

Gypsum – A building block for Green homes

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The economic growth of any country is closely linked to the advancement of the industrial sector. A paradox to the above is that in spite of technological changes that have taken place, industrial growth still poses environmental problems, in terms of air, water pollution and land degradation. It has been widely accepted by the scientific community that the uncontrolled emission of greenhouse gases has been largely responsible for the widespread climatic changes. Recognising that, climate change is becoming the defining issue of our era, UNEP is asking countries and communities to focus on reducing greenhouse gas emissions. The World Environment Day slogan for 2008 is “CO₂ **Kick the Habit ! Towards a Low Carbon Economy**”.

In line with the UNEP– Theme of the year, this paper focuses on the utilization of an industrial Solid waste –Phosphogypsum from fertilizer industry, with a new concept of Green Construction. The threat of global warming necessitates serious exploration of energy efficient building materials, as a good share of CO₂ emission is caused by building industry. There is a huge growing requirement of building materials in countries like India to address the existing housing shortage, mainly for the poor and low income groups in urban India.



A recent study on the declining agricultural land in Kerala has revealed that in the last 50 years, Kerala's agricultural paddy field has reduced by about 35 to 40%. The findings of the study is that paddy fields are eroded mainly due to the urbanization and use of paddy fields for brick manufacturing and quarrying of sand to meet the ever growing needs of the building industry.

Building construction causes Green House Gas (CO₂) emission by way of embodied energy consumed in the production of energy intensive building materials and the recurring energy consumption during normal use of the house (cooling and heating of indoor environment)

The basic raw material "Gypsum" generally occurs in two forms: as natural gypsum from mineral deposits and as a by-product of phosphoric acid manufacture, known popularly as Phosphogypsum. For every ton of phosphoric acid made, from the reaction of phosphate rock with sulphuric acid, about 4.5 to 5 tons of Phosphogypsum are generated. The amount of phosphogypsum being generated each year is directly proportional to the industrial production of P₂O₅.

The main raw material Gypsum is present as hydrated form of CaSO₄, usually dihydrate CaSO₄.2H₂O. It is the mineral calcium sulfate with two water molecules attached. By weight it is 79% calcium sulfate and 21% water. Gypsum has 23% calcium and 18% sulfur. This Dihydrate form consists of relatively soft, principally silt-size (<0.075mm) aggregates of crystals, the morphology of which depends on the source of the phosphate rock and the reactor conditions.

While traditionally gypsum has been utilized over the ages as a filler in the cement manufacture and as a soil conditioner, utilizing the secondary nutrients like calcium and sulfur to the soil, its foray into new fields as landfill covers and as a building block for low cost construction in housing, has been relatively a recent development.

What Makes a Construction Green ?

A Green building, is a structure designed, built, renovated, operated, or used in an ecological and resource-efficient manner, using energy, water, and other resources efficiently, minimising the overall impact to the environment.

Glass Fiber reinforced, load bearing Gypsum panel is an energy efficient green building material with modular cavities suitable for both external and internal walls. It can also be used as floor slab/ roof slab in combination with RCC as a composite material. This technology, developed in 1990 in Australia, has been widely used for buildings in Australia, China and Malaysia. It has very high compressive strength, shearing strength, flexural strength and ductility, very high level of fire resistance, thermal resistance, water resistance, earth quake resistance and is also free from corrosion. The dimensions of a standard panel is 12 M long and 3 M high with 120 MM thickness. Instead of brick by brick construction, Gypsum Panels enable wall by wall construction, leading to considerable savings in terms of Bricks, Steel, Cement, river sand and Construction time.



One such wall panel can replace one lorry load of conventional bricks. No plastering of the wall is required. The smooth and superior finish is ready for a primer coat and painting. Glass Fiber Reinforced Gypsum (GFRG) wall panel is an energy efficient green building material with huge potential for use as load bearing and non load bearing wall panels. GFRG panel like Rapidwall is a large load bearing panel with modular cavities suitable for both external and internal walls. It can also be used floor slab/roof slab in combination with RCC as a composite material. Modular hollow cavities make the product light weight as well as thermally efficient, making it ideal for tropical climates.

Numerous buildings including large multistoried apartments with more than 3000 units and buildings up to 17 storeys have been built in Australia using this material. The technology has been given to Malaysia and China since 1999. In China multistoried buildings up to 7 storeys have been built using the materials as load bearing wall. In China internal walls of 62 storeys have been built using the Rapidwall panels.

Buildings designed and built with the panels can resist natural disasters like earth quakes, cyclones etc. It is resistant to fire, water, corrosion and free from rot and termite. The product has high compressive strength, tensile strength, flexural strength and ductility. One of the greatest advantage is the modular cavities of the large panel which enables to use it in combination with concrete and RCC. It forms composite material by which the strength of the material can be increased many folds. By filling the cavities of the roofing panel with RCC tying down to the foundation through the wall panel, the structure can resist cyclones and disasters. It is most ideal for coastal regions as the panel can resist corrosion.

The weight of one 12 mtrs. X 3 mtrs. panel is only 1.5 tons. Compared to this an equivalent 23 cm. Thick brick wall weight is about 19 tons. The light weighted material with high compressive, tensile, flexural strength and high ductility helps to withstand earth quakes. It is most ideal for tropical climate like India as it has high thermal insulation and making interiors cooler during summer and warmer during winter

Gypsum is calcined in a fluidized bed calciner. Additives like water resistant emulsions, setting acid etc. are mixed with calcined gypsum to produce slurry of required viscosity. By mixing water and micro-strand glass rovings into the calcinated gypsum it re-converts and forms a slurry of efficient building material. The slurry is poured into casting tables and dried to produce wall panels .

This material is cost effective and provides fast track method of construction which can save more than 50% time. It saves about 25% cost of construction compared to conventional building construction.

FACT and RCF (Rashtriya Chemicals and Fertilizers Ltd) have formed a Joint Venture - FRBL, "FACT-RCF Building products limited" company for the manufacture of load bearing building panels using Phospho gypsum. The phospho-gypsum from RCF and FACT were extensively tested in Australia and suitability of the same for these end-products has been established. A demonstration building was constructed at Udyogamandal, in a record time of 22 days, using imported panels, aimed at promoting public opinion in favour of the new material / technology. The project is expected to be commissioned by September 2009.



This project when implemented will also help to save agricultural land of Kerala as it will provide a cost effective alternative for construction using country bricks and river sand. This will also serve the national objective of protection of agricultural land from further degradation which is very vital for maintaining food production to feed the growing population.

Conclusion

Traditionally Gypsum has been utilized over the ages as a filler in the cement manufacture and as a soil conditioner . The use of Gypsum as a building block for Green Homes is a relatively a recent development by which, the total impact to the environment during construction activities is minimised. During this construction technique using Load bearing Gypsum Panels, the use of scarce natural resources like river sand, water and agricultural land is significantly reduced. This technique minimizes the embodied energy for the house construction activity and also reduces the energy requirement for thermo-regulation of interiors during normal use, .bringing down the overall impact to the environment supporting the fight against Global warming.

