한국소음진동공학회 2013년 춘계학술대회논문집, pp. 79~80

Dynamic analysis of helicopter-mounted electronic equipment

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1. Introduction

Nowadays, an experimental study on the reducing weight and volume of an avionics component installed in a helicopter is necessary since it is be required to get the capacity of longer flight time and range. An avionics component is required to reduce weight and volume at once withstand dynamic loads from a helicopter. In the past, isolators has been applied to avionics components for reducing vibration and shock without distinction. But, isolator applied to an avionics component installed in a helicopter amplify vibration magnitude, and damage to a chassis, circuit card assembly and isolator itself by resonance at low frequency sinusoidal vibration.

The most obvious characteristic of random vibration is that it is non-periodic. A knowledge of the past history of random motion is adequate to predict the probability of occurrence of various acceleration and displacement magnitudes, but it is not sufficient to predict the precise magnitude at a specific instant. Pure sinusoidal vibration is composed of a single frequency. On the other hand, random vibration is composed of a multitude of frequencies. In fact, random vibration is composed of a continuous spectrum of frequencies. Therefore, understanding of difference between sine on random and random vibration is necessary for comparison of vibration, shock, and acceleration loads. This paper uses loads comparison, finite element analysis, experiment to find improved the tray plate of an avionics component.

This paper explores the dynamic characteristics of an avionics component on a tray without isolator installed in a helicopter and the modification of its structural dynamics considering the fatigue life of the tray plate by sine on random vibration. The object of this paper is to investigate the dynamic characteristics of an avionics component installed in a helicopter and the structure dynamic modification of its tray plate without isolator using a finite element analysis and experiments. Fig.1.1 shows the procedure of the dynamic characteristics optimization for an avionics component.

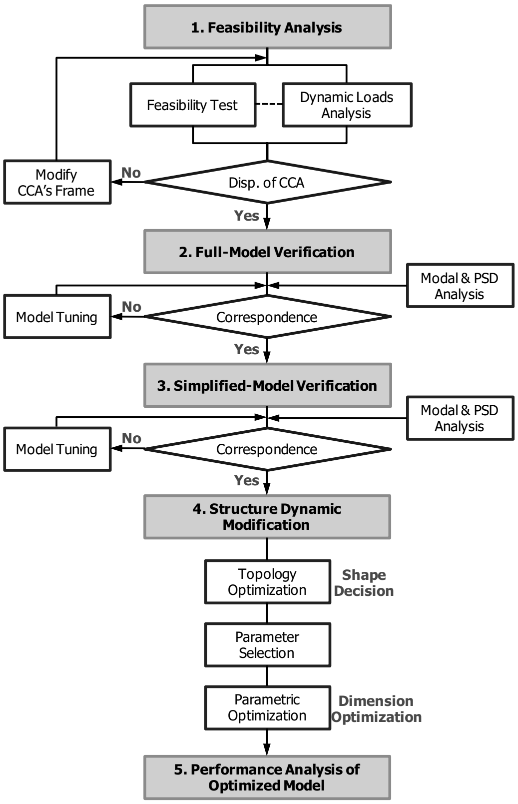

Fig.1.1 Procedure of the dynamic characteristics optimization

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2. Random Vibration Analysis

Random vibration can be represented in the frequency domain by a power spectral density function. The typical units are acceleration [G2/Hz] versus frequency [Hz]. The amplitude is actually [GRMS2/Hz], where RMS is root-mean-square. The RMS notation is typically omitted for brevity. The Hz value in [G2/Hz] refers to a bandwidth rather than to the frequency in Hz along the X-axis. The RMS value of a signal is equal to the standard deviation, assuming a zero mean. The standard deviation is usually represented by sigma σ. A pure sinusoidal function has the following relationship [peak= $\sqrt{2}$ RMS]. Random vibration, however, is very complicated. Random vibration has no simple relationship between its peak and RMS values. The peak value of a stationary random time history is typically 3 or 4 times the RMS value.

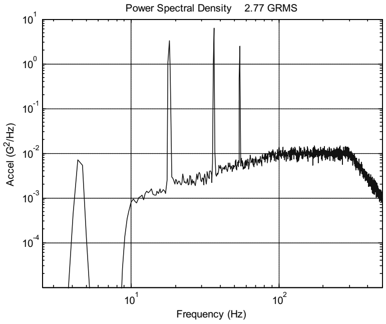

Fig.2.1 Specification for sine on random vibration test

In order to analyze PSD response of the avionics component, an FE-model was created using commercial FE-code, ANSYS. The simplified FE-Model was used and the global modes in the axis from the modal were combined for PSD analysis. Fig.2.1, specification for sine on random vibration test was applied for PSD base excitation load. The FE model is verified by experimental modal analysis (EMA) to compare the dynamic characteristics of the real and FE models. Fig.2.2 shows the measurement position of FEM and experiments. Fig.2.3 represents the PSD response function obtained by FEM and experiments. As a result, the dynamic characteristics of the simplified FE-model agree well with that of experimental model.

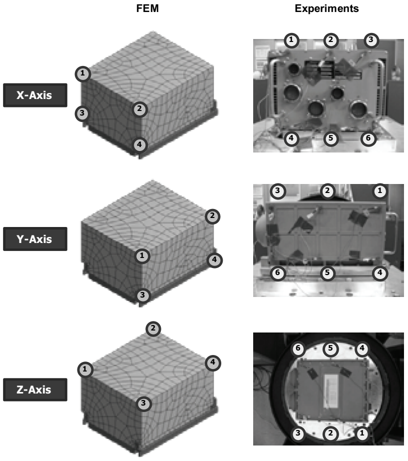

Fig.2.2 Measurement position of PSD response of FEM and experiments

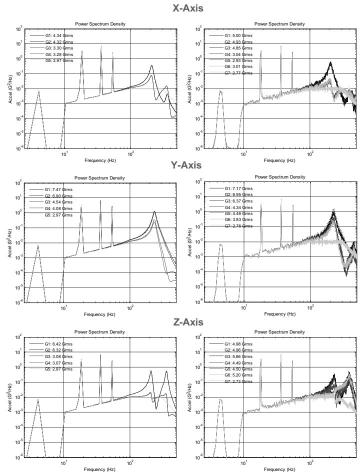

Fig.2.3 PSD response function obtained by FEM and experiments

3. Conclusion

This research proposes the structural dynamics modification of the tray assembly of an avionics component installed in a helicopter for vibration, volume and mass reduction using a simplified finite element model.