Vibratec® akustikprodukter

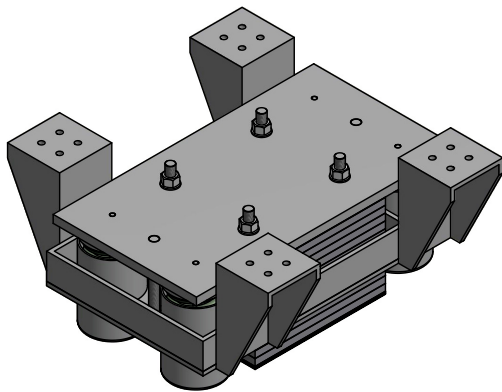## Tuned Mass Damper
Low frequency absorber

Fig 1. Vertical TMD for bridge

Example: Pedestrian bridge in Malmö

During the structural design of the pedestrian bridge at Bagers Plats in Malmö, it became obvious that it would require a TMD, as the lowest vertical eigenfrequency was calculated to 1,85 Hz. A TMD solution was designed. In total 2 TMD's with a vibration mass of each 340 kg was installed in the mid section of the bridge.
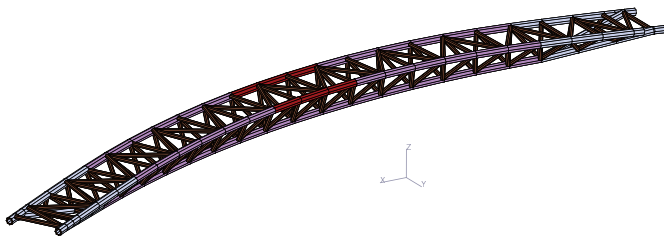

Fig 2. FE model of bridge, by Grontmij A/S

Fig 3. Bagers Bro in Malmö

Damping ratio of bridge with blocked TMD:1,5 %
Damping ratio of bridge with TMD:9,0 %
Due to the increased damping of the first vertical modeshape, the movements by walking persons are dampened, and the comfort criteria are met.

Tuned Mass Damper (TMD)
Description

A TMD is a additional damping device which is used in various building applications. Many structures like predestrian bridges, chimneys, light weight and long span floors, staircases are having critical natural frequencies in in the same range as the excitation forces, as well as having low internal damping. For these types of structures a TMD may be used to improve either the walking confort on a bridge by increaed damping of the natural frequencies, or to increase the structural safety for buildings and structures etc.

A typical TMD concists of a mass suspended on steel coil springs and a viscous damper. A TMD can also be designed as a pendulum damper for application types as wind turburbine towers etc.

A TMD can be designed to work either vertically, horisontally or in torsional directions.

Product Specification

A TMD 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. TMD Mass, TMD damping coeeficient and spring configuration is estimated by optimizing and finding the minumum response for a main system + TMD, by solving the related differential equations.

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

TMD mass: Range from 50 kg-
TMD frequency; Range from 0,5 Hz-30 Hz
TMD tuning range: ± 10 % og TMD frequency
Color and surface treatment: acc. requirements
Installation type:acc. requirement

Vibratec® akustikprodukter

Applications and General theory of TMD

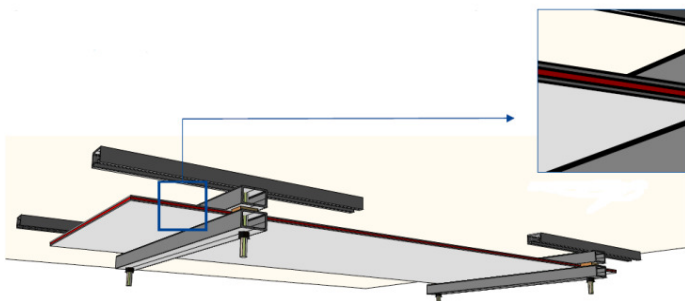Tuned mass dampers are usually implemented in the following typical application types:

• Pedestrian bridges and staiscases etc. which can be excited by jumping or walking. Primarily this is a comfort problem and not a structural problem.

• Office floors and similar being excited either by jumping and walking or machinery. May cause dis comfort as well as structural problems.

• Subsea oil & gas transmission lines. Excitations by wave loads

• Tall and slender structures, like bridges, chimneys and towers which can be extited easily by wind causing dangerious situations for the structure.

The design of a TMD to a pedestrian bridge is 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 SDOF equivalent:

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

Example: TMD below office floor

This is an NON classical TMD solution, as it consists of a sandwich plate with constraining damping layer. Placement of support points, dimensions of plate results in a tuning frequency similar to the actual bending mode of the floor.
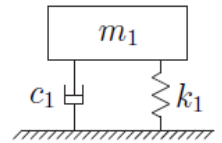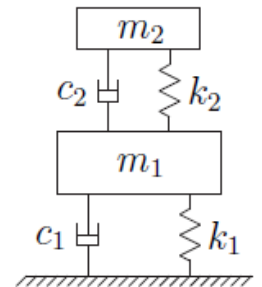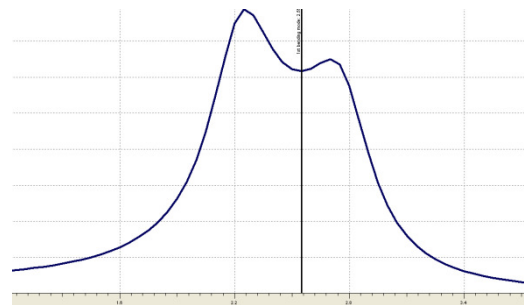
A normal TMD with springs and dampers may also be used.

As the floor is a 2D structure, several TMD's must be installed in order to reduce responses at a given modeshape.

Example: Inhouse predestrian bridge-Solution. for pre design. m_2=830 kg.

Optomized solution, m_2=890 kg