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Discussion

On the Dynamics of Stability of Cylindrical Shells Conveying Inviscid or Viscous Fluid in Internal or Annular Flow[1]

C. Dupuis and J. Rousselet.[2] The authors' paper provides a good opportunity to discuss (and hopefully resolve the discrepancies with experiments) some theoretical features of the linear stability of fluid-conveying cylindrical structures supported at both ends, namely post-buckling restabilization of the initial equilibrium and post-buckling coupled-beam-mode flutter. This discussion comes within the scope of an earlier one by Professore Païdoussis (1979).

Professor Huseying (1978) studied the broad family of gyroscopic systems, which includes the fluid-structure systems under discussion, and showed that "gyroscopic forces can stabilize an unstable conservation system... and create flutter regions between divergence points," in agreement with the results (Figs. 2 and 3) of the papers. When material (internal) damping was added to these gyroscopic systems, it was also shown that "an equilibrium state of a gyroscopic conservative system which was (re)stabilized by gyroscopic forces will lose its stability with the addition of dissipation; in other words, all the higher regions of stability (restabilization) are wiped out by dissipation while the fundamental region of stability remains unaffected." Therefore, if the present fluid-structure systems were to be modeled more realistically by introducing material damping, one may wonder what effect this would have on the reported restabilization and, incidentally, one coupled-beam-mode flutter.

Regarding the global mechanism of solution, it is not specified in the paper whether the linear theory used to describe the infinitesimal dynamics is with respect to the *straight* equilibrium position or the *buckled* equilibrium position when it comes to predicting post-buckling stability. In Figs. 2 and 3, when the flow velocity[3] is in the range $[0, v_B]$, the *straight* equilibrium configuration is the only equilibrium position of the cylindrical structure and it is marginally stable. When $v = v_B$, the structure buckles (static instability) in its first axial (beam) mode to reach a new configuration of small, yet finite, curvature after nonlinear effects have set in. So for $v \geqslant v_B$, there are two equilibrium positions: the *straight* configuration, which is unstable whatever the disturbance, and the slightly curved (or *buckled*) configuration, the curvature of which increases with v. It is the stability of this new *buckled* configuration which remains to be investigated. Past the buckling point, a linear stability prediction will be useful in simulating an actual experiment if it is made with respect to the *buckled* configuration. Hence, it matters to know how the theoretical results of the paper (and the references cited therein) were obtained so that they can be legitimately compared (and reconciled?) with experimental results.

As to the much simpler (but more familiar to the discussers) case of the simply supported pipe (beam and plug-flow theories), a **linear** stability theory with respect to the *buckled* equilibrium position *does not* predict post-buckling restabilization, *nor* post-buckling coupled-mode flutter (the *buckled* position is linearly stable), in any of the many cases investigated, including those reported by Païdoussis (1979) and Huseyin (1978), and this in qualitative agreement with the corresponding experiments. These simple results are supportive of the foregoing comments on the results of the paper.

References

Huseyin, K., 1978 *Vibrations and Stability of Multiple Parameter Systems,* Noordhoff International Publishing, Alphen Aan Den Rijn.

Païdoussis, M. P., 1979, "Nonlinear Stability of a Two-Dimensional Model of an Elastic Tube Conveying a Compressible Flow" (Discussion), ASME *Journal of Applied Mechanics,* Vol. 46, pp. 963–964.

[1]By A. El Chebair and A. K. Misra, published in the August 1991 issue of JOURNAL OF PRESSURE VESSEL TECHNOLOGY, Vol. 113, pp. 409–417.

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[3]The symbol "v" is used to represent either the internal or annular velocity for simplicity.