

PART 3

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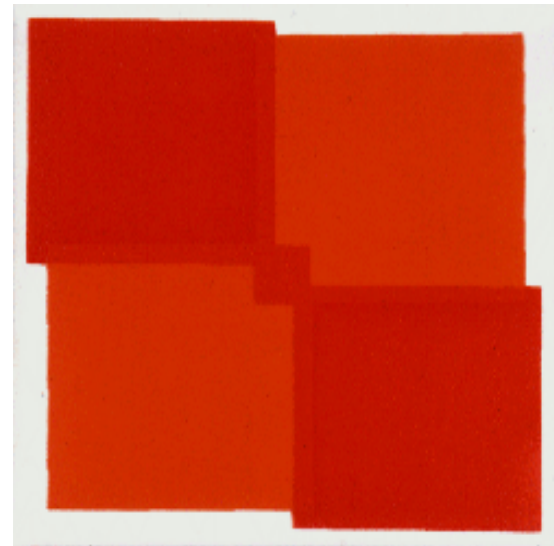
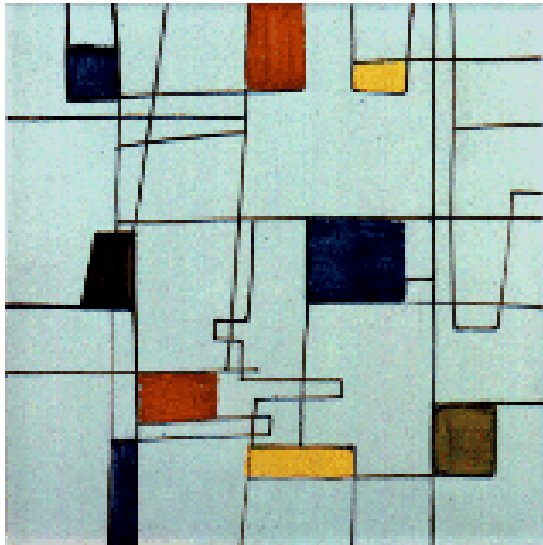
Tiles

to

Tiled surface

Introduction

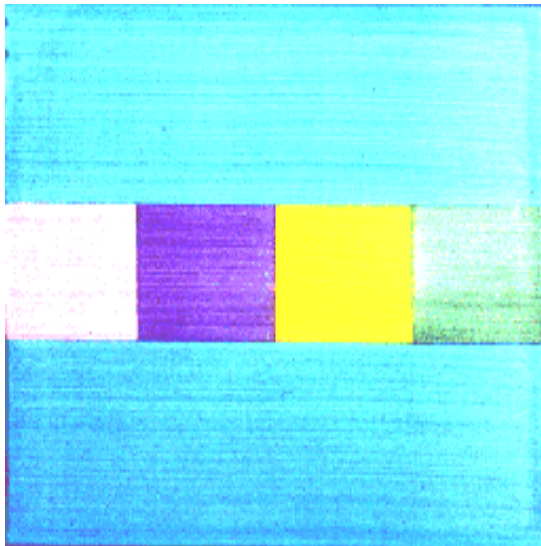
By the conclusion of the previous stage of their inquiry, the Homeowner and the Specifier had identified the types of tiles that, among all those available on the market or offered by their vendors, best suited their specific technical and aesthetic needs.



We will now attempt to show the Homeowner and the Specifier how a tile that is strictly speaking “suitable and well-selected” may not necessarily guarantee a successful tiled surface, according to the terms used in the diagram on page 171.

It could be said that the same difference – and distance – exists between tiles and a tiled surface as between a piece of fabric and a dress.

Just as the choice of a fine, suitable fabric is necessary but not sufficient



for the making of a quality dress, which also requires the all-important contribution of an expert designer and an expert tailor, so a successful tiled surface requires not only well-chosen quality tiles, but also: [a professional specifier and a good installer](#) (possibly in the same person).



Tiles in the hands of the specifier/installer constitute the original raw material, like fabric in the hands of the designer/tailor. But a further factor consists in the final user, the Homeowner, who plays his own part in the success of the installation through correct use and maintenance.

These simple observations, which are only common sense, suggest the outline of this final part of this manual, from **tiles** to **tiled surface**. This is still another technical stage, apparently more complex than it really is, at least to the Homeowner: that in most cases he can tranquilly expect accurate and competent support from all of the workers involved.

Section § 3.1 focuses on the **planning** stage. A tiled surface is a “Costruction system” that requires the preparation of a detailed plan, drawn up by a specialist, before the surface can actually be installed.

The plan for a tiled surface must specify the following:

1. the installation technique (for example, with grout or adhesive) with appropriate materials;
2. any treatments or additional layers to be applied to the background;

3. the width, direction and orientation of the joints between tiles;
4. the location and dimension of any deformation joints.

Once the plan has been drawn up, an **order** must be drafted for the proper quantity of tiles. **Section § 3.2** considers this aspect, as well as the confirmation of the lot of materials received, and its safe storage pending installation.

Section § 3.3 illustrates the various aspects of **installation**, or of the construction of the tiled surface, in keeping with the above-cited plan. This section focusses on the ways in which the different stages of installation can affect the final quality of the tiled surface. Some general rules are suggested which should be observed for an optimal installation. The quality of the installation undoubtedly depends on the professionalism and skill of the installer, but also on the extent to which the Homeowner and the Specifier help the installer do his job. This section also aims to sensitize the user to these concerns.

The “success” of a tiled surface – and especially its endurance over time – also depends on the careful **use** of the tiled surface as well as the use of appropriate methods for its special cleanings and, even more importantly, for **regular maintenance**. **Section § 3.4** considers this issue, which often involves the direct

participation of the Homeowner.

This last stage – and the entire process reviewed in this manual – concludes with a discussion of the **possible defects of tiled surfaces**. **Section § 3.5** aims to sensitize readers to the risks created by not observing the guidelines proposed in this manual (for example, by using tiles, adhesives or other materials of low quality or with performance levels inadequate for their areas of intended use; or by using a careless, inadequate plan, by poor installation, or the like). The prevention of defects depends on a keen awareness of these risks, and a realization that *most defects* in tiled surfaces cannot be corrected once they have appeared except by replacing the tiled surface; while *all defects*, by contrast, can be prevented.

Such prevention, and thus full user satisfaction with ceramic tiles, requires the participation of all parties involved, from the manufacturers of tiles and other installation materials to the vendors, from builders to specifiers, from installers to the users themselves.

We trust that this guide – whose authors are academic researchers and not members of any of the cited industry categories (except that of consumers, of course), may make its own modest but not insignificant contribution to the successful use of ceramic tiles.

**IDENTIFYING THE TYPE OF
CERAMIC TILE SUITABLE FOR
THE ENVIROMENT
AND FOR THE USER'S NEEDS**

3.1

Planning the tiled surface

3.2

Tile Consignment

3.3

Installation

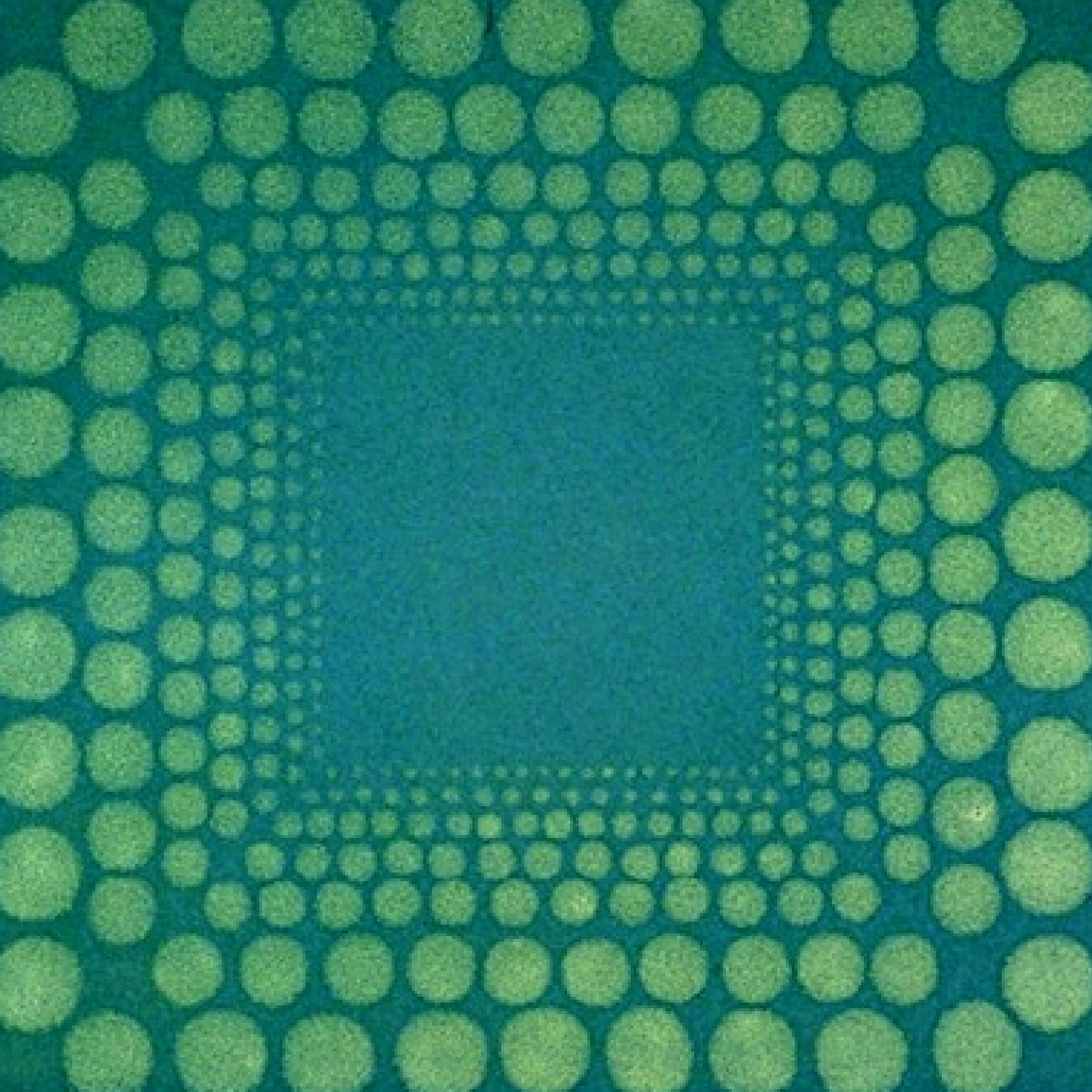
3.4

Use and maintenance

3.5

***Defects and complaints:
prevention and management***

**A SUCCESSFUL TILED
SURFACE:
• BEAUTIFUL •
• DURABLE •
• SAFE •**



3.1 - Planning the tiled surface

A tiled surface is a “construction system” that requires careful planning in advance of its actual assembly. Such a job requires a technical expert, like our Specifier, on whom



the Homeowner can depend. The building constructor, the vendor of tiles installed (that is, the supplier of both tiles and installation work), and the installer himself can in some cases fulfill this planning function. All that

Analysis of the setting conditions: the background of the tiled surface

Setting conditions regarding “intended area of use” and “selected tiles, with technical specifications” have already been considered in detail in the second part of this manual. We now consider the properties of the surface to be tiled (the background of the tiling).

Horizontal and vertical structures suitable for covering with ceramic tiles can be of various sorts of materials, construction, dimensions, etc. Such structures represent the load-bearing layer

of the floor or wall. Floors structures may be made of layers of reinforced concrete (either poured in situ or prefabricated); of mixed brick-concrete floors; of concrete-steel floors, etc. Walls, instead, may be made of heavy claybricks or concrete blocks of cement conglomerate or reinforced concrete, or they may be prefabricated panels of wood-concrete, reinforced concrete, plasterboard or the like.

Without examining in detail the various types of structures, we will stress that the structure to be covered in ceramic tiles plays a critical role in determining the proper tiling plan for

the wall or floor, and also determines the appropriate installation techniques.

The conditions, properties and structural behavior that must be known, at least qualitatively, before planning a ceramic wall or floor, are the following:

□ condition of the surfaces:

an examination of the surfaces at the planning stage will determine if the application of an additional levelling layer is needed, or a thorough cleaning of the surface to eliminate loose pieces; or a preliminary treatment

of the surface with special products like a primer (a synthetic resin-based product in an aqueous dispersion which is applied to a surface and dries to form a dense, shiny film that protects the porous bisques from humidity, consolidates the surface and increases the efficacy of the adhesives). The state of the surface may also affect the choice of adhesive;

□ dilatometric behavior, or dimensional variations during the curing stage:

this aspect should be considered for all materials composing the floor and wall-covering system, since it affects the behavior of the multi-

layer complex during use. Consider, for example, thermal expansion: it is well known that every material has its own characteristic range of variation for the coefficient of thermal expansion, so that its dimensions will vary in response to a given variation of temperature. What must be remembered, in the planning of a the floor or wall-covering, is that because the layers composing the system are tied together, they are not free to move and alter their dimensions: and because they are bonded to each other, variations in temperature will inevitably create

matters is that a tiling plan be drafted in accurate detail.

The requirements of a tiling

The specifier who prepares a tiling plan must

begin with a thorough familiarity with the requirements for a successful tiled surface.

A successful tiled surface must be:

□ **regular and harmonious:** that is, flat and even, without bumps or dimples, with straight,

tension. This is an important matter, considering that, in a country like Italy, an exterior floor or wall may be exposed to temperatures ranging from -10 to $+40$ °C at the change of seasons, or from day to night, or during extreme weather conditions.

Among the materials used in the types of structures considered, the one most subject to size variation at the curing stage is concrete. As is commonly known, concrete undergoes substantial and irreversible shrinkage during its lengthy curing stage. Such behavior must

be kept in mind when planning a tile job, especially in cases where tile is being installed to cover large surfaces, in environments characterized by substantial temperature shifts and on concrete background;

□ **modulus of elasticity and sizing:** the mechanical properties of the structure, and especially the modulus of elasticity of its material, are important since they determine the behavior of the structure under actual weight-bearing conditions, and make

it possible to gauge the likelihood that deformations may occur due to vibrations or loads, even within the limits of resistance calculated in the planning stage, and even if the sizing of the structure was properly calculated. The planning stage must of course take into account the structure's possible deformations during use, considering that the tiles themselves are extremely rigid and thus almost undeformable;

□ **composition and structural articulation:** all types of structures have joints between

contiguous parts which allow for at least some shifting between the parts. These include *construction joints*, which are used when the structure is constructed out of bands or panels, or at points where work is suspended at the end of a day; *expansion and contraction joints*, which function to compensate, respectively, for temperature and humidity deformations of the structure itself, and for shrinkage due to the curing of the cement. The location, development and dimensions of these joints must be known,

since these joints must continue also in the tiling;
 □ **shape and dimension of the surface to be covered:** this may affect the choice of tile shapes, their disposition, the installation method (closed or open joint). As noted earlier, the dimension of the surface may require expansion joints, and the available thickness may influence the choice of an installation technique (with cement mortar, which implies a thick bed installation, or with adhesives in a thin bed).

regular joints without steps or the like;

□ **intact**, or without detached pieces or breaks;

□ **durable**, or able to fulfill its technical and aesthetic functions over an extended period of time without deteriorating;

Installation techniques: cement mortar thick bed installation and adhesive thin bed installation

For the bonding layer - the layer on which the tiles are applied and which insures anchorage to the bisque – two general options exist:

□ **cement mortar**, applied in a “thick bed”(of about 3 to 5 cm);

□ **adhesive**, applied in a “thin bed” (of about 1.5 to 5 mm).

Clearly, these two types of bedding materials are associated with two distinct techniques of installation. A major difference regards the thickness of the double layer of tile/

bedding: in cement mortar installation, this amounts to about 5-6 cm, as against 1-2 cm in installation with adhesives. This difference has an obvious effect on the thickness and weight of the floor/wall covering system, as well as on the composition of the system itself.

Cement mortar installation (traditional installation)

Cement mortars are mixes that are prepared in the building yard, part binding material (cement and/or lime), part inert (sand) and part water, with the appropriate amount of water so that the mixture is pasty, yet



□ safe as regards events that may cause harm to people (like falls from slipping).

Setting conditions

The development of a plan requires

knowledge of certain basic information. In the case of tile jobs, the “setting conditions” which the planner must be familiar with and evaluate include the following:

□ the properties of the surface to be tiled,

wet enough for the binding material to attain its proper consistency and mechanical resistance. The layer in direct contact with the tiles has a higher cement content, thanks to a “dusting” with a thin layer of pure cement that must then receive enough water during the tapping of the tiles.

The composition of cement mortars used for the installation of ceramic tiles is generally between 200 and 350 kg of cement per m³ of sand. Important parameters are the granulometric distribution, the morphology, the purity of the sand

(dangerous impurities consist in clay-like fractions, organic residues, soluble salts), and the ratio of water to cement. As noted earlier, the setting and hardening of the cement causes some variation in size and particularly some shrinkage, more so when the cement content is greater and when the ratio of water to cement is higher. A cement content which is greater than the level indicated above may thus be dangerous, despite the fact that it clearly enhances the mechanical properties of the bedding. The water/cement ratio may also affect the microstructure of the bedding, whose

porosity generally increases as this ratio increases.

Mortars of such composition thus allow for the creation of a bonding layer which is quite thick and:

- structurally compact;
- very rigid and thus almost undeformable, mechanically fragile and thus unable to withstand plastic deformations;
- with a good degree of adhesiveness;
- resistant to frost and to humidity;
- only moderately resistant to chemicals.

Installation with adhesives

The selection of adhesives is far broader.

Practically speaking, adhesives can be classified into two general categories: **cement-based and organic.**

Cement-based adhesives are essentially cement mortars that are pre-measured and sold in powder form to be mixed with water when used. They consist of cement, sand of the proper fineness, resins, and other additives which basically function to enhance the adhesive’s retention of water and make it more adhesive. The function of the water-retaining additives is essential: these absorb the water of the mix and

make it available to the binding element so as to promote setting and hardening. For these additives to work properly, the adhesive must be spread in thin layers, a technique which is absolutely inappropriate for conventional mortars.

In general, from a chemical-physical and a mechanical point of view, adhesives of this kind do not differ substantially from conventional mortars: they have a relatively compact structure, are frost-resistant and moderately resistant to chemicals, and offer adequate levels of

which will constitute the background of the specifications.
tiled surface;

□ the intended destination environment of **The contents of the plan**

the tiled surface;

Based on this information, the specifier must
establish and specify:

□ the selected tiles with their technical

adhesiveness. As cement mortars, however, these adhesives are also rigid and mechanically fragile, which fact must be carefully considered in relation to the fact that the bonding layer is quite thin. This is the major limitation in the use of this type of adhesive, which is strongly discouraged in all applications on structures that are very flexible or evidence substantial shrinkage from curing. The typical drawbacks of cement adhesives in powder are at least partially overcome by the “two-component cement adhesives” or the “cement adhesive

systems”, consisting in a powdered ingredient (for example, a cement adhesive of the type described above) to be mixed at the time of installation with a liquid ingredient (an aqueous dispersion of organic polymers). These adhesives are superior to their precedents in terms of adhesiveness and cohesion (and are thus recommended for particularly stressed environments, or for the installation of tiles with a very compact, vitrified structure, or for installation on a preexisting tiled surface), as well as their resistance to water and to frost.

They are also fairly flexible, and therefore appropriate (that is, functional) with backgrounds of a certain dimensional instability.

Organic adhesives are of two types. First, *those in dispersion or in a ready-to-use paste*, which are essentially pre-made aqueous dispersions with resins of various types (acrylic, vinyl, etc.), fillers and various additives; and second, *adhesive systems with reactive resins*, to be mixed at the time of use, which have a synthetic resin base (epoxy, polyurethane, furanic) with the appropriate

hardening agent. In the former of these types, the hardening occurs after the evaporation of the water; in the latter, after a chemical reaction.

Organic adhesives in dispersion are easy to use and highly flexible, but they possess properties that limit their field of application to interior wall coverings. Adhesives with reactive resins, by contrast, are highly elastic and flexible (polyurethane adhesives, for example), possess great chemical resistance (like epoxy adhesives), and are effective even with materials and surfaces that prove

problematic to other types of adhesives. They are used in special applications that require bonding layers with especially high mechanical and chemical resistance.

The principal advantages of cement mortar installation are the mechanical resistance of the system produced, and its capacity to adapt to irregular backgrounds; the disadvantages or limits regard the greater thickness and weight of the system, the longer time required for some phases of installation, and its limited chemical resistance.

- the **installation technique**: specifically, the type, composition, thickness and manner of application of the bonding layer which anchors the tiles to the background. This layer may be composed of a thick bed (as is traditional), or
- of adhesives of various types;
- other **treatments to be used, or supplementary layers to be applied to the background**;
- the **width, direction and orientation of the joints between tiles**. The specifier must establish

Correspondingly, the advantages in using adhesives regard the broader array of products available, making it possible to achieve greater resistance to environmental stress...a lighter and thinner system (in cases where the tile/adhesive layer is applied directly to the load/bearing structure so that a complementary screed is not needed)...and the greater speed of some stages of installation. On the other hand, special care must be taken to insure that the thickness of the adhesive is kept strictly constant (since differences in

thickness generally cause shrinkage and tension that threaten the stability of the system), and the tiles must be installed on surfaces that are as smooth and regular as possible. Adhesives thus often require the application of an additional layer to insure a level and regular surface.

Grouts

The selection of materials for filling the joints between tiles – or grouts - is no less important a consideration in the planning stage than is the selection of tiles, since the joints are an integral part of the floor or wall surface and play an

important part in both its appearance and its technical performance. Here too there are various types of materials to choose from:

- **conventional cement mortars**, consisting in relatively liquid mixes of cement, fine sand and water;
- **ready-to-use cement adhesive mortars in powder**, (containing sands, cement, synthetic resins with various additives), to be mixed before use with water or with an aqueous dispersion of organic polymers;
- materials with a reactive resin base (especially epoxy resins).

Unlike conventional cement mortars, which produce only gray or white joints (depending to the quality of the cement and sand used), the materials cited can absorb a variety of colors and are commercially available in various shades. It must be noted, however, that they are also quite different in terms of their chemical-physical and mechanical resistance. **Cement-based materials** are more rigid, less flexible, and are thus at risk of cracking from shifts or differential movements between the covering layer and underlying

layers. Such cracks create areas where dirt, water and chemicals may penetrate to the heart of the system, with obvious attendant risks. As we have noted, in the area of chemical resistance, cement mortars have a low resistance to acid substances and various staining agents. The use of latex with suitable properties makes the material less porous and thus appreciably improves the resistance to chemicals and stains; it also somewhat increases flexibility. **Materials with a reactive resin base (epoxy grouts)** are superior to those described above

and specify – in agreement with the user or whoever has selected the tiles – whether the installation calls for closed or open joints, with “continuous” or “not continuous” joints, with parallel or diagonal positioning. The specifier must also select and specify the material to be used in filling the joints. It must be noted that the type and direction of the joints will have a notable effect on the appearance, cost and technical aspects of the

especially in their chemical resistance; they are thus the only suitable choice for areas exposed to such stress, like laboratories and chemical, pharmaceutical and food plants. Grouts must be selected keeping in mind any possible negative impact such materials may have on the tiles, as well as the level of resistance to expected stress in the area to be tiled. An example of such a negative impact is the way in which such materials may soil glazed and unglazed tiles that are microporous. Such tiny pores can absorb the finest

particles of the grouts. This can be tested prior to installation.

Joints: width and direction

In terms of joint width, there are two basic methods of installing ceramic tiles:

- **“closed joint”** installation, in which tiles are placed right next to each other; in this case, the joint consists in the narrow space that inevitably remains between contiguous tiles, between 0 and 1-2 mm wide, depending on the size of the tiles;
- **“open joint”** installation, with joints wider than 2-3 mm.

As we have clearly shown in section 2.7, the use of one or the other system will substantially affect the appearance of the tile surface: closed joint installation yields a more uniform and continuous surface, while the joints created by open joint installation create a sort of pattern on the tiled surface which, given the various colors available in filling material, can also serve a design function. It must be noted that open joint installation is a longer and more laborious process than the closed joint method, and therefore also more costly – not an



insignificant detail. Normally, the open joint method of installation is required for extruded tiles like terracotta and clinker tile, since this type of

shaping does not generally guarantee enough stability in the dimensions of the tiles to allow the tiles to be placed side by side.

job in question. For example, closed joint installation highlights the continuity of the surface and is faster and more economical, but has the disadvantage of creating a more rigid tiled surface which may entail, under some environmental and structural conditions, the risk of that tiles may buckle and loosen. It also entails a greater difficulty in achieving regular path of the joints and greater difficulty in filling joints in a uniform



In the case of pressed tiles, both installation methods may be suitable. For floors especially, though, a number of circumstances must be carefully evaluated case by case during the planning stage, since they may dictate the choice of open-joint installation as safer and more reliable. Such circumstances are as follows:

□ *open joint installation allows for an appreciable reduction of the modulus of elasticity, and thus the rigidity of the covering layer:* in fact, while in closed joint installation the layer of tiles can be practically considered a continuous slab, as rigid as a single tile, in the open-joint installation, by contrast, especially where joints are filled

with a deformable grout, the covering layer has its own structural articulation, with distinct elements that have a slight freedom of movement. Under these conditions, movement among the layers making up the system will generate considerably less tension in the wall- or floor-covering than it will in surfaces installed with closed joints. Thus this system of installation reduces the risk of buckling and detachment of floor tiles;

□ *installation with open joints reduces the effects caused by differences in size between tiles.* In

closed joint installation, it may be difficult to achieve a perfect fit between two contiguous tiles, even if tiles comply with the requirements fixed by norms for dimensional characteristics. In other words, closed joint installation may make even minor discontinuities and irregularities at the joints evident enough to alter the appearance of the tiled surface. The more distinct separation between tiles in open joint installation helps to minimize such an effect on the appearance of the surface;

□ *open joint installation makes it*

easier to fill joints evenly and durably. In fact, in closed joint installation, the joint consists essentially in the extremely narrow space that inevitably remains between one and another tile: this fissure, of necessarily variable dimensions, is difficult to fill and is often filled unevenly, even though the grout is fairly liquid. This creates the risk that parts of the grout will detach so that dirt, water and other substances may penetrate, including chemical substances that will create a breach to the interior of the system. From this point of view, open joint installation is less risky or problematic.

and stable manner. For these reasons, open joint installation, with joints a few millimeters wide between the tiles, is considered the most reliable and safe solution (in contrast to closed joint installation which in some countries is



Despite these risks, **closed joint installation** is the most popular in Italy. By contrast, current regulations on the installation of ceramic tiles in many other countries (including Germany, France, Belgium, England and the U.S.A.) specifically require open joint installation, with joints whose width depends on the tile format but must exceed 2 mm.

The appearance of the tiled surface is affected not only by the size of the joints but also by the layout of the tiles, and thus by the direction of the joints. This aspect too has been considered, in its design and decorating implications, in section

2.7 above. The type of joints used has technical implications. The tiled surface is less rigid, all things being equal, when joints are straight. When joints are not straight the tiled surface has a higher degree of rigidity.

Expansion joints

Expansion or deformation joints are discontinuities of the tiled surface that are filled with permanently deformable materials, and are used for the following purposes:

□ *to detach or separate the tiled surface from the fixed elements of the construction* (example:

columns, walls, baseboards) so as to allow for a modest degree of movement in all directions. In such cases, the joint further serves to help insulate the circumscribed area thermally and acoustically from the tiled surface; □ *to subdivide large tiled areas into areas of more workable size*; joints in this case serve to absorb any tensions that dimensional variations and deformations (caused by either mechanical or temperature-humidity factors) may create in the tiled surface itself or the underlying layer; the joints thus prevent the development of such dangerous tensions as

can be created in a "monolithic" surface; □ *to interrupt the tiled surface at the discontinuous points of the background surface* (construction joints, expansion joints, shrinkage joints in the structure): discontinuities that, as noted earlier, allow for some slight movement between contiguous elements. The importance of expansion joints in reducing tensions in the tiled surface and thus preserving the surface's stability and durability is evident; as is the necessity that such joints engage the entire layer of tiles/bedding, and that they connect to the structural joints and be of a width that is not inferior to these.

Therefore, in the planning of any tiled surface, whether vertical or horizontal, the following must be attended to:

1. the creation of separation joints at the perimeter of the covered surface, or where this surface borders on the fixed elements of the construction;
2. the creation of joints of sufficient width in relation to structural joints (we repeat that the properties, size, location and direction of structural joints are indispensable data for planning a tiled surface);
3. the creation of a network of other expansion joints for the entire tile/bedding

explicitly forbidden by law) despite the fact that it is slower and costlier than the alternative; which the user does not always like, but perceives as an “esthetic” disturbance. These are, however, of fundamental importance for the reliability and durability of the installation.

□ the location and dimensions of any deformation joints. These joints constitute also a visual discontinuity in the tiled area,

layer, with a mesh of the appropriate size. While the presence of joints as discussed in points 1 and 2 is always recommended and indeed necessary, the joints described in point 3 require some further specifications. First of all, they are necessary only on surfaces of substantial extension, and need to be more frequent depending on:

- the severity of the temperature-humidity conditions in the environment: in exteriors, joints must be placed at shorter intervals;
- the flexibility and deformability of the background structure;
- the rigidity of the floor or wall covering layer: joints must be

more frequent where installation is closed joint, and also for installation with a joints in a non-linear direction (that is, with discontinuous joints in one or both directions);

- the narrowness of the expansion joint itself;
- the severity of the general conditions of use of the tiled surface.

From the above it can be seen that this aspect of the planning stage must be undertaken with great care, evaluating each project on an individual basis. Some general guidelines are presented below, concerning the minimum

recommended size of the network described by the joints:

- A. Interior spaces
- *closed joint installation*: joints at intervals of 4-6 m
 - *open joint installation*: joints at intervals of 6-10 m
- B. Exterior spaces
- *closed joint installation*: joints at intervals of 2-3 m
 - *open joint installation*: joints at intervals of 3-5 m

An example of tiling plan: Interior floor, on not thermo-insulated background, installed with adhesives

In the simplest tiling

plan, illustrated in Figure 1, the bonding layer is directly applied to the load-bearing layer, provided that this be even enough (since bonding with adhesive is relatively thin, its application to surfaces that are too uneven is risky); if this layer is not sufficiently even, an added layer that is level and even must be added. If and only if the structure is dimensionally stable and not subject to substantial deformation, cement adhesives can be used; in other cases, either organically based, highly flexible adhesives must be used (following the manufacturer's

recommendations and instructions for use), or the tiles must be installed on a screed, possibly reinforced with an electro-welded net and disconnected from the structure by a separating layer (see Fig. 2). A particularly interesting example of installation with adhesives is the case where tiles are installed on a preexisting floor (Fig.3). In most cases of restoration, recovery and renovation, the creation of a new floor covered with ceramic tiles would require the demolition of the preexisting floor, the construction of a new

For the installation of ceramic tiles, specifiers and installers can now make use of many installation materials (like adhesives, grouts, joints, etc.) which are the result of intense research and which allow for the creation of high-performance, reliable tiled surfaces even in unusual applications and on special structures. The specifier need only be aware of the products available, and make appropriate technical selections.

installation base, and then the installation of the new floor, planned in conformity with relevant standards. These costly, lengthy and cumbersome operations can be avoided in part if the preexisting floor is stable and dependable enough to allow for the direct installation of a new tiled surface. Such installation requires adhesives with special properties, depending on the material of the previous floor: generally, a cement adhesive system for installation on preexisting ceramic or natural stone floors, or an adhesive system of reactive

resins (generally polyurethane) for installation on preexisting floors in other special materials. This construction solution is obviously practical only if, in this particular case, both the added weight on the load-bearing structure and raised level of the floor are acceptable. The added weight is generally not substantial, about 20-25 kg/m²; and the floor level is also raised only a slight amount that consists of the sum of the thickness of the tile (about 8-10 mm for most pressed tiles) and the thickness of the adhesive (less than 5 mm).

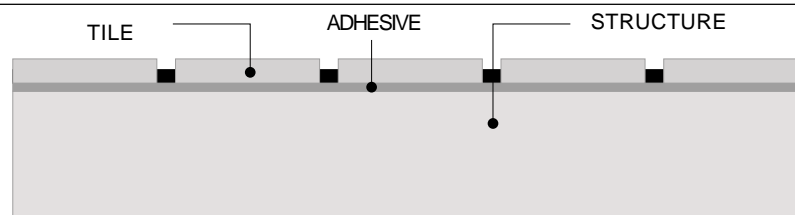


Fig. 1 - Tile installation with adhesive on backing surface.

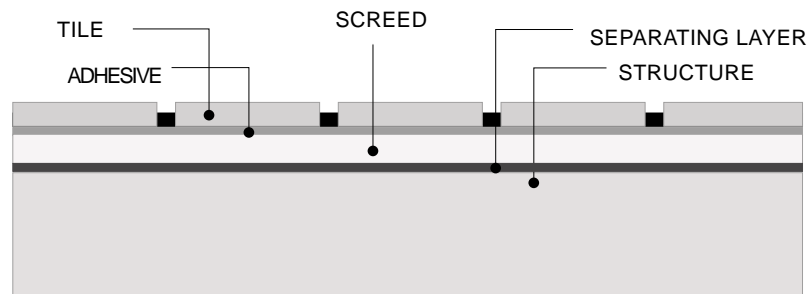


Fig. 2 - Tile installation with adhesive in thick cement bed.

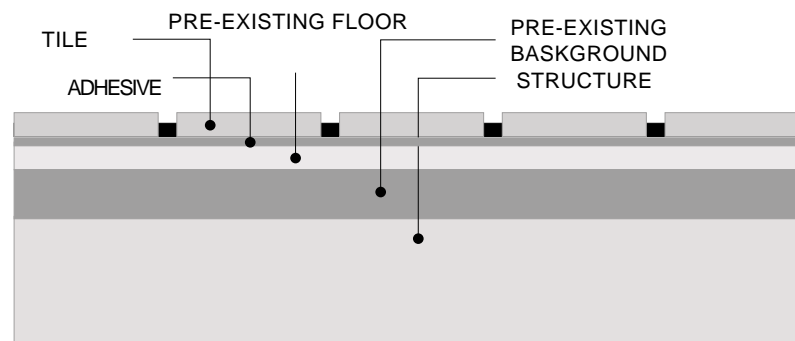


Fig. 3 - Tile installation with adhesive over previous flooring.

3.2 - Tile consignment

The Homeowner and the Specifier are ready to purchase their selected tiles. Now they must be sure to order the right amount of tile, and they are wondering how to verify the accuracy of the consignment. We offer some suggestions on the subject.

How many tiles to order

To answer this question, we must:

- ❑ know the extension of the surface to be covered;
- ❑ have selected an installation method and plan (that is, closed joints or open joints; with discontinuous joints; parallel or diagonal).

Keeping in mind that:

- ❑ even a consignment of first-choice tiles may contain some defective pieces (the EN ISO norms allow for up to 5% of defective tiles in a first-choice lot);

- ❑ some tiles must be cut or perforated, so a certain amount of reject material must be expected. The amount of such material depends on the shape and size of the surface to be tiled, especially on the presence of irregularities, and on the installation method (for example, diagonal installation entails more rejected tiles than does parallel installation);

- ❑ it is useful to keep some tiles in reserve at the end of the installation (to be used for any necessary repairs, or as a representative sample of the material in case of complaints).

It is advisable to order about 10% more tiles than the amount called for by a measurement of the surface to be tiled.

The quantity must be carefully assessed before the order is placed, since there is no

guarantee that the product available for later orders will perfectly match those of the original order.

How to insure an accurate consignment

First, the order must be clear and complete.

That is:

It must include all identifying product data (manufacturing company, catalogue name, format) and type of selection (as well as any properties agreed upon).

❑ **Quality grade:** the term “1st choice” is defined by EN ISO norms. No more than 5% tiles of defective appearance are allowed. Other, non-first choice selections (2nd and 3rd choices, 1st commercial choices, kiln output, etc.) are of inferior quality and may contain a greater number of defects. In any



case, the meaning of these terms may change from one manufacturer to another, so that it is advisable to request a written definition of indicated selections from the vendor. Appendix 4 offers a specification of the second choice, based on an international agreement reached by CET (the European Federation of Ceramic Tile Manufacturers).

Consignment is characterized by two further factors:

□ **tone**: the color tonality of a lot of tiles.

In industrial production, for reasons related to manufacturing techniques, it is virtually impossible for tiles to all be produced with the identical color tonality, and there may be small variations in color – noticeable only if the tiles are placed next to each other – between tiles that in other respects are identical. For this reason, at the end of the production process and before packaging, a



selection phase occurs in which, after defective pieces are eliminated, tiles are grouped according to color tonality. In many cases the tone is indicated by a letter which is stamped on the package (for example, Tone A, Tone B).

□ **caliber** (or “work size”).

For reasons similar to those noted above, and especially in the case of tiles of highly compact body, tiles may come out of the kiln in varying sizes. In this case as in the selection phase, tiles are grouped in homogeneous lots, according to the work size. Within this lot, tile size variations do not exceed those allowed by EN ISO norms. The work size is also written on the packaging, next to the nominal dimensions of the product, as follows:

20 x 20 cm (W 198 mm x 198 mm)

where 198 mm is the work size. Or:

20 x 20 cm - Caliber 01

Tonality and caliber are usually also noted in the accompanying documents (seal and invoice).

Consignments must be checked for homogeneity, since tiles of the same type but of different tonality and caliber must be considered to be different products, and thus not suitable for covering the same surface.

If the area to be tiled allows for the use of lots of different tonality and caliber, these lots must be grouped separately in the building yard, and must not be confused with each other.

□ **Technical properties:** as discussed in § 2.4, technical properties of tiles are part of **technical specifications** document. This document is the source to use when placing the order. For further documentation of the technical characteristics of the tiles ordered, and their conformance to the requirements of the standards, one can request the related test reports issued by the Centro Ceramico - Bologna (see Appendix 5). If tiles ordered carry the UNI marking on the carton (see §2.4 and Appendix 3), tiles have been certified to meet the norm. Thus the UNI marking serves as a guarantee that product is in line with the norms.

3.3 – Installation

The installation is the practical execution of the tiling plan. How well the installation is executed – with what degree of care, attention and professionalism – plays a



critical part in the quality of the tile-covered surface, and thus in user satisfaction.

The individual in charge of the installation is the **installer** or **contractor**. Having considered the environment, the surface to

Stages of installation

We briefly review below the stages of installation, not as a

how-to guide but rather to explain the role and importance of each stage in insuring the quality of the final tiled surface.



The following overview is organized in terms of installation techniques (thick bed installation and installation with adhesives), focusing especially on the installation of ceramic floors both with mortar and with adhesives, and on the installation of wall coverings with adhesives. We will examine in particular detail the construction of the layer formed by the bedding and the tile.

Thick bed installation for ceramic floor tiles

Installation stages are as follows:

- preparation of the mortar, according to the ingredient ratios specified in the tiling plan, and thorough



- mixing;
- moistening of the background surface, to keep the bedding mortar from drying out;
- spreading of the mortar to the desired thickness; the mortar should be barely moist, with no water rising to the surface;
- levelling and compression of the

- mortar bed with a straight edge;
- spreading of a thin layer of dry cement (“dusting”);
- application of the tiles (which have first been immersed in water for a length of time) on the mortar bed using spacers to create joints of uniform thickness; the

be tiled, the tiles selected and the tiling plan (perhaps drawn up by him), the contractor must:

- set up and organize the installation building yard;

- examine the surfaces to be tiled, and prepare them as needed;
- carefully check all measurements, the rectangularity, the verticality of the walls, any slopes in the floor, etc., and take all



tiles must be pressed firmly into position;

- thorough wetting of the floor. Enough water must be used to enter into the interstices between the tiles, so as to blend the mortar with the water spray needed for the mixture to set;
- vigorous and

uniform tapping of the floor (using special vibrating equipments). At this point the tiles are in their permanent position. The tapping has been successful when, if a tile is picked up, a fair amount of mortar adheres to it;

- filling of the joints with preselected grout.

This operation must

be conducted when the mortar bed is already partially hardened, generally about three days after installation;

- to apply the grout, use a rubber or plastic spatula;
- cleaning of the floor with a wet jute cloth, taking care to remove all residual bits of grout when it is still fresh and thus easily removable;
- following these steps the floor must be kept moist, so that water does not evaporate too quickly. The floor should not be walked on for 3-4 days, or if it must be, special planks should be used. Exterior floors should be protected from wind, direct sunlight and rain

for the first few days after installation;

- a final water cleaning. Stubborn traces of cement, soil or other materials can

be removed with a diluted acid solution, or a special-purpose commercial detergent (keeping in mind the tiles' properties of



necessary measurements;

□ **check the materials** (if there are visible defects, the contractor must report them at this point, before beginning to install);

□ **perfect the tiling plan**, choosing the right

references lines so as to achieve the most successful tiling of the surface, and so as to prevent regrettable effects (like the presence of cut or mis-matched tiles in highly visible positions);

resistance to acids).

Installation with adhesives of ceramic floor tiles

Installation includes the following stages:
 □ preparation of the background surface: this surface must be perfectly level, without fissures and cracks, and well cleaned;

parts that are not firmly attached must be carefully removed. Some surfaces, like gypsum plasters, require a precautionary application of primer, in cases where a cement adhesive is being used;
 □ preparation of the adhesive: this stage is

necessary only for powdered or two-ingredient adhesives; by contrast, adhesives in ready-to-use paste require only a simple re-mixing. This stage is needed to obtain a perfectly homogenous paste that is liquid enough, easily applied, and whose ingredients are able to perform their proper functions. In this phase it is important to follow manufacturer instructions closely regarding dosage and application. It must be remembered that the paste is usable for only a limited length of time (termed the “duration” of the paste); for details on this matter, which may vary depending on weather conditions



and especially on temperature, individual manufacturer techniques should be consulted;
 □ application of adhesive and installation of tiles: the adhesive is applied with a special toothed trowel which makes it possible to regulate

the thickness of the bonding layer and to create a surface with grooves deep enough to demarcate the areas of initial contact between the bonding layer and the tiles. When the tile is placed on the surface of the adhesive and pressed down, these areas are

- prepare the mortar or the adhesives, and proceed to the application of the tiles;
- when enough time has passed following the application of the tiles – this can vary from several hours to several days, depending on the type of surface (floor or wall) and on the type of mortar or adhesive – proceed to the filling of the joints and the final cleaning of the surface.



squeezed and spread until they stick to most of the back of the tile: this operation must be verified by trying to lift a tile right after it has been applied. It must be remembered that the “open time”, that is the interval when the applied layer maintains its

properties of adhesiveness, depends not only on the type and quality of the adhesive used, but also on environmental factors, like the porosity of the subfloor, the temperature and humidity of the environment, and

conditions of insulation and ventilation. The adhesive must thus be applied to limited areas, checking from time to time that the adhesive has not, as they say, “given up the skin” so that its wetting capacity is reduced. This can be checked in the way described above, by picking up a tile right after it has been applied to check if the adhesive is sticking to the surface in question. If the results of this check are negative, the surface of the adhesive must be renewed by re-spreading the adhesive with the spatula, or applying fresh adhesive;

- filling of joints: this

stage is also performed with a rubber or plastic spatula, so as to fill the joints completely, evenly and compactly;

- cleaning: a first rapid cleaning can be performed with a humid sponge, to be followed by a deeper cleaning using materials or products

which are appropriate for the levels of chemical and mechanical resistance of the tiles and the sealers.

Installation with adhesives of ceramic wall tiles

Installation steps are as follows:

- check the evenness



At this point the installer is ready to “deliver” his work, which may and must then be checked before it is accepted.

The following two aspects must be remembered:

1. The binders (cement and adhesives) used for installation require a certain amount of time to harden – some types more than others – and will be effective if the surface is not used too soon; a floor must not be

and verticality of the wall, as well as the levelness of the base;
 clean the wall carefully;
 apply adhesive with the special toothed spatula, observing the

same precautions as with floor installations;
 apply the tiles individually, pressing them well into their positions Usually the application of the tiles begins at the floor; or

in cases where the floor does not constitute an accurate enough horizontal reference point, at a special listel which serves as a temporary substitute for the first

row of tiles. In areas of heavy stress (for example, exterior walls), the technique of floating-buttering is recommended, with a thin layer of adhesive applied to the back of

the tiles as well;
 with closed joint installation, check the alignment of the horizontal joints line by line; check the vertical joints every two or three meters;



immediately walked on without protective planks, or loaded with heavy furniture. Without this precaution, the tiles may come loose.

2. If electrical and plumbing work and

carpentry and the like must be done in an area that has just been tiled, the surface – especially of floors – must be carefully protected to prevent damage like abrasion, scratches, or chipping from dropped tools.

continuously check the levelness of the installed surface;
 with open joint installation, use the special spacers;
 once the adhesive has set, remove the

listel that has served as surrogate base for the first line of tiles, and apply tiles there that have been cut and modified as needed. As already noted, for this line of

tiles, which constitutes the connection with the floor, it is advisable to use specially shaped pieces (the so-called "bullnose" tile) which hide the external

expansion joint without hampering its functionality;
 fill the joints with the pre-selected grout, using the special rubber or plastic spatula;
 finally, clean with a

moist sponge. For a more thorough cleaning, use materials or products that are compatible with the level of chemical resistance of tiles and grouts.



3.4 Use and Maintenance

The durability of a tiled surface also depends on the manner in which it is used and maintained.

Thus the user too plays an important part in insuring that a tiled floor or wall will preserve its technical and aesthetic qualities over time.



A tiled floor or wall that has been properly planned and installed is an extremely strong surface, especially as compared with surfaces covered with other less hard, or more flammable or stainable surfaces.

Some precautions must nevertheless be taken, using common sense and based on an understanding of the properties of the material.

A few examples:

□ Tiles and joints

The tiled surface – or more precisely, the part of it that we see – consists of tiles and joints. Both must be treated with care.

□ Cleaning agents

Use appropriate detergents, like those available on the market for tiles. Specifically

avoid very strong acid detergents, like those based materials.

used for cleaning toilets: these may damage the tiles, or the acids may damage joints that are filled (as most of them are) with cement-based materials. It must be remembered that only joints filled with epoxy materials have a high resistance to chemicals.



Maintenance of terracotta floors

Floors tiled in terracotta or other porous, unglazed products, especially for interior spaces, are especially treated after installation to make the surface less permeable and thus more resistant to staining and soiling liquids, as well as to enhance the tile's color.

The treatment must be performed a certain number of days after the installation, depending on the environmental conditions and the technique used: in general, the length of time varies from about ten days for tiles installed with

adhesives, to about a month in the case of thick bed installation. The delay is required to allow humidity to rise out of the material and the subfloor. As it rises through the tile, water also carries soluble salts with it that form whitish deposits on the surface. The first step preliminary to the treatment is thus the careful removal of this salty film with a suitable acid cleaning solution. The actual treatment begins several days after this cleaning, once it has been ascertained that the salty film has not reappeared. For interior floors a basic treatment, usually a dispersion of a

siliconic water repellent material in hydrocarburic solvent, is first brushed on. This product penetrates deep into the tile and lodges in its pores, thus making them less permeable. The tile surface is then saturated with a wax paste. A polishing with an ordinary liquid wax concludes the treatment. Tiles for exterior floors can be treated with a water-repellent solution, but for obvious reasons wax treatments are not recommended because of their poor resistance to weather conditions. The treatment of terracotta in exteriors must in any case be

undertaken with great care, since it interferes with the distribution of the pores' dimensions,

sometimes negatively affecting the tiled surface's response to frost.



□ Cleaning methods

In cleaning, use abrasive instruments (like metal scouring pads) sparingly and very carefully: this is especially important for glossy tiles which are most vulnerable to visible scratches, dulling, and the like.

□ Abrasive dirt

Certain types of dirt, like dust and sand, increase the abrasive effect of pedestrian traffic. Try to keep the floor as clean as possible, and prevent the presence of this kind of dirt, which is brought in from the

outdoors, by placing a doormat at the entrance.

□ Precautions and protection

Ceramic floors are not “resilient”, which is to say they have only limited resistance to impact. Care must thus be taken to avoid as much as possible the falling of heavy objects, and to protect – maybe with a rug or a doormat – areas where objects may fall more frequently or easily (for example, in a private kitchen, the floor area in front of the sink and stove).



3.5 - Defects and complaints: prevention and management

Considering that very large quantities of tiles are sold and installed every year, defects and complaints are a rare event: a sign that, in most cases, the quality of materials, the accuracy of the tiling plan, the professionalism of the installation and the careful use and maintenance make for full user satisfaction.

Nevertheless, when something does go wrong, defects may result. Sometimes



these are only aesthetic defects; in other cases, defects may threaten the functionality of the tiled surface, which must be demolished and replaced — at a cost and an inconvenience that can be easily imagined.

Without detailing the variety of possible defects, we offer several ideas and suggestions for the user.

❑ “There’s a speck on the tile!”

An “effect” on a tile is strictly speaking a “defect” – that can or must be complained about – only if it truly mars the appearance or impedes the functionality of the surface under normal conditions of use. For example, effects in a floor that are visible only from close up – such as by kneeling on the floor, or through a

magnifying glass, or under special lighting – are not considered defects.

□ “The floor is ruined, so the tiles must be defective!”

Any defect of a tiled surface will show on the tiles themselves (which will break, buckle, etc.), since the tiles are what we see. But this does not mean that the tiles themselves are necessarily defective: the site where the defect becomes evident may not necessarily be the cause of the defect!

Just as the quality of a tiled surface depends on the quality of the materials – especially of the tiles, the tiling plan, the installation, and the use and maintenance – likewise the defects too may be traceable to one or another of these causes.



For example, the very same defect - like the rapid deterioration of the glazed surface of the tiles of a given floor - could be caused by:

- poor quality tiles, if these do not possess the promised properties of chemical and mechanical resistance;
- a poor choice of tiles, made without properly considering the area of intended use; that is to say, by an error in planning;
- careless installation, as when a recently

installed floor is cleaned too late and with cleaning agents that are too strong;

- **poor maintenance** - for instance, by cleaning with strong chemicals or with abrasive equipment.

Therefore the “diagnosis” of defects is generally complex, and all players may bear some responsibility, included the users themselves.

❑ “They sold me defective tiles, I installed them, and now I want to sue...!”

When a consumer opens a package and notices that the tiles are defective – in a way that is apparent to simple, careful inspection — then the tiles must not be installed. Rather, the consumer must appeal to the vendor with his guarantee (noting that this guarantee is valid only if

the defect is reported within a limited number of days).

The fairness of this measure, which aims to prevent substantial added costs, is clear. The replacement of defective tiles before installation entails only a modest delay in schedule, while the replacement of installed tiles requires the demolition of the tiled surface, the removal of the rubble, the preparation of a new surface for installation, and the installation of new tiles. The time required, the expense and the inconvenience are incomparable!

❑ “Court of law or arbitration board?”

In case of the emergence of defects that were not initially evident, the user must immediately contact the vendor and/or installer to request explanations and, if

necessary, reparation.

In case of dissatisfaction or failure to reach an amicable agreement, the user may seek legal recourse, with the support of legal counsel and trusted technical experts. In such a case, the dispute may take several years to resolve, and the costs are substantial.

The use of the [Ceramic Arbitration Board](#) of the [Centro Ceramico Bologna](#) will substantially limit both the time and the expense involved.

The Arbitration Board nominates a highly qualified technical expert, who undertakes the necessary investigations and issues a sentence within several months. To make use of this service, both parties involved (for example, consumer and distributor) must state in writing their desire to avail themselves of the experts and the expertise of the Ceramic Arbitration Board.

More information on the Ceramic Arbitration Board can be found in Appendix 6.

Faced with the need to cover a floor or wall surface with materials that will satisfy their respective technical and aesthetic needs, the Homeowner and the Specifier have now concluded the process that has led them to:

- ❑ focus their search on ceramic tiles
- ❑ identify, among the tiles available on the market, those types that can best satisfy their needs, considering the area of intended use
- ❑ oversee the installation of the tiles and the maintenance of the tiled surface in such a way as to insure the full satisfaction of essential requirements

regarding regularity, durability and safety.

The satisfaction of the user – of the Homeowner and of the Specifier – was the final goal of this guide:

- a goal that, as we have shown, can be simply and dependably achieved with ceramic tiles;
- a goal whose achievement required the cooperation and commitment of the manufacturers and vendors of the tiles and other installation materials...of builders and specifiers...of the installer... and of the users themselves, in conformity with the guidelines set forth in this manual.

