Support Structural Health Monitoring developments with simulation

Background

SHM based on Guided Waves enables to monitor the health of structural devices during service life. Experimental campaigns become rapidly prohibitive if you want to conduct sound optimization and reliability studies. Indeed:

- Structural Health Monitoring sensors are embedded in the specimen,
- Implementation is complex and costly,
- A large number of influential parameters are involved (depending on the sensors, their distribution, the defects to be detected, environmental conditions, etc.).

Moreover, as sensors are embedded "for life" in the monitored structure, and due to the automated measurement process, a solid performance demonstration stage is required to properly define decision thresholds in order to **optimize the Probability of Defection** while limiting false alarms.

Benefits

The SHM module of CIVA enables you to simulate **SHM by Guided Waves**. It can address the monitoring of various specimen geometries, whether it be **metallic or composite**.

Among others, CIVA SHM will allow you to:

- Compute **dispersion curves** and therefore predict available modes and their characteristics (wavelength, velocities, etc.),
- Try different numbers of sensors, geometrical distributions, excitations types, etc.,
- Predict the signals received when a defect appears, for various defect types, sizes and locations,
- Use imaging tools to **reconstruct defect signatures** and **improve their detection and identification**,
- Evaluate the impact of **influential parameters** variability for performance demonstration and POD studies.

EXTENDE CIVA

CIVA license cea

www.extende.com

Support Structural Health Monitoring developments with simulation

Case study

Use imaging to optimize SHM sensors choices

THE CHALLENGE

This case deals with the instrumentation of a **composite panel** made with 16 carbon-epoxy plies for a 2mm total thickness.

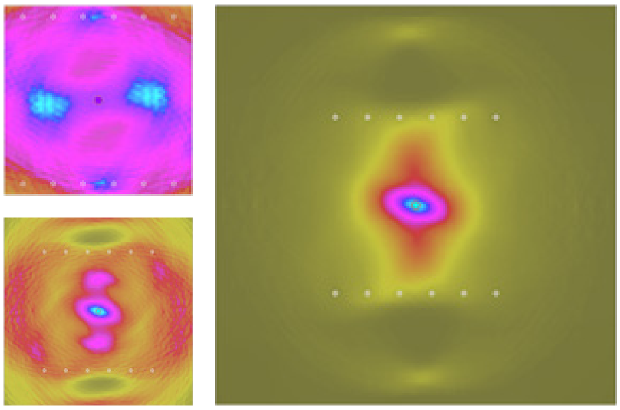
Deciding about the type, number and location of sensors encompasses key parameters for defect detection, while a too large number of sensors will lead to **prohibitive instrumentation costs** for the structure. A compromise must be found. The **anisotropic nature** of the composite material with respect to the ultrasonic wave propagation shall be also taken into account.

CIVA'S CONTRIBUTIONS

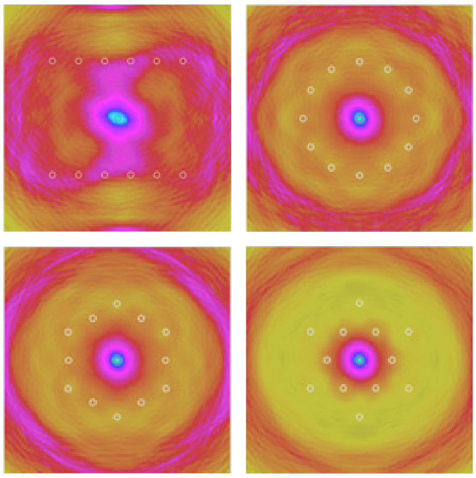
Among others, and with very competitive computation times, CIVA can help with:

- evaluating the impact of the distance between the sensors and component edges on the signals received and the reconstruction image,
- trying different numbers of sensors (e.g., 4, 6, 8, 12) and different organizations (aligned, in circles, in staggered rows, etc.), and see the impact on the defect signature,
- comparing the response of a Through Wall Hole and a delamination (different sizes, located at different plies),
- trying different sensor sizes and frequencies.

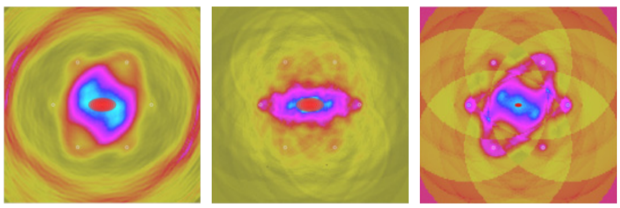
More than a competition, it is a **complementarity between simulation and experiment** that needs to be pointed out: experiments can precisely show the behavior of real monitoring devices and see the impact of environmental parameters changes (structural noise, temperature, aging process, etc.), while simulation can **quickly**, **massively** and at a **low cost** test different monitoring scenarios and **predict many damages situations**.



Through Wall Hole signature obtained with a set of 12 Guided Waves sensors located at different distance from the edges of composite plates (from left to right: specimen dimensions of 500 mm x 500 mm; 600 mm x 600 mm; 700 mm x 700 mm)



Through Wall Hole signature obtained with different sensors arrangements (from left to right: aligned, in circle, in staggered circles).



Delamination signatures for various cases (from left to right: 40 kHz sensor, 100 kHz sensor, smaller delamination size and 100 kHz sensor).

www.extende.com

EXTENDE CIVA

14 Avenue Carnot
91300 Massy • France
contact@extende.com
Fax : +33 (0)9 72 13 42 68

PO Box 41114, Norfolk
VA 23541 • U.S.A.
contactus@extende.com
Fax : +1 518 602 1368