Journal of Sound and Vibration (1991) **145**(3), 409–428

THE HARMONIC RESPONSE OF RECTANGULAR SANDWICH PLATES WITH MULTIPLE STIFFENING: A FLEXURAL WAVE ANALYSIS

D. J. MEAD

Department of Aeronautics and Astronautics, University of Southampton, Southampton, SO9 5NH, England

AND

Y. YAMAN†

Department of Aeronautical Engineering, Middle East Technical University, Ankara, Turkey

(*Received* 10 *October* 1989, *and in revised form* 4 *June* 1990)

An exact analytical method is presented for the vibration response of a finite, three-layered, rectangular sandwich plate with a visco-elastic core, subjected to a harmonic line force which varies sinusoidally across the plate. Uniform parallel stiffeners (which may all be different) span the plate between one pair of simply supported edges. The other pair of edges may have any degree or type of uniform constraint. In the analysis the known flexural wave motion in an infinite parallel unstiffened plate subjected to a single harmonic line force or moment is utilized. A matrix equation is set up for the reactions imposed on the plate by the stiffeners and for the amplitudes of wave motion reflected from the ends of a finite plate. The sandwich core may have large or small amounts of damping. Results computed from the theory are presented and are shown to compare well with experimental data. The influence of the stiffener and core properties on the plate harmonic response is readily determined.

1. INTRODUCTION

Stiffened plate structures are widely used in aircraft and are often subjected to intense acoustic loading. Knowledge of the natural frequencies and normal modes of such structures has generally been regarded as essential in the study of acoustic response and fatigue. Effective ways of damping the excessive response created by resonating modes have long been sought, and sandwich structures with constrained layers of visco-elastic damping material have been of particular interest.

When such sandwich plates are stiffened to form multi-bay structures, their natural frequencies become bunched together, and the high damping of the structure causes resonant response peaks to merge together. This prevents single, identifiable resonant response peaks from appearing in the multi-mode acoustic response spectrum, and it is questionable whether the response is best predicted by conventional normal mode analysis. Normal modes certainly cannot be measured experimentally on these heavily damped structures.

The earliest attempts at analyzing the response of a multi-bay stiffened structure were based on the normal mode approach, but this became extremely tedious when the number of bays was large. Lin proposed a model consisting of a row of flat plates supported by open section stringers between two frames to represent an aircraft fuselage [1]. He initially

†This work was conducted while the second author was on study leave at the University of Southampton.

0022-460X/91/060909+20 $03.00/0