Efficient structures help build a sustainable future

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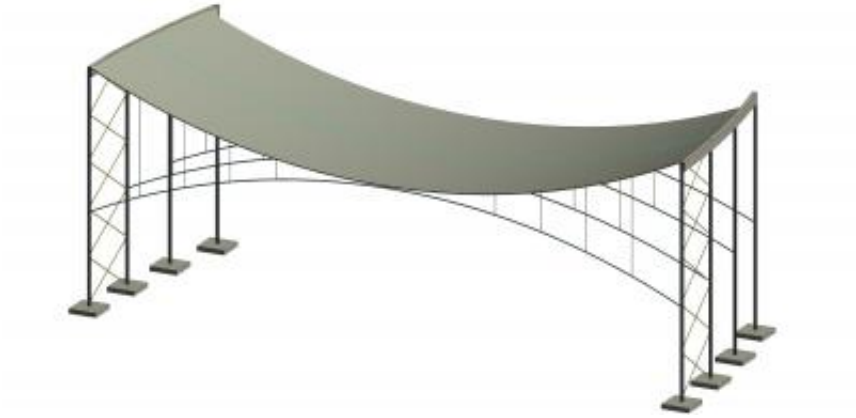


This is a cable structural system for Functional Unit 2 (3 bays or units). Credit: ASCE

When envisioning a new structure, engineers often have to balance design choices against the environmental impact of materials used. It is estimated that 40 to 50 percent of greenhouse gases are produced by the construction industry, according to the California Integrated Waste Management Board. Lessening the impact of construction on the environment is a work in progress.

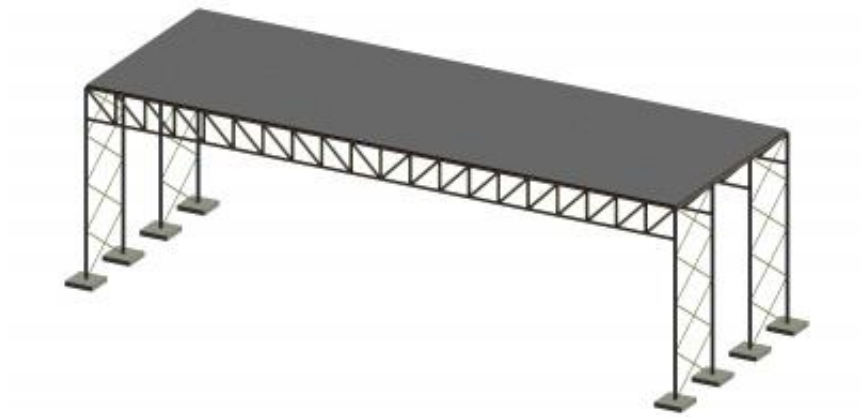
Researchers at the University of Miami (UM) and the University of Milwaukee School of Engineering are searching for designs and materials that are less harmful to the environment. The team compared the sustainability of two structural systems commonly used for spans

exceeding 250 feet: the steel cable system and the steel truss system.

"Thoughtful selection, by the architectural engineer, in the initial stages of the design process, can reduce environmental impact related to the construction process," says Matthew Trussoni, assistant professor in practice, at the UM College of Engineering and corresponding author of the study.

The findings show that the selection of steel cable structural system for long spans has considerably less environmental impact than a steel truss system to achieve the same structural requirements, through the entire life cycle of the structure.

Like a spider web, the cable system utilizes tension to sustain a structure. In contrast, the truss system uses compression members in the span of the structure.



This is a pratt truss structural system for Functional Unit 2 (3 bays or units). Credit: ASCE

"Most structures in nature rely on tension as it is the most efficient way

to transfer forces," Trussoni says. "They typically minimize compression members and maximize tension members," he says. "In a tree, for instance, the trunk is the only compression member, and the braches and leaves rely on either a combination of tension and compression, or tension alone, for their support."

For the study, the researchers designed and compared the most efficient configurations for a steel truss and a steel cable structural system. Both systems were intended for the same function and with the same requirements.

To analyze the sustainability of each structure, they used the life-cycle-assessment (LCA), which estimates the environmental impact of a structure during material extraction, manufacturing, construction, use, maintenance and end-of-life phases.

The results show that the cable system has 29 percent less mass, 65.1 percent less embodied energy (the energy required to produce the structural system, including both materials and placement) and generates 67.2 percent less CO2 emissions, than the truss system.

The findings imply that understanding how material selection can affect efficiency is one way to mitigate environmental damage from construction.

The current study titled "Life-Cycle Assessment Comparison for Long-Span Cable and Truss Structural Systems: Case Study" was recently published in in the Journal of Architectural Engineering. Other authors are Evan Simatic, Christopher H. Raebel and H. Peter Huttelmaier, from the Milwaukee School of Engineering.

The researchers are continuing to investigate and compare environmental impacts of other structural systems that can serve the same purpose.

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