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OBSERVATION OF CONTINUOUS MODE CONVERSION OF LAMB WAVES IN COMPOSITE PLATES FOR SHM

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Summary: The increasing use of carbon fiber reinforced plastic, e.g. in aerospace structures, requires advanced techniques for the monitoring of components from this material. Actually, guided waves (Lamb-waves) are considered as an appropriate means for the detection of structural defects like delaminations. After the excitation of guided waves at least two wave modes are propagating, i.e. the symmetric S0-mode and the antisymmetric A0-mode.
Due to the higher group velocity, the S0-mode is faster than the A0-mode and thus these wave modes separate with time. In non-damaged plates the optical observation of propagating waves through a scanning laser vibrometer shows a regular pattern, which, however, is disturbed by structural defects. At defect localizations, mode conversions take place which become clearly visible by optical measurements. Moreover, detailed experimental investigations of the wave propagation show an additional effect between the moving S0- and A0-waves which point to additional A0-waves. At this location, the occurrence of an A0-wave cannot be explained by the originally excited A0-wave, since the group velocity is too low. For this reason, a "quasi-continuous" mode conversion is assumed.
This work presents mode conversion effects in carbon fiber reinforced plastic plates. The optically observed pattern of wave propagation, which include the inhomogeneity of the material, consisting of stiff carbon fibers in a comparatively weak epoxy matrix, and which contain additionally the information of eventually existing defects, will be discussed. Furthermore, the modeling of the carbon fiber reinforced plastic for subsequent finite element analysis of wave propagation in plates from this material will be presented. Microscopic observations show, that the distribution of the fibers in the matrix material is not periodical, but clusters of fibers and matrix material occur. This random distribution of stiffness and mass has to be considered in a microscale model if the above mentioned quasi-continuous mode conversion shall be captured properly. Finally, a numerical example will show the influence of the material model on the developing wave modes.