STRUCTURAL HEALTH ASSESSMENT AND DAMAGES PROGNOSIS FOR COMPOSITE SHELL WITH DELAMINATION USING PIEZOELECTRIC SENSORS AND ROUGH SETS

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Abstract: Laminated composites have an important application in modern airframes due to extraordinary properties. The most important properties are (1) excellent strength and stiffness to weight ratio, (2) ability to form complex shapes, (3) outstanding fatigue and durability potential, (4) very high tolerance to chemical /environmental effects and (5) ability to reduce induced vibrations. Unfortunately, they have flaws as manufacturing results as well are susceptible to damage under impact loading during an operation. The flaw and impact treatments can affect that excellent mechanical properties during fatigue loads and often results in causing premature failure of the composite. The damages can be only internal and cannot be detected visually. Failures that occur in laminated composite structures can be intralaminar and interlaminar. Here, the delamination has been discussed.

The laminate composite shell of airframe can be exposed to local losses of stability caused by delaminations. To date a lot of models for impact damages in laminates have been developed with any accuracy. The models can replace real and expensive testing in laminated structures of airframe with some simplifications and assumptions. The research results based on such models can be effective with condition of an assessment the global uncertainty. The global uncertainty analysis is developed as a tool to evaluate the performance of the models. A global sensitivity analysis is defined and used as a complementary tool to find the most important sources of uncertainty. The models and their uncertainties have been discussed.

The prevention systems of the critical failure which can occur during an operation have to be applied. It's very important to develop the structural health monitoring system, integrated with airframe. Piezo elements are one of the predestined for use in health monitoring system and damage prediction which has been demonstrated in numerous studies. The deployment of Structural Health Monitoring (SHM) systems into airframe can significantly improve the safety. The possibilities of the deployment SHM systems into an airframe has been discussed.

Due to multidisciplinarity and complexity of the issue an artificial intelligence methods of the global uncertainty can be applied. The rough sets application has been proposed.

A new model of structural health assessment and damage prognosis for airframe shell with delamination using piezoelectric sensors and rough sets has been proposed.