Multiphysics based Condition Monitoring of Composite Materials

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Abstract

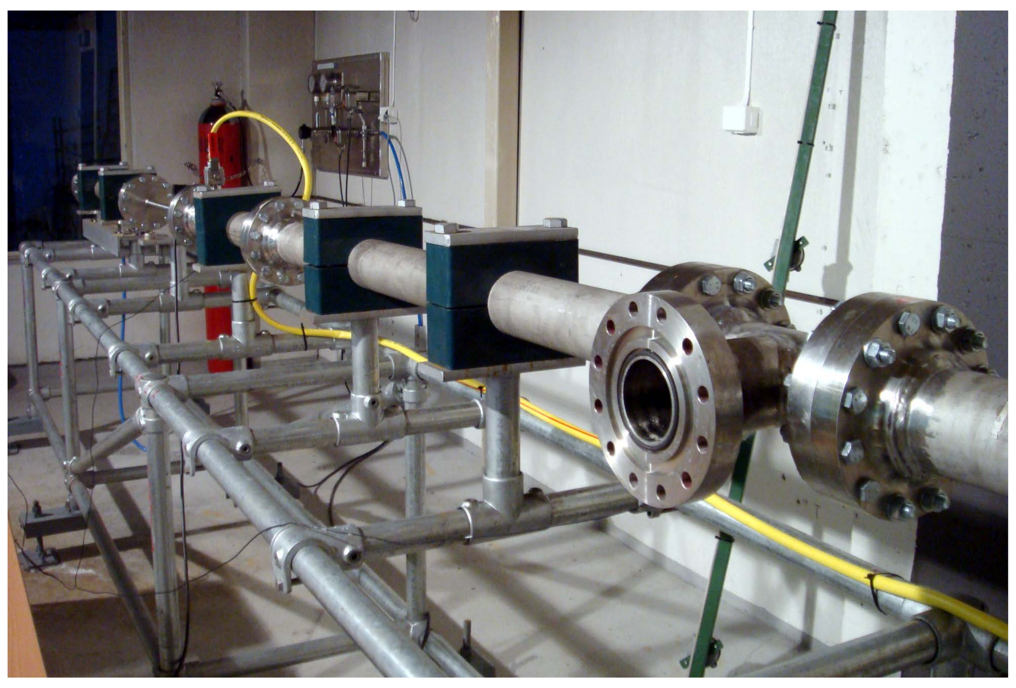
Composites are increasingly being used in products such as: automobiles, bridges, boats, drillships, offshore platforms, aircrafts and satellites. The increased usage of these composite materials and the fact that the conditions pertaining to their failure are not fully understood makes it imperative to develop condition monitoring systems for composite structures.

In this work, we present a theoretical framework for the development of a condition monitoring system. For this, we plan to perform experimental and numerical analysis. The experimental analysis of composites will be carried out using a shock tube facility. The experimental data will be measured using sensors such as: strain gauges, thermocouples and pressure transducers. Furthermore, a high speed camera and an infrared thermography will be used for post processing of events. The numerical analysis will be carried out using ANSYS® Multiphysics software. The numerical simulation will be modelled using the principles of Fluid-Structure Interaction (FSI), Finite Element Method (FEM) and Arbitrary Lagrangian Eulerian (ALE) methods.

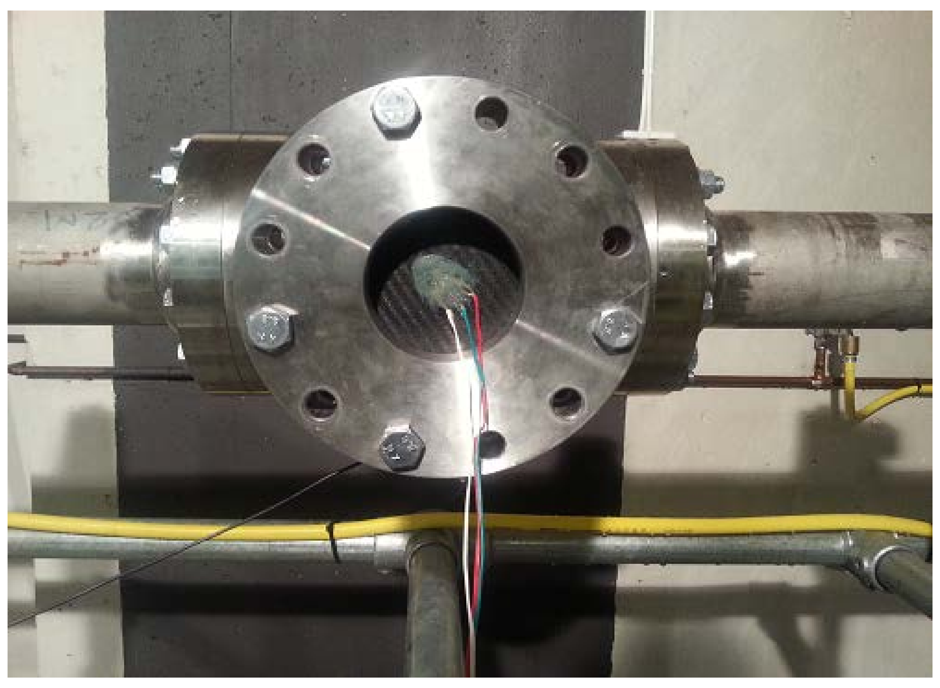
The proposed framework will allow us to identify the significant changes in composite structures leading to fault, failure or breakdown. The results will also shed light on factors such as maintenance scheduling, periodic inspection and lifespan analysis.

Proposed Experimental Methodology

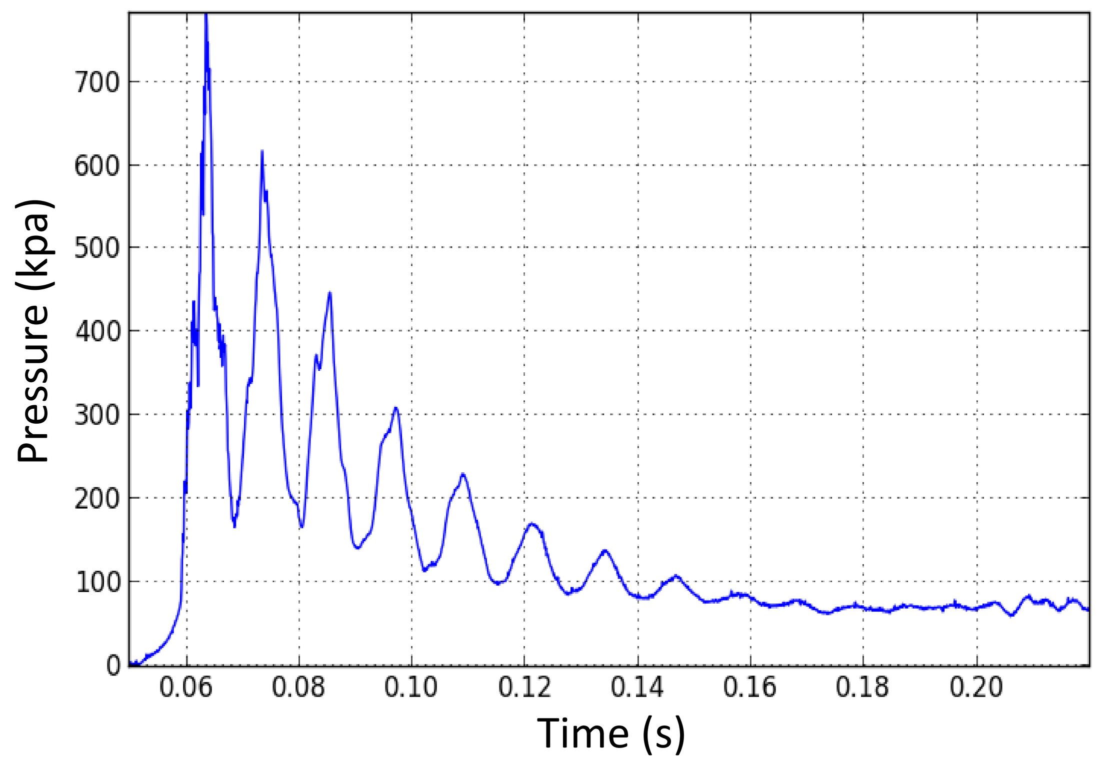
Shock tube facility



Composite sample with a rosette strain gauge

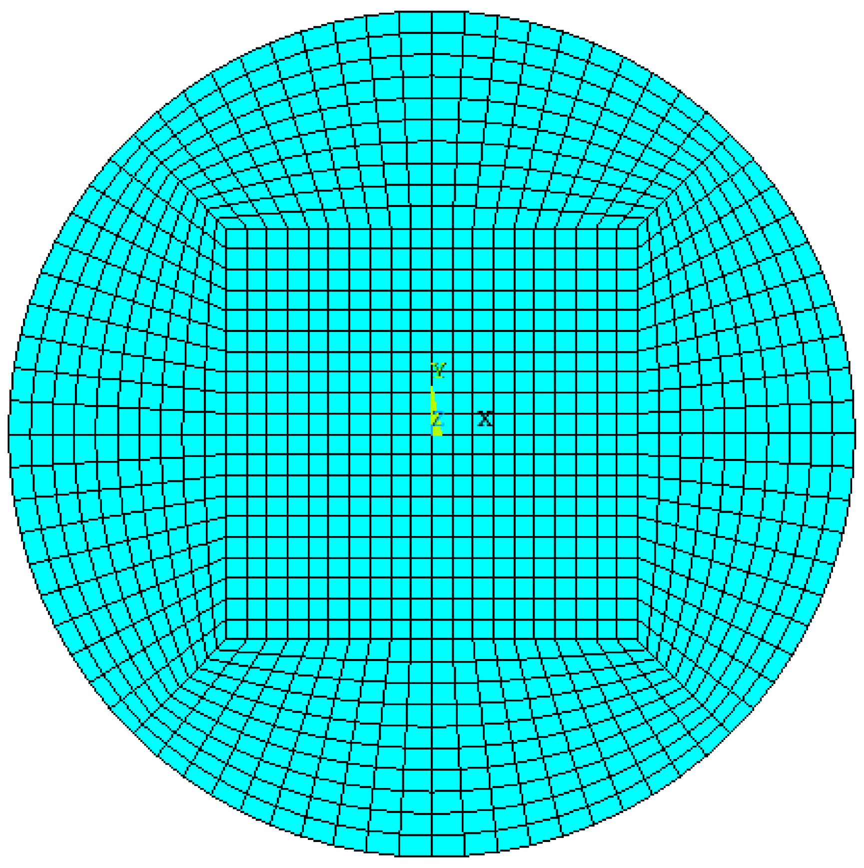


Pressure signal from shock tube experiment

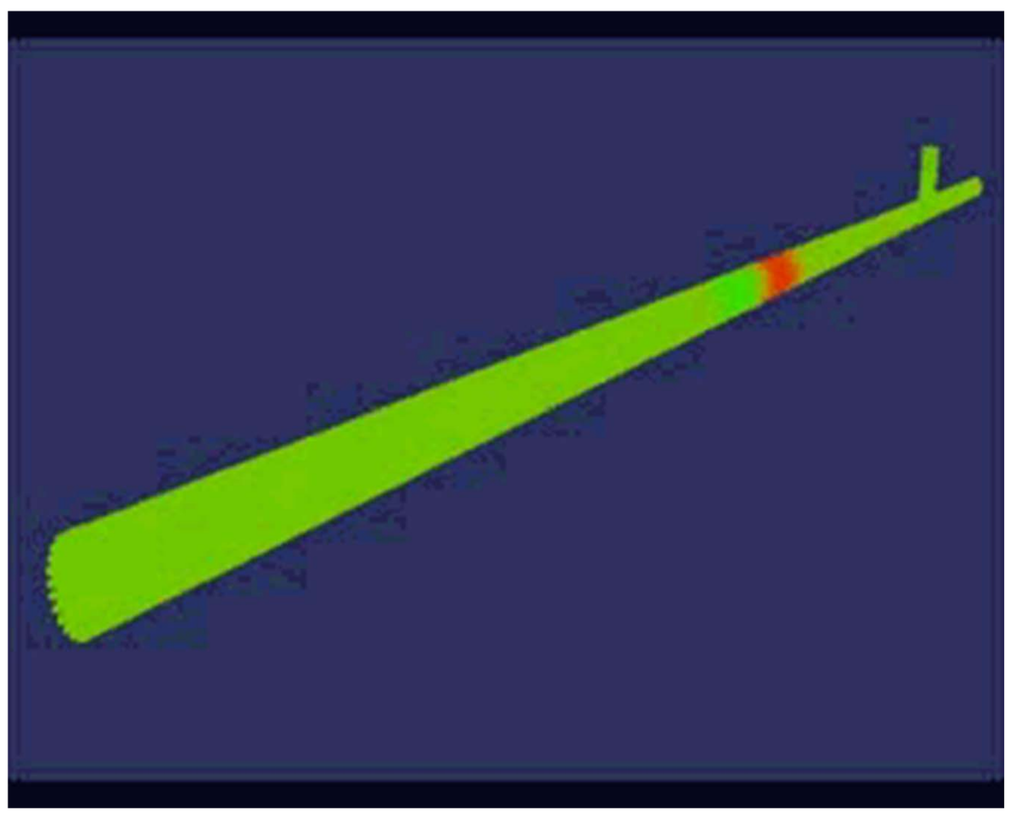


Proposed Numerical Methodology

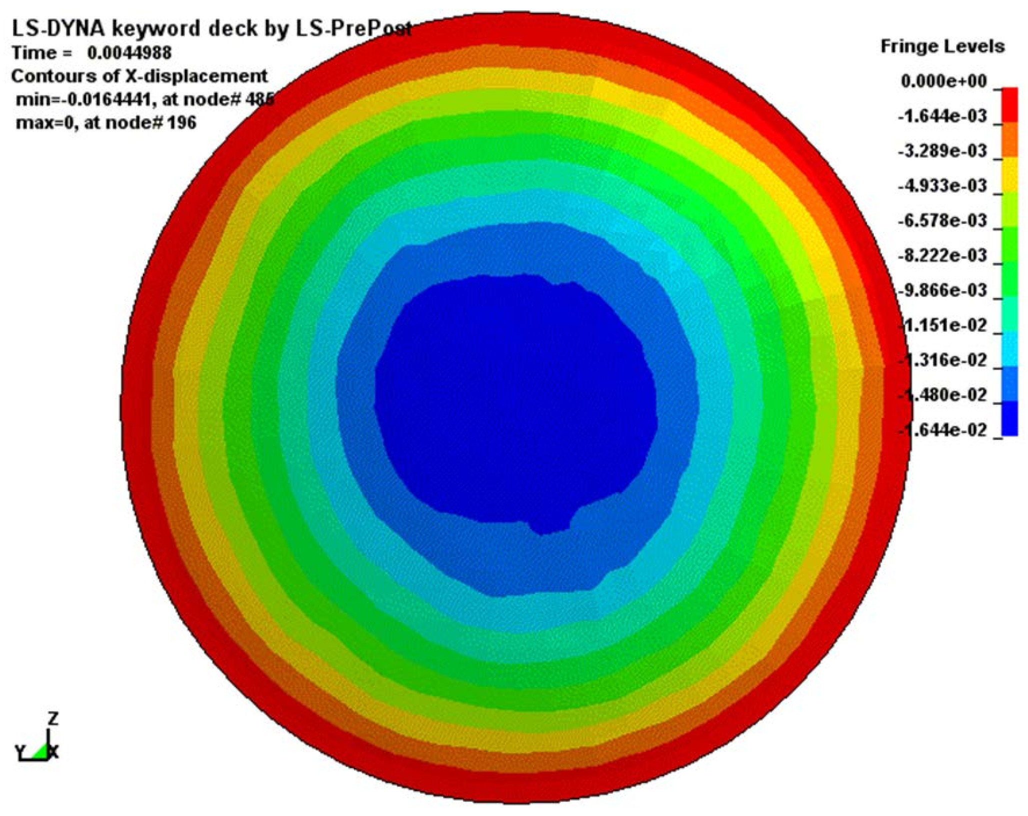
FEM numerical model



ALE numerical model



Displacement contours of a composite sample



Conclusion

The proposed experimental and numerical methodologies will allow us to identify the significant changes in composite structures leading to fault, failure or breakdown. The results will also shed light on factors such as maintenance scheduling, periodic inspection and lifespan analysis.

Recommendation

It is recommended to employ shock tube experimental setup to investigate the composite structures. By combining condition monitoring with the shock tube setup, it is possible to identify the conditions leading to fault, failure or breakdown.

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