

Annex III – Short public report. STSM

Title of the STSM: Multiresolution numerical-experimental framework for impact induced delamination localisation in composite plates

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Relevant Working Groups: WG4, WG5, WG6, WG8

Objectives / Description / Main outcomes (150-250 words)

The objective of this STSM was to develop a multiresolution numerical-experimental framework for localising impact-induced delaminations in composite plates using guided waves. During the mission, a 0.5m x 0.5m cross-ply CFRP plate was subjected to three 12.5J impacts (Figure 1). Its wave response was then measured at 50, 100 and 200 kHz with a scanning laser Doppler vibrometer over the full plate surface. Figure 2a shows a out-of-plane velocity wavefield snapshot concerning the 50 kHz excitation, and the three impact-induced delaminations. In parallel, specific plate-strip layerwise models were developed with the Multiresolution Finite Wavelet Domain (MR-FWD) method. These models were reduced with the second order Arnoldi iteration (SOAR) algorithm, which gave reduced order models with excellent accuracy and a large reduction in computing time. Also, the measured wavefields were decomposed with discrete wavelet transform (DWT) using Daubechies wavelets. The total measured response agreed with the total MR-FWD solution, and the measured detail components agreed with the MR-FWD fine solutions. This confirms that the fine-scale components can serve as damage-sensitive features. In example, if delamination in location 1 is isolated, the plate strip shown with the orange dashed line in Figure 2b is considered, and Figure 3 illustrates the remarkable agreement between the total MR-FWD solution and the experimental measurements. Finally, Figure 4 shows very good experimental-numerical correlation in normalized RMS velocity maps, indicating the delamination position and highlighting the high sensitivity of the fine MR-FWD solutions and detail components of DWT-decomposed measurements.

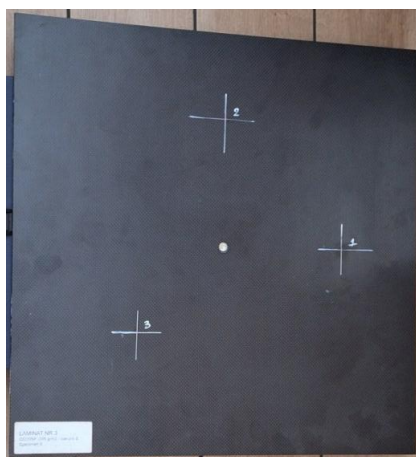


Figure 1. CFRP plate after the three impacts, with the impact locations indicated by the white crosses.

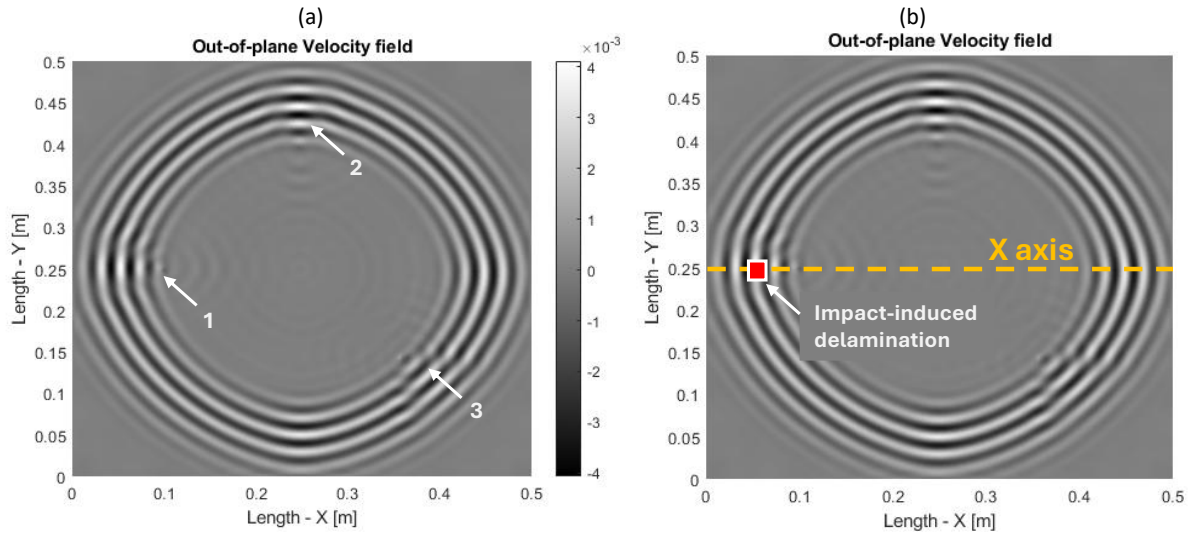


Figure 2. (a) Out-of-plane velocity wavefield at $t=200\mu s$, with the 3 impact-induced damages presented; (b) Isolation of a single plate strip to create a MR-FWD layerwise model for the estimation of delamination in location 1.

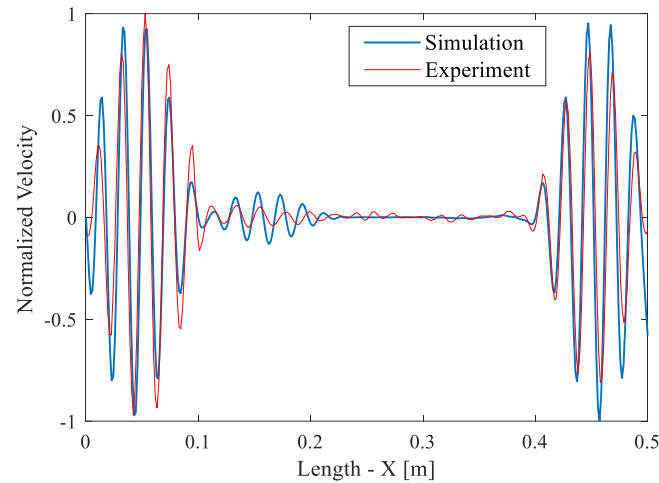


Figure 3. Normalized velocity snapshot of experimental and numerical results for delamination in position 1. The delamination location is approximately at 0.1m in the X axis.

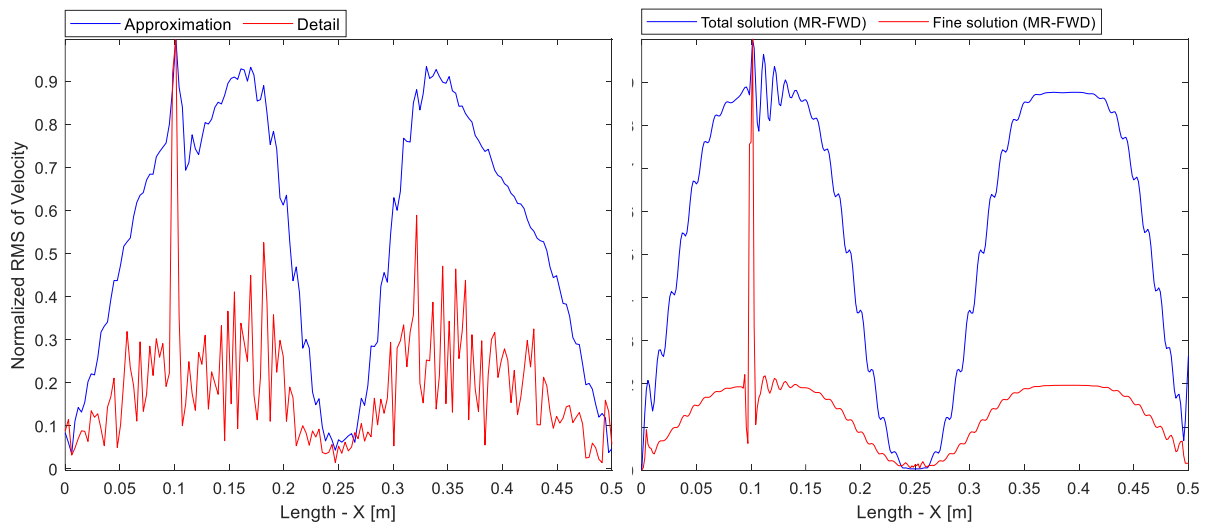


Figure 4. Normalized RMS of the velocity for the approximation and detail component of the decomposed measurements (left) and the total and fine solution of the MR-FWD model (right).