Embodied Carbon Reduction

Floor Loading Assumptions – the Low-Hanging Fruit!

3 December 2021

ASCE/SEI has made a substantial commitment to leading and guiding the structural engineering design profession toward reducing embodied carbon in construction. SE2050 challenges engineers to re-assess their designs, practices, and specifications in all regards. To date, most efforts have focused on the "supply side" of the equation, with significant attention paid to material design choices and specifications. For example, cement replacements, efficient steel production processes (including renewable energy sources to power steel mills and the use of recycled materials), and mass timber construction all aim to supply construction materials that reduce embodied carbon.

In addition to these efforts, progress has been made to modify the basic methods of building design. A convincing argument can be made that Performance-Based Design methodologies reduce embodied carbon by building structures that are more efficient and reliable compared to conventional designs that adhere to prescriptive Code procedures. Over the last 25 years, the practice of structural seismic engineering has transformed to where Performance-Based Seismic Design for tall buildings is now considered the standard of care. Performance-Based Wind Design and Performance-Based Structural Fire Design are in the initial stages of implementation, with more research to complete and lessons to learn. But there is great promise that Performance-Based Design methodologies will significantly reduce embodied carbon.

Still, little attention has been given to the most basic and simple parameters of structural engineering—those that reside on the "demand side" of the equation, where the lowest hanging fruit grows. By re-evaluating basic loading requirements, a substantial reduction in material consumption can be readily achieved and directly result in a dramatic reduction of embodied carbon. To achieve these carbon reduction goals, we must re-examine these fundamental loading parameters.

One current example relates to the design of "collaboration spaces," which are prevalent in most commercial offices today, especially in the tech sector. Most American AHJs interpret these collaboration spaces as "Assembly Occupancy" for the purposes of exiting calculations. As a result of this interpretation, structural engineers are compelled to design floor systems supporting these areas considering a 100-psf, non-reducible live load. This loading requirement is excessive, resulting in millions of tons of unnecessary embodied carbon.

Loading diversity is another example worthy of reconsideration. For instance, in a sports facility, the number of people entering the stadium or arena is known and controlled. So, why are engineers required to consider all those people occupying simultaneously all venue areas—from the entire seating bowl to the stacked concourses to the back of the house? This condition cannot exist, but engineers continue to design structures as if it could because that is the requirement and the expectation.

Other prescriptive live loading requirements deserve reconsideration such as:

- General Office Use
- Decks and Balconies
- Hospitals, Operating Rooms and Laboratories
- Assembly Areas
- Kitchens

The point is that the simplest and easiest changes are also the most overlooked. The “demand side” of the design equation needs reconsideration—*quickly!* It is time for the profession to unite and set a new course to achieve our stated goals.

Research efforts are being organized in the United States and the United Kingdom (IStructE) to study actual floor loading demands for the conditions described above, as well as others, with the aim to provide better design guidance and update Code-stipulated loading requirements. In doing so, we can readily and quickly achieve a substantial reduction in embodied carbon.

The Charles Pankow Foundation (CPF) believes these efforts are critical steps toward successfully achieving the goals of SE2050. CPF is leading a coalition of funding partners and coordinating efforts with IStructE colleagues in the UK, where complementary efforts are underway.

ASCE/SEI’s technical and financial support for the research necessary to update these ASCE 7 Code requirements is essential.