Research on the tearing properties of woven coated fabric

Rijin HE*, Xiaoying SUN, Yue WU

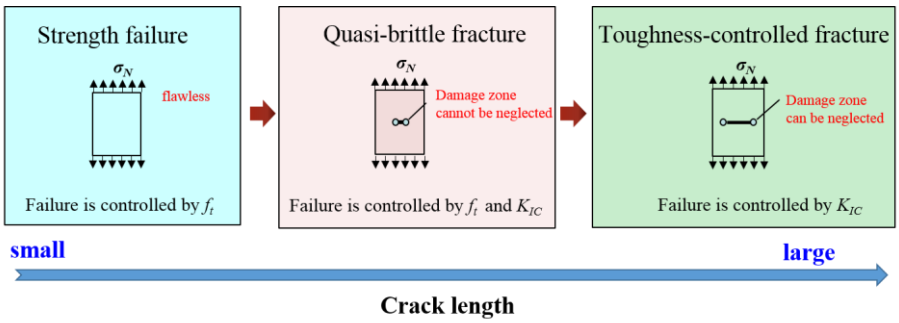
*School of civil engineering, Harbin Institute of Technology
73 Huanghe Road, Harbin, Heilongjiang Province, China
herijinhit@163.com

Abstract

Owing to the windborne debris puncturing, small cracks would be introduced to the fabric surface inevitably. Under the pre-stress of tension membrane structure, crack propagation can be easily induced due to the stress concentration in the vicinity of crack tip. Therefore, failure caused by crack propagation is the most common failure mode of tensile membrane structure, tearing resistance is the key issue in membrane structure design.

Residual strength is defined as the critical failure load of a structure containing pre-existing cracks, many efforts have devoted to the tearing test and residual strength model. Bigaud [2] conducted biaxial tensile tests on previously notched coated fabrics, the influence of initial crack orientation and the loading ratios are considered. Furthermore, fracture toughness K_{IC} is derived by Linear Elastic Fracture Mechanics (LEFM). However, the classical LEFM theory is restricted those cases where the damage zone in the vicinity of a crack tip is much smaller than the crack length, thus the LEFM based residual strength prediction model is limited to the large crack cases. Maekawa [3] also carried out the biaxial central crack tearing test, both the Thiele's empirical formula and exponential stress field model were adopted to the residual strength prediction. However, the exponential stress field model is a semi-empirical model which relies largely on curve fitting.

This study concerns the tearing property of PTFE coated fabric. Central crack tearing test is firstly conducted, the effect of crack length on residual strength is studied, and two kinds of failure modes are distinguished. Furthermore, merits and draw backs of commonly used residual strength models are discussed. Consequently, an asymptotic model based on fracture mechanics model is proposed. The transition from strength-controlled fracture to quasi-brittle fracture and finally to toughness-controlled fracture can be considered by this model. Parameters in the proposed model have definite physical meaning, this research can provide a novel approach to the residual strength prediction and better understanding of the tearing failure mechanism of coated fabric.



References

[1] D. Bigaud, C. Szostkiewicz and P. Hamelin, "Tearing analysis for textile reinforced soft composites under mono-axial and bi-axial tensile stresses", *Composite Structures*, vol. 62, No. 2, pp. 129-137, 2003.

[2] S. Maekawa and T. Yoshino, "Tear Propagation of a High-Performance Airship Envelope Material", *Journal of Aircraft*, vol. 45, No. 5, pp. 1546-1553, 2008.