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PROCEEDINGS

Theoretical Study on the Bending Collapse of Multi-Cell Thin-Walled Rectangular Beams

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ABSTRACT

Thin-walled beams with various cross-sectional shapes were widely applied in automobiles or other large-volume industrial products. Researchers have tried different methods to improve their crashworthiness performances and predict the collapse responses of the beams under various loads. Multi-cell thin-walled beams were reported to show excellent energy absorption efficiency and crashworthiness performances under many load conditions. Up to now, theoretical analyses on the axial crushing of multi-cell beams have attracted extensive attentions, and significant progress has been made in predicting the energy absorption of multi-cell beams with various sections. However, the theoretical analysis on the bending collapse of thin-walled beams is much more complicated than those on the axial crushing since there are more influence factors, such as the span and shear forces. Moreover, due to the significantly increased complexity on theoretical analysis of multi-cell beams, the existing theoretical models are primarily focused on single-cell beams. There are still no systematic theoretical methods to predict the large deformation bending response of multi-cell beams under three-point bending. In this work, a constituent element method is proposed to predict the bending response of multi-cell rectangular beams. Theoretical models are established for two types of constituent elements: E-shaped (Type I) and Ⱶ-shaped (Type II) elements. The bending process of the constituent elements is divided into two stages: the elastic-plastic bending stage and the buckling stage. Theoretical solutions are derived individually for these two stages. The bending moment-rotation responses of several groups of multi-cell sections with 2×2 and 2×3 cells, constituted by these constituent elements, are then predicted by the proposed theory. The feasibility of the constituent element method and the accuracy of the proposed theories for E-shaped and Ⱶ-shaped elements are validated by numerical results. The present work provides an effective approach to predict the bending moment response and energy absorption of multi-cell beams under three-point bending.

KEYWORDS

Multi-cell beams; bending collapse; energy absorption; theoretical study; constituent element method

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