ABSTRACT

The use of lightweight flexible structures in construction, aerospace and marine industries are increasing. Thin flexible plate is the most common lightweight flexible structure. A plate in the structure is generally designed to withstand static loading. However, in the actual scenario, the plate is prone to unwanted vibration due to the presence of dynamical loading. The method used to eradicate unwanted vibration comprises the use of passive and active control. Passive control utilizes vibration absorber, isolator etc, which changes the stiffness or damping coefficient of the system and thereby lowering the vibration level. This method is effective at high frequencies but ineffective at lower frequencies. It is also expensive and bulky in nature to implement. On the other hand, active vibration control (AVC) involves the use of an artificial source which will interfere with primary sources present in the system and cause a reduction in vibration level. This thesis investigates the use of active force control with the optimized value of the parameter in the AFC algorithm obtained from particle swarm optimization (PSO) using MATLAB. The plate system is modelled by using the Kirchhoff plate equation as the governing equation. Validation of the finite difference (FD) model is investigated by comparing the natural frequencies of the plate predicted by the FD model with the exact value from the analytical solutions. For active vibration control, the active force control algorithm is embedded in the FD algorithm to investigate the performance of the proposed control method. The performance of AFC is evaluated for the first mode. It is further checked for the second mode and impulse type disturbances for two conditions, first by keeping the disturbance, control and sensing point identical as in case of first mode analysis. In the second case, the control point is kept at the maximum amplitude of vibration location. The performance is estimated in terms of reduction in root mean square error of the amplitude of vibration at the sensing point. The effect of AFC performance is also evaluated by increasing the distance between the control point and disturbance point with the same sensing point location as in case of the first mode. Then the performance is evaluated for a modified configuration i.e. with nine sensors on the plate. Results obtained show the effectiveness of the proposed control scheme for a reduction in amplitude of vibration of a flexible thin plate.