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Efficient First-Order Plastic Hinge Analysis Based on the Generalized Finite Element Method

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This paper presents a generalized finite element formulation for classical Euler-Bernoulli beam elements. The method efficiently performs first-order plastic hinge analysis of large frame structures where pin connections or plastic hinges are simulated by proper enrichment functions describing weak discontinuities of the solution. The proposed methodology enables the insertion of plastic hinges without modifying the connectivity of elements. The formations of plastic hinges are instead achieved by hierarchically adding degrees of freedom to existing elements. The most time-consuming portion of a first-order plastic hinge analysis is the solution of a series of linear elastic problems to simulate the collapse of a large frame structure. Its computational cost can be significantly reduced by utilizing a static condensation scheme similar to the one proposed in [1]. This is possible due to the hierarchical nature of generalized finite element shape functions. Several numerical examples are analyzed to investigate the effectiveness and accuracy of the proposed method.

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