Influence of cracks on the elastic stability of columns and frames

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Civil Engineering

January 1985

Abstract

Influence of elastic, non-propagating, transverse cracks on the elastic, stability of columns and frames is investigated in this thesis. The crack has been modelled as a rotational spring having a stiffness proportional to the reciprocal of the crack compliance. The general solution of the governing differential equation of the column should satisfy the conditions at the crack location in addition to the boundary conditions at both ends, leading to a system of homogeneous equations which may be reduced to the characteristic equation of the system. The system of equations (or the characteristic equation) is solved numerically using a computer algorithm which traces the required eigenvalue from which the critical load of the system can be obtained.

Using the static approach, the influence of a single crack on the elastic stability of columns under conservtive force is investigated, and the characteristic equations are derived in terms of the compliance and the location of the crack for different boundary conditions. Also, the influence of two multiple cracks on the elastic stability of a cantilever column under conservative force is investigated, and the characteristic equation is derived in terms of the compliance and the location of each crack.

Using the dynamic approach, the influence of a single crack on the elastic stability of a cantilever column under conservative force is investigated for various values of the compliance and the location of the crack. Also, the influence of single and two multiple cracks on the elastic stability of a cantilever column under a nonconservtive force is investigated, and the results are interpreted using a new concept of buckled mode shapes.

Finally, the influence of a single crack in the column member on the elastic stability of two-member frames under conservative force is investigated using the static approach, and the characteristic equations are derived in terms of the crack compliance, the crack location, and the stiffness ratio (the relative stiffnesses of the beam and column members) for different boundary conditions.