Real mode parameter estimation for experimental modal analysis

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A new method of real mode parameter estimation for experimental modal analysis was developed. Data for a car body in white and for a full vehicle pickup truck were analyzed using this new parameter estimation method. This paper shows the advantage of this method by comparing its results with the results of a general complex mode estimation method.

At present, complex mode parameter estimation methods are popular for performing modal analysis. But using these methods, there is sometimes too much phase shift in the complex modes, even for lightly damped structures. In order to overcome this problem, the authors developed the idea of using only the imaginary part of Frequency Response Functions (FRF) in the parameter estimation process, with FRF computed as inertance (A/F) or compliance (D/F) functions. If the FRF are computed as mobility (V/F) functions, then only the real part of the FRF should be used. In other words, the assumption was made that mode shapes should be represented as real numbers before starting the parameter estimation.

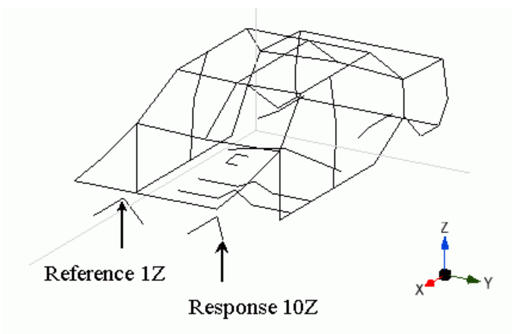

Fig.1 Geometry of a Car Body in white

Figure 1 shows the geometry of the car body in white. Single point excitation was used and a total of 216 FRFs were measured. Modal parameter estimation was conducted using both real mode estimation method and complex mode estimation methods.

Figure 2 shows a comparison of FRF of the car body in white. The FRF shown in Figure 2 compare measured FRF (blue color), FRF (green color) synthesized using the real mode estimation method, and FRF (red color) synthesized using the complex mode estimation method. Both methods appear to produce similar synthesized FRFs, but actually, the residual terms caused by adjacent modes serve to hide some of the errors in the curves.

Figure 3 shows the comparison of synthesized FRFs when using only one mode. The natural frequency is 5.995Hz and the damping ratio is 5.3%. The mode shape is a rigid body pitching mode. Phaseshift (red color) is observed when using complex mode estimation method, but no phaseshift (green color) is observed when using the real mode estimation method.

Modal data for a pickup truck were also analyzed, and the results showed that the real mode estimation method was successful even for a structure of medium damping level.

Therefore, an important question is: How high can the damping ratio of the structure be for the real mode estimation method to remain practical? The authors plan to continue application research on this topic in the future.

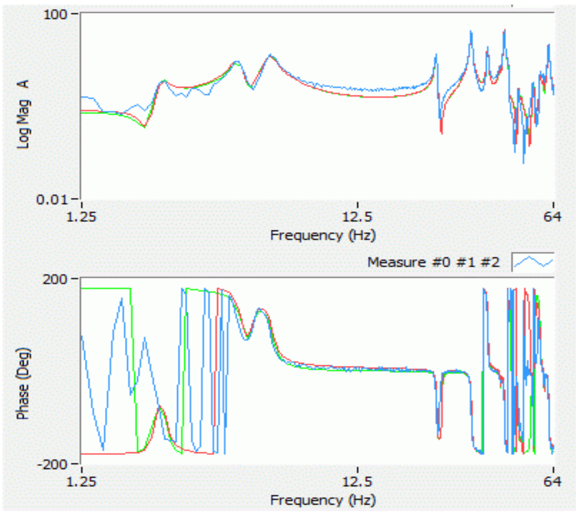

Fig.2 Comparison of Real and Complex modes (MDOF)

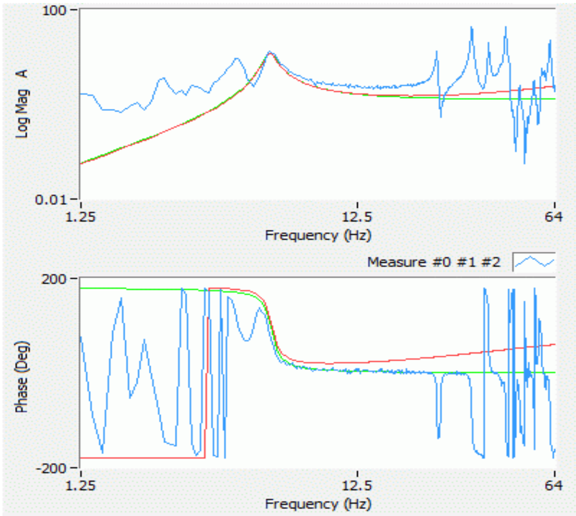

Fig.3 Comparison of Real and Complex modes (SDOF)