EFFECT OF THE PANEL ZONE ON PROGRESSIVE COLLAPSE

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In progressive collapse, a minor damage or local collapse shall be totally resulted in ruining building or its large part. Final collapse is not proportional to the initial collapse. Panel zone plays a key role in this collapse, so, this study has considered the behaviour of panel zone on progressive collapse. For this purpose, a steel four- story building, having special moment resisting frame, is designed for a high seismic hazard- prone regions. Then, potential of occurring progressive collapse has been investigated, during sudden removal of a column, from first floor.

In this paper, the influence of modelling the panel zone in beam to column connections is studied in a four story building. Opensees is applied here for the analyses, in which the panel zone is modelled with "Krawinkler model".

Much research has been carried out regarding the validity and applicability of the various analysis methods recommended in design guidelines for accurate prediction of progressive collapse (Powell, 2005; Marjanishvili and Agnew, 2006). Khandelwal and El-Tawil (2007) presented a calibrated micromechanical constitutive model for steel to investigate a number of key design variables that influence the formation of catenary action in special steel moment resisting frame sub-assemblies.

Even though in depth analytical and experimental studies have been carried out to evaluate the progressive collapse potential of steel structures as stated above, the effect of the panel zone on the performance of a steel structure subjected to the loss of any load-resisting element has not yet been investigated. In this study the progressive collapse of steel moment-resisting frames has been investigated taking into account the deformation of panel zones.

In this study the panel zone model of Gupta and Krawinkler (1999) shown in Figure 1 was used to simulate a panel zone adopting the full dimensions of the panel zone with rigid links, and a rotational spring were modeled by the 'zero Length' element and the 'Hysteretic' material model.

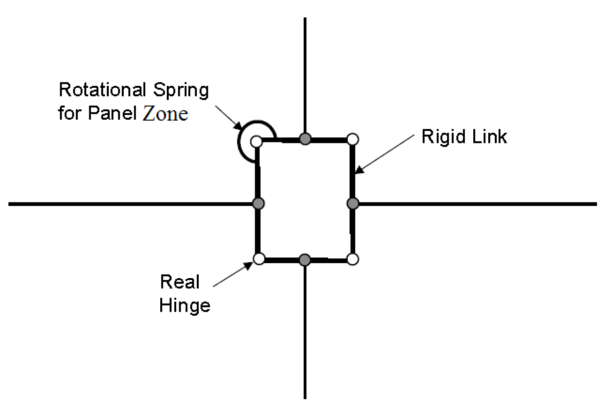

Figure 1. Modeling of beam-column joint with panel zone (Gupta and Krawinkler, 1999)

To include panel zone deformation in frame analysis, the traditional center-tocenter line representation of the frame must be modified. Figure 2 shows a comparison between an experiment on a beam–column subassemblage and an analytical prediction of the subassemblage response. The experiment was specimen A1 reported by Krawinkler et al. (1971). Inelastic response of this specimen was dominated by yielding of the panel zone. The analytical results are obtained from a model of the specimen using center-to-center line dimensions. A beam–column element with plastic hinges was employed in this analysis. From the figure it can be seen that the analysis using the center-to-center line dimension, without explicit modeling of the panel zone, may produce misleading results. Clearly, the panel zone response must be explicitly modelled to obtain realistic predictions of the overall frame behavior.

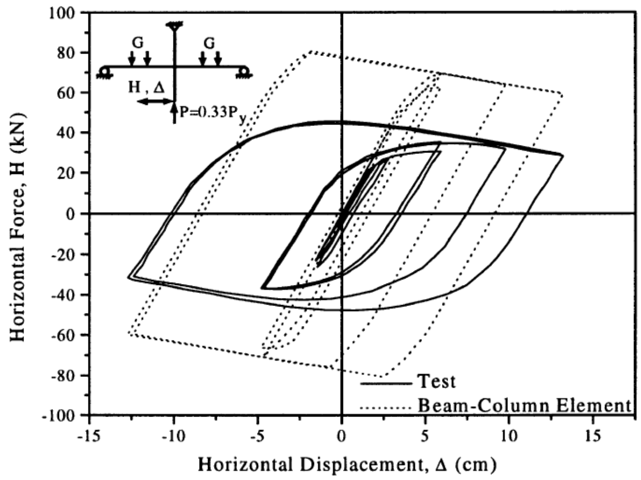

Figure 2. Comparison of test results (Krawinkler et al., 1971) and analytical results obtained by using center-to-center line dimension modeling

REFERENCES

Gupta A and Krawinkler H (1999) Seismic Demands for Performance Evaluation of Steel Moment Resisting Frame Structures (SAC Task 5.4.3), John A Blume Earthquake Engineering Research Center Report No. 132, Department Of Civil Engineering, Stanford University, Stanford, CA

Khandelwal K and El-Tawil S (2007) Collapse Behavior of Steel Special Moment Resisting Frame Connections, *Journal of Structural Engineering*, *ASCE*, 133(5): 646-655

Krawinkler H, Bertero VV and Popov EP (1971) Inelastic behavior of steel beam-to-column subassemblages, Report No. EERC 71/07, University of California, Berkeley, CA

Marjanishvili S and Agnew E (2006) Comparison of Various Procedures for Progressive Collapse Analysis, *Journal of Performance of Constructed Facilities*, 20(4): 365-374

Powell G (2005) Progressive Collapse: Case Study Using Nonlinear Analysis, Proceedings of the 2005 structures congress and the 2005 forensic engineering symposium, Apr. 20-24, New York