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NASA TECH BRIEF

Interaction of Crippling and Torsional-Flexural Instabilities for Centrally Loaded Columns

An empirical technique is proposed for prediction of failure loads for centrally loaded columns, with thin-walled, open cross sections, which may fail by a combination of torsional-flexural buckling and crippling. Knowing the torsional-flexural buckling load and the crippling load for a column, their interaction can be predicted by a modification of the Johnson-Euler equation which is often used to relate crippling and Euler-type buckling:

$$P_c = P_{cs} - (P_{cs}^2/4P^*)$$

where P_c is the critical load (pounds) in combined crippling and torsional-flexural buckling, P_{cs} is the crippling load (pounds), and P^* is the critical load (pounds) in torsional-flexural buckling.

For such loaded columns that fail at stresses within the elastic range, the critical mode of failure is often torsional buckling or a combination of torsional and flexural buckling; it depends primarily on the geometry of the cross section and the length of the column.

There are methods for evaluation of this torsional or torsional-flexural buckling load for many variations in cross-sectional geometry and restraint conditions. All such methods, however, are based on the assumption that the cross-sectional shape does not change during buckling; that is, the theories consider primary failure of columns, rather than secondary failure, characterized by distortion of the cross section. Formulation of a theory incorporating coupling distortion and flexure with local buckling would be extremely complex.

For very short columns of thin-walled, open cross sections the failure stress is determined by the crippling-stress method, which does provide for local distortion of elements of the cross section.

Thus the coupling of these two failure modes by empirical means would provide a simple means for prediction of failure loads of columns that may fail by a combination of the torsional-flexural mode and the crippling mode. This approach has been followed already in the coupling of crippling and Euler buckling for closed sections (Johnson-Euler equation); the approach is the same in this coupling of crippling and torsional-flexural buckling. Although no attempt has been made to generate or correlate test data to confirm the accuracy of this technique, it is believed to be accurate.

Notes:

1. The following documentation may be obtained from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-CR-61287 (N69-32465), Interaction of Crippling and Torsional-Flexural Instability for Centrally Loaded Columns
2. Technical questions may be directed to:
   Technology Utilization Officer
   Code A&TS-TU
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B70-10598

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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