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Cyclic elastoplastic finite element analysis and ductility evaluation of cold-formed thin-walled steel tubular columns

Iraj H P Mamaghani
University of North Dakota, USA

Thin-walled steel tubular columns are very useful in highway bridge pier construction as it offers flexible space requirement and have speedy construction time. The paper deals with the elastoplastic analysis and seismic performance evaluation of thin-walled steel tubular bridge piers subjected to constant axial force and cyclic bidirectional lateral loading. The important characteristics of the thin-walled steel tubular bridge piers are noted and the basic seismic design concepts of such structures are presented. Four patterns of bidirectional lateral loading; diagonal, rectangular, diamond and circular, are considered in the analysis. Cyclic circular loads are adopted as virtually the severest bidirectional horizontal loads for tubular columns. From the experimental and numerical results, it is anticipated that the strength and ductility of the steel bridge piers decrease considerably under the cyclic bidirectional circular loads, compared with those under the conventional cyclic unidirectional loads. The experimental results are used to confirm the validity of the nonlinear finite element analysis where the two-surface cyclic plasticity constitutive model is implemented in the analysis to account for material nonlinearity. With the extensive numerical results obtained from the nonlinear finite element analysis, empirical prediction equations are derived to evaluate the strength and ductility of thin-walled circular and rectangular steel bridge piers under the cyclic bidirectional loads. The effects of some important parameters, such as width- to-thickness ratio, column slenderness ratio, and loading history on the ultimate strength and stability of thin-walled steel tubular bridge piers are presented and discussed.

iraj.mamaghani@engr.und.edu