Reinforced Concrete Inverted-T Beams: Strut-and-Tie Modeling and Experimental Testing

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Abstract: Several recently constructed inverted-T bridge bent caps have developed significant diagonal shear cracking. The resulting safety and serviceability concerns prompted an investigation into the design and behavior of such structures. Contrary to rectangular deep beams, inverted-T beams are loaded on a ledge at the bottom, or tension chord, of the beam. This loading induces a tension field into the web and the resulting complex strain distribution renders sectional design provisions inadequate. The current design methodology did not capture all critical elements of the structural behavior so an improved design procedure was recommended. The applicability of strut-and-tie modeling, developed for rectangular deep beams and simpler, two-dimensional design, was evaluated. An extensive experimental study was conducted in which thirty three large-scale reinforced concrete inverted-T specimens were tested and the effects of the following variables were investigated: ledge geometry, quantity of web reinforcement, number of point loads, member depth, and shear span-to-depth ratio. It was concluded that strut-and-tie modeling offers a simple and accurate design method for the more complex strain distributions in these beams and was recommended for use in inverted-T beam design along with existing serviceability requirements for deep beams. The final step will be code implementation to aid future designers.

Biography: Nancy Larson is a Ph.D. Candidate at the University of Texas at Austin. She received her B.S. from Lehigh University in Pennsylvania and her M.S. from the University of Texas at Austin. Her interests include reinforced concrete design and analysis with emphasis on disturbed regions and strut-and-tie modeling.