

A STUDY OF CONSTRUCTING LOW COST HOUSING BY USING AEROCON BLOCK AND M-SAND

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Abstract - Low cost housing can be achieved by use of effective planning and project management, low cost materials, economical construction technologies and use of alternate construction methods available. The selection of building materials should meet the needs of local circumstances to improve value of life for the most desired ones by building innovative structures or by refining existing structures. Various studies showed that a big variety of wall materials have been used in different building systems with traditional and modern construction methods, but only few of them (extruded clay bricks, hollow concrete blocks) have successfully been implemented in low-cost housing projects. The current era of real estate has ripened and the clay bricks and mortar are replaced with alternative construction materials like aerocon bricks. Innumerable properties in India are constructed with aerocon bricks and the method is rapidly flourishing. Some alternative materials have already been used as a part of natural sand e.g. M-sand, fly-ash, slag limestone and siliceous stone powder are used in concrete mixtures as a partial replacement of natural sand. The main objective of this paper is to give detailed study on low cost building using aerocon block and M-sand.

Keywords – Aerocon block, Alternative material, Construction material, Eco-friendly building material, M-sand

1.INTRODUCTION

Low-cost housing projects are characterized by an increasing demand mainly due to urbanisation. The selection of building materials should meet the needs of confined conditions to improve quality of life for the most needed ones by building new structures or by improving existing structures. Sustainability concerning urban housing intends to expand new approaches to manage human settlements and integrate energy and environmental issues. To attain a sustainable housing project is required a balance of environmental, economical and social issues with technical issues. Results show that up to 60 % of the total cost of a low-income housing project is allocated to engineering design and construction resources [2]. Moreover, walls constitute up to 50% of the total cost of materials and up to 45% of total construction time. Material origin, production techniques and labour necessities all have major impacts on the selection of wall building material. The study of particular local conditions will determine where materials are most suitable for their use. Furthermore, the time when materials and techniques are mostly used will conclude whether they could be classified as traditional or modern [8]. The reliability of use will determine whether materials and methods could be classified as conventional or alternative.

Various studies showed that a big variety of wall materials have been used in different building systems with traditional and modern construction methods, but only few of them (extruded clay bricks, hollow concrete blocks) have successfully been implemented in low-cost housing projects[5-8]. Conventional materials (e.g. cement, steel, concrete) in low-cost houses comprise up to 98% of the materials used. Non-conventional materials (polymers, composites, recycled) have been left aside in spite of better thermal and condensation characteristics for local conditions. The current era of real estate has grown and the clay bricks and mortar are replaced with alternative construction materials like aerocon brick. Numerous properties in India are constructed with aerocon bricks and the method is rapidly booming [15-18].

Today sand is becoming a very inadequate material, in this situation research began for inexpensive and easily available alternative material to natural sand. Some alternative materials have previously been used as a part of natural sand e.g. M-sand, fly-ash, slag limestone and siliceous stone powder are used in concrete mixtures as a partial replacement of natural sand[20]. Now a day's sustainable infrastructural increase demands the alternative material that should satisfy technical requisites of fine aggregate as well as it should be available abundantly. The main objective of this paper is to give detailed study on low cost building using aerocon block and M-sand.

I. SIGNIFICANCE AND SCOPE OF THE WORK

Aerocon block is a new creation building block that helps in creating sustainable buildings and infrastructure. The unique characteristics of these bricks like light-weight, fire resistance, etc., not only grabbed the concentration of construction industry, but also made users more curious about its performance. Though there is publicity in the industry about this new innovation, only few are clear about what exactly Aerocon is all about. So, in a view to help such folks, here is our small effort to put forward all the information related to Aerocon blocks. Aerocon bricks are Autoclaved Aerated concrete (AAC) blocks made with a mixture of cement, fly ash, lime, an aerated agent, and water[17].

2.1 Types of Aerocon bricks:

One remarkable aspect of Aerocon brick is that it lets the user build the walls of with the thickness of his choice. Divergent to the wall made by traditional bricks, walls made with Aerocon bricks are thinner but are still sustainable. However, depending on dissimilar various needs of internal and external walls, Aerocon bricks are existing in different sizes and varied thickness as follows,

- ❖ **Infill blocks:** The size of the Infill Aerocon brick is 600X600 mm and the thickness varies in the ranges of 75,100,125,150,200 mm. The main advantage of Infill blocks is that they can easily replace 60% of the concrete in roof slabs and thus help in saving significant amounts of concrete, steel, labor, water, plaster etc. These blocks are especially suitable for building roofs in large column-free constructions.
- ❖ **Jumbo blocks:** Jumbo blocks are typically in the size of 600X300 mm, and thickness ranges from 75,100,125,150, to 200 mm. The distinctive large size of Jumbo Aerocon bricks results in the usage of much fewer bricks and hence less mortar is required. These bricks are more suitable for non-load bearing walls, multi-stored buildings etc.
- ❖ **Thermal blocks:** These blocks are also known as Aerocool thermal blocks whose size and thickness is 300X200 mm and 50 mm respectively. These blocks are perfect for roofing since they interruption the transmission of heat flow and also help interiors remain warm during winters and cool during summers.

2.1.1 Characteristics of Aerocon blocks:

- ❖ **Light-weight:** The typical aircrete arrangement of Aerocon bricks resulted in light-weight blocks. Their weight is only one third the densities of clay bricks which make them simple to handle on-site. Reduced weight of the brick decreases the dead weight on the structure; hence Aerocon bricks are perfect for low load bearing soil and for seismic zones. Even for building additional floors in an accessible building, Aerocon blocks are ideal choice as their less weight will not affect the strength of the structure. Using Aerocon bricks from the foundation stage of the building helps to save considerable amounts of concrete and steel.
- ❖ **Fire resistance:** Walls build by means of Aerocon bricks, with a minimum thickness of 100mm can resist fire for up to four hours which make them the safe choice in construction. Especially for industries and companies, which are susceptible to fire accidents, these blocks are of much help.
- ❖ **Sound insulation:** One more remarkable characteristic of Aerocon bricks is their sound insulation. A good quality Aerocon brick can reduce the sound transmission up to 42 decibels. Apparent manufactures of Aerocon bricks do have a sound transmission class rating for their blocks, which made them perfect for wall construction in hotels, auditoriums, hospitals, etc., where sound insulation is quite essential.
- ❖ **Thermal insulation:** Due to the closed cell structure of the Aerocon blocks, they afford outstanding thermal insulation. They help interiors to stay cooler during summer and warmer during winter which further aid the user to save electricity bills and thus help in conserving natural resources.
- ❖ **Strength and durability:** Aerocon bricks made with elevated weight ratio help in building stronger and economical structure. As they remain unaltered by the environmental conditions they ensure longer life for the building.
- ❖ **Perfect finish and dimensional stability:** The autoclaving process used in the manufacturing of Aerocon bricks gives ideal dimensions to the blocks along with low tolerances. Dimensionally ideal blocks help in building uniform, thin walls with faultless finish.
- ❖ **Consistent quality control:** As brick producing is in India is an unorganized market, the excellence of regular bricks often vary based on the manufacturer. Hence steady quality control is an issue with traditional bricks which is not an issue with the Aerocon bricks.

2.2 M-Sand

Manufactured sand is a substitute for river sand. Due to fast increasing construction industry, the demand for sand has increased immensely, causing insufficiency of suitable river sand in most part of the world. Due to the reduction of good quality river sand for the use of construction, the utilize of manufactured sand has been increased. Another reason for use of M-Sand is its accessibility and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily existing at the nearby place, reducing the cost of transportation from far-off river sand bed[20].

Thus, the cost of construction can be restricted by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the necessary grading for the given construction.

2.2.1 Advantages of Manufactured Sand (M-Sand) are:

- ❖ It is well graded in the required proportion.
- ❖ It does not have organic and soluble compound that affects the setting time and properties of cement, thus the necessary strength of concrete can be maintained.
- ❖ It does not have the existence of impurities such as clay, dust and silt coatings, increase water condition as in the case of river sand which damage bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- ❖ M-Sand is obtained from exact hard rock (granite) using the state-of-the-art International technology, thus the essential property of sand is obtained.
- ❖ M-Sand is cubical in shape and is manufactured using technology like High Carbon steel hit rock and then rock on rock process which is identical to that of natural process undergoing in river sand information.
- ❖ Modern and imported machines are used to manufacture M-Sand to ensure required grading zone for the sand.

The study on builders provides information to get better upon the marketing strategies, and to conquer the various problem areas identified during the study. In view of this, an experimental investigation was conducted on the alternative constructive materials such as M-sand and Aerocon brick.

II. MATERIALS AND METHODOLOGY OF INVESTIGATION

The major idea of this experimentation is to discover the effect of replacement of natural sand by manufactured sand with 0%, 50% and 100% on hardened properties of cement mortar. The experimental work includes the casting, curing and testing of specimens. Material properties are shown in Table 1. Mortar mix is prepared with proportion of 1:2, 1:3 and 1:6 with water cement ratio of 0.5 and 0.55 respectively. All of the experiments are performed in normal room temperature. The mortar ingredients specifically cement and fine aggregate first mixed in dry state. Manufactured sand is used as a partial alternate to the natural sand then calculated amount of water is added and mix it systematically to get a homogeneous mix. Mortar is poured in the moulds layer by layer and compact thoroughly. Cubes are used for compressive strength test having size 7.06 mm (0.3 in) x 7.06 mm (0.3 in) x 7.06 mm (0.3 in) that are cured in water for 28 days and tested at 28 day's on Universal testing Machine (UTM).

AAC blocks are a relatively new phenomenon in Indian construction industry. Although original AAC blocks plant in India was set up in early 1970s by Siporex at Pune, it is only recently that manufacturing and handling of AAC blocks has reached sizeable number. In spite of radical growth in manufacturing of AAC products, fact is that market share of AAC products is extremely small compared to red clay bricks. There are different reasons for this, but that is a topic for another post. In this work we have provided a comparison between AAC blocks vs clay bricks and we let you be the judge for selecting the best product to suit your needs.

Table : 1.List of AAC blocks manufactures in India

S.No.	Brand Name	Company	Location
1.	Aerocon	Aerocon India	Rajkot
2.	Aerocon	HIL	Golan
3.	Ascolite	Aswani Construcion Pvt Ltd	Surat
4.	BBEL	Avantha	Palwal (NCR)
5.	Xtralite	Ultratech	Hyderabad
6.	Renacon	Renaatus Procon Pvt Ltd	Chennai
7.	Reliconz	Reliconz Brixs Pvt Ltd	Hyderabad
8.	Ecolite	JVS Comastco	Sinnar
9.	JK SMARTBLOX	JK Lakshmi Cement	Jhajjar
10.	Magicrete	Magicrete Building	Surat
11.	PRIME AAC	ECO-CARE Building Products Pvt Ltd	Vijayawada
12.	Siporex	B G Shirke Group	Pune
13.	EFCON	Phenix Procon Pvt. Ltd	Bawla
14.	Ecogreen	Ecogreen PVT Ltd	Gandhinagar
15.	Ecolite	JVS Comastco	Sinnar (Nashik)

IV. RESULT AND DISCUSSION

4.1 Manufactured Sand (M Sand)

Only, sand manufactured by VSI crusher/Rotopactor is cubical and angular in shape. Sand made by other types of machines is flaky, which is troublesome in working. The Jaw crushers, are generally used for crushing stones in to metal/aggregates. Manufactured sand from jaw crusher, cone crusher, roll crusher often contain higher percentage of dust and have flaky particle.

4.1.1 IS Code Provisions

BIS Guidelines IS: 383-1970 for selection and testing of Coarse and Fine aggregates available. Generally, Sand is classified as Zone I, Zone II, Zone III and Zone IV (i.e. Coarser to Finer). There is sieve designation for each zone. Gradation is made in accord with the usage of the sand. There are testing sieves, consists of 4.75mm, 2.36mm, 1.183mm, 600microns, 300 microns, 150 microns and a pan

Table -2-Typical Sieve analysis: Comparison of River & Manufactured Sand

IS Sieve	% of passing(River Sand)	% of passing (Manufactured Sand)	Zone II (As per IS:383)
4.75mm	100	100	90-100
2.36mm	99.7	90.7	75-100
1.18mm	89	66.2	55-90
600micron	60.9	39.8	35-59
300micron	17.7	25.5	8-30
150micron	3.1	9.9	0-20
75micron	Max 3	Max 15	Max 15
	Zone II	Zone II	

Zone II Zone II Note: The gradation of manufactured sand can be controlled at crushing plant

Table - 3-Technical specification - comparison between Manufactured and River sand

SI No	Property	River sand	Manufactured sand	Remarks
1	Shape	Spherical particle	Cubical particle	Good
2	Gradation	Cannot be controlled	Can be controlled	
3	Particle passing 75micron	Presence of silt shall be less than 3%(IS:383-1970)reaffirmed 2007	Presence of dust particle shall be less than 15%	Limit 3% for uncrushed & limit 15% for crushed sand
4	Silt and Organic impurities	Present (Retard the setting & Compressive Strength)	Absent	Limit of 5% for Uncrushed & 2% for Crushed sand
5	Specific gravity	2.3 - 2.7	2.5 - 2.9	May vary
6	Water absorption	1.5 - 3%	2 - 4%	Limit 2%
7	Ability to hold surface moisture	Up-to 7%	Up-to 10%	
8	Grading zone(FM)	Zone II and III FM 2.2 -2.8	Zone II FM 2.6 - 3.0	Recommends Zone II for Mass Concrete
9	Soundness(Sodium sulphate-ss & Magnesium sulphate -ms) (5 cycles)	Relatively less sound (Ex. >5)	Relatively sound (Ex. <5)	Limit 10% ss and 15% ms
10	Alkali Silica Reactivity	0.002 -0.01	0.001- 0.008	Limit 0.1%expansio

Table - 3-Behaviour of Manufactured & River Sand when used in Concrete:

SI No	Property	River sand	Manufactured sand	Remedies
1	Workability & its retention	Good & Good retention	Less & Less retention	Control of fines & apply water absorption correction, use of plasticisers
2	Setting	Normal	Comparatively faster	Apply water absorption correction, use retarders
3	Compressive strength	Normal	Marginally higher	As shown above
4	Permeability	Poor	Very poor	
5	Cracks	Nil	Tend to surface crack	Early curing & protection of fresh concrete

Sl no	Location- Bangalore City	River sand	Artificial sand	Remarks
1	Market rate	Rs 1100 per MT	Rs 600 per MT	50% Cheaper
2	In Concrete - Rs per Cum	Rs 770 - 880	Rs 420 - 480	Saving of Rs 350-400 per cum
3	In Mortar(1:5) for 100kgs	Rs 198	Rs 156	20% less

4.2 Aerocon blocks

Table -5-Comparison of Aerocon blocks with clay bricks.

Serial	Parameter	Aerocon Blocks	Clay Bricks
1	Basic Raw materials	Cement, pfa/sand, gypsum and aluminium as aerated compound	Top soil & Energy
2	Structural saving due to dead weight reduction	55% reduction in weight of walls. Tremendous structural saving for high rise buildings in Earth quake/ Poor soil area	No additional saving
3	Water absorption capacity	Less than 20% by volume	20% by volume
4	Productivity	Output 100% more than brick work	Normal
5	Soil Consumption	Zero soil consumption. Primary raw material for AAC blocks is fly ash. This fly ash is industrial waste generated by coal-based thermal power plants.	One sq ft of carpet area with clay brick walling will consume 25.5 kg of top soil.
6	Fuel Consumption	One sq ft of carpet area with AAC blocks will consume 1 kg of coal.	One sq ft of carpet area with clay bricks will consume 8 kg of coal.
7	CO ₂ Emission	One sq ft of carpet area will emit 2.2 kg of CO ₂ .	One sq ft of carpet area will emit 17.6 kg of CO ₂ .
8	Labour	Organized sector with proper HR practices.	Unorganized sector with rampant use of child labour.
9	Production Facility	State-of-the-art factory facility.	Unhealthy working conditions due to toxic gases.
10	Size	600 / 625 mm x 200 / 240 mm x 100-300 mm	225 mm x 100 mm x 65 mm
11	Variation in Size	1.5 mm (+/-)	5 mm (+/-)
12	Compressive Strength	3-4 N/m ²	2.5-3 N/m ²
13	Dry Density	550-700 kg/m ³	1800 kg/ m ³
14	Fire Resistance (8" wall)	Up to 7 hours.	Around 2 hours
15	Cost Benefit	Reduction in dead weight leading to savings in steel and concrete.	None

V.SUMMARY AND CONCLUSION

5.1 M-Sand Environmental Impact

Owing to digging of the sand from river bed decreases the water head, so fewer percolation of rain water in ground, which result in lesser ground water level. The roots of the tree may not be able to get water. The rainwater flowing in the river contains more impurities. Soil Erosion of nearby land due to surplus sand lifting trouble due to digging for sand & lifting, Destroys the flora & fauna in surrounding areas. The connecting village roads will get badly damaged due to over-loading of trucks, hence, roads become problem to road users and also become accidents prone. Withdrawing of Natural Rivers or river beds will lead to deficiency for future generations.

5.2 Aerocon block.-Ecofriendly

Recently made aerocon blocks are constructive products in the green building revolution. They are autoclaved, aerated, concrete blocks and used for the construction of walls. The resources used in the production of these blocks are certified as green products and they are eco friendly.

There are many problems involved in acquiring sand and bricks, besides the prices of these essential materials hiking up. As the traditional construction materials have a higher price the initiation of aerocon blocks acts as good substitutes with reasonable prices. Owing to these reasons the aerocon blocks are in huge demand. Adding to it is the manufactured sand which also can be acquired without any disturbance. In order to make use of these building materials more resourcefully and make people know its benefits, an organized technique is required to endorse them. It is very significant that people are aware of the benefits of using the substitutes for construction materials.

According to various experts related to the real estate sector, the best eco friendly construction can be acquired through the usage of manufactured sand from stone quarries and brick substitutes. This will also avoid over-exploitation of natural resources like river sand and clay. Aerocon blocks these days are being used in unbelievable projects taken up by business tycoons and real estate builders. It is also essential that the government should start promoting these environment friendly construction substitutes to boost market acceptance.

The government authorities have to put a stop to the mining of sand owing to environmental concerns but the manual operations in the sand mining have increased its prices. The sand prices have enlarged since the last few months and so are the brick prices due to climatic changes. Owing to all these reasons it is better that the usage of the aerocon bricks be adopted.

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