4.5.17. LOCKIN-SPECKLE-INTERFEROMETRY WITH MODULATED OPTICAL AND INDUCTIVE EXCITATION

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Introduction. Speckle-interferometric methods like ESPI and shearography monitor the mechanical behaviour of an object under load, which makes them valuable tools for non-destructive testing. The load can be applied in various forms, like optical heating, pressure variation, mechanical loading etc. Lockin-Technique can improve classical speckle-interferometrical methods significantly by using a periodical loading and a Fourier transformation of the modulated object response. This paper discusses the performance of this technique in general and presents the novel combination of Lockin speckle-interferometry and modulated inductive excitation.

Methodology. ESPI and shearography are well-known speckle-interferometric methods. Conventionally, they are used with a static loading of the test object. To overcome some drawbacks of these two methods (the depth of defects cannot be determined, and sometimes the signal of a flaw is superposed by a large deformation of the sample itself which makes defect detection difficult), the excitation can be performed modulatedly. This causes a modulated object displacement, which can be monitored by ESPI or shearography, respectively, and after the measurement, the local phase and amplitude of the periodical object displacement can be retrieved by a discrete Fourier transformation (fig. 1) [1].

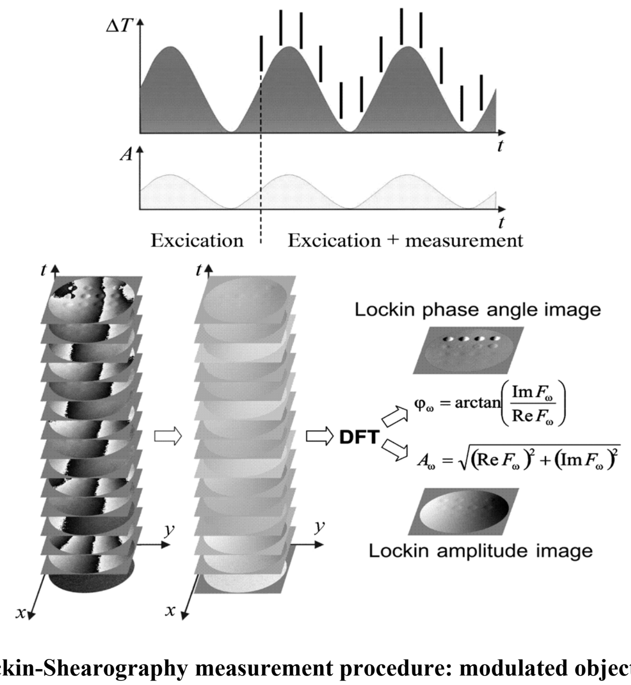

Fig. 1. Lockin-Shearography measurement procedure: modulated object excitation with simultaneous displacement monitoring and image stack and data analysis

Various excitation techniques can be used. Generally, non-contact excitation should be preferred, which is why we focus on optical heating and since very recently inductive heating.

Basic Results. The first results show that defects can be revealed with Lockin-Shearography using eddy-current-excitation. A CFRP pipe with an impact damage was tested at an excitation frequency of 0.05 Hz. The best image from the image stack (which complies with a conventional shearography measurement) reveals the defect, but there is a lot of noise (fig. 2 on the left). In the Lockin phase angle image, the defect can be observed much more clearly (fig. 2 on the right).

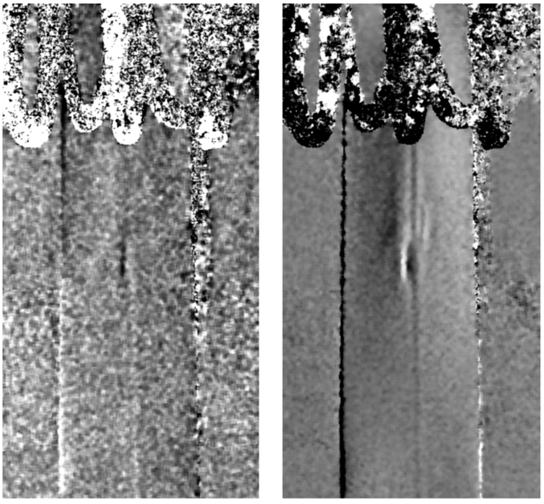

Fig. 2. Eddy-current-excited Lockin-Shearography: best image from image stack (left) and Lockin phase image at 0,05Hz (right)

The signal-to-noise-ratio is improved significantly by a combination of amplitude-modulated eddy-current excitation and pixelwise temporal analysis of the recorded stack of fringe images.

We found a strong influence of the geometry of the test object, its orientation to the coil and its material properties (different types of CFRP are heated very differently). The influence of variation of the Lockin frequency is currently under investigation, as well as the variation of the induction frequency. After this, the new method will be compared with optically excited Lockin-Shearography.

Summary. Modulated eddy-current heating is a new excitation technique for Lockin-Speckle-Interferometry. Though there are some limitations, the first results are very promising regarding some challenging problems in NDT which could not be solved by conventional speckle-interferometry so far.

References:

1. **Menner, P.; Gerhard, H.; Busse, G.** Remote defect visualization with thermal phase angle shearography, Proc. Review of Progress in Quantitative Nondestructive Evaluation, Vol. 29, Kingston, USA, 2009.