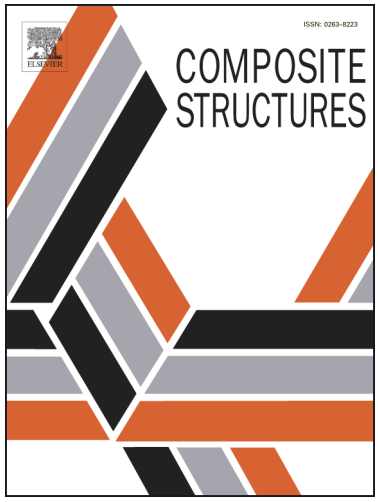

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PII: S0263-8223(18)30469-0
DOI: https://doi.org/10.1016/j.compstruct.2018.02.069
Reference: COST 9419

To appear in: *Composite Structures*

Received Date: 31 January 2018
Revised Date: 13 February 2018
Accepted Date: 22 February 2018

Please cite this article as: Zu, L., Xu, H., Zhang, B., Li, D., Zi, B., Zhang, B., Design and production of filament-wound composite square tubes, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.02.069

Design and production of filament-wound composite square tubes

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Abstract:

Composite square tubes have gained increasing attention as energy absorbers due to their high specific energy absorption capacity and long stroke. One of the key important issues for producing filament-wound composite square tubes demands both windability and uniform coverage of winding patterns. Based on the analytic geometry, the spatial relation between the feed eye and the mandrel was outlined and the kinematic equations for coupling the motion of the mandrel and the feed eye were derived. Consequently, a design method for small-angle winding of composite square tubes was proposed, taking the non-slippage condition of winding trajectories into account. A periodically geodesic winding theory was presented and its winding error for various initial winding points was analyzed. The designed fiber patterns were then applied to the practical production of a composite square tube with small winding angles. The results show that the present design method for filament-wound square tubes is accurate and reliable. The obtained kinematic equations and motion laws of the feed eye and the mandrel satisfy the basic winding principle and manufacturability of filament-wound composite square tubes. The present method is able to provide a useful tool for design and production of composite square tubes.

Keywords: Composite materials; Filament winding; Square tube; Small-angle geodesic; Windability

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