



DESIGN OF AN ADAPTIVE DYNAMIC VIBRATION ABSORBER

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Notation

Notation

m_a = mass of absorber or secondary structure (kg)

m_b = mass of base or primary structure (kg)

ω_a = natural frequency of absorber (rad/s)

ω_b, ω_n = natural frequency of base (rad/s)

ω_{11}, ω_{22} = first and second modes of the composite system (rad/s)

p = excitation or operating frequency (rad/s)

E = modulus of elasticity (Pa)

I = second moment of inertia (m^4)

ρ = density (kg/m^3)

H_a = impedance of absorber (N/m/s)

H_b = impedance of base (N/m/s)

u_b = maximum displacement of base with absorber attached (m)

u_F = maximum displacement of base without absorber attached (m)

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ABSTRACT

The aim of this thesis is to investigate the use of a Dynamic Vibration Absorber to control vibration in a beam. Traditional means of vibration control have involved the use of passive and more recently, active methods. This study is different in that it involves an adaptive component in the design of vibration absorber using two novel designs for the adaptive mechanism.

The first design incorporates the use of an enclosed air volume to provide the variable stiffness component in the absorber. By adjusting the volume of compressible air within the absorber, the stiffness characteristics of the absorber can be altered, enabling the device to adapt to changing vibration frequencies. Work here includes a theoretical investigation of the device. Following this, two prototypes are constructed and tested, the second of which is the refined model used for further testing.

The second design incorporates the use of two concentrated masses cantilevered from two rods. The adaptive solution is achieved by moving the two masses along the length of the rod, producing a changing natural frequency for the absorber device. An analytical model of this device is developed as well as a finite element model. Results from both are compared to those obtained experimentally.

Finally, a tuning algorithm is derived for the second absorber, and a control system constructed to make the dynamic vibration absorber “adaptive”. Experiments are undertaken to determine the effectiveness of the absorber on the beam subject to changing excitation frequencies. The outcome of this research is that an Adaptive Vibration Absorber has been constructed with a computer interface such that the device can be used “on line”.

STATEMENT OF ORIGINALITY

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