

Reliability Analysis of Glass Epoxy Composite Plate under Low Velocity

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Abstract : Safety assurance and failure prediction of composite material component of an offshore structure due to low velocity impact is essential for associated risk assessment. It is important to incorporate uncertainties associated with material properties and load due to an impact. Likelihood of this hazard causing a chain of failure events plays an important role in risk assessment. The material properties of composites mostly exhibit a scatter due to their in-homogeneity and anisotropic characteristics, brittleness of the matrix and fiber and manufacturing defects. In fact, the probability of occurrence of such a scenario is due to large uncertainties arising in the system. Probabilistic finite element analysis of composite plates due to low-velocity impact is carried out considering uncertainties of material properties and initial impact velocity. Impact-induced damage of composite plate is a probabilistic phenomenon due to a wide range of uncertainties arising in material and loading behavior. A typical failure crack initiates and propagates further into the interface causing de-lamination between dissimilar plies. Since individual crack in the ply is difficult to track. The progressive damage model is implemented in the FE code by a user-defined material subroutine (VUMAT) to overcome these problems. The limit state function is accordingly established while the stresses in the lamina are such that the limit state function ($g(x) > 0$). The Gaussian process response surface method is presently adopted to determine the probability of failure. A comparative study is also carried out for different combination of impactor masses and velocities. The sensitivity based probabilistic design optimization procedure is investigated to achieve better strength and lighter weight of composite structures. Chain of failure events due to different modes of failure is considered to estimate the consequences of failure scenario. Frequencies of occurrence of specific impact hazards yield the expected risk due to economic loss.

Keywords : composites, damage propagation, low velocity impact, probability of failure, uncertainty modeling

Conference Title : ICSRS 2018 : International Conference on Structural Reliability and Statistics

Conference Location : New York, United States

Conference Dates : August 27-28, 2018