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# CHARACTERISATION OF RESILIENT INTERLAYERS

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**ABSTRACT:** In buildings the sound transmission between rooms is characterized not only by direct transmission but also by flanking transmission through the structure. Timber structures, like all lightweight structures, do not have high acoustic performance if they are designed like heavy structures. It is important to take in account the effect of sound propagation through the wall/ceiling structure junctions, because it can significantly reduce the acoustic performance of these elements. Elastic separating layers between rigid junction can prevent the propagation of sound vibrations in the building structure and reduce the contribution of flanking transmission.

This paper provides the guideline to codify the characteristics of flexible interlayer made by a homogeneous viscoelastic material for the reduction of flanking sound transmission for airborne, impact and building service equipment.

To select a correct resilient strips, it is important to consider that acoustic interlayers are working at the level of the structure and the material needs to be extremely stable in long term to guarantee the stability of the building and avoid later deformation that will affect linings and static.

**KEYWORDS:** Building acoustic, interlayers, flanking transmission, static-acoustic interaction, standardisation

## 1 INTRODUCTION

The wooden structures are statically assembled with different types of connections. Mainly we talk about screws, angular and hold-down. These connection systems have the task of precisely coupling the different structural elements to form a single large junction structure. While in parallel to overcome the problem of transmission of vibrations, in recent years resilient profiles in polyurethane or EPDM are very often being used which have the task of decoupling and reducing the transmission of vibrations between the different elements. To date, there are no common standards that describe in detail how to characterize the product and which performance shall be determined to guarantee a proper static and acoustic performance.
Aim of this paper is to analyse the intended use of resilient interlayers and define the values that allow to design a joint with them. Defining a common test procedure allow also to compare products from different manufactures and chose the best product depending on project requirements.

## 2 EUROPEAN ASSESMENT DOCUMENT (EAD)

Resilient interlayers are used between structural elements, typically between floor and wall, and they become part of the structure. For this reason, not only acoustic performance, but also static stability and durability over the time shall be investigated.
For materials used as elastic interlayers, there are no standards which characterize the mechanical properties in accordance with the use for reducing noise transmission in buildings.
From an acoustic point of view, it is not enough to define dynamic elastic modulus and damping factor. $K_{ij}$ value must be determined for the calculation of airborne sound insulation between rooms according to ISO 12354-1 [1] and impact sound insulation between rooms according to ISO 12354-2 [2].
From a static point of view, it is important to test the compressive behaviour of the material through the determination of elastic modulus, compressive creep, compressive stress and deformation and compression set.
In recent years, resilient interlayers are increasing their presence in buildings for the reduction of flanking transmission and consequently the demand to characterize and compare the different types of products placed on the market has increased.
In order to find a common criterion for the assessment of product's performance, a specific EAD was developed. The EAD is developed by the EOTA network consisting of some 45 highly qualified Technical Assessment Bodies (TABs) mandated by their states to issue ETAs. EOTA also co-operates with external experts and stakeholders to

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develop state-of -the-art technical specifications for the construction sector.
EAD provides manufacturers with a way to CE marking for construction products that are not or not fully covered by a harmonised European standard (hEN) under the Construction Products Regulation (EU) 305/2011.
It contains, at least, a general description of the construction product and its intended use, the list of essential characteristics relevant for the intended use, methods and criteria for assessing the performance of the product and principles for the implementation of the system for assessment and verification of constancy of performance.

### 2.1 DESCRIPTION AND INTENDED USE

The EAD covers flexible interlayers made of a homogeneous viscoelastic layer of monolithic polyurethane or EPDM (ethylene propylene diene monomer rubber) or similar material.
The product is used as flexible interlayer for the reduction of flanking transmission for airborne, impact and building service equipment sound between adjacent rooms and/or vibration transmission. The product is installed between at least two elements (i.e., floor and wall).
Methods and criteria for assessing reaction to fire, compressive creep, compression set, compressive stress and deformation, dynamic elastic modulus, damping factor, flanking transmission for airborne, impact and building service equipment sound between adjacent rooms and compressive modulus are described in the EAD.

### 2.2 COMPRESSIVE CREEP AND COMPRESSION SET

Resilient interlayers are subjected to constant load during their working life.
It is important to estimate the long-term behaviour for static reasons (to avoid differential failure in the structure) and for acoustic reasons (a crushed interlayer does not have the same elastic response and consequently the acoustic performance decays).
For the same reason it is important to define the ending thickness of the product after compression for a given time and after a given recovery time.
For the determination of the compressive creep ISO 8013 [7] can be used, for the determination of compression set it is recommended ISO 1856 [8].

### 2.3 COMPRESSIVE STRESS AND DEFORMATION AND COMPRESSIVE MODULUS

Resilient interlayers have been tested with very high compression stress, demonstrating a linear behaviour even with high loads. Despite this behaviour, from a static point of view it is important to provide the compressive stress as a function of the strain (e.g.: 1mm, 2mm and 3mm compression) in order to limit the maximum deformation and possible structural failure.
Compressive stress and compressive modulus have been tested according to EN ISO 844 [9] under different conditions of friction.
Tests show that friction could affect the result and for this reason it is necessary to perform always the measurements with appropriate lubricant to make the effects of surface friction negligible. This ensures the repeatability of the result and without any treatment to have the in situ operating value of elastic modulus and compressive strength [10].

### 2.4 FLANKING TRANSMISSION

In previous investigations it has been shown that $K_{ij}$ depends on the test setup. Due to the lack of a common standard, each manufacturer provides $K_{ij}$ values tested in a different configuration (choosing the type of joint, the number of fastening system, etc). Many variables can affect the $K_{ij}$ and it is important to make clear the test setup [3, 4, 12].
Considering the variety of possible joints, materials and fastening systems, it was not possible to define a single configuration useful to define the performance of the resilient profile.
Although there is a detailed standard to determine the vibration reduction index (ISO 10848 [5]), there is a need to improve the way results are expressed in order to avoid ambiguities on fastening systems.

## 3 EUROPEAN TECHNICAL ASSESMENT (ETA)

The European Technical Assessment (ETA) provides an independent Europe-wide procedure for assessing the essential performance characteristics of non-standard construction products.
The ETA offers manufacturers a voluntary route to CE marking, when the product is not or not fully covered by a harmonised standard (hEN) under the Construction Products Regulation (EU) 305/2011.
CE marking based on the ETA allows manufacturers to freely market their product on the entire European internal market and introduce innovative products and new product features with short lead times.
Only independent Technical Assessment Bodies (TABs) may issue ETAs. The independent assessment strengthens the credibility of the product performance information, enhances market transparency and builds customer trust.
ETAs provide reliable product performance information that is comparable across Europe based on harmonised technical specifications, the European Assessment Document (EAD).

### 3.1 MEASUREMENT OF COMPRESSION CREEP

The samples provided are in the form of cylinder of 13 mm diameter and 6 mm of nominal thickness (tolerance class M4 according to the ISO 3302-1). The test is carried out on 3 specimens of each material.


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The method for the determination of the compression creep consists in subjecting the samples to a compression of 10% strain for 6000 seconds.

$$\frac{\Delta\varepsilon}{\varepsilon_1} = \frac{\delta_1 - \delta_2}{\delta_0 - \delta_1} \quad (1)$$

Where:

- $\delta_0$ [mm]: initial thickness of the test piece
- $\delta_1$ [mm]: thickness of the test piece under constant force 10 min after application of the force
- $\delta_2$ [mm]: thickness of the test piece under constant force 6000 s after the application of the force

The test is done at ambient temperature. The compression is made with a hydraulic machine for tensile/compression INSTRON 8032. by mounting a load cell of 1 kN for the transduction of the pressing load. After the compression of 10% strain. the force obtained is held constant and the acquisition of the deformation starts for 6000 s.

***Table 1:*** *Compressive creep*

| Product | $\frac{\Delta\varepsilon}{\varepsilon_1}$ |
|---|---|
| XYLOFON 35 | 0,54 |
| XYLOFON 50 | 0,53 |
| XYLOFON 70 | 2,9 |
| XYLOFON 80 | 10,3 |
| XYLOFON 90 | 0,28 |

### 3.2 COMPRESSION SET

The samples provided are in the form of squares of 50x50mm with 6 mm of nominal thickness (tolerance class M4 according to the ISO 3302-1).

Four samples are overlapped to obtain the minimum thickness of 25 mm. The assembly shall work as a single layer of equivalent thickness.

The method for the determination of the compression set consists in subjecting the samples to a thermal conditioning at ambient temperature and then to a mechanical conditioning. imposing a deformation of 50% for a 22h time interval. At the end of the application of the static load, after a recovery time of 30 minutes, the residual deformation is measured and the compression set (c.s.) is calculated as a percentage variation in the thickness of the sample compared to the pre-test measured thickness.

The compression set $c.s._i$ is defined as:

$$c.s._i = \frac{d_0 - d_r}{d_0} \times 100 \quad [\%] \quad (2)$$

The absolute value of the product after compression and recovery. $t_{c.s.}$. is defined as:

$$t_{c.s.} = t - (c.s. \times t) \quad [mm] \quad (3)$$

Where:

- $d_0$ [mm]: original thickness of test piece
- $d_r$ [mm]: thickness of the test piece after recovery
- $t$ [mm]: nominal thickness of the product

The thermal conditioning of the specimens is made at ambient temperature, according to EN ISO 1856 [8]. The mechanical conditioning of the specimens runs on a hydraulic machine for tensile/compression INSTRON 1275 (±100 mm stroke) by mounting a load cell of 500 kN for the transduction of the pressing load.

After the mechanical conditioning and the subsequent relaxation time, the thickness of the sample is measured again on 5 points using the bench thickness gauge.


***Figure 1:*** *Measurement equipment mounted on the hydraulic machine INSTRON*

***Table 2:*** *Compression set*

| Product | c.s. | t [mm] | $t_{c.s.}$ [mm] |
|---|---|---|---|
| XYLOFON 35 | 0.72 % | 6 | 5,96 |
| XYLOFON 50 | 1,25 % | 6 | 5,93 |
| XYLOFON 70 | 0,71 % | 6 | 5,96 |
| XYLOFON 80 | 1,31 % | 6 | 5,92 |
| XYLOFON 90 | 2,02 % | 6 | 5,88 |

Results of the test show that the tested materials have very good elastic behaviour and the residual deformation is negligible.

### 3.3 COMPRESSIVE STESS AND DEFORMATION

The samples provided are in the form of squares of 50x50mm with 6 mm of nominal thickness (tolerance class M4 according to the ISO 3302-1).
The test is carried out on 5 specimen and 5 lubricated specimens of each material.
The method for the determination of the compressive stress σ at 1mm, 2mm and 3mm is to correlate the pressure required to obtain the different deformations.
The thermal conditioning of the specimens is made at ambient temperature, according to EN ISO 1856. Also the test is done at ambient temperature. The compression is made with a hydraulic machine for tensile/compression INSTRON 8032 by mounting a load cell of 10 kN for the transduction of the pressing load.

***Table 3:*** *Compressive stress and deformation*

| Product | $\sigma_{1mm}$ [MPa]<br>$\sigma_{1mm,\ lubricant}$ [MPa] | $\sigma_{2mm}$ [MPa]<br>$\sigma_{2mm,\ lubricant}$ [MPa] | $\sigma_{3mm}$ [MPa]<br>$\sigma_{3mm,\ lubricant}$ [MPa] |
|---|---|---|---|
| XYLOFON 35 | 0,5<br>0,3 | 1,5<br>0,7 | 3,6<br>1,6 |
| XYLOFON 50 | 1,1<br>0,5 | 3,5<br>1,2 | 8,6<br>2,6 |
| XYLOFON 70 | 2,4<br>1,2 | 5,4<br>3,0 | 11,1<br>6,0 |
| XYLOFON 80 | 3,9<br>2,1 | 9,5<br>5,2 | 19,5<br>9,8 |
| XYLOFON 90 | 5,8<br>3,4 | 14,4<br>8,0 | 29,0<br>14,9 |

Where:

- $\sigma_{1mm}$ [MPa]: mean value of compressive stress at 1 mm strain (surfaces not treated with lubricant)
- $\sigma_{1mm,lubricant}$ [MPa]: mean value of compressive stress at 1 mm strain (surfaces treated with appropriate lubricant)
- $\sigma_{2mm}$ [MPa]: mean value of compressive stress at 2 mm strain (surfaces not treated with lubricant)
- $\sigma_{2mm,lubricant}$ [MPa]: mean value of compressive stress at 2 mm strain (surfaces treated with appropriate lubricant)
- $\sigma_{3mm}$ [MPa]: mean value of compressive stress at 3 mm strain (surfaces not treated with lubricant)
- $\sigma_{3mm,lubricant}$ [MPa]: mean value of compressive stress at 3 mm strain (surfaces treated with appropriate lubricant)

### 3.4 COMPRESSIVE MODULUS

The samples provided are in the form of squares of 50x50mm with a 6 mm of nominal thickness (tolerance class M4 according to the ISO 3302-1).
The test is carried out on 5 specimen and 5 lubricated specimens of each material.
The compressive modulus is calculated as following:

$$E_{C.i} = \frac{\sigma_{15.i} - \sigma_{5.i}}{\varepsilon_{15} - \varepsilon_{5}} \quad (4)$$

Where:

- $\sigma_{15.i}$ [MPa]: compressive stress at 15% strain ($\varepsilon_{15}$)
- $\sigma_{5.i}$ [MPa]: compressive stress at 5% strain ($\varepsilon_{5}$)

The thermal conditioning of the specimens is made at ambient temperature according to EN ISO 1856. Also the test is done at ambient temperature. The compression is made with a hydraulic machine for tensile/compression INSTRON 8032 by mounting a load cell of 10 kN for the transduction of the pressing load.

***Table 4:*** *Compressive modulus*

| Product | $E_c$ [MPa] | $E_{c,lubricant}$ [MPa] |
|---|---|---|
| XYLOFON 35 | 3,2 | 1,7 |
| XYLOFON 50 | 7,1 | 2,9 |
| XYLOFON 70 | 14,2 | 7,3 |
| XYLOFON 80 | 25,4 | 13,2 |
| XYLOFON 90 | 36,6 | 21,9 |

### 3.5 DYNAMIC ELASTIC MODULUS AND DAMPING FACTOR

The samples provided are in the form of a cylinder of 9 mm diameter and a nominal thickness (class M4 according to the ISO 3302-1) of 6 mm. The form factor is h(height) : d(diameter) = 1:1.5.
The test is carried out on 3 specimens of each material.
The thermal conditioning of the specimens is made at ambient temperature, according to EN ISO 1856.
The measurement equipment is made of DMA 242E Artemis NETZSCH.


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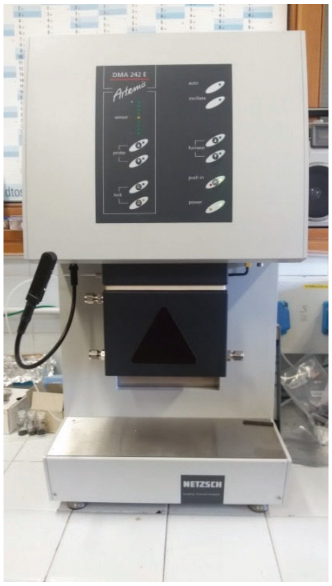

***Figure 2:*** *DMA apparatus*

***Table 5:*** *Dynamic elastic modulus*

| Product | $E'_{1Hz}$[MPa] / $E''_{1Hz}$[MPa] | $E'_{5Hz}$[MPa] / $E''_{5Hz}$[MPa] | $E'_{10Hz}$[MPa] / $E''_{10Hz}$[MPa] | $E'_{50Hz}$[MPa] / $E''_{50Hz}$[MPa] |
|---|---|---|---|---|
| XYLOFON 35 | 2,8 | 3,1 | 3,3 | 3,6 |
| | 0,8 | 1,0 | 1,1 | 1,4 |
| XYLOFON 50 | 4,6 | 3,9 | 4,1 | 4,4 |
| | 0,6 | 0,7 | 0,7 | 1,0 |
| XYLOFON 70 | 6,0 | 6,4 | 6,9 | 7,9 |
| | 0,5 | 0,8 | 1,0 | 2,2 |
| XYLOFON 80 | 15,4 | 16,9 | 18,0 | 21,8 |
| | 1,5 | 2,5 | 3,3 | 6,9 |
| XYLOFON 90 | 32,2 | 39,9 | 45,4 | 65,7 |
| | 6,9 | 12,2 | 16,0 | 29,8 |

Where:

- $E'_{1Hz}$ [MPa]: mean value of elastic normal modulus (storage normal modulus) at 1 Hz
- $E''_{1Hz}$ [MPa]: mean value of loss normal modulus at 1 Hz
- $E'_{5Hz}$ [MPa]: mean value of elastic normal modulus (storage normal modulus) at 5 Hz
- $E''_{5Hz}$ [MPa]: mean value of loss normal modulus at 5 Hz
- $E'_{10Hz}$ [MPa]: mean value of elastic normal modulus (storage normal modulus) at 10 Hz
- E”10Hz [MPa]: mean value of loss normal modulus at 10 Hz
- E’50Hz [MPa]: mean value of elastic normal modulus (storage normal modulus) at 50 Hz
- E”50Hz [MPa]: mean value of loss normal modulus at 50 Hz

***Table 6:*** *Damping factor*

| Product | tan $\delta_{1Hz}$ [MPa] | tan $\delta_{5Hz}$ [MPa] | tan $\delta_{10Hz}$ [MPa] | tan $\delta_{50Hz}$ [MPa] |
|---|---|---|---|---|
| XYLOFON 35 | 0,28 | 0,32 | 0,33 | 0,38 |
| XYLOFON 50 | 0,15 | 0,17 | 0,18 | 0,23 |
| XYLOFON 70 | 0,08 | 0,12 | 0,15 | 0,28 |
| XYLOFON 80 | 0,10 | 0,15 | 0,19 | 0,32 |
| XYLOFON 90 | 0,21 | 0,31 | 0,35 | 0,45 |

Where:

- tan $\delta_{1Hz}$ : mean value of tangent of the loss angle at 1 Hz
- tan $\delta_{5Hz}$ : mean value of tangent of the loss angle at 5 Hz
- tan $\delta_{10Hz}$ : mean value of tangent of the loss angle at 10 Hz
- tan $\delta_{50Hz}$ : mean value of tangent of the loss angle at 50 Hz

### 3.6 FLANKING TRANSMISSION

The samples provided are in the form of rolled stripes of 6 mm of nominal thickness (tolerance class M4 according to the ISO 3302-1).
The vibration reduction index $K_{ij}$ is a quantity related characterises the transmission of vibrations through the structural elements of a junction. It is calculated according to ISO 10848 [5]:

$$K_{ij} = \frac{D_{v,ij} + D_{v,ji}}{2} + 10\,log\frac{l_{ij}}{\sqrt{a_i \cdot a_j}} \quad dB \tag{5}$$

Where:

- $D_{v.ij}$ [dB]: velocity level difference between element i and j when element i is excited
- $D_{v,ji}$ [dB]: velocity level difference between element j and i when element j is excited
- $l_{ij}$ [m]: common junction length between elements i and j
- $a_i$ [m]: equivalent absorption length of element i
- $a_j$ [m]: equivalent absorption length of element j

The values stated in the ETA refers to transmission path characterized by the presence of the resilient interlayer. For each path shall be defined the vibration reduction index with resilient interlayer in frequency ($K_{ij}$) and correction of the $\overline{K_{ij}}$ in presence of elastic interlayers in junction ($\Delta_l$).

$\Delta_l$ for a specific path is calculated as difference between $\overline{K_{ij}}$ of the same path with and without resilient interlayer.

$\overline{K_{ij}}$ is the arithmetic average of $K_{ij}$ within the frequency range 200 Hz to 1 250 Hz (one-third octave bands) according to point 10 of the EN ISO 10848-1 [5].

$$\Delta_l = \overline{K_{ij,with}} - \overline{K_{ij,without}}$$

For the acquisition of the velocity levels the panels were excited using piezoelettrics shaker screwed to panels. Velocity levels were acquired using 4 accelerometers at a time.

Structural reverberation times $T_{15}$ have been extracted from MLS measurements, which were measured in the number of six positions on each panel.

The excitation and measurement points were chosen according to the EN ISO 10848 [5] standard. For each element a minimum of 3 source positions are required and for each excitation position three pairs of measurement positions must be considered randomly over the test element. In the measurement session 6 receivers and 3 source were used.

Two types of junctions were constructed: “T vertical junction” and “X vertical junction”.

Tested build up of “T vertical junction” (Figure 1):
- (4) Top wall: 5-ply CLT, 100 mm, (2,4 m x 3 m)
- (1) Floor: 5-ply CLT 100 mm (2,4 m x 3,5 m)
- (2) Bottom wall: 5-ply CLT, 100mm, (2,4 m x 3 m)

Fastening system:
- 6 Partially threaded screws HBS 8x240mm; step 440mm
- 2 Angle brackets NINO15080 (CLT pattern with 31 screws 5x50 mm) + XYLOFON 35 (55x150x6 mm); step 1760mm


***Figure 3:** “T vertical junction” build up*

Tests on this configuration were conducted changing the type of resilient interlayer and the load applied. An example with results follows.

Product: XYLOFON 50
Position: between top wall and floor and between floor and bottom wall.
Dimensions: width=100mm, thickness=6mm, length=2,40m
Contact area: continuous stripe (same width and length of the wall)
Load applied[N/m$^2$]: 338000

Path 1-4

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{14}$ (dB) | 17,6 | 17,7 | 20,5 | 21,3 | 18,4 | 21,9 | 24,3 | 16,9 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{14}$ (dB) | 20,5 | 21,0 | 18,6 | 19,7 | 21,9 | 16,1 | 16,3 | 20,7 |

$\overline{K_{14}}$=19,9 dB $\overline{K_{14,0}}$=13,3 dB $\Delta_{l,14}$= 6,6 dB

Path 1-2

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{12}$ (dB) | 22,1 | 19,2 | 15,9 | 21,0 | 20,5 | 21,5 | 24,0 | 21,2 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{12}$ (dB) | 19,8 | 23,0 | 23,7 | 23,6 | 26,8 | 23,2 | 24,3 | 28,3 |

$\overline{K_{12}}$=21,8 dB $\overline{K_{12,0}}$=14,5 dB $\Delta_{l,12}$= 7,3 dB

Path 2-4

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{24}$ (dB) | 18,7 | 26,7 | 26,6 | 31,1 | 24,4 | 27,8 | 26,6 | 25,3 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{24}$ (dB) | 22,5 | 27,8 | 28,6 | 33,2 | 28,6 | 33,3 | 34,0 | 31,6 |

$\overline{K_{24}}$=27,9 dB $\overline{K_{24,0}}$=17,3 dB $\Delta_{l,24}$= 10,6 dB

Tested build up of “X vertical junction” (Figure 2):
- (4) Top wall: 5-ply CLT, 100 mm, (2,4 m x 3 m)
- (1+3) Floor: 5-ply CLT 100 mm (2,4 m x 7,1 m)
- (2) Bottom wall: 5-ply CLT, 100mm, (2,4 m x 3 m)

Fastening system:
- 6 Partially threaded screws HBS 8x240mm; step 440mm
- 2 Angle brackets NINO15080 (CLT pattern with 31 screws 5x50 mm) + XYLOFON 35 (55x150x6 mm); step 1760mm


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***Figure 4:*** *"X vertical junction" build up*

Tests on this configuration were conducted changing the type of resilient interlayer and the load applied. An example with results follows.

Product: XYLOFON 50
Position: between top wall and floor and between floor and bottom wall.
Dimensions: width=100mm, thickness=6mm, length=2,40m
Contact area: continuous stripe (same width and length of the wall)
Load applied[N/m$^2$]: self-weight of the structure

Path 1-4

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{14}$ (dB) | 17,4 | 20,1 | 18,5 | 17,8 | 15,6 | 17,6 | 19,8 | 19,6 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{14}$ (dB) | 21,0 | 19,2 | 25,1 | 23,0 | 24,1 | 21,8 | 18,7 | 21,6 |

$\overline{K_{14}}$=20,2 dB $\overline{K_{14,0}}$=17,0 dB $\Delta_{l,14}$= 3,2 dB

Path 1-2

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{12}$ (dB) | 19,6 | 18,9 | 14,0 | 14,9 | 14,7 | 17,1 | 19,7 | 21,0 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{12}$ (dB) | 23,0 | 20,9 | 22,1 | 21,5 | 25,3 | 24,1 | 23,5 | 24,2 |

$\overline{K_{12}}$= 19,8 dB $\overline{K_{12,0}}$= 15,9 dB $\Delta_{l,12}$= 3,9 dB

Path 2-4

| F (Hz) | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
|---|---|---|---|---|---|---|---|---|
| $K_{24}$ (dB) | 14,9 | 27,3 | 23,4 | 25,4 | 23,0 | 29,5 | 28,3 | 25,4 |

| F (Hz) | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 |
|---|---|---|---|---|---|---|---|---|
| $K_{24}$ (dB) | 29,0 | 28,5 | 33,3 | 34,2 | 33,7 | 36,4 | 34,6 | 32,0 |

$\overline{K_{24}}$=29,0 dB $\overline{K_{24,0}}$=23,2 dB $\Delta_{l,24}$= 5,8 dB

Other junction types we assessed following the same principles, changing the type od profile and the load applied.

## 4 CONCLUSIONS

The aim of this work is to demonstrate how a harmonized standard can be produced to uniquely characterize resilient profiles used in flanking transmission, to assess in a harmonized manner the effects of including these profiles in building joints from an acoustic, mechanical and structural point of view.
The project led to the definition of a European Assessment Document (EAD) and to the issue of a European Technical Assessment (ETA), that allows manufacturer to introduce innovative products and new features to the entire European market.

## REFERENCES


[1] ISO 12354-1:2017. Building acoustics – Estimation of acoustic performance of buildings from the performance of element. Part 1: Airborne sound insulation between rooms. ISO, Switzerland.

[2] ISO 12354-2:2017. Building acoustics – Estimation of acoustic performance of buildings from the performance of element. Part 2: Impact sound insulation. ISO, Switzerland

[3] Barbaresi L., Morandi F., Garai M., Speranza A. *Experimental measurements of flanking transmission in CLT structures*. Proc. Mtgs. Acoust. **28**, Buenos Aires, 2016

[4] Speranza A., Barbaresi L. and Morandi F. *Experimental analysis of flanking transmission of different connection systems for CLT panels*. Proc. of WCTE 2016, Vienna, 2016.

[5] ISO 10848:2017. Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms, ISO, Switzerland

[6] ISO 4664-1:2011. Rubber, vulcanized or thermoplastic, Determination of dynamic properties, Part 1: General guidance, ISO, Switzerland

[7] ISO 8013:2019. Rubber, vulcanized, Determination of creep in compression or shear, ISO, Switzerland

[8] ISO 1856:2018. Flexible cellular polymeric materials, Determination of compression set, ISO, Switzerland

[9] ISO 844:2021. Rigid cellular plastics, Determination of compression properties, ISO, Switzerland

[10] Barbaresi, L., Morandi, F., Belcari, J., Zucchelli, A., Speranza, A. *Optimizing the mechanical characterization of a resilient interlayer for the use in timber construction,* 24th International Congress on Sound and Vibration, ICSV 2017, 2017

[11] What is an ETA? | EOT

S. Mecking, T. Kruse, U. Schanda Measurement and calculation of sound transmission across junctions of solid timber building elements EuroNoise, Maastricht, The Netherlands (2015)