THE ELASTIC AND PLASTIC BUCKLING OF CIRCULAR CYLINDERS IN BENDING

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Abstract

An analytical and experimental study of the buckling of circular cylinders in bending is carried out, with emphasis on the elastic-plastic problem. A review of past work on this problem shows that many of its aspect require further investigation.

A set of linear equations is derived, and used to investigate the bifurcation characteristics of both linear-elastic as well as elastic-plastic cylinders subjected to end moments. In most general case, and J_2 incremental theory is used. The replacement of the tangent modulus in the general buckling equation by the elastic modulus reduces this equation to Donnell's linear stability equation.

In the treatment of the elastic problem, the circumferential distribution of lateral buckling displacement is approximated by a Gaussian distribution, and results are obtained from a relatively simple analysis for both the cases of pure bending as well as combined bending and internal pressure. These results compare very well with those obtained by others in more rigorous analyses.

Some of the results of the elastic buckling analysis are then made use of in the treatment of the corresponding elastic-plastic problem. New results are presented for the bifurcation of elastic-plastic problem cylinders under pure bending. Theses results are compared with corresponding results for elastic-plastic axially compressed cylinders.

The results of an experimental study of the collapse of cylinders in pure bending are presented. The tubes tested were thick enough to buckle in the plastic range. Collapse of these specimens was due mainly to wrinkling on the compressive side though a small amount of cross-sectional ovalisation also occurred. Measurements of the ripples are presented and discussed. The presence of these ripples before collapse took place indicated the presence of initial imperfections.

A comparison between experimental critical strains and various theoretical strains shows that the experimental values are closest to deformation theory predictions for axially compressed cylinders. A similar conclusion is reached with regard to the comparison of experimental and theoretical critical stresses.