A New Approach for Resilient and Rapidly Erectable Steel Structures

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Abstract:

A major challenge in the design, fabrication, and erection of steel bridges and buildings is the connection between members. Designers typically develop a structural form, and then design connectors to meet geometric and structural demands. However, this leads to complicated connections that are difficult and expensive to fabricate. Each connection is often unique, further complicating the fabrication and erection.

To address this challenge, this research presents a new approach to modular construction using (1) a modular joint designed for ease of fabrication and erection and (2) an adjustable bolted steel plate connection. Specifically, a two-dimensional (2D) modular joint for planar structures and a three-dimensional (3D) modular joint for spatial structures have been developed. The modular joints are steel nodal connectors comprised of a weldment/built up section of webs and flanges that includes a starter segment for each connecting member. They join standard rolled wide flange sections through the adjustable bolted steel plate connection. The adjustable bolted steel plate connection is a slip-critical, double shear, splice connection that can join members at a range of angles as well as adjust in-situ to achieve additional angles or compensate for erection and fabrication tolerances. The connection is comprised of plates that are cold bent by press brake to a specific set of angles. Adjustability is achieved by further cold bending the plates in the field through bolt tightening. As flanges and webs are connected independently through these splice connections, a moment-resisting connection is formed. This provides flexural stiffness for truss-like, membrane-like or beam-like behavior and enables the structure to tolerate member loss. Combined, the modular joint and the adjustable bolted steel plate connection form a “kit-of-parts” type approach, where members are standard sections and prefabricated modular joints can be repeated throughout a single structure and also used for many different structures. This presentation will feature numerical and experimental research into the behavior of the modular joint and the adjustable bolted steel plate connection.

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Bio:

Dr. Ashley P. Thrall is the Myron and Rosemary Noble Associate Professor of Structural Engineering in the Department of Civil & Environmental Engineering & Earth Sciences at the University of Notre Dame where she directs the Kinetic Structures Laboratory. Her research investigates the behavior, design, and optimization of kinetic civil infrastructure utilizing numerical and experimental approaches. Kinetic bridges, shelters, and buildings include modular systems, which are rapidly movable, erectable, and deployable. Dr. Thrall has won several distinguished awards, including an NSF Faculty Early Career Development (CAREER) award, the American Institute of Steel Construction Early Career Faculty Award, and the Hangai Prize from the International Association for Shells and Spatial Structures. She earned her PhD and MSE in Civil & Environmental Engineering from Princeton University and her BA in Physics from Vassar College.

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