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SEMINAR ON LIGHTWEIGHT APPLICATIONS AT SEA (E-LASS)

ATLANTIC HOTEL UNIVERSUM, BREMEN, GERMANY

STRUCTURAL HEALTH MONITORING (SHM) OF LOCAL AND GLOBAL ELEMENTS OF FIBRE-BASED VESSELS

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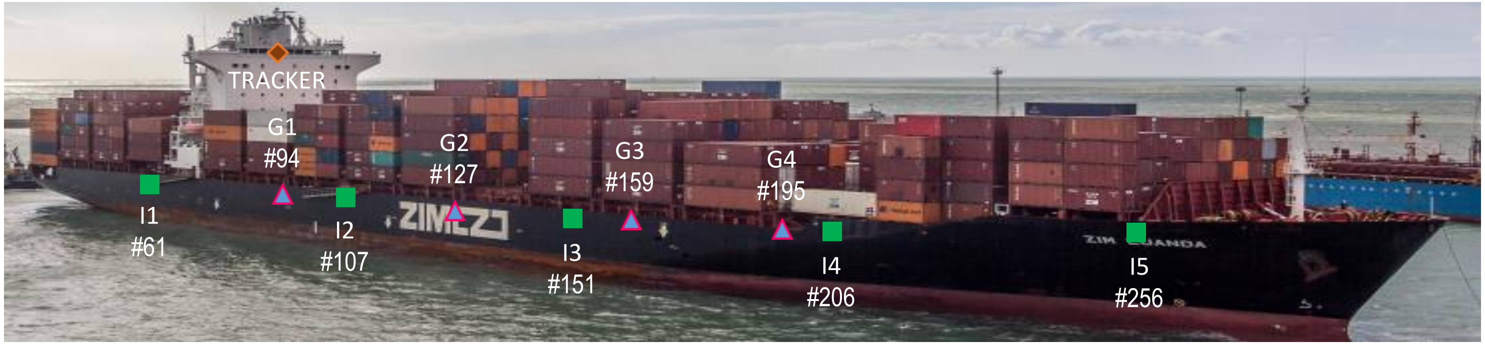
Structural health monitoring (SHM) in the maritime industry

- CASE 1: SHM system to evaluate the hull integrity of a containership



- CASE 2: Detection of delamination in composite ships

CASE 1:
SHM OF ZIM LUANDA CONTAINERSHIP

The main objective is to monitor the structural integrity of the ZIM Luanda containership during the navigation route from Valencia (Spain) to Halifax (Canada)

Dimensions

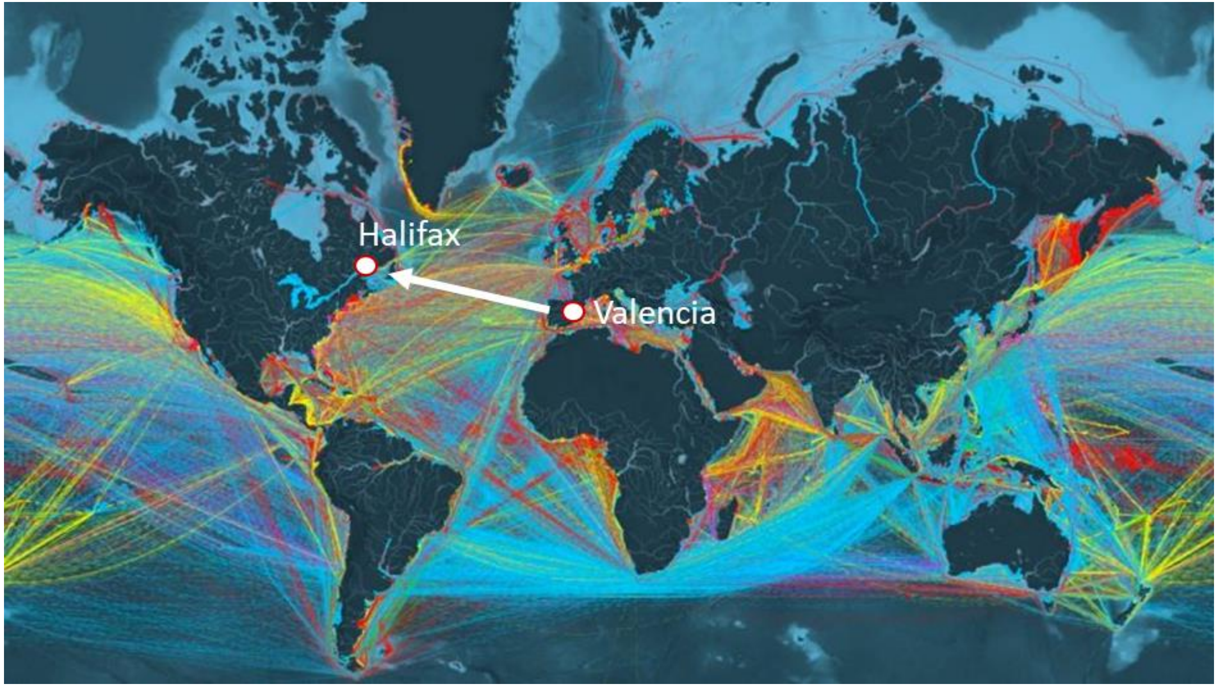
Length O.A: 260 m

Length P.P: 245 m

Breadth: 32 m

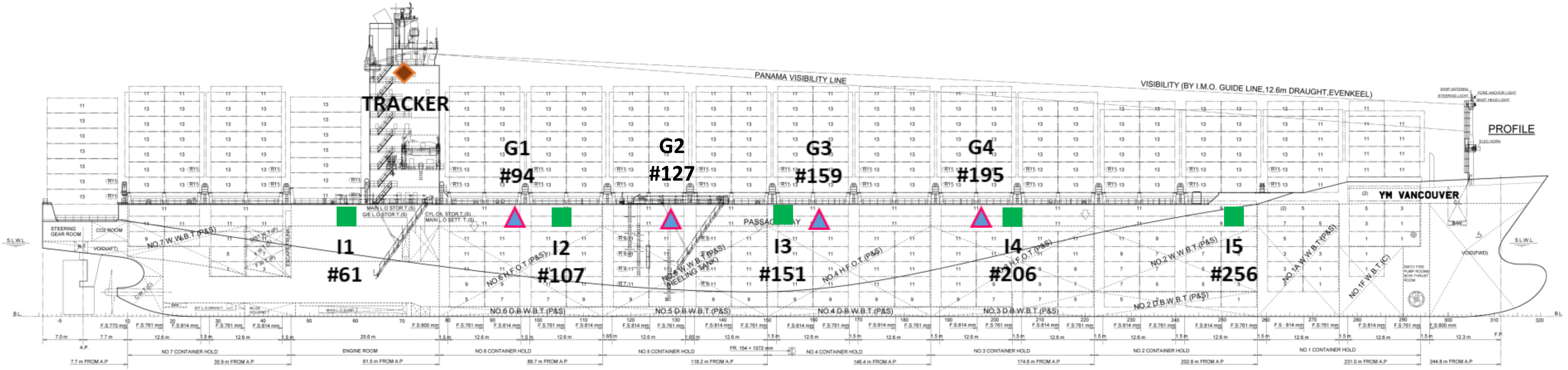
Draft: 11 m

Depth: 19 m



METHODOLOGY

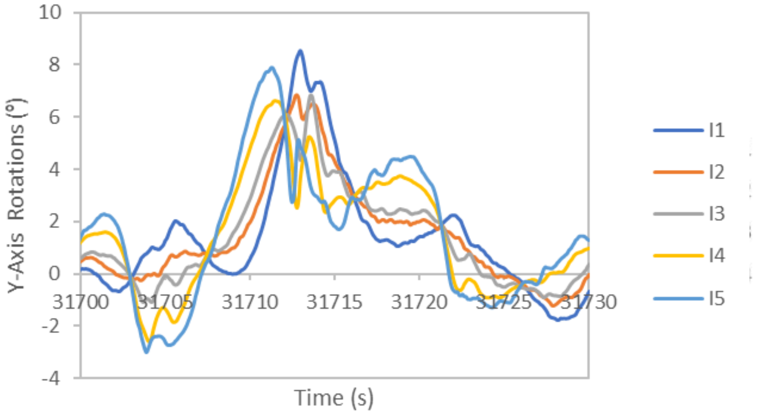
Installation of the sensors in the containership? Type and location of sensors



Environmental tracker (wave height, period, wind speed, ….)

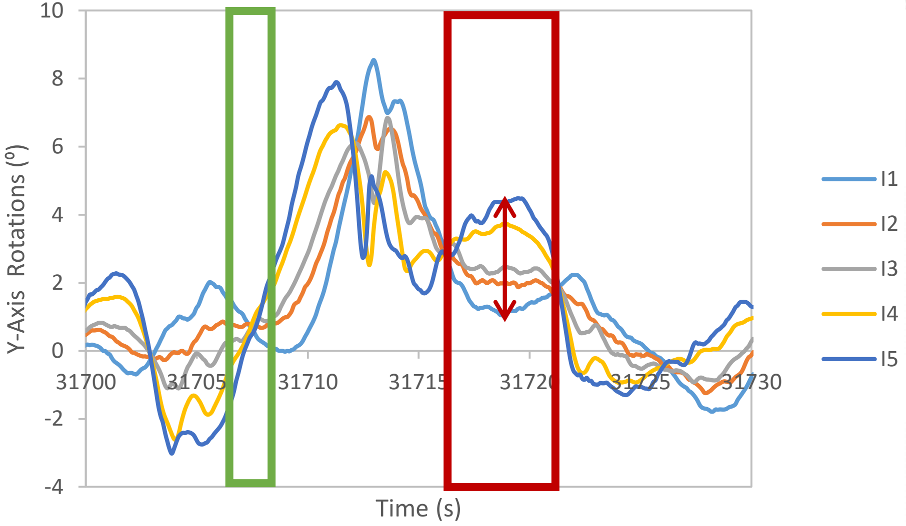
Strain gauges

Inclinometers

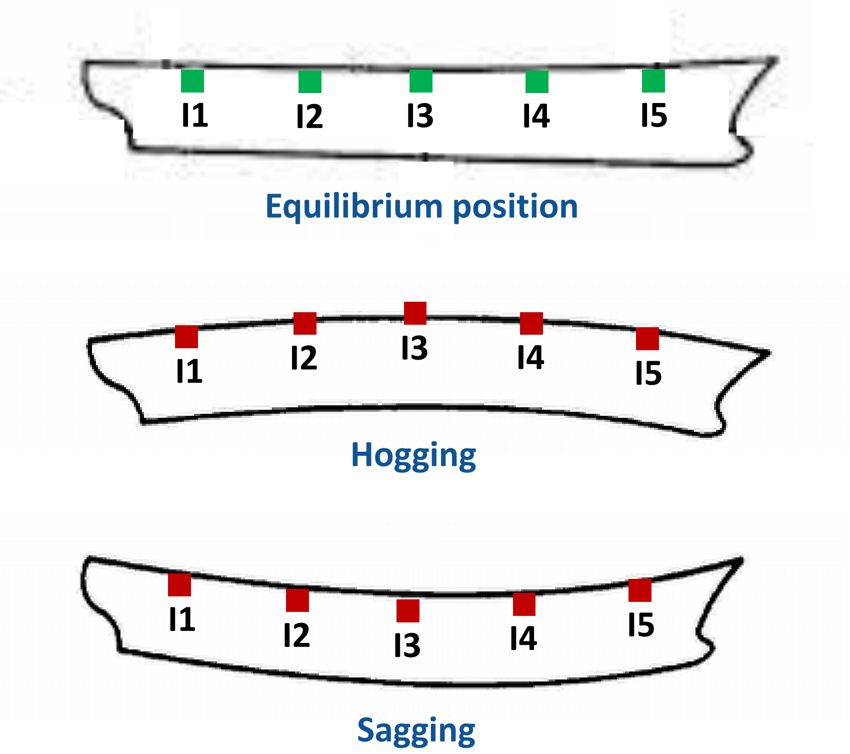


FIBRESHIP INTEGRAL COMPOSITE SHIP

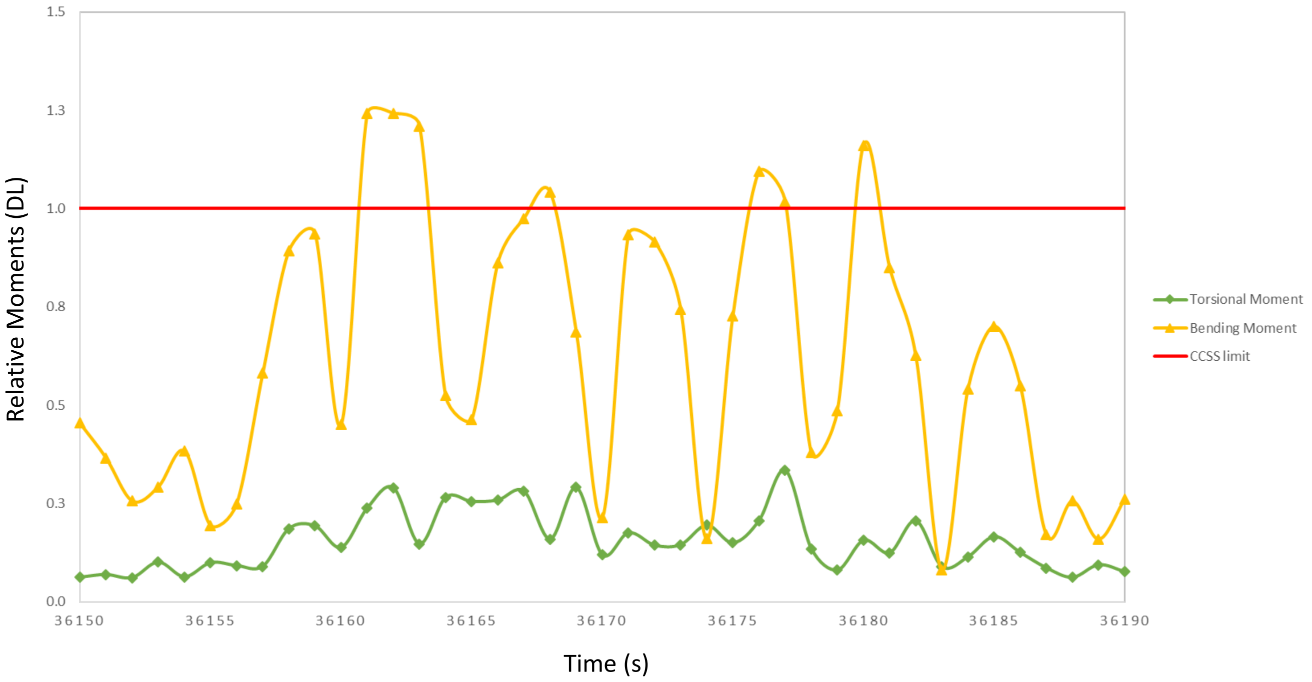
Analysis of the rotations of the containership for a certain period of time



Wave Height = 7.5 m Wind Speed =30 Knots



Analysis of the flexure and torsional moments in the worst-case scenario.



Relative moments above 1 are not recommended by CCSS.

The CCSS recommend relative moments below 1 to navigate in safe conditions

Wave Height = 7.5 m Wind Speed =30 Knots

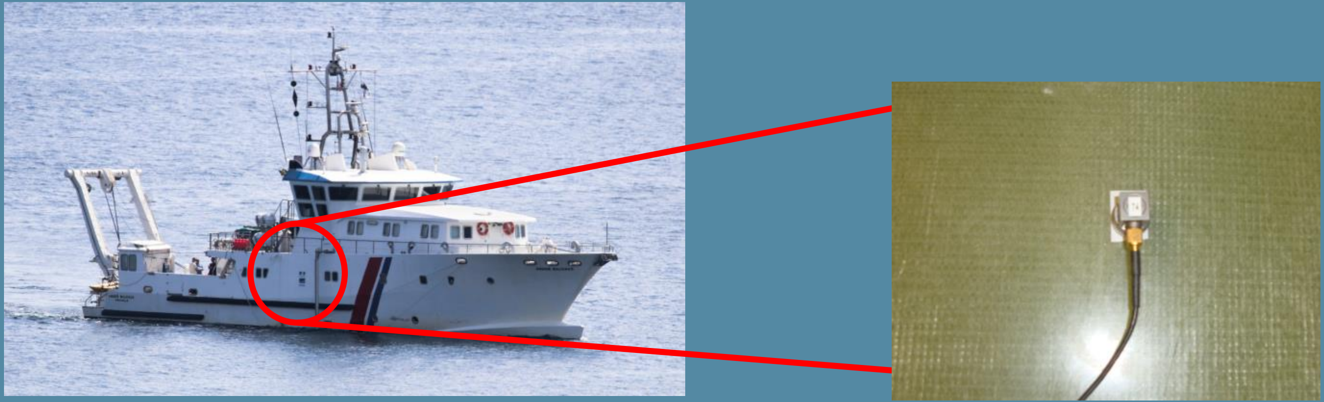
A SHM system has been developed to monitor the integrity of the ZIM Luanda containership.

- The environmental sea conditions are recorded using an environmental tracker.

- The vessel hull deformations (bending and torsion moments) are measured during the navigation.

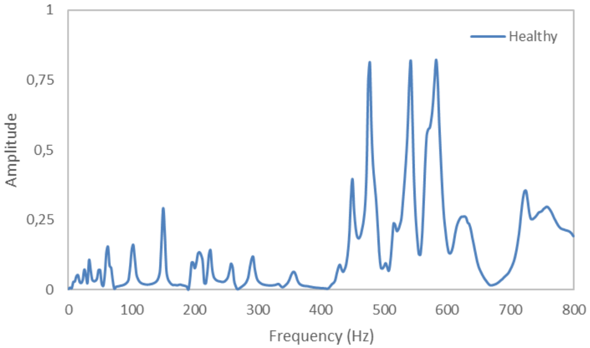
- The probability of damage due to bending/torsion is evaluated by CCSS limits.

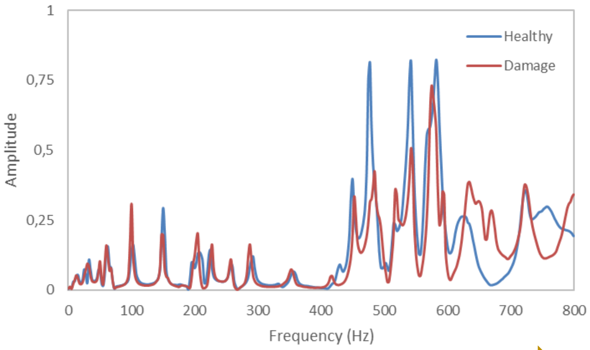
CASE 2:
DETECTION OF DELAMINATION IN FRP SHIPS



This study investigates the feasibility of a vibration based method for the detection of delamination in decks/bulkheads of composite ships.

This methodology is a cost-effective and non-destructive approach which can be applied using three consecutive steps:

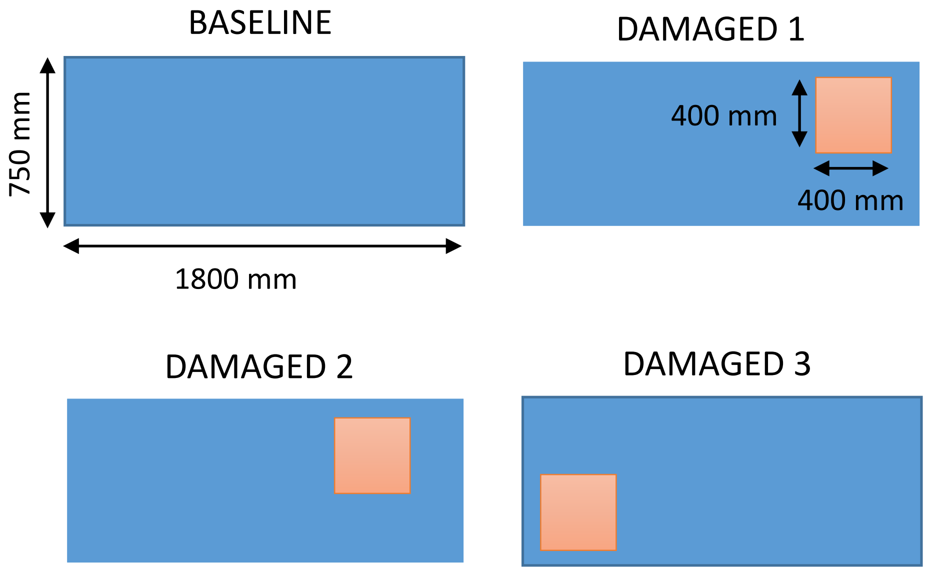


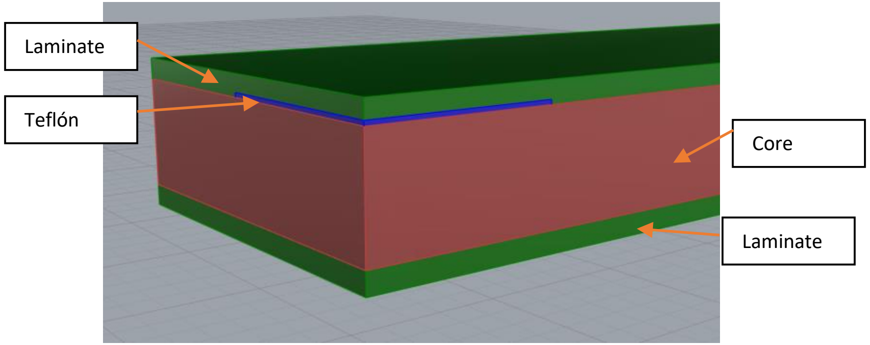


1. Vibration Measurement 2. Analysis of modal parameters 3. Damage effect in modal parameters

The main purpose of this investigation is to identify the presence of delamination in composite bulkheads used in small length ships (< 50 m)

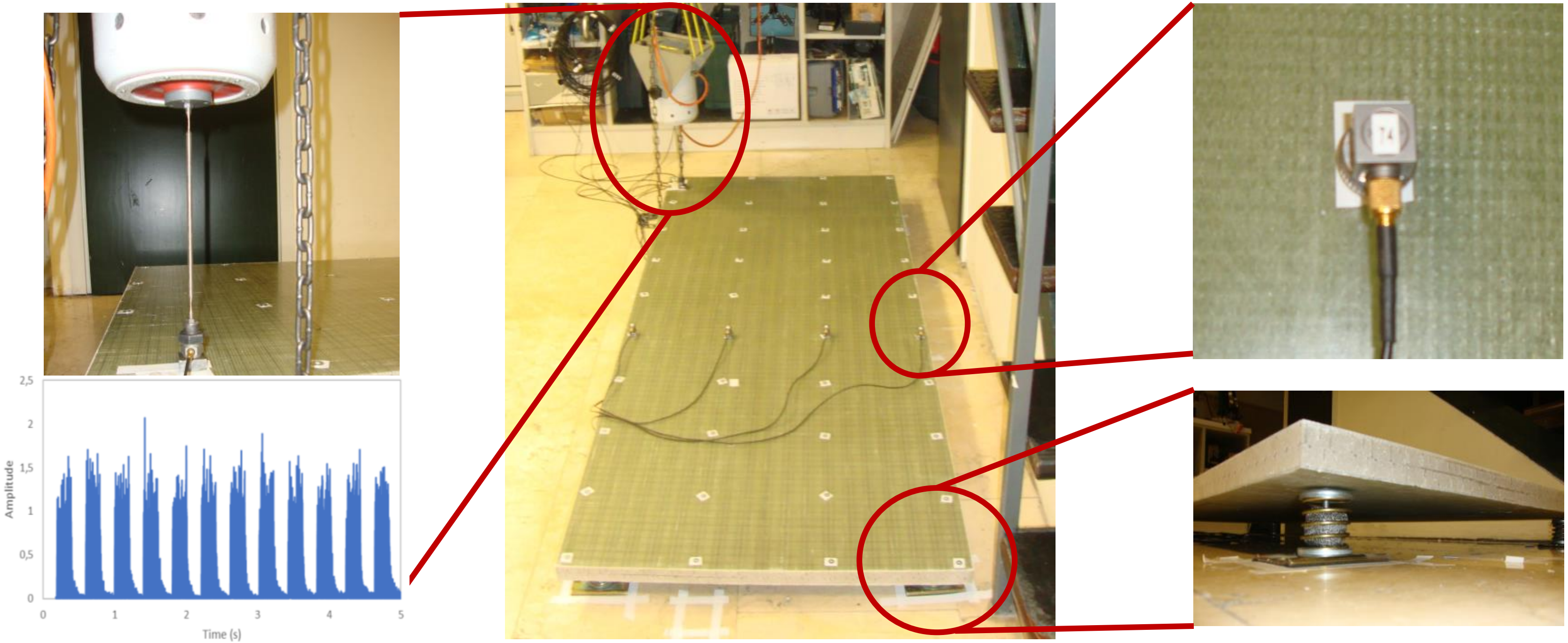
So, we will study how the modal parameters (natural frequencies, damping and vibration energy) of the composites are affected due to the delamination.



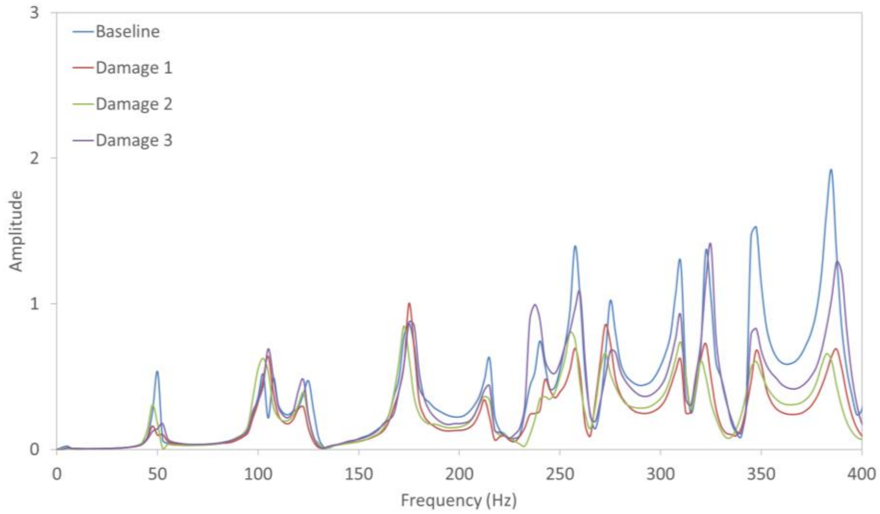


The vibration response of four panels with different delamination cases is considered.

The methodology used in this investigation to determinate the modal parameters of composites with and without internal delamination is a free vibration test.



Influence of delamination on natural frequencies



Mode	Baseline	Damage 1	Damage 2	Damage 3
1	50.1 Hz	47.5 Hz	47.6 Hz	52.5 Hz
2	102.6 Hz	104.9 Hz	102.6 Hz	105.1 Hz
3	125.1 Hz	122.5 Hz	122.5 Hz	122.5 Hz
4	175.0 Hz	175.0 Hz	172.6 Hz	175.0 Hz
5	215.0 Hz	212.5 Hz	212.5 Hz	214.9 Hz

The natural frequencies of the composites are barely affected due to the presence of delamination. Thus, the variations of the natural frequencies is not recommended as a diagnosis parameter for the identification of delamination failures.

This study has considered the problem for the identification of the existence of delamination in composite laminates.

The **natural frequencies** of the composite panels are barely affected by the existence of delamination failures. Thus, the detection of delamination through changes in frequency is not a reliable method.

The **damping** of the damaged composite specimens considerably increased due to the presence of delamination phenomenon. So, the changes in damping are a simple and economic method to detect delamination.

This study proves that the **vibratory energy** of laminates with delamination is superior with respect to the neat specimens. Thus, the variation of the overall vibration energy in composites is a reliable parameter to detect the delamination.

Any question?

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