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LIMIT ANALYSIS OF 3D FRAMES WITH NONLINEAR HARDENING BEHAVIOR AND COMBINED INTERACTION

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This work deals with limit elastoplastic analysis of steel structures in the framework of mathematical programming. The maximum load carrying capacity of the structure is determined by solving an optimization problem with linear equilibrium, compatibility and yield constraints together with a nonlinear complementarity constraint. The disjunctive nature of the latter enforces the formulation of a non-linear programming problem using a penalty function method. Axial force - biaxial bending interaction is described by a 3D nonlinear surface. Yield condition is formed for every cross section depending on the intersection point of the stress vector with the nonlinear yield surface. The tangent plane to the yield surface at the intersection point is determined and its normal vector is evaluated. Then, yield condition is formed only for the specific tangent hyperplane for every cross section at every optimization step. Moreover, isotropic nonlinear hardening/softening cross-sectional behavior is considered combining the corresponding constitutive relations. The entire formulation succeeds in reducing the size of yield, hardening and complementarity conditions to a minimum enabling the solution of large scale problems. Numerical results of 3D steel frames are presented that verify the validity and demonstrate the computational efficacy of the proposed method.

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