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Vibration Analysis of a Beam Structure Attached with a Dynamic Vibration Absorber

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Abstract. In this paper the transverse vibration of a fixed-fixed end beam will be investigated by experimental measurement. This paper is concerned with the classical theory formula as well as the analysis and design of the dynamic vibration absorber (DVA) which is composed by a flexible beam with two masses symmetrically mounted at its both sides. The fixed end beam clamped to a static structure where dynamic vibration absorber then being attached onto it. One side of end of the beam is harmonically excited in transversal direction by an electric shaker. The structure equipped with accelerometer sensor to measure its vibration response amplitudes and natural frequencies. The dynamic vibration absorber arrangement located under motor near the beam end was then being vibrated and done in two conditions; before and after mounting dynamic vibration absorber. The comparison amplitudes before and after equipped dynamic vibration absorber were compared and discussed. From the experimental results, proved that the DVA has successfully absorbed the beam vibration hence reduced the vibration amplitude of the beam structure. The knowledge and result obtained from this study can help engineers control the vibration level of beam structure.

Introduction

There have been very many cases of systems failing or not meeting performance targets because of resonance, fatigue and excessive vibration of one component [1]. In general, each vibrating structure has tendency to oscillate with larger amplitude at certain frequencies. These frequencies are known as resonance frequencies or natural frequencies of the structure. These resonance frequencies, even a small periodic driving force can result in large amplitude vibration. When resonance occurs, the structure will start to vibrate excessively. To suppress the vibration, the dynamic vibration absorber (DVA) widely used as passive vibration control device. The concept of DVA is eliminating the vibration by a counter back motions. When some force are applied to a structure, the DVA will reacts by producing some amount of force in the opposite direction henceforth restraining the beam motion. When correctly tuned and attached to a vibrating body subject to a harmonic excitation, eliminates steady-state motion of the point to which it is attached. A simple DVA basically consists of mass and a spring.

In this research, a new control strategy have been designed in order to absorb vibration. This vibration absorbing devices demonstrated as a good vibration absorber when applied on fixed-fixed end beam and analyses in two phases; theoretical and experimental. This special DVA can be used to control the vibration level of a building built in earthquake prone area, to control the vibration level of a bridge exposed to high speed or turbulence wind and to control airplanes wing flutter.

Theory and Formulation

Theoretically, every undamped vibration system can be modelled by an equivalent mass-spring vibration system [2, 3]. A classical DVA consists a single pair of an auxiliary mass-spring system. This classical DVA is useful for a single degree of freedom system [4-6]. The mathematical equation is based on the classical DVA theory and represents a single degree of freedom as shown in Fig. 1.