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Bellaterra: 26th of April, 2019

File number: 19/19154-550

Test petitioner: **BEKA SPORT Zeminleri Ins. Mad. Koz. San. ve Dis Tic. LTD. STI.**
Altunizade Mahallesi, Kisikli Cad.
Tekinak is Merkezi No:3 D:8, 34662
Uskudar - Instanbul (Turkey)

TEST REPORT

The present document is a translated copy of the Spanish test report 19/19154-550. This report is issued on the 3rd of May, 2019. In case of dispute, the valid document is the original Spanish version.

Requested test: Laboratory measurement of the improvement of impact sound insulation, in accordance with the standards UNE-EN ISO 10140-3:2011, UNE-EN ISO 10140-3:2011/A1:2015 and UNE-EN ISO 10140-1:2016 (Annex H), by a floor covering composed of rubber tiles referenced ***BEKA rubber tiles***.

Dates of test: 19th of March, 2019

Test carried out by: Xavier Roviralta (Acoustics Laboratory - LGAI Technological Center)

Firmado digitalmente por Xavier Roviralta

Xavier Roviralta
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1.- SCOPE OF THE TEST

The scope of this test is to determinate the improvement of impact sound insulation, in accordance with the standards UNE-EN ISO 10140-3:2011, UNE-EN ISO 10140-3:2011/A1:2015 and UNE-EN ISO 10140-1:2016 (Annex H), by a floor covering composed of rubber tiles referenced ***BEKA rubber tiles***.

2.- MEASUREMENT EQUIPMENT

The equipment used in the test is the following:

- Spectrum analyser id. number: 170701 (Bruel&Kjaer mod. Pulse LAN-XI)
- Microphone calibrator id. number: 103032 (Bruel&Kjaer mod. 4231)
- Diffuse field microphone id. number: 103131 (Bruel&Kjaer mod. 4943)
- Rotating microphone boom id. number: 170692 (Ntek mod. MB-01)
- Standard tapping machine id. number: 103187 (CESVA mod. MI005) with casing id. number: 170642
- Sound source id. number: 103098 (AVM mod. DO12)
- Noise generator with power amplifier id. number: 103125 (CESVA mod. AP600)
- Equalizer id. number: 170092 (INTER mod. EQ-9231)
- Thermo-hygrometer and barometer id. number: 170680 (PCE mod. THB-40)
- Tape measurer id. number: 103095 (Stanley mod. Powerlock)
- Distance meter id. number: 170136 (Stanley mod. TLM130)
- Set of weights id. number: 170564 (12 weights are used)

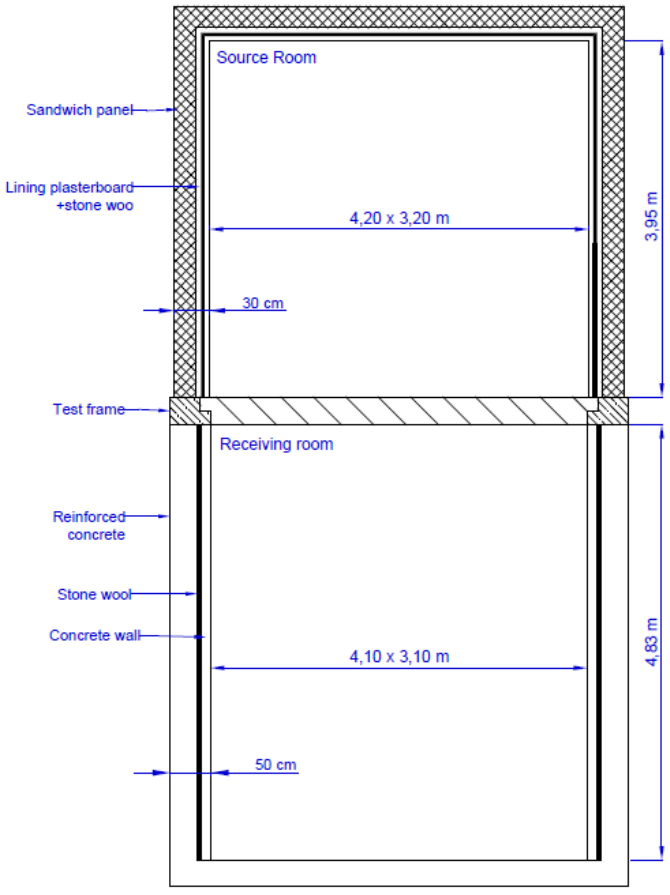
3.- TEST PROCEDURE AND EVALUATION

3.1. TEST METHOD

The test is carried out in accordance with the standards UNE-EN ISO 10140-3:2011 "Measurement of impact sound insulation" together with its Modification 1 UNE-EN ISO 10140-3:2011/A1:2015 and UNE-EN ISO 10140-1:2011 Annex H "Floor coverings. Improvement of impact sound insulation", which are part of the set of standards UNE-EN ISO 10140 "Laboratory measurement of sound insulation of building elements".

The test procedure consists on measuring the impact sound insulation of a basic construction (reference floor) with or without the lining to be tested. Both measurements are carried out according to the standards UNE-EN ISO 10140-3:2011 and UNE-EN ISO 10140-3:2011/A1:2015.

Two vertically adjacent rooms are used; the upper being designated the 'source room' and the lower the 'receiving room'. The test element is mounted in the opening between those rooms. The test procedure is based on measuring for every frequency band within the range of study, customarily from 100 Hz to 5000 Hz, the sound pressure level in the 'receiving room' when exciting the upper floor with a standardized tapping machine placed in at least four different positions. The equivalent absorption area in the receiving room is calculated from the reverberation time measurements.



Schematic drawing of the test rooms

Sound pressure level and reverberation time measurements are carried out according to the standard UNE-EN ISO 10140-4:2011.

The background noise level shall be at least 6 dB (and preferably more than 15 dB) below the level of signal and background noise combined at each frequency band. If the measured sound pressure level does not fulfil this condition, the corrections indicated in section 4.3 of the standard UNE-EN ISO 10140-4:2011 shall be applied.

At each frequency band, the **normalized sound pressure level**, $\mathbf{L_n}$, is calculated increasing the impact sound pressure level, L_i, by a correction term which depends on the reverberation time and the receiving room volume:

$$L_n = L_i + 10\ Log\ (\frac{A}{A_0})\ [dB]$$

where:

- L_i is the impact sound pressure level, corrected by the background noise if necessary, at each frequency band;
- A_0 is the reference equivalent absorption area, 10 m^2;
- A is the measured equivalent absorption area of the receiving room, defined in the UNE-EN ISO 10140-4:2011, and calculated by:

$$A = \frac{0.16\ V}{T}\ [m^2]$$

where:

- V is the receiving room volume, in m^3;
- T is the reverberation time in the receiving room, in seconds. It is defined as the time required for the sound pressure level in a room to decrease by 60 dB after the sound source has stopped.

3.2. IMPROVEMENT OF IMPACT SOUND INSULATION

The standard UNE-EN ISO 10140-1:2011 "Application rules for specific products" specifies, in Annex H "Floor coverings. Improvement of impact sound insulation" the procedure to measure the improvement of impact sound insulation of floor coverings intended to improve the impact sound insulation of floors.

The quantity determined is the **improvement of impact sound insulation**, **ΔL**, in decibels, defined as the reduction in normalized impact sound pressure level resulting from the installation of the test floor covering on the reference floor:

$$\Delta L = L_{n0} - L_n \text{ [dB]}$$

where:

- L_{n0} is the normalized impact sound pressure level of the reference floor without the floor covering;
- L_n is the normalized impact sound pressure level of the reference floor with the floor covering.

The standard reference floors are defined in the standard UNE EN-ISO 10140-5:2011 Annex C; one heavyweight reference floor and three lightweight reference floors. Commonly the heavyweight reference floor is the floor used, which consist of a reinforced concrete slab of thickness 120^{+40}_{-20} mm, preferably 140 mm for the construction of new laboratories. It should be homogeneous and shall be of uniform thickness.

3.3. PROCEDURE FOR EVALUATING SINGLE-NUMBER QUANTITIES FOR IMPACT SOUND INSULATION RATING

The method of measurement gives values for the impact sound insulation which are frequency dependent. The standard ISO 717-2 normalizes a method whereby the frequency-dependent values of impact sound insulation can be converted into a single number characterizing the acoustical performance.

From the curve of impact sound it is possible to obtain the global weighted value comparing that curve with the reference spectrum (given in table 3.1) defined between 100 and 3150 Hz:

Freq. (Hz)	100	125	160	200	250	315
Ref.	62	62	62	62	62	62
Freq. (Hz)	400	500	630	800	1000	1250
Ref.	61	60	59	58	57	54
Freq. (Hz)	1600	2000	2500	3150	4000	5000
Ref.	51	48	45	42	-	-

Table 3.1: Reference values for impact sound for every frequency band

The global weighted value is the value, in decibels, of the reference curve at 500 Hz after shifting it in accordance with the following procedure.

To evaluate the results of a measurement (L_n, for example), the reference spectrum is shifted in increments of 1 dB towards the measured curve until the sum of unfavourable deviations is as large as possible but not more than 32,0 dB. An unfavourable deviation at a particular frequency occurs when the results of measurements exceed the reference value for that frequency band.

By the appliance of this evaluation to the normalized impact sound pressure level, L_n, the **weighted normalized impact sound pressure level**, $\mathbf{L_{nw}}$, is obtained.

3.4. PROCEDURE FOR EVALUATING THE WEIGHTED REDUCTION IN IMPACT SOUND PRESSURE LEVEL, ΔL_w

To calculate the **weighted reduction in impact sound pressure level**, $\mathbf{\Delta L_w}$, it is necessary to relate the measured ΔL levels with a reference floor. The reference floor is defined by the values for the normalized impact sound pressure level, $L_{n,r,0}$, given in table 3.2:

Freq. (Hz)	100	125	160	200	250	315
Ref.	67	67,5	68	68,5	69	69,5
Freq. (Hz)	400	500	630	800	1000	1250
Ref.	70	70,5	71	71,5	72	72
Freq. (Hz)	1600	2000	2500	3150	4000	5000
Ref.	72	72	72	72	-	-

Table 3.2: One-third octave band values of the reference curve

The weighted normalized impact sound pressure level of the reference floor, $L_{n,r,0,w}$, is 78 dB.

The weighted reduction of impact sound pressure level, ΔL_w, is calculated according to the following equations:

$$L_{n,r} = L_{n,r,0} - \Delta L$$
$$\Delta L_W = L_{n,r,0,W} - L_{n,r,w} = 78\ dB - L_{n,r,w} \quad [dB]$$

where:

- $L_{n,r}$ is the calculated normalized impact sound pressure level of the reference floor with the floor covering under test;

- $L_{n,r,0}$ is the defined normalized impact sound pressure level of the reference floor (see Table 3.2);
- ΔL is the reduction in impact sound pressure level measured in accordance with the standard UNE-EN ISO 10140-1:2016;
- $L_{n,r,w}$ is the calculated weighted normalized impact sound pressure level of the reference floor with the floor covering under test;
- $L_{n,r,0,w}$ is obtained in accordance with section 4.3.1 of the standard ISO 717-2 (see section 3.3).

The reduction in impact sound pressure level measured on a concrete floor slab as defined in the Annex H of the standard UNE-EN ISO 10140-1:2011 and the single-number quantity ΔL_w may only be used in connection with similar types of massive floors (concrete, hollow concrete, hollow bricks and similar); it is not appropriate for use on other types of construction.

3.5. CALCULATION OF THE SPECTRUM ADAPTATION TERMS

The rating by $L_{n,w}$ has been shown to be quite adequate in characterizing impact noise like walking for wooden floors and concrete floors with effective coverings such as carpets or floating floors. However, it insufficiently takes into account level peaks at single (low) frequencies, for instance with timber joist floors, or the behaviour of bare concrete floors in this respect. There is clear evidence that the unweighted impact level of the tapping machine is more representative of the A-weighted impact levels as caused by walking for all types of floor, while this rating is also more restrictive to single noise peaks.

Therefore an adaptation term C_I is introduced to take this effect into account, given as a separate number which cannot be confused with the value for $L_{n,w}$. This term is so defined that for massive floors with effective coverings its value is about zero, while for timber joist floors with dominating low frequency peaks it will be slightly positive. For concrete floors without cover or with less effective covering, it will range from -15 to 0 dB.

If these effects are to be taken into account in requirements, these could be written as the sum of $L_{n,w}$ and C_I.

The results of a measurement of L_n in one-third-octave bands in the frequency range 100 Hz to 2500 Hz are added up on an energetic basis resulting the $L_{n,sum}$. The spectrum adaptation term C_I is calculated from the following equation:

$$C_I = L_{n,sum} - 15 - L_{n,w} \quad [dB]$$

The spectrum adaptation term is calculated with decimal precision and rounded to an integer afterwards.

A spectrum adaptation term for flat response for the impact sound reduction may be determined and stated. This spectrum adaptation term $C_{I\Delta}$ is calculated from:

$$C_{I\Delta} = C_{I,r,0} - C_{I,r} \quad [dB]$$

where:

- $C_{I,r}$ is the spectrum adaptation term for the reference floor with the floor covering under test;
- $C_{I,r,0}$ is the spectrum adaptation term for the reference floor with $L_{n,r,0}$ ($C_{I,r,0}$ = - 11 dB).

3.6. UNCERTAINTY OF RESULTS

The uncertainty associated to the test has been calculated and is available to the petitioner. The expanded uncertainty has been calculated as the typical measurement uncertainty multiplied by a coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

4.- REFERENCE FLOOR AND STANDARD TAPPING MACHINE DESCRIPTIONS

The basic element is a heavyweight reference floor in accordance with the requirements in the Annex C of the standard UNE-EN ISO 10140-5:2011. It is a reinforced concrete slab of thickness 140 mm, homogeneous and of uniform thickness.

The tapping machine is a standard tapping machine that fulfils the requirements of the standard UNE-EN ISO 10140-5:2011 Annex E.

5.- TEST ELEMENT DESCRIPTION

The main characteristics of the test element are listed below (commercial references are provided by the client). LGAI Technological Center, S.A. is not responsible for the documentation and/or information provided for the petitioner.

Type of test element	Floor covering
Manufacturer	BEKA SPORT Zeminleri Ins. Mad. Koz. San. ve Dis Tic. LTD. STI.
Model / Reference	***BEKA rubber tiles***
Supplied by	BEKA SPORT Zeminleri Ins. Mad. Koz. San. ve Dis Tic. LTD. STI.
Date received	7th of March, 2019
Area, *S*, of test element (test opening)	12,71 m^2 – 4,10 x 3,10 m
Test element thickness	160 mm (reference floor: 140 mm; floor covering: 20 mm)
Mass per unit area, *m* (estimated)	≈368 kg/m^2 (reference floor: ≈350 kg/m^2; floor covering: 18 kg/m^2)
Type of mounting	In the opening of a concrete frame (test frame)
Composition	- Reference floor: Heavyweight reference floor, heavyweight standard floor in accordance with the Annex C of standard EN ISO 10140-5. Reinforced concrete slab of thickness 140 mm - Floor covering 4,4x3,4 m composed of (from bottom to top): - Tiles made of EPDM and recycled SBR Rubber with MDI polyurethane adhesive of nominal dimensions 1000x1000 mm and 20 mm of thickness. Nominal density material of 970 kg/m^3 (provided by the test petitioner) and 18 kg/m^2 of mass per unit area.
Test element sealing	High density mastic
Test arrangement	In accordance with the specifications in Section 6 of UNE-EN-ISO 10140-3:2011 and Annex H of the UNE-EN-ISO 10140-1:2011
Type of floor covering	Category II, according to Annex H of the EN ISO 10140-1
Test element assembling (carried out by/date)	Applus Laboratories - LGAI Technological Center /18th of March, 2019
Mounting type	See figures 1 and 2

The technical information of the test element, provided by the test petitioner, is attached in the Annex.

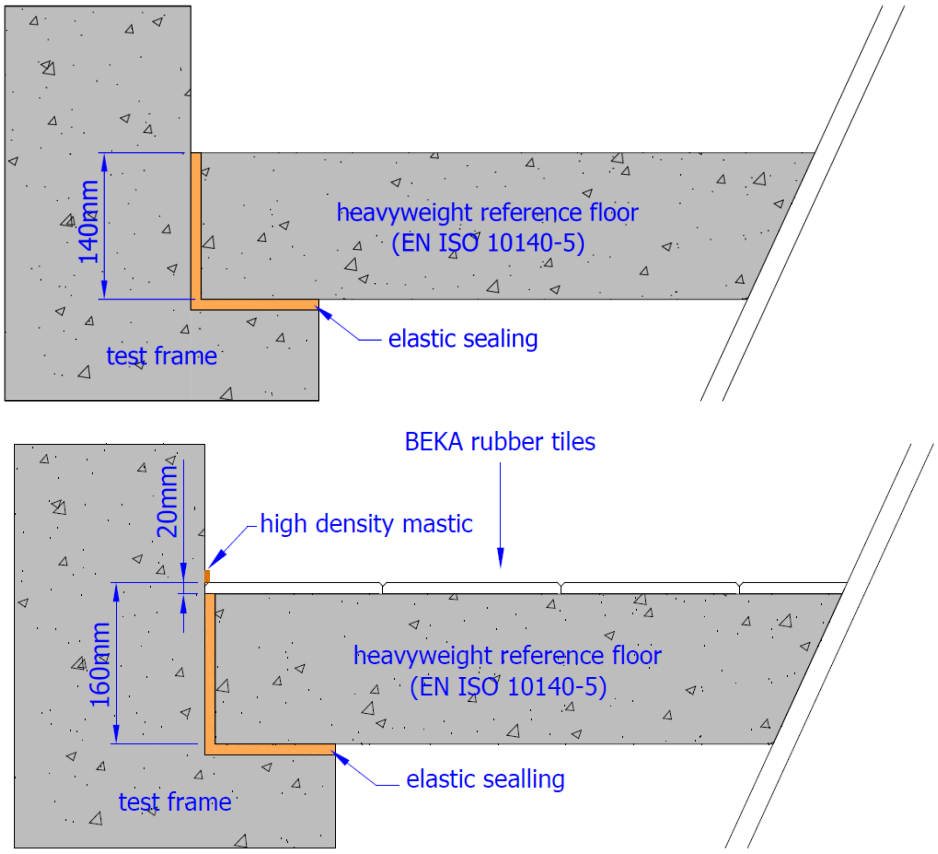
In order to determinate the improvement of impact sound insulation provided by the floor covering two measurements are carried out: the measurement of the standard reference floor without the floor covering (22/02/2019) and the measurement of the standard reference floor with the floor covering (19/03/2019).

Images 1 to 4 Details of *BEKA rubber tiles*

Images 5 to 12 Installation and sealing of the floor covering on the reference floor

Images 13 Test specimen installed and ready for the test

The following figures show the sections of the tested constructions.



Figures 1 and 2 Reference floor and reference floor with the floor covering

6.- TEST CONDITIONS

6.1. STANDARD REFERENCE FLOOR (heavyweight reference floor in accordance with UNE-EN ISO 10140-5:2011 Annex C)

	Source Room	Receiving Room
Room volumes	52,9 m^3	62,9 m^3
Climatic conditions	Temperature: 20,8 ±0,6 ºC	Temperature: 21,1 ±0,6 ºC
	Humidity: 52,2 ±4,7 %	Humidity: 50,4 ±4,7 %
	Static pressure: 1012,6 ±1,3 hPa	

6.2. STANDARD REFERENCE FLOOR + FLOOR COVERING

	Source Room (Note 1)	Receiving Room
Room volumes	52,6 m^3	62,9 m^3
Climatic conditions	Temperature: 20,2 ±0,6 ºC	Temperature: 19,9 ±0,6 ºC
	Humidity: 61,3 ±4,7 %	Humidity: 60,1 ±4,7 %
	Static pressure: 1007,1 ±1,3 hPa	

Note 1: The floor covering (test element) is located into the source room.

7.- RESULTS

Reduction of impact sound pressure level in accordance with the Standard ISO 10140 (all parts)

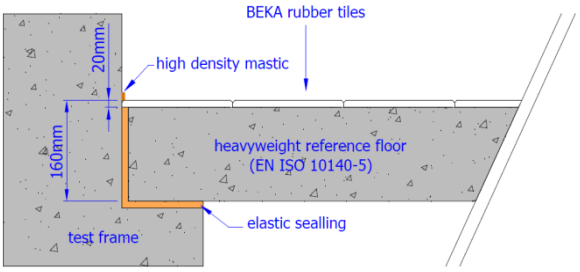
Client: BEKA SPORT Zeminleri Ins. Mad. Koz. San. ve Dis Tic. LTD. STI.

Test element:
Floor covering composed of rubber tiles referenced ***BEKA rubber tiles***, installed on a heavyweight reference floor (standard reference floor in accordance with UNE-EN ISO 10140-5:2011 Annex C).

Mass per unit area, *m*, estimated: 368 kg/m^2 (18 kg/m^2 floor covering)

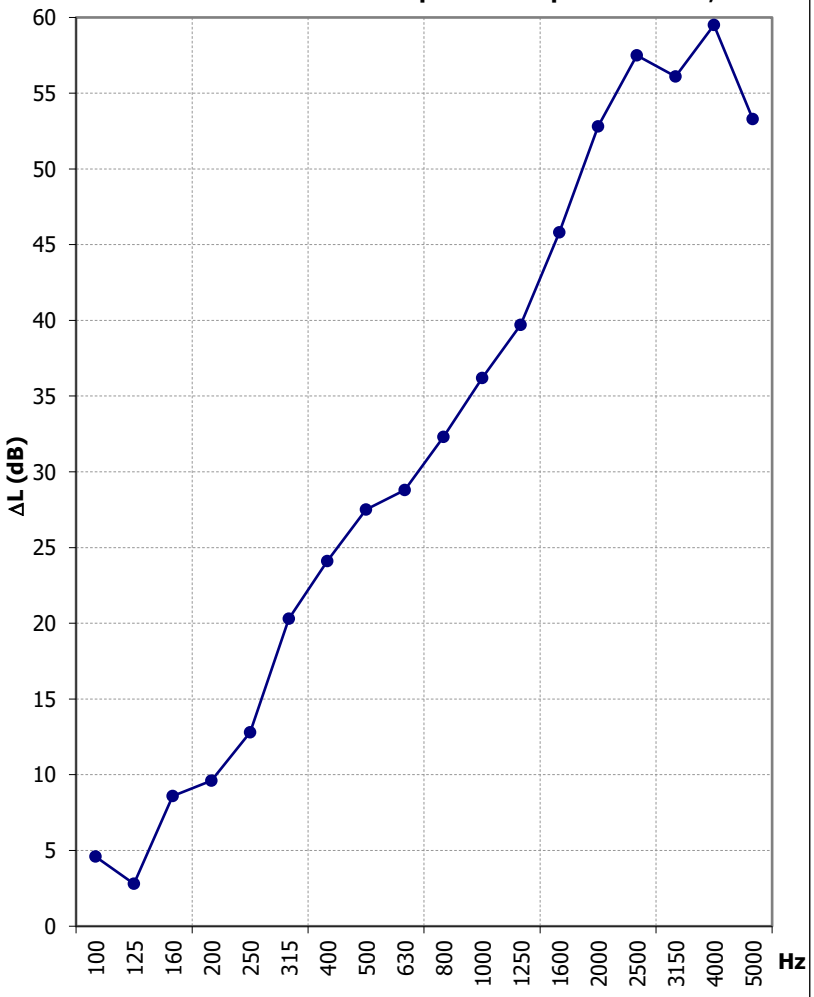
Area, *S* of the test element: 12,71 m^2 (4,10 x 3,10 m)

Dates of test: 19/03/2019 (reference floor 22/02/2019)



Frequency (Hz)	$L_{n,0}$ (dB)	ΔL (dB)
100	56,5	4,6
125	59,3	2,8
160	70,2	8,6
200	71,4	9,6
250	75,2	12,8
315	75,0	20,3
400	76,2	24,1
500	77,0	27,5
630	76,0	28,8
800	76,0	32,3
1000	75,6	36,2
1250	75,4	39,7
1600	75,5	45,8
2000	75,0	52,8
2500	74,8	57,5
3150	74,8	56,1
4000	73,5	59,5
5000	71,9	53,3

Reduction of transmitted impact sound pressure level, ΔL



ISO 717-2	$L_{n,0,w}$ = 81 dB	$L_{n,w}$ = 52 dB	$L_{n,r,w}$ = 52 dB	**ΔL_w = 26 dB**
	$C_{I,0}$ = -9 dB	C_I = 1 dB	$C_{I,r}$ = 1 dB	$C_{I\Delta}$ = -11 dB

ANNEX. TECHNICAL INFORMATION PROVIDED BY THE TEST PETIOTIONER

BEKA RUBBER

Technical Specifications | **Rubber Tile**

EXPLANATIONS

MATERIALS:
Original EPDM and recycled SBR Rubber. Color pigments. MDI poliurethan adhesive.

SPECIFICATIONS:
2 or 3 layer according to demanded Sbr Rubber Tile. On top base EPDM rubber wear layer, SBR shock absorption layer and SBR rubber base layer. The wear layer provides maximum safety and slip resistance along with an aesthetic surface. This layer would be produced only by Sbr if it is requested. SBR layers give you a comfortable feeling of pushing and walking / jogging and provides shock absorption and cushioning.

APPLICATION AREAS

Indoor and outdoor climbing wall areas, indoor and outdoor playgrounds, recreation areas, playing rooms, child care centers and fitness facilities.

WARRANTY

Beka Rubber guarantees that there will not be a problem due to production defects under standart use conditions for a period of 2 years from the original installation date, when the product installed using the recommended procedures and adhesives of Beka Rubber.

TECHNICAL SPECIFICATIONS

COLORS: Red (terra cota), Green, Black (sligth color differents or fades are possible).

TOP SURFACE: Open-pored, smooth.

BOTTOM SURFACE: Dimpled pattern, flat, grooved and / or different type (for drainage).

DIMENSIONS:

Thikcness [mm]	Fall Height [m]	Weight [kg]/max.
20 mm	0.70 m	4,5 kg
25 mm	0.89 m	5,75 kg
30 mm	1.00 m	6,75 kg
35 mm	1.10 m	7,5 kg
40 mm	1.20 m	8,25 kg

SIZES:
40x40 cm - 50x50 cm - 100x100 cm

TEST RESULTS

Permitted Fall Heigth:
DIN EN 1177: 2018, EN 1177: 2018 according

HIC 1000:
DIN EN 1176-1: 2017, EN 1176-1: 2017

Fire Resistance:
Class E (DIN EN 13501-1, 2010)

Chemical Resistance:
Conditionally resistant to acids and bases

UV Resistance:
According DIN EN 1297, DIN EN, ISO 3386-2

Chlorine Resistance:
According DIN EN ISO 175, DIN EN, ISO 3386-2

Cold Fracture Resistance:
24 hours / -20 ° C, no fracture

Cold Cracking Resistance:
5 hours / -15 ° C, no crack

Slip Resistance:
Wet: 50,75,
Dry: 50 ASTM E 303 according

Water Resistance:
40 mm panel: 0,011 gpm / in^3
70 mm panel: 0,015 gpm / in^3