

ECO-FRIENDLY INORGANIC BONDED SANDWICH PANELS (AEROCON PANELS): PRODUCTION, PROPERTIES AND APPLICATIONS

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ABSTRACT

This paper reports the production of inorganic bonded sandwich panels (Aerocon Panels) made of two fibre reinforced cement sheets enclosing a light-weight core composed of Portland cement, binders and a mix of siliceous and micaceous material aggregates.

The use of Fly ash and its substitution for timber based products makes the panels Eco-friendly.

Aerocon panels are resistant to water, fire, termites and rodents which makes them withstand adverse weather conditions. Also, they exhibit very good thermal and acoustic insulation properties. Panels are strong, durable, light weight and easily re-locatable.

Design of the product and method of application makes it suitable for seismic and cyclone prone zones. Panels are also suitable for fast track construction by elimination of onsite wet plastering and curing.

The panels have wider applications such as External load bearing walls, Internal partition walls, Flooring and roofing, Fascias, Sun hoods, Infill or veneer walls with steel or concrete structures, Louvers, Shelves, stair treads, Compound walls, Disaster shelters, Fire rated enclosures, Mezzanine floors, Acoustic barriers.

KEYWORDS

Sandwich panels; Eco-friendly panels; Fibre cement sheet; Fast track construction; Building products.

INTRODUCTION

Hyderabad Industries Limited is run by a team of dedicated professionals and has grown from small beginnings to an organisation occupying an eminent position in the industrial scene of India.

The Company has the backing of the vast experience and expertise, both organizational and technical, of one of the largest business houses in India, the Birla's. Hyderabad Industries limited has already built a formidable reputation for it self as the largest manufacturer of fibre cement roofing sheets of brand name 'CHARMINAR' and flat sheets 'Flex-O-Board'. As part of company's product diversification, innovative building materials such as AEROCON Sandwich panels and AEROCON Autoclaved Aerated Concrete (AAC) blocks are also manufactured by this company.

The Company also specializes in the development and supply of turnkey plants and machinery for the production of various building products such as fibre cement corrugated and flat sheets, Autoclaved Aerated Concrete (AAC) blocks and Sandwich panels.

The masonry brick wall is heavy and its construction is time consuming. Other products like plywood, Gypsum Board, Cement bonded particle board, Resin bonded particle Boards etc., have one or more deficiencies such as not being resistant to water, fire, or termites, or being non-load bearing etc. An initiative was taken by the company to develop a product called Aerocon sandwich panels. These panels were developed using a unique process called 'Aeration' which avoids these deficiencies and allows their use in structural applications.

The Aerocon panels are Eco-friendly owing to the following reasons:

- **Environmental friendly**
Utilization of fly ash (waste generated from thermal power plants) and may be substituted for wood and metal
- **Protection of precious fertile lands**
Utilization of fly ash in the product avoids the dumping of fly ash on fertile agricultural lands. Substitution of conventional clay bricks with panels avoids the use of clay from fertile land and soil for making clay bricks.
- **Conservation of forests**
Since the product can replace plywood and Cement bonded particle boards etc., in which wood is used, deforestation can be avoided.
- **Pollution free process (Zero waste disposal)**
The process utilized for making panels does not generate any by-product and the waste material generated is reused thus preventing the pollution of environment.

THE PRODUCT

Aerocon panel is an interlocking Sandwich panel with tongue and groove jointing system as shown in figure 1. It is made up of two fibre reinforced cement sheets on either side of light weight concrete core composed of Portland cement, binders, fibres, fly ash and light weight mineral aggregate.

AEROCON PANEL

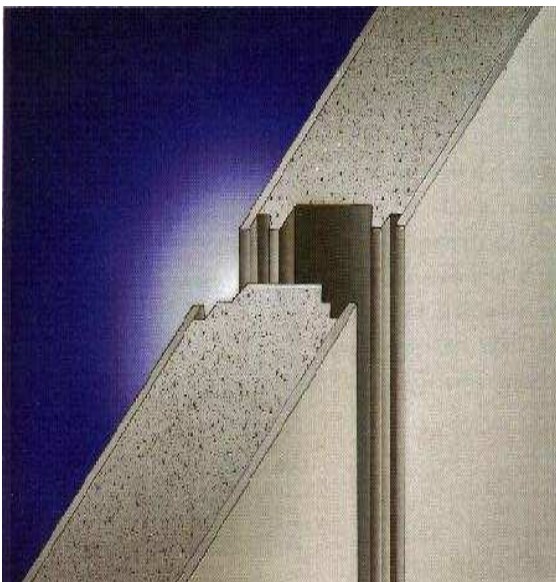


Figure 1

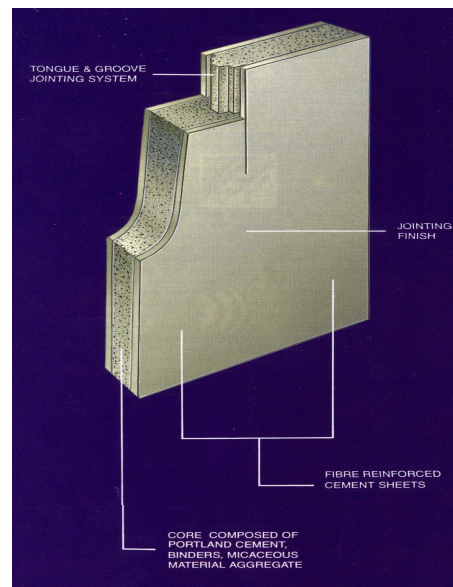


Figure 2

PRODUCTION OF ECO-FRIENDLY INORGANIC BONDED SANDWICH PANELS (AEROCON)

The core of the panel is prepared using binders like ordinary Portland cement and reinforcing fibres such as cellulose and synthetic fibres, pulverised fly ash, light weight aggregates as fillers and foaming agents. These

materials are mixed thoroughly with water in conventional manner and introduced in between a pair of fibre cement facing sheets which are separated and supported by using conventional jigs and fixtures. The adhesion between the core material and fibre cement sheets is achieved due to inorganic bonding while manufacturing the panel in-situ. The panels so prepared should be allowed to harden for a predetermined period and thereafter jigs/fixtures are separated. These panels can be cured either by high pressure steam curing or conventional humid/water curing.

AEROCON PANELS PROCESS FLOWCHART

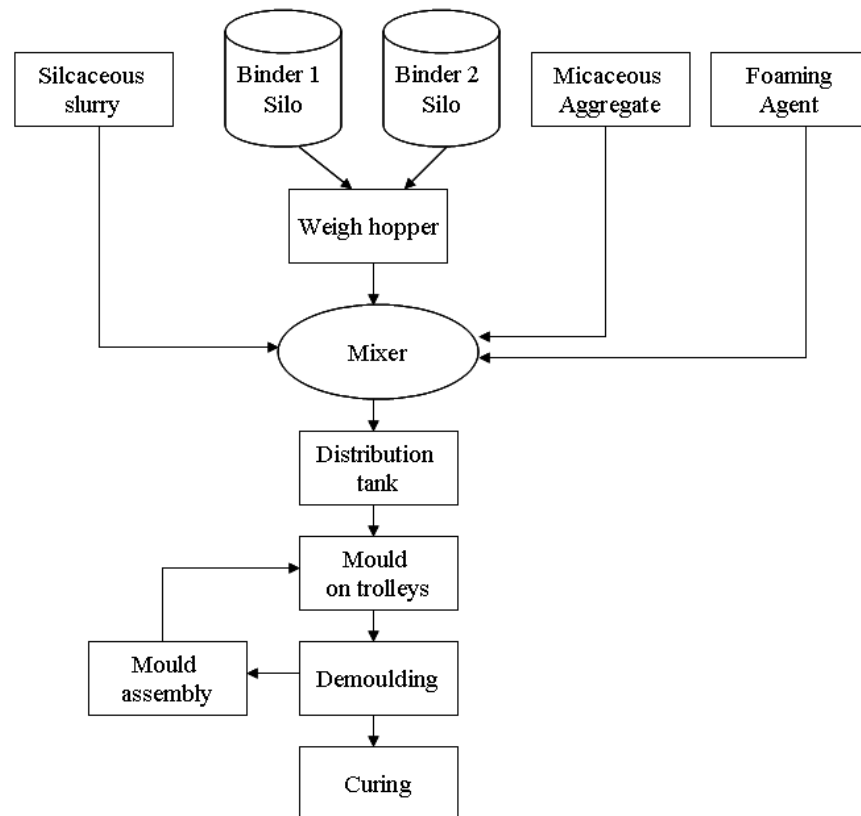


Figure 3

TECHNICAL SPECIFICATION AND PROPERTIES OF AEROCON PANELS

Technical specifications of the panels are given in table 1 and their characteristics in table 2

PHYSICAL DIMENSIONS

Thickness (mm)	Weight (Kg/m ²)	Width (mm)	Length (mm)	Tolerance (mm) (T, W & L)
50	39	600	2400, 2700, 3000	+/- 1
75	54	600	2400, 2700, 3000	+/- 1

Table 1

CHARACTERISTICS

Properties	Units	Thickness		Remarks
		50 mm	75 mm	
Axial Load	KN/m	53	83	Factor of safety – 2.5
Bending strength 2.9 M Span (U.D.L) (Safe design load) 1.5 M Span	Kg/m	81	109	Factor of safety – 2.5
Flexural Strength	Kg/cm ²	67	58	Typical Test results
Compressive Strength	Kg/cm ²	50	70	Typical Test results
Thermal Conductivity	W/m deg. K	0.22	0.21	As per BS 4370-Part 2
Sound Transmission Coefficient	db	33	36	IS: 9901 (Part III) – 1981 IS: 11050 (Part I) – 1981
Fire rating	minutes	120	120	BS 476 Part 20 – 22
Surface spread of flame	Class	I	I	BS 476 Part 7 – 1971
Fire Propagation Index	Class	I	I	BS 476 Part 6 – 1981
Ignitability	Class	P	P	BS 476 Part 5 – 1968

Table 2

Comparative Features of the Technology Innovation of Aerocon Panels vis-a-vis its competitive products

SL. NO.	FEATURE	AEROCON WALL PANEL	PLY WOOD BOARDS	CEMENT BONDED PARTICLE BOARDS	RESIN BONDED PARTICLE BOARDS	GYPSUM PLASTER BOARDS	CLAY BRICK WALL
1	Environment Friendly	<input type="checkbox"/>	x	x	x	x	x
2	Conservation of forests	<input type="checkbox"/>	x	x	x	x	<input type="checkbox"/>
3	Conservation of precious fertile lands	<input type="checkbox"/>	x	x	x	<input type="checkbox"/>	x
4	Water resistance	<input type="checkbox"/>	x	x	x	x	<input type="checkbox"/>
5	Fire resistance	<input type="checkbox"/>	x	<input type="checkbox"/>	x	<input type="checkbox"/>	<input type="checkbox"/>
6	Termite resistance	<input type="checkbox"/>	x	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Suitability for Seismic and cyclone prone zones	<input type="checkbox"/>	x	x	x	x	x
8	Relocatable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	x	x
9	Load bearing Structural applications	<input type="checkbox"/>	x	x	x	x	<input type="checkbox"/>
10	Density	Less than 1	<1	>1	>1	>1	More than 1
11	Thermal Insulation	Better	Poor	Poor	Poor	Poor	Poor
12	Sound reduction	<input type="checkbox"/>	x	x	x	<input type="checkbox"/>	<input type="checkbox"/>

SL. NO.	FEATURE	AEROCON WALL PANEL	PLY WOOD BOARDS	CEMENT BONDED PARTICLE BOARDS	RESIN BONDED PARTICLE BOARDS	GYPSUM PLASTER BOARDS	CLAY BRICK WALL
13	Curing	No on-site curing	x	x	x	x	On-site curing
14	Decorative Finish						
	a) Painting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	b) Wall paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	c) Cladding of Granite, Marble Ceramic tiles etc.	<input type="checkbox"/>	x	x	x	x	<input type="checkbox"/>

Table 3

SIGNIFICANT PRODUCT ATTRIBUTES

- 1) Eco-friendly
- 2) Faster construction, No wet plastering and on - site curing
- 3) Light weight
- 4) High thermal insulation
- 5) Fire resistant
- 6) Excellent sound reduction properties
- 7) Water, termite and weather resistant
- 8) Suitable for Seismic and Cyclone prone zones
- 9) Relocatable
- 10) Thin walls (space saving)
- 11) Smooth finish
- 12) Construction of houses/shelter is possible where sand, water and cement are not available like high mountain regions
- 13) Minimum foundation or ground preparation required
- 14) Easy workability

INTELLECTUAL PROPERTY RIGHTS

Invention related to method of manufacturing of "Light weight prefabricated constructional element" (Aerocon Panels) is patented in India, United Kingdom, Australia, Indonesia, Malaysia, Sri Lanka and Pakistan. Details of Intellectual Property Rights are given in Table 4

S.No	Country	Patent Number
1	INDIA	182,033
2	INDIA	182,034
3	INDIA	187,766
4	INDIA	188,942
5	INDONESIA	P-962178
6	MALAYSIA	PI-9603809
7	SRI LANKA	11,050
8	AUSTRALIA	752,467
9	PAKISTAN	135,907
10	UK	GB 2324105

Table 4

AWARDS

- 1) Department of Science and Industrial Research National award for In house R&D efforts in industry in the area of new materials given by the Govt. of India in the year 2000.
- 2) Department of Science and Industrial Research International award for fly ash utilization in Aerocon panels given by the Govt. of India at the International Congress for fly ash utilization in the year 2005

APPLICATIONS OF ECO-FRIENDLY INORGANIC BONDED SANDWICH PANELS (AEROCON)

Product is being successfully used since 10 years in various building applications in India, Australia, Indonesia and Middle East. Some of the product applications are given below:

- Large size prefabricated elements for permanent or temporary disaster shelters (see Figure 2)
- Mezzanine floors, Cavity flooring
- Building walls and roof (see Figure 3)
- The production of complete prefabricated houses (see Figure 4)
- External load bearing walls (see Figure 5)
- Internal partitions (see Figure 6 & 7) and Compound walls
- Infill or veneer walls with steel or concrete structures
- Fascias, Sun hoods, Louvers, Shelves,
- Stair treads, Fire rated enclosures, Acoustic barriers

**DISASTER SHELTERS - Figure 2****WALLS & ROOF - Figure 3****PREFABRICATED HOUSES - Figure 4****EXTERNAL WALL - Figure 5****INTERNAL FULL PARTITION - Figure 6****HALF PARTITION - Figure 7**

Some of the Interesting projects where Aerocon panels were extensively used

- 1) In the event of natural calamities like cyclone, earth quakes etc., shelters can be constructed quickly by transporting the Aerocon panels.
- 2) Numbers of rehabilitation works were carried after the earth quake in Gujarat like Red-cross society Houses, Telephone Exchanges, Schools, Railway Stations etc., the basic needs in event of Environmental calamities.
- 3) A project called 'Mass Housing' under "VALMIKI" scheme sponsored by Govt. of India for improving the living conditions of slum dwellers in Mumbai was completed in a very short span of time
- 4) In the difficult terrains like Leh in Himalayan regions of Northern India, construction of Army shelters with load bearing walls becomes easy with our product. In such regions, construction of walls using cement is difficult as it does not harden at sub zero temperatures.
- 5) Rural telephone exchanges and school buildings are constructed with Aerocon wall panels in a week's time enabling the public to utilize the services in a short time.

A Real strength of the Product demonstrated by withstanding the Environmental disasters

In a classic case of passing the test by fire and brimstone, Aerocon prefab structures built for Reliance Petroleum in Jamnagar, Gujarat withstood the fury of the massive cyclone with wind speeds of 200km/hr that hit Kandla port in 1998. Again when Gujarat was affected by a severe earthquake of 6.9 magnitude on Richter scale in January 2001, the Reliance Petroleum structures along with the Gujarat Customs cabin in Bhauch, Kutch district built with Aerocon panels remained unscathed (see Figure 8), amid the rubble and ruins of buildings that collapsed all around.



Figure 8

CONCLUSION

The use of fly ash in Aerocon panels and substituting them for wood and metal makes them an eco-friendly product. The panels have high thermal and acoustic insulation properties and are resistant to fire, water and termites. They have wide applications in construction of Pre-Fab houses, high rise buildings, shelters etc... Compared to conventional building products, they take much less construction time, they are reusable and can be easily relocated. In difficult terrains where other materials are not suitable this product becomes the favoured option for construction. The design of the product makes it suitable for application in seismic and cyclone prone zones.