A MODEL FOR SLIT-DAMAGED BRAIDED FABRIC TUBES

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In recent years inflatable "air-beams," including both woven and braided fabric technologies, have been developed for use in large shelters, inflatable break waters, and space structures. Air-beams are tubular fabric structures which exhibit significant flexural and compressive rigidity when internally pressure-stabilized by air-inflation. Accidental damage to inflated air-beams can result in explosive rupture, and such a concern has motivated extensive study of the effects of slit-like damage in woven fabrics [1-4]. Determination of the stress concentration at the end of a slit has been used to predict damage growth in woven fabrics with [4] and without [3] an elastomeric coating. A non-dimensional parameter has been identified which may be used to compare different woven fabric materials as to their damage tolerance [2].

In this paper, a micromechanical model is developed to investigate a slit-damaged braided fabric air-beam structure. As such, the relevant system of non-dimensional ordinary differential equations is derived and solutions are given for the stress concentration near the broken yarns. The equilibrium equations are derived in terms of appropriate yarn displacements, u and v, in the fabric plane, where strains and yarn rotations are assumed small so that terms involving products of displacements are neglected. The complement of the angle between yarn systems is denoted by Ψ, so that when $\Psi = 0$ the yarns are normal to each other as in woven fabrics. Also, by appropriate non-dimensionalization, a parameter, $e = T / EA$, appears, where T is the remote yarn tension and EA is a measure of yarn stiffness. Typically $e < 0.03$ in present braided fabric air-beams. When e approaches zero there is a marked decoupling of the governing simultaneous equations, for any value of Ψ, and the structure of the equations becomes essentially that of the previous woven fabric model, with the implication that stress concentrations due to yarn breaks are similar to those for woven fabrics.

In the present work the full coupled equations are used to find solutions for various values of e, ranging from 0.0 to 0.10, and values of Ψ in the neighborhood of current air-beam technology. The results indicate that there is little or no change in stress concentration for the chosen values of e and Ψ. This significant finding suggests that most of the information defined for woven fabric air-beam technology may be applied with appropriate modifications to the assessment of braided fabrics.

References

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