

COST ANALYSIS BETWEEN AAC VS. FERROCEMENT VS. RCC WITH MASONRY MADE SINGLE-STORY CONSTRUCTION

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ABSTRACT

The study undertakes a cost comparison between three distinct building methodologies for single-story structures: Autoclaved Aerated Concrete (AAC) with Ferrocement roofing and Reinforced Concrete (RCC) with traditional masonry in a simulated environment. The primary objective of this research is to put emphasis on the cost benefits associated with the utilization of AAC, a technology that the government has been actively promoting as the future of the construction industry and as an eco-friendly alternative for red bricks. Despite the economic advantages and widespread availability of clay bricks, it is necessary to conduct a thorough analysis to determine the economic viability of AAC in comparison. There is a distinct lack of studies that portray the economic competitiveness of AAC blocks in numerical values. There are always claims about such benefits, but usually, they are not backed by studies as many research works find it difficult to manage a complete tab for expenses, especially in the cases dealing with the construction sector of Bangladesh. This study makes a simplified attempt to calculate and put some solid numerical values for such economic benefits for the use of alternate construction materials, as in ferrocement, AAC blocks against fired clay bricks, and aims to provide insight into the financial aspects of three construction methods, thereby contributing to better decision-making in the construction industry's approach to sustainable and cost-effective building solutions.

Keywords: *Cost comparison, Single-story structures, Autoclaved Aerated Concrete (AAC), Ferrocement roofing, Reinforced Concrete (RCC)*

1. INTRODUCTION

Bangladesh is a developing country with a high population density and rapid population growth. As a result, there is a high demand for affordable housing. However, the rise in the cost of materials in recent years makes it difficult for many people to afford to build their own homes. For construction, currently there are different options at hand for prospective any person. The traditional method of construction is done with fired clay bricks, there can be RCC as a frame or roof. Then there are ferrocement panels and AAC blocks, both of which have specific benefits in specific sectors, namely ferrocement being sustainable(Mahyuddin & Byrd, n.d., Chapter 6)(Mohana et al., 2021), pre-castable and have good structural properties(Yardim, 2018). Similarly, AAC block has its own benefits such as, fast construction and cost benefits(Mishra & Aithal, n.d.) and ecofriendly characteristics with reduced emissions(Islam, 2020). No matter all other benefits, though, the cost becomes the main driving factor in choosing the method of construction for a layperson. Thus, in this paper, the Public Works Department of Bangladesh (PWD) rate schedule was taken as a reference to make a cost comparison for all three kinds of construction options and paint a picture of expenses for easy comparison.

Autoclaved aerated concrete (AAC): A lightweight, pre-cast cellular concrete building material. By mixing cement, sand, lime, and water and finally autoclaving it under high pressure it can be produced. The produced material can be moulded as block or any shape needed but currently in Bangladesh only blocks are being produced. AAC can be a good insulator and can be relatively easy to work with, thus making it a better and effective choice for single-story construction(*AAC Blocks | Climate Technology Centre & Network | Mon, 10/08/2018*, n.d.).

Ferrocement: a composite structural material comprising thin sections consisting of cement mortar reinforced by a number of closely spaced layers of steel wire mesh. Ferrocement is light and durable which can help creating thin and light structures. Ferrocement is a type of thin-wall reinforced concrete commonly constructed of hydraulic-cement mortar reinforced with closely spaced layers of continuous and relatively small wire mesh. The mesh may be made of metallic or other suitable materials. Ferrocement has a very high tensile strength-to-weight ratio and superior cracking behaviour in comparison to conventional reinforced concrete. Unlike conventional concrete, ferrocement reinforcement can be assembled into its final desired shape and the mortar can be plastered directly in place without the use of a form.(*Ferrocement Topic*, n.d.).

Reinforced concrete (RCC): Concrete that is reinforced with steel bars. RCC is very strong and durable and is the most popular choice in the field of construction in many countries. It can be expensive depending upon the mix and the type of materials used for the respective environment of the site. Concrete is an age-long material that has been used since ancient times. Though it is a popular construction material it's to increasing carbon footprint (*A Complete Guide To Reinforced Cement Concrete*, n.d.).

Masonry: Construction that uses bricks and stones held together by a cement and sand mixture commonly known as mortar. It is a traditional form of construction and can be time-consuming and expensive but it is mostly used for small structures (House, 2020).

This study can help to identify a cost-effective construction method for single-storied buildings in Bangladesh. Developers and homeowners can benefit from this information to pick an affordable method based on their needs.

This study can also help promote the use of sustainable construction methods in Bangladesh, helping to reduce the negative impact on the environment.

2. METHODOLOGY

The study is primarily a pre-experimental analysis of structural cost. PWD schedule (*PWD SCHEDULE OF RATES 2022 (REVISED) PART A: CIVIL WORKS SIXTEENTH EDITION (REVISED) PUBLIC WORKS DEPARTMENT GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH EFFECTIVE FROM 23 FEBRUARY 2023*, n.d.) was taken as the standard for setting the price. The prices for the AAC panel were calculated by using the AAC block price and adding mesh and rebar

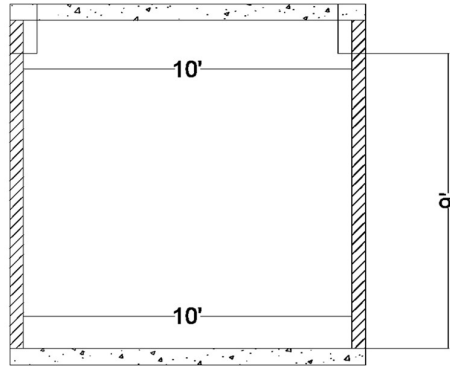


Figure 1: Side Section View of the model

prices to it, as the price for the AAC roof panel is not included in the PWD schedule. **Figure 1** and **Figure 2** illustrate a basic design sample used to calculate the structure. We considered 10' by 10' rooms, a height of 9'. For the simplicity of calculation, the same beams and columns on four sides were considered, and then the frame and foundation were excluded from estimation as, in this case, they are considered to be made of the same materials for all three cases and thus do not influence the cost.

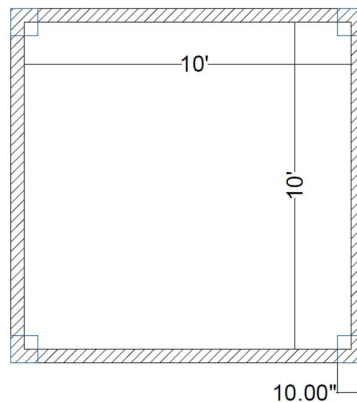


Figure 2: Top View of the model

2.1 Material calculation

Each type of material was individually calculated and then compared.

2.1.1 RCC and masonry structure

Table 1: Total quantity of Material(RCC model)

Item	Quantity
1 st class brick Wall	34.375 cft
RCC works for roof	45 cft
RCC work for floor	45 cft
Rebar	150.1 kg

For RCC-masonry structure, the roof and the floor are made of reinforced concrete while the surrounding four side walls are covered with brick. The cost for RCC, rebar and bricks are calculated according to their consumed quantity.

2.1.2 AAC

Table 2: Total quantity of Material (AAC model)

Item	Quantity
Wall 125mm thick	41.25 cft
AAC work for roof	50 cft
AAC work for floor	50 cft
Rebar	9.38 kg
Wire mesh	100 sft

For AAC structure, the roof, the floor and the walls are made of AAC blocks. The cost for AAC blocks, in between rebar and inner wire mesh are calculated according to their consumed quantity.

2.1.3 Ferrocement

Table 3: Total quantity of Material (Ferrocement model)

Item	Quantity
25 mm thick pre-cast ferrocement wall panel	82.5 sft
Ferrocement corrugated sheet roof	100 sft
Ferro-cement slab	100 sft

For ferrocement, we have both wall panels, roof panels and slabs. We don't need any other rebar. So, we make the calculation by measuring the surface of the respective panel or slab required in their proper place of the façade.

2.2 Estimation

The cost of the structures was calculated using the PWD 2022 revised schedule.

Table 4: Cost of RCC and masonry structure

Item	Unit Price	Sub Total	Total
1 st class brick Wall	258.82	8896.8	
RCC work for roof	417.62	37585.48	
RCC work for floor	417.62	37585.48	102229.10
Rebar	121	18161.35	

Table 5: Cost of AAC and masonry structure

Item	Unit Price	Sub Total	Total
Wall 125mm thick	206.37	8512.89	
AAC work for roof	206.37	20637.30	
AAC work for floor	245.59	24559.18	57344.45
Rebar	121	1135.08	
Wire mesh	25	2500	

Table 6: Cost of Ferrocement structure

Item	Unit Price	Sub Total	Total
25 mm thick pre-cast ferrocement wall panel	177.17	14616.22	
Ferrocement corrugated sheet roof	184.78	18478.43	46537.73
Ferro-cement slab	134.43	13443.08	

3. RESULT AND DISCUSSION

The cost for each model was compared with the conventional RCC model in terms of savings.

Table 7: Savings in using other materials instead of RCC

Item	Saving, %
RCC	-
AAC	43.91
Ferro-cement	54.48

Here, it is seen that the savings for using AAC is 43.91%, and for using Ferrocement, it is 54.48%. The calculated data may vary during implementation as different external factors may affect the expenditure during construction.

4. CONCLUSIONS

This study is an estimation of models to compare the variation in price if other technologies were used besides the conventional method. RCC affects the environment adversely and should be avoided if possible. Thus, if environment-friendly materials like AAC and Ferrocement can be incorporated instead of RCC at a cheaper rate, many developers and owners will find it an acceptable alternative material. The government of Bangladesh has declared that within 2028, the use of Clay bricks will be prohibited as the fertile soil is a limited resource for agricultural needs. Thus, incorporating alternative AAC block and ferrocement technology in construction becomes a very good option to consider. This study can help design further investigations in this area, especially for any further work in real life to compare the costs, this work may present a point of reference.

ACKNOWLEDGEMENTS

We want to thank the Housing and Building Research Institute for providing us with the opportunity to work on the topic and provide us with necessary support in the form of encouragement and other information.

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