ARE WE READY FOR GREEN SUSTAINABLE STRUCTURES?

Yes, green is here to stay. But are we ready to completely change our way of thinking? Maybe not just yet. Structural engineers are very familiar with our first social responsibility - life safety. Building and material codes continually evolve for the safety of the public. But now is the time for structural engineers to take another look at our profession and further our social responsibility in sustainability, because our profession is more than wind uplift forces and earthquakes.

There is a balance between buildings and nature; finding that balance is a science that involves an entire team willing to cut across discipline lines early in the design process. The balance requires stepping back and evaluating the quality of a building in terms of energy, sustainability, health and productivity. We can't shy away from this one.

So, how do we as structural engineers contribute? Until now, not many of us have taken a break from our busy lives to see our individual impact on the earth and its people. Each of us makes choices both at home and in our professions that ultimately affect our future generations. Structural engineers are not exempt. We need to understand green principles and apply them to our designs and details every day.

Life Cycle Cost Analysis

Engineers must understand and consider the life cycle cost of structures and their details. Material selection and detail constructability greatly impact the carbon footprint of the structure, along with durability and length of life. Life cycle costs include a material's embodied energy due to extraction, manufacture and transportation, as well as operation and maintenance. Life cycle cost analysis should also include material evaluation based on reuse and recyclability at the end of its useful life.

Transportation is part of a material's embodied energy. Using regional materials not only minimizes fuel impact, but also supports the regional economy. Material selection should consider the long term maintenance impact. There is an energy cost to maintenance, as well. Engineers need to understand energy cost and realize not all green strategies are equal. Structural options that provide high strength and durability with the least amount of material make sense. See the WBDG website for more information.

Green Materials and Structural Technologies

There are many developed green technologies and materials available to structural engineers and many more on the way. So everyone needs to keep an open mind and do their research! Structural Insulated Panels (SIPS), Insulated Concrete Forms (ICFs), blended concrete using flyash, slag and recycled concrete aggregate, engineered trusses and wood, and other composite materials are green materials that continue to prove sustainable design will work. Below are just some of the green technologies that Steven Schaefer Associates has researched and used in our projects.

Examples of structural design contributing to a green building:

1. Highland Local School District High School (Columbus)
   - Used a non-typical concrete mixture with reduced cement content
   - Constructed with building materials whose manufacturing facilities where within a specified distance to the construction site
   - Designed the floor framing on the HS to minimize spray-fireproofing materials required
2. Xavier University's Hoff Academic Quad
   - Used thermal isolators (one of the first uses in the Cincinnati area)
   - Utilized recycled structural material throughout
   - Several buildings included green roofs which minimize the impact of the building on the environment and energy resources needed
3. Quebec Heights Pre-Kindergarten – 8th Grade School
   - Used ICFs in lieu of the exterior CMU walls
   - Includes green roofs which minimize the impact of the building on the environment and energy resources needed
4. Cincinnati Zoo
   - Some of the wood buildings such as the turnstile structure at the new main entrance and the green garden shelter were specified using FSC (Forest Stewardship Council's Principles and Criteria), a more LEED compliant material than standard wood product by documenting a green chain-of-custody and using forest products that are harvested and replanted in an environmentally friendly manner.

Existing Buildings

Saving an existing building and redefining its use is one of those conscience choices engineers fully understand. Many times existing big box buildings are thrown away, as chain businesses lure customers into their latest and greatest store. Developers tear down the old and get ready to 'build to suit' for the next lease. Salvaging these buildings with some small façade and interior updates, takes a lot of creativity from the designer and the owner, but greatly reduces the impact on the environment. Structural engineers can use alternative codes for older buildings and find durable solutions for retrofit that are cost effective. *See our article entitled* *Encouraging Renovation: Approaches to Upgrading Existing Buildings*.

Frost Protected Shallow Foundations

In areas of the country where there are not a significant amounts of moisture sensitive clays , Frost Protected Shallow Foundations (FPSF) are becoming an accepted practice for protecting foundations against frost heave (cracking). FPSFs increase the energy efficiency of a building when detailed properly, eliminating thermal bridges. The concept behind FPSF is to strategically place polystyrene insulation to protect the foundation and underlying soil against freezing temperatures and frost heave, effectively raising the frost depth by conserving building and geothermal heat. Guidelines for the design of a FPSF system are found in ASCE Standard 32. It is a cost effective application for areas where frost depths are 24" or more. Frost heave is dependent on below-freezing temperatures, frost susceptible soil (clay) and an adequate supply of moisture in the soil. If you remove any one of the three dependents, your foundation will be protected from frost heave. FPSF systems typically see cost savings with less concrete and shallower excavations.

Detailing to Avoid Thermal Bridges

Structural engineers, proactively using green principles, should avoid thermal bridging in their structural details. Thermal bridges are often found in structural details for relieving angles for brick support, balcony structures and frost walls. Early discussions with the architect typically resolve these issues with simple solutions. Understanding where to hold back a slab edge, extend insulation, or show a break between steel with a Fiberglass Reinforced Plastic (FRP) plate are key to providing energy efficient structural details. There are also new products that break the thermal transmission. Steven Schaefer Associates is currently working with a European manufacturer to adapt their products for the U.S. market – see our next issue for more information. Engineers are part of the process and need to stay current with the latest products available.

Thermal Mass Structures

Thermal mass is simply a solid or liquid material that will absorb and store heat or cold until it is needed. Concrete, masonry and water have a much larger thermal mass storage capacity than air. Structures with significant thermal mass (concrete structures, masonry bearing wall structures) will prevent large changes of indoor temperature as the outdoor temperatures rise or fall, reducing HVAC requirements year-round as well as providing a very durable life-long structure.

Modular Structures

In general, modular structures save construction time, but they also reduce waste and use less material upfront. They are typically designed to be dismantled, moved and used again. The modular concept also applies to multiple applications. High rise construction can use modular stairs, elevator and mechanical shafts, fabricated in the shop, transported to the site and lifted into place. Stackable bathroom units are also done this way, reducing materials, waste and crane time.

There are a few ambitious targets out there. Because buildings are the major source of demand for energy and materials that produce by-product greenhouse gases, The Architecture 2030 Challenge encourages us, building professionals, to have all new buildings be carbon neutral by 2030. Passed unanimously by the US Conference of Mayors and supported by organizations such as the American Institute of Architects, the US Green Building Council, and the American Society of Heating, Refrigeration and Air-Conditioning Engineers, the 2030 Challenge starts with a fossil fuel reduction standard for all new buildings and major renovations to be increased to 60% in 2010, moving to carbon neutral by 2030. This can and will work, but not without a clear change in the attitude of our profession. Design teams need to work together, along with the owner, end users and the contractor to maximize the green potential, minimize redesign and assure the overall success and economic viability of the green elements of the building project. As structural engineers we need to establish project green goals and set a path to succeed. We need to provide for our current needs without future compromise. Structural engineers are part of the solution too.