building blocks

Sustainability and the Role of the Structural Engineer

By Christopher Hewitt, LEED™ A.P.

If future generations are to remember us more with gratitude than sorrow, we must achieve more than just the miracles of technology. We must also leave them a glimpse of the world as it was created, not just as it looked when we got through with it. – Lyndon B. Johnson

President Lyndon B. Johnson, upon signing the protection of the US wildlife preserves into law some 40 years ago, highlighted the very essence of what protection of the environment and conservation of our resources means to the hearts and minds of Americans.

For many years, environmental awareness has been a grass roots effort spurred by a small group of people pushing for regulatory solutions to environmental protection. These efforts still exist, but out of them a new breed of incentive programs have emerged, which raise the awareness that individuals have on the environmental impact of consumer decisions. These consumer-based environmental strategies are becoming broadly accepted in the context of good business. Successful examples of this include the EPA's Energy Star program, which creates a market identity for energy efficient appliances, and new experiments by the automotive industry to develop hybrid automobiles in response to a better-informed market.

A similar effort, which is beginning to transform the US construction industry, is the US Green Building Council's LEED™ Rating System. This system awards a LEED certification to high performance, energy efficient buildings. The certification gives architects a way to market building performance to owners, and gives owners a basic idea of the energy and environmental efficiency that they are getting in their building.

A LEED certification is attained by earning "points" in any of 64 areas highlighted in the LEED rating system. These points are awarded for incorporating "green" initiatives into a building project. Green initiatives might include sitework protection, the use of efficient HVAC systems, or the selection of building materials that have a reduced environmental impact.

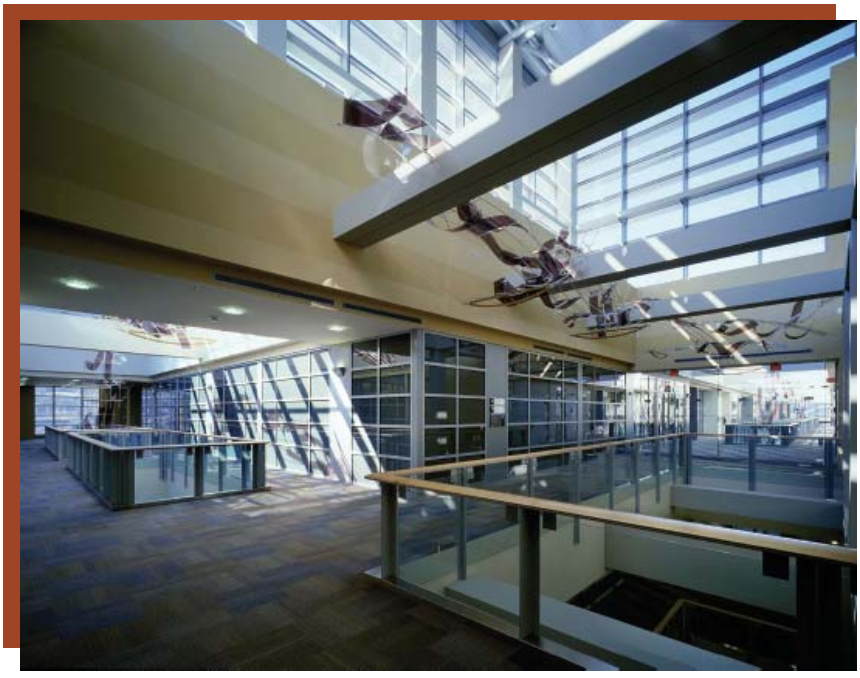
Sustainable design as a whole, and the use of the LEED rating system, continues to gain interest as a design movement in the architectural community. Architects are embracing the idea of sustainable construction because sustainability represents highly efficient and environmentally sensitive design. And, the ability of a building to interact sensitively with its environment has always been one of the goals of Architecture. The LEED rating system is simply a way of packaging the services that good architectural design is meant to provide.

Although the LEED rating system predominantly impacts the design of the architectural and mechanical components of a building, as the trend continues to grow all members of the project team will be asked to contribute what they can and to "think outside of the box" to deliver a sustainable design.

As structural engineers, most of us have probably heard of LEED, although you may or may not really understand what it is. Of the 41 different initiatives (called credits) that are addressed in the LEED rating system, only a few directly impact the work of the structural engineer. Under LEED version 2.1, the most recent edition of the rating system, the choices of the structural engineer on a building project most directly affect the following items, which are presented in order by how often they are achieved on LEED rated projects:

- Use of locally and regionally available resources
- Recycled content of materials
- Construction waste management
- Use of certified wood, when applicable
- Reuse of building materials
- Reuse of an existing building

It is important to note that any structural system can be applied toward these LEED credits and anyone that tells you that specifying one item or material will in itself earn LEED points is misleading you. All materials and individual efforts on a project can contribute towards credits, but the credit is only achieved when looking at the building as a whole. The differences in structural materials emerge when considering which materials contribute toward LEED credits most economically in the context of the entire building.



For instance, LEED offers a credit for the use of certified wood. At first glance this seems to imply that the credit is encouraging the use of more wood, but in reality the credit is simply encouraging the use of responsibly forested wood for any building products that do happen to contain wood, not the use of more wood overall on a project. So, while the structure does not need to be made of wood to contribute toward this credit, if a wood structural system is used, the wood must be responsibly forested in order to be applied toward the credit.

Similarly, the credit available for recycled content of building materials requires that a certain percentage of the sum total of the building materials on a project, from the beams to the doorknobs, contain recycled content. In the structural system of a commercial building, both steel and reinforced concrete with fly ash can be used towards achieving the credit for recycled content. Neither is exclusively required in order to achieve the credit and neither will get you the credit on its own, but both have reasonable recycling options for contributing towards the LEED goal. The sustainable goals can therefore be rationalized by looking at the relative cost of several good environmental strategies, and looking at how existing technologies can be adapted to achieve an affordable and responsible green design.

While it is desirable to achieve as many LEED points as possible on a building project, LEED's ultimate goal of promoting a sustainable building should not be overshadowed in the pursuit of collecting points. It is not possible to achieve all of the points in the LEED rating system on one project. Choices have to be made as to which points are most important for meeting sustainable design goals, and which can be achieved most efficiently.

As a structural engineer interested in contributing toward a LEED rating on your project, you should, at a minimum, consider the following:

Use of locally and regionally available resources

Consider the availability of your materials with respect to the project site, and try to cut down on transportation impacts. Most structural materials are available within the 500-mile distance specified by LEED to every project site in the United States. However, in keeping with the intent of this credit, certain sources, like imported sources of cement or steel, will have to be avoided. It is important to note that within the context of LEED there are two different points available in this credit category – one is awarded for projects that use products that are manufactured within 500 miles of a project site, and another is awarded for projects which use products that are extracted within 500 miles of a project site. The first credit for local manufacture of products is rather easy to obtain - only the steel fabricator or the batch plant need be within 500 miles of the project site. The second credit for local extraction of materials requires that

the raw ingredients for the product (ie. the recycled steel scrap source or the cement and aggregate sources) also be within 500 miles of the project site. For many products, purchasing techniques may make it impossible to document a consistent point of extraction for all of the raw ingredients that go into a product, which will make it very difficult to apply the structural frame toward the second point.

Recycled content of materials

The structural frame is very often applied toward this credit, whether the system uses structural steel (which has 90-95% recycled content from mostly post-consumer uses), concrete with pozzolans (such as fly-ash, a coal combustion by-product that can replace 20-35% of the portland cement used in conventional concrete), or composite wood products (which can have varied levels of recycled content depending on their application).

Construction waste management

This credit is awarded for practices during the construction of the building that reduce the amount of material ultimately sent to a landfill. By using materials that arrive on site as completely assembled products, the total amount of waste generated during on site construction is reduced. In this way the use of completely fabricated products such as steel beams and precast concrete members, whose production waste is controlled in the manufacturing process, can avoid on-site waste that is difficult to control, such as that generated from scrap pieces of cut products or conventional formwork with a limited reuse life.

This credit also encourages the collection of recyclable materials in lieu of disposal. There is often an economic incentive to do this, as collection of recyclable materials can offset tipping fees (fees paid to landfills to accept waste), or in some cases can generate a profit. Any wasted metals, such as structural steel or rebar, can be sold for a profit to a recycler, concrete can be crushed and reused as road base or as site fill, and other materials such as brick, when separated, are often accepted for free at landfills without having to pay conventional tipping fees.

Use of certified wood, when applicable

As mentioned earlier, if structural timbers are used on a project, the designer should specify that they be responsibly forested. This avoids the clear-cutting of forests and lessens the environmental impact of collecting this material.

Reuse of building materials

The reuse of building materials requires a material source that can be extracted intact and reused in a new building. Steel and precast concrete, products that arrive on site as discrete net-finished components, are

potential sources of reusable structural material which can be easily demounted from a structure without a loss of strength. Structural timbers can also be reused, but wood products are more often reclaimed as siding material rather than structural members.

When reusing building materials from another project site, it is advisable to employ an independent testing agency to assess the structural integrity of the reclaimed structural members.

Reuse of an existing building

The ability to upgrade an existing structure for a future use is important to meeting this credit, and as such, if this credit is sought, substantial assessment of the existing structure will have to take place to identify the suitability of the structure for receiving new loads. The use of durable and adaptable materials facilitates the reuse of structures. Design structures that can adapt to future expansion, and structures that will be easy to upgrade to unexpected loads, should this become necessary.

Innovation and the design process

The final credit category presented in LEED is meant to encourage innovation. The number of ways that a structural engineer can contribute toward this credit is only limited by the breadth of his or her imagination. It is within this mechanism that new environmental technologies will emerge and the face of sustainable construction will transform. Successful past strategies have included optimizing the use of materials in a structural system beyond that which is called for in typical design, and highly integrating the work of the mechanical, electrical and structural trades to increase the overall performance of the building. In this credit category, all of the members of the project team are asked challenge today's conventions and to look toward the future.

LEED empowers and challenges all members of a building project team, including structural engineers, to push the envelope of design to sustain our communities, environment, and atmosphere in the midst of a fervently competitive world. As evidenced by LEED's continued growth, the construction market is responding to the challenge, improving the performance of our buildings, and ultimately building the image by which future generations will remember us.▪

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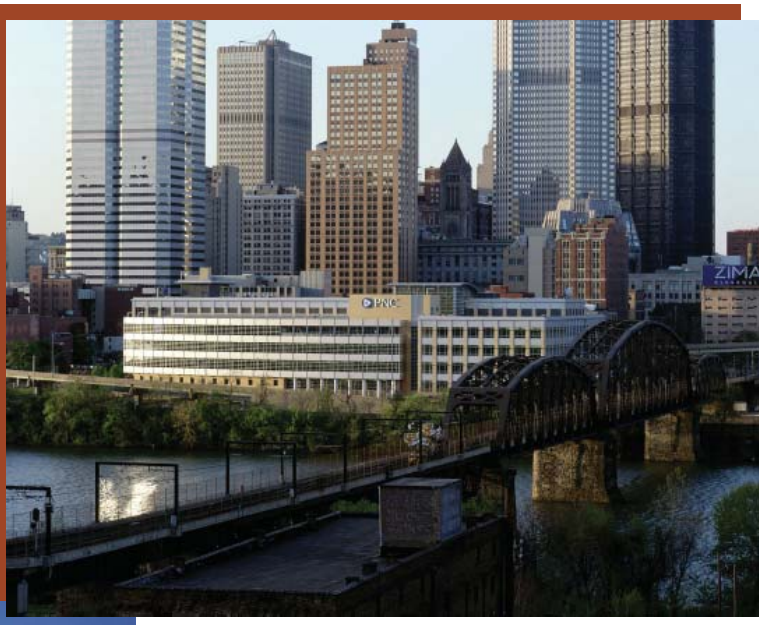

AISC provides several resources on how steel can effectively contribute toward a LEED rating. For more information on steel's role in sustainable design, please visit www.aisc.org/sustainability.

Photos provided by Pittsburgh-based architect and engineer Astorino and Edward Massery Photography. The photos are from two of Astorino's LEED™ rated building projects-the PNC First-side Center in Pittsburgh, PA and the J. Richard Carnall Center, PFPC Worldwide Headquarters in Wilmington, DE.