Professor E. F. Masur

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Selected Publications:


ABSTRACT: The buckling mode of a structure is defined to be symmetric if its sign is indefinite; this happens when the potential energy expansion near the buckling point does not contain terms which are cubic in the buckling mode. If, in addition, the cubic terms vanish identically for all possible modes then the structure is defined to be “completely symmetric”. Many structures of technical significance are included in this definition, such as columns, plates, frameworks, etc. If certain technically realistic order-of-magnitude assumptions are made, the analysis of the buckling and post-buckling behavior of completely symmetric structures can be carried out in great generality. For example, it is shown in the present paper that structures of this type buckle under increasing loads and are therefore insensitive to initial imperfections. The post-buckling state is characterized by the satisfaction of a minimum complementary energy principle, which represents an extension of the corresponding classical principle into the nonlinear domain. Moreover, the energy can be bracketed between upper and lower bounds and an error estimate is thus established at least in an averaging sense. Under certain circumstances the load approaches a finite value as the structure approaches collapse. This collapse load can also be bracketed between classes of “statically admissible” load parameters (representing lower bounds) and “kinematically admissible” load parameters (representing upper bounds). The gap between these bounds can be reduced arbitrarily. The example of a slender statically indeterminate beam subjected to lateral and torsional buckling is introduced to demonstrate the general principles developed in the paper.


ABSTRACT: A general discussion of the behavior of the shallow circular arch is presented. It is shown that, irrespective of specific loading or boundary conditions, it is possible to arrive at general conclusions regarding buckling, postbuckling, and imperfection sensitivity. General methods of analysis are established which lead to the determination of points of bifurcation and of postbuckling paths under symmetric loads. Modifications
accounting for antisymmetric load components are introduced, with special emphasis on their asymptotic and
limit load effect.

National Structural Engineering Meeting, San Francisco, April 9-13, 1973

L. W. Glaum, T. Belytschko and E. F. Masur (Department of Materials Engineering, University of Illinois at
Chicago Circle, Chicago, IL 60680, U.S.A.), “Buckling of structures with finite prebuckling deformations—a
perturbation, finite element analysis”, International Journal of Solids and Structures, Vol. 11, No. 9, September
1975, pp. 1023-1033, doi:10.1016/0020-7683(75)90045-1
ABSTRACT: In some technically important structures, finite prebuckling displacements have a profound effect
on the bifurcation load. To ignore these displacements, as is done in most instability analyses, is to invite major
errors, usually on the unsafe side. A method is presented which approximates this effect without the necessity of
solving nonlinear equations. The general theory is developed for any elastic body under conservative loads. The
governing equations are subsequently discretized by a finite element approach and it is shown that for planar
framed structures, the second order approximation to the buckling load can be found in terms of the standard
linear and geometric stiffness matrices of structural analysis; the solution procedure does not require iterations.
For illustrative purposes, a computer program was developed for planar structures and the results are compared
to the exact solution for the buckling of shallow circular arches.

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“On the use of the complementary energy in the solution of buckling problems”, International Journal of Solids
ABSTRACT: A systematic derivation of the expression for the complementary energy in elastic buckling
problems is presented. Compatibility is identified with variation with respect to the stress components, and the
resulting eigenvalue problem is shown to be equivalent to, and sometimes more convenient than, the
responding formulation in terms of the potential energy. Similarly, approximate techniques may lead to
better as well as simpler estimates, whose upper bound property can, however, be assured only through
appropriate safeguards. The method is applied in some detail to buckling of columns of arbitrary boundary
conditions and axial force distribution. Another example is the problem of lateral beam buckling, with the effect
of warping restraint included. In both cases (and presumably in many others) the complementary energy
formulation is of lower order than the conventional potential energy formulation, and it is clear that the same
simplification should also apply to finite elements or other discrete formats. The method is restricted to the
(technically significant) case of a linear prebuckling state.