In restorative construction, a chemical-resistant urethane used to provide a non-porous surface finish to protect and enhance an existing warehouse floor, as well as contribute to less maintenance and less repair, allow the urethane to have **green** characteristics. However, if it's made with hazardous chemicals and the manufacturing process is poisonous, or it emits toxic fumes during its application posing health risks to the installers, it's not **sustainable**.

Sustainable Design & Green Engineering

In a continuing effort to reduce overall energy consumption throughout the country, most industries now embrace the concept of **sustainable** development. Architects and building designers are implementing "whole building" design strategies to create high-performance buildings from an ecological standpoint. Because operating a building over time is far more energy intensive than developing it, demand for durability and energy performance has become paramount in project planning.

Recognizing that U.S. buildings use nearly 10 percent of the world's energy, and also use three times more energy than comparable buildings in similar climates in Europe, the U.S. government is adopting **green** building programs, and an increasing number of states are offering tax benefits for **green** public buildings. The U.S. government defines **green buildings** as those that demonstrate the efficient use of energy, water and essential materials; limit impact on the outdoor environment; and, provide a healthier indoor environment.

Projects are required to reduce waste, adapt to the site, use renewable energy and materials from local sources, creatively seek synergies from all building and site components, and, above all, avoid toxic materials, protect ecosystems and restore damaged surroundings. As a result, all of this has created vast new markets for **green** building ***materials,*** and **green** building ***practices***, i.e., **sustainability**.

The LEED Green Building Rating System was conceived and implemented by the United States Green Building Council (USGBC) to define and measure the **sustainability** of "**green buildings**." Since the introduction of Version 2.0 in March 2000, the LEED rating system has radically transformed building design and construction by awarding points for its evaluation in five separate categories that reduce the negative impact of buildings. The greater the point total, the more **sustainable** the project. Importantly, LEED does not certify ***products***. Only ***projects*** can be LEED certified with a maximum of 69, and a minimum of 26 points required for certification.

LEED Point Categories

1) Sustainable Site Planning
2) Water Efficiency & Conservation
3) Renewable Energy & Efficiency
4) Materials & Resources Conservation
5) Indoor Environmental Quality

PERMA•CRETE® & Cement

The primary and most widely-used portion of the extensive **PERMA•CRETE®** product line continues to be its high-early strength, cementitious Matrix Mix bag mixes which are

polymer-modified to provide remarkable compressive, tensile and flexural strengths along with superb surface-bonding capability. As a result, a **PERMA•CRETE®** surface provides a new architectural, load-bearing surface of unusual strength and flexibility.

PERMA•CRETE® has sold over one million, 40 lb. bags of its Matrix Mix products to **PERMA•CRETE®** Dealers worldwide, and the key ingredient in the composition and manufacture of these products has been **cement**, thousands of tons of cement, which is a very **sustainable/green** building product. Cement is a fine grey or white powder that is a key ingredient in concrete production, and typically comprises 10 to 12 percent of the entire concrete mixture. When cement is mixed with water (or waterbase polymers), sand and gravel, it turns into concrete. When **PERMA•CRETE®**'s Matrix Mix is mixed with its liquid Bonding Additive, it becomes ***polymer concrete***.

The durability of concrete is a significant, **sustainable** attribute because it will not rust, rot, or burn, requiring less energy and resources over time to repair or replace. Structures built with concrete have optimal energy efficiency not found in other building materials like steel or wood. Additionally, concrete is easy to use, incurs little waste, and can be optimally recycled. As the most widely used building material in the world, concrete structures have withstood the test of time for more than 2,000 years.

Cement Products: Green & Sustainable

The cement industry utilizes industrial byproducts like fly ash, and consumes less energy than its competitors. Fly ash is a byproduct of coal-fired power plants that is difficult to use because of inconsistent grind and weight, and because it contains some radioactivity; massive amounts of fly ash are unused and go to landfills for disposal. However, a ton of fly ash used in concrete can save almost a ton of carbon-dioxide (CO_2) emissions from entering the atmosphere and contributing to global warming. In 2005, more than 20.5 million metric tons of fly ash were used in concrete, and 3 million metric tons of recycled slag, a byproduct of steel production, were used saving millions of tons of CO_2 from entering the air we breathe.

CO_2 results from the combustion of carbon-based fuels, i.e., the burning of oil, natural gas or coal, and raw material changes occurring from intense heat, which is the conversion of carbonates in the raw materials into the various compounds which give cement its unique properties. However, most cement manufacturers are now closing wet process kilns that require large amounts of water and energy to grind raw materials, and installing energy efficient dry process plants which use energy-rich alternative fuels that are consumer wastes or byproducts from other industries. This type of energy recovery conserves valuable fossil fuels for future generations while safely destroying wastes that would otherwise be deposited in landfills.

Although the U.S. is the world's third largest manufacturer of cement, the U.S. Department of Energy statistics show that U.S. cement production accounts for just 0.33 percent (about 1/3 of 1%) of energy consumption in the U.S. – lower than petroleum refining at 6.5 percent, steel production at 1.8 percent, and wood production at 0.5 percent. The greatest consumption of energy comes from the homes and buildings we live and work in at 38.8% of total U.S. consumption, and the cars and trucks we drive at 27.6%.

Since 1975, the cement industry has improved energy efficiency by thirty-three (33%) percent. Today, the cement industry accounts for less than 2% of ***all*** U.S. carbon dioxide (CO_2) emissions, well below other national sources such as electric power plants at 33%, transportation at 27%, and industrial operations at 19%.

Specifically designed and delivered for each project, concrete typically produces very little waste. The major ingredients in concrete, cement, sand and coarse aggregates, are typically obtained and manufactured locally, reducing shipping impacts and benefiting the local economy. When a concrete structure has served its purpose, it can be crushed for use as aggregate in new concrete or as base materials for roads, sidewalks and concrete slabs. Even the reinforcing steel in concrete (which is often made from recycled materials) can be recycled and reused. In 2006, the Construction Materials Recycling Association estimated that approximately 125 to 140 tons of concrete are recycled each year.

Further still, the cement industry uses about 65 million scrap tires, or over 20 percent of the total amount of scrap tires each year, as an alternative fuel source during cement production. Pound for pound, tires contain 1/3 more energy than coal. Recycling tires in this way effectively removes them from landfills or other disposal methods.

Finally, structures built with concrete have optimal energy performance. Homes and buildings constructed with insulated concrete walls are not subject to large daily temperature fluctuations. This means home or building owners can lower heating and cooling bills up to twenty-five (25%) percent. Also, heating, ventilating and air-conditioning systems can be designed with smaller capacity equipment. High performance insulated concrete wall systems provide high R-value and thermal mass with low air infiltration to provide superior thermal efficiency.

The manufacture of cement and its ultimate use in concrete is an outstanding example of **sustainable** design and **green** engineering for environmentally sound construction as it reduces waste, reduces carbon emissions, and increasingly uses new sources of renewable energy.

PERMA•CRETE® Products: Green & Sustainable

Product ingredients, uses and finished applications of **PERMA•CRETE®** all contribute to the **green** and **sustainable** characteristics of **PERMA•CRETE®** products. One of the most critical standards in determining their **green** factor is the Volatile Organic Compounds (VOCs) "toxic out-gassing" emitted by the products as they're installed, as well as the amount of time needed for the installed products to finish any continued out-gassing. All cementitious **PERMA•CRETE®** surfaces, installed in all types of both vertical and horizontal applications, including residential and commercial buildings, sidewalks, garage decks, highway bridges and airport runways, have **zero VOCs**.

Even after **PERMA•CRETE®**'s final acrylic, epoxy or urethane sealer application, each of which have less than 10 g/l VOCs and barely register on the Environmental Protection Agency's (EPA) established, national VOC limit of 450 g/l (grams per liter), one hundred percent of all out-gassing in the completed sealer application occurs in less than three days.

Other **green** characteristics of **PERMA•CRETE®** products and finished applications that, when incorporated within a LEED candidate's overall project scope, will qualify for LEED points, are listed below:

- Reducing urban heat island on parking lots and roofs. **PERMA•CRETE®** surfaces are 20 degrees cooler than even light-colored concrete, which in itself reflects solar energy and reduces heat gain.

- **PERMA•CRETE®** products are manufactured in Nashville, Tennessee, and are within 500 miles of over 75% of the U.S. population, thereby qualifying for the LEED regional materials credit on a sizeable portion of U.S. building projects.
- Refurbishing old or damaged floors; providing low maintenance and treatment to protect floors; and, creating decorative floors for aesthetic benefits.
- Seamless, vertical-surface systems improve indoor air quality because reduced air infiltration minimizes moist air penetration.
- Seamless, vertical-surface systems increase energy efficiency by minimizing thermal breaks resulting in improved insulation efficiency.
- Durability; low, toxic-free maintenance; and, easy, economical repair, all qualify for the LEED projected life cycle costs credit.

With the exception of **green** and **sustainable** Matrix Mixes, all **PERMA•CRETE®** products are either ***waterbase*** (made with water in the formulation), or ***waterbourne*** (made with materials compatible with water), being virtually VOC-free, environmentally safe, friendly to use, and **sustainably *manufactured*** with renewable resources that are **sustainably *harvested***.

For instance, all water used to make **PERMA•CRETE®** products is obtained from a 1,000 foot deep well on the **PERMA•CRETE®** manufacturing site, eliminating the costly energy required to obtain, purify and deliver normal city water. Also, **PERMA•CRETE®** eliminates sewer wastes and the resultant energy-dependent, processing and retrieval costs by utilizing all water obtained for the manufacture of the products. **PERMA•CRETE®** uses renewable resources and energy-efficient manufacturing processes to achieve **sustainable** design.

Completed installations of **PERMA•CRETE®** products result in reduced energy costs and produce no harmful effects to the environment or the air we breathe. **PERMA•CRETE®** ***exterior surfaces*** over buildings, sidewalks, driveways and other areas remain attractive, durable and functional with low, occasional maintenance costs using normal household cleaning supplies even after nearly ***twenty years*** of continual consumer use. ***Interior surfaces*** on walls and floors using **PERMA•CRETE®** can produce wall and floor gloss levels with high reflectance that can reduce lighting costs by up to 40%, and provide surfaces that are more abrasion-resistant and long-lasting than conventional surfaces of drywall, carpet, vinyl tile, and quarry tile. All of these **PERMA•CRETE®** characteristics are **green** in their applications.

With higher energy prices, new homes now have a tighter seal that results in trapped moisture inside walls and living spaces, and higher humidity for mold and fungus to feed on cellulose, the primary ingredient in paper and wood on walls and floors. Importantly, there is no food source in **PERMA•CRETE®'s green** surfaces to support these expensive and unwanted problems, nor from other damaging but also common occurrences resulting from termites, rot and rodents.

During the past several years, the **PERMA•CRETE®** research center has continued to reformulate and reduce all product VOC levels without compromising or affecting the intrinsic performance characteristics of each product. Additionally, **PERMA•CRETE®** has also created many new, environmentally-safe products for additional surface installation features to expand its Dealers' capabilities for **green** building projects.

For instance, **PERMA•CRETE®** is nearing completion of a new interior wall, basecoat Matrix Mix that, when directly applied over Insulated Concrete Form (ICF) interior walls or other wall surfaces, will provide a thermal barrier that will limit the average temperature rise

of the unexposed surface to not more than 250 F after 15 minutes of fire exposure, a long-standing code requirement for safety. This will allow the normal **PERMA•CRETE®** surface application to then be applied, and eliminate the very costly procedures of installing studs, drywall, finishing and painting on these interior wall surfaces. This new **PERMA•CRETE®** product application will be significantly **green** and can earn LEED points in, potentially, several categories.

The exterior and interior surface installations of **PERMA•CRETE®** products, for both vertical and horizontal applications, provide outstanding examples of **sustainable** design and **green** engineering for environmentally sound construction in extending the life of, and reducing the environmental impact of new and existing buildings, maximizing a building's energy efficiency, and improving indoor environmental quality, while at the same time providing products that have been manufactured in a **sustainable** manner.

Our planet consists of a finite support system, and our air, water, food, soil, and ecosystems are not infinitely expandable in their ability to absorb mankind's willful excesses and disregard for conservation. **PERMA•CRETE®** will continue to contribute its corporate share in creating a better and safer, **green** world for all of us to live in.

Research Sources:

Concrete Home Building Council
NAHB Green Building Program
U.S. Green Building Council (USGBC)
LEED Reference Guide (LEED)
Portland Cement Association (PCA)
Concrete Construction Magazine
Sustainable Products.com
Environmental Protection Agency
Sustainable Buildings Industry Council
Research and Markets.com
The Science of Sustainability & Green Engineering
Financial Times.com
Environmental Building News
Qualified Remodeler Magazine
Wall Street Journal
Internet Search Engines
QSI Quality Control Research