Geometric nonlinear analysis of doubly symmetric thin-walled beams with variable open section subjected to axial load and torque

Student：Feng-Cheng Liu　　　　Advisor：Dr. Kuo-Mo Hsiao

Department of Mechanical Engineering

National Chiao Tung University Hsinchu, Taiwan

ABSTRACT

A six node degenerate element is proposed based on the concept of Ref. [1] by using consistent co-rotational finite element formulation for the geometric nonlinear analysis of doubly symmetric thin-walled I beam with slow varying flange. Only the axial displacement and axial rotation are considered for the element developed here. The kinematics of the element is governed by two sectional nodes and four true element nodes. The deformations of the element are described in the current element coordinate system, which is constructed at the current configuration of the element. In element nodal forces, all coupling between twisting and stretching deformations of the element is considered by consistent second-order linearization of the large displacement theory.

An incremental-iterative method based on the Newton-Raphson method combined with constant arc length of incremental displacement vector is employed for the solution of nonlinear equilibrium equations. The zero value of the tangent stiffness matrix determinant of the structure is used as the criterion of the buckling state. Numerical examples are studied to verify the accuracy of the present method and investigate the torsional buckling load and post-buckling behavior of thin-walled I beams with different variable sections subjected to different axial loads. The geometric nonlinear behavior of thin-walled I beams subjected to axial load and axial torque simultaneously are also studied.