A Structural Perspective on Sustainability

By Robert D. Richardson, P.E., P.Eng, ENV SP

What makes a bridge (or any other structure) sustainable? The American Society of Civil Engineers (ASCE) defines sustainability as, "A set of environmental, economic and social conditions in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality or availability of natural, economic, and social resources."

Based on this definition, it is clear that the structural component is one piece of the much larger picture in terms of sustainability.

The Envision™ sustainability rating system was developed through a partnership between the Zofnass Program for Sustainable Infrastructure and the Institute for Sustainable Infrastructure (ISI), a not-for-profit organization founded by ASCE, the Council of Engineering Companies (ACEC), and the American Public Works Association (APWA). The goal was to establish a comprehensive tool that provides a holistic, cost-effective framework for evaluating and rating the community, environmental and economic benefits of all types and sizes of infrastructure projects.

Envision™ categorizes a project's contribution to sustainability into two key areas: pathway contribution and performance contribution. Pathway contribution is used to assess the important question, "Are we doing the right project?" by considering how the project aligns with overarching community needs and quality of life, and supports responsible and sustainable development. Generally, these issues are beyond the scope of the structural engineer. However, knowing how they affect the overall sustainability of a project, structural engineers are positioned to provide valuable input on aspects of performance contribution.

Performance contribution is the determination of the project's efficiency and effectiveness, and attempts to answer the question, "Are we doing the project right?" The project team should explore all practical opportunities to improve sustainable performance in multiple areas including increased energy efficiency, decreased water consumption, and reduced materials consumption.

What can structural engineers do to enhance a project's sustainability?

- Design with sustainability in mind. Look for ways to incorporate sustainable practices to improve design and project performance.
- Identify opportunities to re-use existing materials or make use of structural systems that are easily decommissioned and deconstructed in the future, perhaps for use elsewhere.
- Consider how the project will be built. If built in an urban environment, consider methods of accelerating construction to minimize impacts to the community. If built in a "greenfield" environment, consider how the foundations will be built and how that work may impact the ecology of the site, both temporarily and long-term. Evaluate alternative foundation layouts that may reduce those impacts.
- Stay informed of new technologies. Although limestone is an abundant resource, Portland cement production requires significant energy to process. Waste materials, such as fly ash and blast furnace slag, are being used to replace Portland cement in concrete mix designs. Reduced need for Portland cement production, and using materials that would otherwise go to a landfill, provide excellent benefits. But what is the next step? In the UK, research is underway to investigate the performance of low-carbon cements (LCC), such as supersulfated cements and calcium sulfoaluminate cements, in structural concrete.
- Avoid "standards traps." Many design standards were developed decades ago and do not take into account the pressing need for sustainable growth or the changing conditions current infrastructure will face in the future. Following established standards without accounting for these factors will not help achieve the necessary systemic change toward sustainability. Standards traps can present significant challenges for structural engineers because, even though the engineer may embrace the re-examination of long-standing proceedural approaches, the project owner may not agree. This provides an opportunity for the engineer to partner with the owner to increase understanding and perhaps initiate changes to the standard practices that capture the positive benefits achieved by designing with sustainability in mind.
- Perform detailed drawing and calculation reviews. Drawing and calculation errors can lead to construction re-work, which is a waste of both materials and energy and negatively impacts the project's sustainability. Moreover, the structure may not achieve its full anticipated design life and may require early replacement, which will result in significant resource and quality of life impacts for the community down the road. Finding the time to perform proper checks has always been a challenge, and the required commitment will be even greater in the future with the pressures and unforgiving deadlines of the design-build project delivery method.

Upton Sinclair wrote, "It is difficult to get a man to understand something, when his salary depends on his not understanding it." Designing and building safe, reliable structures requires the consumption of energy and materials. Typically cautious, structural engineers may be hesitant to enthusiastically embrace change and consider new pathways in design that appear to focus on conservation. However, with the depletion of natural resources and resulting enhanced environmental regulations, coupled with an industry-wide drive toward sustainable building practices, sustainable design should not be thought of as a change, but as "career sustainability."▪

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Sinclair, Upton. *I Candidate for Governor: And How I got Licked* (1935). Reprinted University of California Press, 1994, p. 109. ISBN 0-520-08198-6.