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Shear Strength of Reinforced Web Openings in Steel Beams

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Abstract : The floor beams of steel buildings, cold-formed steel floor joists, in particular, often require large web openings, which may affect their shear capacities. A cost effective way to mitigate the detrimental effects of such openings is to weld/fasten reinforcements. A difficulty associated with an experimental investigation to establish suitable reinforcement schemes for openings in shear zone is that moment always coexists with the shear, and thus, it is impossible to create pure shear state in experiments, resulting in moment influenced results. However, finite element analysis can be conveniently used to investigate the pure shear behaviour of webs including webs with reinforced opening. This paper presents that the details associated with the finite element analysis of thick/thin-plates (representing the web of hot-rolled steel beam, and the web of a cold-formed steel member) having a large reinforced openings. The study considered thin simply supported rectangular plates subjected to inplane shear loadings until failure (including post-buckling behaviour). The plate was modelled using geometrically non-linear quadrilateral shell elements, and non-linear stress-strain relationship based on experiments. Total Lagrangian (TL) with large displacement/small strain formulation was used for such analysis. The model also considered the initial geometric imperfections. This study considered three reinforcement schemes, namely, flat, lip, and angle reinforcements. This paper discusses the modelling considerations and presents the results associated with the various reinforcement schemes under consideration. The paper briefly compares the analysis results with the experimental results.

Keywords : cold-formed steel, finite element analysis, opening, reinforcement, shear resistance
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