



USG Presents **Selecting and Specifying Sustainable Walls, Ceilings and Substrates**

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Any way you look at it, sustainability has become a fundamental principle underlying successful building design. From a global standpoint, sustainability is imperative, as it offers a critically important means for

Use the learning objectives below to focus your study as you read **Selecting and Specifying Sustainable Walls, Ceilings and Substrates**. To earn one AIA/CES Learning Unit including one hour of health safety welfare credit, answer the questions on page 297, then follow the reporting instructions on page 368 or use the Continuing Education self report form located at [architecturalrecord.com](http://architecturalrecord.com).

**Learning Objectives:**

- Understand the environmental benefits inherent in common wall, ceiling and substrate panels;
- Recognize the impact that embodied energy has on green product selections;
- Learn some general guidelines for creating green specifications.

conserving our dwindling natural resources. From an architectural business standpoint, it's becoming an increasingly important consideration, as a growing percentage of building owners and homeowners not only desire "green" buildings, but are now demanding them.

Green has, in fact, gone mainstream. Manufacturers are giving high priority to environmental concerns in their product development processes; builders and developers are acutely aware of how sustainability can impact project success; and retailers are proactively promoting green products.

Despite its growing acceptance, sustainable building design remains a complex undertaking. Because environmental issues can – and should – be considered in virtually every aspect of the design process, specifiers need to have a working knowledge of a wide range of green definitions, criteria, standards and applications.

This article will attempt to clarify some of the issues relative to green product selections and design specifications as they relate to walls, ceilings and substrates.

**Green Product Selection**

Green product selection is a key component of sustainable design. Green products can loosely be defined as those that reduce, recycle and renew – the three R's of sustainability. Specifically, sustainable products:

- Reduce the amount of raw materials needed for the manufacturing process. Lighter and/or smaller products generally require the use of less energy for transportation, storage and construction. Reduce can also refer to decreasing the amount of material used and/or wasted.
- Offer high recycled content and/or environmentally friendly reuses. The benefits here are obvious. Products with a high-recycled content may reduce raw material usage, energy consumption and landfill waste.
- Renew the environment by using materials that can be regenerated and/or materials offering environmentally friendly benefits.

The virtues of the reduce, recycle and renew principles must be balanced with an awareness of how embodied energy impacts sustainability. Embodied (or embedded) energy is the amount of non-renewable energy

required to extract, manufacture, transport and construct building products. It must be factored into all green product specifications, as it can have a significant – and sometimes surprising – impact on sustainable design.

Generally speaking, products with low embodied energy are good sustainable design choices. However, this is not to say that products with high embodied energy are always poor sustainable choices. A high embodied energy product containing large amounts of thermal mass may provide significant savings in energy usage over the life cycle of a building. The initial high embodied energy in the product is more than compensated for by its ability to reduce a building's recurring long-term energy needs (e.g. heating and cooling).

One aspect of embodied energy that is sometimes overlooked is material transportation. Transportation requires the use of non-renewable fossil

fuels, which under certain circumstances can negate the benefits of an otherwise excellent sustainable product selection.

Consider the use of gypsum board. In certain areas of the country, the product is manufactured using recycled gypsum formed as a by-product of operations in some power plants. The coal burned in many of these facilities produces



*Gypsum board scores extremely high on nearly all sustainable design criteria. It is made from an abundant and non-endangered mineral (gypsum) and has low embodied energy. Drywall made from recycled gypsum reduces landfill waste resulting from fossil-fuel power plant generators.*

undesirable pollutants, including sulfur dioxide. Wet 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 to create calcium sulfate, or recycled gypsum. Gypsum manufacturers source this recycled gypsum to produce wallboard, thereby reducing landfill waste. The wallboard made from recycled gypsum is indistinguishable in terms of performance and quality from panels made from mined gypsum rock.



Given these benefits, the use of recycled gypsum in drywall would seem to be a win/win scenario. And in most cases, it is. However, when the embodied energy required to transport the panels over a longer distance is factored in, the green value of

*Environmentally friendly gypsum fiber panel floor underlayments (shown here) and exterior sheathings are made from 95 percent recycled materials, offering a sustainable alternative to wood-based products such as lauan.*

recycled gypsum can be significantly diminished. When a recycled gypsum panel is shipped more than about 200 miles by truck or 400 miles by rail, the environmental benefits of the recycled content in the board are offset by the increased energy required for long-distance transportation. In other words, it doesn't make environmental sense to ship recycled gypsum panels made in Alabama to a job site in California.

The same premise holds true with other recycled and renewable products, making transportation a key factor to be aware of when creating sustainable specifications.

With that said, let's take a closer look at how gypsum board, acoustical ceiling panels, cement board panels and gypsum fiber panels rate in terms of the reduce, recycle and renew principles.

### Gypsum Board Panels

Gypsum board scores extremely high on nearly all sustainable design criteria. Gypsum, the primary raw material used to make wallboard, forms naturally like salt or limestone, and is one of the most abundant minerals on the planet. It is neither rare nor endangered.

The bulk of the remaining materials in gypsum board consist of paper (recycled, from newspapers, phone books, old corrugated cartons and cardboard cuttings) and corn or wheat starch binders. The corn and wheat starch binders are renewable agricultural resources and are environmentally superior choices compared to using polymers derived from petroleum.

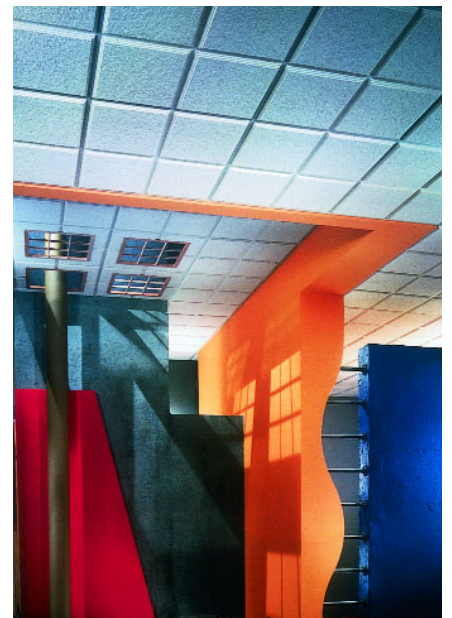
The embodied energy of gypsum board is extremely low. Drywall has less embodied energy than a wide variety of building products, including brickwork, concrete, particleboard, insulation, glass, vinyl flooring, plastics, steel and aluminum.

It is also important to note that manufacturing gypsum board is a low-waste production process. Approximately 95 percent of the raw materials entering a board plant leave as finished product. And most of the remaining 5 percent is recycled into small strips used to support stacks of finished gypsum panels. Overall, high-efficiency board plants can produce less than 1 percent material waste.

Manufacturers are now using hundreds of thousands of tons of recycled gypsum to produce wallboard, reducing power plant landfill needs. Both mined and recycled gypsum can also be reused to manufacture new gypsum panels. Other reuses include soil amendment (using gypsum as a high-calcium fertilizer or as a method for treating high soil pH), neutralizing the high pH levels caused by road salt applications, odor treatment and concrete set.

### Acoustical Ceiling Panels

Some acoustical ceiling panels contain mostly mineral wool, gypsum and smaller amounts of paper and starch, as well as other miscellaneous materials. The recycled content in ceiling panels varies from approximately



*Most acoustical ceiling panels consist of approximately 40 percent mineral wool, which is usually made from slag, a by-product of steel manufacturing. The use of slag eliminates the need to mine and process naturally occurring materials, while reducing landfill waste.*



Cement board panels are made from approximately 20 percent recycled materials, including fly ash, a by-product of power plant emission control processes.



To minimize construction waste, conduct a pre-construction meeting with contractors to discuss waste and disposal strategies and to explore alternative reuse options.

20 to 80 percent, depending on the product type, manufacturing process and plant location. The mineral wool used in the panels is usually made from slag, a by-product of steel manufacturing that consists of calcium silicate and other impurities. The slag is melted in coke-fired cupolas or electric melters and spun into fibers, which are incorporated into the ceiling panel production process. The use of slag reduces the need to mine naturally occurring materials such as basalt rock. It also decreases landfill waste. A high percentage of the paper used in the manufacturing process is recycled pre-consumer (cuttings from cardboard box manufacturing) and post-consumer (newspapers). The starches used as binders in the manufacturing process are renewable agricultural resources.

Like gypsum board manufacturing, acoustical ceiling production is a low-waste process. Panels that are chipped or broken during manufacturing are recycled and returned to the process.

The steel suspension systems used to support ceiling panels are considered green because they can be more easily reused than wood. The suspension systems can be 100 percent recycled by remelting and salvaging the metal.

It is also worth noting that some acoustical ceiling panels are available with a limited warranty against mold and mildew growth, which can help promote indoor air quality (IAQ).

### Gypsum Fiber Panels

The gypsum fiber manufacturing process combines gypsum and cellulose paper fibers to create a variety of high-performance panels, including floor underlayments and exterior sheathings. Gypsum fiber underlayment and sheathing panels are both made from 95 percent recycled materials. Specifically, 85 percent of the content in these panels comes from recaptured gypsum and 10 percent is from post-consumer recycled paper fiber. The panels offer an excellent sustainable alternative to other wood-based panels, most notably lauan, which is harvested from endangered, old-growth forests.

### Cement Board Panels

Cement board, a water-durable, multiuse panel commonly used as a backer for ceramic tile, is made from approximately 20 percent recycled materials, including fly ash. Fly ash is a waste stream material from power plant emission control processes that features cement-like properties. It is produced by electrical power companies in the combustion of coal and other solid fuels, and is subsequently purchased by cement board producers and used to manufacture the cement board panel core.

## LEED: A SUSTAINABLE RATING SYSTEM

The U.S. Green Building Council (USGBC), a diverse coalition of principal groups involved in the building industry, was established in 1993. The council's mission is to promote buildings that are environmentally responsible, profitable and healthy places to live and work.

Developed by the USGBC, the Leadership in Energy and Environmental Design (LEED) program created a building rating system to evaluate environmental performance from a "whole building" perspective, providing a standard for what constitutes a green building. Credits are earned for satisfying specific building criteria.

The LEED™ Rating System evaluates the environmental performance of a building, awarding points for:

- SUSTAINABLE SITES
- WATER EFFICIENCY

- ENERGY AND ATMOSPHERE
- MATERIALS AND RESOURCES
- INDOOR ENVIRONMENTAL QUALITY
- INNOVATION AND DESIGN PROCESS

Within "Materials and Resources" for example, points are awarded for specifying a certain percentage of building materials that contain a specified percentage of post-industrial recycled content or post-consumer recycled content. Points are also awarded for specifying materials that are manufactured regionally within a certain radius.

The LEED™ Reference Package includes an extensive reference guide and rating system and is available to order at: [www.usgbc.org](http://www.usgbc.org) or write: U.S. Green Building Council, 1015 18th St., N.W., Suite 805, Washington, D.C. 20036, or call (202) 828-7422.

## Green Specifications

In order to maximize the sustainable value of these – and other – green building products, architects should incorporate sustainable design criteria into building specifications. Proper specification details ensure that the benefits inherent in green products are supported during the construction process and fully realized throughout the building's life cycle.

The first step in creating an effective green specification is to use a standard specification layout, such as MasterFormat™, from the Construction Specifications Institute. The MasterFormat divides specifications into three categories:

- **Part 1: General** – Describes general procedures and administration.
- **Part 2: Products** – Describes materials, products, equipment and systems.
- **Part 3: Execution** – Describes the proper procedures for the installation of specific products and systems into designed applications.

The three-section format provides architects with a structure to add detailed notes and full explanations of the environmental requirements expected for each project. There's no need to add additional sections, as this may only confuse contractors and building owners who are already familiar with the MasterFormat structure.

When creating environmental specifications, define your terms. Don't assume that users of the specification will know the exact meaning of recyclability, post-industrial materials or other environmental terms.

Consider including the following general criteria in your specifications as needed to meet the sustainable objectives of a specific project:

- Outline on-site product storage procedures. Given the fact that standing water is a common occurrence on many construction sites, materials should not be stacked on the ground and cartons should not be left unopened and exposed to weather.
- Detail appropriate methods for storing and discarding construction waste that cannot be eliminated. Conduct a pre-construction meeting with appropriate contractors to discuss methods for minimizing construction waste and disposal, and to explore alternative reuse options.
- Encourage the establishment of good construction practices. Realistic construction schedules will enable contractors to fully enclose buildings to minimize moisture penetration issues that may contribute to poor product and system performance.

Do *not* include descriptions of a project's environmental goals (e.g. attaining a LEED green building rating) in the specification. Rather, include this information as part of your instructions to bidders.

Last, but not least, remember the three R's discussed previously when selecting products to include in the specification. Choose products that reduce, recycle and/or reuse. Bear in mind though, effective green product selection requires a careful analysis of a wide range of factors. A product with high recycled content or other obvious environmental benefits is usually a solid choice for sustainable design. However, mitigating factors, such as the product's embodied energy or its impact on a building's life cycle energy usage, must be weighed in order to make the best sustainable choices.

In the end, well-researched green product selections, combined with intelligent sustainable specifications, offer architects a practical and effective solution for helping conserve our natural resources, while meeting a growing demand for environmentally friendly design and construction practices.

## ADDITIONAL REQUIRED READING

*As part of this CES activity, you are required to read the following additional materials:*

“Drywall Recycling” provides more information on gypsum reuses. To access the material online, visit the California Integrated Waste Management Board Web site at <http://www.ciwmb.ca.gov/ConDemo/factsheets/Drywall.htm>.

To request a faxed copy of the material, contact Marty Duffy at (312) 606-5781 or [mduffy@usg.com](mailto:mduffy@usg.com).

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“Environmentally Preferable Purchasing (EPP) Terms” on the Environmental Protection Agency Web site provides definitions for dozens of environmental terms. To access the material online, go to: <http://www.epa.gov/opptintr/epp/eppterm.htm>. To request a faxed copy of the material, contact Marty Duffy at (312) 606-5781 or [mduffy@usg.com](mailto:mduffy@usg.com).

## About USG

USG Corporation is a Fortune 500 company with subsidiaries that are market leaders in their key product groups: gypsum wallboard, joint compound and related gypsum products; cement board; gypsum fiber panels; ceiling panels and grid; and building products distribution.

United States Gypsum Company, a subsidiary of USG Corporation, is the nation's leading manufacturer of gypsum board panels and the largest user of recaptured gypsum. The company uses more than 2.3 million tons of recaptured gypsum annually in the production of its SHEETROCK® Brand Gypsum Panels. Overall, the panels contain an average of 31 percent recycled content – 5 percent post-consumer waste and 26 percent post-industrial waste. The company also manufactures FIBEROCK® Brand Sheathing with AQUA-TOUGH™ and FIBEROCK Brand Underlayment – AQUA-TOUGH, both of which are made from a gypsum fiber manufacturing process that utilizes 95

percent recycled materials. The panels offer an excellent sustainable alternative to wood-based panels, most notably lauan, which is harvested from endangered, old-growth forests.

USG Interiors, another subsidiary of USG Corporation, is the only manufacturer to offer a limited lifetime warranty against mold growth on acoustical ceiling panels. The warranty is offered on the company's ECLIPSE™ CLIMAPLUS™ and ASTRO™ CLIMAPLUS ceiling panels, both of which are treated with the proprietary AEGIS Microbe Shield™.

For further information about USG's environmental practices and products, write USG Corporation, P.O. Box 806278, Chicago, IL 60680-4124, call USG's Customer Service Department at 800-USG-4YOU or visit the company's Web site at [www.usg.com](http://www.usg.com).

### Learning Objectives

- Understand the environmental benefits inherent in common wall, ceiling and substrate panels;
- Recognize the impact that embodied energy has on green product selections;
- Learn some general guidelines for creating green specifications.

### Instructions

Refer to the learning objectives above. Complete the questions below. Go to the self report form on page 368. Follow the reporting instructions, answer the test questions and submit the form. Or use the Continuing Education self report form on *Record's* website—[architecturalrecord.com](http://architecturalrecord.com)—to receive one AIA/CES Learning Unit including one hour of health safety welfare credit.

### Questions

**Q:** 1. Which of the following factors will negatively impact the sustainable benefits of using gypsum panels made from recaptured gypsum?

- A:**
- Installing the panels horizontally
  - Transporting the panels over long distances
  - Exposing the panels to moisture on the job site
  - Kiln drying the panels during manufacturing

**Q:** 2. Products with low embodied energy:

- A:**
- May negatively impact indoor air quality
  - Are usually of lower quality than high-embodied energy products
  - Will not promote the growth of mold or mildew
  - Save on non-renewable energy required for manufacturing and transportation

**Q:** 3. Which of the following is not a recognized aspect in the LEED Rating System?

- A:**
- Products that contain post-industrial or post-consumer recycled content
  - Products that are manufactured regionally
  - Products with high fire ratings
  - Indoor environmental air quality

**Q:** 4. Which of the following is not a possible reuse for gypsum panels?

- A:**
- Drywall manufacturing
  - Soil amendment
  - Road salt treatment
  - Slag

**Q:** 5. A key benefit of green building products that reduce is:

- A:**
- They lower a building's life-cycle energy usage
  - They require fewer raw materials to produce
  - They minimize the growth of mold and mildew
  - They are less costly

**Q:** 6. Which of the following is not considered part of the green specification process:

- A:**
- Choosing products that minimize construction waste.
  - Considering material transportation and embodied energy issues.
  - Encouraging proper material storage on the job site
  - Recommending fastest-possible construction schedules

**Q:** 7. Match the environmental term with its correct definition:

- A:**
- Biodegradable
  - Compostable
  - Disassembly potential
  - Energy consumption
- Capability of organic material to biologically decompose into humus-like material
  - The total amount of energy consumed for product or service manufacture, use, and disposal.
  - Capable of decomposing under natural conditions.
  - The ease with which a product can be disassembled for maintenance, replacement, or recycling.

**Q:** 8. Match the environmental term with its correct definition:

- A:**
- Extended product responsibility
  - Life cycle assessment
  - Reactivity
  - Reconditioned
- The tendency of a solid waste to exhibit harmful characteristics when in contact with other substances
  - Refers to the process of restoring used, durable products to meet original performance standards, resulting in less waste and raw material and energy use
  - The examination of a product's environmental and economic aspects and potential impacts throughout its lifetime, including raw material extraction, transportation, manufacturing, use and disposal.
  - A product systems approach to environmental protection that considers product chain and life cycle environmental impacts

**Q:** 9. Ways to reduce drywall waste can include all but which of the following:

- A:**
- Constructing standard-sized walls and flat ceilings
  - Reducing the embodied energy of material transportation
  - Ordering custom-sized sheets for nonstandard walls
  - Finding substitutes that are reusable, such as modular "demountable partitions" for commercial buildings

**Q:** 10. Most drywall waste is generated by which:

- A:**
- Manufacturing
  - Demolition
  - New Construction
  - Renovation



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