IMPROVEMENTS OF FORCE ANALYSIS TECHNIQUE FORFLAW DETECTION ON COMPOSITE MATERIALS

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ABSTRACT

In the light of fossil energy dry, the transportation industries are looking on lighter materials to be applied on their vehicles, in order to reduce their energy consumptions. Composite materials perfectly meet the needs of these industries by offering light weight and high resistance. Although these materials still lack of comprehension regarding their dynamic behavior and the visualization of typical flaws like delamination or tears. Moreover considering wide structures like a plane wing makes usual ultrasonic methods uncomfortable because of complex implementation and the amount of time needed. The goal of our work is to develop a fast vibratory method that could detect flaws on large composite structures with an improvement of the Force Analysis Technique. In a second time if necessary a sharper scanning could be done with ultrasonic methods around the defect region.

Created around 1994 the Force Analysis Technique allows detection of vibratory source by using the equation of motion. Its local aspect confers it a strong point since the boundary conditions are not necessary. Around 2012 an important enhancement of the Force Analysis Technique was brought by applying it out of the vibratory sources, giving access to local cartography of Young modulus and structural damping. The latest improvement deals with non-destructive testing for flaw detection on composite materials, through the analysis of its materials parameters (Young modulus, structural damping and/or shear modulus) in space domain and in frequency domain.

Our first development concerns composite beams. In order to best consider such material we used Timoshenko's beam theory which involves shearing effect unlike the mostly spread Euler-Bernoulli beam theory. By applying the equation of motion out of controlled vibratory sources one can deduce the local material parameters. If a flaw is present in the scanned area, a strong

singularity should appear on the cartographies. Furthermore defects are linked to physical consequence making our method able to deduce the kind of flaw: for instance a delamination might only appear as a variation of the shear modulus, a local lack of viscosity would be seen solely on the cartography of structural damping, etc.
The presentation will deal with a general explanation of our method, and results obtained from various kind of flaws existing on composite beams and will also highlight the advantages of considering Timoshenko theory instead of the Euler-Bernoulli's one. Then we'll draw some conclusions about feasibility of our procedure and opportunities to apply it on more complex composite structures.