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BEND-FREE DESIGN OF SUPER ELLIPSOIDS OF REVOLUTION COMPOSITE PRESSURISED VESSELS

Shahrzad Daghighi*[1], Giovanni Zucco[2], Mohammad Rouhi[3], Paul M. Weaver[4]

[1] PhD student,Bernal Institute, School of Engineering, University of Limerick, Limerick, Ireland, Shahrzad.Daghighi@ul.ie

[2] Post Doctoral Researcher, Bernal Institute, School of Engineering, University of Limerick, Limerick, Ireland, Giovanni.Zucco@ul.ie

[3] Research Fellow, Bernal Institute, School of Engineering, University of Limerick, Limerick, Ireland, Mohammad.Rouhi@ul.ie

[4] Professor, Bernal Institute, School of Engineering, University of Limerick, Limerick, Ireland, Paul.Weaver@ul.ie

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Shell structures are well-known curved elements that are used widely in many engineering applications because of their exceptional structural performance. Shell structures can resist external transverse loads by generating membrane stresses and inefficient bending deformations and stresses. Bend-free design provides an opportunity to use the full load carrying potential of the structure since the load is uniformly distributed through thickness. This study set out to extend Daghighi et al.'s study [1] for more complex and realistic geometry and generalized the bend-free design for a family of structures named super ellipsoids of revolution under uniform internal pressure. This family of structures are a baseline design for many structural applications such as blended wing body, high pressure vessels and submarine structures. Super ellipsoids of revolution not only provid a great packing efficiency, but they also provide a smooth change in stress as a result of smoothly changing the curvature that can be beneficial. Moreover, in manufacturing process there will be no need for joining several parts together that can be hard and costly. We can also eliminate the stress concentration at the location of joints and caused by a sudden change in geometry. To suppress bending in this family of structures, a new generalised governing equation for bend-free state that is valid for all super ellipsoids of revolutions is found and used for stiffness tailoring. A parametric study is performed on several super ellipsoids of revolution and fibre orientations are found as shown in Fig 1. Analytical solution is verified using numerical modelling in ABAQUS and results compared with the isotropic baseline. As shown in Fig 2, by tailoring the stiffness via fibre steering the internal pressure-induced bending is suppressed throughout the structure.

REFERENCES

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