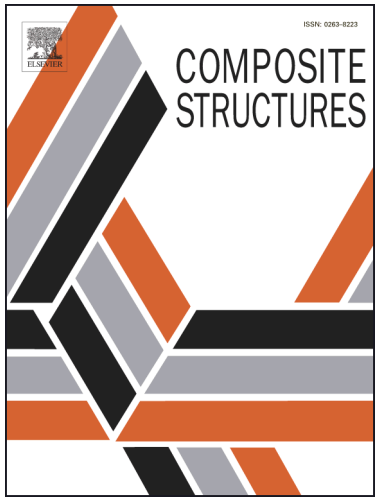

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Lei Zu, Weidong Zhu, Huiyue Dong, Yinglin Ke

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Application of variable slippage coefficients to the design of filament wound toroidal pressure vessels

Lei Zu, Weidong Zhu*, Huiyue Dong, Yinglin Ke

College of Mechanical Engineering, Zhejiang University, Zhejiang 310027, China

Abstract:

The non-geodesics using variable slippage coefficients along the winding trajectories are gaining increasing attention for composite pressure vessels. The aim of this paper is to evaluate the influence of several slippage coefficient distributions on fiber trajectories and the resulting mass of toroidal pressure vessels. The distributions of slippage coefficients are represented in terms of three functions satisfying C^1 continuity. The governing equations for designing non-geodesics on a toroid are formulated using the given functions of slippage coefficients. For each function, the initial fiber angle and the shell thickness are considered as the design variables, and the minimum mass is taken as the objective. With the aid of the classical lamination theory and the SQP algorithm, the optimal fiber trajectories are respectively determined for the given three slippage coefficient distributions, and the corresponding masses of the toroids are then obtained and compared to each other. The results indicate that toroids produced using variable slippage coefficients show improved performance than toroids using constant slippage coefficients; this is mainly due to the maximum utilization of the laminate strength. It is also revealed that the weight efficiency of toroidal vessels can be significantly improved using the quadratic distribution function of fiber slippage coefficients.

Keywords: Composite Materials; Filament winding; Toroidal pressure vessel; Non-geodesic; Slippage coefficient distribution

*Corresponding author. Tel.: +86 571 87953929; Fax: +86 571 87953929
E-mail address: zulei83@163.com (W. Zhu).