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Editors

Materials for Construction and Civil Engineering

Science, Processing, and Design



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PRESS

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Materials for Construction and Civil Engineering

Preface

The current economic panorama has been particularly adverse for the architecture and civil engineering sectors. We firmly believe that the innovation and development of new materials with enhanced and/or innovative properties will bring about the opportunity of restoring these sectors.

However, the remarkable multiplicity and diversity of materials currently available in civil engineering put designers, architects, and civil engineers in a problem of growing complexity—the *selection of materials*.

The selection of materials in civil engineering can be based, naturally, on features such as suitability, cost, life cycle, and the materials recyclability. Nevertheless, the future of civil engineering lies in the higher value-added materials. Hence, the selection of materials for a certain project is an iterative task, where the optimization of solutions can only be obtained through the dialogue between the project's specialists, architectures, and civil and materials engineers.

Naturally, for such discussion to be possible, it is imperative that all the actors dominate the same technical language and share a set of scientific knowledge, which will allow for communication and optimized solutions.

The present work is intended to contribute to that platform of specialists that is committed to the civil engineer/architecture project. We intend to offer its readers information regarding the main groups of materials used in civil construction, highlighting the nomenclature, properties, fabrication processes, selection criteria, products/applications, life cycle and recyclability, and even normalization.

This book is the result of extensive work in a broad spectrum of subjects and competences in the areas of materials and civil engineering, as well as architecture. In its foundation there is a multidisciplinary team of several specialists of distinct Portuguese institutions, such as LNEC, CTCV, ISEL, LNEG, and IST. Despite the scientific edition of the work, it certainly reflects some level of heterogeneity in the approach chosen by each author.

Chapters 1–5 include the structural and more traditional materials in civil engineering—hydraulic binders, bituminous materials, concrete, plastering, and renders; Chaps. 6–9 comprise structural materials and/or finishing materials like steel, ceramic, glass, ornamental stones, polymers, and polymer matrix composites; Chaps. 12 and 13 depict the natural materials such as wood and cork; in Chap. 14 we introduce nanomaterials; Chaps. 15 explain the corrosion phenomena and its control; Chap. 16 introduces structural adhesives, while the main properties and the

uses of paints and organic coatings are presented in Chap. 17. Chapter 18 presents the life cycle of the different products, as well as the integrated waste management of; and Chap. 19 concludes the book with the regulation and certification of construction products. To the authors, we publicly express our sincere thanks for their contribution, without which this book would not be possible. Thanks to the first publisher, “ISTPress” the IST academic publisher, since day one. Very special thanks to Springer, for its recognition and commitment on the publication of the book.

Lisbon, Portugal

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Glossary

A

Abrasion resistance (Plaster; render) Wear resistance of the surface of a hardened mortar by mechanical action

Abrasive (Ornamental stone) Generic designation of hard and wear-resistant substances used to wear and polish

Acid rock (Ornamental stone) Igneous rock with more than 66 wt% silica

Addition (Plaster; render; concrete) Finely divided inorganic material, which can be added to the matrix (mortar, concrete, and others) with the purpose to obtain or improve specific properties

Additive (Polymeric matrix composites; organic coatings; structural adhesives; polymer) Substance added in small quantities to a formulation (adhesive, polymer resin, paints, varnishes, etc.) with the purpose of improving or modifying the processability (plasticizers, lubricants, stabilizers, release agents, etc.), the external appearance (colors, pigments, etc.), the performance (antioxidants, protection to ultraviolet radiation, the antistatic flame retardants, foams, etc.), or the recycling processes (stabilizers, additives repairers, etc.)

Adherence (Plaster; render) Maximum breaking force per unit area of a mortar applied on a support, which can be determined by applying a tensile force or shearing

Adherence (Organic coatings) Property of a film used to evaluate the set of binding forces that develop between that film and the substrate where it is applied

Adhesion (Organic coatings) Property of a film, resulting from the binding forces developed between the film and the substrate on which it is applied

Adhesion (Structural adhesives) Phenomenon by which two surfaces are held together by chemical, physical, or physicochemical forces resulting from the presence of an adhesive [NP 3672:1990]

Adhesive (Structural adhesives) Product able to maintain in a state of adhesion of two surfaces of one or more identical or different materials [NP 3672:1990]

Adhesive failure (Plaster; render) Rupture that occurs at the interface between the mortar and the support, or generally at the interface between the adhesive and either glued surfaces

Adhesiveness (Structural adhesives) Capacity of a material to produce adhesion

Adhesives (Structural adhesives; polymer) Formulations usually involving polymer, used to bind two or more surfaces together, providing a certain strength to this union. Divided into adhesives of thermal, contact, and structural application. Nonmetallic substance capable of joining materials by surface bonding (adhesion), and the bond possessing adequate internal strength (cohesion) [EN923:2005 + A1:2008]

Admixture (Render; plaster; concrete; polymer) Denomination given to additions used in small amounts (<4 wt%; <5 % per cement weight in concrete) to improve specific properties of the final product (see additives)

Agglomerate (Cork) Material obtained by agglomeration of granules (expanded or not expanded) or possibly reggranulates

Aggregate (Concrete and binders; Bituminous materials) Natural, artificial, reclaimed, or recycled granular mineral materials used in construction

Air-entraining agent (Plasters; Stucco) Admixture that allows the incorporation of a controlled amount of air bubbles distributed uniformly throughout the mortar, which remain after hardening

Alkyd resin (Polymer) Alkyd resins (“al” as alcohol and “id” as acid) are made from esters of unsaturated carboxylic acids and polyhydric alcohols; polymerization by radical attack to double links produces a coating (see *resin*)

Alternating copolymer (Polymer) Copolymer wherein the constituent monomers are alternately distributed in the chain (see *copolymer*)

Anion (Corrosion) Negatively charged ion (e.g., Cl^- or OH^-)

Annual ring (or Annual growth ring) (Wood) Cross section of a tree growth layer, or part thereof, corresponding to the wood produced in a year

Anode (Corrosion) Electrode where an oxidation reaction occurs. This reaction may involve molecules or anions from the environment or the atoms of a metal (giving rise to positive ions or insoluble compounds)

Anodic current (Corrosion) Current caused by the occurrence of oxidation reaction

Anodic inhibitor (Corrosion) Inhibitor that interferes with the anodic reaction. Normally, these are anions that migrate to anode surfaces, forming protective film layers

Anodic protection (Corrosion) Protection against corrosion is obtained by increasing the electrode potential so as to achieve the material’s passivation. It is only feasible if the material shows a passivation domain at the working pH

Anodizing (Corrosion) Corrosion protection method used in several metals in which the oxidation of the metal is promoted in order to obtain a thick layer of protective oxide

Antireflective glass (Glass) Glass with a surface coating that allows to minimize the light reflection component and maximize the transmitted component, so that transparency and visibility in transmission are optimized (class of coated glasses)

Arcade (Ornamental stone) Series of contiguous arches; dome

Atmospheric corrosion (Corrosion) Corrosion by exposure to the atmosphere, usually to outdoors (see corrosion)

B

Bands (Ornamental stone) Strips or risers for coping

Banister (Ornamental stone) Small column usually used in support railings and window sills

Bark (Wood) Generic term for all exterior tissues that involve the xylem

Basalt (Ornamental stone) Extrusive igneous rock of volcanic origin and usually very hard, whose color ranges from dark gray to black

Basic rock (Ornamental stone) Igneous rock containing silica between 45 and 52 wt%

Belly or womb (Cork) Suberous inside part of the cork tissue corresponding to the last annual growth that reproduces all the irregularities of the surface of the inner bark. It is located inside relatively to the tree

Beveled (Ornamental stone) Wedge-shaped edge of a slab, tile, or plaque obtained by a beveling operation

Bimetallic corrosion (Corrosion) See *galvanic corrosion*

Binder (Structural adhesives) Component of an adhesive that is primarily responsible for the adhesion [NP 3672:1990]

Binder (Hydraulic binders) Substances that harden independently and that bind other solid materials together conferring cohesion and resistance to the whole system

Binders (Polymer matrix composites) Materials (usually resinous) that help the fibers remain agglomerated, providing them with protection to degradation due to environmental agents and also promoting the adhesion between the fibers and the matrix

Biochemical rock (Ornamental stone) Sedimentary rock formed by sedimentation of organic deposits

Biological corrosion (Corrosion) Deterioration of a metal by corrosion processes which result, directly or indirectly, from the activity of living organisms. Biological corrosion is not in itself a type of corrosion, but is characterized by the intervention of living organisms (see *corrosion*)

Biopolymer (Polymer) Polymer of biological origin (produced by living beings) (see *polymer*)

- Bitumen (Binders and bituminous materials)** Organic, very viscous, almost nonvolatile material, adhesive and impervious to water, crude petroleum derivative or present in natural asphalt, completely or nearly completely soluble in toluene
- Bitumen emulsion (Binders and bituminous materials)** Fine dispersion of bitumen in water, performed with the aid of an emulsifier
- Bituminous binder (Binders and bituminous materials)** Adhesive material containing bitumen or natural asphalt, or a mixture of both
- Bituminous mixture (Binders and bituminous materials)** Mixture of stone, sand, with or without filler, and a bituminous hydrocarbonated binder. The following bituminous mixtures can be distinguished: (1) closed or dense, when the percentage of voids is equal to or lower than 5 wt% after applying and compacting (virtually impermeable); (2) semi-closed or semi-dense, when the percentage of voids in work is less than 15 wt% and higher than 5 wt%, after spreading and compacting; and (3) open, when the percentage of voids is greater than 15 wt% after spreading and compacting
- Bituminous mortar (Binders and bituminous materials)** Mixture of sand with bitumen (3–4 wt%). In Portugal, the percentage of bitumen is not previously defined (see *mortar*)
- Blended cements (Hydraulic binders)** (1) Cements in which the clinker is partially replaced with cementitious materials or minerals during the cement manufacturing process, or (2) cements blended with cementitious materials or minerals during the preparation of grout, mortar, or concrete (see *cement*)
- Bleeding (Concrete)** Particular case of segregation that corresponds to the rise of water to the top concrete's surface and can drag fine particles, namely cement
- Block (Cork)** Large piece with the shape of a rectangular parallelepiped comprising one or more elements bonded
- Block copolymer (Polymer)** Copolymer whose chain is constituted by a sequence of different blocks, each one being constituted by a homopolymer sub-chain (see *copolymer*)
- Bond, adhesive joint (Structural adhesives)** Union of two adjacent substrates by means of an adhesive [NP 3672:1990]
- Bond strength (Structural adhesives)** Force per surface unit necessary to bring an adhesive joint to the point of failure, with failure occurring in or near the plane of the bond-line [EN 923:2005 + A1:2008]
- Bonding (Structural adhesives)** Action of bond and the result of that action [NP 3672:1990]
- Breccia (Ornamental stone)** Sedimentary rock consisting of fragments of natural agglomeration, cemented together by calcite or silica
- Brittle conchoidal fracture (Glass)** Morphology of brittle fracture in vitreous material. In brittle conchoidal fracture the fracture surface is similar to a shell surface. In brittle fracture, the forming energy of a critical crack is much bigger than the crack's propagation energy

Bush hammering (Ornamental stone) Surface finishing process that consists of creating protrusions and depressions with a puncture from 4 to 25 teeth in conical or pyramidal shapes. The finish can be made manually or automatically using an especially designed device

Brushed (Ornamental stone) Finishing processed with steel brushes giving a brushed aspect to stone

C

Calcite (Ornamental stone) Mineral composed of calcium carbonate (CaCO_3)

Calibrate (Ornamental stone) Regulate the caliber of

Calibration (Ornamental stone) Operation of making the thickness of the statutory plates uniform

Calibrator (Ornamental stone) Machine with a rotating diamond coated head that performs the calibration

Capillarity (Plaster, Stucco; structural adhesives) Phenomenon associated with the liquid flow in capillaries due to surface tension

Cathode (Corrosion) Electrode where a reducing reaction takes place

Cathodic current (Corrosion) Current involved in a reduction reaction

Cathodic protection (Corrosion) Corrosion protection achieved by a decrease in the electrode potential (down to values close or even below the equilibrium potential of the metal's oxidation reaction). It can be achieved through the use of a generator (protection through impressed current) or by the use of a less noble metal (sacrificial anode)

Cation (Corrosion) Positively charged ion (e.g., H^+ or Fe^{2+})

Cathodic inhibitor (Corrosion) Inhibitor that interferes with the cathodic reaction. Typically, these are cations that migrate to cathode surfaces where they react, creating deposits and polarizing reactions taking place here

Cavitation (Corrosion) Formation of vapor bubbles in a liquid under the action of low localized pressures, followed by the instantaneous collapse of these bubbles, producing extremely high localized pressures

Cavitation—Corrosion (Corrosion) Form of corrosion caused by the joint action of corrosion and cavitation. Cavitation causes the removal of the corrosion products, increasing the exposure of the metal to the corrosive environment (see corrosion, cavitation)

Cement (Hydraulic binders; concrete) Hydraulic binder produced by heating from a mixture mainly of limestone and clay—forming clinker and subsequently finely grinded with gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and, optionally, other additives. When mixed with water, the hydration reactions lead to the setting and hardening of the system with the ability to agglomerate other solid materials. The hardened material retains its strength and stability both underwater and when exposed to wet weather

Cementitious materials (Hydraulic binders) Designation that includes both pozzolanic materials and latent hydraulic binders, either naturally occurring or from industrial wastes. These additions take part in the hydration reactions altering the mechanical properties of the hardened cement-based materials

Ceramic tiles (wall and floor tiles) (Ceramic) thin plates made of clay and/or other inorganic raw materials, used as coatings for pavements and walls. Ceramic tiles are generally conformed by extrusion or pressing at room temperature (but may be shaped by other methods), followed by the drying and firing at temperatures high enough to obtain the required properties. Setts can be glazed (GL) or unglazed (UGL); they are refractory and are not affected by solar radiation (see *tile*)

Chamfer (Ornamental stone) Finished beveled or rounded edge

Characteristic strength (Concrete) Value of strength below which 5 % of the population of all possible strength determinations of the volume of concrete under consideration are expected to fall

Charges (Organic coatings) Inorganic substances in the form of particles, with low covering power, used in the formulation of organic coatings to increase its volume and modify their properties

Chemical tempering (Glass) Tempered produced by cation exchange between the lithium ions (Li^+) (located on the surface of the glass), and potassium (K^+) (outside environment), is performed by dipping the glass in a solution of potassium nitrate, for ~16 h at 400 °C. The exchange of potassium ions for lithium ions modifies the surface chemistry of the glass. The fact that potassium ions are larger than lithium ions makes glass surface under compression. The mechanical strength of the chemically tempered glass increases fivefold in relation to ordinary glass

Chemical modification (Wood) A treatment where a chemical reacts with components of wood (usually hydroxyl groups) resulting in a permanent chemical bond. An example of chemical modification of wood is acetylation

Clastic rock (Ornamental stone) Rock consisting of fragments from preexisting rocks which were produced by alteration and erosion and usually conveyed to a place of deposition

Cleaved or chipped slab (Ornamental stone) Facing slab with “coarse” appearance, divided into plates

Closed assembly time (Structural adhesives) Time elapsed between the time the substrates, with adhesive already applied, are brought into contact and the moment when heat and/or pressure is applied [NP 3672:1990]

Coated glass (Glass) Class of glasses (including anti-reflection, mirror, and low-emissive glasses) where a coating has been applied on a glass surface. It does not include enameling. Most common coatings are composed of metal or metallic oxide films. The coating process can be classified into two categories: *online*, when it takes place during the manufacturing process (usually inside the float chamber), and *offline*, when it occurs after the manufacturing process

- Coatings (Polymer)** Thin layer of material deposited over a surface with the purpose of protecting or decorating a substrate, in which case they are commonly referred to as paints. Polymeric coatings may or may not contain a volatile solvent, and the formation of the thin layer (film) may or may not involve a chemical reaction
- Cohesion (Structural adhesives)** Phenomenon by which the particles of a substance are held together by intermolecular forces [NP 3672:1990]
- Cohesive failure (Plaster; Render)** Rupture occurring within the mortar (its resistance being lower than that of the support), or rupture occurring at the support (when the mortar's resistance is higher than that of the support). In general, a disruption that occurs outside of the interface between the adhesive and the bonded surfaces
- Column (Ornamental stone)** Pillar based on appropriate base or executed directly on the floor having a variety of shapes, including rounded, segmented, and square, among others, serving to support vaults, entablatures, or as simple adornment
- Common cements (Hydraulic binders)** Cements whose composition, requirements, and conformity criteria are specified in the European standard EN 197-1:2000. This standard defines 27 distinct common cements including the composition of each product and the corresponding notation (that start with the letters "CEM"). These cements are grouped into five main cement types and described by their composition, main constituents, strength class, and rate of early strength development (see cement)
- Compaction (Plaster; Render)** Manual or mechanical process aimed at increasing the density of a fresh mortar
- Compatibilizer (Polymers)** Additive that lowers the interfacial tension in immiscible polymer blends and thereof enables control of their microstructure and morphology
- Composite cements (Hydraulic binders)** Hydraulic binders in which (1) the clinker is partially replaced with cementitious or mineral materials (in this case these additions are considered major constituents of cement) or (2) the cement is partially replaced by cementitious or mineral materials during the preparation of grout, mortar, or concrete (see cement)
- Compressive strength (Ornamental stone)** Physical and mechanical characteristic which assesses the ability of an element in rock (sample) to resist deformation when loaded in compression
- Concentration cell (Corrosion)** Galvanic cell formed by two identical electrodes, where the electromotive force is due to the difference in concentration of a common species in the two electrodes
- Concrete (Concrete)** Material formed by a mixture of cement, fine and coarse aggregates, and water, with or without the incorporation of admixtures, additions, or fibers, developing its properties by means of the cement hydration
- Conformity assessment (Concrete)** Systematic examination to determine whether the product satisfies the specified requirements

- Cutback Bitumen (Binders and Bituminous materials)** Bitumen whose viscosity was reduced by adding a relatively volatile fluxing (CEN)
- Cutter (Ornamental stone)** Machine used for continuous cutting (milling); side cutting tool, which is operated by a vertical or horizontal milling machine
- Curing time, Setting time (Structural adhesives)** Period of time necessary for an adhesive in an assembly to cure or set under specified conditions of temperature or pressure, or both [NP 3672:1990]

D

- Decorated glass (Glass)** Class of glasses (including silkscreen printed and rolled plate glasses) that enables light transmission to be controlled, reduces solar energy gain, and can create distinct environments, with or without visibility, defining levels of privacy
- Defect (Wood)** Physical, morphological, or anatomical singularity of wood that may limit its use
- Deformability (Render; Plaster)** Ability of a hardened mortar to be deformed under the action of stresses without destruction of the structure
- Degradation (Polymer)** Deterioration of a material with loss of performance; the development of the “degree of loss” may be monitored by successive measurements of one or more selected properties (mechanical, electrical, optical, etc.). The mechanisms involved are multiple: hydrolysis, thermal degradation, rust, UV radiation, solvents, depolymerization of others
- Degree of crystallinity (Polymer)** Volume fraction of crystallized material presented in a given volume of a polymer. In some civil engineering applications, the degree of crystallinity is considered as the mass fraction of crystallized polymer
- Degree of polymerization (Polymer)** Number of monomers per polymer chain (see monomer, polymer)
- Density (Ornamental stone)** Mass that exists in certain unit of volume or surface with length
- Desboia (Cork)** First extraction in the young cork trees
- Diaclase (Ornamental stone)** Natural crack in a rocky block, without having occurred displacement throughout the crack
- Diamond abrasive (Ornamental stone)** Generic designation of hard and wear-resistant substances used to wear and polish, in which the main component is diamond
- Diamond blades for sawing (Ornamental stone)** Steel blades in which (welded or brazed) diamond inserts or segments are integrated
- Diamond disk (Ornamental stone)** Tool whose circular contact surface with the stone is diamond (continuous or segmented)

- Diamond drill (Ornamental stone)** Tool whose circular contact surface with the stone is achieved using diamond grit (continuous or segmented)
- Differential aeration (Corrosion)** Difference in dissolved oxygen concentration at two points of the same system
- Differential aeration cell (Corrosion)** Concentration cell caused by a gradient of oxygen concentrations between the two electrodes (see concentration cell)
- Diluent (Organic coatings)** Volatile liquid, partially or completely miscible with its vehicle, which, added to a paint or varnish during the manufacturing process or at the time of application, reduces its viscosity
- Dispersion (Organic coatings)** Intimate mixture of a liquid with a solid placed in it in the form of finely divided particles
- Dome (Ornamental stone)** Construction raised in arch; arched ceiling
- Double glazing (Glass)** Structure consisting of two (or more) sheets of glass separated by a spacer bar that hermetically seals the cavity width (usually filled with dehydrated air) between the two glasses. In addition to the seal, the presence of a desiccant agent is recommended for moisture absorption inside the glass and to ensure long-term performance. The type of frame is crucial in the performance of the double glass
- Draining bituminous concrete (Binders and Bituminous materials)** Bituminous mixture of discontinuous grain size, formulated so as to obtain a significant proportion of empty interconnectors (20 % volume or more) to facilitate the passage of water (CEN) (see *concrete*)
- Dry cutting (Ornamental stone)** Cutting process without the use of coolant
- Dry pressed tiles (type B) (Ceramic)** Tiles formed from a powder mix finely milled, conformed in high-pressure molds (see *ceramic tiles*)
- Dry strength (Structural adhesives)** Strength of an adhesive joint determined immediately after drying under specified conditions [NP 3672:1990].
- Drying (Structural adhesives)** Set of physical and/or chemical transformations that cause an adhesive to pass from the liquid or pasty state to the solid state [NP 3672:1990]
- Drying oil (Organic coatings)** Liquid animal or vegetable oils that react with oxygen to form solid films
- Ductile fracture (Glass)** Type of fracture in which significant deformation (plastic deformation) of the test specimen occurs before rupture. In ductile fracture, the forming energy of a critical crack is much smaller than the crack's propagation energy
- Durability (Plaster; Render; Concrete)** Capacity of a building, system, component, structure, or product to maintain a minimum performance for a given time (lifetime) under the action of different chemical, mechanical, and climatic conditions
- Dynamic fatigue (Polymer)** Test whereby the resistance of a test specimen to a cyclic charge is measured

E

- Earlywood (Wood)** Part of the growth layer formed in the initial phase of a tree's growth period. It is usually less dense and less dark than the xylem of latewood
- Edge (Ornamental stone)** Line determined by the intersection of the planes of the faces of an element in stone. The edges may undergo different types of finishing in the final stage of preparation of the product
- Effective water content (Concrete)** Difference between the total amount of water present in the fresh concrete and the amount of water absorbed by the aggregates
- Efflorescence (Plaster; Stucco)** Formation of salt crystals on the surface of a mortar
- Elastic recovery (Polymer)** Test whereby the response (deformation) after interruption of a fluency test is measured (response to a rectangular voltage wave)
- Elastomer (Polymer; Structural adhesives)** Designation that encompasses polymers with a mechanical behavior similar to that of natural vulcanized rubber at room temperature: they can endure high deformation (over 100 %) without snapping and quickly recover their initial shape and dimensions after cessation of application of the load
- Electrochemical series (Corrosion)** List of chemical elements, ordered according to the value of their standard electrochemical (reduction) potentials
- Electromotive force (Corrosion)** Potential difference of a galvanic cell when the current flowing through the system is null
- Embedding (Ornamental stone)** Carving; damascening; introducing pieces of a different color or texture in furniture, floors, etc.
- Embossing (Ornamental stone)** Carving with chisel; to mark with stamp
- Emulsion (Organic coatings)** Intimate mixture of two nonmiscible liquids, one of them (the emulsified) being dispersed in the other (the dispersing liquid) in the form of droplets
- Enamel (Organic coatings)** Finish that generates a film with a more or less shiny appearance and characterized by a good lacquering
- Engobed tiles (Ceramic)** Tiles to which a surface coating based on clay is applied with a matte finish that can be permeable or impermeable. These are classified as glazed (UGL) (see *ceramic tiles*)
- Environmental actions (Concrete)** Those chemical and physical actions to which the concrete is exposed and which result in effects on the concrete or reinforcement or embedded metal that are not considered as loads in structural design
- Environmentally induced cracking (Corrosion)** Corrosion involving a synergistic effect between the corrosive environment and the applied mechanical stress (see corrosion)
- E-pH diagram (Corrosion)** The same as the Pourbaix diagram
- Equilibrium moisture content (Wood)** Stabilized moisture content corresponding to the environmental conditions of the site of application
- Erosion-Corrosion (Corrosion)** Increase of the rate of attack on a metal due to relative motion between a corrosive fluid and the metal surface (see corrosion)

- Extruded tiles (type A) (Ceramic)** Tiles whose pulp is conformed in the plastic state at an extruder, with the bar being cut into tiles with predetermined dimensions (see *ceramic tiles*)
- Extrusive rock (Ornamental stone)** Igneous rock brought to the surface of the earth in a cast product condition

F

- Façade (Ornamental stone)** Vertical envelope of a building
- Face (Ornamental stone)** Surface of an exposed piece of stone
- Falca (Cork)** Virgin cork, usually from pruning and mechanically or manually extracted (ax, adze), lengthwise according to the branch, presenting adherent fragments of inner bark and xylem
- False joint (Ornamental stones)** Finishing process where nonexistent joint is reproduced (see joint)
- Fatty oil (Organic coatings)** Name given to vegetal or animal oils whose basic components are triglycerides of fatty acids
- Feedstock (Ornamental stone)** Material which can give rise to one or more types of products
- Fiber (Wood)** Long and narrow cell (or group of cells) constituting a large part of the xylem (mainly arranged parallel to the axis of the trunk or branches)
- Fiber (Polymer matrix composites)** Material with a geometry in which the length/diameter ratio is >100 and is used as a reinforcing element
- Fiberglass (Plaster; Render)** Inorganic and amorphous fiber generally from silica, or modified silica, obtained by different methods ("spray," drawing of glass test specimen, etc.) and usually used for reinforcement, either in fabric or mesh form
- Filiform corrosion (Corrosion)** Occurs very often in coated or painted surfaces and consists in the development of very fine filaments between the metal and the coating, which propagate along the surface, causing delamination of the coating (see corrosion)
- Filler (Structural adhesives)** Relatively inert solid substance, generally inorganic, added to an adhesive to improve its working properties, permanence, strength, or other qualities (EN 923:2005 + A1:2008)
- Filler (Organic coatings)** Inorganic substance in the form of particles with weak coverage power that, incorporated into a matrix (paint, among others), alters its characteristics
- Filler (Hydraulic binders; Binders and Bituminous materials)** Addition of finely grinded and chemically inert, which modify the mechanical properties of the materials in which they are incorporated (cement, bituminous materials, etc.) by filling the pores
- Fillers (Polymer)** Substances added in order to occupy the free volume of the piece with lower cost materials (calcium carbonate, silica, kaolin, etc.)