

## **An Investigation of Using Aerocon Block and M-Sand in Constructing Low Cost Housing**

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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*

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### **I. 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 local conditions to improve quality of life for the most needed ones by building new structures and/or by improving existing structures. Sustainability regarding urban housing intends to develop new approaches to manage human settlements and integrate energy and environmental issues. To achieve a sustainable housing project is required a balance of environmental, economical and social issues with technical issues. Findings show that up to 60 % of the total cost of a low-income housing project is allocated to engineering design and construction materials[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 requirements all have major impacts on the selection of wall building material. The analysis of particular local conditions will determine where materials are most suitable for their use. Furthermore, the time when materials and techniques were / are mostly used will determine whether they could be classified as traditional or contemporary[8]. The regularity 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 constitute up to 98% of the materials used. Non-conventional materials (polymers, composites, recycled) have been left aside despite better thermal and condensation characteristics for local conditions. Alternative design including use of non-conventional materials have also been left aside despite reduction of construction time of more than 50%. 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[15-18].

Now a day's sand is becoming a very scarce material, in this situation research began for inexpensive and easily available alternative material to natural sand. 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[20]. However, scarcity in required quality is the major limitation in some of the above materials. Now a day's sustainable infrastructural growth 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.

## **II. Significance And Scope Of The Work**

Aerocon brick/block is a new generation 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 attention of construction industry, but also made users more curious about its performance. Though there is hype 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 interesting aspect of Aerocon brick is that it lets the user build the walls of with the thickness of his choice. Contrary to the wall made by traditional bricks, walls made with Aerocon bricks are thinner but are still sustainable. However, depending on different various needs of internal and external walls, Aerocon bricks are available 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 unique 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-storeid buildings etc.
- ❖ **Thermal blocks:** These blocks are also called as Aerocool thermal blocks whose size and thickness is 300X200 mm and 50 mm respectively. These blocks are ideal for roofing since they delay 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 structure of Aerocon bricks resulted in light-weight blocks. Their weight is only one third the density of clay bricks which makes them easy to handle on-site. Reduced weight of the brick decreases the dead weight on the structure; hence Aerocon bricks are ideal for low load bearing soil and for seismic zones. Even for building additional floors in an existing building, Aerocon blocks are perfect choice as their less weight will not affect the stability of the structure. Using Aerocon bricks from the foundation stage of the building helps to save substantial amounts of concrete and steel.
- ❖ **Fire resistance:** Walls build with 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 vulnerable to fire accidents, these blocks are of much help.
- ❖ **Sound insulation:** One more interesting characteristic of Aerocon bricks is their sound insulation. A good quality Aerocon brick can minimize the sound transmission up to 42 decibels. Reputed manufactures of Aerocon bricks do have a sound transmission class rating for their blocks, which made them ideal 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 provide excellent thermal insulation. They help interiors to remain 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 higher weight ratio help in building stronger and economical structure. As they remain unaffected 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 perfect dimensions to the blocks along with low tolerances. Dimensionally perfect blocks help in building uniform, thin walls with perfect finish.
- ❖ **Consistent quality control:** As brick making in India is an unorganized market, the quality of regular bricks often vary based on the manufacturer. Hence consistent quality control is an issue with traditional bricks which is not an issue with the Aerocon bricks.

### **2.2 M-Sand**

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed[20].

Thus, the cost of construction can be controlled 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 required 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 contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be maintained.
- ❖ It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- ❖ M-Sand is obtained from specific hard rock (granite) using the state-of-the-art International technology, thus the required 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 synonymous to that of natural process undergoing in river sand information.
- ❖ Modern and imported machines are used to produce M-Sand to ensure required grading zone for the sand.

The study on builders“ provides knowledge to improve upon the marketing strategies, and to overcome 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.

## III. Materials And Methodology Of Investigation

The main objective of this experimentation is to find out 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 namely cement and fine aggregate first mixed in dry state. Manufactured sand is used as a partial replacement to the natural sand then calculated amount of water is added and mix it thoroughly 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 first AAC blocks plant in India was set up in early 1970s by Siporex at Pune, it is only recently that manufacturing and usage of AAC blocks has reached sizeable number. In spite of drastic growth in manufacturing of AAC products, fact is that market share of AAC products is very small compared to red clay bricks. There are various 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	Jhajjhar
10.	Magcrete	Magcrete 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

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**

Sl 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

Sl 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	Less than 20% by volume	20% by volume

	capacity		
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 <sub>2</sub> Emission	One sq ft of carpet area will emit 2.2 kg of CO <sub>2</sub> .	One sq ft of carpet area will emit 17.6 kg of CO <sub>2</sub> .
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	Tax Contribution	Contributes to government taxes in form of Central Excise, VAT and Octroi.	Does not contribute to government exchequer.
11	Size	600 / 625 mm x 200 / 240 mm x 100-300 mm	225 mm x 100 mm x 65 mm
12	Variation in Size	1.5 mm (+/-)	5 mm (+/-)
13	Compressive Strength	3-4 N/m <sup>2</sup>	2.5-3 N/m <sup>2</sup>
14	Dry Density	550-700 kg/m <sup>3</sup>	1800 kg/ m <sup>3</sup>
15	Fire Resistance (8" wall)	Up to 7 hours.	Around 2 hours
16	Cost Benefit	Reduction in dead weight leading to savings in steel and concrete.	None
17	Thermal conductivity (W/m.k)	0.132-1.151 for 600kg/m <sup>3</sup>	0.184
18	Energy Saving	Approximately 30% for heating and cooling.	None

## V. Summary And Conclusion

### 5.1 M-Sand Environmental Impact

The River sand lifting from river bed, impact the environment in many ways: Due to digging of the sand from river bed reduces the water head, so less percolation of rain water in ground, which result in lower ground water level. The roots of the tree may not be able to get water. The rainwater flowing in the river contents more impurities. Erosion of nearby land due to excess sand lifting Disturbance 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. Diminishing of Natural Rivers or river beds, not available for future generations

### 5.2 Aerocon block.-Ecofriendly

The newly invented *aerocon blocks are constructive products in the green building revolution*. They are autoclaved, aerated, concrete blocks which are used for the **construction of walls**. The materials used in the production of these blocks are certified as **green products** and are **environment friendly**.

There are a number of problems involved in acquiring sand and bricks, besides the prices of these basic materials hiking up. As the traditional construction materials have a higher price the initiation of aerocon blocks acts as better substitutes with affordable prices. Due to these reasons the aerocon blocks are in great demand. Adding to it is the manufactured sand which also can be acquired without any hassle. In order to make use of these building materials more efficiently and make people aware of its benefits, an organised technique is required to promote them. It is very important 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 environment 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 incredible projects taken up by business tycoons and real estate builders*. It is also necessary 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 due to environmental concerns but the manual operations in the sand mining have increased its prices. The sand prices have increased 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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