

## ***Design and Manufacturing of a Vibration Absorber for Sound Reduction of a Turboprop Aircraft***

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### ***ABSTRACT***

The sound produced by the engine penetrates into the airplane through the structure and fuselage is still a grave concern for turboprop plane designers. The engine's propellers rotation is the main source of the sound in this kind of planes, the sound is transmitted to the fuselage through the structure and air so makes it vibrated. The decrease of noise made in the planes by dampers such as rubber, visco-elastic, and other non-dynamic absorber is not possible due to frequency low level. The present study investigates the designing of dynamic absorber for installing on the fuselage to absorb vibration and damping of the sound energy in the structure of the plane which makes the transmission way of vibration and sound possible in the structure. In the beginning, the theoretical relationship to design tunable dynamic absorber is gained, then the finite element model of the absorber is analyzed by ANSYS, and at the end, structuring and examining it for turboprop Antonov-140 is carried out.

**KEYWORDS :** Tunable dynamic absorber, Turboprop aircraft, Sound reduction, Vibration reduction, Finite element

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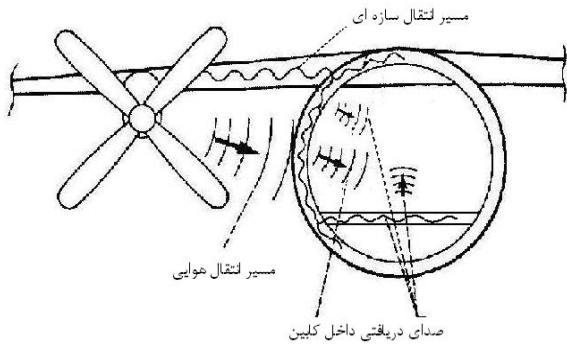
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$$f = \frac{n \cdot N}{\epsilon_0}$$

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$n$

$N$

rpm

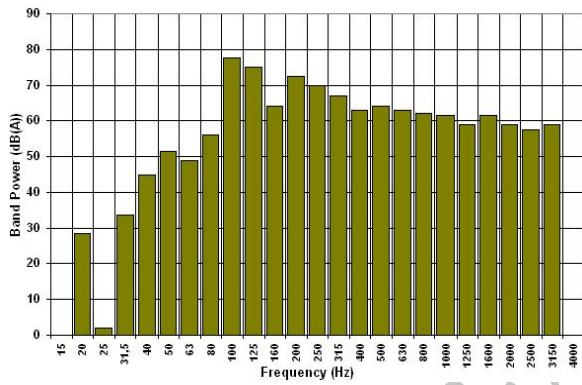
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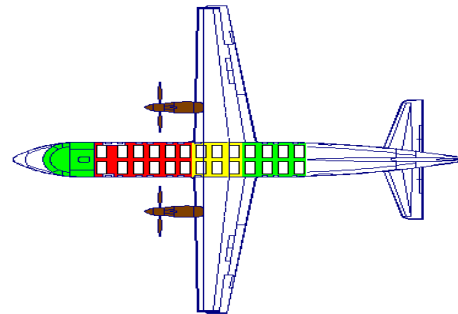
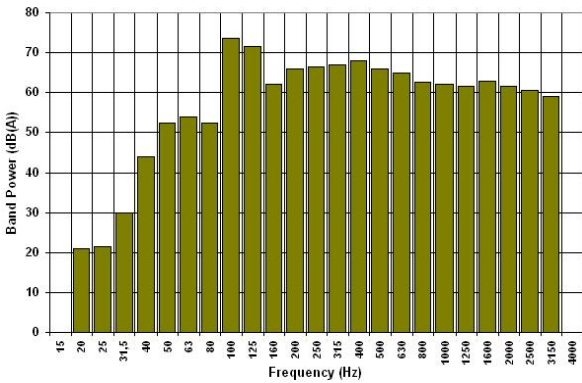


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dB

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x

y

z



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%

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$$L_a(dB) = \gamma \cdot \log\left(\frac{A}{A_0}\right) \quad ( )$$

$$A_0 \quad L_a$$

$$A \quad \gamma \cdot \gamma^{\gamma} (m/s^{\gamma})$$

z y x

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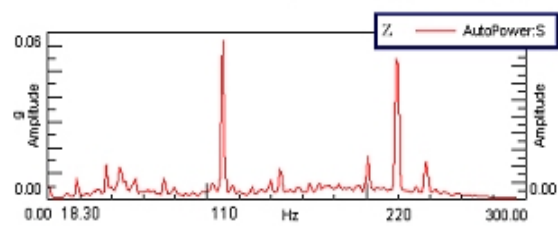
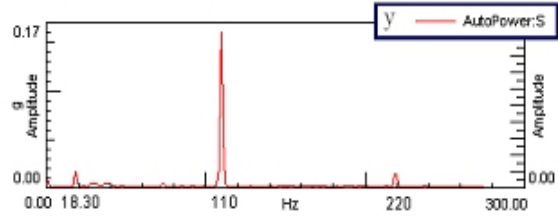
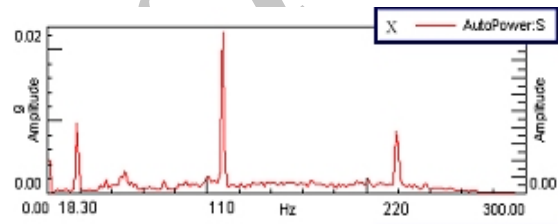
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$$\Delta SWL(dB) = \gamma \cdot \log(\dots - T) = \gamma \cdot \log(I_s) \quad ( )$$

$$T \quad \Delta SWL$$

$$I_s$$



z y x

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$$\lambda = (\rho A \omega^2 / EI)^{1/4} \quad \omega^2$$

$$C_1, C_2, C_3, C_4$$

$$(1 + \cos \phi \cosh \phi) + \frac{m\phi}{\rho AL} (\cos \phi \sinh \phi - \cosh \phi \sin \phi) = \dots \quad (m)$$

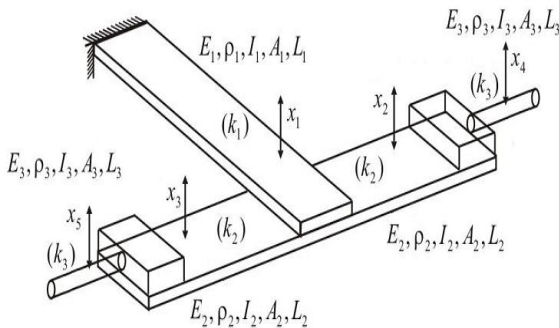
$$(\phi = \lambda L)$$

$$\rho \quad L \quad A \quad m \quad \phi$$

$$[\ ] \omega_i = \phi_i^2 \sqrt{EI / \rho AL}$$

$$\begin{bmatrix} k_1 + \gamma k_r - m\omega^2 & -k_r & -k_r & \cdot & \cdot \\ -k_r & k_1 + k_r - m\omega^2 & \cdot & -k_r & \cdot \\ -k_r & \cdot & k_1 + k_r - m\omega^2 & \cdot & -k_r \\ \cdot & -k_r & \cdot & k_r - m\omega^2 & \cdot \\ \cdot & \cdot & -k_r & \cdot & k_r - m\omega^2 \end{bmatrix} \begin{Bmatrix} A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{Bmatrix} = \dots \quad (n)$$

$$f = \omega / \gamma \pi$$



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(m) (k)

$$EI \frac{\partial^4 w}{\partial x^4} + \rho A \frac{\partial^2 w}{\partial t^2} = \dots \quad (k)$$

$$w(x, t) = \dots \quad (k)$$

$$\frac{\partial^2 w}{\partial x^2}(L, t) = \dots, \quad EI \frac{\partial^2 w}{\partial x^2}(L, t) = m \frac{\partial^2 w}{\partial t^2}(L, t) \quad (k)$$

$$w(x, t) = X(x) e^{i\omega t}$$

$$X(\cdot) = \dots, \quad \frac{dX}{dx}(\cdot) = \dots, \quad \frac{d^2 X}{dx^2}(L) = \dots, \quad EI \frac{d^2 X}{dx^2} = -m\omega^2 X \quad (k)$$

$$X(x) = C_1 \cos \lambda x + C_2 \sin \lambda x + C_3 \cosh \lambda x + C_4 \sinh \lambda x \quad (k)$$

$$X(\cdot) = \dots \rightarrow C_1 + C_2 = \dots, \quad \frac{dX}{dx}(\cdot) = \lambda C_1 - \lambda C_2 = \dots$$

$$\frac{d^2 X}{dx^2}(L) = \dots \rightarrow -\lambda^2 \cos \lambda L C_1 - \lambda^2 \sin \lambda L C_2 + \lambda^2 \cosh \lambda L C_3 + \lambda^2 \sinh \lambda L C_4 = \dots \quad (k)$$

$$\frac{EI}{m} \frac{d^2 X}{dx^2}(L) = -\omega^2 X(L) \rightarrow \left( \frac{\rho A}{m} \sin \lambda L + \lambda \cos \lambda L \right) C_1 + \left( -\frac{\rho A}{m} \cos \lambda L + \lambda \sin \lambda L \right) C_2 + \left( \frac{\rho A}{m} \sinh \lambda L + \lambda \cosh \lambda L \right) C_3 + \left( \frac{\rho A}{m} \cosh \lambda L + \lambda \sinh \lambda L \right) C_4 = \dots$$



11 Gpa  
CRES316

BT6

kg/m<sup>3</sup>

Gpa

Gpa

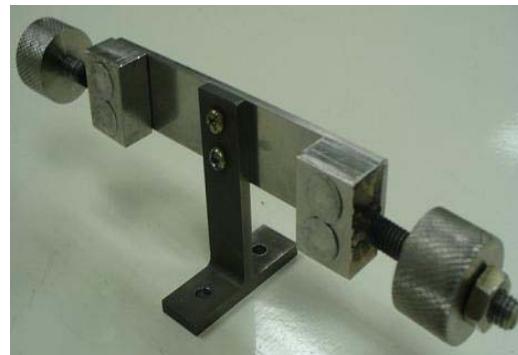
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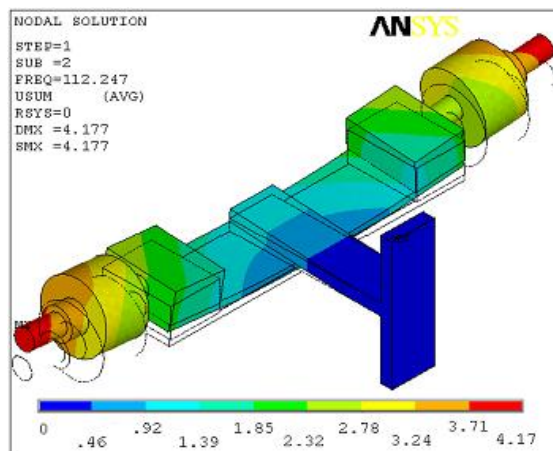
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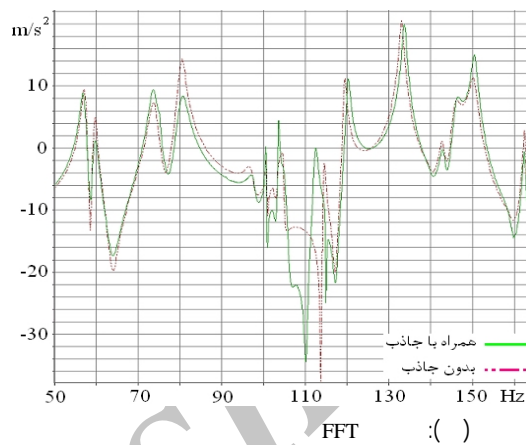
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Hz	Hz	Hz	

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