Dynamic instability characteristics of anisotropically damaged composite panels under harmonic in-plane and follower loading

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Abstract

The present work deals with the study of vibration, buckling and dynamic instability characteristics in damaged cross-ply and angle-ply curved laminates under partial in-plane harmonic and follower loading. The damage is anisotropic in nature and parametrically incorporated into the composite using the concept of reduction in stiffness. Finite element is used to obtain the governing differential equation of the panel. The effect of damage on the free vibration and buckling characteristics of panels has been studied. It has been observed that damage shows a strong orthogonality and in general deteriorates the vibration and buckling characteristics.

For the case of in-plane harmonic loading, the boundaries of instability due to combination resonance is obtained using a second-order Method of Multiple Scales on the Mathieu-Hill equation. The present work explores the effect of damage intensity, location and area on the regions of dynamic instability due to parametric resonance. Changes in the onset of instability and width of the instability region are observed due to increase in damage intensity and variation in the damage location. Further, the instability regions due to combination resonance effects are comparable to those of simple parametric regions which are usually observed in the literature. The effect of damping on the instability regions has also been studied and their stabilising characteristics have been observed.

For follower type of loading, analysis is carried out on panels to obtain divergence or flutter characteristics. The effects of load type, load width,

damage and its location on divergence and flutter characteristics are studied. The desirable position of damage on the panel based on the different stability behaviour is discussed. The results show that the introduction of damage influences the flutter characteristics of panels more profoundly than the free-vibration or buckling characteristics. It has been observed that heavily damaged panels show steeper deviations in stability characteristics than mildly damaged ones. The results also indicate that narrow edge loading is undesirable in most cases. The effect of damping on the flutter characteristics of panels have been studied and it has been found that in certain cases damping may have a destabilising effect.

Keywords : anisotropic damage, composite panels, damping, harmonic loading, follower force, parametric resonance.