# WHITE PAPER

Differences in Porcelain Tile Body Types

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## Two Body Types

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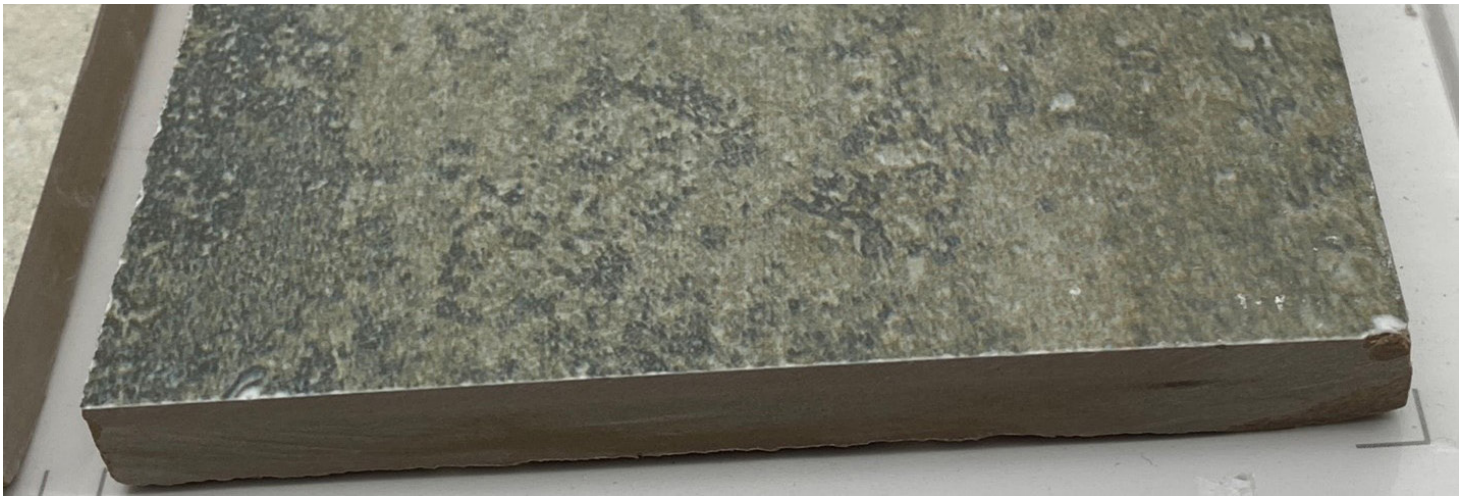
There are two different body types in the world of porcelain tile. They are commonly referred to as Unglazed and Glazed. Nonporcelain ceramic tiles, like colorful wall tiles, are generally always going to be glazed as they are usually composed of white or red clays, and then glazed with a decorative color on the surface as part of their production process. For this reason, this category of tile has been omitted from the information below. In this white paper, we will discuss the porcelain version of ceramic, which is vitreous porcelain with water absorption below 0.5% when tested using ASTM C373. There is often confusion about types of product within the porcelain category, and I hope to clear up some of that confusion.

In traditional porcelain production, where a tile is created using combinations of raw materials like quartz, feldspar, kaolinite, clay, and pressed in a mold using extremely high pressures, there are really two types of production. The first type is unglazed because the entire body and surface of the tile is created using only raw materials and no surface glazes – this is commonly referred to as through-body. The second type is glazed – which includes designations such as "color-body" and "grey body".

However, due to recent advances in technology of production and glazes, there are now tiles that are categorized as unglazed, even though the product is technically glazed. This is because the tiles, in many cases, are now being produced without an engobe layer. As a quick reminder, in traditional production, the engobe is the white primer between the surface and the body. Many glazed tiles (in traditional production) require an engobe layer so that the subsequent glaze can be received without distortion.



*Engobe – between the grey body color and the greenish surface, a layer of white engobe was used in order to provide for a clean image when printing the glaze. The white engobe is visible when the glaze chips, as seen in the lower right corner and along the edges where this tile was cut for sampling.*

With these new advancements in glazing technology, and the subsequent removal of the engobe layer, the glazes are actually absorbed into the surface of the tile and fired into the body. Once out of the kiln, the tiles transform into a single homogenous composition. An unglazed tile – with a glaze.

Tile is classified into various categories using EN 14411. In addition, the standard includes the abbreviation GL for glazed tiles, and UGL for unglazed tiles, and also defines (mechanically) polished tiles, without assigning them a code however.

**Ceramic Tile Classification according to Standard EN 14411**

| Forming Method | Water Absorption Capacity (E) | | | |
|---|---|---|---|---|
| | **Group I**<br>E ≤ 3% | **Group $II_a$**<br>3% < E ≤ 6% | **Group $II_b$**<br>6% < E ≤ 10% | **Group III**<br>E >10% |
| **A**<br>Extrusion | **Group $AI_a$**<br>E ≤ 0,5%<br>EN 14411<br>Annex M | **Group $AII_{a-1}$**(*)<br>EN 14411<br>Annex B | **Group $AII_{b-1}$**(*)<br>EN 14411<br>Annex D | **Group AIII**<br>EN 14411<br>Annex F |
| | **Group $AI_b$**<br>0,5 < E ≤ 3%<br>EN 14411<br>Annex A | **Group $AII_{a-2}$**(*)<br>EN 14411<br>Annex C | **Group $AII_{b-2}$**(*)<br>EN 14411<br>Annex E | |
| **B**<br>Dry Pressing | **Group $BI_a$**<br>E ≤ 0,5%<br>EN 14411<br>Annex G | **Group $BII_a$**<br>EN 14411<br>Annex J | **Group $BII_b$**<br>EN 14411<br>Annex K | **Group BIII**(**)<br>EN 14411<br>Annex L |
| | **Group $BI_b$**<br>0,5 < E ≤ 3%<br>EN 14411<br>Annex H | | | |

(*) Groups $AII_a$ and $AII_b$ are divided in two subgroups based on different production specifications (sections on dimensions and surface quality, and physical properties). They appear as Part 1 and Part 2, respectively, in the corresponding annexes.

(**) This group only covers glazed tiles.

You can find the note on glazed versus unglazed above the chart, where it states, "In addition, the standard includes the abbreviation GL for glazed tiles, and UGL for unglazed tiles".

| Abrasion Stage at Which the Failure is Visible | Class |
|---|---|
| 100 | Class 0 |
| 150 | Class I |
| 600 | Class II |
| 750 | Class III |
| 1500 | Class III |
| 2100 | Class IV |
| 6000 | Class IV |
| 12000 | Class IV |
| >12,000 and pass staining test | Class V |

It is important to note that this test needs to be done per color, as darker colors tend to wear easier than lighter colors.

## Mohs Scale

There is no ASTM test method or ANSI requirement for the Mohs scale. The Mohs scale is another tool that can be used to determine the hardness of either the surface glaze, or the tile body itself. The tile glaze and surface body of one tile may have 2 different Mohs scales.

The Mohs scale was created in 1812 by geologist Friedrich Mohs who created the scale using minerals that were common at the time. The scale runs from 1 to 10 with 1 being talc and 10 being Diamond. The full scale is:

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase
7. Quartzz
8. Topaz
9. Corundum
10. Diamond

The idea of the Mohs scale is that each mineral can be scratched by the mineral above it on the scale, but not the mineral below it. So, Quartz can scratch Orthoclase but not Topaz. Through-body porcelain tile generally falls around 7 on the Mohs scale, which is one of the hardest minerals to scratch (even if there are 3 more above). This is why we use diamond blades to cut porcelain tile.

To compare to some common everyday items, your fingernail is around 2.5 on the Mohs scale, meaning that it could scratch Gypsum and Talc but not Calcite. Copper Pennies fall around 3.5. Metal knife blades fall at 5.5. Masonry drill bits that are used to cut through concrete blocks and other masonry are near 8.5.

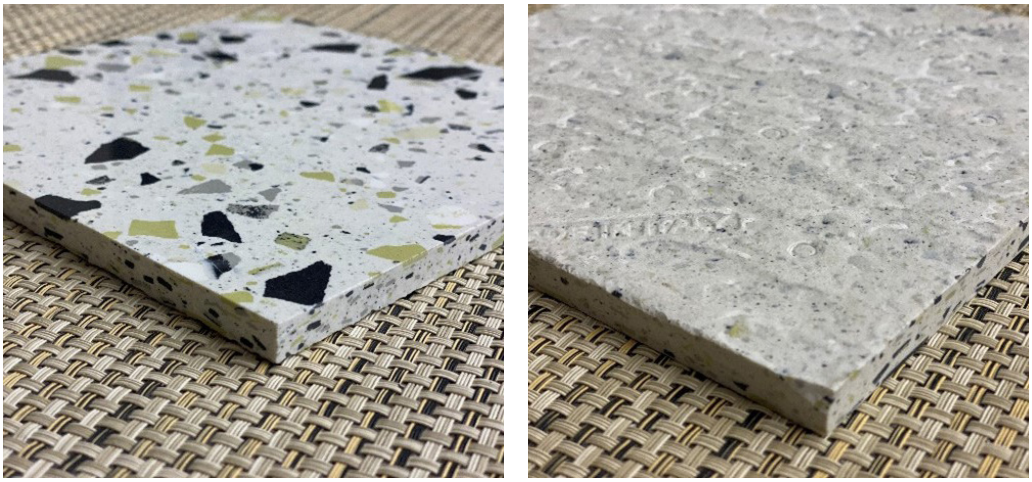
This is important because of the test methods that are used to determine scratch resistance of each product. Glazed tiles, with the designation of GL, use a Porcelain Enamel Institute (PEI) rating for scratch hardness, whether using the European EN 10545-7 test or the American Society for Testing and Materials (ASTM) C1027 (more on this to follow). Unglazed tiles, with the UGL designation, use eep abrasion testing, which is the exact same test used on "through-body porcelain" tiles (either EN 10545-6 or ASTM C1243).

Given that some manufacturers now have the technology to allow glazes to absorb into the surface of the tile, I recommend that commercial clients focus less on the term "through-body porcelain" as a requirement for heavy duty tiles, and instead look for tiles that are classified as "unglazed". This opens up significantly more aesthetic options while providing the high durability required for commercial use. I still recommend traditional "through-body porcelain" for the most extreme uses such as train stations or airports, but nearly every other application can use tile with the 'unglazed" classification and still obtain the durability required for scratch hardness.

## Let's take a closer look at the different body types.

## Unglazed Porcelain Tile | 2 Types

1. Through-body porcelain; no surface glazing applied



*Front and back of unglazed porcelain tile – notice the flecks of color on the surface can be seen on the edges and back of the tile – this a homogenous product containing only components of raw materials without glazes.*

The first type of unglazed porcelain tile with a homogenous composition is commonly referred to as "through-body" porcelain, meaning that the tile has the same characteristics and look on the surface, and throughout the body to the back of the tile. This type of unglazed porcelain tile is comprised of the raw materials noted above, along with colored pigments to give the tile its color and aesthetic. All materials are pressed at once, and the product is fired as is. There are no glazes or top coatings on this version of unglazed

porcelain tiles. True through-body porcelain tile is one of the most durable flooring types, typically recognized as stain resistant, scratch proof and chemical and heat resistant. The Mohs scale measures scratch hardness of minerals on a scale of 1 to 10, with 1 being Talc and 10 being Diamond. Unglazed porcelain tiles generally rate as a 7 or 8 on the Mohs scale, two times harder than natural granite (rated at 6 or 7 on the Mohs scale), and seven times harder than natural marble (between 3 and 5 on the Mohs scale). This means that the unglazed porcelain tiles are extremely durable and resistant to scratching other than with the most aggressive minerals. This is why we use diamond covered blades when cutting porcelain tiles.

The typical surface of a through-body porcelain tile is matte, which is how the product comes out of the kiln. Tiles in matte finish almost always meet ASTM requirements for slip resistance (greater than 0.42 wet using a BOT-3000 tribometer) as they come out of the kiln.

The surface of these products can be ground to achieve a full polished finish, a similar process used for polished natural stone. This is not a top coating like the glossy finish of a ceramic tile, but rather a mechanical process which uses a series of diamond polishing pads to grind the surface of the tile down to a smooth, shiny/polished finish. If a satin or honed finish is desired, the unglazed porcelain tile requires less steps and pads in the grinding process. If a textured finish is desired, a textured mold instead of a flat mold is used to create a structured surface to mimic a slate or granite-like finish. These finishes physically change the surface of the actual porcelain tile, yet sustain the homogeneous product.

*Through-body porcelain tile finishes. Left to right; matte, honed, polished and textured.*

Typically, through-body porcelain tiles are unicolor, have one color throughout, or are speckled to mimic the fine or large aggregate look of granite. The movement in these looks can be minimal or have heavy, dramatic speckled veining. Despite the historically limited aesthetics of through-body porcelain tiles, there have been recent advancements in the production technology. Manufacturers can control the placement of color pigments in through-body production and create pixelated text that goes through the body of the tile. Some manufacturers are exploring the use of through-body technology with their gauged porcelain tiles/slabs, so porcelain marble looks like Calacatta and Carrara can have veining throughout the body of the tile, instead of seeing the white edge of the tile. This helps expand the use of porcelain slabs in the countertop industry.

2. Unglazed porcelain tile; glazes absorbed into the body, then fired

As mentioned earlier, unglazed porcelain tiles are now being produced using techniques that allow for the surface glazes to permeate into the body of the tile prior to firing. This process allows the tile to be a fully vitrified product, while providing enhanced aesthetics due to the use of digital printing technologies. An example of this is our Business collection, shown on the next page.

Prior to advancements in technology, we would have categorized Business as "glazed-color body tile" because the process for producing this tile uses a digital glazing technique on a body color that matches the surface. Each color in the series is produced with a color that matches the surface of the tile.

Looking at the technical information, however, shows this product to be listed as UGL, or unglazed, using EN 10545-6 deep abrasion test as a measure of scratch hardness – the same test used for through-body porcelain tiles. This is because an engobe layer was not used on this product, and instead the digital inks were absorbed into the surface of the tile and fired into the body.

*Business series test results – showing the tile is unglazed (signified by UGL) and using EN 10545-6 test for deep abrasion, the same test used on through-body porcelain tiles.*

TECHNICAL FEATURES UNGLAZED PORCELAIN TILES
CONFORMING TO EUROPEAN STANDARDS EN 14411 ISO 13006 APP. G (GROUO BIA UGL WITH EB ≤ 0,5%)
DECORSCARATTERISTICHE TECNICHE GRÈS PORCELLANATO NON SMALTATO Conformi a Norme Europee EN 14411 ISO 13006 App. G (Gruppo Bla UGL con Eb ≤ 0,5%)TECHNISCHE EIGENSCHAFTEN UNGLASIERTES FEINSTEINZEUG Gemäß den Europäischen Normen EN 14411 ISO 13006 App. G (Gruppe Bla UGL mit Eb ≤ 0,5%)CARACTERISTIQUES TECHNIQUES GRÈS CÉRAME FIN NON ÉMAILLÉ Conformes aux Normes Européennes EN 14411 ISO 13006 App. G (Groupe Bla UGL avec Eb ≤ 0,5%)

| | TECHNICAL FEATURES<br>CARATTERISTICHE TECNICHE<br>TECHNISCHE DATEN<br>CARACTERISTIQUES TECHNIQUES | TESTING METHOD<br>METODICA DI PROVA<br>PRÜFVERFAHREN<br>NORME D'ESSAIS | REFERENCE STANDARD<br>RIFERIMENTO NORMA<br>STANDARDWERT<br>REFERENCE NORME | TEST RESULTS<br>VALORE PRODOTTO<br>PRODUKTWERTE<br>VALEUR PRODUIT |
|---|---|---|---|---|
| | Sizes<br>Dimensioni<br>Abmessungen<br>Dimensions | EN ISO 10545-2 | No 15cm<br>• Length and width - Lunghezza e larghezza - Länge und Breite - Longueur et largeur: (%) ±0,6% / (mm) ±2,0 mm<br>• Thickness Spessore - Stärke - Epaisseur: ±5,0 / ±0,5<br>• Linearity - Rettilineità spigoli - Kantengeradheit- Rectitude des arêtes: ±0,5 / ±1,5<br>• Wedging - Ortogonalità - orthogonalité - Rechtwinkligkeit Orthogonalité: ±0,5 / ±2,0<br>• Warpage - Planarità - Ebenflächigkeit-planarité: ±0,5 / ±2,0<br>• Appearance: percentage of acceptable tiles, per lot Aspetto: percentuale di piastrelle accettabili nel lotto Oberflächenbeschaffenheit: Prozentsatz der Fliesen, die den geforderten Eigenschaften entsprechen Aspect: pourcentage de carreaux acceptables sur la fourniture totale: 95% min. / - | **Compliant**<br>Conforme<br>Erfüllt<br>Conforme |
| | Water absorption<br>Assobimento d'acqua<br>Wasseraufnahme<br>Absorption d'eau | EN ISO 10545-3 | $E_b \leq 0,5\%$ | **Compliant**<br>Conforme<br>Erfüllt<br>Conforme |
| | Modulus of rupture<br>Resistenza alla flessione<br>Biegezugfestigkeit<br>Résistance à la flexion | EN ISO 10545-4 | Medium value 35 N/mm² min. | **Compliant**<br>Conforme<br>Erfüllt<br>Conforme |
| | Breaking strenght<br>Carico di rottura<br>Bruchlast<br>Charge de rupture | | sp. > = 7,5 mm: min 1300 N | **Compliant**<br>Conforme<br>Erfüllt<br>Conforme |
| | Abrasion resistance<br>Resistenza all'abrasione<br>Abriebbeständigkeit<br>Résistance à l'abrasion | EN ISO 10545-6 | 175 mm³ max | Average<br>Media - Mittelwert - Moyenne<br>< 150 mm³ |
| | Thermal expansion coefficient<br>Coefficiente di dilatazione termica lineare<br>Wärmeausdehnung<br>Coefficient de dilatation thermique linéaire | EN ISO 10545-8 | *Declared value<br>Valore dichiarato<br>Angegebener Wert<br>Valeur déclaré | ≤9 MK-1 |

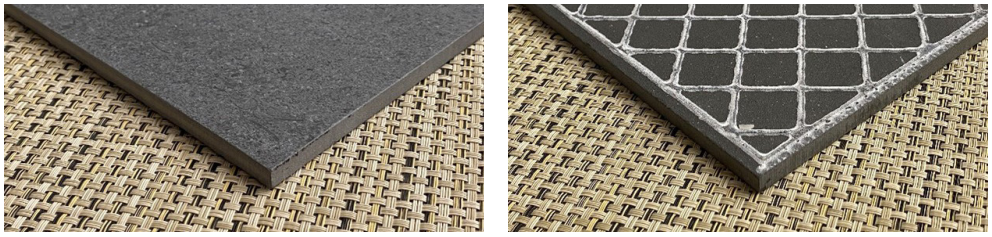
## Recap

There are now two types of unglazed porcelain tile. The first is through-body, which I recommend using in the most extreme commercial spaces such as airports and train stations. The second is unglazed, with glazes being absorbed into the body, then fired to create a vitrified product. I recommend this type of product for any demanding commercial space – hotel lobbies, schools, restaurants, etc.

## Glazed Porcelain Tile

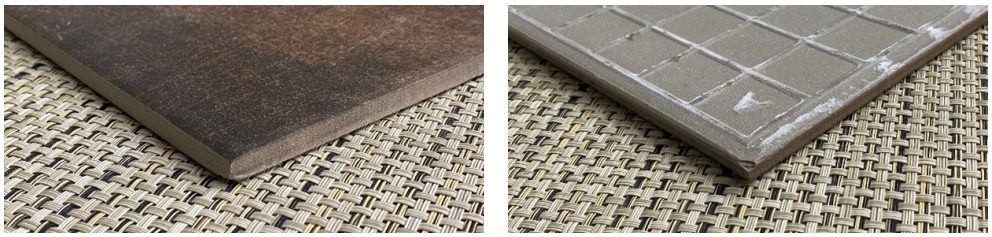
The second production type is glazed porcelain tiles. Glazed porcelain tiles are a heterogenous product, which means the surface of the tile looks different from the body of the tile. A glaze is applied to the surface of the porcelain body, over an engobe layer, to

enhance the aesthetics of the product. Porcelain tiles that are reminiscent of beautiful natural marbles, fabrics or wood aesthetics are glazed to create the image of the product it is mimicking. The majority of porcelain tiles in production these days utilize digital printing, which essentially means taking a photo of a natural product and printing it with heavy-duty inks on the surface of the tile, to creating a visual - much like how your everyday inkjet printer would print an image from your computer.



*Front and back of glazed color body tile – the surface is created using digital glazes and the manufacturer has chosen to color the body a similar color to the surface.*

Glazed porcelain tiles can have what is commonly referred to as a "grey-body" or a "color-body". Generally, the durability of the body is the same whether it is a grey-body tile, or whether the manufacturer decides to color the body a color like the surface glaze. Many commercial clients prefer to have a color-body tile in case the surface glaze chips. Imagine a black slate glazed porcelain on a grey body tile. If that black glaze were to chip in a corner, the resulting color underneath that would show through would be a light grey and would be very noticeable verses if the color underneath were black.



*Front and back of glazed non-color body tile – the surface is created using digital glazes and the manufacturer has chosen to use a "grey body" as the base of the tile.*

As glazed porcelain tiles have a coating over the porcelain body, the tests mentioned above for Abrasion Resistance do not apply to the surface of these tiles. Instead, glazed tiles are rated on the hardness of the glazes using what is commonly referred to as "PEI", or a rating created by the Porcelain Enamel Institute. As with Abrasion Resistance, there are two tests for PEI rating. In the US, the test is ASTM C1027 and in Europe, the test is EN 10545-7. Both have a rating system of Class 0 to Class 5, but the European tests also include levels of rotations of abrasion within the higher levels. Class 0 is typically rated for walls only, while Class 5 is for heavy commercial use. Most commercially rated glazed porcelains fall into the Class 3, 4 or 5 ranges. (Class 3 = Residential – Light Commercial Use; Class 4 = Medium Commercial Use; Class 5 = Heavy Commercial Use.) Keep in mind that PEI is not rating a whole tile collection, but rather each individual color within the

collection. It is very possible to have different ratings within a collection. Darker colors tend to have a lower PEI rating, so it's possible that a series with (3) light colors and (3) dark colors can have PEI of Class 3 for the dark colors, and Class 4 for the light colors.


Glazed porcelain tiles, whether color-body or not, are used often in commercial construction. They are durable, stain resistant, scratch proof (when used in the correct applications) and fire & chemical resistant. The main difference is in the cost. Color-body tends to be more expensive as the manufacturer is increasing the costs of their production to color the body. They are using more raw materials or very light color or white raw materials which come at a premium cost as opposed to leaving the body its natural grey color.When you visit our website to view our porcelain and ceramic product offerings (creativematerialscorp.com/product-category/porcelain-ceramic-tile/), you can filter by the body type you are looking for using the "Select Body/Construction" filter on the right hand side. We have updated the available options to: Ceramic, Glazed Color-Body Porcelain, Glazed Non-color Body Porcelain, and Unglazed Porcelain to align with the information detailed in this white paper. We hope this information, as well as the filter options available on the website will guide you in specifying smartly for the requirements of the space you are working on. If you need assistance, we are always available to here to help and consult.

A video on this topic is also available at: https://youtu.be/NPGbpi4I4OE