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Measurement of the velocity level difference according to the Tonpilz method and DIN EN ISO 10846-4

MRP-C

Report No. M145014/15

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Total number of pages:	19 pages, thereof 7 pages of Text, 3 pages of Appendix A and 9 pages of Appendix B

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1 Task

In order to identify the velocity level difference as a measure for the noise mitigation capability of pipe clamps equipped with insulations, measurements according to the Tonpilz method and the DIN EN ISO 10846-4 [1] standard were conducted. The vibration transmission factors in the form of velocity level differences measured by this method can be used as product information for manufacturers, suppliers and users.

2 Documents and references

[1] DIN EN ISO 10846-4: Acoustics and vibration – Laboratory measurement of the vibro-acoustic transfer properties of resilient elements – Part 4: Dynamic stiffness of elements other than elastic supports for translatory motion. 2004-02

[2] DIN ISO 5348: Mechanical vibration and shock – Mechanical mounting of accelerometers. 1999-07

3 Test procedure

The measurements were performed according to the Tonpilz method in conjunction with the indirect method according to the DIN EN ISO 10846-4 [1] standard.

According to the ISO 10846 standard, the vibration transmission factor was measured in the form of the velocity level difference. This measurement's objective is to demonstrate the relative vibrational insulation characteristics of the pipe clamp at the given boundary conditions for the chosen test situation and can therefore only be used for comparison purposes tested under the same systemic conditions as described below.

The measured components shall be mounted between two masses of 30 kg each. An adapter is used to fix the test component between the two masses. An electro-dynamic shaker is mounted on the side of the exciter mass. This mass is excited in the longitudinal direction with a discretely increasing sinusoidal signal with a constant velocity amplitude. Vibrations are transmitted through the test object to the blocking mass (receiver side). The acceleration levels are measured in the axial (excitation) direction on both masses. The measured accelerations are integrated into velocity and the difference between the excitation and receiver side was calculated.

In order to obtain a relative evaluation of the effectivity of the pipe clamps, a test was carried out with insulation fitted in the outer ring and a test in which only the outer ring was fitted (respectively a larger pipe dummy diameter was used in that case). Subsequently, both transfer curves can be compared, and the relative insulation capability can be calculated.

To eliminate disturbances during the measurements, the vibration system was suspended on ropes as shown in Figure 1.

The measurement method is limited to the measuring range from 20 Hz up to 1600 Hz. Above this limit, the difference between useful and interfering signal on the receiving side is insignificantly small and a clear evaluation of the signal is not possible.

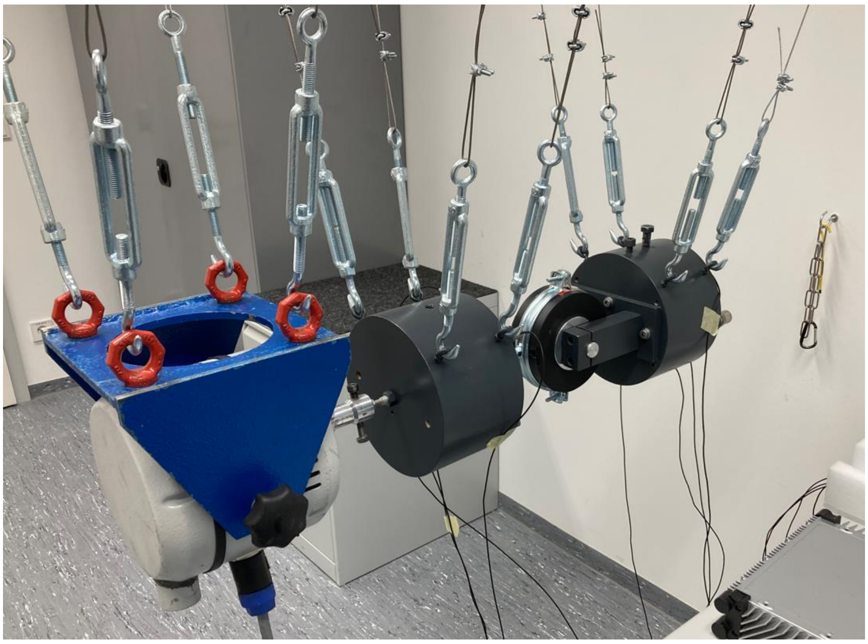

Figure 1. Test configuration.

4 Conduct of test

4.1 Time, place and involved personnel

The vibration measurements were carried out between December 2023 and March 2024 by Andreas Haager, Müller-BBM Industry Solutions GmbH at the test bench of Müller-BBM Industry Solutions GmbH in Planegg.

4.2 Ambient conditions

Temperature:	approx. 22 °C
Relative humidity:	approx. 55 %

4.3 Test objects

Table 1. List of pipe clamps to be measured.

No.	Pipe clamp	Dummy size [mm]	Torque [Nm]
1	MRP-C 13/12	12	1
2	MRP-C 19/12	12	1
3	MRP-C 25/12	12	1
4	MRP-C 32/12	12	2
5	MRP-C 13/35	35	1
6	MRP-C 19/35	35	2
7	MRP-C 25/35	35	2
8	MRP-C 32/35	35	2
9	MP-H 38-45 M8/M10	42	1
10	MP-H 45-52 M8/M10	49	1
11	MP-H 59-66 M8/M10	63	1
12	MP-H 74-83 M8/M10	77	2
13	MP-H 83-92 M8/M10	92	2
14	MP-H 92-101 M8/M10	98	2

The test objects are pipe clamps consisting of two steel bows on the outer ring. They are connected to each other by two tightening screws. The pipe clamp is tested as a reference measurement without insulation (MP-H) and with insulation (MRP-C). Additionally, one bow is equipped with an internal M10 thread for connection purposes (photos of the variations are shown in the appendix).

4.4 Measurement equipment

The calibration of the measurement equipment used is listed below and was checked and found to be fully operational. Within the scope of the quality management system, the measurement equipment is reviewed within regular intervals and calibrated according to national standards (DAkkS calibration laboratory). The accelerometers on the excitation and response side were applied on the two masses according to DIN ISO 5348 “Mechanical vibration and shock – Mechanical mounting of accelerometers” [2].

Table 2. Compilation of the used measurement equipment.

Measuring device	Type	Serial no.	Manufacturer	Date of calibration
MK2-Messsystem				
Controller	PQ20 G2	1118M3033	Mecalc	-
Input card	SC42 G2	1020M6102	Mecalc	20.07.2023
Input module 1-4	ICP4211 G2	0521M0274	Mecalc	20.07.2023
Input module 5-8	ICP4211 G2	0521M0283	Mecalc	20.07.2023
Electrodynamic shaker	54216/ LS-130	043/04	Tira	-
Amplifier	BAA 1000	B1000E01A03K0050	Tira	-
Charge amplifier excitation side	2647A	2708969	Brüel & Kjaer	08.09.2023
Charge amplifier response side	2635	1325795	Brüel & Kjaer	30.11.2023
Accelerometer	4371	0976150	Brüel & Kjaer	20.05.2022
excitation side	4371	976137	Brüel & Kjaer	20.05.2022
	4371	31453	Brüel & Kjaer	27.07.2023
	4371	31452	Brüel & Kjaer	27.07.2023
Accelerometer	4381	984902	Brüel & Kjaer	20.05.2022
response side	4381	985057	Brüel & Kjaer	20.05.2022
	4381	1354558	Brüel & Kjaer	20.05.2022
	4381	1354552	Brüel & Kjaer	20.05.2022

5 Results

The results of each pipe clamp with and without insulation were arithmetically averaged from three individual measurements. The sound reduction at 500 Hz of the pipe clamp is obtained from the difference between the two transfer functions of the reference measurement without insulation (MP-H) and the measurement with insulation (MRP-C) and is listed in the right-hand column (rounded to whole dB). A graphical representation of the calculated velocity level difference in the one-third octave band is also shown in the appendix.

Table 3. Presentation of the results.

Product Name	Diameter Dummy	Torque	Results at 500 Hz	Arithmetic mean	Sound reduction
	[mm]	[Nm]	[dB]	[dB]	[dB]
MRP-C 13/12	12	1	46,6 47 46,5	46,7	**31**
MP-H 38-45 M8/M10	42	1	16,2 15,9 16,4	16,2	
MRP-C 19/12	12	1	47,4 50 50,1	49,2	**29**
MP-H 45-52 M8/M10	49	1	20 19,5 19,6	19,7	
MRP-C 25/12	12	1	47,9 49,2 46,8	48,0	**29**
MP-H 59-66 M8/M10	63	1	18,8 18,6 19,5	19,0	
MRP-C 32/12	12	2	46,5 46,2 46,2	46,3	**28**
MP-H 74-83 M8/M10	77	2	18,6 18 19,4	18,7	

Product Name	Diameter Dummy	Torque	Results at 500 Hz	Arithmetic mean	Sound reduction
	[mm]	[Nm]	[dB]	[dB]	[dB]
MRP-C 13/35	35	1	40 41,8 43,3	41,7	**23**
MP-H 59-66 M8/M10	63	1	18,8 18,6 19,5	19,0	
MRP-C 19/35	35	2	41,2 40,7 42,4	41,4	**23**
MP-H 74-83 M8/M10	77	2	18,6 18 19,4	18,7	
MRP-C 25/35	35	2	41,2 41,6 41,6	41,5	**24**
MP-H 83-92 M8/M10	92	2	17,5 18,1 17,9	17,8	
MRP-C 32/35	35	2	40,8 41,3 42,2	41,4	**23**
MP-H 92-101 M8/M10	98	2	18,1 18 18,7	18,3	

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Appendix A

Photo documentation

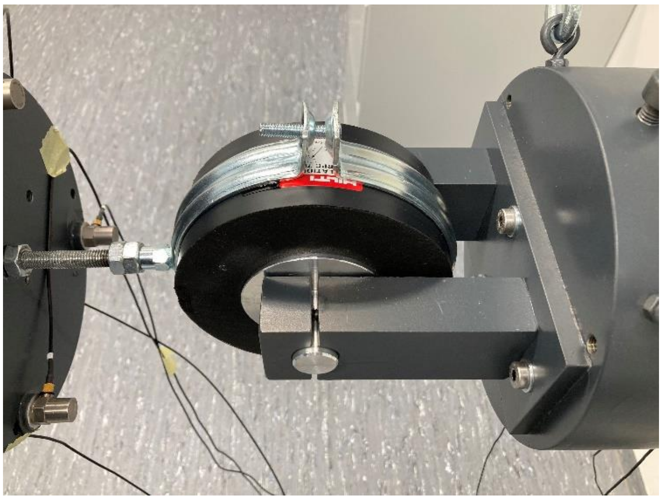


Figure 1. Measurement of pipe clamp MRP-C.

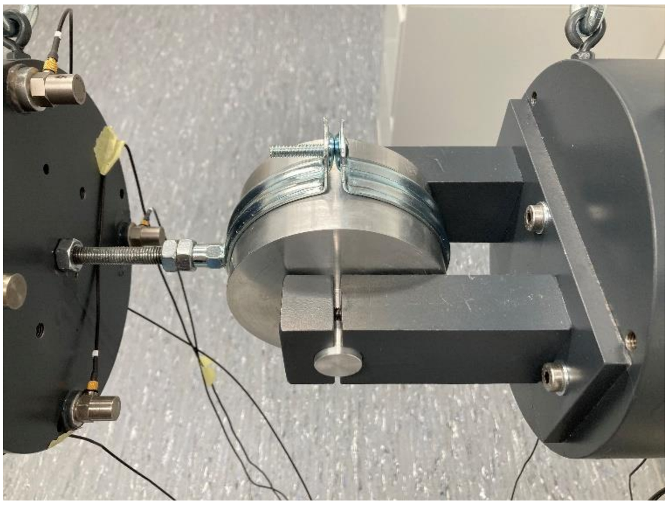


Figure 2. Reference measurement of pipe clamp MP-H.

Figure 3. Interior view of the pipe clamp insulation.

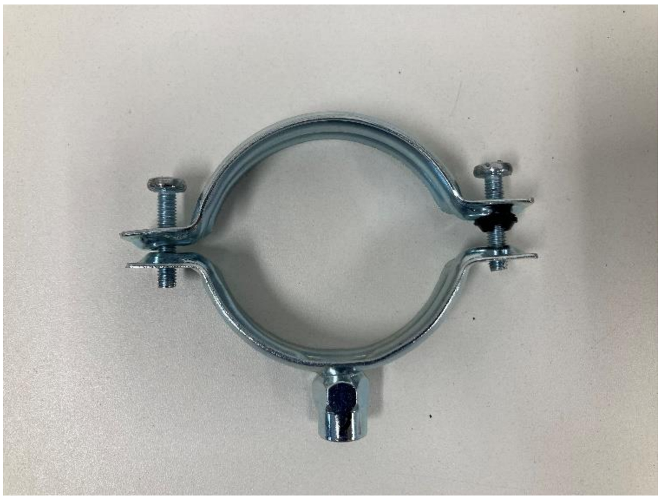
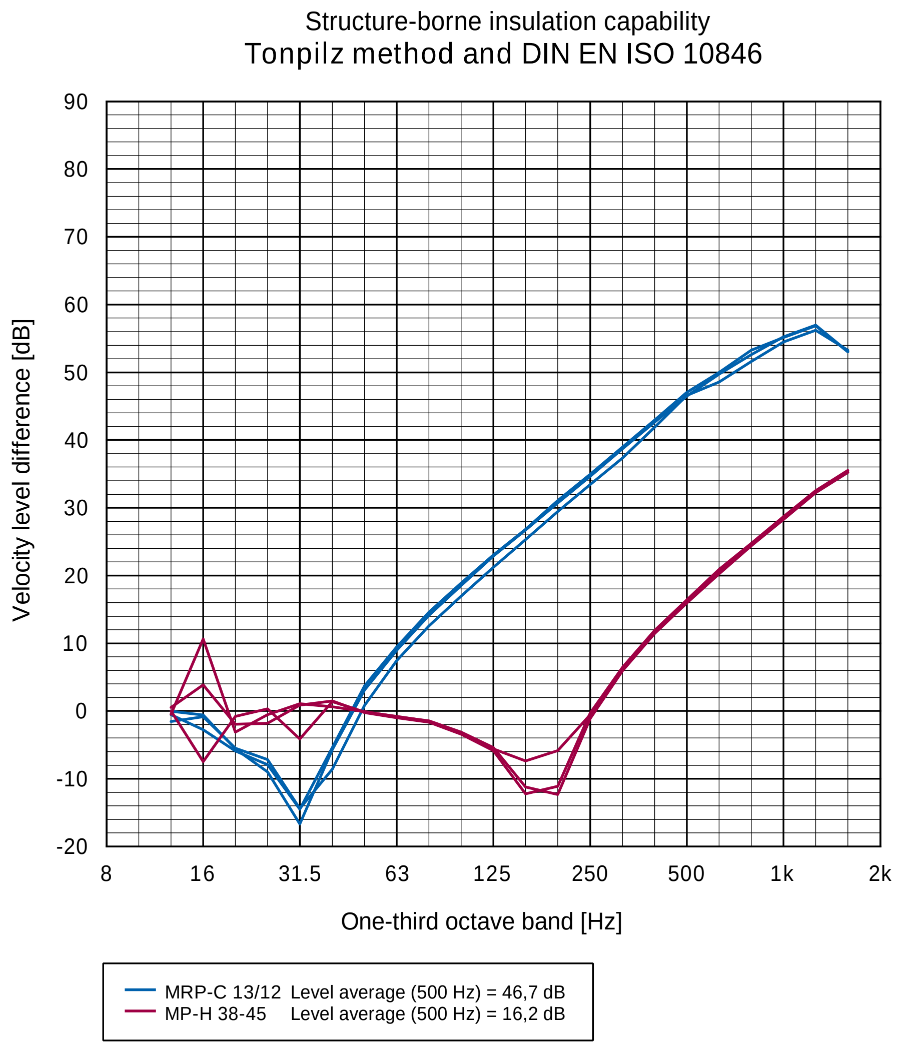


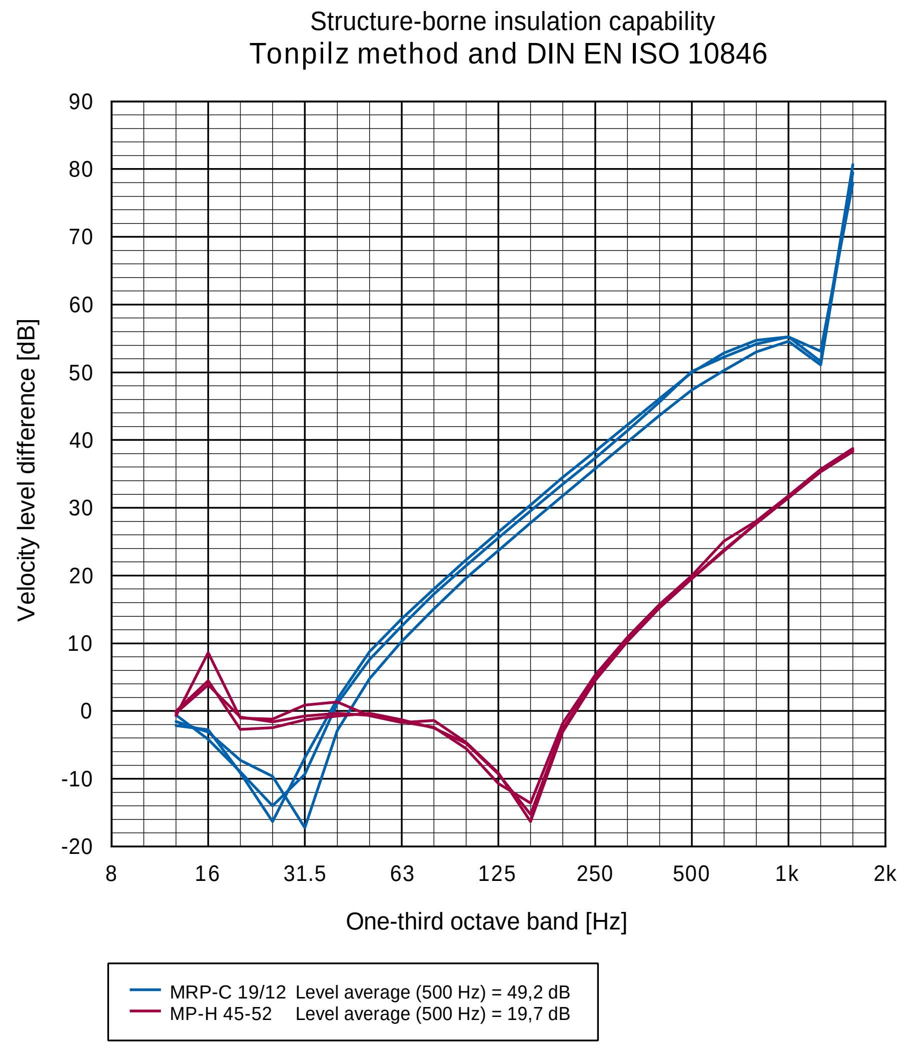
Figure 4. Outer ring with screwed steel bows.

Appendix B

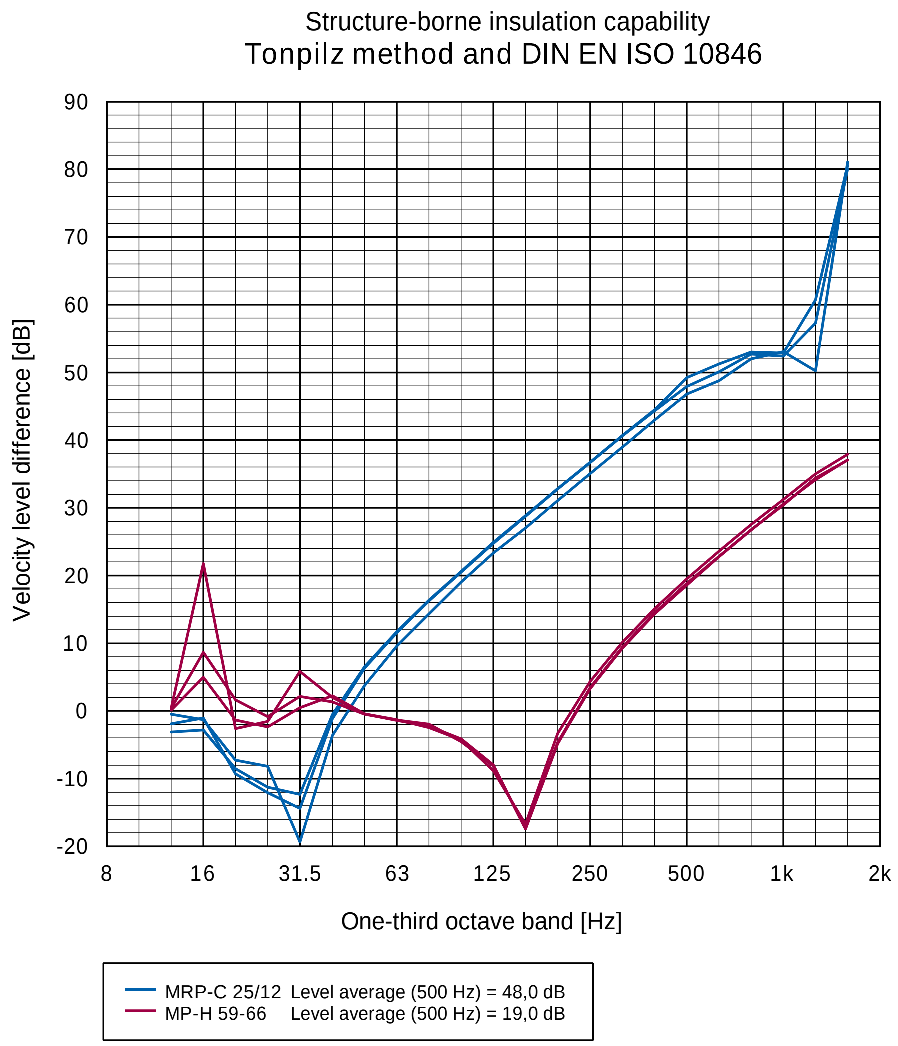
Graphic results



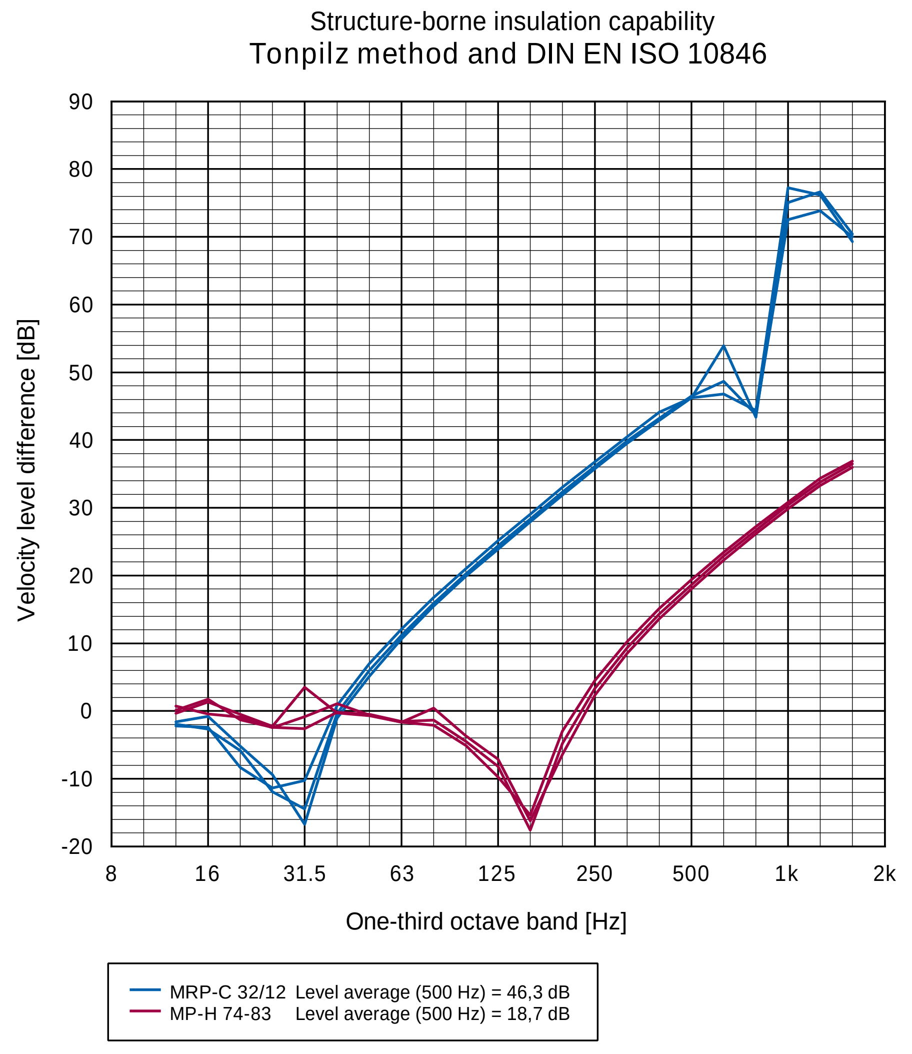
Graphic 1. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



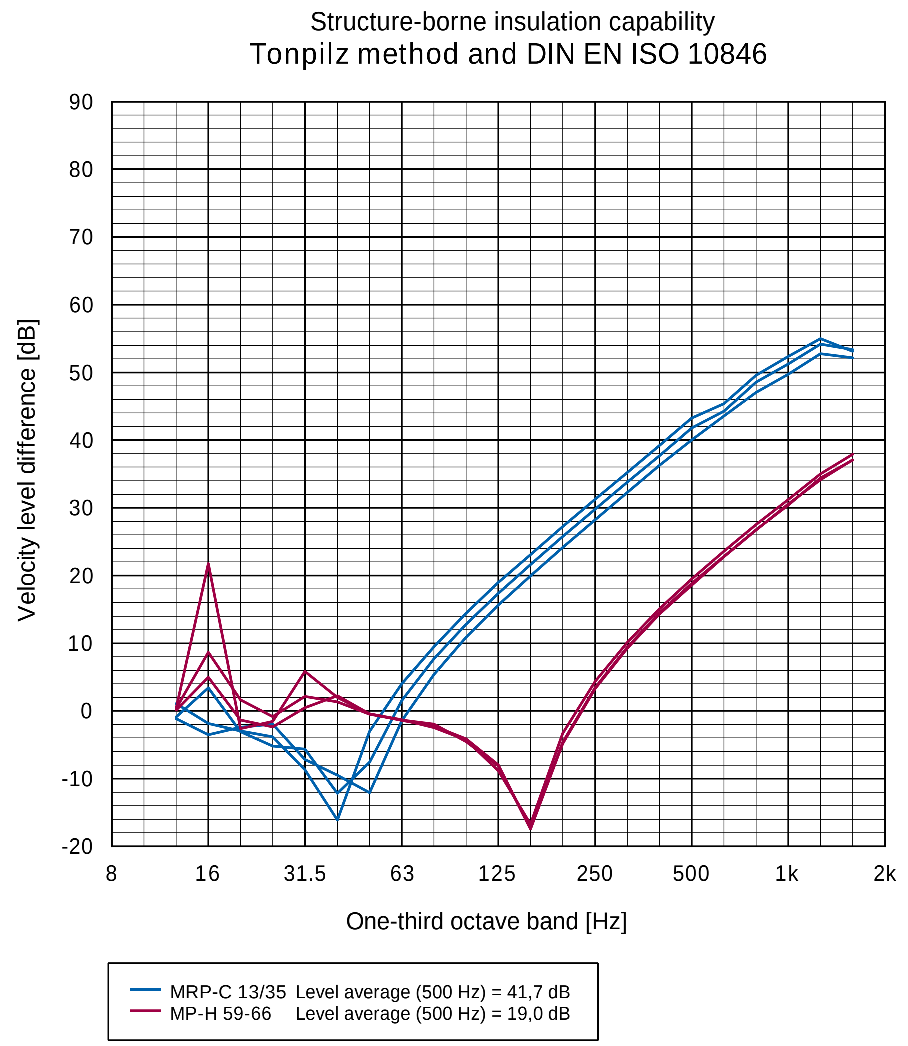
Graphic 2. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



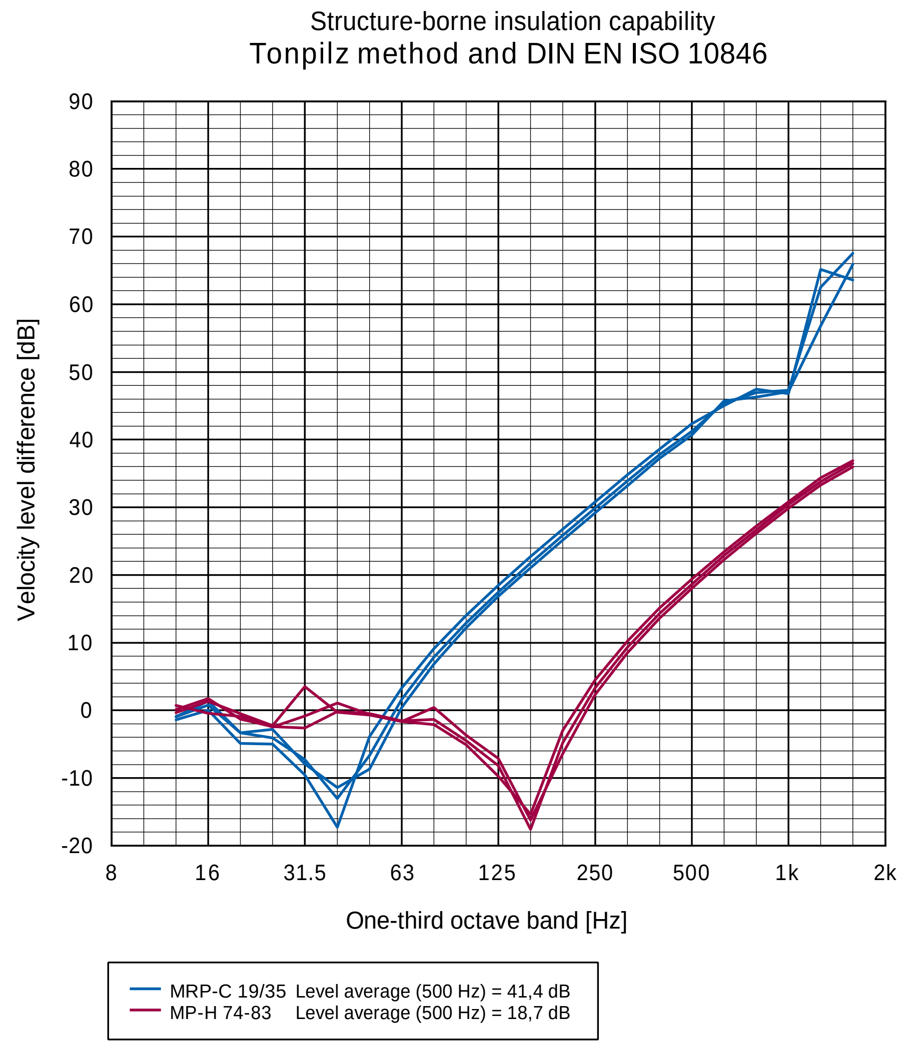
Graphic 3. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



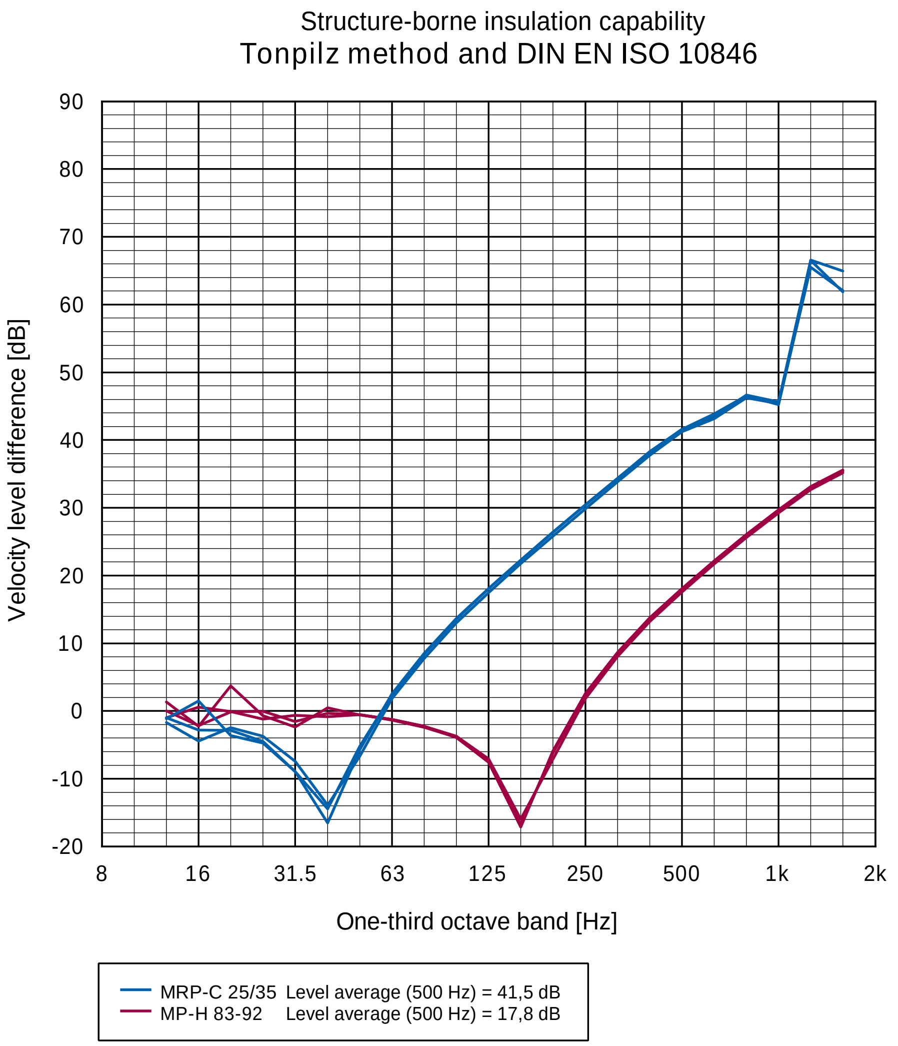
Graphic 4. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



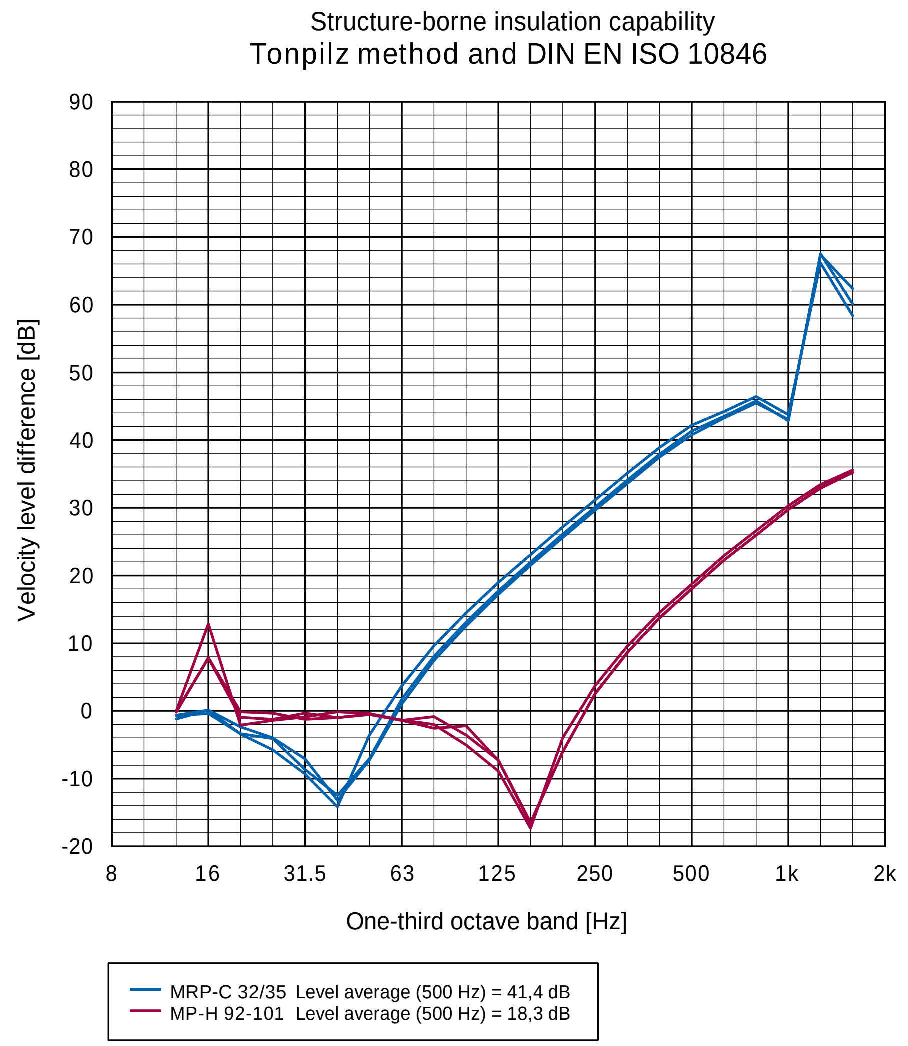
Graphic 5. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



Graphic 6. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



Graphic 7. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.



Graphic 8. Representation of three structure-borne noise measurements for a pipe clamp with insulation (MRP-C) and without insulation (MP-H). Information regarding dummy size and tightening torque are listed in chapter 4.3.