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Zero Group Velocity Resonances of Three Layer Plates for Bonding Evaluation

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Lamb waves in plates are strongly dispersive. For some branches of the dispersion curves $\omega(k)$, a minimum occurs at a non-zero wavenumber k, corresponding to a Zero Group Velocity (ZGV) Lamb mode. Such ZGV modes also exist in multi-layer plates and depend on the quality of the bonding. Because the group velocities of these modes vanishe, after a local impact, the energy remains trapped under the source resulting in sharp resonances. Laser based ultrasonic techniques offer a unique tool to observe these resonances. When the layer thickness is small compared with the plate thickness and the acoustic wavelength, the coupling layer can be modeled by a normal and a tangential spring to take into account the normal and shear interfacial stresses [1]. For greater layer thicknesses, the three layer model was used [2], taking into account normal and tangential springs at both interfaces. Under certains hypothesis, such spring stiffnesses can be evaluated from ZGV frequencies [3]. Theoretical results are illustrated through measurements conducted on several samples made of couple of millimeter thick metal plates bonded with submillimetric glue layer. Eventually, spring stiffnesses measurements are realized into samples with different controled bond strengths provided by Safran Tech.

Acknowledgement:

This work was supported by the Chaire SAFRAN – ESPCI and the LABEX WIFI.

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