Tuned Mass Damper (TMD)

Description

A high frequency TMD is a additional damping device which is used in various mechanical applications.

A High frequency TMD is primarily used for either reducing the radiation of audible resonant structure borne noise from larger structures having eigenfrequencies in the range of 15-100 Hz.

Or to reduce transmission of structure noise from noise sources through stiff or elastic joints to a primary structure in a building or steel structures.

Typical problems comes from engines, gensets, compressors etc. and are normally problem with transmission/radiation of noise in the range 50-60 Hz.

In the highest frequency range with many natural frequencies present in the structure a traditional contrained layer(CLD) damping is often used. Often above 100 Hz

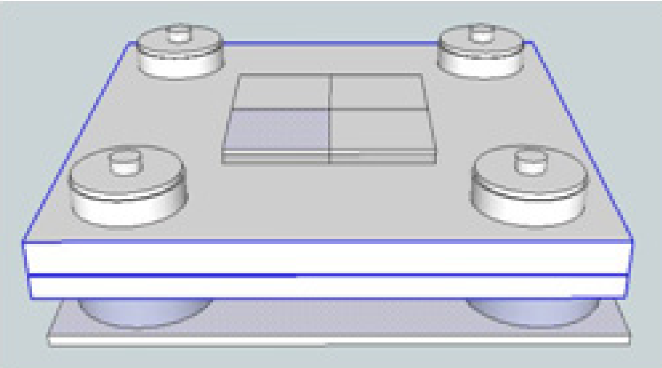


Fig 1. Principal design of tunable elastomer HFTMD

Example: 54 Hz absorber for a generator

During the structural design of a generator, it became obvious that it would require a number of TMD's in order to reduce the amplitude of the resonant modeshape. The generator is constructed in app. 30 mm thick steel plate, having the 1. modeshape in the raange of 52-58 Hz. As this is a 2D problem with rotational forces, a large no. of radial TMD's were designed and manufactored with pre-compression in order to take care of the gravitation.

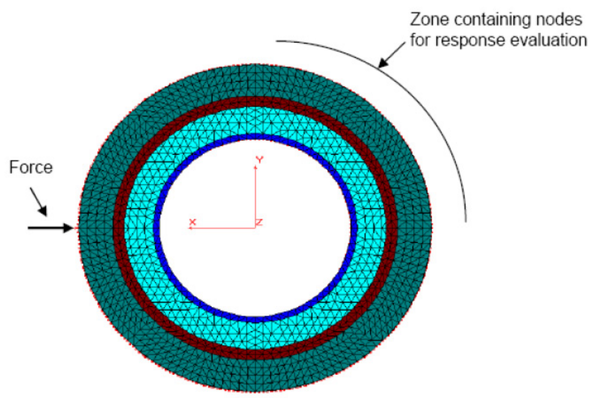
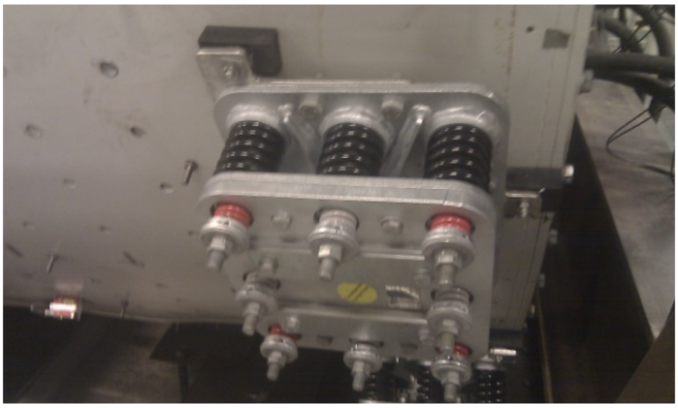


Fig 2. Frint view/FE model of generator.

Fig 3. HFTMD's mounted on generator



Product Specification

A Vibratec HFTMD is a customized product and is designed and manufactured according to the given specifications. In each case the TMD is designed to a tuning frequency F_t, which can be found when the natural frequencies of the main structure is known. Classical theory may be approched, however often there is a coupling to the acoustic, as the vibroacoustic parametes plays a major role.

Finite element analysis may also be used to predict the overall global response with a HFTMD implemented in the FE model.

HFTMD mass:	Range from 5 kg-
HFTMD frequency:	Range from 15-100 Hz
HFTMD tuning range:	± 10 % of TMD frequency
Color and surface treatment:	According to requirements
Installation type:	According to requirement

HFTMD's are often designed in co-operation with leading acoustic consultants or vibroacoustic specialists.

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High FrequencyTuned Mass Damper
High frequency absorber

High Frequency Tuned Mass Dampers are usually implemented in the following typical application types:

- Reduce radiation of structureborne noise of thin steel plate construction, HFTMD type CLD to be used
- Reduce radiation of structureborne noise of heavy duty steel plate construction, elastomer and coil spring type HFTMD
- Reduce radiation of structureborne noise of rail for track systems, Elastomer type HFTMD
- Reduce radiation of structureborne noise of steel bridges, Elastomer type HFTMD
- Reduce transmission of structure borne noise through elastic suspensionsm, HFTMD type

Example: A 49 Hz noise absorber for a cooling compressor

Even after replacement of PU foam isolation strips to low frequency coil spring configuration, which gave additional insertion loss of 8-10 dB, there were still complaints of the tone transmitted to the offices below.

On each support an adjustable HFTMD were attached. Each HFTMD is ranging from 45 Hz -58 Hz, and is adjusted in the lab as well as on the site.

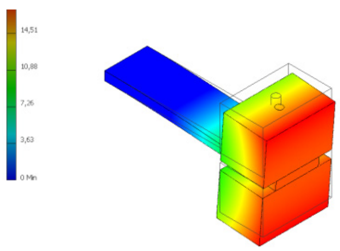
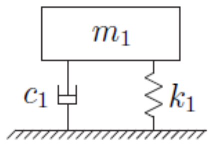


Fig 4. FE analysis and installation

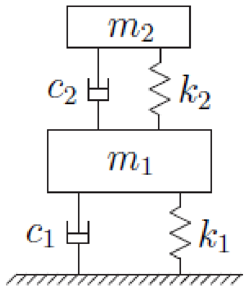
Conclusion: The TMD only added a further reduction of 1-2 dB at 49 Hz. To gain a higher reduction would require a lower point mobility $Y_0(\omega)$ of the deck and different room acoustic properties of the offices below.

The design of a HFTMD can be based on classical theory using the SDOF method, as the dynamic behaviour of the structure is described by a linear combination of several different harmonic ossicilations. The structure can therefore be transformed into different equivalent mass spring ossicilators each with a single degree of freedom.

Basic DOF equivalent:



SDOF system + TMD:
TMD parameters
m_2, k_2 and c_2



However it's important to notice that classical theory does not take the vibroacoustic coupling into account, and it doesn't take care of the behavior of the HFTMD are having NON rigid body movements.

During the design of a coil spring absorber, it's necessary to analyze the viscous damping further, as a typical dash pot type damper normally does not have succicient damping at higher frequencies. At higher frequencies a elastomer solution therefore may give the best result.

Finite element analysis(FEM) and vibroacoustic analysis(SEA, AFEM,BEM)may be required in order to ensure that the HFTMD is designed correct.

- High internal eigenfrequencies for internal elements
- High loss factor for potentially radiating surfaces
- Avoid resonance in coil spring

Also ensure low mobillity $Y_0(\omega)$ of the attachment point, either by stiffening or moving the source.

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