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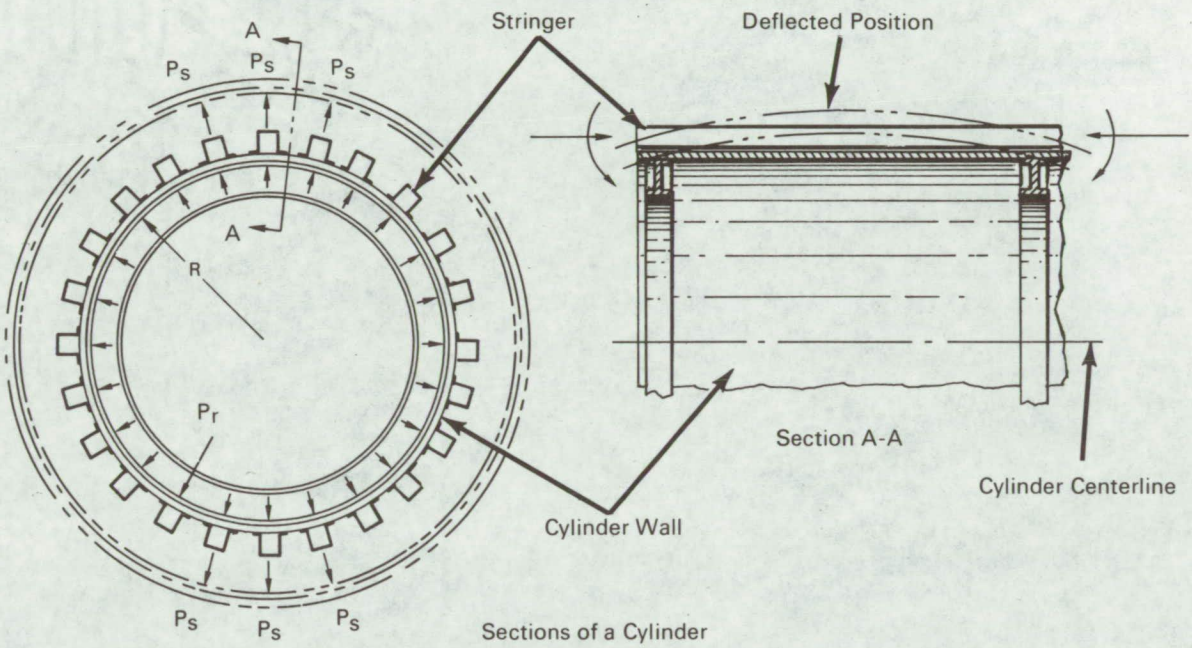
NASA TECH BRIEF

Hoop Restraint on Beam-Column Behavior in a Stiffened Cylindrical Shell



Sections of a Cylinder

A new method accounts for the skin's hoop restraint on the beam-column behavior of an axially loaded, stiffened, cylindrical shell; each stringer is treated as an independent column on an elastic foundation. For the very conservative former method it was assumed that the stringers were radially supported by the frames only, which resulted in either overweight structures or unrealistically low margins of safety.

The equivalent radial support of the skin's hoop restraint on the stringers is simulated by elastic supports on a beam column. The spring rates (pounds per inch) of these supports are determined by the formula

$$K = (btE)/R^2$$

where b (inches) is the spacing of stringers, t (inches) is skin thickness, E (pounds per square inch) is the material's modulus of elasticity, and R (inches) is the cylinder's radius.

For the figure it is assumed that circular sections remain circular; this assumption is essentially correct if the cylinder is stiffened by frames or bulkheads and if the longitudinal stringers are closely spaced. The figure shows that beam-column deflection of the stringers causes the cylinder to expand or contract. The stringers must apply a load equivalent to the pressure load that would cause the expansion or contraction.

Where P_r is equivalent pressure in pounds per square inch and P_s is stringer load (pounds per square

(continued overleaf)

inch) applied to the skin, for a unit length of cylinder, $P_s = P_r$ b and $K = P_s$ required for 1-in. deflection; the hoop stress is $P_r R/t$; and the strain due to hoop stress is $P_r R/tE$. Since the change in R is proportional to the change in circumference,

$$\Delta R = [P_r R/tE(R)] = Pr\, R^2/tE = P_s R^2/btE$$

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Code A&TS-TU
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Patent status:

No patent action is contemplated by NASA.

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