PuraSys KRAIBURG

Customised Solutions in PUR Foam

PAC International | NOISE CONTROL SOLUTIONS

REAL SOLUTIONS IN CONSTRUCTION

Sound insulation in timber construction with

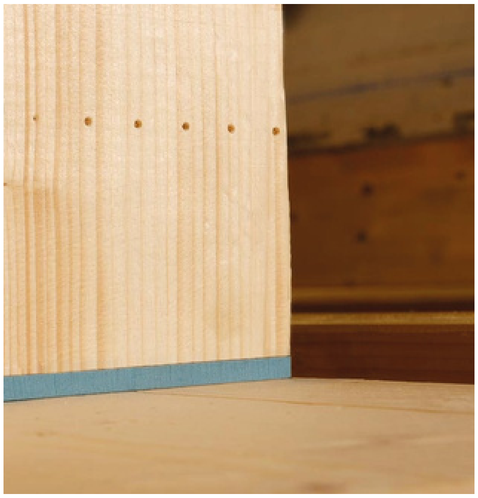
vibrafoam | vibradyn

1. Timber construction

Modern building construction is defined by a wide range of materials that give homes their unique character. The use of stone, concrete, glass, steel, and wood is constantly being reinvented. Wood, surely the most ancient of building materials, has by no means outlived its usefulness. In actuality, it is currently experiencing a renaissance.

As a natural raw material, wood continues to gain popularity as a building material for homes. That being said, the physical properties of wood and especially its sound conductivity mean that appropriate steps must be taken to meet sound insulation requirements. Increased sound transmission via joints in particular is observed.

Significant sound insulation improvements in timber construction can be obtained by using the products PURASYS **vibra**foam and PURASYS **vibra**dyn.



2. Fundamentals

2.1. Sound

Sound consists of longitudinal waves, where the oscillations occur parallel to the propagation direction of the waves. Since sound waves are mechanical waves, they always require the presence of a material medium.

2.2. Types of sound

One differentiates between structure-borne and airborne sound. Airborne sound refers to sound waves that propagate through the air. Structure-borne sound refers to sound waves that propagate in a solid body. Impact sound is a special form of structure-borne sound produced by the impact between two solid bodies, for example, when walking on a floor.

2.3. Sound Intensity I and sound level β

In addition to the frequency, wavelength and speed, sound has the property of volume. However, volume as a technical term is used inconsistently. The sound intensity and sound level on the other hand are clearly defined.

> The **sound intensity** I of a sound wave on an area is equal to the average rate of transfer per unit area, at which the wave transfers energy through or onto the area:
>
> $$I = \frac{P}{A}$$

P	the rate of energy transfer (the power) of the	$[W]$
A	wave the area that is impacted by the sound	$[m^2]$

The human ear can perceive sounds over an enormous intensity range. The ratio for the limits of human hearing is 10^{12}. Logarithms are used to facilitate working with such a large range of values.

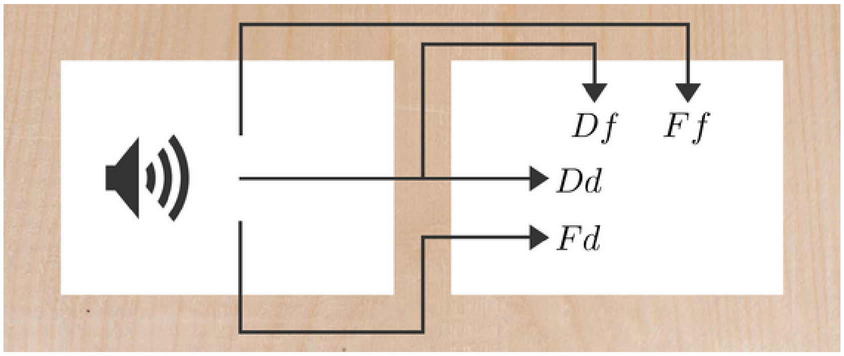
> **Sound level** β **:**
>
> $$\beta = (10dB)\ \lg\left(\frac{I}{I_0}\right)$$

I_0	standardized reference value for the intensity; $I_0 = 10^{-12}$	$[W/m^2]$

The abbreviation dB stands for decibel, the unit for the sound level. The value for I_0 is close to the lower limit of perception for human hearing.

3. Building acoustics

3.1. Parameters



3.1.1. Sound transmission paths *i j* between two rooms

Sound transmission between two rooms takes place both directly through the separating building element and via the flanks. All possible transmission paths *ij* are taken into account for the overall assessment of airborne sound and impact noise transmission. *i* is the building element being excited, designated *D* with for direct excitation or with *F* for flank excitation. *j* is the radiating building element, designated with *d* for direct radiation or with *f* for flank radiation. Thus, one always has one transmission path *Dd* and multiple transmission paths *D f* , *F f* and *F d* .

3.1.2. Apparent sound reduction index R'

> The **apparent sound reduction index** *R'* describes the sound insulation capacity of a separating building element, i.e. the sound level difference between two rooms due to the separating building element:
>
> $$R' = L_1 - L_2 + 10\lg\left(\frac{S_S}{A}\right) \text{ dB}$$

L_1	the average sound pressure level in the source room	[dB]
L_2	the average sound pressure level in the receiving room	[dB]
S_S	the area of the separating element	[m^2]
A	the equivalent sound absorption area in the receiving room	[m^2]

3.1.3. Normalized level difference D_n

> The **normalized level difference** D_n is the difference between the average sound pressure level L_1 in the source room and the average sound pressure level L_2 in the receiving room, corrected by a term that takes sound absorption in the receiving room into account:
>
> $$D_n = L_1 - L_2 - 10\lg\left(\frac{A}{A_0}\right) \text{ dB}$$

A_0	the reference absorption area; $A_0 = 10$	[m^2]

3.1.4. Normalized impact sound pressure level L'_n

The **normalized impact sound pressure level** L'_n is the impact sound pressure level L_i of a separating ceiling measured by using the standard tapping machine, in relation to a reference value for the equivalent absorption area in the receiving room:

$$L'_n = L_i + 10 \lg \left(\frac{A}{A_0} \right) dB$$

L_i	the impact sound pressure level measured in the receiving room	[dB]

3.1.5. Vibration reduction index K_{ij}

The **vibration reduction index** K_{ij} is determined by normalizing the direction-averaged velocity level difference over the junction, to the junction length and the equivalent absorption length of both elements. Therefore, the vibration reduction index describes
the structure-borne sound transmission reduction at a joint lying in the transmission path ij:

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

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

3.2. Calculation method

3.2.1. Airborne sound insulation according to DIN EN ISO 12354-1

The weighted apparent sound reduction index R'_W between two rooms:

$$R'_w = -10\ lg \left(10^{-R_{Dd,w}/10} + \sum_{F=f=1}^{n} 10^{-R_{Ff,w}/10} + \sum_{f=1}^{n} 10^{-R_{Df,w}/10} + \sum_{F=1}^{n} 10^{-R_{Fd,w}/10} + \frac{A_0}{S_S} \sum_{j=1}^{m} 10^{-D_{n,j,w}/10} \right) dB$$

where

$$R_{Dd,w} = R_{s,w} + \Delta R_{Dd,w}$$

$$R_{Ff,w} = \frac{R_{F,w} + R_{f,w}}{2} + \Delta R_{Ff,w} + K_{Ff} + 10lg\left(\frac{S_S}{l_0 l_f}\right) dB$$

$$R_{Df,w} = \frac{R_{s,w} + R_{f,w}}{2} + \Delta R_{Df,w} + K_{Df} + 10lg\left(\frac{S_S}{l_0 l_f}\right) dB$$

$$R_{Fd,w} = \frac{R_{F,w} + R_{s,w}}{2} + \Delta R_{Fd,w} + K_{F,d} + 10lg\left(\frac{S_S}{l_0 l_f}\right) dB$$

$R_{Dd,w}$	the weighted sound reduction index for direct transmission	[dB]
$R_{Ff,w}$	the weighted flanking reduction index for the transmission path *Ff*	[dB]
$R_{Df,w}$	the weighted flanking reduction index for the transmission path *Df*	[dB]
$R_{Fd,w}$	the weighted flanking reduction index for the transmission path *Fd*	[dB]
$D_{n,j,w}$	the weighted normalized level difference for transmission through a small technical element *j* ($D_{n,e}$) or an airborne sound transmission system *j* ($D_{n,s}$)	[dB]
n	the number of flanking elements in a room	[-]
m	the number of elements or systems *j* for airborne sound transmission	[-]
$R_{s,w}$	the weighted sound reduction index of the separating element	[dB]
$\Delta R_{Dd,w}$	the total weighted sound reduction index improvement by additional lining on the source and/or receiving side of the separating element	[dB]
$R_{F,w}$	the weighted sound reduction index of the flanking element *F* in the source room	[dB]
$R_{f,w}$	the weighted sound reduction index of the flanking element *f* in the receiving room	[dB]
$\Delta R_{Ff,w}$	the total weighted sound reduction index improvement by additional lining on the source and/or receiving side of the flanking element	[dB]
$\Delta R_{Df,w}$	the total weighted sound reduction index improvement by additional lining on the separating ele ment at the source side and/or flanking element at the receiving side	[dB]
$\Delta R_{Fd,w}$	the total weighted sound reduction index improvement by additional lining on the flanking element at the source side and/or separating element at the receiving side	[dB]
l_f	the common coupling length of the junction between separating element and the flanking elements *F* and *f*	[m]
l_0	the reference coupling length; $l_0 = 1$	[m]

3.2.2. Impact sound insulation according to DIN EN ISO 12354-2

For adjoining rooms, the total impact sound pressure level $L'_{n,w}$ in the receiving room is given by:

$$L'_{n,w} = 10\lg \left(\sum_{j=1}^{n} 10^{L_{n,ij,w}/10} \right) dB$$

where

$$L_{n,ij,w} = L_{n,eq,0,w} - \Delta L_w + \frac{R_{i,w} - R_{j,w}}{2} - \Delta R_{j,w} - K_{ij} - 10\lg\left(\frac{S_i}{l_0 l_{ij}}\right) dB$$

For superimposed rooms, the total impact sound pressure level in the receiving room is given by:

$$L'_{n,w} = 10\lg \left(10^{L_{n,d,w}/10} + \sum_{j=1}^{n} 10^{L_{n,ij,w}/10} \right) dB$$

where

$$L_{n,d,w} = L_{n,eq,0,w} - \Delta L_w - \Delta L_{d,w}\ dB$$

$L_{n,i,j,w}$	the weighted normalized impact sound pressure level of flanking elements that is produced on the ceiling *i* and radiated by the element *j*	[dB]
n	the number of elements	[–]
$L_{n,eq,0,w}$	the equivalent weighted normalized impact sound pressure level of the ceiling	[dB]
ΔL_w	the weighted reduction of impact sound pressure level by a floor covering	[dB]
$R_{i,w}$	the weighted sound reduction index of the ceiling *i*	[dB]
$R_{j,w}$	the weighted sound reduction index of the element *j*	[dB]
$\Delta R_{j,w}$	the weighted sound reduction index improvement by a facing structure on the receiving side of the flanking element *j*	[dB]
S_i	the surface area of the element *i*	[m^2]
$L_{n,d,w}$	the weighted normalized impact sound pressure level for the direct transmission path	[dB]
$\Delta L_{d,w}$	the weighted reduction of impact sound by a facing structure on the receiving side of the separating element	[dB]

4. PURASYS vibrafoam and vibradyn

4.1. General information

PURASYS **vibra**foam and PURASYS **vibra**dyn are products of high technical quality made of mixed-cell or closed-cell polyurethane, suitable for the realization of demanding vibration decoupling and sound insulation projects.

Thanks to a wide range of standard types in small increments, the correct type can be found for every load range.

PURASYS **vibra**foam and PURASYS **vibra**dyn set themselves apart with their permanent, constant insulation effect and feature outstanding chemical properties that also make the material highly resistant to water, concrete, oils, and diluted acids or bases.

PURASYS products are tested and approved by the DIBt.

4.2. Use in timber construction

PURASYS products are used for acoustic decoupling in case of vertical flanking transmission. Significant improvements in the vibration reduction index are obtained by installing PURASYS **vibra**foam and PURASYS **vibra**dyn at the joints, i.e. between the separating ceilings and the walls.

4.3. Vibration reduction index K_{ij}

The vibration reduction index for the PURASYS products is based on values determined by the Fraunhofer Institute for Building Physics IBP in Stuttgart. The measurements were taken based on DIN EN ISO 10848-4 with excitation using an electrodynamic vibration generator and a realistic timber construction structure.

> The improvements ΔK_{ij} compared to the rigid connection $K_{ij,starr}$ can be used as guiding values for calculations:
>
> $K_{ij} = K_{ij,starr} + \Delta K_{ij}$

	K_{Df} [dB]	K_{Ff} [dB]	ΔK_{Df} [dB]	ΔK_{Ff} [dB]
rigid (without bearing)	10.8	13.5	0	0
PURASYS **vibra**foam 6mm (bearing top and bottom)	18.5	24.0	7.7	10.5
PURASYS **vibra**foam 12.5mm (bearing top and bottom)	20.1	24.2	9.3	10.7
PURASYS **vibra**dyn 6mm (bearing top and bottom)	19.4	24.0	8.6	10.5
PURASYS **vibra**dyn 12.5mm (bearing top and bottom)	20.7	24.4	9.9	10.9