The Effect of Reinforcing Bar Bend Radius on the Strength and Behavior of Knee Joints

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ABSTRACT

The strut-and-tie method (STM) is used by structural engineers to design discontinuity regions of reinforced concrete structures. Using STM, the stress distribution in a concrete member is expressed as a set of struts, ties, and nodes in a strut-and-tie model. These components are then proportioned and evaluated to develop an appropriate design. One type of node that appears in knee joints (i.e., frame corners) subjected to closing moments is referred to as a curved-bar node. Although curved-bar nodes represent a unique concentration of stresses in a structure, little research focused on curved-bar node design has been conducted. In response to this research need, the current study aims to investigate the behavior of frame corners, and more specifically, how the bend radius of curved bars within knee joints affects the strength and behavior of the joints. To accomplish this, the study includes a database analysis, computer simulations, and an experimental program. Experimental data from past research on reinforced concrete knee joints subjected to closing moments were collected and analyzed. Furthermore, a numerical model of a knee joint was built using finite element analysis software. Lastly, frame corner specimens containing reinforcing bars with different bend radii were constructed and will be later tested by applying closing moments. The results of the research program are expected to clarify the evaluation of curved-bar nodes and result in recommendations for the design of knee joints under closing moments.

KEYWORDS

Strut-and-tie method, reinforced concrete, frame corner, knee joint, curved-bar node, steel reinforcement, corner strength