ABSTRACT

Project Code: RSA 5480001

Project Title: Nonlinear Frame Model for Large Displacement Inelastic Analysis of Frame Structures

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The main goal of this research is to develop and implement the simple but efficient nonlinear frame models (bar and beam) that take into account geometric and material nonlinearities. These frame elements can be used to model both elastic and inelastic behaviors of slender framed structures undergoing large displacements and large rotations. The material nonlinearity is included into the models through the fiber-section discretization. This could be done with ease since the Euler-Bernoulli-von Karman beam theory will be used in describing the frame section kinematics. Therefore, the local geometric nonlinearity ($P-\delta$ effect) is automatically accounted for. However, the use of standard displacement-based frame element with this nonlinear beam theory can lead to the so-called *membrane-locking* problem, thus resulting in an over-stiff frame model. One way to remedy this locking phenomenon is to use the reduced integration technique. In this research, both Hellinger-Reissner mixed and force-hybrid variational principles are used to develop the nonlinear frame elements within the corotating local framework. This stems from the fact that the resulting frame elements are locking free and have superb performance in describing the inelastic actions when compared with the standard displacement-based frame models. The global geometric nonlinearity ($P-\Delta$ effect) is introduced into the models via the corotational approach.

Keywords: Corotational formulation; Large displacement/rotation; Hellinger-Reissner mixed functional; Nonlinear bar element; Nonlinear beam element; Geometric nonlinearity; Material nonlinearity; Euler-Bernoulli-von Karman beam theory; Total Lagrangian formulation.