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BUILDING STONES

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Outline of Topic 2:

- ❖ **What is natural stone?**
- ❖ **Definition**
- ❖ **Features and Properties**
- ❖ ***Characteristics and Qualities of Good Building stones***
- ❖ **Classification**
- ❖ **Applications and uses of the natural stone**
- ❖ **Rip-rap**

We will explore all of the above in Topic.

Granite-quarry 1



WHAT IS NATURAL STONE?

- ❑ Throughout history, human beings have made use of natural stone for their social and cultural manifestations.
- ❑ The greatest legacy we have received from our ancestors derives from their use of stone.
- ❑ It is through the use of natural stone that we have found out most of what we know about their way of life.

DEFINITION

- ❑ The term natural stone includes all those stony products traditionally used by men in the construction industry, including those used in decoration and indoor flooring and walls. The applications of this material are manifold and, as is the case with other materials, new products and applications are continuously found.
- ❑ However, natural rock is more than just a mere construction element to be used for a given work. It is a product that is full of symbolism, has excellent durability and great plastic beauty. This has been proven by stonework carried out by human beings throughout History.



6) Building Stones

Rocks

- Rock is the term used to name a solid portion of the earth's crust .
- It has no definite shape and chemical composition .
- It is generally very big in size .
- The rocks have one or more than one materials .

Stones

- The stone is always obtained from rock. The rock quarried from quarries is called stone.
- Quarried stone may be in form of stone blocks, stone aggregate, stone slabs, stone lintels , Stone flags ,.....etc.
- These materials are known as engineering materials; *building materials or materials of Construction.*



Tests for stones:

- ❑ Building stones are required to be tested for their different properties before they may be recommended for any specific case.
 - Acid test.
 - Water absorption test.
 - Impact test.
 - Crushing test.
 - Hardness test.

FEATURES AND PROPERTIES

- ❑ The most relevant characteristics of natural rock are hardness, resistance to different stress types, composition, porosity, colour, and durability. The latter is perhaps the most important technological feature. There are numerous architectural remains where stone has been the only remaining material, which demonstrates its stability at real scale.
- ❑ The best uses of natural stone require good knowledge of its properties, which are determined through testing. The European standards of these products establish the specific parameters to be determined in the laboratory, namely,
 - Petrographic analysis to determine composition and structure.
 - Resistance to bending stress.
 - Resistance to compressive stress.
 - Resistance to impacts.
 - Slip resistance.
 - Resistance to thermal changes.
 - Frost resistance.
 - Resistance to SO₂ (sulphur dioxide) pollution.

For natural stone to be used correctly, these and other complementary characteristics should be determined in a laboratory

Characteristics and Qualities of Good Building stones

- ❖ The stone should be easily and economically obtainable in bulk.
- ❖ Ease of quarrying
- ❖ Durability and hardness: The stone should be hard, strong and durable.
- ❖ It should weather well.
- ❖ It should have fine compact texture.
- ❖ Color and aesthetic value
- ❖ It should be capable to withstand the effects of smoke and acidic atmosphere.
- ❖ The stone should be free from soft patches, flaws, cavities and cracks.
- ❖ Impurities and other undesirables
- ❖ It should be well seasoned and easily workable.
- ❖ These come from all geological environments.
- ❖ Building materials are by far the lowest cost geological materials and their value is usually in the order of only a few dollars per ton.
- ❖ The most important economic factor for building materials is that the material has to be close to where it is going to be used, as the highest cost is in its transportation.

CLASSIFICATION

- **Classification of rocks**
 - 1) Geological classification
 - 2) Physical classification
 - 3) Chemical classification
 - 4) Classification based on stone hardness:
Natural (Rock) stone
- **Stone classification:**
 - According to its contents
 - According to place which refer to
 - According to its texture
- **Natural stone properties (advantages)**
- **Natural stone properties (Disadvantages)**
- **Stoning**
- **Manufacturing**
- **Stone construction:**
- **Stone finishing**

CLASSIFICATION

□ Building Stones may be:

i) Crushed rock (or Aggregate Stone): Natural aggregate (**crushed stone, sand, and gravel**) is the most commonly used building material, along with concrete which is derived from crushed limestone. Bricks are made from fine aggregate along with clay which acts as the binding material, and iron oxide minerals for colouration.

- ✓ Aggregate is also used as a sub-surface lining on our roads.
- ✓ Plaster is derived from crushed and refined gypsum.
- ✓ Coarse and fine aggregates
- ✓ Fillers
- ✓ Proximity to market
- ✓ Optimum targets for exploitation.

ii) Dimension (or Ornamental) stones are much higher-value building material and are used as decorative facings on buildings.

Examples: Marble, Quartzite, Gneiss, Schist, Serpentinite, Slate, Migmatite.
By far the most commonly used dimension stones are marbles.

CLASSIFICATION

- Natural stone may be classified according to the genetic classification of crustal rocks:

- **Igneous Rocks**

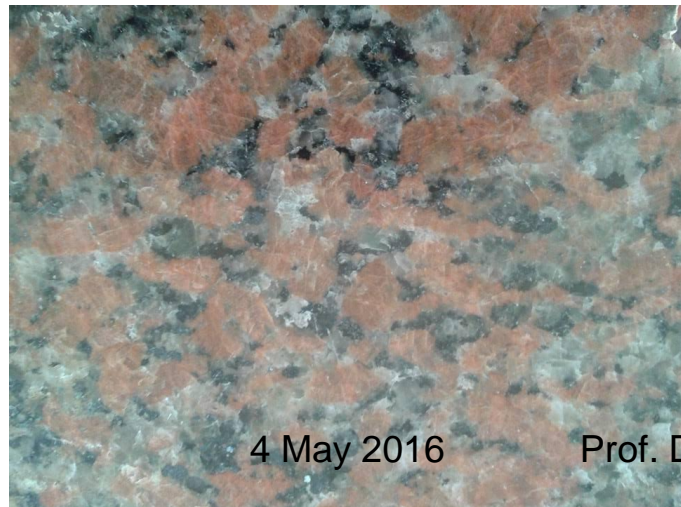
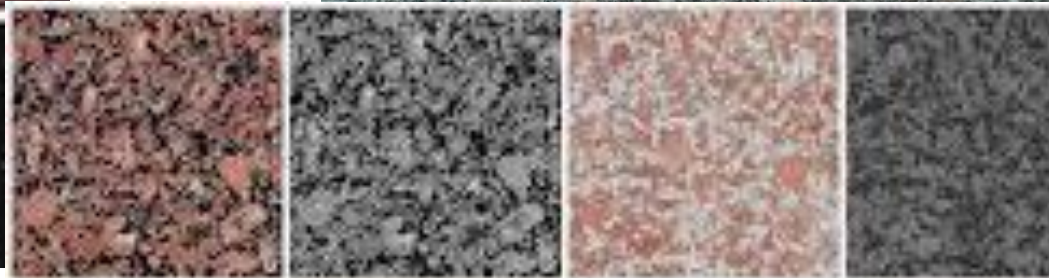
- a) Plutonic rocks***

- They are formed by slow cooling and consequent solidification of magmas inside the terrestrial crust. They are also called crystalline rocks because the slow solidification process allows complete mineral matter crystallization.
- Among plutonic rocks, the most commonly used ones are acid rocks, above all granite, which is the basic constituent of continental plates, and syenite, also called pink quartz due to its high alkali feldspars (orthose) content.

- b) Volcanic Rocks***

- The outcropping magma in volcanic complex has reached the surface and it undergoes rapid cooling, which hinders minerals crystallization.
- Basalt is probably the best-known rock among volcanic rocks. Its composition is the same as that of the Earth's crust, although it is rare in continental zones.

Granitods



4 May 2016

Prof. Dr. H.Z. Harraz Presentation
Building Stones

CLASSIFICATION

□ Sedimentary Rocks

- They originate as a result of the external geodynamic activity on the surface of the Earth's crust. On the surface, rocks become weathered, disintegrate or decompose.
- Later on, different types of rocks generate in different environments due to diverse crystallization, sedimentation and burial processes. These rocks can be further classified into two main groups depending on the genetic process involved in their genesis, namely,

a) Detrital Rocks, which are generated by accumulation of more or less cohesive fragments of other rocks. In turn, they may be classified according to the size of the fragments. *Sandstones are the most appreciated as natural stone due to their cohesion.*

b) Chemical rocks, which are formed by mineral precipitation. Carbonates are the most frequently occurring and also the most used subgroup, i.e. limestone, mainly composed by microscopic calcite crystals (calcium carbonate), although other minerals may also occur, but far less frequently: silica, clays, iron and manganese oxides, organic matter... and other carbonates. Iron oxides confer interesting yellow, orange, red and black coloration. Meanwhile, organic matter confers black or grey colours. Fossils are very common and can be clearly observed in polished sections.

- ❖ If dolomite (magnesium carbonate) content is high, the term dolomite rock is used. Depending on the content of either carbonate (calcium or magnesium carbonate), rocks will receive different names, such as dolomite rock, limestone or calcareous dolomite rock.
- ❖ In industry, both sedimentary rocks, i.e. **Limestone and Dolomite rock**, may be called "**MARBLES**" due to their appearance once polished, although, as discussed below, marble is not a sedimentary but a metamorphic rock. The presence of fossils in rocks determines their sedimentary origin.
- ❖ **Tufas are limestones** in whose genesis the photosynthetic activity of microorganisms and vegetables is involved. Carbonate material accumulates around them, thus preserving a high porosity which leads to a decrease in weight. Tufas have been widely used in popular architecture (for arches and vaults) as they can be easily worked, maintaining good consistency and compactness.
- ❖ **Evaporites** are also a type of chemical rock, so called because they form in water masses that are subjected to intense or complete evaporation. Only rarely have these rocks had any interest as natural stone, but there exists an evaporite rock in the Northern coast of Egypt that, due to its post-sedimentary evolution, displays characteristics that have turned it into a valued material. This rock is alabaster, to which a chapter will be dedicated. At a global scale, the most important extracting sites for this rock are located in Upper Egypt.

CLASSIFICATION

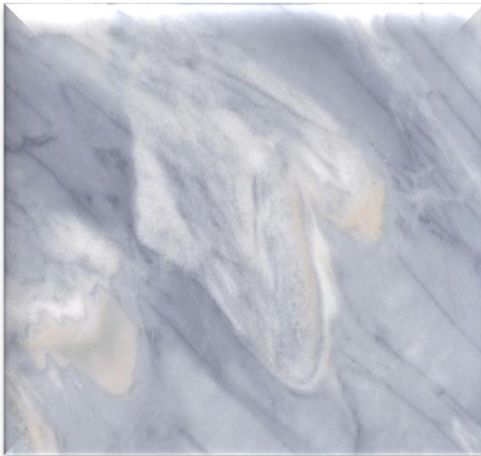
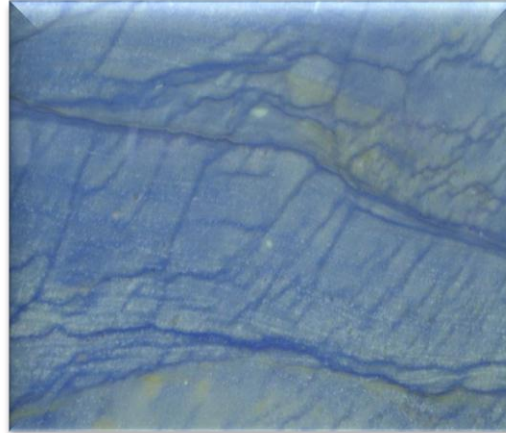
❑ Metamorphic Rocks

- All types of rocks may be subjected to intense pressure and/or high temperatures, as a result of the activity of the Earth's crust. This gives rise to major transformations in texture, structure and atomic organization in minerals. Rocks that have undergone such transformations are called metamorphic rocks.
- This group includes a variety of lithologies, among which marble, quartzite, slate or serpentine stand out.
- ❖ **Slate** is used mainly for roofing, as an alternative to tiles, due to the development of schistosity planes that have resulted from pressure metamorphism. Slabs can thus be obtained, their usual thickness being 2-8mm.
- ❖ **Quartzites** are mainly composed of quartz, which is a stable mineral in surface conditions. From the point of view of alterability, this confers the rock interesting characteristics. Its use as natural stone is scarce given its high hardness.
- ❖ **Serpentinite** is another metamorphic rock with great ornamental interest. Its colour is green and may display various tonalities, from light to dark. It is formed by regional metamorphism of ultramafic magmatic rocks (peridotites). It is frequently used in emblematic spaces such as palaces and magnificent hotels, both in floor coverings and wall linings or skirting boards. It has also been called "**Green Marble**".

Marble Slabs and Tiles for Flooring

- ❖ **Marble** is the metamorphic rock that is most important in mining. It is a carbonate rock that has undergone metamorphism due to the proximity of hot magma, thus presenting different mineralogical composition and texture with respect to the original rock. It is, together with alabaster, the most representative natural stone because it was used by the greatest masters of the Renaissance as a raw material for their sculptures.
- ❖ Marble is the metamorphic rock which contains calcite and / or dolomite.
- ❖ Marble is used to build sculptures, Art crafts, and Interiors of Houses.
- ❖ Marble tiles produced from the excavated marble rocks.
- ❖ Italy is the No.1 Marble Supplier.

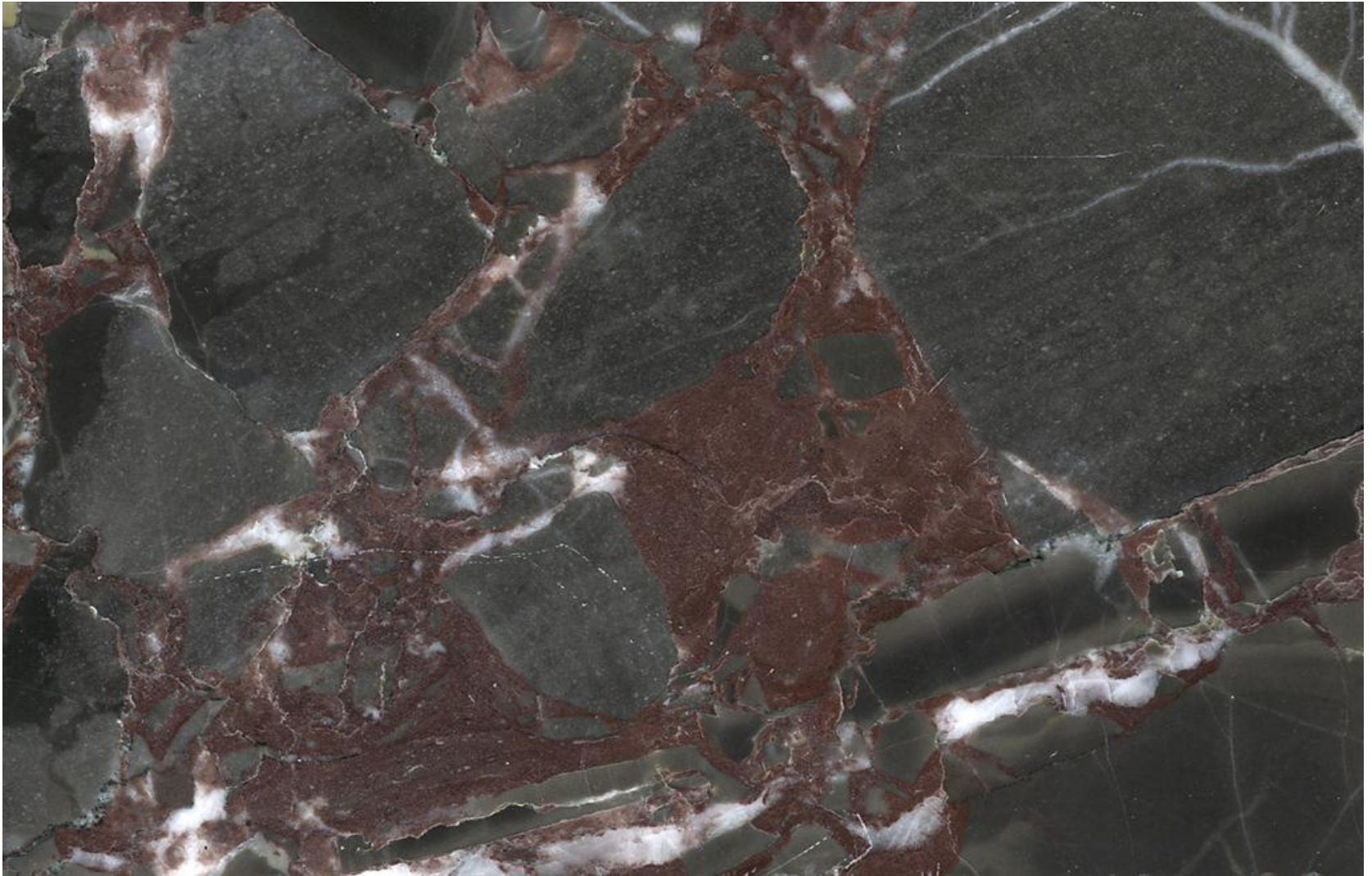
Marble Slabs and Flooring from Italy



Rain Forest Gold



Breccia Antica





1) THE OPERATION OF NATURAL STONE

- a) Research
- b) Rock blasting

2) TRANSFORMATION AND RECYCLING PROCESSES

- a) Cutting
- b) Surface finish
- c) Treatments for improvement
- d) Recycling



Marble Slabs



Blue on Dulato



Palissandro Bluette



Tobacco Wood



Traditional quarrying methods



In slate, marble and granite quarries, the extracted blocks are rather large and heavy. After the cutting process, smaller pieces can be obtained, which are treated and sold for different uses



Slabs are obtained by cutting up the blocks from the quarry with different thicknesses. For its part, the final product is obtained by cutting up the slabs with different measures, according to demand

APPLICATIONS AND USES OF THE NATURAL STONE

- ❑ There are many applications of natural stone in the world of construction, covering a wide range of commercial products, which include:
 - For masonry work
 - for lintels and vertical columns
 - for covering floors of building
 - for paving of roads and foot paths
 - As a covering material for buildings.
 - Façades veenering,
 - Roofing
 - Individual cut stones
 - for the construction of roads in form of boulders and aggregate
 - as an aggregate in cement as well as lime concretes
 - Base material for water and sewage filters.
 - For the manufacture of cement and lime.
 - In the construction of masonry dams , stones of good quality and durability are of vital importance.
- ❑ The design possibilities of ornamental stones are almost endless, especially if we take into account the sheer variety of rocks existing in nature, the combinations that can be obtained with the size and shape of the rock pieces, their colour and appearance as well as the different surface finishes that can be achieved.

PRODUCTS AND MATERIALS



1) Paving

The use of natural stone for the construction of pavements represents the single most important application of this material.

The paving of roads resulted from the need to adapt existing communication routes to new transport systems, which led to the construction of the first cobbled road surfaces in the Roman era. Cobbled roads still maintain their validity today from a conceptual perspective.

This kind of application underwent a period of crisis at the start of the second half of the 20th century, which led to the destruction of many cobbled roads in different cities, maybe due to budgeting restrictions or to a lack of expertise regarding adequate laying techniques.

Fortunately, stone paving is currently being recuperated, so much so that, these days, the restoration of the old part of a town cannot be envisaged without the use of stone.

However, apart from cobbled streets, other types of outdoor pavement and indoor flooring are also made of stone. In this case it is larger pieces of stone, or tiles, which are used.

Paving tiles are one of the most frequent applications of stone in urban areas



In construction we can also find examples of flooring such as this marble staircase



2) Veneering for cladding and façades

These construction work units have replaced traditional masonry as the visible external elements in buildings.

From the technological point of view, façade veneering, unlike traditional masonry, does not have a structural function but it can act as an insulating material.

Although veneering can be fixed to the building with chemical adhesives or cement mortars, nowadays, the laying is more and more frequently carried out by means of anchorages, thereby creating what is known as ventilated façades.

This construction system, which is considered by many as one of the greatest architectural achievements of the 20th century, requires metallic anchorages made of stainless steel acting as connecting elements between the stone and the wall. An air gap between them can thus be created, which facilitates ventilation, thereby significantly increasing the design life of the rock. It is commonly said that natural stone, like man, needs to breathe, which is why this kind of solution is perfect.

Although the main technological function of claddings for façade claddings is for insulation, day by day innovations in this field appear, creating shapes from different claddings as those of the image at the top, in granite and glass, or on the left, a skyscraper with limestone cladding



3) Masonry

Masonry is the most traditional use of stone in architecture. From the regulatory standpoint, masonry can be defined as those stone pieces with a structural function and thicknesses greater than 80mm. If the pieces are irregularly shaped, they are generally called rough ashlar, and if they are square blocks, ashlars.

The joining of the pieces is carried out with lime mortars or mixed lime and cement mortars in the load-bearing walls, arches, retaining walls, and so on, which constitute the different structural elements of this type of architecture.

The use of stone masonry has been largely replaced by other materials such as bricks or concrete. However, there are still exceptional examples thanks to which stone masonry has taken a new impulse as a symbol of wealth, durability and comfort, especially as compared to other materials.

A clear example of this is rural Galicia in NW Spain, where the use of stone masonry for a family home is almost a cultural imperative.



Masonry is the use of stone from a structural point of view. There are many historic town or city centers in country fully built or restored with masonry

4) Slate roofs

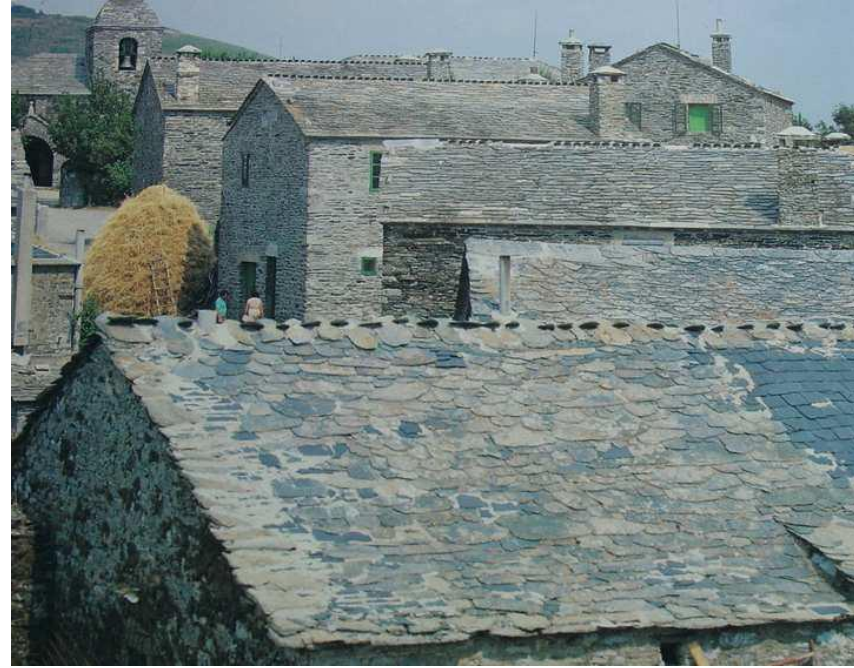
Slate roofs constitute an additional, very important application of natural stone.

As will be seen below, Spain is the world's largest producer of roofing slate, although only about 15% of the total production is consumed domestically. The remaining 85% is exported, mainly to other European countries.

The laying method for these stone units is quite complex, although very effective, and requires highly skilled labour.

Slate pieces overlap each other forming a scaly surface of tiles which are attached either by nailing them directly onto wooden battens, or by hooks that hold the tiles and are also nailed to the battens.

The shape of the tiles can vary greatly, but the rectangular ones predominate.



Spain is the largest producer of roofing slate

NEW APPLICATIONS

Natural stones, like any other construction material, are not unaffected by the development of new products, which mainly result from technological advances both in cutting processes and adhesives.

In this regard, it is worth mentioning the tiles or panels involving a stone slice of about 4-5mm in thickness to which a cheaper material has been adhered with suitable adhesives, thereby providing the material with enough rigidity. The materials used on the stone may be ceramic or made of fiber cement, or they may be lightweight honeycombed aluminium structures or a nylon mesh with a thick enough layer of resin.

The main advantage that these products share is that they all entail a more efficient use of mineral resources since they require a smaller volume of stony material per square meter of covered area. Some products, especially with honeycombed structures, allow us to manufacture large but very light panels, which significantly improves laying time, even though the final cost may still not be the lowest.

Other rather novel products which are increasingly entering the market are aged stone units. These are pieces that have been subjected to physical erosion treatments with abrasives, such as steel shot projection, or chemical erosion, which provides them with a rough, altered look similar to that of those materials that have been degraded by use and or by the passing of time.

Marble Flooring



Ornamental rocks (Marble Limestones and dolomites)

- Due to their durability and the fact that they can be easily polished, cut and carved, these rocks have a wide range of applications in the construction and interior finishing sectors.
- Limestones are mostly composed of microscopic calcite (calcium carbonate) crystals, although other minerals are also present to a lesser extent, i.e. silica, clays, iron and manganese oxides, organic matter and other carbonates. Iron oxides provide interesting yellow, orange, red and black colorations; organic matter, for its part, produces black or grey colours. Fossils are very common and can be easily observed in polished sections.
- Calcium carbonate is called calcite and forms limestones, whereas calcium and magnesium carbonate is called dolomite and forms dolomite rocks. Considering the proportion in which either one is present, rocks will receive different names, such as dolomitic limestones or calcareous dolomites. Tests carried out in order to determine their quality will also establish their resistance to compressive stress, expansion capacity, hardness, resistance to friction, elasticity, etc.

لماذا يستعمل الجرانيت لكونترتوب المطبخ؟

□ غالباً ما يتعرض كونترتوب المطبخ للمواد الحمضية مثل الليمون والخل والكحول وصلصة الطماطم ويحتك به السكاكين والأطباق والأواني والأدوات الأخرى.

الرخام (Marble)	الحجر الجيري الصلب (Limestones)	الجرانيت (Granite)
فهو مسامى فيسهل أن يتسخ ويحتفظ بالبقع كما أنه يتفاعل مع الأحماض		هو الأصلد والأكثر كثافة من كل الأحجار الطبيعية المستخدمة في تلك الصناعة فهو يقاوم الماء ولا يتشربها ولا تتفاعل مع الأحماض وهذه الخصائص تساعد الجرانيت على <u>مقاومة الإلتساخ أو البقع والاحتفاظ بالبريق لسنوات عديدة</u> لا تقارن بالسيراميك أو الأحجار الأخرى
صلادة الرخام (Marble) = 3	صلادة الحجر الجيري الصلب = 2.5	صلادة الجرانيت (Granite) = 6 - 7
ينصح باستخدامها في الكونترتوب في الحمامات والأرضيات أيضاً	لأنهم لا يتعرضون للأحماض ولا لإحتكاك بأدوات خادشة مثل أدوات المطبخ.	ينصح باستخدام للكونترتوب في المطبخ ولا أرضيات المطبخ
	لا ينصح باستخدام هذه الحجارة للكونترتوب في المطبخ ولا أرضيات المطبخ	



Rip-rap

There are many techniques used for reducing the power of waves before they erode a coastline.

- Rip-rap is a sheet of boulders used at the toe of a slope to add weight and break the force of the waves.
- Rip-rap is made of highly resistant rocks to physical and chemical weathering, often Basalt, Gabbro, Dolerite, Quartzite, Granite, or Gneiss, which will not weather or break down.
- Because the blocks are angular, they fit together tightly, but still allow water to drain through back to the sea.

The part of the coast was in the process of being reinforced with a wall of rip-rap. Beyond the wall was a grassy area with geotextiles and plants to reduce further the force of the waves.

Area of soft rocks which needed to be reinforced.

RIP-RAP

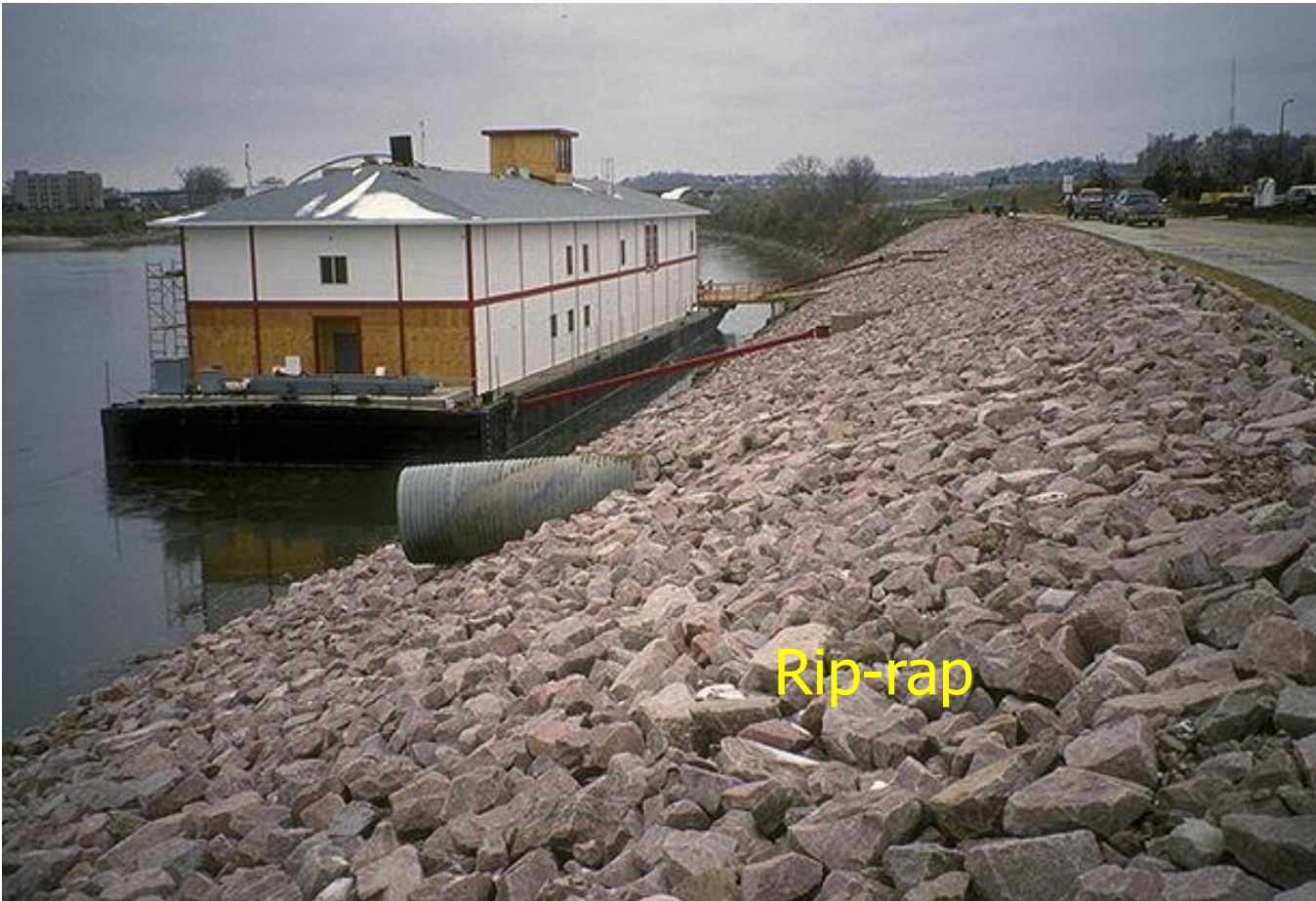


Slope angle has been reduced

Till cliffs

Rip-rap

Geotextiles help to support the glacial till slope so that vegetation can establish itself.



Quartzite is highly resistant to physical and chemical weathering, so it does well in applications like this rip-rap