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# INVERSE TECHNIQUE FOR CHARACTERISATION OF ELASTIC AND DISSIPATIVE PROPERTIES OF MATERIALS USED IN A COMPOSITE REPAIR OF PIPELINES

Barkanov E. N.[1], Chebakov M. I.[2]
1 - Riga Technical University
2 - Southern Federal University
*chebakov@math.sfedu.ru*

Polymeric fillers, adhesives and laminated composites are the constituent materials in most cases used in the advanced composite repair systems to bring an efficiency of damaged section up to the level of undamaged pipeline. Unfortunately the technical data of such materials provided by manufacturers do not contain all necessary information to predict the behaviour of advanced composite repairs using different analysis tools. For this reason, an inverse technique based on simple vibration tests has been developed to characterise the elastic, hysteretic and viscoelastic material properties. In the case of viscoelastic materials, this novel approach allows to preserve the frequency and temperature dependencies of the storage and loss moduli in a wide range of frequencies and temperatures. The computational effort has been substantially reduced by using an optimisation based on the planning of the experiments and the response surface technique in order to minimize the error functional.

The developed inverse technique uses vibration tests and consists of the experimental set-up, the numerical model and the material parameters identification procedure. The first step involves the planning of the investigation depending on the number of measured parameters and experiments. Next, a finite element analysis is applied at the reference points of the experimental design and the different dynamic parameters of the structure are calculated. In the third step of this technique, these numerical data are used to determine simple functions using a response surface method. Simultaneously, vibration experiments are carried out to measure the natural resonance frequencies and corresponding loss factors of the tested samples. The identification of the material properties is performed in the final step of the method by minimising the error functional, which describes the difference between the experimental and numerical parameters of the structural responses.

The present inverse technique has been tested on metallic plates and successfully applied to characterise orthotropic material properties of laminated composites and viscoelastic properties of adhesive materials. A very good agreement between experimental and numerical results was obtained. The numerical experiments have shown that the accuracy of the developed inverse technique and identified material properties only depends on the accuracy of the physical experiments. The experimental errors mainly appear to be due to badly simulated boundary conditions, an added mass from exciting devices, air damping, and measurement noise.

It is important to note that our current approach, like any other inverse approach based on vibration tests, has a non-destructive character and does not require special specimens for testing. The identified mechanical properties of adhesive materials generally reflect all the features of the technological processes used for the advanced composite repair.

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