Device Concept for Early Damage Detection of Structural Defects Using Guided Lamb Waves

Enrico KÖPPE, Matthias BARTHOLMAI, Jens PRAGER
BAM, Berlin, Germany
(eMail: enrico.koeppe@bam.de)

Abstract

Limited access to the object of relevance is often an essential problem in testing routines, e.g. for non-destructive testing of industry facilities or components of means of transportation. The presented project is about the development of a non-destructive testing method for application over great distances (up to 100 m). The method is based on directed excitation and measuring of lamb waives. It enables an effective differentiation of structural and defective indications as well as a classification of different defect types.

The advantage of guided lamb waves is the ability of propagation over great distances. This offers innovative possibilities for the investigation of large or difficult to access constructions. The testing method can be helpful in a broad variety of applications. It is useable for the characterization of plane or cylindrical, thin-walled surfaces of metal or fiber laminated materials. For example the investigation of aircraft wings and other aerospace components as well as the investigation of pipelines are addressed fields of application.

The project was based on BAM's established testing technology and know-how regarding ultrasound methods. During the project we were able to gain a comprehensive understanding about the lamb-wave principles and application relevant parameters (specimen materials and dimensions, wave characteristics, excitation, transmission und reflection). Algorithms were developed to identify and analyze damage patterns (cracks, wholes, weakening).

Beside the algorithm processing the main project focus was on developing a capable equipment technology. Ultrasound multichannel technique was used as sensor elements. Very challenging demands consist on the excitation technology to generate the wave modes using piezo actuators. Because there is no adequate existing solution available for this purpose, a new development was carried out. An innovative wave generator was implemented, particularly for the multichannel use and configuration of different wave forms and modes. Synchronization, frequency adjustment and amplitude modulation for up to 16 channels are possible at very high frequencies.

The Specifications allow building up application oriented structural health monitoring systems for the investigation of large-scale structures. Next steps are the validation and optimization of the system on suitable reference objects and the expansion of the actor techniques also for operating the sensors.