : To identify Function(s).

Excavation/Filling	P.C.C Work	Brick Work	R.C.C Work
Rs.6059.16	Rs.31242.33	Rs.162489.83	Rs.99768.24
Prcparc Sitc	Transfer Load	Distributcs Load	Distributcs Load
1.10%	5.68%	29.54%	18.14%

Plastcr Work	Flooring Work	Colour Work	China Mosaic
Rs.36707.44	Rs.47493.66	Rs.9163.73	Rs.33908.73
Smoothens Surface	Facilitates Level Surface	Protccts Surfacc	Rcduccs Hcat Effect
6.67%	8.64%	1.67%	6.17%

Door/Window	Plumbing Work	Electrical Work	Material Testing
Rs.54010.8	Rs.48351.69	Rs.13500.00	Rs.7300.00
Facilitates Ventilation & Barrier to Entry	Convcy Water/Waste Water	Prevent Darkness	Ensures Quality
9.82%	8.79%	2.45%	1.33%

3. CREATIVE PHASE – IDEA LISTING

Objective : To generate alternative method/material for providing the Function and/or item, through creative thinking, brainstorming and even speculation.

Table - 3 Creative Phase – Idea Listing

CREATIVE IDEA	ADVANTAGE	DISADVANTAGE
Brick Work		
1. Frame Structure	More Strength	Costly
2. Using Hollow Concrete Blocks	Relatively Low Cost	Not easily available
3. Using AAC Blocks	Reduce Overall Cost	Not easily available
4. Using Fly ash Bricks	Cheaper	Lack of Awareness
5. Using Dry wall(Non Load baring)	Faster Construction	Automation needed & overall costly
R.C.C Slab		
1. Using Roof Truss	Relatively Low Cost	Low adaptability & Less temperature resistance
2. Using Mix Design Concrete	Lesser Material Used	Resistance at end User
P.C.C Work		
1. Using B.B.C.C Work	Relatively Low Cost	Low strength
Door and Window		
1. Using Wooden Door and Window	Better Appearance	High Cost
2. Using PVC Door	Relatively Low Cost	Resistance at User
3. Using Aluminum Section Window	Better Ventilation & Lighting	Costly
Non Return Metal Wheel Valve		
1. Using Half (Patti) Valve (Brass)	Relatively Low Cost, Easy to use	
Ball Cock Copper Metal		
1. Using PVC Ball Cock	Relatively Low Cost	
Mild Steel Tubes(Pipes)		
1. Using PVC/CPVC Pipes	Easy to use, Relatively Low Cost, No Corrosion	

4. *EVALUATION PHASE*

In Evaluation phase ranking of the ideas are done using decision matrix.

It is done by assigning relative weights to each criterion and then deriving an overall measure of effectiveness.

It can be done using a five point scale and making paired comparison of all ideas. The idea with the final weighted score is selected.

POINT SCALE: Excellent = 5 Very Good = 4 Good = 3 Fair = 2 Poor = 1

Table – 4 Criteria Weightage for Evaluation

Identity	Criteria	Weightage
A	**Availability**	**8**
B	**Initial Cost**	**9**
C	**Maintainability**	**7**
D	**Aesthetic**	**6**
E	**Durability**	**9**
F	**Ease of handling**	**6**
G	**Performance**	**9**

1. BRICK WORK:

Table – 5 Decision Matrix for Brick Work

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Frame Structure	4	3	4	3	4	2	4	189
	32	27	28	18	36	12	36	
Using Fly Ash Bricks	4	5	4	3	4	4	4	**219**
	32	45	28	18	36	24	36	
Using AAC Blocks	2	3	4	3	4	4	4	185
	16	27	28	18	36	24	36	

POINT SCALE: Excellent = 5 Very Good = 4 Good = 3 Fair = 2 Poor = 1

Table - 6 Decision Matrix for Brick Work/Partition Wall

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Using Hollow Concrete blocks	2	4	4	3	4	5	4	**200**
	16	36	28	18	36	30	36	
Using Dry Wall	2	4	3	4	4	3	4	187
	16	36	21	24	36	18	36	

2. DOOR AND WINDOW WORK:

Table - 7 Decision Matrix for Door

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Using Wooden Door	4	2	3	3	4	4	4	185
	32	18	21	18	36	24	36	
Using PVC Door	4	5	5	4	4	4	4	**232**
	32	45	35	24	36	24	36	

3. PLUMBING WORK:

Table - 8 Decision Matrix for Non Return Valve

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Using Metal Wheel Valve	4	3	3	3	4	3	4	188
	32	27	21	18	36	18	36	
Using Brass Half valve	4	5	4	3	4	4	4	**219**

(Patti Valve)	32	45	28	18	36	24	36	

POINT SCALE: Excellent = 5 Very Good = 4 Good = 3 Fair = 2 Poor = 1

Table – 9 Decision Matrix for Ball Cock

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Using Copper Ball Cock	4	3	3	3	4	4	4	194
	32	27	21	18	36	24	36	
Using PVC Ball Cock	4	5	4	4	5	3	4	**228**
	32	45	28	24	45	18	36	

Table – 10 Decision Matrix for Pipes

CRITERIA FOR EVALUTION	Availability	Initial Cost	Maintainability	Aesthetic	Durability	Ease of handling	Performance	TOTAL
FACTOR WEIGHTAGE	A	B	C	D	E	F	G	
	8	9	7	6	9	6	9	
Using Mild Steel Pipes	4	3	3	3	4	4	4	194
	32	27	21	18	36	24	36	
Using CPVC Pipes	4	5	4	4	4	5	4	**231**
	32	45	28	24	36	30	36	

POINT SCALE: Excellent = 5 Very Good = 4 Good = 3 Fair = 2 Poor = 1

5. DEVELOPMENT PHASE – IDEA RANKING

Objective : To Select/Rank the best alternative idea for further development.

Table – 11 Evaluation Phase – Idea Ranking

CREATIVE IDEA	ADVANTAGE	DISADVANTAGE	RANK
Brick Work			
1. Frame Structure	More Strength	Costly	2
2. Using Hollow Concrete Blocks	Relatively Low Cost	Not easily available	4
3. Using AAC Blocks	Reduce Overall Cost	Not easily available	3
4. Using Fly ash Bricks	Relatively Low	Lack of Awareness	1

	Cost		
5. Using Dry wall(Non Load baring)	Faster Construction	Automation needed & overall costly	5
CREATIVE IDEA	**ADVANTAGE**	**DISADVANTAGE**	**RANK**
Door and Window			
1. Using Wooden Door and Window	No Corrosion, Better Appearance	High Cost	2
2. Using PVC Door	Relatively Low Cost	Resistance at User	1
Non Return Metal Wheel Valve			
1. Using Half (Patti) Valve (Brass)	Relatively Low Cost, Easy to use		1
Ball Cock Copper Metal			
1. Using PVC Ball Cock	Relatively Low Cost		1
Mild Steel Tubes(Pipes)			
1. Using PVC/CPVC Pipes	Easy to use, Relatively Low Cost, No Corrosion		1

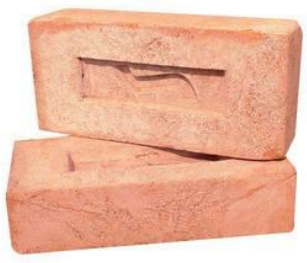
6. DEVELOPMENT PHASE

Objective : **To prepare Value Engineering change proposal.**

To Record the benefits and savings.

Project: Construction of Various Aganwadi Building

Table – 12 Development Phase – Brick Work

Original Concept: Brick work using common burnt clay building brick having crushing strength not less than 35 kg/sq. cm. in foundation and plinth in cement mortar 1:6 (1 Cement : 6 fine sand) (B) Conventional	
Proposed Change: Brick work using common burnt clay building brick having crushing strength not less than 35 kg/sq. cm. in foundation and plinth in cement mortar 1:6 (1 Cement : 6 fine sand) (B) Fly ash brick	
Discussion: Reduction in the material cost of this proposal is a definite advantage.	

Considerable agricultural land will be save. Effective use of thermal industry waste is possible.

Table – 13 Cost Summary– Brick Work

COST SUMMARY	
Original Cost	Rs.162490.00
Proposed Cost	Rs.138700.00
Total Saving	Rs.23790.00

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Table – 14 Development Phase - Door and Window

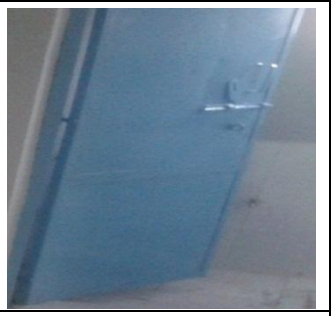
Original Concept: Providing and fixing M.S.Doors and windows using frame of M.S.Angle 40 mm x 40 mm x 6 mm and sheet of 18 - B.S.Gauge including necessary fixtures and fastenings with primer coat of red lead paint and three coats of oil paints etc. Complete.	
Proposed Change: Providing and fixing Doors using PVC Door necessary fixtures and fastenings etc. Complete.	
Discussion: Reduction in the material cost of this proposal is a definite advantage. Effective weight reduction is achieved. Easy in handling and no corrosion problem. No need of colour coating so saving in time.	

Table – 15 Cost Summary- Door and Window

COST SUMMARY	
Original Cost	Rs.7458.00
Proposed Cost	Rs.4560.00
Total Saving	Rs.2898.00

Table – 16 Development Phase -Non-Return Valve

Original Concept: Providing and fixing gun metal check or non-return full way wheel valve.	
Proposed Change: Providing and fixing non-return half valve (Patti Valve) – Brass valve.	
Discussion: Reduction in the cost of this proposal is a definite advantage. No Corrosion problem. Easy in handling.	

Table – 17 Cost Summary- Non-Return Valve

COST SUMMARY	
Original Cost	Rs.910.00
Proposed Cost	Rs.370.00
Total Saving	Rs.540.00

Table – 18 Development Phase - Ball Cock

Original Concept: Providing and fixing ball cock of approved quality as directed. (A) Copper Metal	

Proposed Change: Providing and fixing PVC ball cock of approved quality as directed.	
Discussion: Reduction in the material cost of this proposal is a definite advantage. No Corrosion problem. Lighter in weight.	

Table – 19 Cost Summary - Ball Cock

COST SUMMARY	
Original Cost	Rs.485.00
Proposed Cost	Rs.90.00
Total Saving	Rs.395.00

Table – 20 Development Phase - Pipes

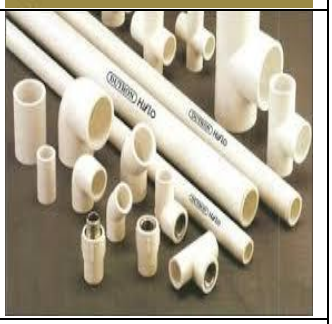
Original Concept: Providing and fixing to wall ceiling and floor galvanized mild steel tubes (Medium grade) of the following nominal bore tube fitting and clamps including making good the wall, ceiling and floor. (A) 15 mm	
Proposed Change: Providing and fixing to wall ceiling and floor CPVC pipes of the following nominal bore tube fitting and clamps including making good the wall, ceiling and floor. (A) 15 mm	
Discussion: Reduction in the material cost of this proposal is a definite advantage. No Corrosion problem and easy in jointing. Lighter in weight.	

Table – 21 Cost Summary – Pipes

COST SUMMARY

Original Cost	Rs.3191.00
Proposed Cost	Rs.1180.00
Total Saving	Rs.2011.00

III COST COMPARISION

Cost Comparison before & after applying VE in Rs.

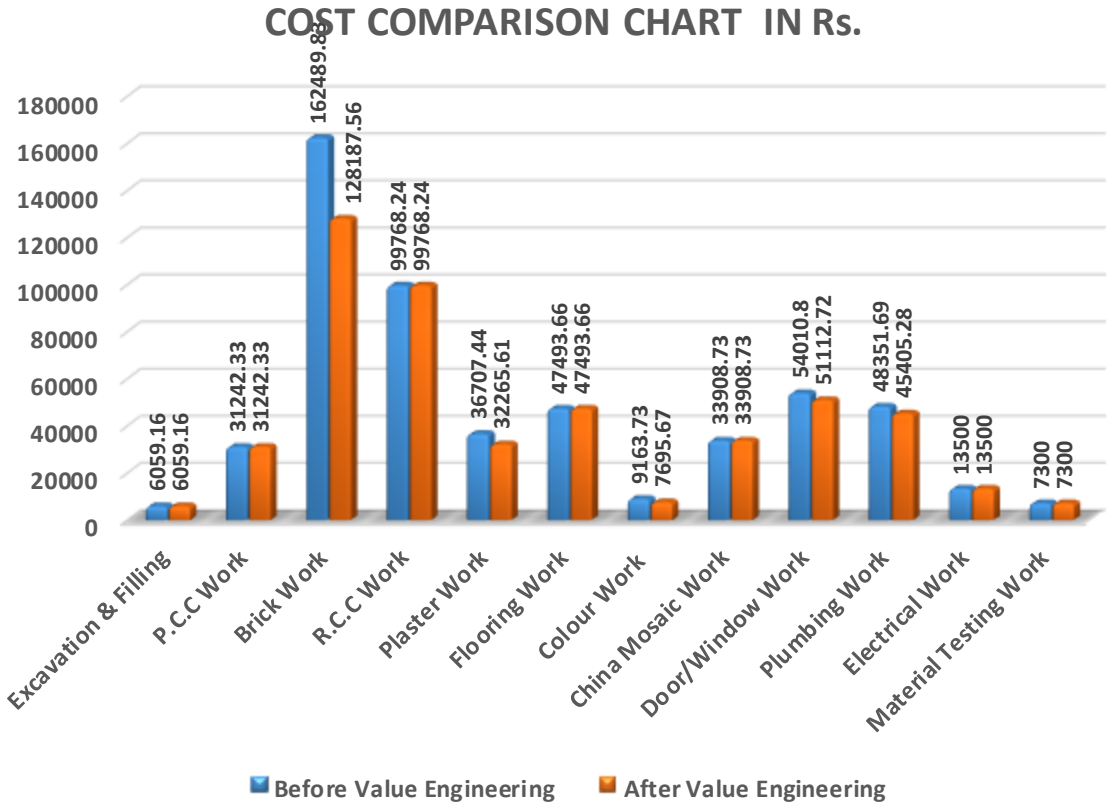


Fig. 2 Cost Comparison before & after applying VE in Rs.

Cost Comparison before & after applying VE in %

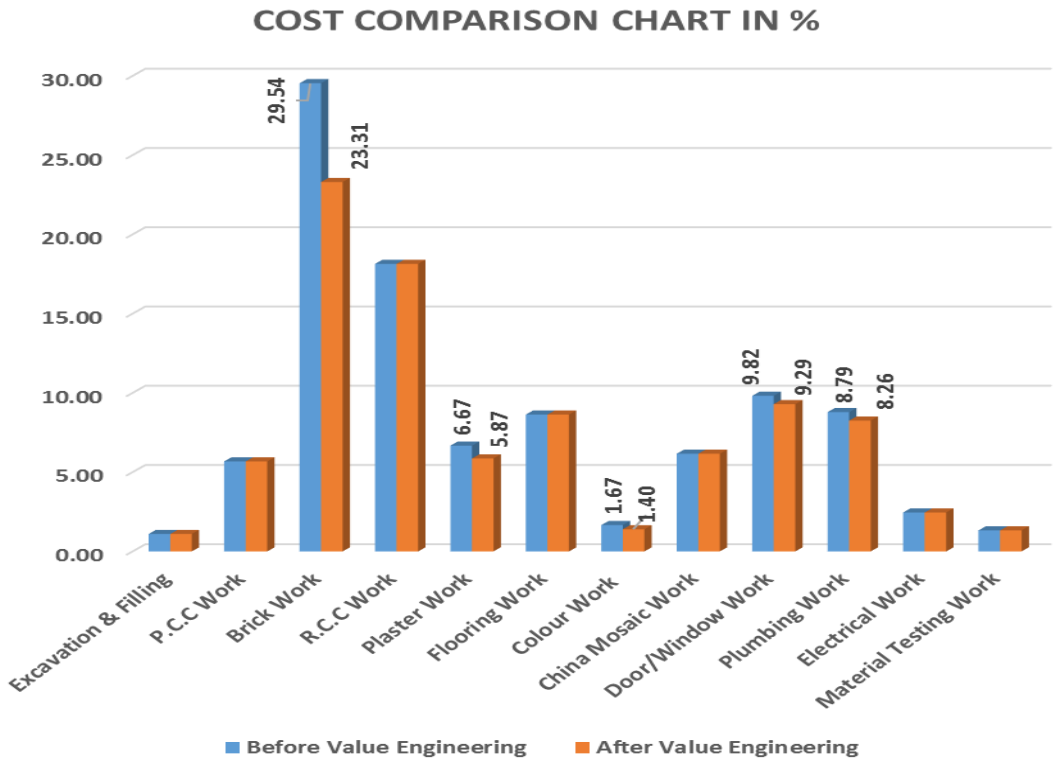


Fig. 3 Cost Comparison before & after applying VE in %

IV CONCLUSIONS

Value Engineering is recognized as an effective way to improve the performance of a project and reduce unnecessary capital and operating costs. It is more effective and influential on the performance, quality, and cost of a project when done relatively early in the project schedule. It encourages creativity in the organization and provide cost effective solution for the project without compromising its quality, cost, performance.

Value Engineering Job Plan and Functional Analysis methods were employed for entire study for effective cost reduction of Aganwadi Building. This study shows how the VE is used for the cost reduction of construction of Aganwadi Building without the change in the product design & its value. An appropriate decision matrix is prepared for choosing the appropriate alternative from the feasible choices available and following conclusions are drawn:

- The total cost of proposed value engineering proposal can be reduced from Rs. 5,50,000/- to Rs. 5,04,000/- Comparing this with existing Aganwadi estimates, we achieved the cost saving of Rs.46000/-, which is about 8 % reduction in overall cost for each Aganwadi unit.
- With the use of value engineering:
  - Effective reduction in use of agriculture land as it suggest to use Fly Ash Bricks instead of clay Bricks.
  - No corrosion problem as CPVC pipes are suggested instead of M.S. Pipes by VE team. Also reduction in weight and easy in handling/jointing is value added advantage of this proposal.

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