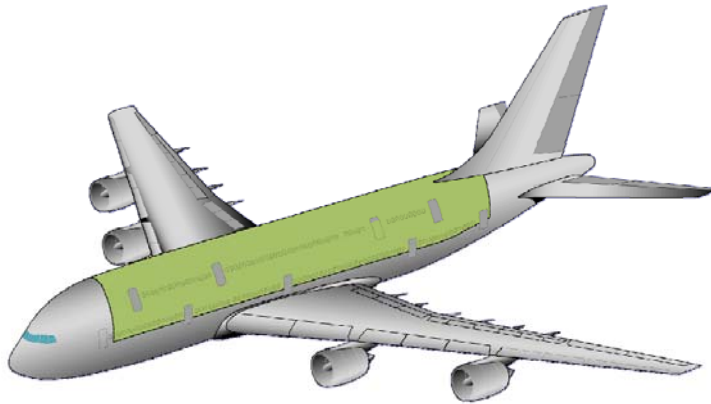


SHM Based Characterization of Failure Properties of Hybrid Composites

Kuldeep Lonkar

Motivation

- With the advent of aluminum-fiberglass fiber metal laminates (FMLs) in the 1980's they have become viable for aerospace structures
- Because of better fatigue behavior, higher specific yield and ultimate strength, impact tolerance, FMLs such as GLARE (GLASS Reinforced FML) are beginning to see widespread use in commercial aircraft
- Procedures for SHM-based characterization must be developed for detection, quantification, identification of damage forms



Much of the upper fuselage skin of the Airbus A380 is GLARE, represented in green

Problem Statement

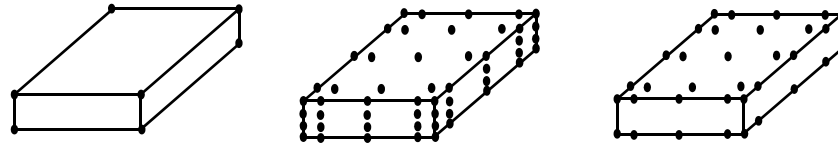
- Develop diagnostic techniques to detect, characterize and quantify damage in hybrid composite.

The technique would include:

1. Modeling wave propagation in laminated structures to give us an idea how the sensor network should be designed and what frequency should be used
2. Interpretation of sensor signal in order to detect, characterize and quantify damage in hybrid composite
3. Experiments to validate the diagnostic techniques

Approach for simulation

Finite element Solid & Hybrid spectral elements



- Higher accuracy
- Higher convergence rate
- Coarser mesh
- Less computational time

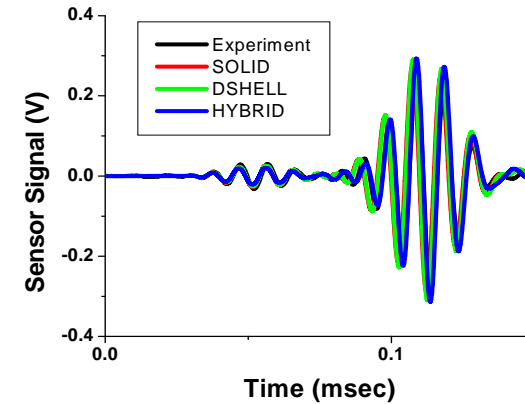
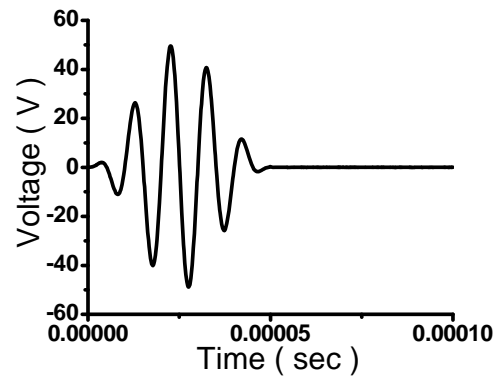
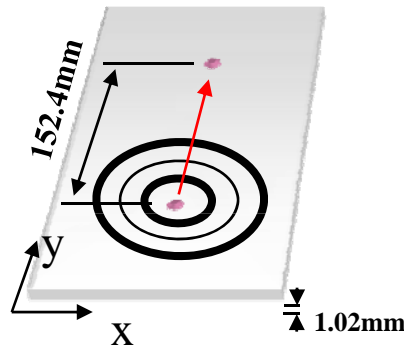


Plate dimension :
355.6 mm x 508 mm

PZT location

Actuator : (177.8 mm, 177.8mm)

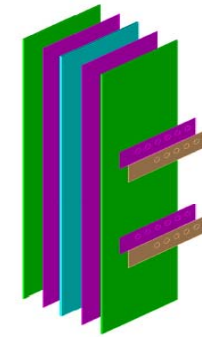
Sensor : (177.8 mm, 330.2mm)

	FEM	Solid	Hybrid
Total DOF	5,458,626	716,280	252,780
Mesh size:	0.4 mm	5.0 mm	6.0 mm
Computational time	~450 min	~60 min.	~20 min

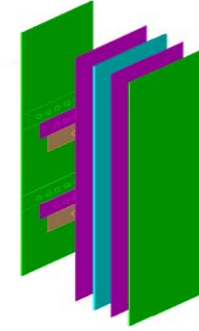
Existing solid spectral element: Source : Y. Kim, S. Ha, FK. Chang AIAA journal, 2008

Preliminary Results

- Data Taken every 1,000 cycles
- Data taken at Min, Mean, and Max Loads
- Typical test duration ~16,000 cycles
- Max. load = 13000 lbf
- Min. load = 1000 lbf



Externally mounted
SMART Layers



Internally mounted
SMART Layers

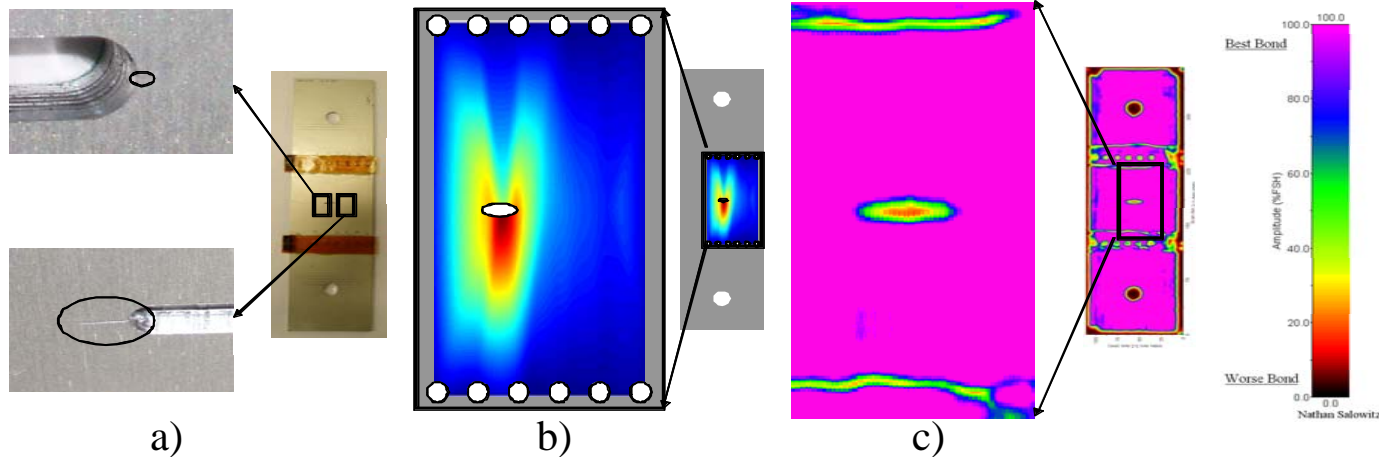


Figure a) hair line cracks detected by visual inspection on hybrid laminates, b) diagnostic image by SHM detected the presence of these cracks, c) traditional NDE showed no damage on the same coupons.

Test conducted by Nathan Salowitz

Bio

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Birthplace: Mumbai, India

Education: M.S. Aero/Astro Engg
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Experience: Summer Intern
University of Bristol 2006

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