VIBRATION TESTING OF COMPOSITE STRUCTURES

N. Shevchenko, D. Heider, J.W. Gillespie, and S. Andersen

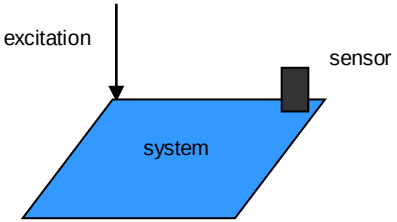
University of Delaware . Center for Composite Materials

INTRODUCTION

- Vibration testing is a diverse field including a variety of non-destructive evaluation techniques. Applications are found in electronics, automobiles and structures to name a few. Results can be determined by comparison to analytic and discrete models. Simple and some complex systems can be solved this way. Results can also be determined directly from acquired data. This is useful when a mathematical model is hard to build or will consume more resources than are available.
- CCM involvement over the past decade has been in the application to bridges, aircraft, vehicles, and naval vessels. Modal analysis and the SIDER method have been used primarily.

MODAL ANALYSIS

- Evaluation of the dynamic characteristics of a system can be achieved using modal analysis. This does not require the application of external loads. However, some sort of excitation is needed. Sound, shaker or hammer may be used. Measurement of strains and deflections is not required. However, some sort of sensor is needed. A microphone, accelerometer or strain-guage may be used.



EXPERIMENTAL TECHNIQUE

- The resonant frequencies, damping factors and mode shapes for a system can be determined from the Frequency Response Functions recorded during a test.

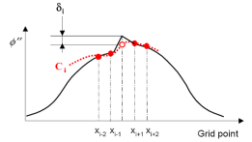
- Roving hammer or accelerometer methods acquire data over a set grid. Fast Fourier Transform is used to obtain the FRF's at each grid point. The system parameters obtained this way may be compared to the models and thereby evaluate the structure.

SIDER

- The Structural Irregularity and Damage Evaluation Routine is a non-destructive method that can detect flaws and anomalies in composite materials. Data are acquired over a grid as in the modal analysis procedure. Mode shape can be used to obtain resonant parameters. Non-resonant method involving the operating deflection shape can also be used. Upon application of the gap-smoothing method contour plots yield a graphical representation of property variations

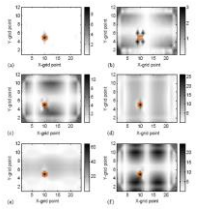
GAP SMOOTHING METHOD

- Curvature of the mode shape is determined using the central difference approximation $\phi_i'' = (\phi_{i+1} + \phi_{i-1} - 2\phi_i)/h^2$
- The structural irregularity index can be determined directly if a base line measurement had been taken for the system. Otherwise a polynomial fit can be used. $\delta_i = |\phi_{i,d}'' - \phi_{i,u}''|$



GSM APPLIED TO MODE SHAPE

- Plots for different mode shapes show the damage areas
- Unexpected variations in stiffness detected while rastering over the surface gives rise to contrast.



CONCLUSION

- Vibration testing can be used to indirectly determine the structural parameters of a system. A great tool for refining designs. Models and baseline measurements are useful but not required. Non-destructive damage evaluation is possible on complex shapes.

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