Buckling, Post-Buckling, and Material Failure Behavior of Noncircular Composite Cylinders

Miao Sun and Michael W. Hyer (hyerm@vt.edu)
Department of Engineering Science and Mechanics
Virginia Polytechnic Institute and State University
Blacksburg VA 24061

Cylinders with a noncircular cross section may be better suited for some applications than cylinders with a circular cross section. However, relative to circular cylinders, noncircular cylinders may be less efficient in withstanding a variety of loads. The varying radius of curvature with circumferential location leads to a nonuniform stress state that results in the cylinder being more prone to material failure at some circumferential locations than at others, independent of any geometric or material imperfections that may develop during cylinder fabrication [1]. Additionally, the flatter portion of the cylinder cross section may be prone to buckle at a low load level [2]. This study investigates a method to mitigate the effects on the axial load carrying capacity of the varying radius of curvature in fiber-reinforced composite cylinders with elliptical cross sections by varying the lamination sequence with circumferential location. An elliptical cross section is believed to be representative of noncircular cross sections. Ideally, the fiber angles would vary continuously with circumferential location, as the radius of curvature does, but for the initial studies reported on here, the circumference is divided into segments and the lamination sequence varies in a discrete fashion from segment to segment. Such an approach has been used in the study of circular composite cylinders [3]. The study seeks the combination of laminates in the segments, all with the same number of layers, which leads to the highest axial buckling load capacity. Of equal importance is minimizing the drop in axial load capacity after the cylinder buckles, and examining the potential for material failure in both the pre- and post-buckled states.

References

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