Calling on Structural Engineers to Design for Sustainability

By Jay Arehart, Ph.D.

Structural engineers neglect a key tenet of their professional obligation to society – designing for sustainability. While the concept of sustainability spans the social, economic, and environmental domains (the so-called *triple bottom line*), immediate action in the environmental domain is required in the face of the climate crisis, specifically around greenhouse gas emissions. Anthropogenic greenhouse gas emissions (e.g., carbon dioxide and methane) are causing global temperatures to increase, resulting in increased frequency and severity of weather events, impacting infrastructure in the United States and worldwide. According to the Intergovernmental Panel on Climate Change (IPCC), all sectors, including buildings, must decarbonize (have net-zero carbon emissions) by 2050 to avoid a 1.5 degree C (2.7 degrees F) temperature rise. However, today, the manufacturing of construction materials for buildings contributes to 11% of global greenhouse gas emissions. Thus, to achieve a decarbonized built environment, structural engineers must consider strength and serviceability when designing structural systems and commit to mitigating their greenhouse gas emissions.

The structural engineering profession is home to some of the best problem solvers in the world. While the profession has been charged with ensuring the public's safety, it is also responsible for designing breathtaking buildings and bridges. In both realms, structural engineers are the ones who have contributed creative solutions to increasingly complex design problems and have enabled concepts to come to life. However, despite the profession's ingenuity and leading problem-solving abilities, the structural engineering community has only recently been engaged in developing solutions to the climate crisis.

Many structural engineers think that the sustainability of a building is best left to the architect or systems engineers on the design team – that the structural engineer's role is to ensure the safety of the building. Yet, the recently updated Code of Ethics from the American Society of Civil Engineers states that engineers must "mitigate adverse societal, environmental, and economic effects" of infrastructure. Thus, as structural engineers, our ethical imperative is to reduce the greenhouse gas emissions of the structural systems we design.

Some may argue that structural engineers have no control over reducing the greenhouse gas emissions of their structural designs – that building codes and architectural geometry constrain their designs too much. However, instead of pushing away the responsibility, the structural engineering profession must become advocates for sustainable design and apply their creative problem-solving skills to reduce the greenhouse gas emissions of the structural system. While this is a paradigm shift for many surrounding the discussion of sustainable building design, it is a necessary one if we are to address the most complex and challenging issue of our generation – global climate change.

So, how should structural engineers address the greenhouse gas emissions of their structures? During the life of a building, greenhouse gas emissions can be categorized in two ways: embodied and operational. Embodied emissions are those associated with the manufacturing, transportation, and disposal of construction products, while operational emissions are those associated with heating, cooling, and lighting a building. For a high-performance building that achieves net-zero energy status, the annual operational greenhouse gas emissions are near zero, but the embodied emissions can be substantial. Thus, structural engineers are well-positioned to bring buildings to *absolute-zero carbon*, that is, net-zero greenhouse gas emissions over the lifecycle of the building.

Structural engineers can contribute to achieving absolute-zero carbon buildings through first tracking and measuring the embodied carbon of their structural systems and second, applying their problem-solving skills to reduce it. Just as loads are tracked through a structure, so should the embodied carbon. The SE 2050 Commitment is one place where structural engineers can commit to tracking and reporting the embodied carbon of the projects they work on, with the aim of reducing embodied emission of all structural systems to net-zero carbon by the year 2050.

As structural engineers, we must embrace that designing for sustainability is a core tenant of our profession – it is no longer enough to just design for strength and serviceability. Over the past century, the profession has been reshaped many times, and addressing embodied carbon is the next most pressing problem and shift for the profession. If we harness the problem-solving expertise of structural engineers, creative solutions will be developed and shared so that, collectively, we can contribute to realizing an absolute-zero carbon built environment.▪

Jay Arehart is a teaching assistant professor of Architectural Engineering at the University of Colorado Boulder and teaches courses on sustainability in the built environment.