Effect of localised damage on flutter instability characteristics of plate subjected to follower load with damping

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ABSTRACT

The static and dynamic stability of beams, plates subjected to conservative loading have been the subject of investigations owing to its great importance in the design of aerospace, mechanical and civil engineering structures. However, in many practical stability problems, particularly in mechanical elements, space and aircraft structures, the applied loading is non-conservative. The follower load is a typical example of non-conservative load. When a structure is under follower force whose direction changes according to the deformation of the structure, it may undergo static instability (divergence) or dynamic instability (flutter) depending on system parameters, giving rise to unbounded deformation or growth of vibration without bound. For example, the wing of an aircraft carrying jet engines is subjected to concentrated follower forces (engine thrust), highly flexible missile and rocket structures subjected to end thrust are prone to divergence and flutter types of instability.

There is a considerable number of papers available on non-conservative instability of beams and columns subjected to follower forces. Bolotin (1963) has extensively studied the non-conservative problems of elastic stability and many investigations have been reported on stability of columns and beams subjected to follower forces. However, investigations on the stability characteristics of the plates and panels under follower loading are relatively few.

In the present study the vibration and dynamic instability characteristics of cantilever plate subjected to edge follower load is studied using finite element technique. The modal transformation technique is considered to the resulting equilibrium equation for the subsequent analysis for reducing computational time. The structural damping is introduced into the system in terms of proportional (Rayleigh) damping. The solution is presented considering the effects of follower load with effect of damping on the instability behavior of the damaged plate. The results show that, under follower loading, the plate may lose its stability either due to flutter or divergence, depending upon the system parameters.