REPORT 1.2.10

BEST PRACTICE REPORT ON METHODS, SKILLS AND COMPETENCES IN RELATION TO STONE PRODUCTS

CONSTRUCTION PROCESS OF RENOVATION OF FLOOR TILING

"The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein".

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

Content

1. INTRODUCTION

The BIMstone project was born from the fusion of three lines of action whose convergence is a consolidate a didactic material base for the training in the stone sector. These three lines of actions are:

- BIM (Building Information Modeling).
- LCA (Life Cycle Assessment).
- Digitisation of stone products placement methodologies.

The European Commission is focused on the construction sector on the criteria of smart growth (knowledge and innovation-based development and economy) and inclusive growth (ensuring social and territorial cohesion through employment).

According to the above context, the general aim of BIMstone project is to increase the skills of workers in the field of placing the stone products particularly in placing different type of floors and walls in buildings and urban environments, in order to increase the quality of the final work, the permanence of the work and the environmental sustainability, by using methods without non-recyclable and/or eco-friendly materials. For that reason, it is necessary to define and compile the most suitable execution systems and placement methods for stone products.

The first task of the BIMstone project "O1. *Establishment of common learning outcomes on stone placing methods, Life Cycle Analysis (LCA) and regulations*" encompasses a number of specific tasks among which we find the elaboration of this report.

This best practice report addresses the establishment of skills and competencies, as well as the definition of the most sustainable and environmentally friendly implementation processes.

Of all the natural stone construction elements selected in this project, this report focuses on the renovation of floor tiling, describing in detail some of their characteristics, both constructive and environmental, and the construction process to be followed to achieve an optimum result.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

2. ENVIRONMENTAL CONSIDERATIONS

The Environmental Product Declarations (EPDs) are the clearest, most rigorous and internationally accepted way to provide the environmental profile of a product throughout its life cycle.

The EPD "***Tiles and Slabs from natural stone***" include natural stone products which main function is for ornamental use to cover interior and exterior surfaces, such as floors, walls, facades, stairs, etc. and has been verified and published at https://ibu-epd.com.

The EPD of limestone slabs has been carried out according to the LCA methodology with quantified environmental information of its entire life cycle. That is to say, the EPD of these materials is of the "cradle to door" type, as can be seen in the following table, which includes the life cycle stages considered.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)																
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	MND	MND	X	MNR	MNR	MNR	MND	MND	MND	MND	MND	X	MND

Source: IBU - Institut Bauen und Umwelt e.V.

This EPD has been developed and verified according to the EN 15804 and EN ISO 14025 standards and the Product Category Rules (PCR) for marble and limestone slabs used in the building construction.

This EPD refers to 1 ton of tiles and slabs from natural stone.
Results refer to a weighted average of EUROROC member companies, therefore also averaging the three major stone groups. The average thickness of the product is 0.04 m.
It means 1 ton of product is equal to 9.11 m².

Natural stone units are produced from thin tiles with 10 mm thickness up to massive slabs with more than 100 mm thickness. Therefore this EPD is declared for average thickness of 0.04 m.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

Technical Data:

Name	Value	Unit
Compressive strength acc. to /EN 1926/	a) 100 - 300	N/mm²
	b) 20 - 240	N/mm²
	c) 100 - 280	N/mm²
Flexural strength acc. to /EN 12372/	a) 5 - 25	N/mm²
	b) 1 - 20	N/mm²
	c) 5 - 40	N/mm²
Water absorption acc. to EN 13755	a) 0.1 - 1	M.-%
	b) 0.1 - 10	M.-%
	c) 0.3 - 2	M.-%
Gross density acc. to EN 1936	a) 2.000 - 3.000	kg/m³
	b) 1.700 - 2.900	kg/m³
	c) 2.600 - 3.000	kg/m³
Thermal conductivity	1.2 – 3.4	W/(mK)
Wear resistance acc. to DIN EN 14157	14 - 35	mm
Specific heat capacity	0.92	kJ/kgK

Source: IBU - Institut Bauen und Umwelt e.V.

Declared unit:

Name	Value	Unit
Declared unit	1	t
Gross density	2744	kg/m³
Conversion factor to 1 kg	0.0003644	m³/kg

Source: IBU - Institut Bauen und Umwelt e.V.

Transport to the building site (A4):

Name	Value	Unit
Litres of fuel [truck]	0.00135	l/100km
Litres of fuel [train]	0,00474	L/100km
Transport distance	411	km
Capacity utilisation (including empty runs)	85	%
Gross density of products transported	2744	kg/m³

Source: IBU - Institut Bauen und Umwelt e.V.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

The results of the LCA – Environmental Impact are:

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 ton tiles and slabs from natural stone

Parameter	Unit	A1 - A3	A4
Global warming potential	[kg CO_2-Eq.]	2.55E+2	2.05E+1
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	5.81E-8	3.58E-10
Acidification potential of land and water	[kg SO_2-Eq.]	7.25E-1	1.3E-1
Eutrophication potential	[kg $(PO_4)^{3-}$- Eq.]	6.75E-2	3.12E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg Ethen Eq.]	4.17E-2	-4.69E-2
Abiotic depletion potential for non fossil resources	[kg Sb Eq.]	3.2E-5	7.64E-7
Abiotic depletion potential for fossil resources	[MJ]	3.39E+3	2.83E+2

RESULTS OF THE LCA - RESOURCE USE: 1 ton tiles and slabs from natural stone

Parameter	Unit	A1 - A3	A4
Renewable primary energy as energy carrier	[MJ]	5.52E+2	1.11E+1
Renewable primary energy resources as material utilization	[MJ]	0.0E+0	0.0E+0
Total use of renewable primary energy resources	[MJ]	5.52E+2	1.11E+1
Non renewable primary energy as energy carrier	[MJ]	3.88E+3	2.84E+2
Non renewable primary energy as material utilization	[MJ]	0.0E+0	0.0E+0
Total use of non renewable primary energy resources	[MJ]	3.88E+3	2.84E+2
Use of secondary material	[kg]	0.0E+0	0.0E+0
Use of renewable secondary fuels	[MJ]	0.0E+0	0.0E+0
Use of non renewable secondary fuels	[MJ]	0.0E+0	0.0E+0
Use of net fresh water	[m^3]	8.29E-1	1.23E-2

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 ton tiles and slabs from natural stone

Parameter	Unit	A1 - A3	A4
Hazardous waste disposed	[kg]	8.44E-2	0.0E+0
Non hazardous waste disposed	[kg]	5.23E+2	3.68E-2
Radioactive waste disposed	[kg]	1.96E-1	3.95E-4
Components for re-use	[kg]	0.0E+0	0.0E+0
Materials for recycling	[kg]	0.0E+0	0.0E+0
Materials for energy recovery	[kg]	0.0E+0	0.0E+0
Exported electrical energy	[MJ]	0.0E+0	0.0E+0
Exported thermal energy	[MJ]	0.0E+0	0.0E+0

Source: IBU - Institut Bauen und Umwelt e.V.

3. CONSTRUCTIVE CONSIDERATIONS

In Spain, the standard UNE-EN 12058:2015. Natural stone products. Tiles for flooring and stairs, defines the quality of stone tile cladding and aims to establish the general rules and associated processes for the design, selection of materials, preparation, installation, delivery and maintenance of use of the systems that must be considered to ensure their quality and durability as well as their technical and aesthetic performance.

In addition, the Basic Requirements for each requirement of the Technical Building Code (CTE) must be met.

In terms of design and execution of coverings with stone tiles, the provisions of the following sections of the Technical Code shall be complied with:

- Structural safety. DB SE.
- Safety in case of fire DB SI.

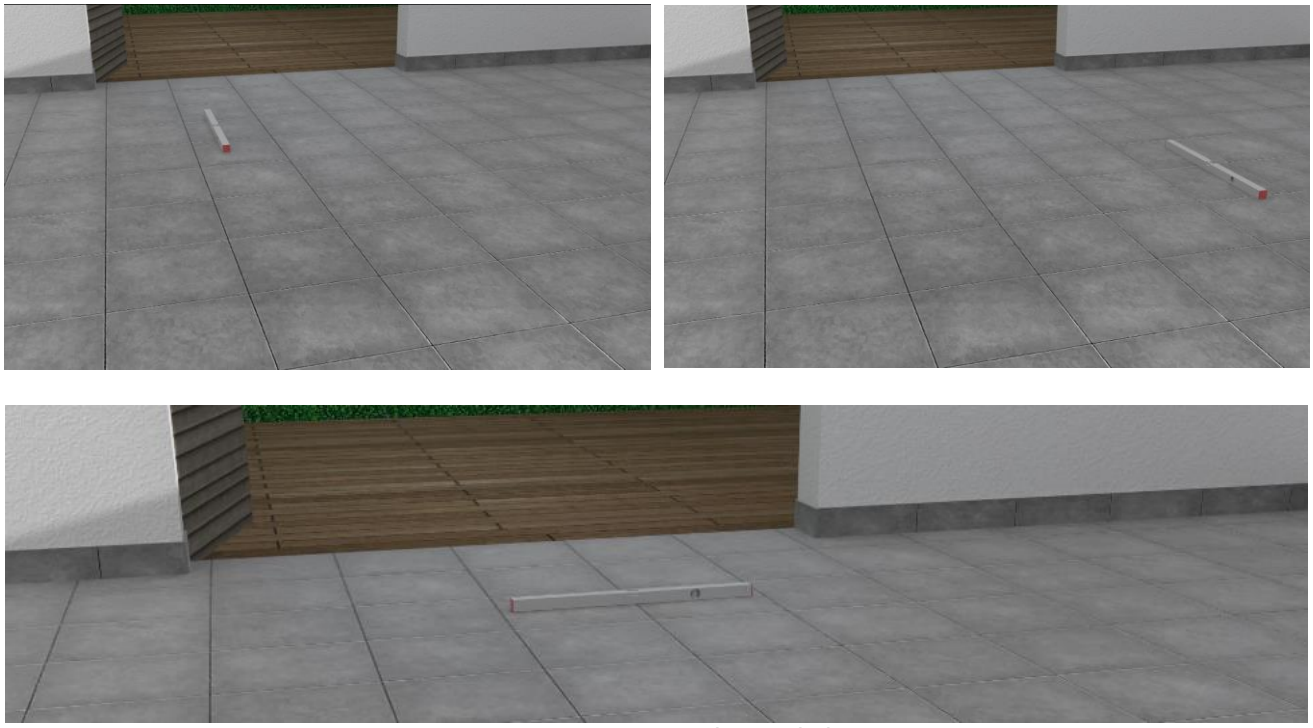
Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

- Health and Safety. DB HS.
- Noise protection. DB HR.
- Energy saving DB HE.

4. CONSTRUCTION PROCESS

4.1. Demolition of the skirting board

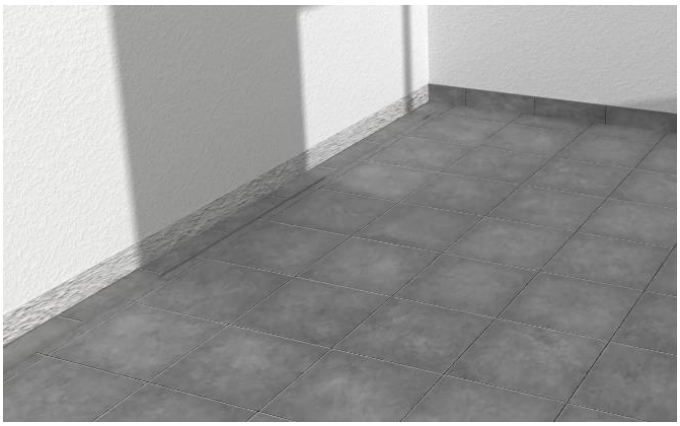
It must first be checked that the previous surface is in good condition, and, in this way, the new tiles will not suffer damages such as screams, lack of levelling, etc.



Source: BIMstone project website.

Since in the selected process a remodelling of the room has been considered and the material to be installed is totally different from the current one, as a previous step to the preparation of the support, all the skirting board and the remains of mortar that may remain after its demolition must be removed.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)



Source: BIMstone project website.

Subsequently, the surface must be cleaned, leaving it free of dust and loose debris.

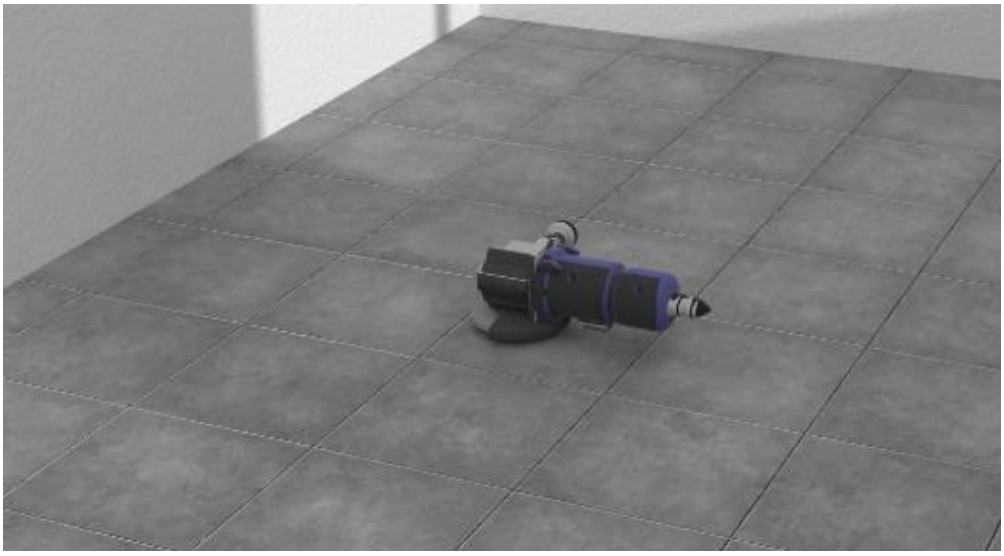
Source: BIMstone project website.

4.2. Preparation of the substrate

To ensure proper adhesion of new tiles, enamel or finish must be removed from the existing surface with the aid of an emery. This creates a rough surface with grooves so that the mortar can be absorbed and adhered better, thus facilitating optimum adhesion of the new tiles.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

Once the entire surface has been polished, it is swept and cleaned thoroughly to ensure that no loose material remains.



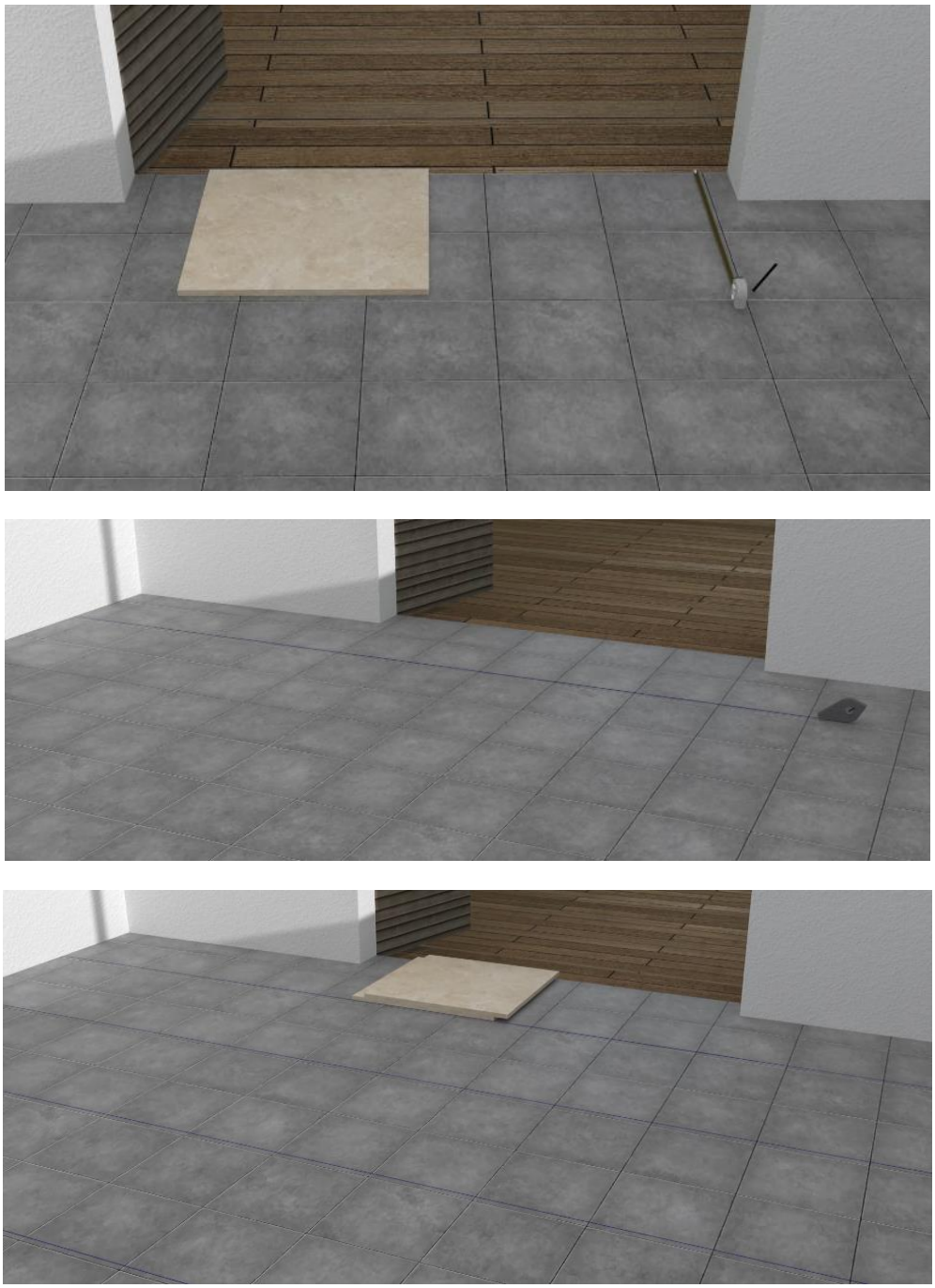
Source: BIMstone project website.

4.3. Measurement

With the surface ready, measures are taken to frame the room and establish a centre from which the tiles will be laid. Knowing the width of the slab, you mark on the floor what will be the boundaries of the tiles once laid, using a linear drawing.

Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)



Source: BIMstone project website.

Next, measurements are taken in the longitudinal direction of the tile and, in this way, the dimensions of the cuts to be made so that the surface is completely covered.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

Source: BIMstone project website.

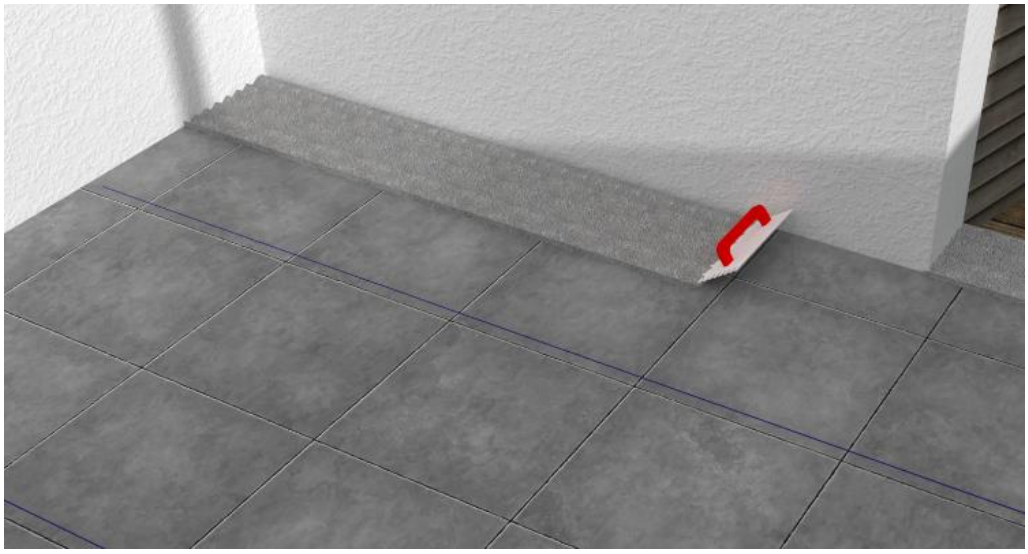
Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

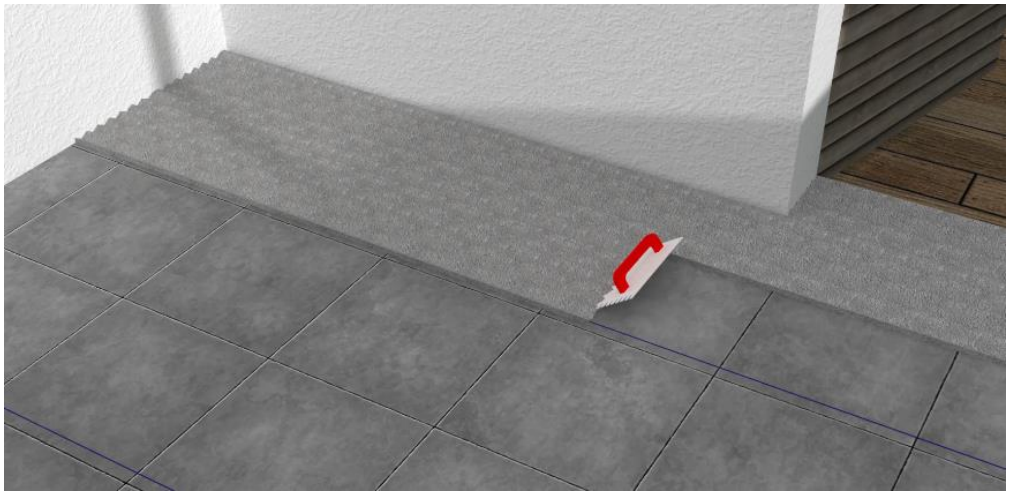
4.4. Adhesive application

For a correct placement of the stone material we must use white coloured adhesive cement, provided that a previous adhesion test has been carried out.

Once the necessary consistency of the mixture has been achieved, the mixture should be spread on the surface of the substrate. A regular layer of 2 to 3 mm should be applied with the help of a notched trowel number 3 in the longitudinal direction of the tiles to be laid.

In the case of large-format tiles, a thin layer of adhesive must be applied to both the substrate and the tile.





Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

4.5. Laying the tiles

The tiles are then carefully laid while the adhesive is still soft, by pressing them with your hands, as well as by tapping with a rubber mallet and checking that the back is completely covered by the adhesive. This ensures that no air bubbles form under the tile and prevents future tile breakage.
To maintain the uniformity of the joints over the entire surface, crossarms must be used.

Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

4.6. Grouting of tiles

After the time necessary for the glue cement recommended by the manufacturer to dry properly, clean the joints with a cutter and then grout the tiles. For the extension of this grout, a smooth rubber trowel should be used, and diagonal movements should be made to the joints of the tiles.

Source: BIMstone project website.

4.7. Cleaning the tiles

Next, remove the remaining surface paste with a glass cleaner and a wet sponge. To do this, press diagonally to lose the joint material.

Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

4.8. Placing the skirting board

Once the flooring area has been completed and finished, the skirting board is installed. For this purpose, adhesive mixture is applied to the slab to be laid and it is pressed for adhesion, placing brackets between the piece to be laid and the floor.

Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

Once all the pieces are in place and after the time estimated by the manufacturer, the brackets are removed, and the pieces are grouted in the same way as the flooring pieces.

Source: BIMstone project website.

4.9. Gluing the skirting board-to-floor joint

Once the skirting boards have been grouted, the joint between the skirting board and the floor is filled with an elastic sealant according to the manufacturer.

Source: BIMstone project website.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

The joints in the corners are then filled with elastic sealants.



Source: BIMstone project website.

5. SUMMARY. STEPS TO FOLLOW IN THE CONSTRUCTIVE PROCESS

The construction processes of renovation of floor tiling:

1. Demolition of the skirting board.
2. Preparation of the substrate.
3. Measurement.
4. Adhesive application.
5. Laying the tiles.
6. Grouting of tiles.
7. Cleaning the tiles.
8. Placing the skirting board.
9. Gluing the skirting board-to-floor joint.

Consortium members: Deutscher Naturwerkstein-Verband E.V (DNV), Asociatia Romania Green Building Council (RoGBC), Colegio Oficial de Arquitectos de la Región de Murcia (COAMU), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Klesarska Skola Pucisca (KLESARSKA)

6. REFERENCES

1. BIMstone project website. www.bimstoneproject.eu/bimstone-products

2. Tiles and Slabs from natural stone. EUROROC - European & International Federation of Natural Stone Industries. IBU – Institut Bauen und Umwelt e.V.

3. Video “10. Renovation floor tiling” of BIMstone project. https://www.youtube.com/watch?v=Ak_Z4aXLBCI