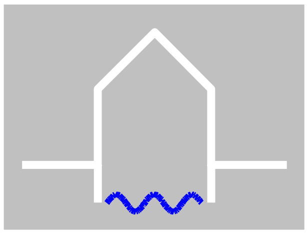
CDM–ABSO–STRUCTURE A PASSIVE ENERGY DISSIPATING SYSTEM



CDM-ABSO-STRUCTURE

1. PRINCIPLE

Dynamic forces applied in or in the neighbourhood of existing building structures can lead to structural damage, malfunctioning of sensitive equipment and discomfort to people. These vibrations can be treated at the source, on the propagation path or at the receiver. Source and transmission path interventions are for the building owner the best solutions to pursue but they are not always feasible or economically justifiable. In many cases receiver type of interventions are the only remaining solution. From the pallet of possible solutions, isolation and structural modification are often difficult to introduce in existing buildings. Damping is in these cases the only remedy to reduce the effect of vibration.

There are two techniques available to increase the existing damping in a structure:

- Spot Attachment Damping (SAD), like tuned mass dampers (TMD), consisting of the introduction of additional inertial mass attached to the structure on the point of maximum vibration annoyance with a defined stiffness/dash-pot. This allows tuning the resonant frequency of the add-on system to the disturbing frequency in the structure. The TMD is made to work in the same direction as the disturbing amplitude with a mass ratio of approx. 10 to 20%. The efficiency of TMD depends on the mass-ratio (the ratio of the add-on mass versus the modal mass in motion of the vibrating structure) and the stiffness/damping of the add-on system. The TMD add-on systems are very efficient on the disturbing frequency (usually fairly fine-band) but are usually voluminous and not easy to introduce in existing structures.
- Add-on damping systems such as the free layer (FLD) and constrained layer damping (CLD) systems. They are most commonly used to damp the bending mode of surfaces (like panels). FLD comprises the adding of a high modulus and high loss factor viscoelastic material to the structure, whilst CLD techniques use low modulus and high loss factor viscoelastic materials to add-on as core in between the existing panel and a constraining elastic layer

SAD methods are the most efficient ones from technical and economical point of view. SAD treatments implicate however fairly heavy masses and require therefore often a large space inside the existing building. A “small” and “space-conscious” SAD treatment is therefore necessary to solve resonant vibration problems in existing structural floors. Until date, no such devices were present on the market place. **CDM-ABSO-STRUCTURE** combines the two principles into a practical system. It is a tuneable SAD device based on a tuneable high-damping CLD sandwich panel, attached (in the middle &) at the underside of the existing vibrating floor within a very limited built-in space (thickness max. 200mm, to be integrated eventually in a false ceiling). The device is designed to vibrate at the same resonance frequency as the disturbing resonance in the existing structure, usually of the first bending mode.

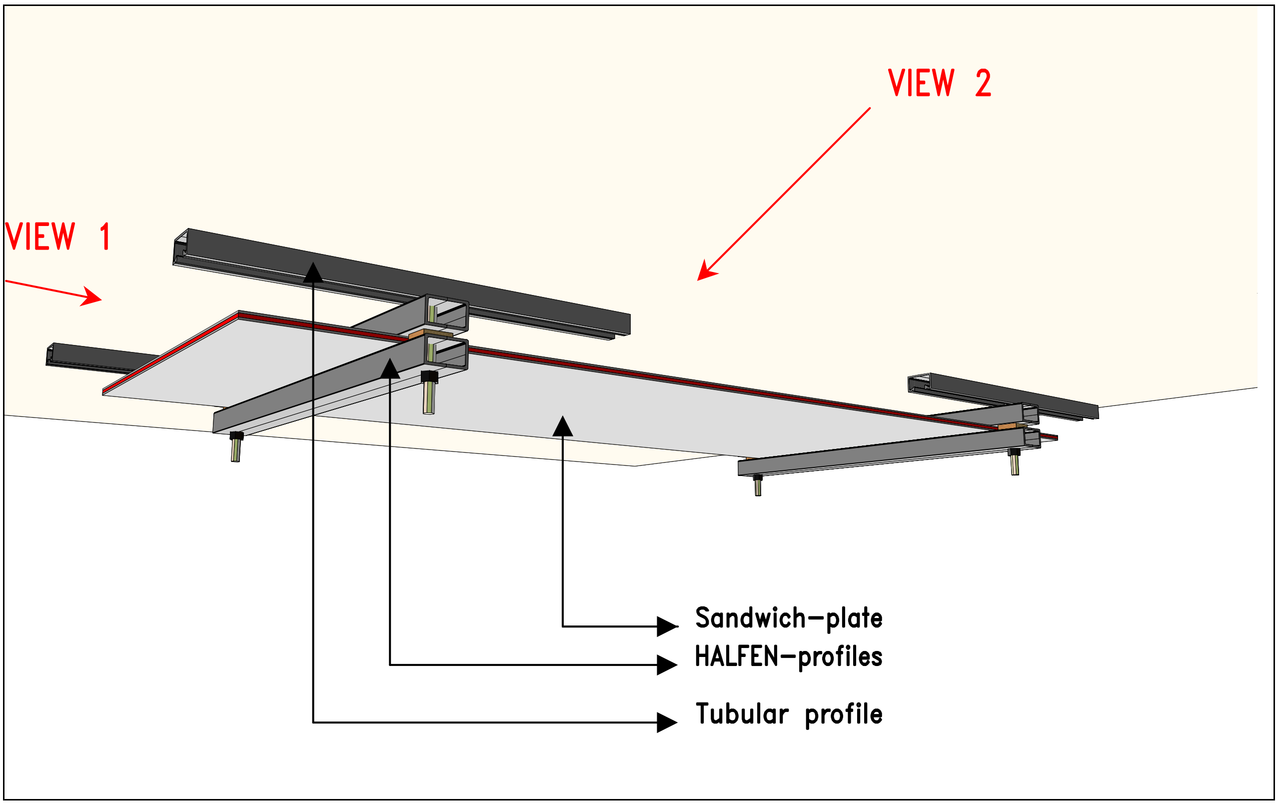
This system was developed in co-operation with the Flemish Regional Government - IWT-Project Nr° 970175.

2. CDM PRODUCTS AND SYSTEMS

CDM-ABSO-STRUCTURE is built up as follows:

- A sandwich plate consisting of 2 outer steel plates (thickness H-steel is a design parameter) with in between a highly damping viscoelastic material, type CDM-66 with specific thickness H-Visco (also a design parameter). The plate dimensions are L x B (design parameters, L = length, B = width). The total thickness is thus 2xH-steel + H-Visco.

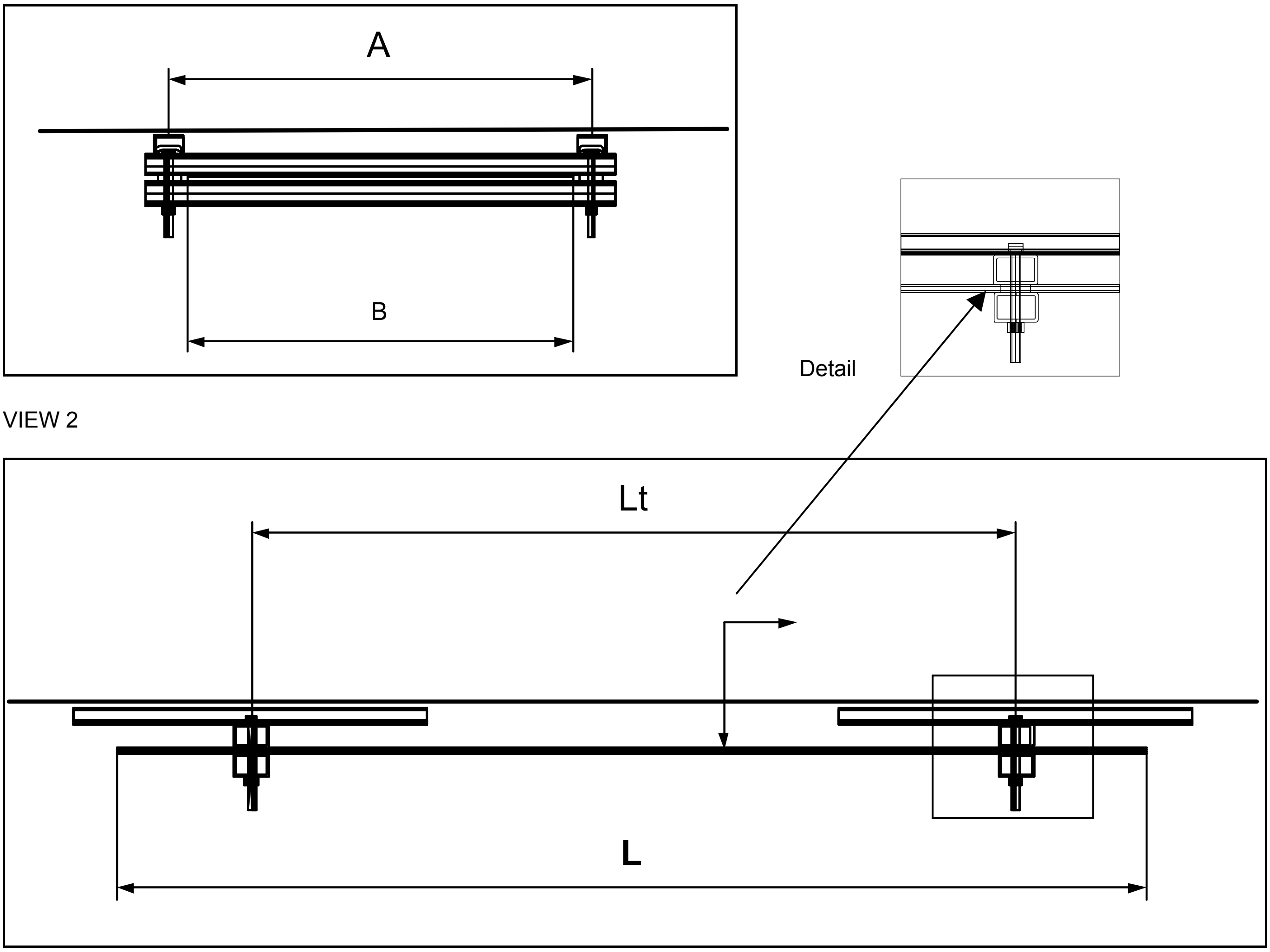
- The sandwich-plate is clamped at the support lines over the full width B of the sandwich-plate via a system of 2 stiff tubular profiles 40/60/4. The prestressing of the sandwich-plate is obtained with a treaded rod M20 with one nut/washer fixed by a hammer-head fixation in a special profile allowing a translational movement perpendicular to the support lines (system HALFEN HM 50/30). The HALFEN system can be materialised by 4 small lengths (2 fixation points per small length) or by 2 long lengths (only 2 fixation points per long length).
- In order to secure a constant prestressing pressure over the full length of the support line, a resilient washer is introduced between the two tubular profiles (CDM-63011 40X40X11 with central hole ∅20 mm).
- The two HALFEN profiles are fixed in the supporting (vibrating) floor at a distance A (=design parameter) with chemical anchors type “Redhead Anchor”M8.
- Fine-tuning tolerance +/- 0.25 Hz by use of add-on magnetic masses (per 100 g).



Parameters that have to be chosen in order to obtain the maximum absorption are:

- H-Steel (mm) = thickness of the steel skins in the sandwich-plate
- H-Visco (mm) = thickness of the CDM-66
- L and B (mm) = plane dimensions of the sandwich plate
- A (mm) (> B) = the distance between the HALFEN profiles
- Lt (mm) (< L) = the tuning length or span of the sandwich plate (distance between the tubular profiles)

VIEW 1



The final tuning of the **CDM-ABSO-STRUCTURE**-system in situ is done by modifying the span of the sandwich-plate (configured as a beam) between the 2 supporting lines. The translational movement of the supporting lines is to be done symmetrically with respect to the point of max. vibration (in most cases the middle of the span).

Practical solutions start from 4-5 Hz and upwards.

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3. MEASUREMENTS

A real in situ test case has been considered. The building of interest is located at the “Molsebaan 43” in Retie. The vibration levels in the house are too high according to the owner of the building.

First, vibration measurements are performed to evaluate the level of vibration in the building according to the DIN standard 4150 part 2 and to determine the dominant frequencies of the vibration. After evaluation, it was found that the level of vibration of the test floor is too high according to the DIN standard. There is a significant disturbance to people. The dominant frequency is about 14.4Hz. The vibration measurements were repeated after the installation of the **CAM-ABSO-STRUCTURE** system. During the test, the influence of different fixation systems have been investigated.

The following table shows in a conclusive way the main results of the tests done with **the CDM-ABSO-STRUCTURE** system.

Structure			**CDM-ABSO-STRUCTURE-system**							**Structure+CDM-ABSO-STRUCTURE-system**	
f_{res} (Hz)	ξ_1 (%)	M_1 (kg)	L (m)	B (m)	H_{steel} (mm)	H_{visco} (mm)	M_2 (kg)	η_{VISCO} (%)	η_2 (%)	μ (%)	R (%)
14.5	0.5	6285	1.75	0.65	3	5	60	14	6.6	1.0	75

With M1: effective mass involved in mode 1, ξ_1 modal damping., M2 the add-on mass, η_{VISCO} the loss factor of the visco-elastic material in the sandwich plate, η_2 the loss factor of , μ = M2/M1 and

$$\text{R: reduction} = 100 \times \frac{\text{decrease of maximum displacement due to ABSO - STRUCTURE - system}}{\text{maximum displacement of structure without ABSO - STRUCTURE - system}} \text{ (at resonance).}$$

The introduction of the **CDM-ABSO-STRUCTURE** system on existing building structural floors with excessive vibrations can reduce the vibrations on resonance by as much as factor 4 to 5 (insertion loss at resonance of 10 to 14 dBV).