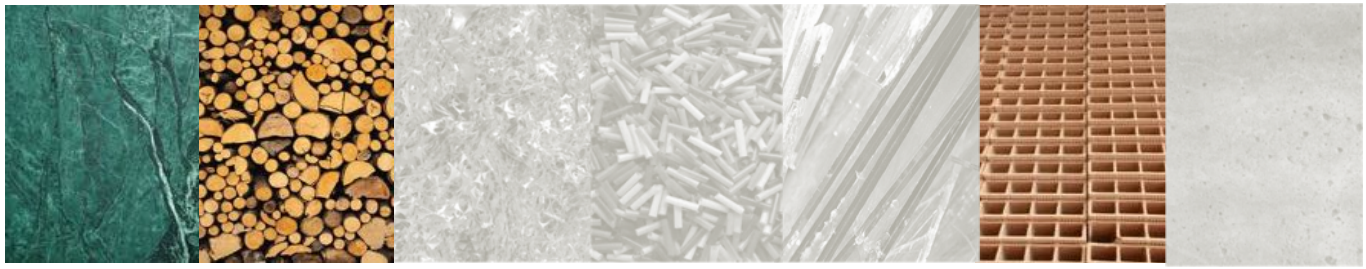
Materials for Architecture and Technological Innovation (6 CFU)

Materials Technologies for the Environment (6 CFU)

Prof. Alberto De Capua

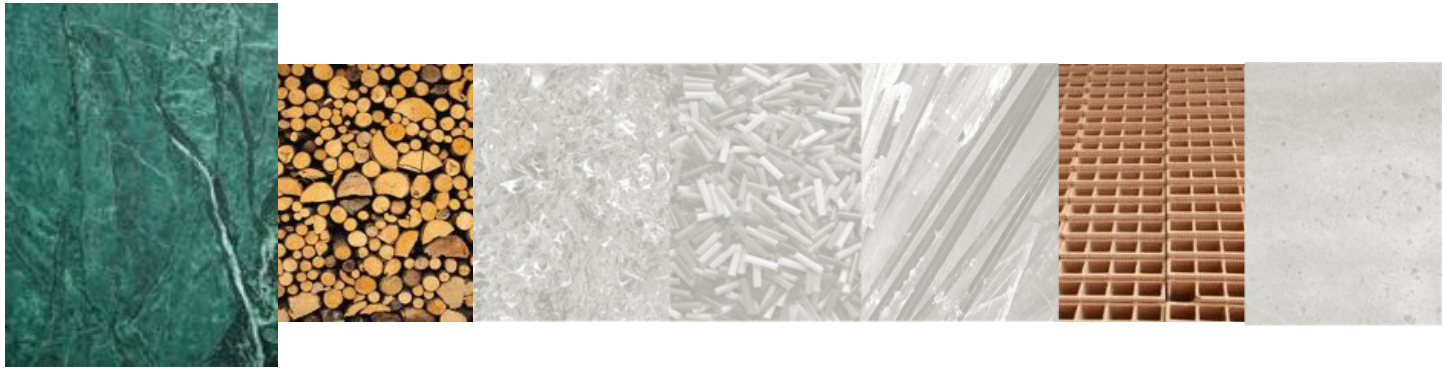
MpA Architecture Materials

- STONE
- WOOD
- BRICK



Lecture by Valentina Palco

- **STONE**
- wood
- brick



STONE - classification

The **UNI 8458** norm classify the stone products used within the building process by elements with predetermined dimensions. The rocks, both ornamental and structural, are join in four commercial categories, in relation to their origin, composition, hardness (of the material that constitute them) and polishing characteristics.

1. MARBLE
2. GRANITE
3. TRAVERTINE
4. STONE

An other classification can be made accordin to the **petrography,** which articulate the stone products in relation to their geological genesis, divided them in:

1. MAGMATIC ROCKS, formed after the crystallization of a magma (massive and debris);
2. SEDIMENTARIES, consisting of materials (called sediments) deriving from the disintegration, within several causes, of pre-existing rocks (clastic, pyroclastic, organogenic and chemogenic);
3. METAMORPHICAL, which are eruptive or sedimentary rocks which are transformed by physical-chemical factors, that consequently have the chemical composition of some of them.

STONES – classification by UNI 8458

1. **Marble** (commercial term)
   Crystalline rock, compact, polishable, usable for decoration and for construction, mainly consisting of minerals classified in the order of 3-4 within the *Mohs hardness* (such as calcite, dolomite, serpentine). This category includes: proper *marbles* (recrystallized metamorphic limestones), *calcareous*, *cipollini*, *dolomites* and *polishable calcareous breaches*; *calcareous alabastrines*, *serpentines*, *oficalci*.

2. **Granite** (commercial term)
   Compact, polishable, crystalline rock usable for decoration and for construction, mainly composed by minerals of Mohs hardness within the order of 6-7 (such as quartz, feldspar, feldspatoids).
   This category includes: granites proper (intrusive acidic fanero-crystalline magmatic rocks, consisting of feldspar quartz, sodium-potassium and mica); other intrusive magmatic rocks (diorites, granodiorites, syenites, gabbros, etc.); the corresponding effusive magmatic rocks, with a porphyric structure; some metamorphic rocks of similar composition such as gneiss and serizzi.

3. **Travertino**
   Calcareous, sedimentary rock deriving from chemical deposit with structural, vacuolar characteristic, usable for decoration and for construction; some varieties are polishable.

4. **Stone** (commercial term)
   Usable for construction and/or decoration porpouses, the stone normally is not polishable. This category includes rocks of very different mineralogical composition, that cannot be included in any classification. They can instead belong to one of the following two groups: *soft rocks* and *not very compact rocks*. Examples of the first group are: several sedimentary rocks (calcareous, sandstone, etc.), several pyroclastic rocks (peperini, tuffs, etc.); the second group includes natural splitting stones (quartzites, mica schists, gneiss lastroids, slates, etc.) and certain volcanites (trachyte basalts, leukites, etc.).

STONES – physical characteristics.

Theese characteristics are relevant to chose the right stone material or product according to its use and porpouse within the building process. For example, humidity in stone products and the thermal variations within the mass that constitute them, can determined theperspiration features of the walls and, at the same time, prevent the heat transfer.

SPECIFIC WEIGHT and **VOLUME**. The specific weight of the rocks ranges from 1000 to 3000 kg/mc. In the majority of the cases, we take into account of the weight and the volume that, according to the entity and in reference to the unity (specific and relative weight of the water), can determine a classification by the weight of the litoids materials.

POROSITY COHEFFICIENT. The porosity of a rock is given by the continuity of the many mineral components and of course by the presence of cavities within the mass. Also, exist an apparent porosity that indicates the relation between the volume of the assorbed water by the rock and the volume of the total amount of the cavities.

IMBIBITION COHEFFICIENT: relation between the weight of the assorbed water unitl saturation and specific weight.

THERMAL DILATION COHEFFICIENT. In general, is a low value because of the rigidity of the rocks.

THERMAL CONDUCTIVITY COHEFFICIENT. In general, is a low value.

STONE – mechanical characteristics

The mechanical properties of the stone materials used within the building process rely only to some of the capacities of the material to tolerate the internal tensions produced by external forces. In particular:

RESISTANCE TO COMPRESSION (simple and after frost). Capacity to tolerate the forces that leads towards the breakage due to crushing, very important for the use of stone for the walls. The resistance to breakage caused by compression may significantly vary depending on the different rock, from a minimum of 200 kg/cm^2 for sandstones and tuffs to a maximum of 2.500-4.000 for some granites, limestones, compact calcareous, quartz and basalts.

RESISTANCE TO BENDING. Capacity to tolerate the exertion related to the curvature, important in case of covering, lintel (architrave) or overhead pavements.

RESISTENCE TO IMPACT. Capacity to tolerate impacts inflicted by blunt objects, relevant in case of pavements or coating.

RESISTENCE TO USURY or USURABILITY. Capacity to tolerate the sliding friction produced by hard objects in movement. According to their usurability, rocks are classified in:

- *less usurable*: eruptive rocks;
- *enough usable*: other schist rocks;
- *usable*: sedimentary rocks.

STONE – technical and tecnological characteristics

The main technical characteristics of the stone can be identified in:

HYGROSCOPICITY. Attitude to absorb humidity from the atmosphere.

FROST SUSCEPTIBILITY. Characteristics of the stone products that have capillaries of 1/10 mm diameter. Such condition, together with the water imbibition, can determined a major cause of fast degradation and the consequent inadequacy of the stone material in its use within the building process.

RESISTANCE TO FIRE. It refers to the absence of toxic emission and it is related to the stone products that are in direct contact with open flames, such as fireplaces.

ASPECT AND COLOUR. Both the aspect and the colour of the stone (depending also to other factors non related to the natural features) are key-features that may influence the use of the product. The colour of the rock is given by its main component; in the composite or conglomerate rocks, the variety of the nuance may change according to the presence and the dimension of the many different chemical components. Of course, the colour may vary also depending by the manufacturing of the surfaces, from the lighter to the darker according to the finishing, unrefined, hewed, hammered, smoothed, polished.

DIVISIBILITY. Attitude of the rocks to separate according to particular directions that may chance in relation the structure of the rock and its genesis. That can happen for stratification, schistosity or fissure.

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LAPIDEI – caratteristiche tecniche e tecnologiche

HARDNESS. The mineralogical composition of rock materials rarely presents uniformity of components, and so a rock can present components with different hardnesses and different behavior when exposed to external strain. For example, rocks soaked in water lose cohesion and hardness, some tuffs quarried too wet are easily cut, in drying take on compactness and greater hardness;

DURABILITY. This term identifies the precise peculiarity of stone to resist degradation over time. It can occur due to atmospheric causes, chemical causes and also for interventions of an organic nature as well as for causes intrinsic to the material itself and is a fundamental characteristic for appropriate use in construction;

WORKABILITY. Capacity of the rock to be worked with simple tools (chisels, bushes, etc..) or complex ones (diamond saws, percussion cutters, etc..). This property includes four types of operations: splitting, sawing, sculpting, polishing.

ADHERENCE WITH PLASTERS. Very important characteristic in the use of stone in masonry and structures. It is preferable to use rocks that binda in a manner consistent with the mortar, for the compositional affinities and adhesion of the surfaces. For example, siliceous rocks normally have a greater chemical affinity with binders than other rocks, whereas sandstones, on the other hand, have a better physical affinity.

STONE – characteristics

It is not possible to give an absolute value to each characteristic of stone, as the different types of rock are clearly distinguished by different performances. In this regard, it is particularly important when choosing the type of stone, to read and know the characteristics and the technical data provided by the manufacturers.

STONE – uses

The possible uses of the stone can be **direct** and **indirect**.

- In relation to the **direct use,** the stones can be distinguished in:
  — Cutting stones: compact limestone, travertine, sandstone, granite;
  — Masonry stones: hard and compact rocks, soft rocks; cladding stones:
  — Eruptive stones (granite, sienite, porphyry), compact and crystalline limestones (botticino, trani, marbles).



- The **indirect use** is related to:
  — the constitution of mixtures, aggregates or inerts;
  — the production of binders: calcium, cement, plaster;
  — drainage works: under-floor cavities and embankments.



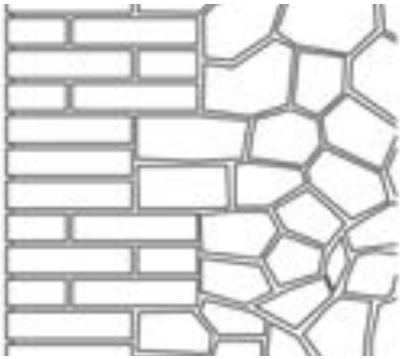
STONE – technical elements

WALLS. The stone elements stay together thanks to the plaster. According to the Ministerial Decree 20 november 1987, the stones must be frost-resistant, not crumbly or flaky, or easily removable; they must not contain significant quantities of soluble substances or organic residues; they must have good adhesion to the plasters and the minimum resistance requirements must be determined according to the methods indicated within the decree.
The decree distinguishes the walls made by natural resistant elements in:

- ✓**not squared stones wall;**
- ✓ **stripped wall;**
- ✓**squared stones wall**.

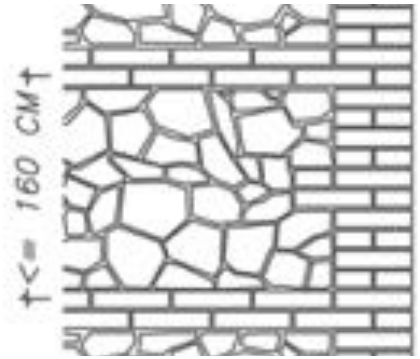
The dry stone walls are built without any plaster are not included in the norm.

NOT SQUARED STONES WALL



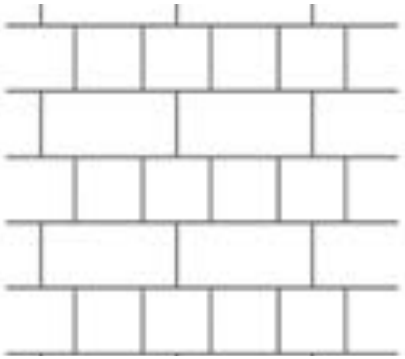
Composed by quarry stones coarsely worked and laid in almost regular layers. The minimum thickness must be 50 cm.

STRIPPED WALL



In this case, the rocks are separated by bands of simple or reinforced conglomerate, or by horizontal strips of at least two rows of solid brick, placed at a distance of not more than 1.6 m and extended to the entire length and thickness of the wall. The minimum thickness must be 40 cm.

SQARED STONE WALL



Composed of parallelepiped stones laid in regular layers.
The minimum thickness must be 24 cm.

STONE – technical elements

ARCHES and **VOLTS.** In the arches, the stone blocks are arranged and bedded with plaster, gradually and symmetrically, taking care that the connections are congruent with the radius of curvature of the intrados. It is possible that the central lintel piece is a single monolithic block.

The construction of the vaults takes place in rows, according to four textures:

- ✓ longitudinal: rows arranged according to the generators of the vault;
- ✓ transversal: rows arranged according to the direction of the vault;
- ✓ diagonal: rows arranged according to the directions of the angle bisectors;
- ✓ Herringbone: rows arranged in a direction perpendicular to the bisectors of the corners.

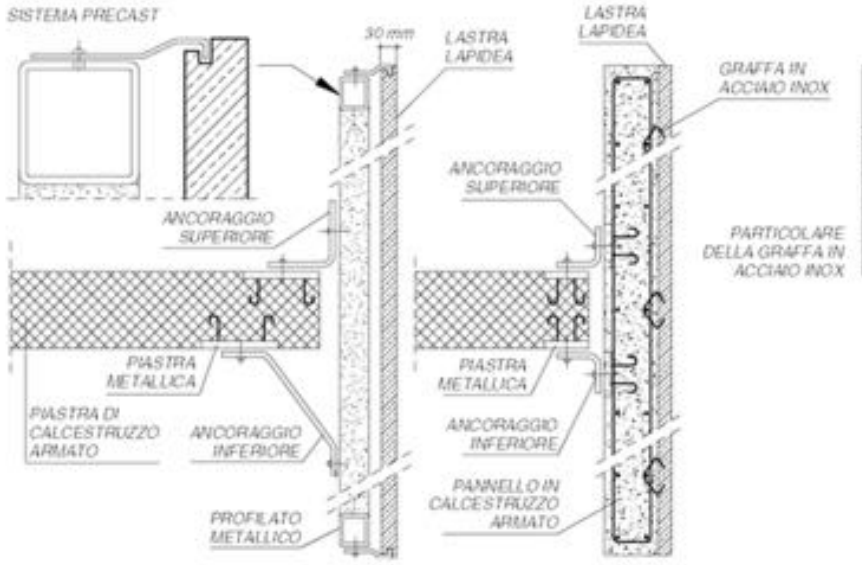







STONE – technical elements

COATINGS: Stone is used for cladding in the form of solid piece, sawn slabs, natural slabs and cubes.
Nowadays, the external claddings are made of slabs with a maximum thickness of 4cm. The durability of the stone is particularly important. For the internal cladding are used the rocks most suitable for polishing or finely carving. The choice depends on the aesthetic and decorative aspect and on the need to have a high resistance to wear and impact.



The **Precast system** is a technique of prefabrication of large panels covered with natural stone (marble or granite); the stone coating is connected to a stiffening support (reinforced concrete, lightened concrete, metal frame) by mechanical, chemical or mixed connections.
An alternative method is for the slab, with a thickness of about 30 mm, to be anchored to a hot-dip galvanised metal frame; the frame is then hooked to the building structure by means of stainless steel or aluminium supports. The latter system must include the completion of the wall to ensure the necessary conditions of comfort.

(*il Nuovissimo Manuale dell'Architetto,* Mancosu editore, pag.F72)

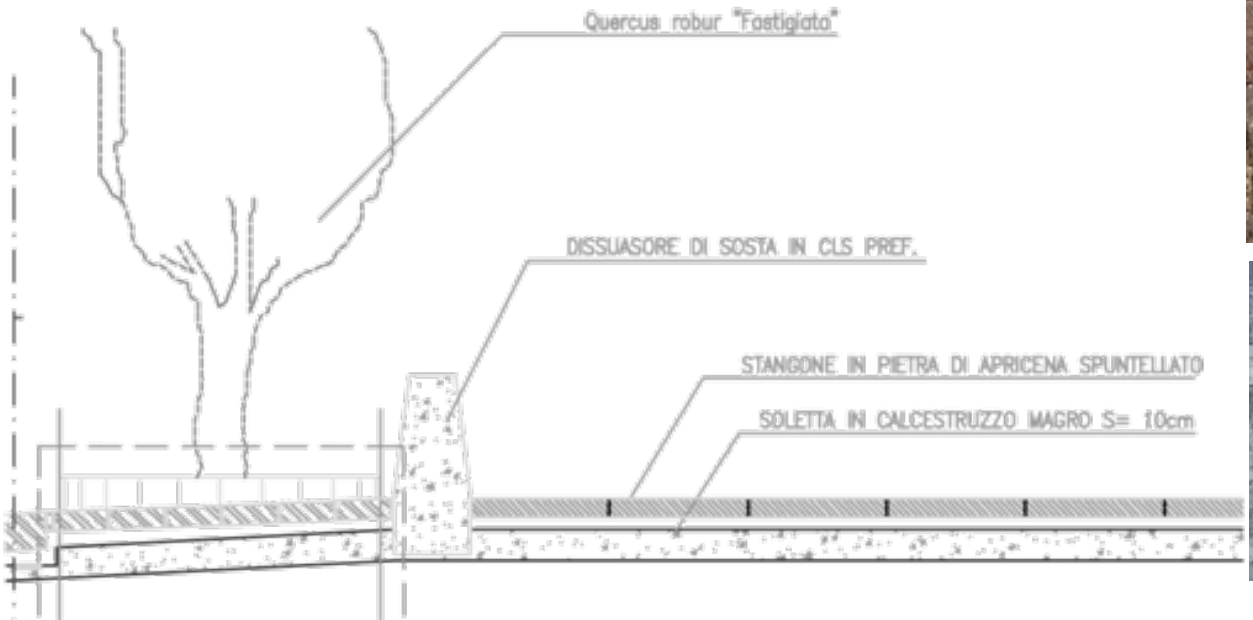
STONE – technical elements

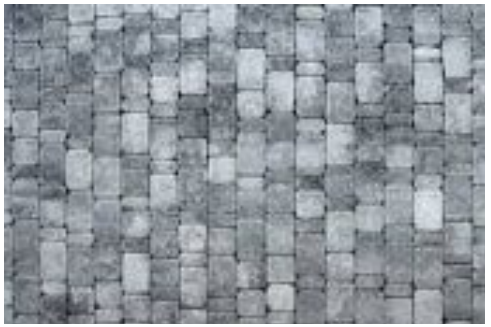
FLOORING: The main characteristics to be considered for flooring are:

- ✓ impact resistance;
- ✓ wear resistance;
- ✓ gelivity;
- ✓ durability.

Are used:

- regular sawn slabs with a thickness of not less than 2 cm;
- slab with irregular contours;
- natural slabs with a variable thickness of 3÷5cm;
- grits of various colours and sizes;
- almost regular cubes obtained by splitting rocky layers of porphyry;
- squared stone sketches, in particular granite and hard sandstone.





STONE – decay

On all stone materials, once exposed to the elements, there are phenomena of alteration. These phenomena have been classified, regardless of the causes that produce them, in Recommendation NORMAL 1/85 published in Rome in 1985 on the initiative of the National Research Council and the Central Institute for Restoration. The phenomena are grouped according to the action they exert on the stone material.

- **WITHOUT WORSENING OF THE CONDITIONS:**
  Colour alteration, Macchia, Patina
- **LOSS OF MATERIAL FROM THE SURFACE:**
  Erosion also differential, Pitting, Alveolization
- **LOSS OF THE MORPHOLOGY OF THE ARTIFACT:**
  Disintegration - Powdering, Exfoliation, Spalling, Detachment, Lack - Gap
- **DEPOSITION AND/OR FORMATION OF BY-PRODUCTS:**
  Concretion - Fouling, Surface deposit, Crust, Efflorescence, Film, Organic coating
- **REDUCTION OF MECHANICAL RESISTANCE:**
  Deformation, Swelling, Fracturing
- **BIOLOGICAL COLONIZATION**

STONE – decay

Exfoliation

Lexical alternative	Desquamation, delamination
Concerned material	Sandstones
Location	On the wall face
Environmental characteristics	External environment exposed to the direct action of meteorological and climatic factors
Phenomenon description	Degradation that manifests itself with detachment, often followed by fall, of one or more sub-parallel layers between them (sheets).
Causes	- Atmospheric pollution that attacks and disintegrates the mineral binder; - thermal oscillations; - chemical-mineralogical composition of the materials; - infiltration of water into micro-cracks in the substrate (beating or runoff meteoric water, more or less acidic, etc.); - migrations of water/humidity in the substrate (condensation humidity, capillary rising damp from the ground, accidental humidity caused by leakage from defective eaves and rainwater, etc.); - crystallisation of soluble salts (sub-florescence formation); - freeze-thaw cycles. Degradation mechanism: - physical action: pressure inside the pores, thermal expansion.

STONE – decay

Exfoliation

Summary description of the intervention procedure

- Fixing and re-adhesion of uneven, detached or almost-detached sheet by mixtures based on natural lime (hydraulic or aerial) or synthetic binders (epoxy resins, polyester, fluorinated copolymers) of variable consistency depending on the technique. The dough must be applied (with a spatula or with micro-injections exploiting the existing continuity solutions) in order to carry out only the "connection bridges" necessary to secure the sheet;
- dry cleaning using brushes and/or soft bristled brushes, sponges and low-pressure vacuum cleaners in order to remove the considerable dust deposits;
- brush or spray application of organic consolidant-reagregulating agent to be chosen after prior sampling. In the absence or at least limited presence of water, ethyl silicate can be used, as an alternative, compounds based on acrylic-silicone resins, fluorinated resins, etc..

Notes and references

The single sheets of sheet (generally between 1/10 micron and 2 mm thick), made of altered material that appears to be intact, after the fall give rise to irregular-shaped continuity solutions, with generally clean edges and a different colour background from the surrounding surfaces.

STONE – decay

Alveolization

Lexical alternatives	Cariatura
Concerned material	Leghorn stone (Pietra livornese)
Location	Widespread on the wall.
Environmental characteristics	External environment exposed to the direct action of meteorological and climatic factors
Phenomenon description	The degradation appears with the formation of cavities of variable shapes and sizes. The alveoli are often interconnected and have a uniform distribution. In the particular case in which the phenomenon develops essentially in depth with a course of diverticules, the term caries alveolization can be used.
Causes	• Chemical-mineralogical composition of the lithoid; • structure of voids (characteristic of pores, fractures, etc.); • crystallisation of soluble salts (sub-florescence formation); • freeze-thaw cycles; • wind action (strong turbulence of air in contact with the stone surface); • infiltration of water into micro-cracks in the substrate (beating or runoff meteoric water, more or less acidic, etc.); • migrations of water/humidity in the substrate (condensation humidity, capillary rising humidity from the ground, accidental humidity caused by leakage from defective eaves and rainwater, etc.); • crystallisation of soluble salts (sub-florescence formation). • Degradation mechanism: • physical action.

STONE – decay

Alveolization

Summary description of the intervention procedure

- Analysis of the size and depth of the alveoli;
- dry cleaning using brushes and/or soft bristled brushes, sponges and low pressure vacuum cleaners to remove surface deposits;
- extraction of soluble salts by means of paper pulp wraps and deionised water;
- consolidation-protection (after preliminary sampling) to be carried out by impregnation with organic compounds such as acrylic-silicone resins.
- Alternatively, for elements without decoration and in an advanced state of deterioration:
- replacement of the stone blocks and subsequent application of protection.

Notes and references

This pathology of degradation is frequently found in clay materials with a particularly porous mixture and in limestone materials with lower mechanical resistance (limestone) which are more exposed to atmospheric agents and runoff. This pathology of degradation can manifest itself in strong differentiation (selective disintegration) due to local variations in the structure of the stone. The materials concerned by this degradation pathology are natural stone (primarily tuff and limestone) and bricks.

STONE – decay

Biological colonisation

Lexical alternatives	Biological attack, weed vegetation
Concerned material	Sandstone
Location	Widespread on the wall
Environmental characteristics	External environment exposed to direct action of meteorological and climatic factors; presence of rising water
Phenomenon description	Attack macrosopically detectable by micro and / or macro organisms of variable color and shape.
Causes	• Structure of voids (pores, fractures, etc.); • access of water (rain, condensation, rising damp, etc.); • presence of sufficient light sources to allow photosynthetic activity; • low-pollution environment characterised by high relative humidity; • high temperature, poor ventilation; • presence of organic materials on the substrate; • north exposure. Mechanism of damage: • chemical action; • physical action.

STONE – decay

Biological colonisation

Summary description of the intervention procedure

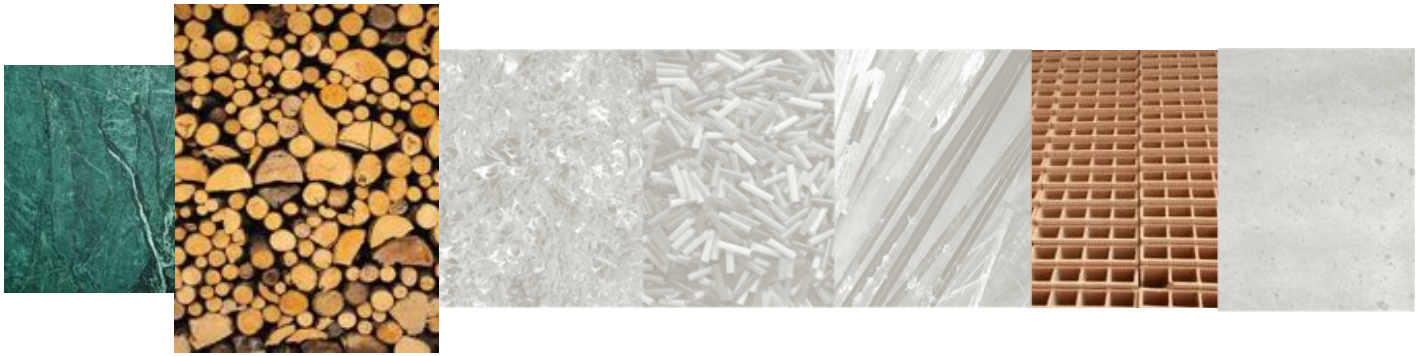
- Possible softening of the lichens by application of the solution on the surface (e.g. 5% ammonia);
- Mechanical removal by means of rigid synthetic brushes and wooden spatulas;
- application (after sampling in order to assess the effectiveness and concentration level of the active substance) of pest-specific biocidal products;
- washing the surface at moderate pressure with clean water so as to remove all traces of the biocide and the remaining biological weeds;
- final preventive treatment by vaporization with low concentration of biocide, against the growth of higher vegetation and against the formation of autotrophic microorganisms.

Notes and references

STONE – innovations

Agglomerated stone products (UNI 10330), commonly called reconstituted stones, are also characterized by high values of strength and compactness; they are made with a mixture of microgranules of porphyry, granite, marble and white high-strength cements, on a layer of concrete. This system allows a wide chromatic variety.

- stone
- **WOOD**
- brick



WOOD - classification

The classification criteria are covered by the **UNI 2853-2854** and **UNI 3917** standards. Coniferous and broadleaf woods are mainly used in the building industry.

	ESSENZA	PESO SPECIFICO (kg/dm³)	LAVORABILITÀ	IMPIEGHI
Conifere leggere	Abete bianco, Abete rosso	0,3-0,6	tenero, lavorabile	palificazioni, casseforme, truciolari
Conifere medie	Larice, Pitch-pine, Pino d'Aleppo, Pino marittimo, Abete douglas	0,6-0,8	duro	traversine,serramenti, pavimenti, costruzioni navali
Latifoglie leggere	Frassino, Pioppo	0,5-0,7	tenero, elastico	manici per utensili, compensati
Latifoglie medie	Faggio, Castagno	0,7-0,8	duro, lavorabile	traversine, travi, serramenti
Latifoglie pesanti	Quercia, Rovere	0,8	duro	travi, pavimenti, costruzioni navali

The essences differ for the different constitutions of the solid phase and for the different percentages of water present. For the same essence, the proportions may also depend on the geographical area of origin, exposure, the growing period of the cut, the age of the plant.

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F59

WOOD - characteristics

Wood is a vegetal fabric formed by macromolecules of cellulose (fibres), which constitute its load-bearing structure, held together by lignin, an aromatic substance that gives toughness to the interweaving of fibres.
The structure of the stem, branches and roots is formed by concentric layers: starting from the centre, the **UNI 4390** standard distinguishes the different layers into: *marrow, heart, wood, sapwood, gearbox, book or phloem, bark.*

Among the characteristics that characterize the wood there are:

- **HYDROSCOCKITY**: the tendency of wood to take water from the environment in the form of steam **(UNI 4145);**

Volumetric variations of the wood as a function of hygroscopicity

DIREZIONE (rispetto agli anelli)	RITIRO % IN VOLUME	RIGONFIAMENTO % IN VOLUME
Tangenziale	7-12	6-12
Radiale	3-16	3-5
Longitudinale	0,1-0,3	0,1-0,5

- **EQUIPMENT SPECIFIC WEIGHT** or density: it is a function of the cellular structure of the essence, of its origin, of its seasoning (UNI ISO 4469, 4858);
- **WATER PERMEABILITY**: it is higher in the direction of the fibres and lower in the transversal direction;
- **RESISTANCE**: it is different depending on the angle that the direction of stress forms with the axis of the fibers and varies with the degree of seasoning of the wood;
- **HARDNESS**: it is determined by the load needed to insert the sample and assesses the possibility of processing the wood.

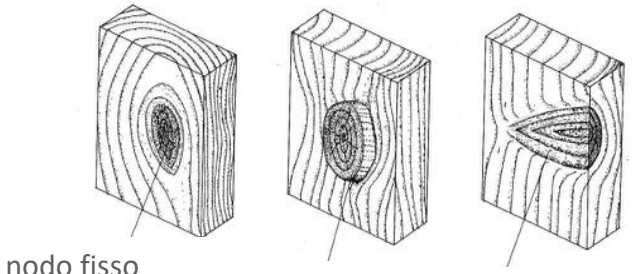
il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F59

WOOD - defects

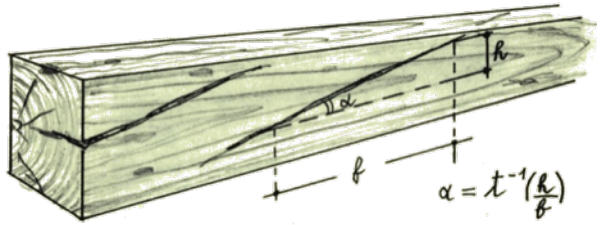
A defect is an anomaly or irregularity in the material that may affect its use for a particular purpose.

In the case of wood used for structural purposes, defects are considered to be all irregularities that cause a loss of mechanical performance, such as:

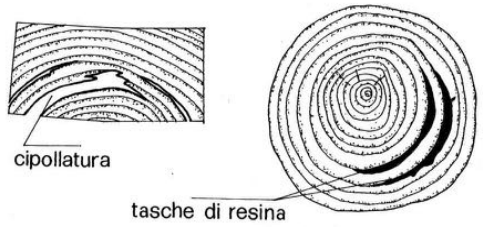
- knot
- deflected grain
- onion



- The **KNOT** is the part of the branch that connects to the stem and that remains incorporated during the growth of the tree. It is an inevitable defect, as there can be no trees without canopies. Knots are considered a defect because their presence causes a localized weakening of the structural element.
- The **DEFLECTED GRAIN** takes on particular importance, at a structural level, the trend of the grain with respect to the geometric axis. When the grain is straight and parallel to its geometric axis, the structural element has the maximum mechanical performance allowed. When the grain is deflected, the higher the inclination of the fibres, the greater the decrease in performance.



- **ONION** is the separation along the grain between two adjacent growth rings or within the same ring. The name derives from the appearance that the different rings assume in the most serious cases, when they tend to peel off like the leaves of the onion. The onion can lead to a decrease in the resistance of the element: in the most serious cases it can lead to the separation of the element into two or more portions that react to the stresses independently.

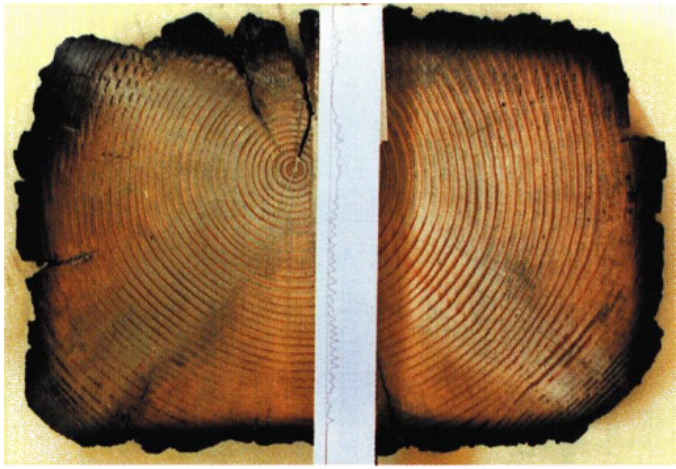


WOOD - treatments

The wood deteriorates due to the variation of the ambient humidity and due to its attackability by xylophagous insects and fungi. Treatments to prevent these phenomena are:

- **Surface treatments**: with paints (transparent films), paints (pigmented paints), tar;
- **Impregnating agents:** with various procedures, the wood absorbs the substance capable of making it impermeable or unassailable.

Wood is easily combustible and flammable. The fireproofing system (surface or impregnating) aims to make the combustion process slow and incomplete, tending to preserve in place the carbonized crust poorly conductive. The treatments should be repeated over time, removing the surface layers exhausted.



LEGNO - manufactures

To be used in construction, the wood must be matured: it must lose the water of imbibition and part of the saturation water.
The seasoning can be natural (1-5 years) or artificial, it takes place on the trunk and on the semi-finished product. The procedures must leave in the wood a quantity of water not exceeding 12-18% **(UNI 4391 and 3253)**. The unidirectional structure of the fibres induces anisotropic behaviour in the wood.

The first processing of wood is the sawing done in the length of the trunk: the different methods allow to have boards of greater width (middle) or mirrored boards (quarters), less deformable.
Sawn timber (beams, boards, etc.) can be used in its original form or further processed. The most common types are:

- **planks or boards**, consisting of large strips of wood with a very flat rectangular section, 12 cm wide to 25 cm wide or more, 1,00 m long to 4,00 m long and 2-12 cm thick;
- **beams, rafters and joists**, consisting of prismatic rods with a mostly square section, long from 2.50 m to 8.00 m and with a section from 6x8 cm to 20x20 cm;
- **mural or half wall**, similar to the previous ones, but with a much shorter length and section;
- **laths**, similar to the murals but with a lower rectangular section.

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F59

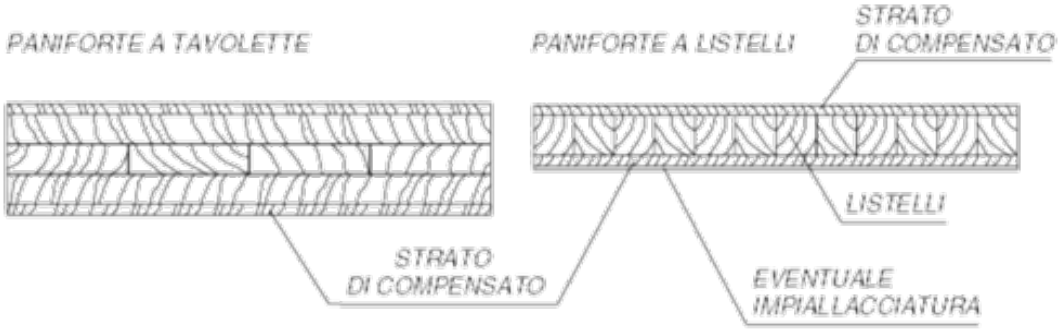
WOOD - products derived from wood

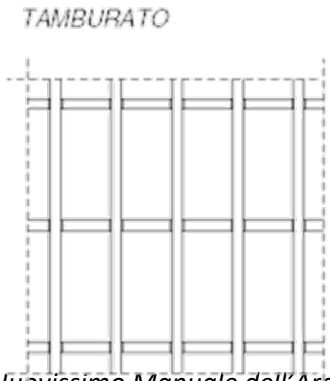
In order to make the performance characteristics of the material more homogeneous and isotropic, it is preferable to use materials derived from wood, obtained through certain processes: the fibrous structure of the wood, first broken down into elements (flakes, chips, strips or thin sheets), is then reassembled through the use of resins and / or mechanical actions (pressing) in the form of panels.

PLYWOOD

Obtained by gluing layers and then pressing thin sheets of veneer arranged with fibers rotated at right angles to each other. Among other products:

- **plywood**: obtained by hot gluing (95-100°C) sheets of variable thickness between 0.15 mm, and 1.50 mm placed at angled fibers, generally in odd numbers;
- **multilayer**: made up of a number of sheets, with a thickness of between 0.5 mm and 1.5 mm, in odd numbers starting from three;
- **paniforte**: obtained by interposing two sheets of veneer of one or more layers of wooden boards placed side by side with the fibres at right angles to the linings.
- **honeycomb sandwich panel**: a panel made up of two sheets of plywood applied to a light, stiffening layer, made up of a wooden grid, a honeycomb of paper or cardboard or expanded plastic material.





LARIMAR "P80"
COMPOSITE PANEL

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F60

- *pannello in scaglie di legno orientate* (Oriented Strand Board, OSB): composto da scaglie di grande dimen- sione (strand) distribuiti sul piano con fibre orientate. Il piano individuato dalla direzione delle scaglie, generalmente coincidente con quello del panne

WOOD - products derived from wood

WOOD PARTICLE BOARD PANELS

They are obtained by pressing, more rarely by extrusion, agglomerates of woody fragments (shavings, flakes) produced by the crushing of waste (residues of processing, branches, foliage) and binders of various kinds (organic, inorganic, synthetic).
Among the products:

- **single-layer chipboard**: the woody mixture is characterised by a rather coarse and constant grain size.

- **multi-layer chipboard**: it is obtained by pressing overlapping layers of variable grain size. Coarser in the central layer, the grain size becomes progressively thinner in the outer layers, which are more compact, are characterized by a smoother surface and less porous thanks to a higher concentration of binder that covers the wood particles.

- **wood wool panels**: formed by pressing a mixture of dried and treated wood chips and artificial resins, cement or mineral binders under reduced pressure. The different orientation of the fragments guarantees an isotropic behaviour of the product.

- **Oriented Strand Board (OSB):** composed of large-sized flakes (strands) distributed on the plane with oriented fibres. The plane identified by the direction of the scales, generally coinciding with that of the panel, has very high values of resistance.

Celenit ABE
Pannello isolante naturale

Lignum K
Pannello isolante autoportante in legno

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F60

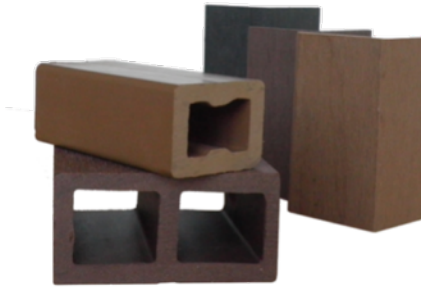
- *pannello in scaglie di legno orientate* (Oriented Strand Board, OSB): composto da scaglie di grande dimen- sione (strand) distribuiti sul piano con fibre orientate. Il piano individuato dalla direzione delle scaglie, generalmente coincidente con quello del panne

WOOD - products derived from wood

PANNELLI DI FIBRA DI LEGNO

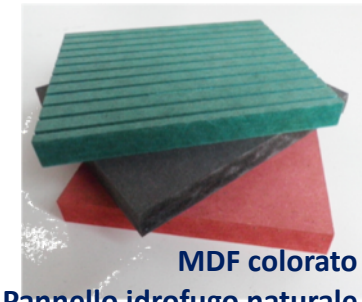
The base material consists of wood chips and flakes that have been felted, a process aimed at improving the adhesion of the fibres with the binder. The fragments are softened with steam and then passed under rotating wheels that cause the defibration. The panels formed by pressing are characterized by isotropy.
Among the products:

- **Novowood WPC:** composed of natural wood fibres (70%), polymers (30%) and additives, the elements are produced by extrusion with different sizes, shapes and colors, is used as flooring in outdoor environments, and resist the marine climate. The material is completely recyclable, at the end of its life cycle, or at any time can be ground and extruded again, this operation can be repeated up to 20 times without the need to add other components, and without altering the physical and mechanical characteristics.



sotto-doga 40 x 30 x 2000 mm e
frangisole rettangolare 60 x 40 mm

- **Medium Density Fibreboard (MDF):** obtained by dry pressing of agglomerates of homogeneous fibres bound with synthetic resins. Characterized by a homogeneous and very compact structure, it makes the panel machinable (sawdust, turning, finishing), and by a thin texture, which allows the veneering or lacquering of surfaces, this panel is often used in place of natural wood.



MDF colorato
Pannello idrofugo naturale

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F60

b) connettori metallici (caviglie e anelli).

WOOD - products derived from wood

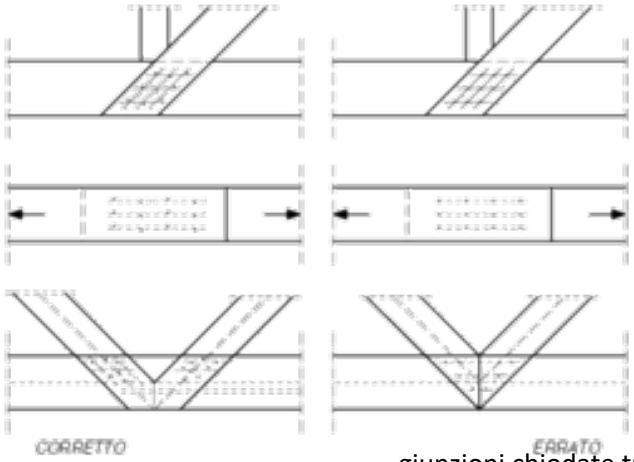
LAMELLAR

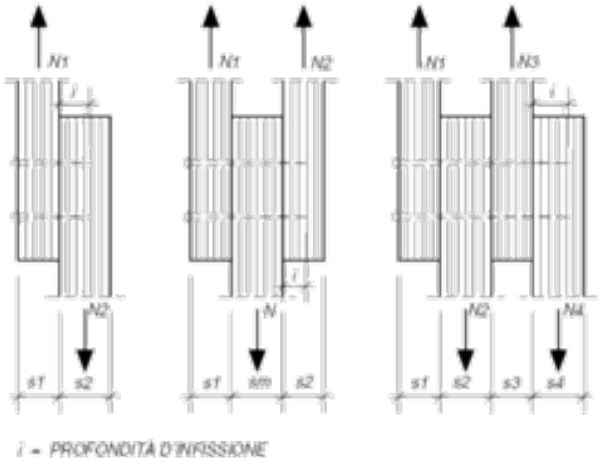
It is a material obtained by pressure bonding layers of wood lamellas or strips (thickness = 50 mm) and synthetic resins. Characterized by high resistance to compressive, tensile and shear stresses, it is used for the realization of structural elements, even of considerable dimensions.

The connections of the structural elements in glulam are made with:

a) bolts, nails, pins;

b) metal connectors (ankles and rings).





giunzioni chiodate tra elementi strutturali

lamellar trellised: it is a beam in spruce lamellar wood in which a trellis in electrowelded steel is inserted by pressure, through particular milling operations. It can be used both for the covering floor and for the intermediate floor. The floor is completed with various types of plugging and concrete slab.

TRAVETTI COMPOUND - solaio compound

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F60 e pag D189

b) connettori metallici (cavigile e anelli).

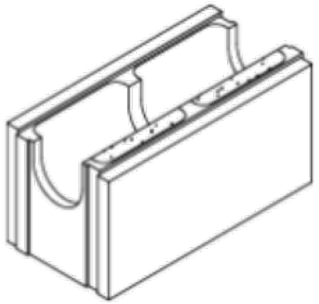
LEGNO – prodotti derivati dal legno

BLOCKS AND BRICKS

- **wood-cement formwork block:** the spruce wood is ground and mineralized with the cement, obtaining a porous structure. The blocks are not really resistant elements but constitute the disposable formwork of the subsequent concrete casting. They are laid dry and are suitable for use in load-bearing masonry. A layer of polystyrene with a thickness of 2 to 5 cm is inserted in the holes.

Dati tecnici indicativi:

- Dimensioni: 25 x 30 x 50 *cm*
- Peso dei blocchi: 74 *kg/m²*
- Peso muratura con calcestruzzo: 327 *kg/m²*
- Isolamento acustico (500 *Hz*): 52 *db*
- Resistenza al fuoco: 180 *REI*



Insulated concrete wooden blocks with central insert in polystyrene adittivated with graffite

- **Modular system:** The modules consist of five layers of solid wood, glued crosswise at regular intervals. The module cavities are then filled with isoteraton (planed wood and clay) by blowing. The surfaces are normally covered, but can also be seen with a surface sanded with the type of wood: spruce/spruce. Installation is carried out by interlocking the elements in each other without the use of lifting equipment, mortars or glues.

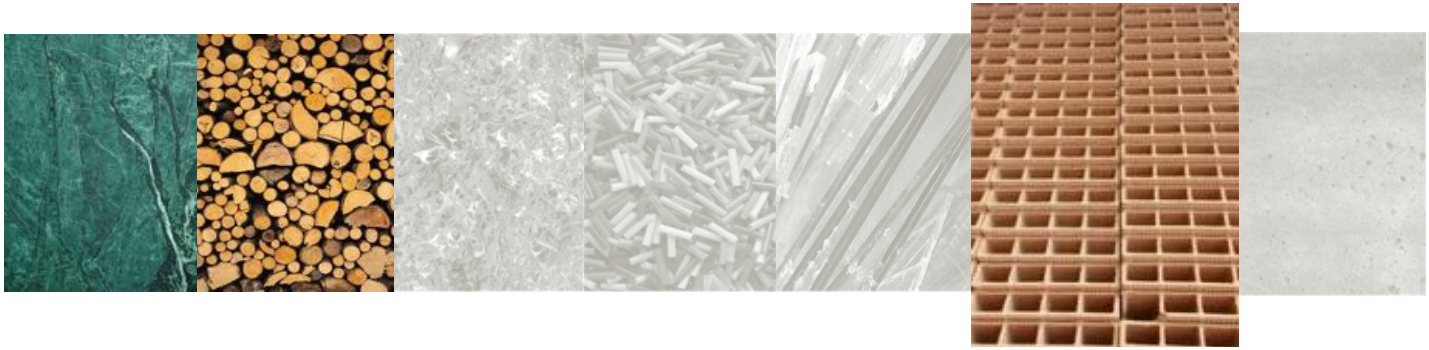
STEKO
Mattone in legno

SUGHERO GRANULATO

Natural cork granules for thermal and acoustic insulation for cavities, attics and lightweight concrete. Depending on the type of application is laid differently: insufflated; in holes specially prepared in the perimeter walls; lying or loose; in attics not practicable or mixed with cement in attics practicable. It is a 100% natural product, free of formaldehyde.

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F60 e pag D189

- stone
- wood
- **BRICK**



CERAMIC MATERIALS – composition and production

Ceramic materials are obtained from the processing, forming and firing of non-metallic inorganic substances.
To be suitable for outdoor use, ceramic materials must have good resistance to pollution and atmospheric agents.
Commercial production includes various formats and special pieces, such as strips, corners and plates. The wide range of colours, geometries and surface finishes makes the ceramic material very versatile.
Ceramic materials include:

- **bricks - porous ceramic materials;**
- **ceramic tiles - compact ceramic materials;**
- **clinker - compact ceramic materials.**

CERAMIC TILES are classified by **UNI EN 87** according to the forming method (extruded or pressed tile) and the coefficient of water absorption (between 0 and 25%), which indicates the porosity of the material and, consequently, the behaviour to external agents.

CLINKER is a ceramic material that uses natural clay of feldspathic origin as its base material. The clay undergoes a process of pulverisation and mixing and the product is fired at temperatures of not less than 1250°C. It is a very compact, hard and resistant material, with a high degree of impermeability, considerable mechanical capacity, high resistance to wear and weathering, non-absorbent (water absorption between 0 and 6%), unalterable, easy to maintain. Commercial production concerns extruded tiles used for external cladding and flooring. Due to its characteristics, it is very suitable for industrial and public buildings, sports and recreational facilities, urban furnishings.

PORCELAIN STONEWARE is particularly suitable for outdoor use. It is a ceramic product with a very compact and waterproof glazed or unglazed surface, with high mechanical resistance (water absorption coefficient between 0 and 0.5%). The highlights on the back of the elements have the function of improving the adhesion to the support.

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F77

BRICKS – composition and production

A **BRICK** is a solid block composed by a porous material that is obtained by firing the clay at about 800°C.

Clay is a loose sedimentary rock of mechanical origin, with a heterogeneous physical and chemical structure. It is composed of varying amounts of silica, alumina, water, iron, alkaline or alkaline-ferrous materials. Impurities include quartz, gypsum, rock salt, pyrite, feldspars, mica, etc.

Production process:

After crushing the clay clods, purifying them of foreign elements and wetting the dough, the production process involves: moulding, which can be done by extrusion, pressing or by hand; drying, through which water is removed from the dough; cooking. By cooking natural quartz clays until vitrification, stoneware is obtained.

The colouring of the final product depends on the type of clay or clay mixture used; in particular, the ratio between the calcium and iron oxides determines the colour variation, which ranges from yellow to bright red; bright red bricks are obtained from very iron-rich materials.

Clay elements are mainly produced by extrusion or pressing; they can still be formed by hand for restoration or restoration. They generally have a parallelepiped shape and are used for regular horizontal recurrences of constant thickness.

The size of the elements varies considerably in relation to their use and local traditions.

BRICKS – composition and production

UNI defines the size of the **solid brick as 5.5 x 12 x 25 cm** and the **double UNI as 12 x 12 x 25 cm.** It also distinguishes between brick and block: the first term the elements with *volume < 5500 cm3* and with the second those with *volume > or = to 5500 cm3.*

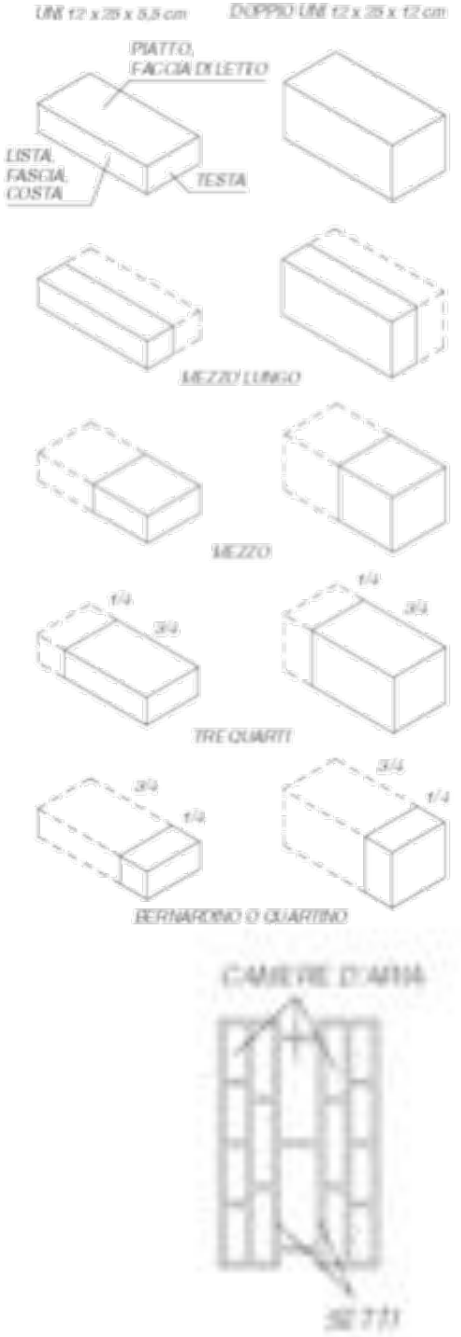
The presence of holes influences the static behaviour of the wall; the elements are therefore distinct (DM 20 November 1987) in relation to the percentage of holes *f = 100 F/A* and the average area f of the normal section of a hole, being: F = total area of holes through and through; A = gross area of the perforated face delimited by its perimeter.

Elementi pieni	i ≤ 15%	f ≤ 9 cm²	S ≥ 12 cm
Elementi semipieni*	15% < i ≤ 45%	f ≤ 12 cm²	S ≥ 20 cm
Elementi forati**	45 < i ≤ 55%	f ≤ 15 cm²	S ≥ 25 cm

* Per la norma UNI 8942 sono denominati elementi “semipieni di tipo A”.

** Per la norma UNI 8942 sono denominati elementi “semipieni di tipo B”

The presence of holes, through holes or deep through holes, or inner tubes improves the insulating characteristics of the resistant element and of the masonry as a whole. The greater the number of air zones crossed by the thermal flow, the better the insulation capacity of the material; the internal partitions must therefore be staggered in the direction of the thermal flow.



il Nuovissimo Manuale dell’Architetto, Mancosu editore, pag.F8

BRICKS – products

LATERIZIO ALVEOLATO

Comprende laterizi speciali a elevato isolamento termico; le categorie sono definite dalla percentuale di foratura degli elementi: 45, 50, 55, 60.
Alle diverse percentuali corrispondono determinate caratteristiche di resistenza e le qualità termoisolanti rimangono sostanzialmente uniformi.
Gli elementi sono quindi adatti per murature portanti monostrato o pluristrato, in zone normali o sismiche di qualsiasi grado.

Dati tecnici indicativi di un elemento di classe 45:

- Dimensioni: 19 x 30 x 50 cm
- Peso medio: 25 kg/cad
- Foratura: 45% *I*
- Trasmittanza termica per murature di 30 cm con intonaco civile su entrambe le facce: 0,76 W/m² K
- Isolamento acustico (500 Hz) (spessore 30 cm): 45 dB
- Resistenza a compressione verticale del blocco: 120 kg/cm²
- Resistenza a compressione verticale della muratura con malta M3: 55 kg/cm²

LATERIZIO ALLEGGERITO

Costituito da argilla e perlite, è un prodotto minerale a basso peso specifico ricavato dall'espansione, a seguito di trattamento termico di una roccia d'origine vulcanica simile all'argilla.
A differenza dei laterizi alveolati, la struttura è compatta senza cavità e fori superficiali.
Adatto per murature portanti.

Dati tecnici indicativi di un elemento di classe 45:

- Dimensioni: 19 x 25 x 30 cm
- Peso medio: 11,7 kg/cad
- Foratura: 45%
- Trasmittanza termica per murature di cm 30 con intonaco civile su entrambe le facce: 0,90 W/m² K
- Resistenza a compressione verticale del blocco: 260 kg/cm²
- Resistenza a compressione verticale della muratura (Tab. A DM 30 novembre 1987): 80 kg/cm²

BLOCCO PER MURATURA ARMATA

Blocchi a foratura verticale in laterizio alleggerito di grande formato per muratura monostrato normale o armata. Gli elementi per muratura armata sono dotati di particolare conformazione per l'alloggiamento dell'armatura. Sono idonei all'impiego in zona sismica.

Dati tecnici indicativi:

- Dimensioni: 25 x 30 x 30 cm
- Peso medio: 8 – kg/cad
- Foratura: ≤ 45%
- Trasmittanza termica per murature di 30 cm con intonaco di 1 cm su entrambe le facce: 0,67 W/m² K
- Isolamento acustico (500 Hz) (spessore 30 cm): 44–48 dB
- Resistenza a compressione verticale del blocco: 80 > kg/cm²
- Resistenza a compressione verticale della muratura (Tab. A DM 30 novembre 1987): 50 kg/cm²

BLOCCO A INCASTRO

Laterizio alleggerito con aggregazione a incastro in modo da consentire pareti di spessore di 30 cm.
Gli elementi base sono corredati del semiblocco e da elementi speciali a spacco facilitato, per lo sfalsamento dei giunti verticali e per la realizzazione di angoli ecroci mazzetta.

Dati tecnici indicativi di un elemento di classe 55:

- Dimensioni: 19 x 22,5 x 30 cm
- Peso medio: 11 kg/cad
- Foratura: 55%
- Isolamento acustico (500 Hz): 46 dB
- Trasmittanza termica per murature di cm 30 senza intonaco: 0,63 W/m² K
- Resistenza a compressione verticale del blocco: 90 kg/cm²
- Resistenza a compressione verticale della muratura (Tab. A DM 30 novembre 1987): 36 kg/cm²

BRICKS – products

A recent construction technology involves the **rectification of the blocks**. Grinding is a high-precision mechanical operation, as a result of which the perforated faces of the blocks are perfectly flat and parallel, thus ensuring a perfect orthogonality with respect to the side faces. This allows the use of cement adhesive instead of mortar, particularly in horizontal beds. This saves installation time and costs, and reduces the thickness of the horizontal joints, improving the thermal insulation of the wall.

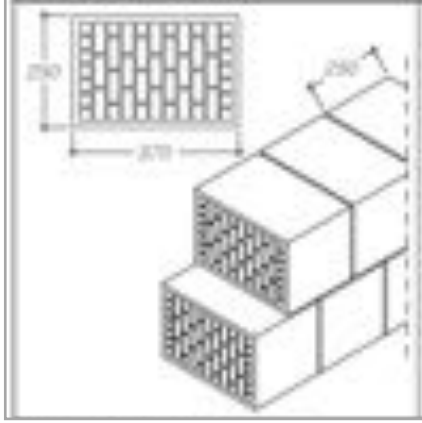
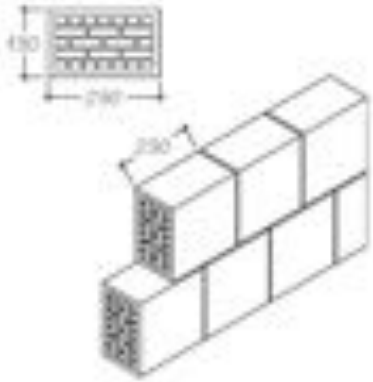
BLOCCO RETTIFICATO IN LATERIZIO PER TAMPONAMENTI

Blocco in laterizio, a fori verticali, dalla speciale struttura a nido d'ape che, grazie al disegno della foratura e al ridotto spessore dei setti, che non superano 3 mm, consente buone prestazioni termiche e acustiche.
La rettifica consente una assoluta precisione nella geometria del blocco, con facce di posa piane e parallele. È previsto quindi l'impiego di collante cementizio per i giunti orizzontali (spessore 3 mm) e la posa a incastro per i giunti verticali, con un notevole risparmio di tempi di posa e dei costi, e con la riduzione dei ponti termici.

Dati tecnici indicativi:

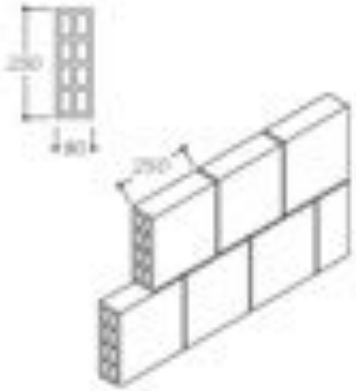
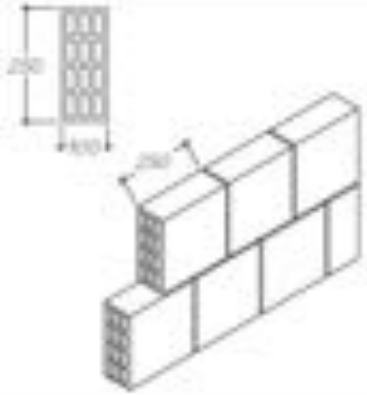
- Dimensioni: 30 x 25 x 25 cm
- Trasmittanza termica: 0,39 W/m² K
- Isolamento acustico: 48 dB
- Resistenza al fuoco: 180 REI

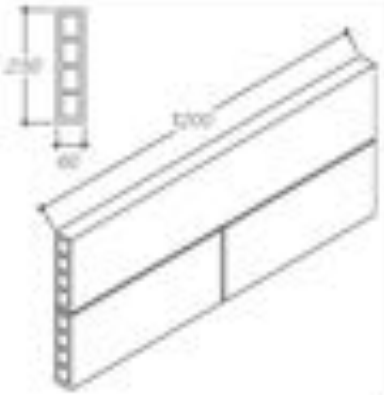
BRICKS – types and characteristic of the wall (from UNI 10355)

SCHEMA DEL SINGOLO ELEMENTO E DELLA MURATURA	CARATTERISTICHE ELEMENTO: MASSA VOLUMICA (kg/mc)	FORATURA (%)	FORATURA (tipo)	MURATURA: GIUNTI VERTICALI	SPESSORE (mm)	RESISTENZA TERMICA	MASSA DI SUPERFICIE (kg/mq)
BLOCCO FORATO							
	1800	66	O	CM GI	370	1,07	348
MATTONE FORATO							
	1800	60	O	CM GI	150	0,65	114

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F14

BRICKS – types and characteristic of the wall (from UNI 10355)

SCHEMA DEL SINGOLO ELEMENTO E DELLA MURATURA	CARATTERISTICHE ELEMENTO: MASSA VOLUMICA (kg/mc)	FORATURA (%)	FORATURA (tipo)	MURATURA: GIUNTI VERTICALI	SPESSORE (mm)	RESISTENZA TERMICA	MASSA DI SUPERFICIE (kg/mq)
MATTONE FORATO							
	1800	63	O	CM GC	80	0.20	62
	1800	62	O	CM GC	100	0.27	78

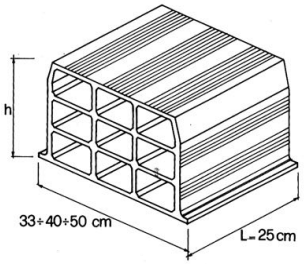
SCHEMA DEL SINGOLO ELEMENTO E DELLA MURATURA	CARATTERISTICHE ELEMENTO: MASSA VOLUMICA (kg/mc)	FORATURA (%)	FORATURA (tipo)	MURATURA: GIUNTI VERTICALI	SPESSORE (mm)	RESISTENZA TERMICA	MASSA DI SUPERFICIE (kg/mq)
TAVELLONI							
	1800	56	O	CM GC	40	0.11	34
	1800	67	O	CM GC	60	0.13	40

il Nuovissimo Manuale dell'Architetto, Mancosu editore, pag.F14

BRICKS – products for the horizontal closures

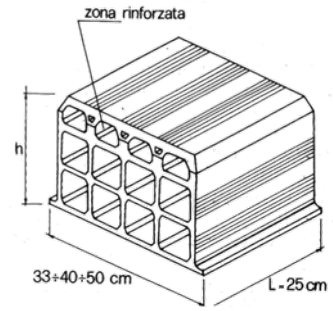
They are distinguished by:

blocks for slabs (pignatta): elements used for horizontal structures in laterally reinforced concrete, are characterized by significant dimensions and drilling ratios between 65% and 70% that affect the structural calculation in the definition of the height of the floor. They have a parallelepiped shape and are equipped with lower fins. Often the blocks are pre-assembled in the factory in suitably reinforced panels, easy to install;

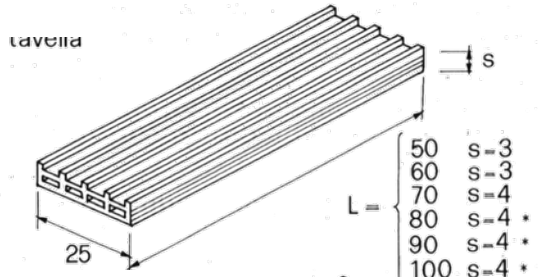


The **UNI 5631/65** standard distinguishes between three types of pignatas:

- **type A,** or volterrana, the lightest and with only filling function.
- **type B**, reinforced with a ribbing.
- **type C**, reinforced smoothly.

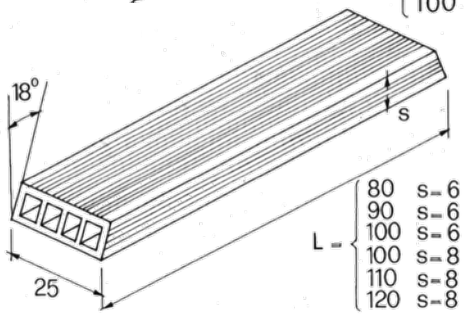


The reinforced types have a load-bearing function as they are responsible for absorbing the compressive stress and for this reason have the upper part (generally equal to 1/5 of the height) with a drilling percentage not exceeding 50%.



Planks and large planks: these are elements that have a fixed width, i.e. 25 cm, and a different length and thickness in relation to each other.

- The **planks** have variable lengths up to 140 cm and variable thicknesses from 6 to 8 cm, are mainly used to obtain non-load-bearing horizons (false ceilings);
- **large planks**, on the other hand, are used to create horizons that are also load-bearing.

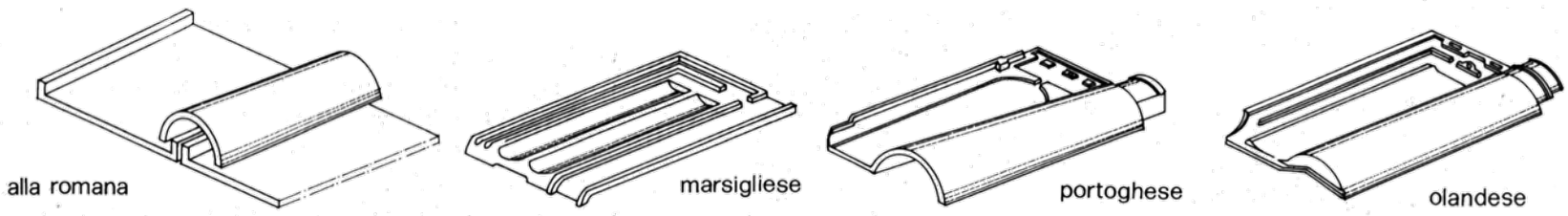


INCLINED ROOFS

The production of brick roofing elements is directed towards two basic types:

- **coppice,** elements with the characteristic truncated-cone shape and curved section;
- **tiles,** products that in relation to their "design" are further distinguished in:
  - ✓ **embrici**, flat elements with raised edges that are used in combination with the tiles for the construction of the so-called;
  - ✓ **marsigliesi**;
  - ✓ **portoghesi**;
  - ✓ **olandesi**.

Special pieces are also produced for covering the ridge line, connecting elements, chimneys for chimneys, tiles with air vents.



BRICKS – products for the exterior coatings

The bricks produced for the dry cladding of facades are elements with grooves or clamps that allow installation on strips and allow the formation of an air chamber (ventilated wall) between the cladding and the load-bearing wall.




Sound absorbing panels for terracotta cladding: terracotta element for cladding coupled with an 80 mm Rockwool panel, to improve sound insulation. The insulation can be covered with a black PVC screen.

Phoniceram

BRICKS – degradation

In the presence of some phenomena the bricks are subject to degradation:

- in the presence of rising damp;
- in the case of moisture from internal condensation, i.e. a phenomenon due to the cooling of water vapour inside the materials making up the external closure.
- in the case of humidity from rain and wind, it is a special case of humidity from condensation and occurs especially when the joints are degraded and the walls are very permeable.

Degradation manifests itself with:

- ✓ **LOSS OF MATERIAL FROM THE SURFACE:**

  Erosion also differential, Pitting, Alveolization

- ✓ **LOSS OF THE MORPHOLOGY OF THE ARTIFACT:**

  Disintegration - Powdering, Exfoliation, Spalling, Detachment, Lack - Gap

- ✓ **DEPOSITION AND/OR FORMATION OF BY-PRODUCTS:**

  Concretion - Scaling, Surface deposit, Crust, Efflorescence, Film, Organic patina

- ✓ **REDUCTION OF MECHANICAL RESISTANCE:**

  Deformation, Swelling, Fracturing

- ✓ **BIOLOGICAL COLONIZATION**

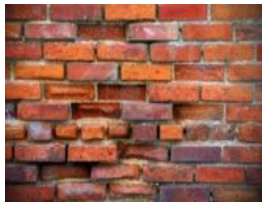
BRICKS – degradation

CRACKS, DETACHMENTS AND DEFORMATIONS

Alveolization — **cause**: environmental conditions
Degradation that manifests itself with the formation of cavities of variable shape and size. The alveoli are often interconnected and have uneven distribution. In the particular case in which the phenomenon develops essentially in depth with a course of diverticules, the term 'alveolization with caring' can be used.

Crust — **cause**: environmental conditions
Surface layer of alteration of the material or products used for any treatments. Of variable thickness, it is hard, brittle and distinguishable from the underlying parts by its morphological characteristics, and often by its colour. It can also spontaneously detach from the substrate, which is generally disjointed and/or pulverulent.

Decoupling — **cause**: environmental conditions
Decoupling of granules or crystals under minimal mechanical stress.



Gap — **causes**: laying error, accidental event, environmental conditions
Falling and loss of parts of elements, with highlighting of the inner layers of plaster or the substrate.

Lack — causes: laying error, accidental event, environmental conditions
Fall and loss of parts. The term is used when this form of degradation cannot be described under other headings of the lexicon.

BRICKS – degradation

Pitting — cause: environmental conditions
Point degradation that manifests itself through the formation of numerous, close, blind holes. The holes tend to be cylindrical in shape with a maximum diameter of a few millimetres.

MACCHIE DEPOSITI E PATINE

Concretion — cause: environmental conditions
Compact deposit generally formed by elements of limited extension, preferably developed in one direction not coinciding with the stone surface. Sometimes it can take the form of stalactites or stalagmites.

Stain — causes: natural aging, accidental cause, environmental conditions
Alterations that occur with accidental and localized pigmentation of the surface; it is related to the presence of foreign material to the substrate.

Efflorescence — cause: laying error
Formation of substances, generally of a whitish colour and of a crystalline, pulverulent or filamentous appearance, on the surface of the product. In the case of saline efflorescence, crystallization can also occur inside the material, often causing the detachment of the most superficial parts: the phenomenon is called crypto-efflorescence or sub-efflorescence.

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