# Talking about tiles...

A Guide to the standards concerning quality and features of Italian ceramic tiles













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A Guide to the standards concerning quality and features of Italian ceramic tiles



Handbook promoted by

#### Association of Italian Ceramic Tile and Refractories Manufacturers

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### Introduction

239 companies, 30,264 employees, annual production of 604 million of square meters, exports accounting for 71% of total sales: these are the figures that sum up the Italian ceramic tile industry as a reference sector on a world scale.

This leadership is based on traditions that are renewed each year thanks to constant technological innovation and new types of products. Today, Italian ceramic tiles account for 12% of world production and for 43% of the tiles produced in the European Union. Italy holds a 29% share of the world tile market. "Made in Italy" tiles are in fact sold and appreciated all over the world and are everywhere acknowledged as an expression of taste, style and quality.

Although the appeal and style of a tile are a matter of personal taste or fashion - even build-

ing materials are subject to fashion - the quality of a tile is defined by precise rules.

Ceramic tiles are one of the few materials for which rules have been drawn up that are valid throughout the world. This is because tiles, especially Italian tiles, are requested and sold world-wide.

The rules that are set out in this guide help the purchaser evaluate for himself the value of the product that he buys from the manufacturer or from the retailer and they can show off the technical properties and performance of their products.

The identification and description of the different products available on the market are based on technical as well as aesthetic characteristics that are evaluated according to the parameters set by UNI EN ISO standards.

### Regulations

As it is the case for most materials, standards exist for ceramic tiles that are not "a true law" but that serve as an official, authoritative reference and benchmark for the quality and properties of the various types of tiles. These standards are technical guidelines that allow manufacturers and retailers of ceramic tiles, as well as buyers and users, to establish - and prove - if a given product is the right one, that is to say it is of good quality. It should be emphasized that the compliance with the regulation (or standard) is voluntary: the ceramic tile manufacturer is not bound to produce tiles in conformity with the standards. It is nevertheless clear that if a manufacturer has undertaken, voluntarily, to observe the regulations, towards the user-purchaser, this conformity with the standards will become an obligation for him, that is to say a promise he has to keep.

#### Who creates the standards

The standards are defined and published by national standardization bodies in each country, established for this purpose and composed by groups and individuals active in the production, research, characterization and use of the various materials. The Italian Standardization Body is UNI (Ente Nazionale Italiano di Unificazione); the Italian



standards are known as the UNI standards. In order to promote the international market, and hence a much more free circulation of products in a variety of markets, the need for international standards

common to different nations has been acknowledged in recent decades. To equalize standards in different countries, international institutes of standardization have been established, which incorporate the national standard agencies of the individual countries. There are two international standards institutes:

• **CEN** - International Committee for Standardization (Comité Européen de Normalisation), which includes the

standards organizations of the European countries; it publishes the EN Standards (European Standards); • ISO - International Organization for Standardization, which includes all the world's national standards agencies, and publishes ISO Standards (valid all over the world). UNI EN ISO Standards are now being published for ceramic tiles. This abbreviation means

Country National Stan	dardization Body
Austria	ON
Belgium	IBN
Denmark	DS
Finland	SFS
France	AFNOR
Great Britain	BSI
Germany	DIN
Greece	ELOT
Ireland	NSAI
Island	STRI
Italy	UNI
Luxembourg	ITM
Norway	NSF
The Netherland	NNI
Portugal	IPQ
Spain	AFNOR
Sweden	SIS
Switzerland	SNV

Table 1

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that standards for ceramic tiles are valid in Italy, because they are published by UNI and that they are exactly the same as those in force in the other European countries (as EN European Standards) and in the world (as ISO World Standards).

#### What the present EN ISO Standards on tiles include

The standards in question basically include:

1. a classification of ceramic tiles into groups (types);

2. a definition of the properties that the tiles of each group must possess, in relation to their intended use;

3. a specification and description of the methods of measurement for the various properties;

4. an indication of the acceptability requirements that tiles in each group must meet for each property. The requirements are essentially limits or benchmarks which the tiles must comply with in order to be considered of good quality;

5. Additional requirements for bearing the CE mark certifying safety for the user.

#### Practical function of the standards

The regulations serve to make business relationships between manufacturers and retailers clearer and more correct, that is the suppliers of ceramic tiles on the one hand, and the buyers of ceramic tiles on the other one. Supplier and buyer can use the standards to define the product's nature and establish its benchmark properties; hence a common language provides clarity. For the same product, a supplier "promises" certain properties, pledging his commitment and responsibility to the buyer who may use the standards to verify that such commitment has been fulfilled: hence the standards guarantee fairness in the business relationship, as a way of safeguarding both parties and above all the consumer.

These are important aims, whose achievement depends on an adequate knowledge of the standards by both parties (suppliers and buyers). The person with the greatest challenge here is the consumer, who generally has no professional expertise or experience in the field.

The starting point and "key" to an understanding of the structure and use of tile standards is the classification of ceramic tiles themselves.

Two types of denomination are used: commercial and technical denominations.

#### **Commercial names**

The commercial names are the names that the dealer and purchaser use in their conversations (the names used in Italy are set out

Table 2

	Sı	urface	Body Structure		Shaping Method		
Technical-commer- cial Classification	Glazed	Unglazed	Porous	Vitrified	W.A.(%)	Press.	Extrud.
Majolica tiles	•		•		15÷25	٠	
Cottoforte tiles	•		•		7÷15	•	
Earthenware whitebody tiles	•		•		10÷20	•	
Red single-fired tiles	•			•	2÷10	•	
Whitebody single-fired tiles	•			•	2÷7	•	
Monoporosa (red and whitebody)	•		•		> 10	•	
"Pressosmaltatura"	•			•	< 3	•	
Clinker tiles	•	•		•	2÷6		•
Terracotta tiles	•	٠	•		3÷15		•
Red Stoneware tiles		٠		•	1÷4	٠	
Porcelain tile	•	٠		•	0÷0.5	•	

on Table 2). Each name indicates the prevalent use of the tile. This use is normally recommended by the manufacturer and depends on whether the tile is glazed or not, is thin, etc.

	Body color		Main sizes		Intended use			Group
Technical-commer- cial Classification	White	Other	(cmxcm)	Floor	Wall	Int.	Ext.	UNI EN
Majolica tiles		•	15x15 15x20 20x20		•	•		BIII
Cottoforte tiles		•	15x25 20x20 20x30	•	•	•		BIII
Earthenware whitebody tiles	•		15x15		•	•		BIII
Red single-fired tiles		•	10x20 20x30 30x30 40x40	•		•	•	BI-BII
Whitebody single-fired tiles	٠		30x30 40x40	•		•	•	BI-BII
Monoporosa (red and whitebody)	•	•	20x20		•	•		BIII
"Pressosmaltatura"	٠	•		•		•	•	BI
Clinker tiles	٠	•	12x24 20x20 30x30	•	•	•	•	AI-AIIa
Terracotta tiles		•	25x25 20x40 30x30 40x60	•		•	•	AII-AIII
Red Stoneware tiles		•	7,5x15	•		•	•	BI-BIIa
Porcelain tile	•		20x20 30x30 40x40	•	•	•	•	BIa

#### **Technical classification**

It must be borne in mind that the EN ISO standards are different from the Italian commercial-technical names.

The technical standards use only two classification parameters, that is:

- tile-forming method, which can be one of the following:
- A. by extrusion
- B. by pressing
- porosity, measured by determining water absorption.

These two parameters alone are used to divide the tiles into 9 groups, e.g. BIa, AIIb, BIII, etc. (see table 3, page 17).

#### Technical-commercial classification of ceramic tiles

The table on the previous pages provides a rapid overview of all the different types of tile.

This table visually indicates very important circumstances that should be borne in mind when choosing the most suitable tiles for one's requirements.

1. Certain tile types correspond to distinctive and relatively homogenous products. Others cover a range of products that vary much more widely, especially from the technical point of view. One example of a distinctive "homogeneous" product is majolica. All majolica tiles are glazed and have a porous and colored body. They are formed by pressing, are mainly used indoors and belong to Group BIII of the EN ISO classification. On the other hand, single-fired tiles, for example, are heterogeneous.

2. Single-fired tiles are, for example, used both for indoor and outdoor floors and walls. This does not mean or imply that any single-fired tile, for example, can be used for any purpose. It merely means that the single-fired tile group includes tiles that can be used outdoors and tiles that can be used only indoors. Everything depends on the technical features of the individual tile.

3. Tiles that belong to the same technical-commercial group may belong to different EN ISO groups. Each group meets different technical requirements that are set out in the product specifications. This remark elaborates on and explains the remark set out in the previous point. Example: red single-fired tiles may belong to the groups BI, BIIa and BIIb.

4. Tiles with the same EN ISO classification may belong to different technical-commercial groups. For example, majolica (double-fired) and monoporosa (single-fired, whitebody or red tiles with water absorption above 10%) belong to the EN ISO BIII group.

5. In general, tiles that are used only and exclusively for walls (especially indoor wall tiles) are thinner than floor tiles (or tiles used for both walls and floors). Tiles that are thinner than 7 mm



are suitable for walls only. Any type of floor tile is generally thicker. If wall tiles (i.e. thinner tiles) are used as floor tiles they are likely to break, so that their use is not only not recommended but is not allowed.

#### Some remarks...

The lay reader might find the existence of two separate unconnected standards for tiles strange or unjustified. In fact, the following questions spring to mind:

A. Why do the EN ISO standards propose a classification that is different from the better known and more widely used commercial classification used in the industry? Why couldn't the EN ISO standards maintain the technical-commercial classification?B. What additional information does the EN ISO classification give us about a tile? In other words, can we be sure of knowing a tile well enough if we do not know which EN ISO group it belongs to?

These questions concern practical and concrete matters, as the following answers show:

A. The above commercial classification is used only in Italy so only at a national level (for example, cottoforte, terracotta and red stoneware are typically Italian products). Different names are used in other countries for products that are to a certain extent similar to the Italian products and are to a certain extent different. The international standards cannot include and take account of all the different classifications of the different countries (almost a hundred have been counted) and of their different meanings. That is why the EN ISO classification is used as the only possible standard

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that can apply in all countries in the world. It is a general classification in which any product can be placed and it is meaningful because it is based on parameters that define many of the technical properties that characterize the different types of product. B. Knowing which EN ISO group a product belongs to, provides important information on the tile's level of porosity that enables products with different properties and performance to be distinguished although they have the same commercial classification. For example, a BIb vitrified single-fired tile for indoor and outdoor flooring can be distinguished from the more porous BII vitrified single-fired tile that is suitable only for indoor use. In addition, knowing the product's EN ISO classification enables one to find out which quality standards the product must meet. So if we do not know which EN ISO group the product belongs to we do not have adequate knowledge of the tile.

#### In conclusion:

• the EN ISO standards are the quality standards for ceramic tiles that are valid throughout the world;

 these standards divide tiles into 9 groups. Each group must meet specific quality standards in order to be judged of good quality:

• in general, in order to define and identify a tile "type" we need to know both the tile's commercial classification (e.g. whitebody single-fired tile) and its EN ISO classification (e.g. BIIa).

It must be noted that normally, both types of classification are printed on catalogues and boxes of tiles.

	water absorption, wA (in %)						
Shaping method	W	$VA \le 3$	$3 < WA \le 6$	6 <wa≤10< th=""><th>WA&gt;10</th></wa≤10<>	WA>10		
A Extrusion	AI		АПа	AIIb	AIII		
B Pressing	BIa WA ≤ 0.5	BIb $0.5 < WA \le 3$	BIIa	BIIb	BIII		

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### **Technical prop**

Technical properties are the properties that tiles must have in order to adequately and reliably perform their function as floor or wall covering. They are therefore critically important properties, on which the "functionality" and "durability" of the tiled surface depend.

The most important technical properties distinguishing the various types of ceramic tiles, and the individual products within a single type, can be grouped into some categories:

- Properties of regularity;
- Structural properties;
- Mass mechanical properties;
- Surface mechanical properties;
- Thermo-hygrometric properties;
- Chemical properties;
- Safety properties.

This classification of properties shows that the main technical properties of the tiles covered by the current standards, reflect clearly and directly:

• the main type of stress (mechanical, chemical, thermal and hygrometric), tiles will be exposed to in their conditions of use.

For example, mechanical properties measure the resistance - and hence the performance - of tiles with regard to the mechanical

### erties

stress caused by the environment and agents on the tile surface. The following equivalence emerges:

high mechanical properties = capacity of withstanding high environmental mechanical stress.

• basic user needs (needs for regularity, for safety).

#### **Properties of regularity**

These properties determine the suitability of a batch of tiles for the creation of a "regular" tiled surface, that is to say free of "irregularities" like dimples or bulges, steps between adjacent tiles, irregular path of joints, etc. Ceramic tiles are not like other ceramic products which are used individually (plates, for example). A ceramic tile is considered a "module", whose regular repetition on a surface creates a tiled surface containing tens or thousands of tiles laid out next to each other. In order that the tiled surface is visually pleasant (leaving aside questions of personal taste which led to the selection of that particular product), tiles must have specific size and appearance properties. The tiles of the same batch may show small differences in size and appearance, or small deviations from flatness. This is unavoidable, therefore these differences and deviations must be controlled to guarantee that they do not compromise the regularity of the tiling. The degree to which the various types of tiles can fulfill the demand for size regularity must be associated to the EN ISO clas-

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sification parameters, that is to the shaping method and to water absorption levels.

With extrusion shaping usually there is a less accurate control of size and of surface finishing in comparison with shaping by pressure.

This affects the appearance of the tiled surface: extruded tiles (terracotta, clinker) generally give a floor or a wall a more "rustic" look, while pressed tiles yield a smoother, more uniform surface. This uniformity is also enhanced by the possibility, with pressed tiles, of achieving relatively narrow joints, which are not easily achievable with extruded tiles. It must be noted that the differences presented here in no way constitute a value judgment in regard to quality: we are not establishing a scale of quality or value, but only clarifying a distinction regarding production technologies. It is sufficient to remember that the "rustic look" of some extruded products (like certain terracotta tiles), far from being considered a defect, is on the contrary a highly desirable effect for many environments.

As regards the role of water absorption, it must be noted that the compactness of the structure created in tiles with vitrified body (Groups AI and BI) is a result achieved with special raw materials and by firing at relatively high temperatures. The firing process in these products entails the substantial formation of a liquid phase, which then leads to an equally wide and compact vitreous phase

during cooling. All this creates a substantial shrinkage: generally speaking we can consider it to be proportionately greater where the desired level of water absorption is lower.

The formation of liquid phases during firing and size shrinkage

entail some risks of difference in dimensions. These risks, typical of vitrified products (red stoneware tiles, porcelain tile, clinker tile, whitebody and red singlefired tile with low water absorption) tend to diminish gradually as



porosity increases and eventually to disappear for those highly porous products (like majolica, cottoforte, and monoporosa, etc.), whose raw material and whose lower firing temperatures allow for a negligible liquid phase during firing and hence a very low degree of shrinkage.

It must however be noted that even with vitrified products, the observance of size tolerances is required and strictly fulfilled by most manufacturers.

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#### Structural properties

Structural properties describe the "structure" of the material that makes up the tile: specifically, its porosity or porous structure. The most important of these properties is *water absorption* (one of the two fundamental classification parameters according to the EN ISO standards) which constitutes a measure of porosity (or more precisely, of "open" porosity). It is a classification property, inasmuch as several other important properties depend upon it. The type of product that is characterized by the lowest levels of water absorption is porcelain tile; porcelain tile products available on the market have water absorption levels of under 0.5%. Products with very low levels of water absorption are also available among whitebody and red single-fired tiles, clinker tiles and red stoneware tiles; these classes however are more varied and the products they include have a much greater range of water absorption levels.

The products marked by the highest levels of water absorption are monoporosa, majolica, cottoforte and terracotta tiles.

#### Bulk mechanical properties

These properties concern resistance to loads (such as for instance the weight of people and of furniture on a floor) to which the tiled surface will be exposed, and to which it must withstand without breaking. We call these properties "bulk" since they concern the tile in its wholeness (in its "mass"), and in order to distinguish them from the "surface" properties that concern only the working surface of the tile. These properties are significant especially in the case of floors.

The mechanical properties that are measured in tiles are *modulus of rupture and breaking strength*. The modulus of rupture is a property of the material that constitutes the tile, and is generally inversely proportional to the level of water absorption (for example, it is much greater in porcelain tile, whose water absorption level is below 0.5%, than it is in monoporosa, whose water absorption level exceeds 10%). The breaking strength is instead a property of the tile, with its own structure and size. It depends not only on its water absorption but also on thickness: the thicker the tile, the greater its breaking strength. Among these properties we also include impact resistance.

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#### Surface mechanical properties

These properties refer to the working surface of the tile; they concern the resistance to scratches, tramping, treading and deterioration from the movement of hard bodies on the surface and in contact with it. These properties too are especially significant for floors, on which one walks, drags chairs and sometimes furniture, carts etc. The most important surface mechanical property is *abrasion resistance*, which measures a tile's tendency to wear down (in the case of unglazed tiles) or to alter its physical appearance (in the case of glazed tiles) as a result of the examined conditions.

As regards this property, the observations and considerations pertaining to glazed tiles are quite different from those pertaining to unglazed tiles.

For *unglazed tiles*, abrasion resistance (meaning the resistance to the removal of material) tends to increase as water absorption decreases, that is as the structural compactness increases.

Therefore the best performance is to be expected especially from porcelain tile and other types of products (like red stoneware and clinker tile) which are characterized by low levels of water absorption.

Even though the data supplied by testing abrasion resistance essentially constitute standards of quality for tiles, and do not directly indicate a tile's durability, it must be acknowledged that, as to durability under abrasive usage, unglazed tiles are absolutely outstanding. Unglazed tiles have an homogeneous composition throughout their thickness, a fact with two consequences: first, that the possible removal of material due to rubbing gradually exposes underlying layers of the tile that are substantially equal in composition and very similar, if not identical, in appearance; and second, the possibility of polishing a tile to regenerate a surface that has been somehow damaged.

The surface mechanical properties depend not only on the type of product but also, to a significant extent, on any specific surface treatment to which tiles may have been submitted either during production or after installation. Examples of such treatments are: for terracotta, treatment with various natural or synthetic substances (linseed oil, waxes ect.); in the case of porcelain tile, smoothing and polishing.

For *glazed tiles*, even more complex and challenging factors must be kept in mind.

We must first underline that *surface abrasion resistance of glazed tiles depends exclusively on the glaze*.

Therefore, contrarily to what has been said for unglazed tiles, the higher levels of abrasion resistance do not necessarily apply to glazed tiles of the groups "I".

That being said, it must be observed that the PEI class, which essentially measures the risk of aesthetic deterioration, and more

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specifically the risk of color change, also depends appreciably on the shade and chromatic texture of the surface:

it is generally higher for lighter glazes, and lower for darker glazes.



However, light glazes can show more clearly the effects of wear: a decline in cleanability, for example, may occur earlier and more visibly.

Glossy glazed tiles, whatever their PEI classification, generally run the risk of becoming opaque in high-traffic areas (since glossy

glazes are generally less hard and hence less resistant to scratching than matt glazes).

#### Thermo-hygrometric properties

These are the properties of resistance to specific temperature ("thermo") and humidity ("hygrometric") conditions, and include *thermal shock and frost resistance*, and, in the case of glazed tiles, crazing resistance. Sudden changes in temperature (which occur, for instance, when a hot pan is placed on a tiled kitchen counter) and exposure to frost (which occurs with floors and wall coverings in cold climates) must not damage tiles at all. Crazing consists in the fine cracks that may appear in a glaze due to some construction or environmental conditions. These properties also include thermal expansion and humidity expansion, which measure how much a tile may expand if exposed to higher levels of temperature and humidity.

*Frost resistance* is substantially influenced by the porosity measured by water absorption. On the basis of the frost mechanism, we can say that the tiles with lower water absorption are certainly the most reliable in terms of frost resistance. Since water cannot penetrate the interior of these materials, the process that leads to frost damage, which is normally implemented by the fact that water - by freezing - increases its volume and "pushes" on the pore walls, cannot even begin.

It must be noted, though, that among the most porous products (with porosity as high as 10%), extruded products that are neither glazed nor treated (such as various terracotta tiles) are often resistant to frost (that is, they pass the frost resistance test specified in the EN ISO standard 10545.12), while pressed products of comparable porosity rarely are.

This difference in performance is due to the more favorable distribution of the shape and of the sizes of the pores, which results from the extrusion method.

The *resistance to crazing* basically depends on the composition of the glaze: some types of glazes, used to achieve various effects, run a higher risk of crazing. For this reason, standards have included resistance to crazing among the standardized properties. The

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high porosity of the body, or rather the possible body tendency to expand as a result of exposure to high humidity, may represent a further "risk" factor, especially because defect may appear at a later time.

As regards *thermal expansion*, no substantial differences exist between the various types of tiles, though it must be noted that in general the amount of the vitreous phase in products with a more compact and vitrified body tends to somewhat increase the thermal expansion coefficient (to 7-7.5 x 10-6 °C-1, as against levels of 6-7 x 10-6 °C-1, which are instead typical of more porous products).

Finally, as regards *humidity expansion*, this is generally correlated to water absorption, although considerable variations exist, presumably due to the effects of other microstructural properties, such as the nature and the distribution of the various phases included.

#### **Chemical properties**

These are the properties of *resistance to the chemically aggressive or staining action of substances* that may come into contact with the tile surface. Chemical properties measured are stain resistance, resistance to household chemicals, acid and alkali resistance.

The compactness of the surface layer of the tile is extremely important for the resistance to chemicals: the greater its porosity, the greater the specific surface or interface that comes into contact with the chemical agent. Clearly, a greater porosity promotes the physical absorption of the substances; furthermore, the pores, because of their shape, constitute areas of penetration of the substance itself, which cannot thus be removed by even the most aggressive cleaning procedures.

As for glazed products, the layer of glaze that covers the surface makes the working surface compact and impervious. A good practical measure of this compactness is the tile's resistance class to stains: obviously, a high resistance reflects a perfectly impervious surface, while a low resistance level reflects the presence of microporous veins/channels through which stains and chemical substances may penetrate the interior of the glaze. Glazes also usually have a high level of chemical resistance, despite the fact that some colorings and decorations are quite sensitive to acids. Their resistance to alkalis, instead, is considerably greater.

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In unglazed products, chemical resistance is generally excellent for all products. Stain and soil resistance is in this case more directly correlated to compactness; hence the best performance can be expected from tile and other types of products with similar compactness. These materials are also subject to a higher firing temperature, which creates not only compactness but a correspondingly greater chemical inertia. It must be stressed though that the surface porosity which is important in order to contain the risk of chemical attack, according to the mechanism described, is not always precisely correlated to the more macroscopic porosity



which determines the degree of water absorption. In other words, even those unglazed products with extremely low levels of water absorption, can still be microporous on the surface and allow for a certain absorption of chemical or staining substances. In the case of unglazed products of greater porosity, like terracotta tiles, the initial disadvantage of the porosity and the surface permeability is corrected with the application



of the impregnation agents mentioned earlier (with the warning to use them only for indoor floors).

Properly treated terracotta floors require greater caution on the user's part than other types of floors, but their chemical resistance and ease of maintenance (cleanability) are more than adequate for many residential environments.

#### Safety properties

These properties are especially significant for the safe use of tiled areas: safety against risk of accidents or regarding hygiene for the



user. The main safety property is *slip resistance*, which is very important for tiles intended for floors in certain exterior public and industrial areas. One parameter used to measure the slipperiness of a surface is the surface friction coefficient (the higher the friction coefficient, the less slippery the surface). Safety properties also include *lead and cadmium release* (metals sometimes contained in glazes), which is especially monitored in the case of tiles whose applications brings them into contact with substances associated with food. The

most common use of this kind of tiles is for kitchen work tops. As regards slipperiness, certain types of ceramic tiles can guarantee excellent safety performance. Along with smooth-surfaced glazed ceramic tiles with a low-to-medium friction coefficient (but not lower than that of other non-ceramic floor materials), there are many commonly used types of ceramic glazed tiles with a rough surface, and unglazed tiles with surface relieves, both of which meet anti-slip requirements for all residential and industrial environments. It must further be noted that the floors for which anti-slip safety requirements are most important are generally public and industrial environments: the same environments that also have the strictest requirements for resistance to surface mechanical stress (especially to abrasion), chemical resistance, cleanability and hygiene. Since slip resistance is generally achieved by making the surface rough, effects which tend to diminish the surface's cleanability, you can easily see how, for the mentioned environments, the best selection is slip resistant tiles with especially high levels of mechanical and chemical resistance. Flooring materials which can meet these special and severe requirements are to be found mostly among unglazed tiles with low water absorption levels, like porcelain tile. There are in fact various products of this type, made with special surface relieves, that combine compliance with the antislip requirements with excellent mechanical and chemical resistance.

All the above mentioned properties are considered in the Standards EN ISO on ceramic tiles.

Some properties, it should be noted, refer only to tiles for certain specific applications (for instance for floors, or for exterior environments).

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For example:

• frost resistance is a relevant property only for tiles to be used for exterior floors or walls (in climates with the risk of frost). It is negligible for tiles for interior areas;

• abrasion resistance is a property relevant only to tiles to be used for floors, that is for areas that will be walked on.

#### **Technical specification**

A tile's technical specification consists of a document containing the list of those properties included in the standards and relevant to that tile, with the respective values obtained through measurements and tests executed in accordance with those standards.

Along with every supply the seller (manufacturer) provides one or more technical tests, carried out by the official Italian testing laboratory (Centro Ceramico Bologna) with the values of the different properties. The specification must be kept so as to verify, even after the purchase or the installation, possible presumed or real deviations with reference to what established.

For every property, next to the measured value of the tile in question, the technical specifications usually also report the acceptability requirement (when existing) for that tile's EN ISO classification group. The comparison between the measured value and the respective requirement yields an immediate assessment of the quality of the product, that is to say its conformity with EN ISO standards.

**EN ISO standards are applicable only to "first choice" tiles.** For lower grades, the requirements may differ. We can deduct that the technical specification is a sort of "identity card" through which the buyer is able to know and evaluate the tile from a technical point of view.

The manufacturer undertakes responsibility to prepare and present the tile's technical specifications.

The *declaration of conformity with the EN ISO standards doesn't constitute a complete technical specification* which should include also the data concerning certain very important technical properties, for which the EN ISO standards do not establish acceptability requirements, leaving these areas to the agreement of manufacturer/retailer and buyer/user.

The properties in question include abrasion resistance and resistance to acids and bases in glazed tiles. EN ISO standards do not establish "absolute" acceptability requirements for these properties, indicating that even glazed tiles with low levels of abrasion resistance and resistance to acids and bases can be adequate - and hence "acceptable" - for use in areas where they will be exposed to equally low levels of abrasion and chemical attack (for example, the floor of a residential bedroom).

This choice made by the drafters of the standards is certainly cor-

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rect and justified. The buyer must however be aware that the declaration by the manufacturer/retailer that "XYZ glazed tiles are of first choice and meet the requirements of the EN Standard 14411, Annex J" does not necessarily imply that these tiles are resistant to acids and bases.

This information must be supplied - and if necessary, requested - as additional information to the statement of conformity with the standards.

Secondly, a simple statement of conformity with the standards does not provide complete and suitable technical information about the tiles, even for the technical properties for which standards establish a well-defined requirement for acceptability. Consider, for example, the stain resistance of the glazed tile (Art. XYZ) belonging to Group BIIa. The requirement established by the relevant standard (EN 14411, Annex J) is that the class of resistance to each of the considered stains must be equal to or higher than 3. This means that Classes 3, 4 and 5 are considered acceptable, while classes 2 and 1 are not. Suppose that our tile has been tested and assigned to Class 5 for resistance to all stains (the highest class, assigned when the stain can be removed simply by washing with running water or cleaning with a damp cloth). The mere statement of conformity with the standards places this tile on the same level with another tile (which we will call Art. ABC), which is assigned to Class 3 for resistance to all stains (the mini-

Characteristics for different applications		Flo	oor	or Wall	
		Int.	Ext.	Int.	Ext.
Dimension and surface quality	Dimensions and appearance	•	•	•	•
	Water absorption Porosity Apparent density	•	•	•	•
	Modulus of rupture (flexural) Breaking strength (flexural)	•	•	•	•
	Resistance to abrasion (unglazed tiles)	•	•		
Physical proprieties	Resistance to abrasion (glazed tiles)	•	٠		
	Slip resistance (friction coefficent)	•	٠		
	Crazing resistance (glazed tiles)	•	٠	٠	•
	Frost resistance		•		•
	Thermal shock resistance	•	•	•	•
	Thermal expansion	•	•	٠	•
	Humidity expansion	•	•	•	•
	Small color differences	•	•	•	•
	Impact resistance	•	•		
Chemical proprieties	Chemical resistance	•	•	•	•
	Stain resistance	•	•	•	•
	Lead and camium release (glazed tiles)	•		•	

mum acceptable class of resistance which is assigned in cases where the stain is not completely removed either by running water or a light detergent and non-abrasive sponge, but only with mechanical cleaning - with a hard-bristle rotating brush and a strong detergent).

Obviously the two products have different levels of stain resistance performance: a difference which the buyer can appreciate - and 38

make use of - only if in possess of the complete technical specifications of the two products.

So, we can conclude that:

• the technical specification of a tile is the document that provides the measured values of all the technical properties relevant and applicable to the tile in question, relative to acceptability requirements, when present;

• the complete technical specification of the tile in question provides more exhaustive (and also more reliable) information on the quality and performance than can be expected.

#### The control organization

Should the need arise to control the actual characteristics with respect to those agreed upon, there is an official control organization, the only one in Italy accredited for testing and carrying out this type of control:



Via Martelli 26, 40138 Bologna, Italy tel. +39 051 534015, fax +39 051 530085, centro.ceramico@cencerbo.it, www.cencerbo.it

Main activities: consultation, analyses, testing, and controls. The certificates issued by the Centro Ceramico of Bologna are recognized worldwide.

## Areas of inten

We have repeatedly underlined how important it is that a correct and educated choice of ceramic tiles be made when considering the area of intended use and the conditions of use to which the installed tiled surface will be subject.

That is to say: "No single type of tile or single product can be considered suitable for all uses and environments".

This implies that a selection cannot be made "casually", but must consider the intended use. In this section we will try to guide the user in



### ded use

his/her analysis of the area of intended use for the tiled surface. The analysis will serve as a basis for the practical application of the technical and aesthetic standards for the selection of a type of tile that is suitable for their respective needs, as considered in the following sections.

The area of intended use and the conditions of use - that is, conditions to which the tiled surface will be exposed in the course of its useful life - are two closely linked factors.



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Let's begin with the conditions of use, which we will describe in terms of the type of stress the environment will expose the tiled surface to, and which the tiled surface must withstand over time. Such stresses can be classified as follows:

• Mass mechanical stress: mechanical stress on the tiled floor or wall, to which these surfaces respond and react in their whole-ness.

• Surface mechanical stress: mechanical stress upon the surface of the tiled floor or wall.

• Chemical stress: chemical aggression on the used surface and sometimes on the underlying strata as well, produced by chemical substances of different nature, which come intentionally or accidentally in contact with the tiled surface.

• Hygrothermic stress: stress connected with the exposure of the tiled surface to particular conditions of temperature and humidity.

The areas of intended use and, consequently, the conditions of use of the tiled surfaces can be characterized in terms of the predictable level of the various classes of stresses (level, that can be from very high to very low).

A qualitative characterization can be made using standards of classification for environments as described below.

#### Horizontal or vertical positioning of the tiled surface

Whether the tiled surface is a floor (horizontal positioning) or a wall (vertical positioning) is important especially with regard to mechanical

stress. A floor is meant to sustain loads. while a tiled wall needs only to sustain its own weight. For a ceramic floor. composition and size are significant in order to determine load-bearing capacity, while for a ceramic wall, the most



important factor is the bond strength between the tile and the bed. Superficial mechanical stress reaches remarkable levels only for floors, while the levels for walls are virtually negligible.

#### Location, interior or exterior

This factor is important especially in relation to the conditions of exposure to hygrothermic stress: conditions which are often severe outdoors (weather, sun, frost, broad temperature ranges, prolonged contact with water, etc.), and usually mild indoors. Indoor areas with high levels of hygrothermic stress include, for example, cold storage areas, which are often covered with ceramic tiles; or areas whose function involves a high level of steam and prolonged contact with water (bathrooms, laundry rooms, industrial environments, etc.).

### Intended use of the building or the area: private or public, residential or industrial

Private residential spaces are generally exposed to relatively low levels of stress, except in cases that will be detailed in the next paragraph. Public spaces with heavy traffic (meeting halls, stores, churches, etc.), with trolleys and other means of transport (supermarkets, shopping malls or centers, waiting rooms and corridors of subways, stations and airports) are generally subject to extremely high levels of mechanical stress, especially surface stress. Chemical stress is high as well, due in part to the risk and frequency of contact with chemicals, but mostly to the particular demands for rapid and effective cleaning, which require vigorous methods of chemical and mechanical cleaning. In some areas, such as hospitals, schools, and restaurant or cafeteria kitchens, hygiene is a priority requirement: this need for thorough cleaning tends to raise the level of chemical stress. To this picture we must add more safety requirements, typical



of high traffic areas: safety from risks of falling (hence floors must have suitable levels of slip-resistance), safety from risk of fire, safety from risks connected with static electricity.

Industrial areas, depending on the specific manufacturing activities involved, are generally exposed to extremely high levels of every kind of stress.

#### Peculiar conditions of the room

Substantial differences, especially in the level of surface mechanical stress, can exist between different rooms in residential spaces. Such differences must be considered in relation to the following factors:

- use of the room: levels of stress range from the very low, as on floors of bedrooms and bathrooms of the night area, to much higher levels in halls, corridors and stairs, especially where unidirectional traffic stresses the central pathway;

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- location of the room and conditions of access: especially high levels of abrasion stress are predictable in rooms with direct access from outdoors, especially in cases where the outdoor walkway is covered with abrasive and loose materials that may adhere to footwear;

- use of the residence: this factor influences not only the intensity of traffic but also (and especially) the length of exposure to stress. It is clear that a private vacation residence, occupied for only a month or two a year, is subject to less stress than a residence lived in all over the year.

#### Technical criteria of selection

The previous analysis of the areas of intended use suggests important guidelines in the selection of tiles, which, as we have shown, are available in different types, with various degrees of resistance to different types of stress, as documented in the relative technical specifications.

The basic technical criterion which the users must consider in choosing a type of tile suitable to their respective needs, is the fact that the *selected tiles must have mechanical, chemical and hygrothermic properties which are adequate to the relevant levels of stress.* 

In other words, an area with high levels of mechanical surface stress will require tiles with a high degree of resistance to mechanical surface stress. The non-compliance with this criterion will inevitably create a risk of rapid and serious deterioration of the quality of the tiled surface, even though the type of tile selected is of good quality (e. g. it meets all standard requirements for that type of product). The analysis of the area of intended use also suggests further important design guidelines regarding the choice of materials for the other layers of the tiled surface (especially the fixing layer, that is the mortar or the adhesive), and also regarding the most suitable design solution.

#### Aesthetic criteria of selection

In order to fulfill their function as floor and wall coverings, ceramic tiles must also meet aesthetic and design requirements: since they become a part of an environment's furnishing (or of the urban furnishing) they have a substantial visual impact on the environment in which they are installed.

The aesthetic properties of ceramic tiles, or rather the critical parameters or considerations for the satisfaction of aesthetic and design requirements, are basically three:

• the *size* and shape, that is the shape (square, rectangular, etc.) and size of the tile;

- the color;
- the decoration.

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These are clearly associated with the tile surface. The support, or body of the tile, meaning the part below the usable surface which is thus not visible, is absolutely irrelevant aesthetically (although it is of critical importance technically).

For every type of tile we have considered in the previous chapters, there are many thousands of products available on the market, all differing from each other as to the properties in question. Let's see how.

#### Size and shape

The size and shape of tiles significantly affect the visual impact of the tiled surface. The "density" of the texture of the joints is in fact a function of a tile's size and shape: the texture appears increasingly dense and "visible" as the size reduces, while conversely it appears larger and less conspicuous if the size is larger. The visual weight of the framework of joints may be varied, within limits, by altering the thickness of the joints and the color of the material used to fill them.

The most common shapes for ceramic tiles are the square and the rectangle. Although these shapes are very simple, they yield a wide range of solutions, with an extremely diversified visual impact, even using the same tile.

You only need to change either or both of the following factors: the path of the joints from continuous joints in both directions to offset joints, or the orientation of the joints in relation to the sides or the axes of the surface to be covered, parallel or diagonal or both.



Further solutions are made possible by combining tiles of different size.

If we consider all the design possibilities available within the same shape, with available sizes ranging from mosaic (with an area less than 90 cm<sup>2</sup>) to slabs of 60 x 60 cm and larger, we can see that the range of aesthetically diversified solutions available is almost limitless.

It must be stressed that this variety of size and shape, and especially the availability of large sizes for some products like porcelain

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tile, are available today but did not exist until some years ago. They are the result of intense and on-going research and development both in technology and in production, on which the Italian industry depends to reinforce its position of world leadership and its competitive status.

Besides the square or rectangular shapes, others exist as well (hexagon, octagon, provencal, moorish, octagon, inset, etc.).

#### Color

In the case of glazed tiles, the color of the working surface is given by the glaze which, as we have noted, is a thin glassy layer covering the surface. The palette of colors available for ceramic glazes is virtually infinite: every basic color, every shade, every tonality can be technically produced, using the appropriate pigments and glaze. For the same color, tile surfaces may vary in gloss (glossy or non-reflective, the latter called "matt" in the ceramic sector) and in chromatic texture. In brief, absolutely any color should be achievable in glazed ceramic tiles.

In the case of unglazed tiles, the issue is more complex. We consider the color is basically the same for the body, and in fact depends on the body; this clearly limits the range of solutions. In a product like terracotta, the limited color range is not considered a "limit" but a virtue, a characteristic and identifying aspect: terracotta is beautiful, appreciated and sought after precisely

because it is of that typical color ("terracotta" color): a color that evokes nature and tradition: a color to be enhanced (but not changed) by the treatments generally applied to tiled surfaces. Porcelain tile does not have a similar uniqueness of color, so



that the evolution and development of new products and solutions has taken a completely different direction. From the neutral shades - from ivory white to gray - to which porcelain tile was limited a few decades ago, when it was a strictly technical product with high performance properties meant for use in areas with few aesthetic requirements, it has gradually developed to include a

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wider range of solid colors and subsequently granular color textures and imitations of some natural stones (among the commercial names introduced are terms like "ceramic granite" and "ceramic porphyry"). New developments in this product type are in the area of increasingly accurate reproductions of natural stone. These objectives are achieved, technically, by modifying the composition and the treatment of the initial powders, and by modifying the surface through techniques that create special effects (like veining, shades, color blends and the like). This wealth of color solutions is further enhanced by the possibility of creating glossy and reflecting surfaces through polishing. Many porcelain stoneware products are thus available on the market with both untreated and polished surfaces.

#### Decoration

As regards decoration as well, considerations differ for glazed and unglazed tiles. For glazed tiles, the range of possible decorations is unlimited, thanks in part to advances in the techniques of decoration. Silk-screening makes it possi-



ble to reproduce any design or photograph, however complex and multi-colored, on the surface of a tile. Any shade, any chromatic texture can also be achieved with specific glazing techniques. Some particular decorations can even be created on the glazed surface after firing. Tiles decorated in this manner are then subjected to a further firing (third firing). Part 3

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Some decorations are "accomplished" within a single tile (so that each of the decorated tiles in a batch are identical), while others involve several tiles, to be installed in such a way as to create a complex and larger pattern. The result obtained can approximate the look of a painting or a fresco.

Unglazed tiles are usually not decorated (except for the engobes sometimes applied to products like red stoneware).

Once again porcelain tile is the exception: research on this product has led to the development of special decorating techniques with interesting results. Silk-screens, penetrating salts, decorated inserts, satin-finish motifs on a glossy tile base and glossy motifs on a satin-finish tile base are just a few examples of the ever increasing range of possibilities available. Both for glazed tiles and unglazed tiles - obtained after pressing are also available decors and relieves, carried out using special moulds.

It should be noted that the reliefs achievable can serve a technical as well as an aesthetic function: in fact they feature specific levels of slip resistance, as required for specific environments and applications.

How best to take advantage of this wealth of solutions that ceramic tile puts at the user's disposal? A detailed and in-depth discussion of the design criteria of a ceramic tile, from an esthetic and furnishing point of view, would carry us into a field that is extremely wide and fluid, and in continuous evolution, hand in hand with ever more rapid changes in taste and fashion.

The fundamental rule that can be suggested to the potential customer - if he would like to be the "designer" of his own tile, without taking advantage of the advice of an architect - is to begin, in this case as well, from a careful analysis of the area of intended use. Its dimensions, the amount of tiling, the use and the location where the tiles are to be installed, the lighting conditions, the furniture and furnishings that will be located in that environment, the color, the chromatic texture and the material with which the walls will be covered in that environment, are all fundamental aspects to be considered.

The tiling must insert itself into this environment harmoniously and increase its value according to the personal tastes of the user. For this to happen, there must be an equilibrium, for example, between the size of the tiling and the tile shape, between the color tones of the tile and the furnishings and the lighting, etc. The buyer, in making his own choice, must force himself to think about the finished tiled area rather than on the individual tile on a display card that he is given in the showroom:

the finished tiled area placed in the environment where it is to be installed, that is the fundamental aesthetic criterion of selection.

Ceramic tiles are one of the few materials for which rules have been drawn up that are valid throughout the world. This is because tiles, especially Italian tiles, are requested and sold world-wide.

The rules that are set out in this guide help the purchaser evaluate for himself the value of the product that he buys from the manufacturer or from the dealer and they can show off the technical properties and performance of their products. The identification and description of the different products available on the market are based on technical as well as aesthetic characteristics that are evaluated according to the parameters set by UNI EN ISO standards.











