

## Sustainability and Innovative Construction: Green Building with Concrete

Yang Lu\*

Research Associate, Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20742-3511, USA

Green building technology refers to structures that are environmental friendly and resource-efficient throughout a building's service life, from design to construction. Green buildings are designed to reduce the overall impact on the natural environment by: 1) efficiently using energy, water, and other resources; 2) reducing waste, pollution and environmental degradation. This article discusses the green concrete's application in the green building movement.

Generally, sustainable building materials lie into two categories. First, there are renewable materials, which are made from resources that can be replaced by nature or recycle. Then, there are green materials, which are generally more efficient than traditional products because they require fewer resources to produce. In addition, materials that help cut down a building's water or energy consumption can be considered sustainable. Demand for sustainable materials is strong, as property owners, developers and regulators put a greater emphasis on cost savings, environmental protection, and energy conservation. Growth in sustainable building materials will be given a further economic boost by the expected recovery in overall construction activity.

A new insight into new technological and social developments guides the introduction of green buildings. As a sustainable material, concrete is also easily and affordably reused and rehabilitated. It is concerned that at least 5 percent of humanity's carbon footprint comes from the concrete industry, both from energy use and the carbon dioxide (CO<sub>2</sub>) byproduct from the production of portland cement, one of concrete's principal components. Portland cement (the binding component with large energy and CO<sub>2</sub> footprints) manufacturing is a complex and massive industrial process undertaken by large organizations. Portland cement in turn holds the key ingredient of concrete, which is the most widely manufactured material on earth. In order to obtain green concrete, innovative approaches are necessary from the manufacture and shipment of cement to the blending and application of concrete to reduce energy use, capture and utilize emissions from cement manufacturing, as well as build energy-efficient and durable structures.

The most common strategy for making a green concrete is to replace the portland cement with industrial by-products (IBP), e.g. fly ash and blast furnace slag. Major questions exist, however, as evidenced by the fact that the average industrial portland cement replacement was only 14% in 2008, despite the availability of tens of millions of IBP materials that end up in landfills each year. This is because the chemistry of an IBP material begins to dominate the chemistry of the portland cement, which can impact the constructability and durability of the blended systems. Because the chemical behavior of IBP materials has not been fully understood, variations in the IBP material properties from multiple sources can have un-predicted consequences, and correcting for these changes becomes particularly challenging. Furthermore, there are a lot of unknown features about the robustness of these blended systems during construction and in service life, and whether the current standard tests accurately reflect the performance of these blended systems. Thus, it is highly desirable to develop a manufacturing procedure that allows precise control of external and internal factors (e.g. environment and chemistry) which affect concretes containing up to 40% IBP materials. Many concrete industry programs have a perspective into the broader issue of green technology and environmental performance. Here are the desirable qualifications of green concrete for sustainability:

1. Long service life and high performance. Reinforced concrete's durability ensures that the structure will retain its structural capabilities for many years due to the high performance concrete, e.g. anti-corrosion and anti-cracking concrete. The carbon footprint and large energy consumption from cement industry are minimized when the need to replace or repair the structure is not necessary.
2. Maximized recycling materials usage and minimized environmental impact. Concrete producers can replace significant amounts of cement in their mixtures with industrial by-products such as silica fume and blast-furnace slag. Their use in concrete removes them from landfills and minimizes cement consumption, even producing a more durable concrete. Waste industry products can be recycled and in turn result in reduced waste release in the environment.
3. Minimized transportation cost. Take the advantage of local materials, reinforced concrete components can be made locally anywhere in the world. This turns out to be the key element in reducing emissions due to transportation. Through the utilization of local materials, the impacts of transportation and energy consumption are minimized.

According to the desirable qualifications of green concrete, the concrete industry has launched a parallel sustainability program, primarily in the United States through the National Ready Mixed Concrete Association (NRMCA) [1]. This program was focused on applications of the product, where the greatest gains in energy efficiency and emission reduction can be implemented. Furthermore, the program also involves reducing the negative impacts of concrete production and distribution. Sustainability also examines the impacts of a product throughout its lifetime. To emphasize the green technology applicability to concrete and its ingredients, the ongoing research will overcome the technical barriers to increase the percentage of IBP in concrete by providing the industry constructability and durability of green concrete. The global cement manufacturing industry has embraced sustainability and the triple bottom line: economic, social, and environmental. Two major examples of sustainability programs are the Cement Sustainability Initiative, a global effort under the auspices of the World Business Council for Sustainable Development (CSI) [2], and the Portland Cement Association's Cement Manufacturing Sustainability Program [3], which involves facilities in the United States and Canada.

In addition to the technical viewpoint, there is a perspective from economic performance. As awareness of environmental sustainability and energy efficiency is turning widespread, there's also a matter of

---

\*Corresponding author: Yang Lu, Research Associate, Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20742-3511, USA, E-mail: [ylu0309@umd.edu](mailto:ylu0309@umd.edu)

Received July 24, 2012; Accepted July 24, 2012; Published July 25, 2012

Citation: Lu Y (2012) Sustainability and Innovative Construction: Green Building with Concrete. J Civil Environ Eng 2:e107. doi:10.4172/2165-784X.1000e107

Copyright: © 2012 Lu Y. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

return on investment. As electricity rates go higher along with prices for natural gas, the costs to heat and cool buildings are expected to increase gradually. Buildings that use innovative, energy-efficient materials help residents contend with escalating utility bills to promote the use of energy-efficient and sustainable materials that lead to less electricity and water usage.

In general, the construction industry consumes 40% of the total energy and about one-half of the world's major resources. Hence, it is imperative to regulate the use of green materials and less energy consumption in construction industry. Sustainable usage of resources plays an important role in the development of sustainable construction. However, unless the means of making these green buildings affordable for the common people are developed, we cannot attain

full sustainability. A truly green building should be energy efficient, incorporate concrete that contains the least amount of portland cement, and use large volumes of supplementary cementitious materials and recycled concrete. To implement the sustainability and innovative infrastructure technology, green building eventually requires the conversion of green concrete technology into construction sites.

#### References

1. NRMCA "National Ready Mixed Concrete Association."
2. CSI "Cement sustainability initiative." World Business Council for Sustainable Development.
3. Reynolds J (2004) Cement association sets green targets The Portland Cement Association has launched its Cement Manufacturing Sustainability Program. Architecture 93: 28.