THE USE OF TUNEABLE MASS DAMPERS FOR BROAD-BAND NOISE CONTROL IN A CYLINDRICAL ENCLOSURE

Vibro-acoustic control in cylindrical structures

Large cylindrical structures are common in both aerospace and naval vehicles. The reduction of noise transmitted into such enclosures is particularly challenging due to the high excitations levels, the complexity of the disturbance (stochastic distribution in space and time) and the severe mass and volume constrains imposed on the design.

Modal – Interaction Model

The transmission of sound into an enclosed acoustic cavity can be simplified into three stages:

- EXTERIOR SOUND FIELD
- STRUCTURAL VIBRATION
- INTERNAL SOUND FIELD

Both the structural and interior acoustic domains are studied in terms of their uncoupled modes. The two domains interact via the coupling terms:

\[
\phi_{\text{in}}(x, \theta) = \sin \left( \frac{m_1 \pi x}{L} \right) \cos (m_2 \theta)
\]

\[
\psi_{\text{in}}(x, \theta, r) = \cos \left( \frac{m_1 \pi x}{L} \right) \cos (m_2 \theta) J_{m_2} \left( \frac{m_2 \pi r}{R} \right)
\]

This leads to the fully-coupled equations of motion:

\[
\begin{bmatrix}
M & 0 & 0 & C & C_{\text{trans}} & 0 & q_s & q_r \\
0 & M_{\text{trans}} & 0 & w_s & C_{\text{trans}} & C_{\text{int}} & 0 & q_r \\
M & 0 & M_{\text{int}} & 0 & 0 & C_{\text{int}} & q_r & 0
\end{bmatrix}
\begin{bmatrix}
K & K_{\text{trans}} & 0 & q_s \\
K_{\text{trans}} & K_{\text{int}} & 0 & 0 \\
0 & 0 & K_{\text{int}} & q_r
\end{bmatrix}
\begin{bmatrix}
Q_s \\
Q_r \\
Q_r
\end{bmatrix} = 0
\]

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Riferimenti bibliografici

E. Turco and P. Gardonio On the use of tuneable mass dampers for broad-band noise control in a cylindrical enclosure. ICSV22, Florence, Italy 2015

Sweeping Tuned Vibration Absorbers

STVAs are classical mass-spring-damper absorbers with the following features:
- Their fundamental resonance and damping coefficient are blindly swept between a lower and a higher tuning limit.
- They can control the cylinder flexural modes resonating within a given frequency band.
- They can be installed without the need of identifying the dynamic response of the hosting structure.
- They are robust to changes of the dynamic response in the hosting structure.

Riconoscimenti

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