HIGHLIGHTS

Advanced Nonlinear Analysis of Frames Composed of Tapered Members And Flexible Connections

Ioana V. MARCHIS

SUPERVISOR:
Prof.dr.eng. Cosmin Gruia CHIOREAN

- The paper presents a new computer method for **nonlinear inelastic analysis of steel frames** consisting with members with non-uniform cross-sections. The behaviour model accounts for material inelasticity (concentrated plasticity) due to combined bending and axial force, geometrical nonlinear effects in conjunction with initial geometric imperfections using **only one element** per physical member. The proposed model is practical in daily design of structures by combining modelling benefits, computational efficiency and reasonable accuracy.

- A **novel second-order flexibility-based tapered Timoshenko-Euler element** that allows explicit and efficient modelling of element geometrical effects, transverse shear deformation, and member distributed lateral loads and initial geometric imperfections has been developed.

- The present formulation combines the **power series approach with the Maxwell-Mohr** method to compute the force-displacement relationship at the element level, with the rigid body modes removed. For this purpose, the **second order differential equilibrium equation** with variable coefficients is successfully solved by applying the **power series approach**, considering as a primary unknown the bending moment. The proposed governing equation and the resulted element stiffness matrix and equivalent nodal load vector are of general forms, they can be applied to any variation of sectional shape along member length.

- The proposed formulation allows us to take into account in a more efficient manner **the initial geometrical imperfections** and member lateral loads, the effects of shear deformation are integrated directly in force-displacement relationships by using the Maxwell-Mohr method. **Distributed lateral loads** acting along the member length can be directly input into the analysis without the need to divide the member into several elements leading to a consistency in the linear and the nonlinear structural models.

- The **plastic hinge method** is extended for non-prismatic elements to simulate member plasticity, in conjunction with consideration of second order effects and lateral loads in the bending moment expression. Also, the proposed procedure ensures the **plastic interaction surface is not "violated", once a plastic hinge is formed.** Using an updated Lagrangian formulation (UL), the global geometrical effects are considered, updating the element forces, member lengths and the rotation matrix R_b , corresponding to transformations equations from local to global coordinates, at each load increment.