Choosing 'green' raw materials for building materials manufacturing

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THE NORTH AMERICAN BUILDING CONSTRUCTION MARKET IS VERY COMPETITIVE. IN TODAY'S BUSINESS ENVIRONMENT, MATERIALS MANUFACTURERS MUST PROVIDE QUALITY, LOW COST PRODUCTS TO EARN THEIR MARKET SHARE. BUT FORCES AT WORK IN THE MARKET-PLACE HAVE ALSO CHALLENGED THESE SUPPLIERS TO USE RECYCLED, RENEWABLE, AND NON-DEPLETABLE RAW MATERIALS IN PRODUCT FORMULATION AND DEVELOPMENT.

USG Corporation (USG), a leading supplier of building materials to North American construction markets, has a long history of manufacturing with low environmental impact materials that pre-dates the "green" movement. USG has expended major efforts in the use of these materials, and promoted "green" building issues before it was fashionable.

With moderate effort, all manufacturers of building products can operate profitably in competitive markets and still be environmentally responsible. Often, green materials are economically preferable to virgin raw materials in production formulation and manufacture. Compared to the processing of raw materials, the use of green materials frequently conserves manufacturing energy and reduces manufacturing costs, thus improving a company's competitiveness. The changing market has provided strong incentives for manufacturers to provide products that reduce environmental impact.

USG Corporation (parent company to United States Gypsum, USG Interiors, CGC Inc., and Yeso Panamericano) is a Fortune 500 company with global operations. The company was founded in 1901 as a gypsum plaster manufacturer. In 1917, SHEETROCK brand Gypsum Panels were introduced. But plaster remained the primary source of revenue until after World War II. The housing boom that followed the war, coupled with a shortage of plaster mechanics, accelerated the use and further development of the dry gypsum panel as known today. U. S. Gypsum is currently the leading global producer of gypsum panels. Further, the use of cement-based panels has proliferated, primarily due to the efforts of U.S. Gypsum in the development and marketing of cement board technology. Another line of business important to USG is acoustical tile and panels. USG Interiors, Inc., has produced acoustical ceiling products since 1929, and has become a major force in the global distribution of these products and their ancillary metal suspension systems.

USG operates seventy-eight plants, mines, and quarries worldwide. Over the years USG has developed and still operates under a self-determined set of environmental guidelines and an environmental stewardship policy. These guidelines cover not only the products that are sent to market, but also the way in which they are manufactured. Where no government regulation exists, the company has established its own standards. With respect to regulations, USG tries to follow both the letter and the spirit of the law.

Building materials development

Historically, building materials were common in the natural world. Trees were cut and formed into structural elements, while mud mixed with straw and baked became bricks. These are examples of primitive building design. Even gypsum plaster technology can be traced back to the time of the Egyptians.

Although modern materials no longer come from mud or can be picked up from the ground, raw materials for building can be obtained from several green sources. The manufacture of gypsum panels is an excellent example, because it uses four alternative resources.

Waste Streams—By-products of other manufacturing processes such as synthetic gypsum, fly ash, and slag.

Post Consumer Waste—Material discarded by consumers. Newspapers and magazines can be turned into the face paper of gypsum panels; a car can become steel studs.

Renewable Agricultural Sources—Crops that become raw materials for manufacturing processes. They are renewable because crops can be harvested and replanted in a continuous cycle, usually annually. Corn and wheat starches used in gypsum are examples. Wood framing is sometimes considered as another.

Construction Waste—Construction projects create waste. Discarded scraps of building materials can be recycled into new

products. This method of recycling is still in its infancy.

Currently, USG's largest product line is gypsum panels. The panels are composed of a gypsum core covered on two sides with a multi-ply paper. Variations are produced by altering the gypsum core matrix or paper type to suit a specific application. The most basic form is the 1/2 inch thick panel used in almost all types of residential construction.

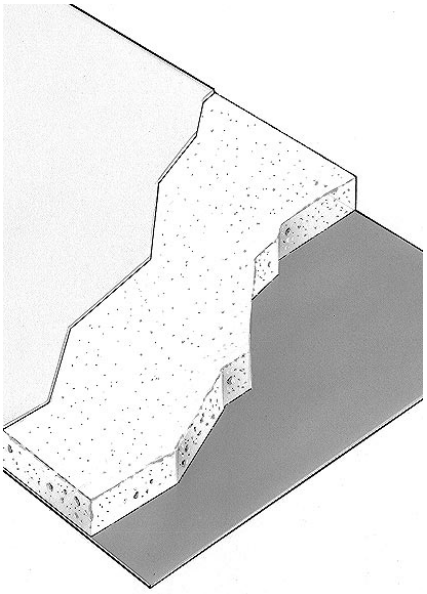

Fig. 1. Primary components of gypsum panels are a gypsum core and face paper. Special ingredients give performance features to core and/or paper.

Natural gypsum, or calcium sulfate dihydrate, is one of the most abundant minerals found on our planet. The mineral is extracted through either surface or deep mining operations. Current U.S. consumption of natural gypsum is 25 million short tons per year, with three quarters going toward the manufacture of gypsum panel products. The mineral is also used for soil stabilization, as a binder in medicines, as a filler in some foods, and in various industrial processes.

One type of gypsum is formed as a by-product of operations in some power plants. The coal burned in many of these facilities produces undesirable pollutants, including sulfur dioxide. Wet-lime-limestone scrubbers are often used to prevent this pollution from entering the atmosphere. As the exhaust smoke from the power plant rises through the scrubber, its pollutants are chemically removed. The calcium and water in the wet limestone combine with the sulfur dioxide in the exhaust to create calcium sulfate (gypsum) and water. This material is called "synthetic," "chemical," or FGS (Flue Gas Desulfurization) gypsum, and can readily be used to manufacture gypsum products.

Gypsum manufacturers are increasingly using this material as a substitute for mined gypsum. The U. S. Bureau of Mines estimates that roughly 20 million tons of synthetic gypsum were generated in 1993 by electric utilities equipped with wet lime-limestone scrubbers. U.S. Gypsum and other gypsum manufacturers have worked with the utilities on sourcing synthetic gypsum for wallboard production.

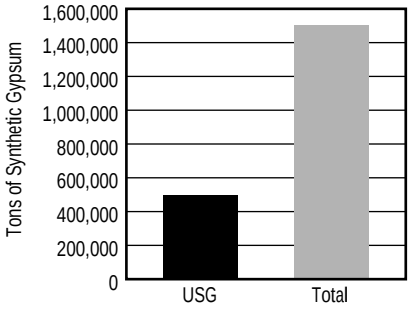

Fig. 2. Use of synthetic gypsum in the U. S. in 1993.

U.S. Gypsum has pioneered the use of synthetic gypsum in wallboard production since the mid-1970's. Presently, U.S. Gypsum uses over 500,000 tons annually; this represents 5% of its total gypsum requirements. Several plants have totally converted from natural to synthetic gypsum. U.S. Gypsum has millions of tons under contract, and will continue substitution as economies permit. Additionally, research is focusing on developing other uses for this increasingly abundant material. Potential uses include construction and industrial plasters, fillers, and agricultural applications. Industry utilization of this by-product has several environmental benefits, particularly curtailment of mineral extraction and reduction of landfill needs by power plants.

Another example of waste stream reutilization is the gypsum industry's use of recycled paper. For over three decades, gypsum panel paper facings have been made from recycled paper. Sources of this material include newspaper, phone books, old corrugated cartons, and kraft cuttings from cardboard manufacturing. U.S. Gypsum has made its own drywall paper with 100% recycled paper since the mid-1960's. U.S. Gypsum consumes over 500,000 tons of recycled paper annually at its seven paper plants. Meanwhile, industry consumption is 1,500,000 tons per year. All the paper that U.S. Gypsum uses in gypsum panel production is unbleached.

Waste newspaper is also used as a low cost fiber in the manufacture of acoustical tile. USG Interiors operates three ceiling tile plants that consume 27,000 tons annually. Total tile industry use is 60,000 tons per year.

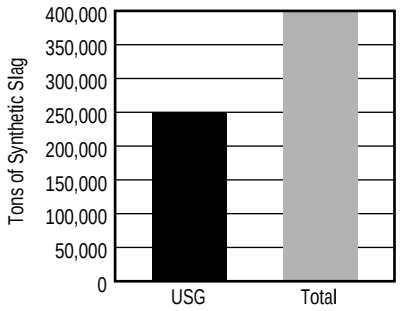

Fig. 3. Use of slag by acoustical ceiling and insulation companies in the U. S.

A good example of adaptive re-use of a material is slag, a by-product of steel manufacure that consists of calcium silicate and other impurities. This material has found reuse as a principle component in the manufacture of water-felted acoustical ceiling products and high-melt-point insulation used in life-safety fire-containment applications. The slag is melted in coke-fired cupolas or electric melters and spun into fibers for use in acoustical or thermal insulation

products. USG Interiors' slag-based products are marketed under the trade names of AURATONE, ACOUSTONE, MILLENNIA, ELCIPSE, and ORION Acoustical Panels and Tile, and THERMAFIBER Mineral Fiber Insulation. By using slag, USG Interiors reduces the volume of landfill material in the U.S. by over 250,000 tons annually, and reduces the need to mine naturally occurring materials such as basalt rock. The acoustical tile and insulation industries convert over 400,000 tons of slag annually.

Fly ash, a waste stream material from power plant emission control processes, is a pozzolanic material with cement-like properties. It is produced by electric power companies in the combustion of coal and other solid fuels. U.S. Gypsum purchases fly ash from local utilities for three regional plants that produce fiber-reinforced cement panels for use in the construction industry. These products are marketed as DUROCK Cement Board in the U.S. and DURACRETE in Canada. Currently, U.S. Gypsum buys over 25,000 tons of fly ash per year.

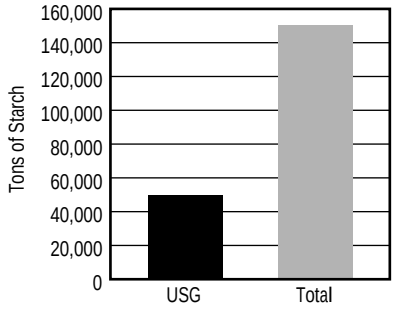

Fig. 3. Use of starch in building materials manufacture in the U. S.

Agricultural corn and wheat starches are renewable materials used in the manufacture of both drywall and ceiling products. These starches function as binders, and are preferred over petroleum-derived polymers. U.S. Gypsum and USG Interiors use nearly 50,000 of the 150,000 tons of starch consumed annually by the industry.

In an effort to stimulate the use of recycled materials, many states (primarily California, Oregon, and Wisconsin) have adopted regulations that require that certain products must contain a minimum amount of recycled materials. U.S. Gypsum requires its suppliers of plastic joint compound buckets to comply with these requirements. Also, U.S. Gypsum is currently looking at using printed plastic sleeves instead of printing labels directly on buckets in order to make buckets more easily recyclable. Joint compound is also offered in alternative poly-lined corrugated cartons that are made from 20-30% recycled paper. The paper in these cartons is fully recyclable.

Typically, acoustical ceilings are suspended on a metal support grillage system. With metal fabrication plants strategically located around the world, USG Interiors is a prime supplier in the global market. Light-gauge carbon steel is roll-formed into acoustical grid components. These grid products can be 100% recycled by re-melting and salvaging the metal. Steel for studs is considered a "green" material, because it can be reused more easily than wood. Currently, 25% of the material used in USG Interiors' steel fabrication plants comes from recycled steel.

U.S. Gypsum maintains several gypsum drywall manufacturing plants that exclusively use synthetic gypsum and recycled paper. At those locations, the products shipped are made of 100% post-industrial and post-consumer waste. Additionally, USG Interiors markets acoustical ceiling tile and life-safety insulation products that contain over 90% post-industrial waste materials. In total, USG recycles over 1,500,000 tons of industrial and consumer waste annually.

Construction waste recycling

There are two primary types of waste generated by the construction industry: construction waste and demolition waste. Construction waste is generated while a building or structure is under construction. Typically, contractors will estimate into their work a 5-10% surplus of construction materials to cover construction contingencies. This includes pieces of scrap gypsum panels that are either damaged or too small to re-use.

Remodeling results in demolition waste. This includes pieces of gypsum panels covered with some type of finishing material, such as paint or vinyl wallcovering.

Construction and demolition (C&D) waste is estimated to be 40 million tons a year. Diminishing capacity, rising tipping fees (cost of leaving refuse at a landfill site), and problems in locating new landfills have encouraged reductions in waste generation and alternative new uses for waste. For new residential construction, gypsum drywall accounts for 10-15% of the on-site waste.

The problem of what to do with the waste affects both manufacturers and their customers. Not only are landfills filling up at an alarming rate; what can be dumped in a landfill is closely regulated as well. Many materials that once could be dumped at landfills are no longer accepted because of their bulk or because of inherent problems with certain materials. For instance, in some areas, gypsum panels are not allowed at landfill sites.

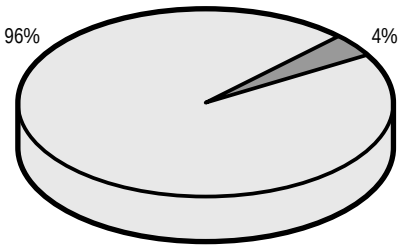

Fig. 4. USG's recovery of waste materials at manufacturing plants.

Gypsum manufacturers are developing methods to recycle their customers' waste. Typically, up to 15% of recycled construction waste can be incorporated into the wallboard manufacturing process. This is possible with a moderate investment in capital equipment. A majority of gypsum plants are capable of recycling plant-produced

gypsum waste back into the manufacturing process. U.S. Gypsum has a 96.2% recovery rate (see Fig. 4), and part of the remaining 3.8% is recycled into small strips to support stacks of gypsum panels.

Nearly a dozen gypsum plants in the U.S. have active customer recycling efforts. U.S. Gypsum recycles customer waste at several plants. One plant recycles over 500 tons a month from a single customer. Further, U.S. Gypsum is involved in construction recycling demonstration projects with the National Association of Homebuilders (NAHB). There are presently no good estimates of the total volume of construction waste coming back to the manufacturers.

The Gypsum Association, an industry trade group, has contracted with the USDA to investigate the feasibility of using scrap gypsum drywall as a site soil additive. A form of gypsum is already sold in agricultural markets as a soil conditioner. Onsite reduction and spreading of waste wallboard as a soil additive would eliminate landfilling and the energy required to transport the waste back to drywall plants or landfills.

Recycling of drywall waste from demolition is more difficult because it may be contaminated by other elements mixed with it during or after installation, such as lead, asbestos, or mercury. The gypsum industry, through the Gypsum Association, does not condone the use of demolition waste in gypsum drywall manufacturing.

Environmental control equipment

USG plants have worked with environmental control equipment since before the Clean Air Act was passed in 1969. Where possible, USG plants consume clean fuels, such as low sulfur oil or natural gas. Significant capital investments have been made to install air cleaning equipment to meet changing air quality standards.

Water treatment equipment has been installed at USG paper mills and ceiling tile plants to recycle process water and reduce effluent discharges to municipal treatment facilities. USG has also invested in a cogeneration plant at one of its facilities.

Indoor air quality

Since the energy crisis of the 1970's, Indoor Air Quality (IAQ) has become a significant issue for building designers, owners and occupants. Quality of indoor air is associated with Building Related Illness (BRI) and Sick Building Syndrome (SBS).

The first initiative is to regulate the number of air exchanges through increasing the use of HVAC units. As the HVAC units run more they generate higher rates of air exchanges and minimize the potential for poor air quality. However, increasing ventilation and the number of air exchanges induces higher energy losses.

A second initiative is to reduce the number of Volatile Organic Compounds (VOCs) in materials used in building interiors. A VOC is defined as any organic compound with a boiling point between 50 and 260 °C, and that participates in atmospheric photochemical reactions. Paint thinner, methyl chloride, and ethyl alcohol are examples of compounds that fall into this definition. The State of Washington and others have promulgated standards regulating product emission levels.

Building material suppliers have reacted to IAQ issues in several ways. Carpeting and particle board groups have instituted voluntary emissions standards. Others have active programs to characterize emission rates for their products and reformulate to lower levels. Gypsum drywall and acoustical ceiling tiles are considered low emitters of VOCs.

Environmental activism

Many avenues of environmental activism are available. One is inclusion in consensus standards organizations such as the American Society of Testing and Materials (ASTM). There are also professional organizations such as the American Society of Chemical Engineers (ASCE) and American Institute of Architects (AIA), and independent environmental groups such as the U. S. Green Building Council.

USG Corporation is active in all these organizations as well as the U. S. Green Building Council and the Civil Engineering Research Foundation (CERF). The Green Council is a diverse coalition of principal groups involved in the building industry. Its mission is to promote energy, health, productivity, and environmental improvement for "whole buildings." CERF is the research arm of the American Society of Civil Engineers. It recently sponsored a symposium to accelerate innovation and application of research in engineering and construction within the context of environmental sustainability. ■

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