Abstract

The thesis strives to develop an understanding of the process of interfacial delamination in glass fiber/foam/epoxy sandwich composite with an objective of developing measures for its identification and mitigation. These lightweight yet high strength sandwich composite panels are typically utilized in civil, mechanical, marine, aerospace and other engineering applications. In-spite of several advantages, sandwich composites are sensitive to interfacial delamination (debonding) between face sheet and core which typically limits their applications in comparison to monolithic structures. Interfacial delamination causes loss of structural integrity leading to severe damage or even catastrophic failures. Identification of interfacial delamination at an early stage may prevent catastrophic structural failures. Two different interfacial delamination identification technologies based on embedded fiber-optic sensors have been developed in this thesis for identification of face-core debond in early stage: Embedded fiber optic Bragg grating (FBG) sensor arrays and single mode – multi mode - single mode (SMS) fiber sensors. A network of FBg sensors have been utilized to obtain a real time identification of face core debond initiation and propagation morphology for sandwich structures through point sensing of strain using the principle of wavelength division multiplexing. Whereas single mode-multi mode-single mode fiber sensors, based on the principle of multi-mode interference (MMI), have been developed as a low cost effective alternative to distributed interfacial strain estimation within the samples. Apart from identification there is also a need to develop mitigation measures initially at the time of manufacturing. Two different methodologies have been established as part of this thesis in the area of mitigation of interfacial delamination of sandwich composites: shear key concept and nano doping of multi walled carbon nanotubes in epoxy resin system. The shear key concept is based on insertion of a key region at the interface to improve upon the shear performance of the sandwich composites. Even though this type of structural modifications might offer cost-effective and conceptually easy solution to the problem but may cause overall weight gain of the component materials in large fabrication (which affects the major advantage of these materials/structures having high strength to weight ratio). Thereby, constituent modifications such as doping of MWCNTs within the resin mix add practically negligible weight and thus preserves the main advantage of higher strength to weight ratio in sandwich structures while improving the mechanical performance of interfacial delamination between the face sheet and the core.