INELASTIC HYSTERESIS BEHAVIOR OF AXIALLY LOADED STEEL MEMBERS WITH ROTATIONAL END RESTRAINTS

by

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SYNOPSIS

Predominantly axial-force-carrying structural members, such as bracing members, have been widely used in earthquake resistant high-rise structures. Past studies of the hysteresis behavior of these members assumed the end conditions to be ideally-pinned, fully-fixed, or fixed-free. The members were also assumed to be perfectly straight and to become unstable at the theoretical buckling load or at the compression yield load. Realistically members have imperfections and their end conditions are different from the assumed ideal conditions. To simulate these effects, axially-loaded steel members with equal initial plastic rotation angles at midspan and at the ends (initially two inclined-straight-segment members) and with symmetrical rotational end springs (connections) were studied (1).

RESULTS

The basic assumptions were that the member has an elasto-plastic moment-curvature relationship with plastic moment modified due to axial force, that local and lateral-torsional buckling cannot occur, and that the connection has an elasto-plastic moment-rotation relationship. The following conclusions were deduced from a parametric study of member behavior (1):

1) A member with nearly balanced strength connections, i.e., connection flexural strength that allows plastic hinges to form simultaneously at midspan and at the ends (the only possible locations), is more efficient with respect to the compressive load capacity and the energy dissipation of the hysteretic curve than members of the same length and cross section with non-balanced strength connections.

2) The normalized hysteretic curve (load/axial yield load-relative end displacement/axial yield deformation) of any member with balanced strength connections can be represented adequately by the hysteretic curve of a pin-ended member of the same cross section and effective slenderness ratio.

3) Variation in connection stiffness influences the hysteretic behavior mainly up to plastification at the member ends, then yielding effectively releases connection end restraint during continued incremental loading.

4) Variation in cross-sectional properties or axis of bending has little effect on the normalized hysteretic curves.

REFERENCES

1. Prathuangsit, D., "Inelastic Hysteresis Behavior of Axially Loaded Steel Members with Rotational End Restraints," Ph.D. Thesis, The University of Michigan, Ann Arbor, Michigan, April, 1976.

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