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## NATURAL FIBRES-REINFORCED IN FALSE CEILING

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**Abstract:** *Buildings are large consumers of energy in most of the countries such as Saudi Arabia, Oman, Syria, Egypt etc. In regions with harsh climatic conditions, a substantial share of energy goes to heat and cool buildings. Thus heating and air-conditioning load can be reduced through many means of insulation. The proper use of thermal insulation in buildings does not only contribute in reducing the required air-conditioning system size but also in reducing the annual energy cost. In recent years natural fibres have been the important part of research community as the world is threatened by the synthetic fibres and its harmfulness as being non-degradable in nature. Gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) as matrix and natural fibres (jute, banana, coir, wool, cotton etc.) as reinforcement will not only be used as thermal insulator but also as light-weight material for wall partitioning. The composites should possess the properties such as lower thermal conductivity, low density, ease of workability and good flexural strength. The natural fibre gypsum composites should possess the basic requirement of being an insulator for buildings. These composites can be used as false ceiling and wall partitioning.*

**Keywords:** *False ceiling, Gypsum, Natural fibres, Reinforcement, Thermal insulation.*

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## **INTRODUCTION**

In the past few decades gypsum has been used as a finishing material for walls and ceilings. Due to its excellent performance, attractive appearance and its healthful contribution to living conditions have made gypsum a most popular finishing material for those applications. In addition, the availability in subsoil, relative low cost, easy handling and mechanical characteristics suitable for different applications, makes the gypsum a widely used construction material. However, gypsum has some undesirable characteristics, such as heaviness, brittleness; impeding exterior application. Heaviness and brittleness may be appreciably reduced by combining gypsum with mineral particles or natural fibers. Buildings consume energy at day and propels out in night, which affect the utility cost of the building as the load of air-conditioning (electricity). Now-a-days, research for new materials is very intense. The competition in the industry, seeking materials that meet both socioeconomic expectations and environment preservation drives towards the use of vegetable fibers. The agricultural industrial residues are generated in a great amount and the proposal of their use. Gypsum based composites have more and more extensive application in the development of new-type wall body materials. A lot of companies in Australia, United States of America, Japan etc, have put out new-type building materials that compound gypsum with wood shaving, and have successfully developed several kinds of production equipment. This kind of composite shows merits like: low density, good properties of insulating against heat and sound and high rate of strength/density, makes it suitable to be used as raw material of light partitioning wall. Thus, investigations of several types of fibers have been aimed to improve the mechanical properties of gypsum.

## **GYPSUM**

Gypsum is a very soft sulfate mineral composed of calcium sulfate bi-hydrate, with the chemical formula  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . It can be used as fertilizer. It is the main constituent in many forms of plaster and is widely mined. As a mineral, it is alabaster, which has been used for sculpture by many cultures including Ancient Egypt, Mesopotamia and the Nottingham alabasters of medieval England. It forms as an evaporate mineral and as a hydration product of anhydrite.



Fig 1. Gypsum powder and gypsum boards.

## FALSE CEILING

False ceiling is the secondary ceiling hung below the main ceiling by aluminum/metal casing and wires. Thus forming a number of channels, a structure is formed; the empty channels will be filled by false ceiling grid or tile. Composite is a combination of two dissimilar materials to perform a function which neither of them can perform individually. False ceiling grid or tile is product of combination of two dissimilar materials formed by matrix as anhydrate/bi-hydrate gypsum and reinforced material. The natural fibre false ceiling grid or tile can be made by short fibre reinforcement or continuous fibre reinforcement.

## TYPES OF FIBRE REINFORCED COMPOSITES

Reinforcement is the enhancement of strength of the material by means of physical or chemical involvement of fibres/particles. The fibre type used depends upon the composite being intended to use. Fiber-reinforced composite materials can be divided into two main categories.

### 1. Short fiber-reinforced composites

Short fibres are used as random and aligned way, as composite being anisotropic component, strength varies with direction of the force applied. The fibres are being chopped to required length and used as reinforcement. The fibres properties are to be analyzed before intended to use in composites, as reinforcement alters all the properties of composites. Particles of minerals or stones are also used as reinforcement. The adhesion/compatibility between matrix and reinforcement will play an important role in determining performance of the composite.

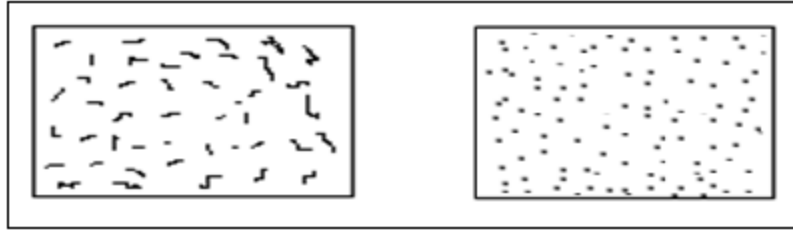


Fig 2. Short fibres reinforced composites.

## 2. Continuous fiber-reinforced composites

Continuous reinforced materials will often constitute a layered or laminated structure. The drawback with the following technique is difficulty in workability, as fibres being continuous it renders the application of gypsum and fibres slurry in molding process. The structure forms a layer or laminate structure which have tendency to detach from the mother composite when an impact force is applied, application of continuous fibres is therefore limited to certain products.

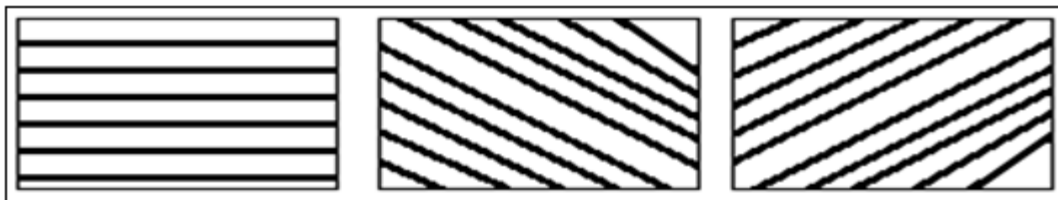


Fig 3. Continuous fibres reinforced composites.

## PROPERTIES OF NATURAL FIBRES

Natural fibres are produced by plants, animals, and geological process. These fibres can be classified according to their origin, namely vegetable fibres, wood fibres, animal fibres and mineral fibres. Natural fibres occur in huge quantity in nature, which have properties which can be used in many applications. Some of the fibres and their properties are mentioned below.

### Coir fibre

Coir is a natural fibre extracted from the husk of coconut and used in products such as floor mats, doormats, brushes, mattresses, etc. Technically, coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton, so are stronger but less flexible. Coir fibres have higher strength and resistance



towards saltwater makes it a better substitute for synthetic fibres; when the coir composites are used in construction industry.

### **Jute fibre**

Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. Jute is one of the most affordable natural fibres and is second only to cotton in amount produced and variety of uses of vegetable fibres. Jute fibres are composed primarily of the plant materials cellulose and lignin. It is thus a ligno-cellulosic fibre that is partially a textile fibre and partially wood. It falls into the bast fibre category along with kenaf, industrial hemp, flax (linen), ramie, etc. The industrial term for jute fibre is raw jute. The fibres are off-white to brown and 1–4 meters long. It has high tensile strength, low extensibility, and ensures better breathability of fabrics. Therefore, jute is very suitable in agricultural commodity bulk packaging. Advantages of jute include good insulating and antistatic properties, as well as having low thermal conductivity and moderate moisture regain. Other advantages of jute include acoustic insulating properties and manufacture with no skin irritations; these properties are useful in making composites.

### **Wool fibre**

Wool is the textile fiber obtained from sheep and certain other animals; including cashmere from goats, mohair from goats, camel from animals in the camel family and angora from rabbits. Wool has several qualities that distinguish it from hair or fur: it is crimped, it is elastic and it grows in staples (clusters). Wool fabrics have a greater bulk than other textiles, and retain air, which causes the product to retain heat. Insulation also works both ways. Because of the crimp, wool fabrics have a greater bulk than other textiles, and retain air, which causes the product to retain heat. Wool fibers are hydrophilic, they readily absorb moisture, but are not hollow. Wool can absorb moisture almost one-third of its own weight. Wool based Composites can enhance both thermal and acoustical insulation.

### **Banana fibre**

Banana fiber is a kind of new-type natural fiber. Banana fiber is extracted from bark of banana tree, it belongs to bast fiber. The appearance of banana fiber is similar with natural original bamboo fiber and ramie fiber, but fineness and spinnability of banana fiber is better than natural original bamboo fiber and ramie fiber. The chemical composition of banana fiber is mainly cellulose, hemicelluloses, and lignin. There are characteristics with high



strength, small elongation, good luster, light weight, fast moisture absorption and release, easy degradation as well as environmentally friendly etc. It has its own physical and chemical characteristics and many other properties that make it a fine quality fiber. The qualities such as strong, low elongation, lightweight, biodegradable etc. makes it suitable for composite application.

## **ADVANTAGES OF NATURAL FIBRES AS REINFORCED MATERIAL IN FALSE CEILING**

The gypsum composites should possess following properties, to be used as false ceiling and wall partitioning. To assist in balancing ecological cycle composite should be biodegradable and should exhibit less energy consumption during manufacture and during degradation.

### **Lower thermal conductivity**

Thermal conductivity plays an important role in determining thermal insulation value. It is the ability of the material to transfer heat from one part to another. Natural fibers gypsum composites should give good thermal insulation value or lower thermal conductivity, as it will be a key aspect of false ceiling grid or tile. Natural fiber gypsum composite will degrade after use; as being a mineral it is ecologically good product to use.

### **High flexural strength**

The flexural strength determines the bending limit of the component as it is being subjected between two assigned points. The composite should have good flexural strength as to avoid accidents, caused due to breakdown of the ceiling panel or high air pressure from the inside or outside. Use of natural fibres, adds flexural strength to composites.

### **Resistant to moisture change**

The change in atmospheric moisture is a natural process; the composites should be sustainable towards any change in moisture. Moisture as vapor acts the same as any other gas. It mixes with other gases in the air, and yet maintains its own identity and characteristics. It is the raw material in condensation. It stores immense quantities of energy gained in evaporation; this energy is later released in condensation. The moisture in the air have tendency to react with natural fiber gypsum composite and swell the surface molecules of composite, as natural fibres have affinity to retain moisture, even though they are covered with gypsum molecules, they try to regain moisture from surrounding. Natural fibre gypsum composite thus sustains moisture variation in atmosphere.



### **Low density**

Density determines the weight of the composite. Higher the density higher the weight and vice-a-versa. Its performance depends upon strength to weight ratio. The composite should possess lower density with higher strength. Natural fibres have density in the range of 1.4 to 1.6.

### **Ease of workability**

Ease of work is by which a material can be cut, shaped, or smoothed by hand or machines. Better the workability quicker the work done. Viscosity of the mixture prepared for manufacturing of the natural fibre gypsum composite is of great importance. The composite should be easily workable. Workability is decided by properties of fibres like length, aspect ratio, proportion of fibres etc.

### **Good aesthetic and pleasant finish**

The composite should possess good aesthetic and pleasant finish, aesthetic properties play an important role in ergonomics. This can be considered as challenge while designing the natural fibre gypsum composites.

### **Applications of natural fibers reinforced false ceiling composites**

The natural fibers gypsum composites are the important insulating materials in buildings. As the climatic conditions are extreme in some countries, these composites can be used as wall partitioning, in fast track houses and as secondary roof. The main applications are listed below.

#### **False ceiling panels or tiles**

False ceiling panels or tiles can be made by many different materials; most preferred material is anhydrate gypsum due to good insulation properties of heat and sound. Worldwide commercial buildings utilizes huge amount of electrical energy to keep working atmosphere comfortable and pleasant, this electrical energy is lost due to heat dissipation through walls and ceilings, hence load on air-conditioning will increase. Good insulators can reduce heat loss by saving valuable energy and cost.



Fig 4. False ceiling with light and air vents.

### Wall partitioning

The walls between two chambers or rooms are usually built with cement products, since heat and noise transfers easily through it. The natural fibers gypsum composites can reduce heat loss from one place to another.



Fig 5. Light weight gypsum panels.

### CONCLUSION

Global warming has forced researchers to enhance the quality products for energy saving. Hence researchers are on the edge to tackle the problem associated with the climate change, maintaining temperature inside the commercial buildings as well as houses, where noise and heat reduction are important aspects. Natural fiber gypsum composites are expected to reduce noise and heat.





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