1.8.17. EXPERIMENTAL CHARACTERIZATION OF SENSORS FOR ELASTIC GUIDED WAVES BASED ON 3D LASER VIBROMETRIC MEASUREMENTS AND THE RECIPROCITY RELATION

Koehler B., Barth M., Windisch T.,
Fraunhofer IZFP, Dresden, Germany

New NDE and structural health monitoring (SHM) concepts initiated the application of new types of sensors and transducers. That is especially true for SHM with guided elastic waves, where among others a variety of piezoelectric disc, foil and fiber transducers were proposed. A reliable characterization of these transducers for different applications is necessary, because the transducer performance will depend on a number of factors as e.g. the way of mounting the transducer (e.g. attached or embedded), on the type and thickness of a glue layer and on the structure they are mounted to. Analytical and numerical modeling of the transducer behavior is helpful, but has its limitations. It is hard to implement into the model all essential aspects of a transducer and its interaction with the structure. Very often there is even a lack of reliable input parameters for the models.

A very strong substitute and/or supplement of numerical modeling are precise and reliable measurements of the transducer behavior. The transducer transmission characteristics for sending plate waves can be characterized by noncontact 3D-vibrometer measurements. If the impulse response is measured this way, the signal for an arbitrary electric excitation can be obtained by convolution.

For characterization of a transducer as a receiver there is no such easy method at hand, due to the lack of simple reproducible excitation sources. It is often mentioned that the transducer-performance as a receiver equals its performance as a transmitter due to reciprocity. This statement is true only if the corresponding sending and receiving transfer functions are defined appropriate.

The paper presents a concept, how the Receiving Transfer Function (RTF) of an arbitrary piezoelectric transducer for guided plate waves can be obtained using measurements and reciprocity. Thereby, the RTF is defined as electrical current measured at the transducer (short circuit conditions) for an excitation at a fixed plate position with a point force of arbitrary (but fixed) direction. The approach is verified for special cases and the implications for transducer characterization are discussed.