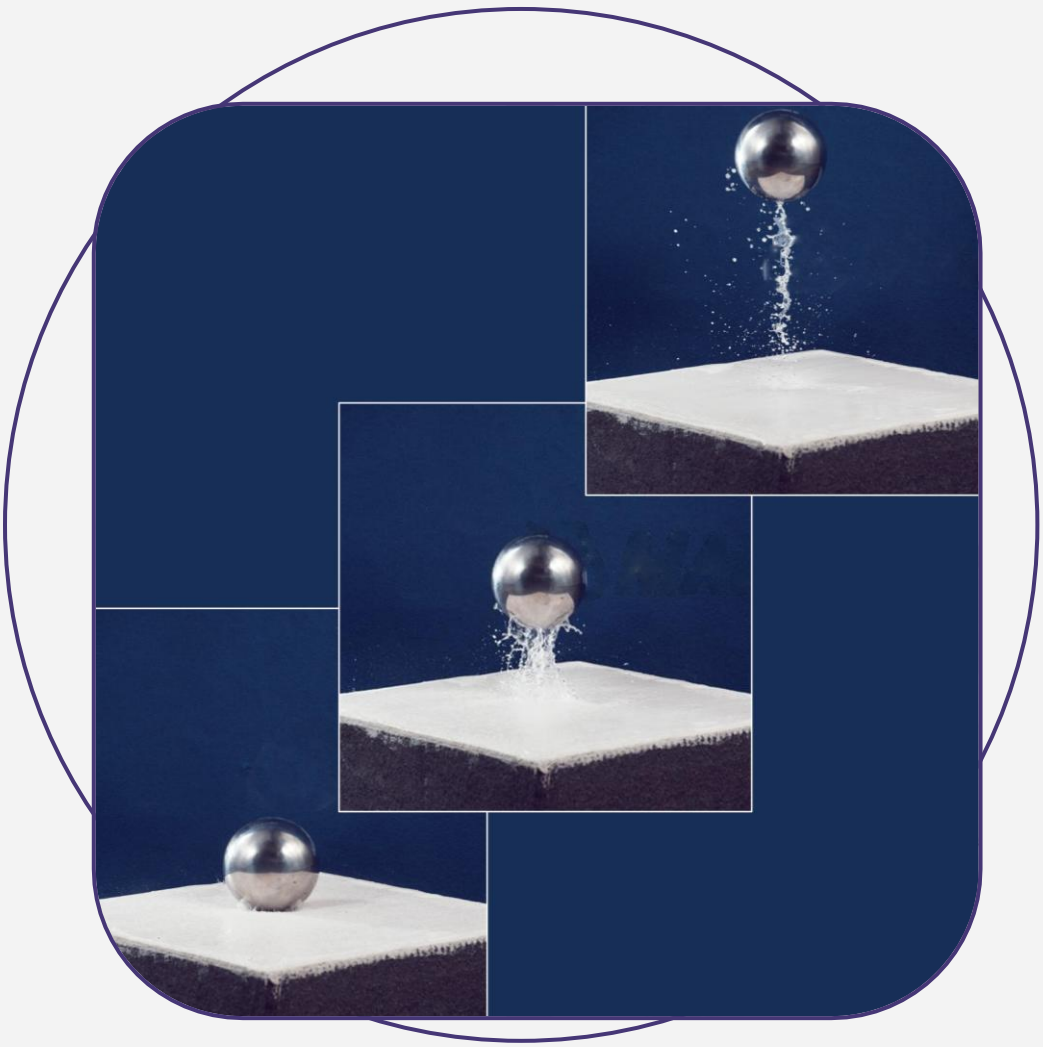
2 November 2026

ANIT
HANDBOOKS

SOUND-INSULATING AND IMPACT-RESISTANT ETICS

English version

Integrated solutions for ETICS with high durability



ANIT

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ANIT HANDBOOKS

ANIT, the Italian National Association for Thermal and acoustic Insulation, periodically publishes documents on topics related to energy efficiency and acoustic insulation of buildings.
The subjects covered include legislation, relevant technical standards, construction technologies, installation guidelines and more.
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INTRODUCTION

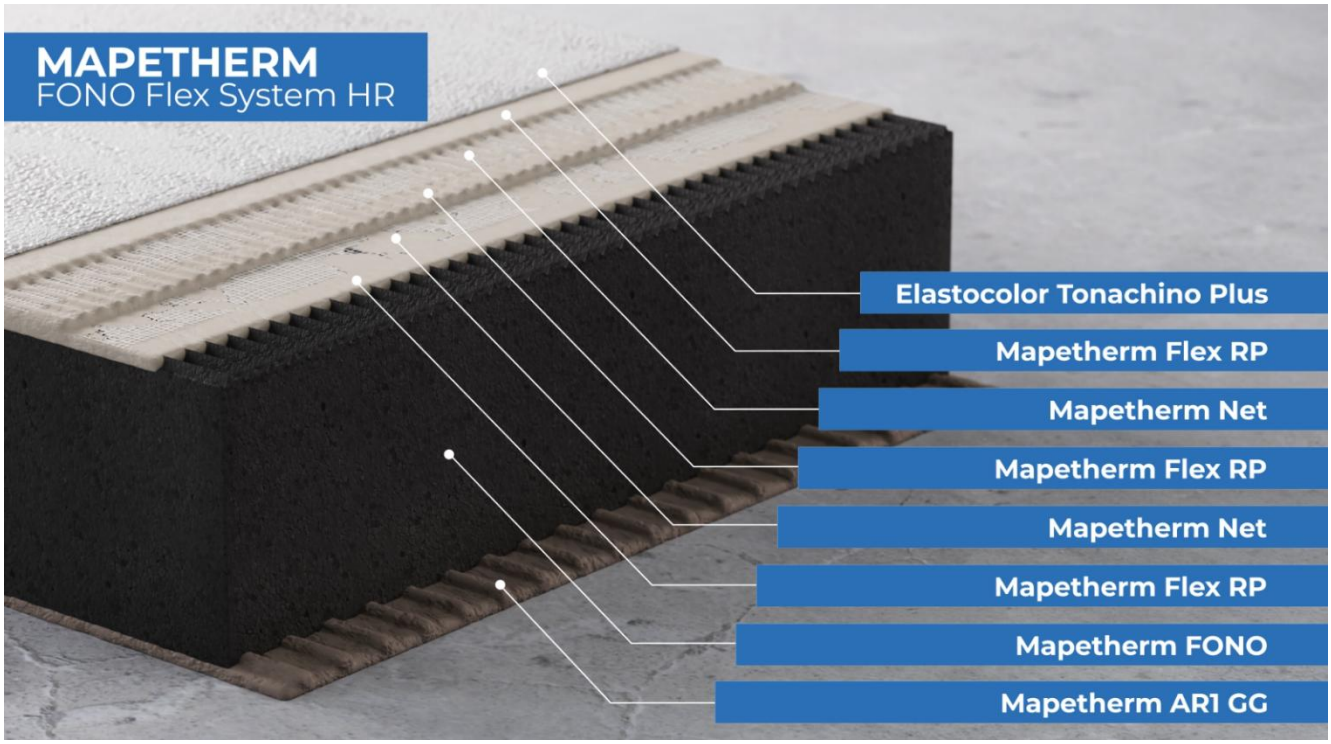
External thermal insulation systems (ETICS) are typically associated with the need to improve the thermal insulation performance of an opaque facade element. However, they can also meet other requirements.

This ANIT Handbook, developed in collaboration with our member company MAPEI, describes how external insulation systems can improve a facade's sound insulation and ensure adequate resistance to impact and hail.

1 SOUND INSULATION PERFORMANCE OF A WALL WITH ETICS

In general, the sound insulation performance of a solid partition can be improved by installing a cladding system capable of reducing the transmission of vibrations and noise.

The overall performance can be determined by adding the increase in sound insulation performance (ΔR_w) of the cladding system to the sound reduction index of the base partition (R_w). This increase can be evaluated through laboratory testing or predictive calculations.



An exterior insulation and finish system that provides sound insulation and high impact resistance to solid walls

1.1 Laboratory Tests

Laboratory tests, which are considered the most reliable data, are conducted in accordance with the guidelines of the UNI EN ISO 10140 series of standards.

In brief, the test involves measuring the sound reduction index (R) twice: one on the unclad wall (reference wall) and the other on the clad wall. Each measurement yields sound insulation values in the relevant third-octave frequency bands, with at least 16 values ranging from 100 to 3150 Hz. The difference between the results in the various frequency bands is used to calculate the increase in sound insulation (ΔR).

The test may be conducted using the "standardized" base walls described in UNI EN ISO 10140-5, or a base wall selected by the client. The standardized base wall may be a heavy wall or a lightweight wall.

A heavy wall is characterized by a surface mass of 350 ± 50 kg/m², the absence of internal cavities, and a block density of at least 1600 kg/m³. An example would be a wall constructed with calcium silicate blocks (density 1700–1800 kg/m³, thickness 17.5 cm), covered on one side with a 1-cm layer of gypsum plaster.

For the lightweight wall, on the other hand, the standard specifies the use of a partition with a surface mass of approximately 70 kg/m², proposing a construction consisting of aerated concrete blocks 10 cm thick and with a density of 600 ± 50 kg/m³, covered with a 1 cm layer of gypsum plaster on the side facing the ETICS.

To "convert" the 16 frequency values into a single evaluation index (ΔR_w), the mathematical procedure described in the UNI EN ISO 717-1 standard is used. If a standardized heavy base wall is used, the result is identified by the abbreviation $\Delta R_{w,heavy}$. If the normalized base wall is of the lightweight type, the result is designated ΔRw,light. If the reference wall was selected by the client, the designation $\Delta R_{w,direct}$ is used.

When the base wall is selected by the client, the ΔRw,direct value is obtained by simply subtracting the sound reduction index (R_w) of the unclad wall from that of the clad wall: $\Delta R_{w,direct} = R_{w\ with\ cladding} - R_{w\ without\ cladding}$

If, on the other hand, the base wall is a standardized wall, the measurement results must be normalized to a "reference" standardized wall as defined in UNI EN ISO 717-1. The standard identifies two reference walls: one for heavy standardized structures and one for lightweight standardized structures.

In this case, the procedure involves:

1. Determine the 16 ΔR values for the frequency bands between 100 and 3150 Hz through laboratory measurements:
   $\Delta R = R_{\ with\ cladding} - R_{\ without\ cladding}$
2. Add the ΔR values to the sound insulation performance of the reference wall:
   $R_{ref\ (heavy/light)\ with\ cladding} = R_{ref\ (heavy/light)\ without\ cladding} + \Delta R$
3. Calculate the performance indices of the reference wall with and without cladding
   ($R_{w\ ref\ (heavy/light)\ with\ cladding}$, $R_{w\ ref\ (heavy/light)\ without\ cladding}$)
4. Determine ΔR_w as the difference between the evaluation indices of the reference wall with and without cladding
   $\Delta R_{w,heavy} = R_{w\ ref\ heavy\ with\ cladding} - R_{w\ ref\ heavy\ without\ cladding}$
   $\Delta R_{w,light} = R_{w\ ref\ light\ with\ cladding} - R_{w\ ref\ light\ without\ cladding}$

1.2 Predictive calculations

To analytically calculate the change in sound insulation performance (ΔR_w) provided by an ETICS cladding system, the calculation method described in Appendix D of UNI EN ISO 12354-1 and in Section 8.3 of UNI 11175-1 may be used.

The mathematical equations allow for the determination of a value called $\Delta R_{w,ref}$, which characterizes a laboratory test situation with:

- a standardized heavy base wall with a surface mass of 350 kg/m² (heavy wall)
- no anchors
- an insulation board bonded to 40% of its surface area to the base wall

ETICS made of cellular material (EPS, elastified EPS or XPS) $\Delta R_{w,ref} = -33\log(f_0) + 76 \geq -3$ [1]

ETICS made of mineral wool (MW) $\Delta R_{w,ref} = -36\log(f_0) + 82.5 \geq -4$ [2]

Where f_0 is the resonance frequency of the system, which is calculated as follows:

$$f_0 = 160\sqrt{s'\left(\frac{1}{m'_1} + \frac{1}{m'_2}\right)} \quad [3]$$

Where:

- s' is the dynamic stiffness of the insulating material [MN/m³], measured in accordance with UNI EN 29052-1:1993
- m'_1 is the surface mass of the base structure [kg/m²]
- m'_2 is the surface mass of the finishing coat[kg/m²]

UNI EN ISO 12354 does not clearly specify how to determine the value of f_0. It is reasonable to apply formula [3], taking into account: m'_1 = 350 kg/m², m'_2 equal to the surface mass of the finish coat, and s' equal to the dynamic stiffness of the insulation panel (Fig. 1).

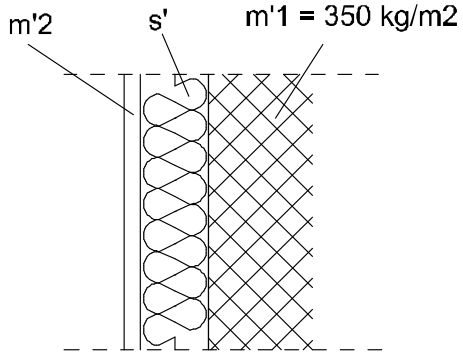


Figure 1: Factors for Calculating f_0 for Exterior Insulation Systems

If the ETICS system includes anchors—ranging from 4 to 10 per m², the value calculated using [1] or [2] must be corrected using [4]

$$\Delta R_{w(anchors)} = 0.66\Delta R_{w,ref} - 1.2 \qquad [4]$$

Furthermore, if the bonding area of the panels differs by more than 40% from the reference condition, the correction in formula [5] applies

$$\Delta R_{w(glue)} = \Delta R_{w,ref} - 0.05 \times \%S_0 + 2 \qquad [5]$$

Where "$\%S_0$" is the percentage of the insulating board's surface area bonded to the reference wall.

1.3 Applying the results to the as-built wall

The increase in sound insulation performance of a wall clad with ETICS depends not only on the characteristics of the cladding system but also on the characteristics of the base wall. Generally, for the same cladding system, the ΔRw value decreases as the surface mass and sound insulation performance of the base structure increase.

For this reason, ΔR_w values determined through laboratory measurements or predictive calculations generally cannot be directly applied to the wall "as built," unless it has characteristics that are entirely similar to those of the base wall considered in the measurements or calculations.

The technical standards UNI EN ISO 12354-1 and UNI 11175-1 propose the following calculation model to adapt ΔR_w values, measured in the laboratory or determined through predictive calculations, which use a standardized "heavy wall" structure as the reference wall, to the actual construction site conditions.

$$\Delta R_{w;situ} = \Delta R_{w;lab} + aX$$

$$a = 1.35 \log(f_0) - 3.5 \leq 0 \qquad [6]$$

$$X = R_{w,situ} - 53 \qquad \text{for} \qquad -10 \leq X \leq 7$$

Where:

- $\Delta R_{w;lab}$ is the change in sound insulation performance measured in the laboratory or determined through predictive calculations (based on a heavy reference wall of 350 kg/m^2)
- $R_{w,situ}$ is the sound insulation performance index of the base structure "as built".

To calculate f_0, it is reasonable to use Equation [3], taking into account the dynamic stiffness of the insulating material (s'), the mass per unit area of the base structure as installed (m'$_1$), and the mass per unit area of the finishing coat (m'$_2$).

For the results of $\Delta R_{w,light}$ and $\Delta R_{w,direct}$ laboratory tests, UNI 11175-2 specifies that they may be applied to the "as-built" wall only if that partition:

- is of the same construction type as that built in the laboratory
- has a surface mass (m') and sound insulation performance (R_w) that are less than or equal to those of the base wall used in the laboratory.

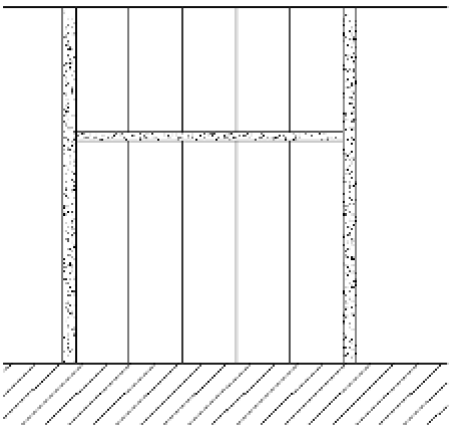
In these cases, the test result may be considered a conservative estimate. In other cases, the ΔR_w value cannot be used in preliminary calculations.

1.4 Calculation Examples

Below are some examples of preliminary calculations for MAPEI systems.

The examples consider:

- a 30 cm-thick wall built with semi-hollow blocks, plastered on both sides
- an outer layer comprising the reinforced base coat and finish coat of the ETICS system with a surface mass of 10 or 12 kg/m²
- adhesive application to 40% of the insulation panel's surface area



BASIC WALL

- cementitious mortar plaster (15 mm)
- masonry made of lightweight clay blocks, perforated for infill, size 30 x 25 x 19 cm, thickness 30 cm, 60% perforation, laid with the axis of the holes vertical and bonded with mortar joints.
- Cement-based mortar plaster (15 mm)

- Total surface mass (m'): **285 kg/m²**
- Sound reduction index (R_w): **46 dB**

The calculations were performed using ECHO software.

All of the following calculations show that, even when considering a finish coat with a low surface mass, these systems provide the wall in question not only with thermal insulation but also with improved sound insulation performance.

The result improves when one or both of the following parameters are increased:

- an increase in the surface mass of the reinforced skim coat and finish coat
- an increase in the thickness of the insulating material and a consequent reduction in the dynamic stiffness value (s').

Furthermore, as will be seen in Chapter 4, these systems provide high impact resistance, preventing damage in the event of severe hailstorms or extreme accidental impacts.

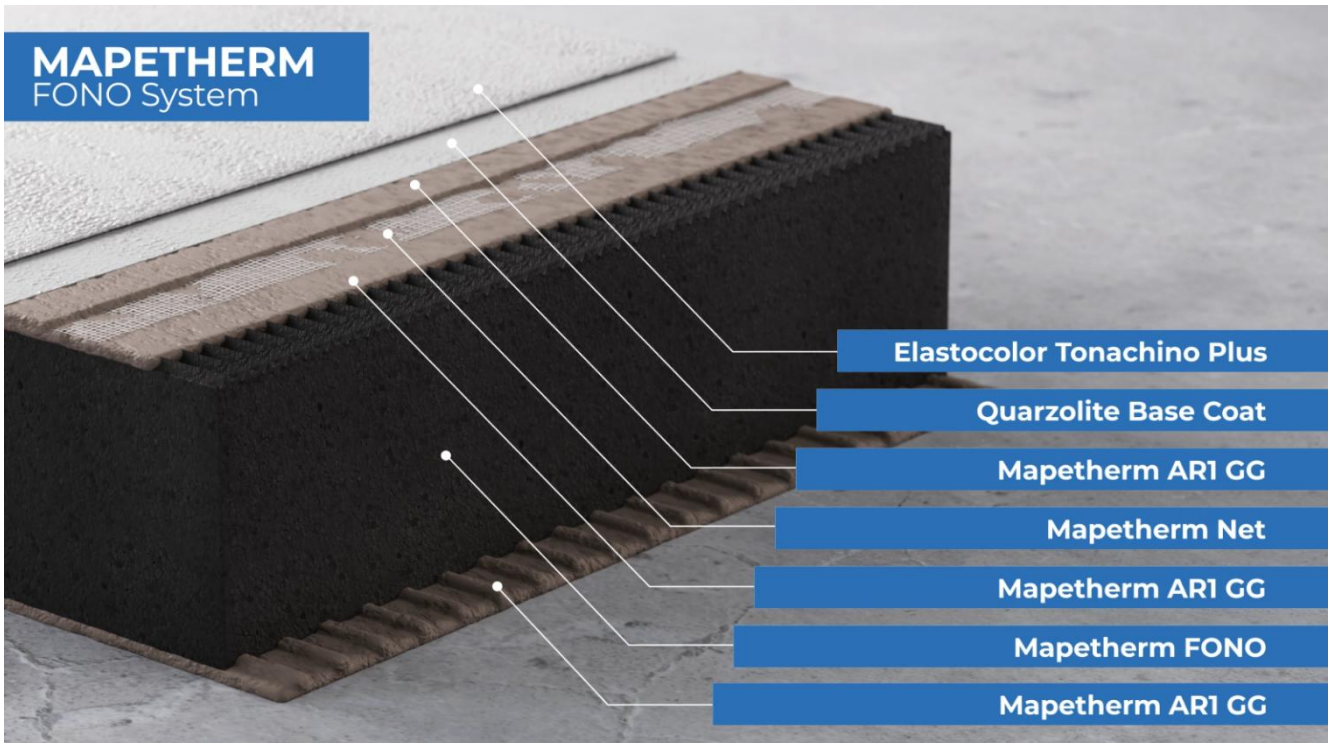
All results are summarized in **Table 1** at the end of the preliminary calculations.

1.4.1 MAPETHERM FONO SYSTEM

The system is constructed using Mapetherm FONO graphite-reinforced EPS insulation with low dynamic stiffness, having a λ_D value of 0.030 W/mK. The panel features specific 6-mm-deep grooves that allow for the application of a reinforced skim coat, with the standard two coats of skim coat and an interposed mesh, to a thickness that ensures the outer layer has a minimum weight of 10 kg/m². This weight is essential to activate the mass-spring-mass principle, improving the system's sound insulation performance. With this design feature, this fundamental requirement is not left to the installer's discretion but is automatically met.
The same acoustic performance can also be achieved with the high-impact-resistant systems Mapetherm FONO System R (80 J) and Mapetherm FONO System HR (200 J).

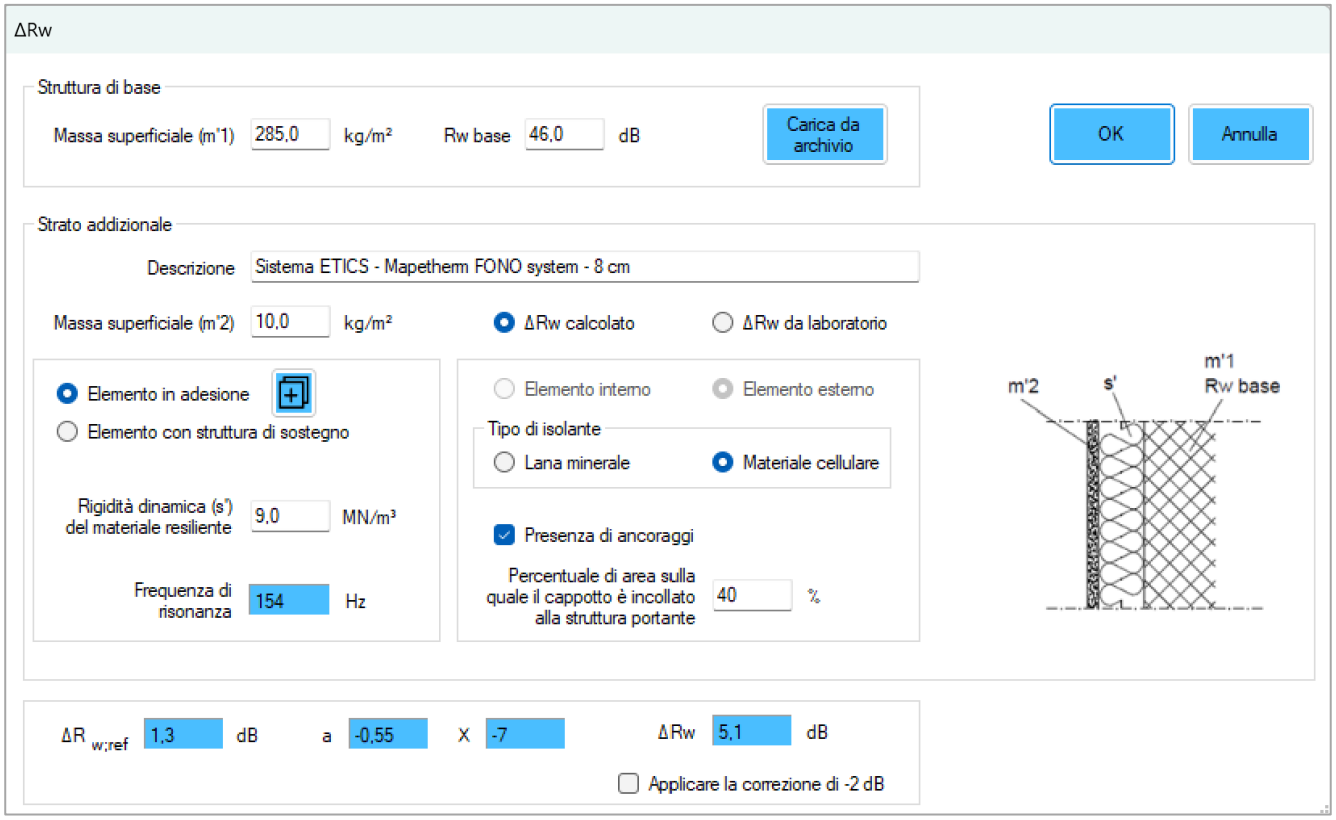
Download the specification documents:

- Mapetherm FONO System
- Mapetherm FONO Flex System R
- Mapetherm FONO Flex System HR

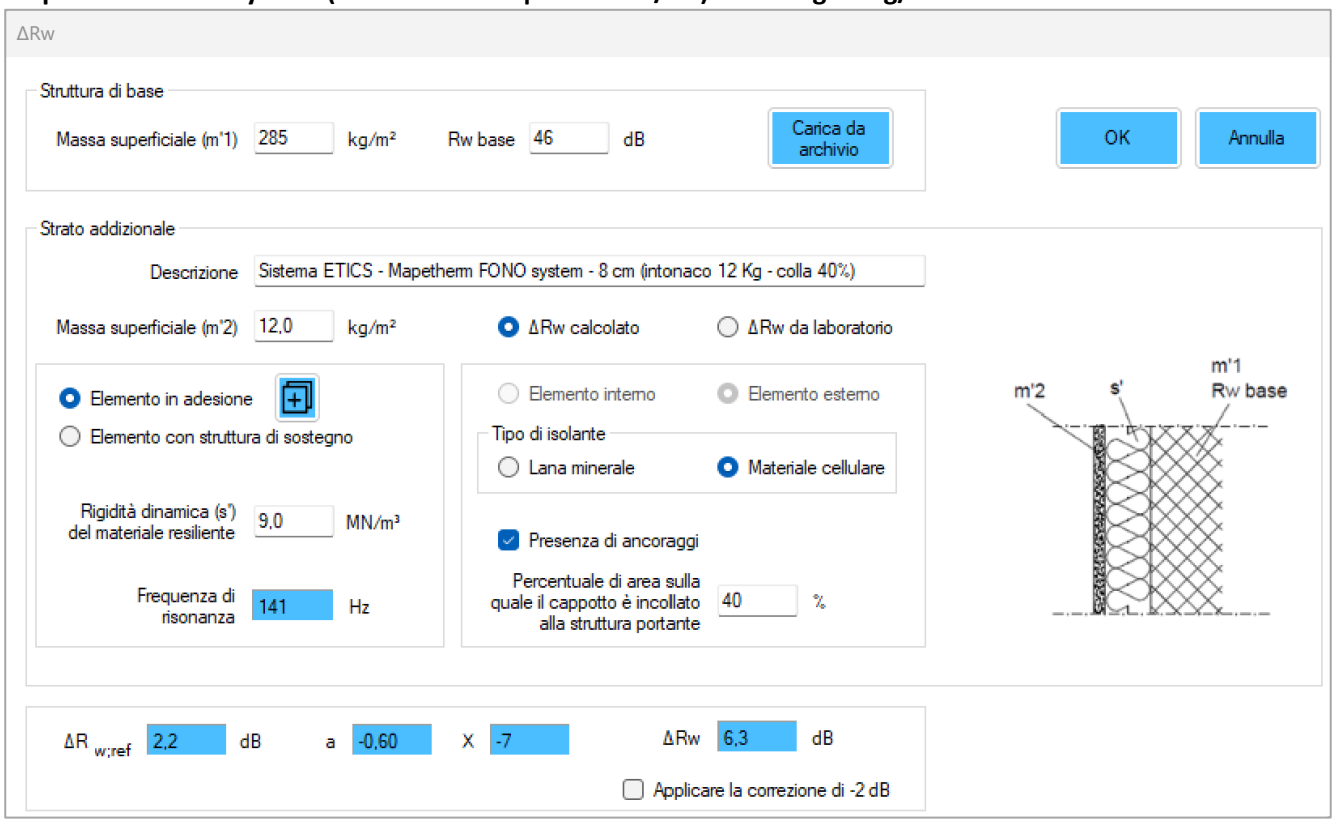


Mapetherm FONO System (Graphite-reinforced EPS with low dynamic stiffness)

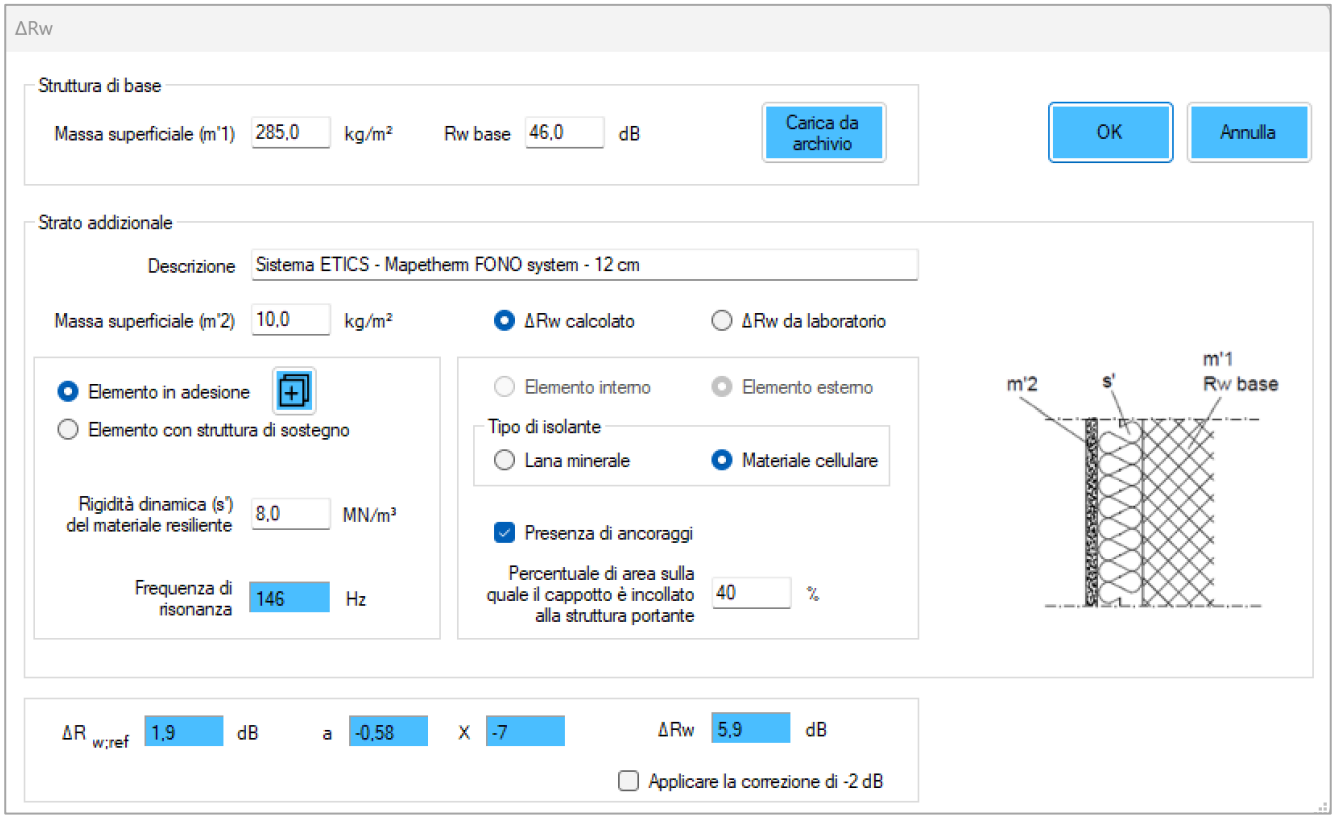
Mapetherm FONO system (thickness 8 cm | s' = 9 MN/m³) – coating 10 kg/m²: ΔRw = 5.1 dB



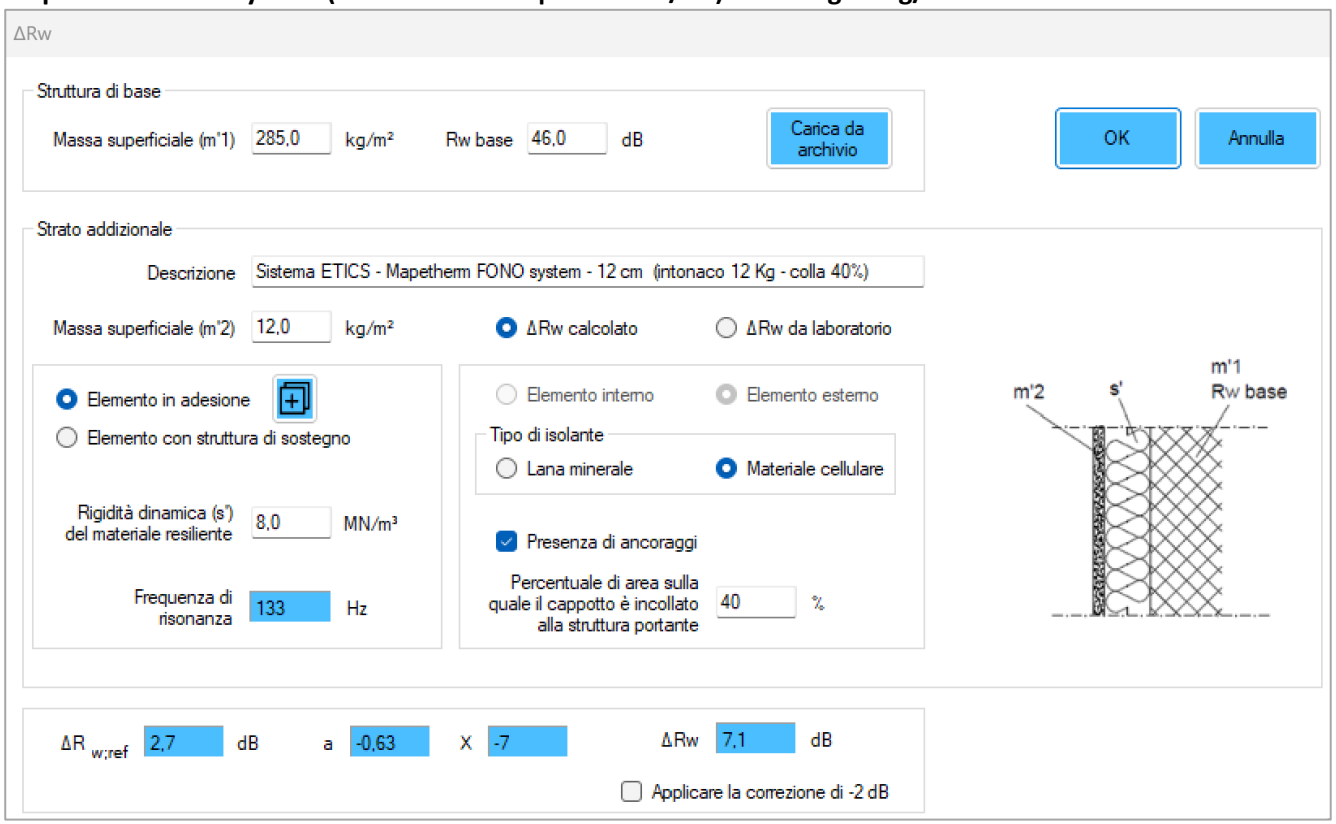
Mapetherm FONO system (thickness 8 cm | s' = 9 MN/m³) – coating 12 kg/m²: ΔRw = 6.3 dB



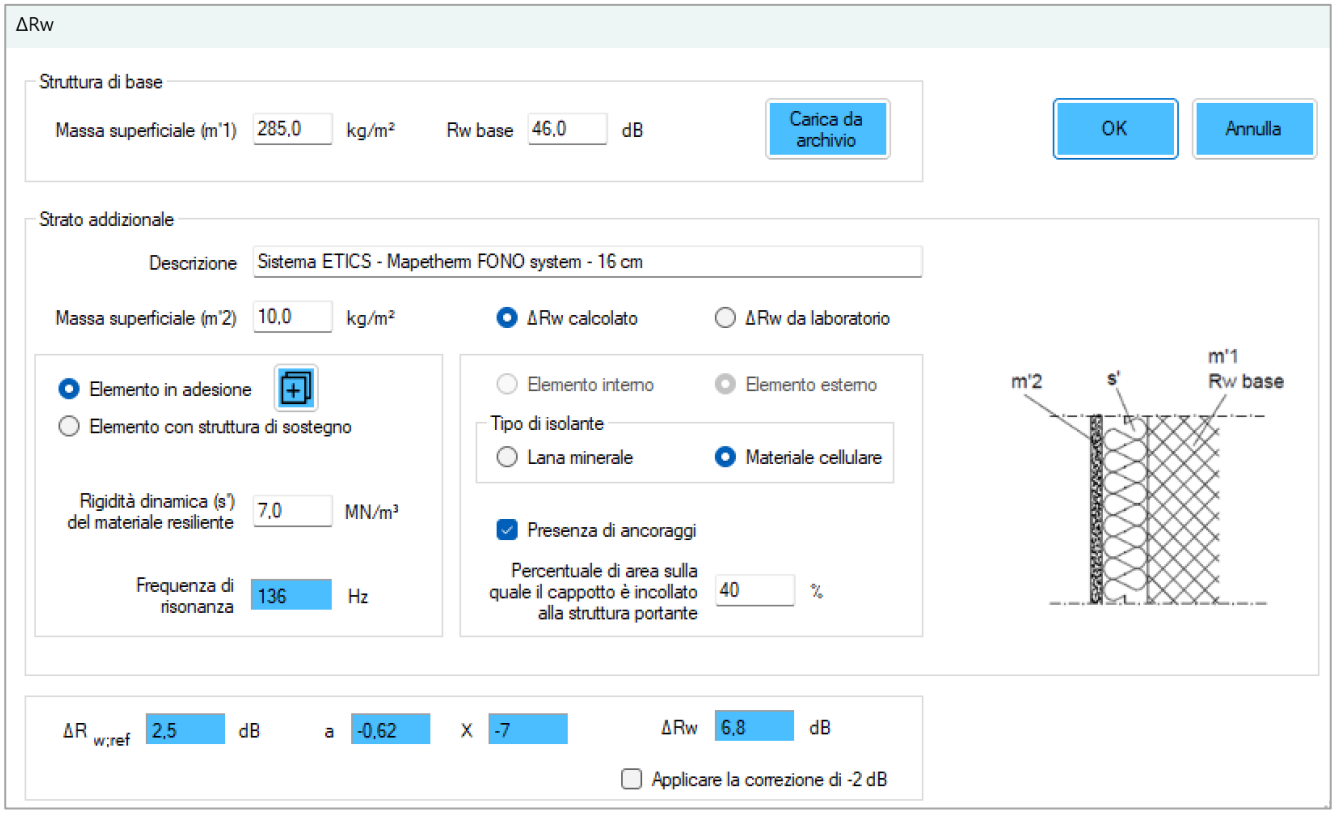
Mapetherm FONO system (thickness 12 cm | s' = 8 MN/m³) – coating 10 kg/m²: ΔRw = 5.9 dB



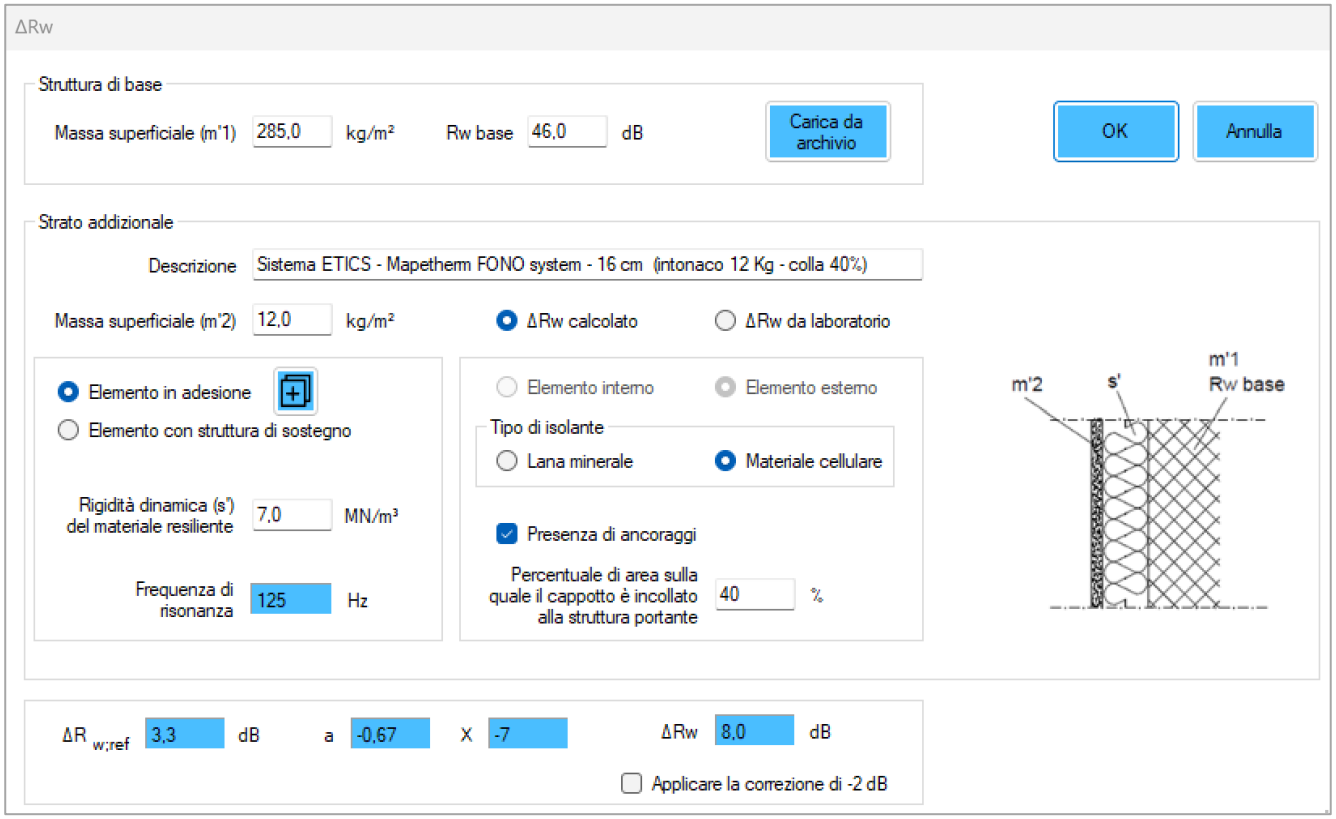
Mapetherm FONO system (thickness 12 cm | s' = 8 MN/m³) – coating 12 kg/m²: ΔRw = 7.1 dB



Mapetherm FONO system (thickness 16 cm | s' = 7 MN/m³) – coating 10 kg/m²: ΔRw = 6.8 dB



Mapetherm FONO system (thickness 16 cm | s' = 7 MN/m³) – coating 12 kg/m²: ΔRw = 8 dB

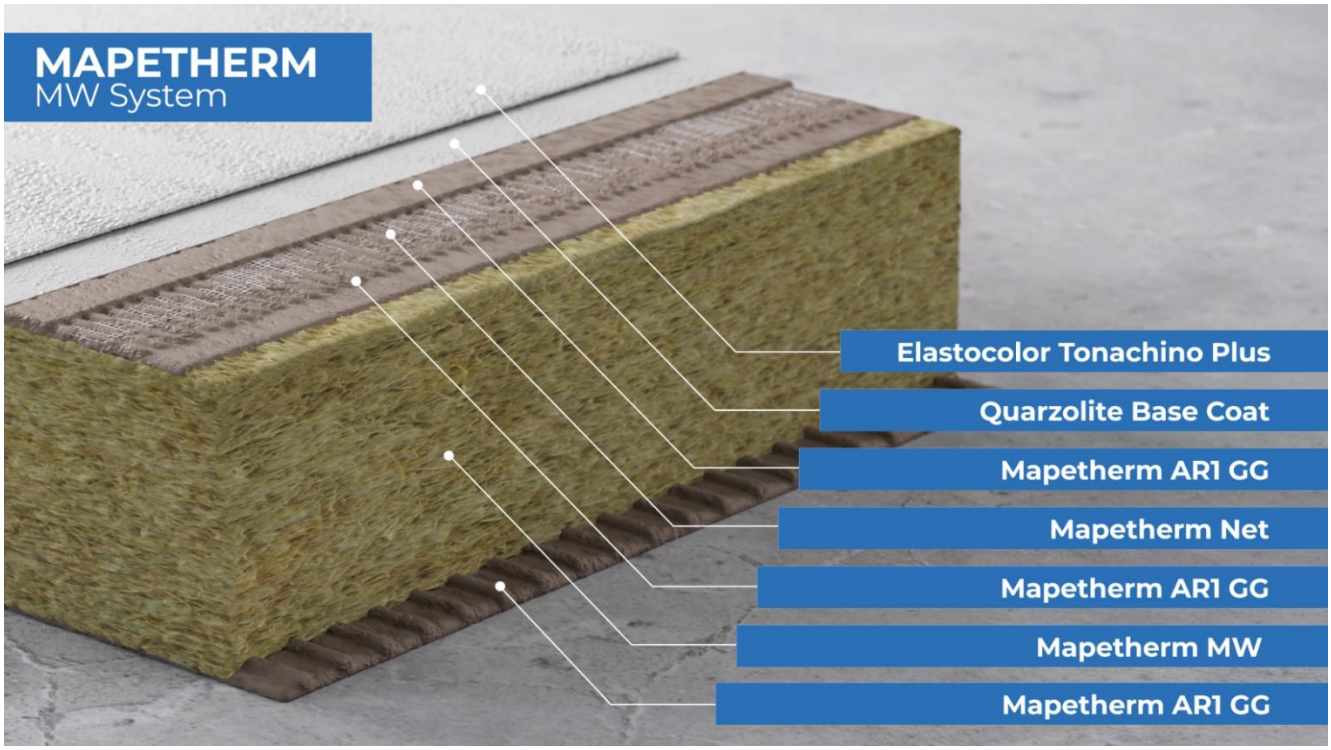


1.4.2 MAPETHERM MW SYSTEM

The system is constructed using Mapetherm MW mineral wool insulation, with a thermal conductivity of λ_D = 0.034 W/mK. To achieve the mass–spring–mass effect and the intended sound-insulation performance, a surface layer of at least 10 kg/m² must be applied. To meet this requirement while also achieving an attractive finish, apply an initial skim coat to level the surfaces, followed by the standard reinforced skim coat consisting of two coats of skim coat with reinforcing mesh in between.
The same acoustic performance can also be achieved with the high-impact-resistant systems Mapetherm MW System R (60J) and Mapetherm MW System HR (125J).

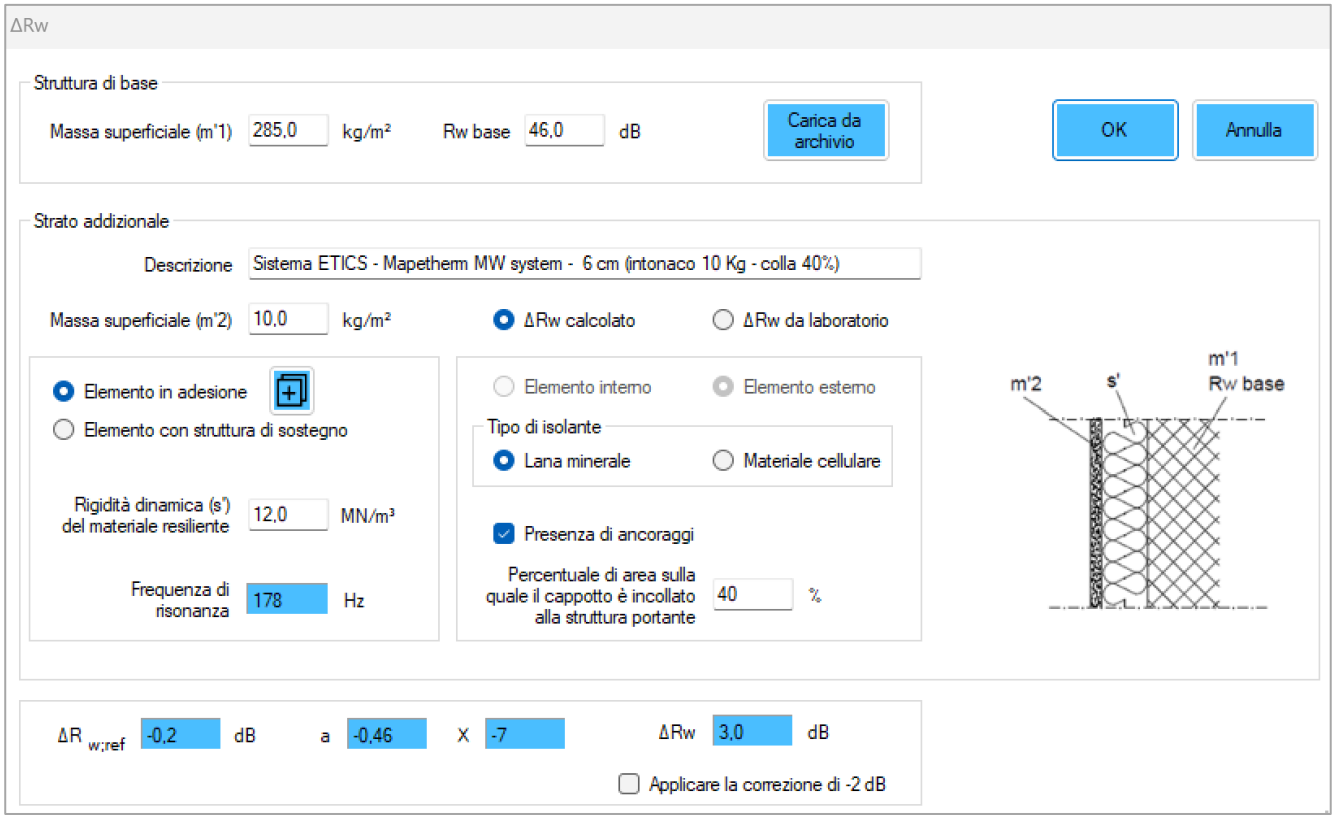
Download the bid specifications:

- Mapetherm MW System
- Mapetherm MW Flex System R
- Mapetherm MW Flex System HR

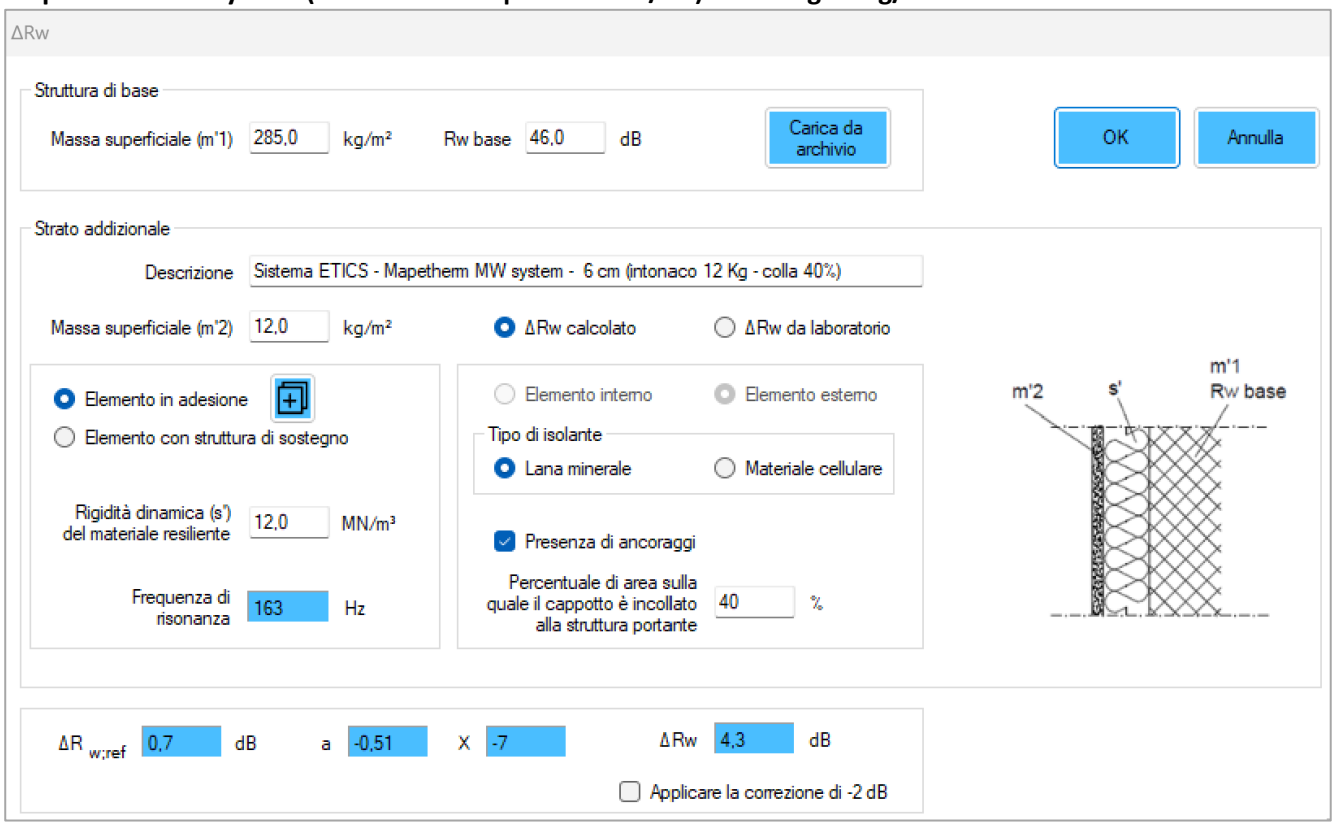


Mapetherm MW System (mineral wool)

Mapetherm MW system (thickness 6 cm | s' = 12 MN/m³) – coating 10 kg/m²: ΔRw = 3 dB



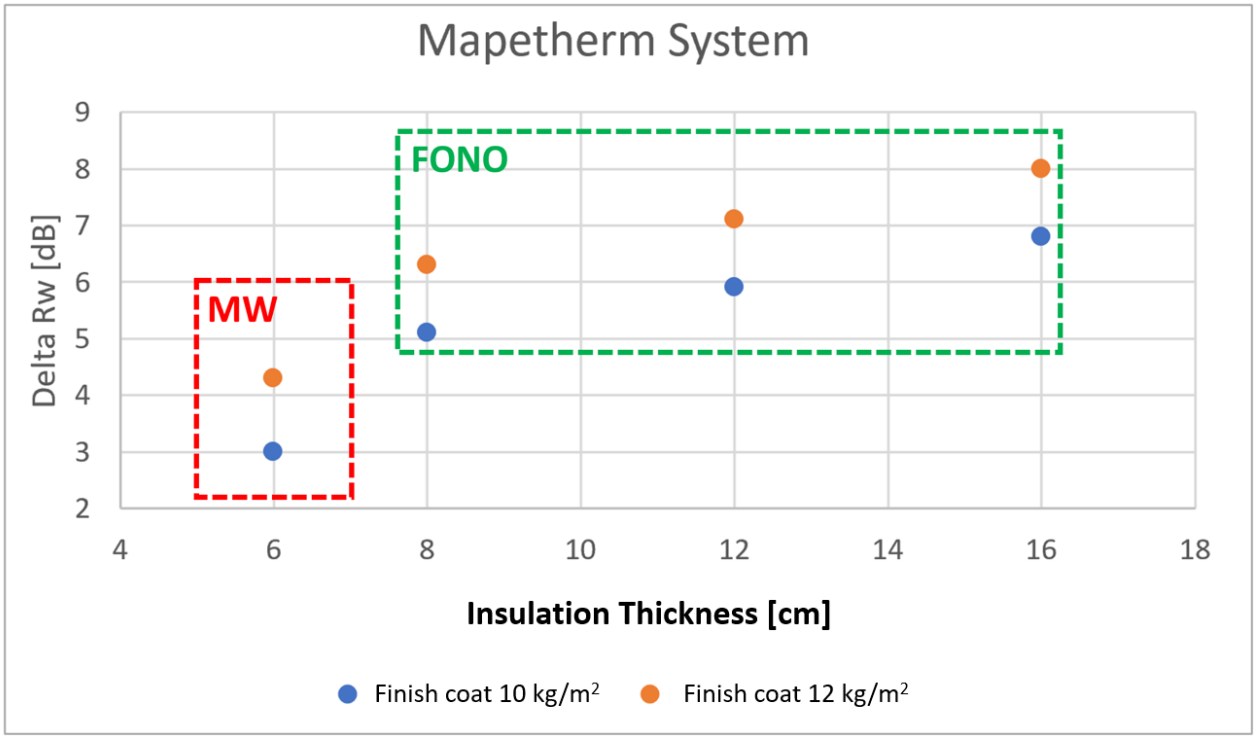
Mapetherm MW system (thickness 6 cm | s' = 12 MN/m³) – coating 12 kg/m²: ΔRw = 4.3 dB



1.5 Summary of Results

System	Insulation Thickness [cm]	Dynamic stiffness of insulating material - s' [MN/m³]	Surface mass of the exterior finish - m' [kg/m²]	ΔR_w [dB]
MAPETHERM FONO	8	9	10	5.1
MAPETHERM FONO	8	9	12	6.3
MAPETHERM FONO	12	8	10	5.9
MAPETHERM FONO	12	8	12	7.1
MAPETHERM FONO	16	7	10	6.8
MAPETHERM FONO	16	7	12	8
MAPETHERM MW	6	12	10	3
MAPETHERM MW	6	12	12	4.3

Table 1 – Summary of Results



As already mentioned in the introductory paragraph, it can be observed that the result improves when one or both of the following parameters are varied:

- an increase in the surface mass of the reinforced skim coat and finish layer
- an increase in the thickness of the insulating material and a consequent reduction in the dynamic stiffness value (s').

2 FACADE SOUND INSULATION - $D_{2m,nT,w}$

The sound insulation performance of a residential building's facade is defined by the parameter "*facade sound insulation index, normalized with respect to reverberation time*" ($D_{2m,nT,w}$).

In simple terms, this parameter indicates how much external noise the façade attenuates, expressed in decibels. The higher the $D_{2m,nT,w}$ value, the greater the sound insulation.

The sound reduction index depends on the sound insulation performance of all the elements that make up the facade (walls, windows and doors, roller shutter boxes, ventilation grilles, etc.) and their proper installation, as well as on the size of the living space and the presence of any external barriers (e.g., balcony railings, recesses, etc.).

2.1 On-site Measurements

This parameter can be measured on site by following the guidelines in UNI EN ISO 16283-3.

Without going into detail, the measurement involves placing a noise source outside the building and measuring the sound pressure levels both outside and inside the dwelling. The sound insulation performance depends on the difference between these two values and the reverberation time of the receiving space.

$$D_{2m,nT} = \left(L_{ext,2m} - L_{int}\right) + \left(10 \log \frac{T}{T_0}\right) \qquad [7]$$

Where:

- $L_{ext,2m}$ is the outdoor noise level, measured 2 meters from the facade
- L_{int} is the indoor noise level
- T is the reverberation time in the receiving space, in seconds
- T_0 is the reference reverberation time, equal to 0.5 s

The sound source must be positioned so as to minimize possible variations in sound pressure on the facade. The angle of incidence of the sound must be 45°, and the distance between the sound source and the center of the facade must be at least 7 meters.

The external noise level is measured at the midpoint of the facade's width and 2 meters from the facade's surface, or 1 meter from any balustrade or other protrusions.

2.2 Estimated Calculations

The sound reduction index of a facade can be calculated analytically using the mathematical equations provided in UNI EN ISO 12354-3 and UNI 11175-1.

$$D_{2m,nT,w} = R'_w + \Delta L_{fs} + \left(10 \log\left(\frac{0.16V}{T_0 S_{tot}}\right)\right) \qquad [8]$$

Where:

- R'_w is the apparent sound reduction index of the facade [dB]
- ΔL_{fs} is a correction factor that accounts for the presence of any shielding elements [dB]
- V is the volume of the room [m^3]
- T_o is the reference reverberation time (0.5 seconds)
- S_{tot} is the total surface area of the facade as viewed from the interior [m^2]

The apparent sound reduction index of the facade (R'_w) depends on the sound insulation performance of all its constituent elements (solid walls, windows and doors, "small elements," and filling materials in the joints between windows/doors and walls) and on noise transmission between the facade and adjacent elements. It is calculated using Equation [9].

$$R'_w = -10 \log\left(\sum_{i=1}^{m} \frac{S_i}{S_{tot}} 10^{-R_{wi}/10} + \frac{A_0}{S_{tot}} \sum_{j=1}^{n} 10^{-D_{n,e,w,j}/10} + \cdots + \frac{l_0}{S_{tot}} \sum_{k=1}^{o} l_{s,k} 10^{-R_{sw,k}/10}\right) - K \qquad [9]$$

Where:

- R_{wi} is the sound reduction index of the i-th element making up the facade [dB]
- S_i is the area of the i-th facade element as seen from inside the room [m^2]
- S_{tot} is the total surface area of the facade as seen from inside the room [m^2]
- A_0 is the reference equivalent sound absorption area, equal to 10 m^2
- $D_{n,e,w,j}$ is the normalized sound reduction index of the "j-th" small element [dB]
- $R_{sw,k}$ is the sound-insulating capacity of the "k-th" joint filler material [dB]
- $l_{s,k}$ is the length of the joint [m]
- l_0 is the reference length of 1 m
- K is the correction related to the lateral transmission contribution [dB]

The contribution of lateral transmission (K) is usually negligible (K = 0). However, if rigid and heavy facade elements (such as concrete or brick) are rigidly connected to other rigid elements within the receiving space, a coefficient of K = 2 may be considered for safety reasons.

The UNI EN ISO 12354-3 and UNI 11175-1 standards list possible values for the parameter Lfs, as referenced in [8]. The performance specified in the standards ranges from -1 to +7 dB and depends on the shape of the facade and other factors.

3 ACOUSTICS: LEGISLATIVE REQUIREMENTS

The regulatory limits for façade sound insulation are set out in the Prime Ministerial Decree of December 5, 1997, and, for public procurement, in the *Minimum Environmental Criteria* Decree (see references at the end of the Handbook n. 4, 5 and 6)

3.1 DPCM 5-12-1997 and CAM Decrees of 2022 and 2025

The **D.P.C.M. 5-12-1997** (Prime Ministerial Decree of December 5, 1997), "Determination of Passive Acoustic Requirements for Buildings," sets forth the legal requirements for: airborne sound insulation (speech, TV, etc.) between different residential units; insulation against noise from outside (facade sound insulation); impact sound insulation; insulation against noise from building services; and reverberation time in classrooms and gyms.
The table below lists the limits for insulation against external noise ($D_{2m,nT,w}$), differentiated according to the intended use of the living space.

Categories of Living Spaces	**$D_{2m,nT,w}$ [dB]**
Buildings used as hospitals, clinics, nursing homes, and similar facilities	≥ 45
Buildings used as residences, hotels, guesthouses, and similar establishments	≥ 40
Buildings used for educational purposes at all levels and similar facilities	≥ 48
Buildings used for offices, recreational or religious activities, commercial purposes, or similar uses	≥ 42

The $D_{2m,nT,w}$ limits are **minimum** permissible values; they apply to individual **living spaces** (not the entire facade of the building unit) and do not depend on noise from outside the building (any residential living space constructed after the Prime Ministerial Decree must have a facade insulation index of at least 40 dB).
Therefore, the roof slopes of **habitable attics** must also comply with the limits set forth in the Prime Ministerial Decree of December 5, 1997.

The "CAM Decrees" (Criteri Ambientali Minimi - Minimum Environmental Criteria) define the requirements for public buildings subject to competitive bidding. **Ministerial Decree of June 23, 2022** has been replaced by **Ministerial Decree of November 24, 2025**. Both documents specify the following requirements for facade.

The passive acoustic requirements for individual technical elements of the building must meet at least Class II of UNI 11367 (Acoustic Classification of Building Units).	$D_{2m,nT,w} \geq 40$
The individual technical elements of **hospitals and nursing homes** must meet the "superior performance" level specified in Appendix A of UNI 11367.	$D_{2m,nT,w} \geq 43$
Schools must meet at least the passive acoustic and indoor acoustic comfort requirements specified in UNI 11532-2.	$D_{2m,nT,w} \geq 43$

Designers must verify compliance with acoustic criteria both through a preliminary calculation report and through on-site testing upon completion of the work.
A comparison of the provisions of the two decrees (both in force at the time of writing) shows that compliance with the requirements of the DPCM 5-12-1997, also satisfies the requirements of the CAM Decree.

Facade sound insulation - $D_{2m,nT,w}$ [dB]	**DPCM 5-12-1997**	**CAM Decree**
Residences, hotels, guesthouses, and similar establishments	≥ 40	≥ 40
Offices, recreational or religious facilities, commercial establishments, or similar businesses	≥ 42	≥ 40
Hospitals, clinics, nursing homes, and similar facilities	≥ 45	≥ 43
Educational institutions at all levels and similar facilities	≥ 48	≥ 43

4 IMPACT RESISTANCE

4.1 Impact resistance in accordance with UNI EN 13497

Impact resistance is particularly important for external thermal insulation composite systems (ETICS). In fact, these systems, especially in their lower sections (near the ground), can be subject to various types of impacts; it is therefore essential that they offer adequate resistance to prevent deformation and, above all, cracking and detachment, which would cause functional damage to the systems.

To obtain an ETA (European Technical Assessment) and CE marking for exterior insulation systems, the relevant EAD (European Assessment Document) (0400083-01-0404) requires that the system's impact resistance be determined using the test described in the UNI EN 13497 standard.

This standard requires testing the system by dropping steel balls of various sizes and masses from predetermined heights to generate an impact with a defined impact energy. After the impact, any damage to the system is assessed.

Impact Energy (J)	Steel Ball Diameter (mm)	Steel Ball Weight (±1.5%) (kg)	Height Above the Surface (mm)
3	50	0.51	610
10	63.5	1.04	990
15	63.5	1.04	1480
20	63.5	1.04	1970
30	80	2.07	1480
40	80	2.07	1970
60	100	4.05	1520
80	100	4.05	2020
100	100	4.05	2520
125	125	7.91	1620
150	125	7.91	1940
175	125	7.91	2260
200	125	7.91	2580

Impact Energy Levels and Specific Heights Above the Test Specimen

This is a test method that determines the impact resistance of an exterior insulation and finish system (ETICS) in a very rigorous manner, primarily for two reasons:

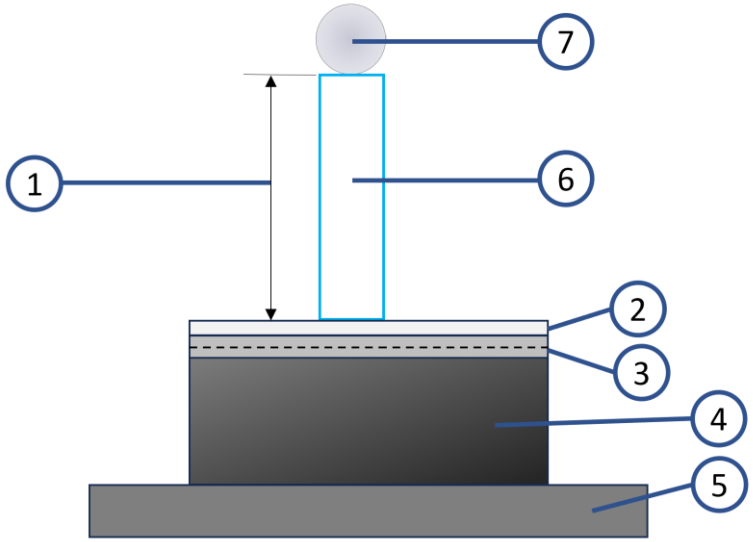
1. The steel ball used in the tests is standardized by the international specification ISO 3290-1; it therefore has very precise characteristics (mass and density) and tolerances and does not undergo physical changes as a function of operating temperature.
2. The impact occurs perpendicular to the surface and, therefore, transfers all of its energy to the exterior insulation system without any energy loss due to the angle of departure (for impacts other than perpendicular ones) and/or the fragmentation of the ball.

Based on these considerations, the impact resistance results obtained using the UNI EN 13497 method ensure ample safety margins compared to other methods.

4.1.1 Test Description

The test specimen must be large enough to allow for 5 impact tests, maintaining a distance of at least 10 cm between each impact point and from the edges of the specimen. Before the test, the specimen must be conditioned to specific temperature and humidity levels and subjected to heat/cold and heat/rain cycles. Alternatively, the specimen may be conditioned by immersing it in water and then drying it.

Five impacts are required for each impact energy level. The steel ball, which will strike the surface of the exterior insulation system perpendicularly, may be released from the specified height using appropriate equipment or dropped through a perforated tube (to prevent a “compressed air” effect) onto the surface of the test specimen.



1. Release height of the metal ball
2. Finish coat
3. Reinforced base plaster
4. Insulation material
5. Substrate
6. Vertical perforated pipe (if any)
7. Steel ball

After the impacts, the impact points must be inspected and described. Both the outer and inner faces of the reinforced base coat must be inspected (by removing the insulation).

Some types of damage—the most severe ones—do not require further assessment. These are:

- Delamination between the base plaster and the finish coat
- Delamination between the base plaster and the insulation material
- Delamination within the base plaster
- Visible reinforcement mesh
- Penetration of the finish coat and/or the base plaster
- Cracks on the impact surface with a thickness greater than 0.2 mm

If none of these damages are found in any of the 5 impact tests, the test is considered passed for that specific impact energy, and the evaluation proceeds to assess any smaller cracks, chipping of the aggregate, or depressions, including through observation under white light from various angles.

The results of these observations are recorded in the test report.

4.2 The Problem of Hail

In recent years, Italy, particularly in the north, has seen a sharp increase in extreme hailstorms, which were previously quite rare. These storms, characterized by hailstones several centimeters in size and particularly violent downpours, cause damage not only to people and crops but also to objects such as vehicles and buildings. The cladding system, which fully or partially covers building facades, is particularly vulnerable to this problem, which is why there has been a need to design and test these systems with this issue in mind.

4.2.1 The International Classification of Hail

Hail is classified internationally using the TORRO Hailstorm Intensity Scale, which is based on the diameter of the hailstones (Table A) or the extent of the damage they cause (Table B). Each class is associated with an intensity category, ranging from H0 (weak hail, causing no damage) to H10 (super hail or exceptional hail). This intensity (last column of Table A) varies depending on various factors: hailstone diameter, hardness, fall velocity, fall inclination, shape of the hailstone, and wind.
All these variables explain why, in the event of hail, damage cannot be uniquely identified based on the diameter of a single hailstone; instead, a range must always be considered, exactly as specified by the Torro scale.

Size code	Maximum diameter (mm)	Description
0	5-9	Pea
1	10-15	Mothball
2	16-20	Marble, grape
3	21-30	Walnut
4	31-40	Pigeon's egg > squash ball
5	41-50	Golf ball > Pullet's egg
6	51-60	Hen's egg
7	61-75	Tennis ball > cricket ball
8	76-90	Large orange > soft ball
9	91-100	Grapefruit
10	>100	Melon

Table A: TORRO Scale - Hail size and diameter

Scale	Intensity category	Size code range	Typical damage impact
H0	Hard hail	1	No damage
H1	Potentially damaging	1-3	Slight general damage to plants, crops
H2	Significant	1-4	Significant damage to fruit, crops, vegetation
H3	Severe	2-5	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	3-6	Widespread glass damage, vehicle bodywork damage
H5	Destructive	4-7	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	5-8	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	6-9	Severe roof damage, risk of serious injuries
H8	Destructive	7-10	(Severest recorded in the British Isles) Severe damage to aircraft bodywork

H9	Super Hailstorms	8-10	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	9-10	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

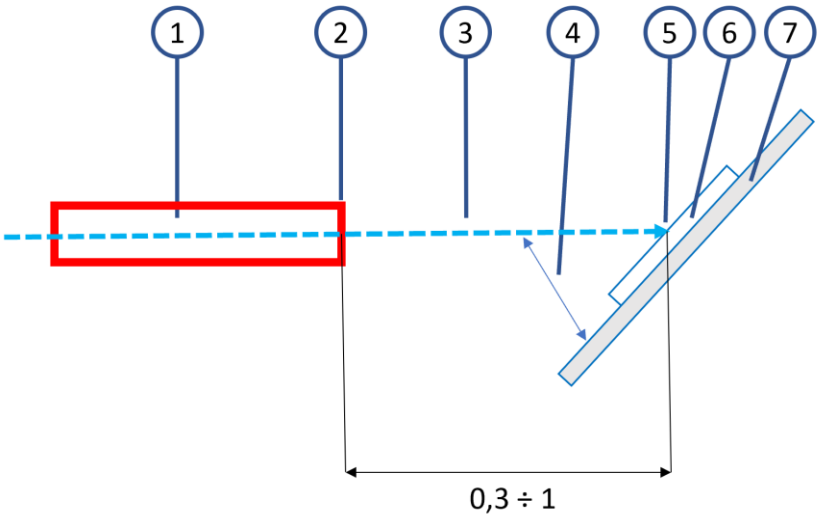
Table B: TORRO Scale - Hailstorm Intensity Scale (H0 to H10) in relation to typical damage and hail size codes.

4.2.2 UNI Standard on the Hail Resistance of ETICS

To evaluate the hail resistance of ETICS systems, a national UNI standard is currently being developed by the CTI (Italian Thermotechnical Committee). The draft standard is expected to follow the Swiss VKF 08 (ACFI 08) method in broad terms, which companies have been using voluntarily for many years to test systems for hail resistance, with some modifications decided at the national level.

The hail test prescribed by the VKF 08 (ACFI 08) methodology shares some similarities and some significant differences with the impact test according to the UNI EN 13497 standard described above.

The most significant difference is that the impact assessment is performed using spherical ice projectiles of various sizes (stored in a freezer at -20°C), fired at a 45° angle relative to the surface of the test specimen to better simulate real-world hail conditions. The projectile's velocity is measured using an electronic device.



1. Compressed-air cannon
2. Velocity measurement
3. Trajectory
4. Impact angle
5. Impact area
6. Sample
7. Support

The test specimen is conditioned prior to testing under specified temperature and humidity conditions for 28 days.
For each specified energy level, 5 impacts are performed at different points on the specimen.
The analysis of the test results is similar to that performed for the impact test per the UNI EN 13497 standard described above. Any cosmetic damage, which is examined specifically, is evaluated under direct light from different angles.
To determine the hail resistance of an exterior insulation and finish system, reference may also be made to the hard-body impact method specified in the UNI EN 13497 standard, which, in fact, has a more general and conservative application (based on the considerations expressed in paragraph 4.1).

4.2.3 Hail-Resistant ETICS Solutions

It is possible to create exterior insulation and finish systems (ETICS) that, by utilizing specific technologies, can withstand even extreme impacts.

The table below lists various systems whose effectiveness has been tested in accordance with the UNI EN 13497 standard "*Determination of the impact resistance of external thermal insulation composite systems (ETICS*)."

For comparison, a standard roof tile shatters when struck by a ball with an impact energy of 30 J (watch video).

Mapetherm System	Impact resistance [J]	Download the Impact Test Report	Specifications Download	Watch the impact test video
EPS	10	LINK	LINK	
FONO	10	LINK	LINK	
PIR	10	LINK	LINK	
XPS	10	LINK	LINK	
MW	15	LINK	LINK	LINK
XPS Flex R	15	LINK	LINK	LINK
PF Flex R	40	LINK	LINK	LINK
PIR Flex R	60	LINK	LINK	LINK
MW Flex R	60	LINK	LINK	LINK
EPS Flex R	80	LINK	LINK	LINK
FONO Flex R	80	LINK	LINK	LINK
XPS Flex HR	80	LINK	LINK	LINK
PF Flex HR	100	LINK	LINK	LINK
PIR Flex HR	125	LINK	LINK	LINK
MW Flex HR	125	LINK	LINK	LINK
EPS Flex HR	200	LINK	LINK	LINK
FONO Flex HR	200	LINK	LINK	LINK

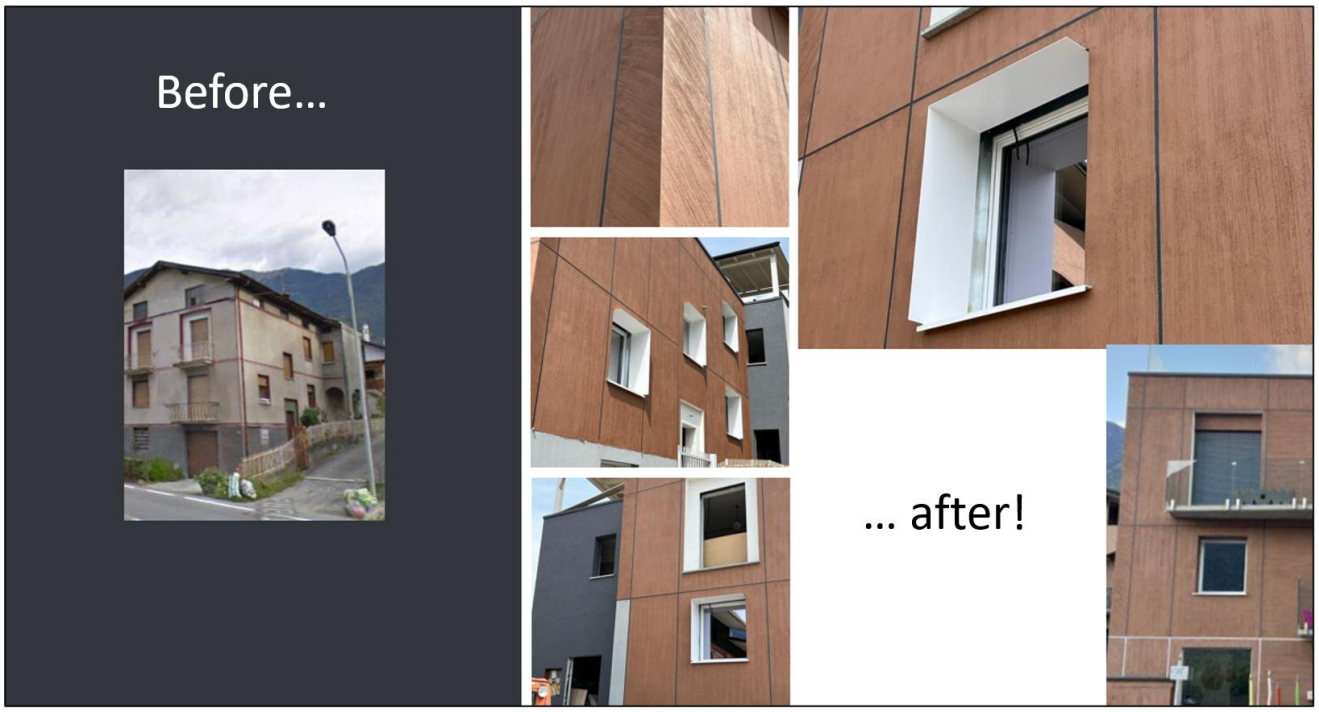
Systems certified according to UNI EN 13497 that fall within the top "Category I" as defined by that European standard.

All of these systems are available—with the same impact resistance performance—in a version featuring MapePUR Multi Adhesive Foam G polyurethane foam adhesive.

All of these systems can be integrated with structural reinforcement systems (view all Mapei solutions and design your project) and with high-quality decorative finish systems specifically designed for ETICS (view the effects and application videos, and download the system data sheets for Mapetherm Materia decorative finishes).



Exterior insulation finishes with exceptional aesthetic appeal



Nursery school in Berbenno di Valtellina (Sondrio, Italy)

These systems, which offer exceptional impact resistance, can also be effectively used to restore old, deteriorated insulation systems (see the ANIT handbook "ETICS RENOVATION AND MAINTENANCE") or to add a second layer to existing ones (see the ANIT manual "ETICS OVER ETICS").





It is worth noting that there are technologically advanced systems, such as the Mapetherm FONO Flex System R or HR and the Mapetherm MW Flex System R or HR, which make it possible to combine several performance characteristics in a single ETICS, capable of combining thermal insulation, sound insulation against external noise, and maximum impact resistance.

CONTACTS

- ANIT, Associazione Nazionale per l'Isolamento Termico e acustico
  https://www.anit.it
  info@anit.it

- Mapei
  www.mapei.it
  coating.hq@mapei.it

REFERENCES

[1] UNI EN ISO 12354-3: Valutazioni delle prestazioni acustiche di edifici a partire dalle prestazioni dei prodotti - Parte 3: Isolamento acustico dal rumore proveniente dall'esterno per via aerea (*Assessment of the Acoustic Performance of Buildings Based on Product Performance - Part 3: Sound Insulation Against Airborne Noise from Outside*)

[2] UNI 11175-1: Linee guida per la previsione delle prestazioni acustiche degli edifici - Applicazione delle norme tecniche alla tipologia costruttiva nazionale - Parte 1: metodo di calcolo semplificato basato su grandezze a numero unico (*Guidelines for Predicting the Acoustic Performance of Buildings - Application of Technical Standards to National Building Types - Part 1: Simplified Calculation Method Based on Single-Number Quantities*)

[3] D.P.C.M. 5-12-1997 "Determinazione dei requisiti acustici passivi degli edifici" (*Determination of Passive Acoustic Requirements for Buildings*)

[4] D.M. 23 giugno 2022 "Criteri ambientali minimi" (*Minimum Environmental Criteria*)

[5] D.M. 24 novembre 2025 "Criteri ambientali minimi" (*Minimum Environmental Criteria*)

ANIT

ASSOCIAZIONE NAZIONALE
PER L'ISOLAMENTO TERMICO E ACUSTICO

ANIT is the Italian National Association for Thermal and acoustic Insulation.
The Association aims to disseminate, promote and develop thermal and acoustic insulation in building construction and industry as a means of environmental protection and people's well-being.

ANIT:

- Spreads accurate information about the thermal and acoustic insulation of buildings,
- Promotes legislative and technical standards,
- Collects, verifies, and disseminates scientific information related to thermal and acoustic insulation,
- Promotes research and studies in technical, regulatory, economic, and market-related areas.

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www.anit.it **info@anit.it** **Tel. 0289415126**