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Shear Capacity of Rectangular Duct Panel Experiencing Internal Pressure

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Abstract : The end panels of a large rectangular industrial duct, which experience significant internal pressures, also experience considerable transverse shear due to transfer of gravity loads to the supports. The current design practice of such thin plate panels for shear load is based on methods used for the design of plate girder webs. The structural arrangements, the loadings and the resulting behavior associated with the industrial duct end panels are, however, significantly different than those of the web of a plate girder. The large aspect ratio of the end panels gives rise to multiple bands of tension fields, whereas the plate girder web design is based on one tension field. In addition to shear, the industrial end panels are subjected to internal pressure which in turn produces significant membrane action. This paper reports a study which was undertaken to review the current industrial analysis and design methods and to propose a comprehensive method of designing industrial duct end panels for shear resistance. In this investigation, a nonlinear finite element model was developed to simulate the behavior of industrial duct end panel subjected to transverse shear and internal pressures. The model considered the geometric imperfections and constitutive relations for steels. Six scale independent dimensionless parameters that govern the behavior of such end panel were identified and were then used in an extensive parametric study. It was concluded that the plate slenderness dominates the shear strength of stockier end panels, and whereas, the aspect ratio and plate slenderness influence the shear strength of slender end panels. Based on these studies, this paper proposes design aids for estimating the shear strength of rectangular duct end panels.

Keywords : thin plate, transverse shear, tension field, finite element analysis, parametric study, design
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