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Validation of Mode Shapes of car bonnet by High Speed Digital Image Correlation

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Digital Image Correlation (DIC) techniques have already been successfully proven to be an accurate displacement analysis tool for a wide range of applications. With the use of two cameras, three dimensional measurements of contours and displacements can be carried out.
Using high speed cameras for the acquisition not only high resolution of the deformation measurements in space but also in time opens a wide range of applications for vibration mode shape analysis. Here, different types of excitation can be used in order to extract single or multiple mode shapes within one measurement. In this application the mode shapes of a car bonnet frame structure made out of fibre reinforced thermoplastic composite material are measured by single frequency excitation using a shaker. As the bonnet is a fairly large structure of about 1.8 x 0.8 m the focus of this paper is also on the description of the different parameter and measurement conditions in order to get good quality results. Beside the setup and calibration of the Digital Image Correlation system the surface preparation plays an important role to get accurate information. As the bonnet having a complex shape the setup of the image correlation system and the evaluation parameters were adapted to be able to measure at most areas of the bonnet structure.

For the measurements using the DIC technique the bonnet structure was excited at single frequencies. The frequencies used for the excitation were taken from the results of the experimental modal test. The amplitude of the excitation could be adjusted that vibration amplitudes reaches values of a few mm.

Figure 1: Setup of High Speed DIC system (right) and bonnet structure with shaker (left)

Figure 1 shows the setup of the High Speed DIC system. The bonnet is hanging in free-free condition and is excited by using a shaker from the back side. From the measured time resolved full field displacement data the mode shape is calculated.

The measured mode shape and a mode shape that were simulated based on the CAD model using FE analysis techniques are compared in Figure 2. A good match of the two results can be found. Nevertheless the experimental data show a slightly unsymmetrical behaviour that was not predicted by the simulations. This might be caused by the mechanical excitation of the object on the right side of the bonnet.

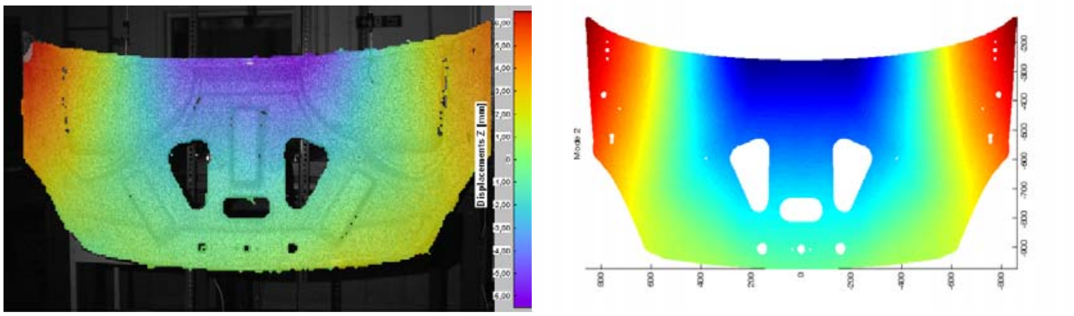

Figure 2: Measured (left) and simulated (right) mode shape at 2nd mode

Overall two different types of car bonnets made of glass reinforced polypropylene (PP) and polyamide (PA) are tested at five different modes each. All comparisons match quite good for both types of bonnet.

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