

## The Effect of Technical Specifications on Ceramic Tiles used for Cladding of Swimming Pools

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### Abstract

The study of the impact of the technical specifications of ceramic tiles requires a comprehensive understanding of the nature of the tiles in order to obtain tiles with special specifications different from ordinary tiles (floors, walls) The research was divided into three chapters and due to the importance of this topic, the researcher wanted to formulate the research issue with the following question: How important are the technical specifications of ceramic tiles used in cladding swimming pools?

**Relevance:** While the importance of the research study is embodied by studying the efficiency of the technical specifications for ceramic tiles, in addition to documenting and enriching the knowledge aspect of the technical specifications.

**Objectives:** While the current study aims to reveal the extent to which the technical specifications of the ceramic tiles used in the cladding of swimming pools are, As for the limits of the research, it was determined through the objective aspect by studying the importance of the technical specifications of ceramic tiles used in the cladding of swimming pools, while the limits of the research included the spatial limit of swimming pools through photographs and the temporal limit of the time period 2014-2024.

**Methods:** The second chapter included the first and its main headings: The specifications of ceramic tiles with architectural cladding, the technique of using

cladding in swimming pools, achieving the aesthetic and functional identity of ceramic tiles used in cladding swimming pools The form and organization of the design body using ceramic tiles for swimming pools, the importance of cladding using ceramic tiles in swimming pools, the level of organization of the technical specifications of the design configurations, the design integration of ceramic tiles used in the cladding of swimming pools) The third chapter specialized in defining the topic of research procedures, represented by the research methodology based on the analytical descriptive method, while the research population was based on the purposive selection method.

**Results:** The fourth chapter included the conclusions of the research findings, as well as the recommendations for future proposals and the proposed design of tiles inside swimming pools.

**Conclusions:** It is possible to determine the technical specifications of the tiles in the design and cladding of swimming pools in accordance with the consumer's desire, taking into account the compositional factors in the cladding processes.

**Keywords:** Ceramic, Tiles, Swimming Pools

### **Chapter One: Research Issue**

The research issue is centered on knowing the importance of the technical specifications of ceramic tiles, by studying and diagnosing the positive and negative technical methods in the use of cladding for swimming pools and knowing their importance in the natural and cultural environment, and because of the importance of this topic, the researcher wanted to formulate the research issue by asking the following question: How important are the technical specifications of ceramic tiles used in the cladding of swimming pools?

## Importance of the research

The importance of the research study is embodied by focusing on studying the importance of the technical specifications of ceramic tiles, and contributing to the knowledge of possible ideas for the development of pool designs using ceramic tile cladding.

## Research Objective

The research study aims to:

Revealing the importance of the technical specifications of ceramic tiles used in the cladding of swimming pools.

## Research limits

The current research is determined by the following:

- 1- Thematic limit: The importance of the technical specifications of ceramic tiles used in the cladding of swimming pools.
- 2- Spatial limit: Swimming pools through photographs have been recently implemented.
- 3- Temporal Limit: The time period highlighted is 2014/2022.

## Terminology

- **Tiles** :(terminology): It is a building material with which floors, walls, ceilings, bathrooms, and even table tops are decorated to give them a varied character and make them more pure and elegant, and tiles are made with earthy materials and minerals, (Frank,1991, p.59).

- **Cladding**: is a surface treatment and decoration technique in interior and exterior construction that refers to the outer layer of a building structure to resist mechanical

stresses, chemical agents and the atmosphere, as well as a finishing stage on an aesthetic level, (Fleming, 1989, p.76)

- **Pools:** (terminology): They are low areas in the earth's surface, where the sides of these areas are higher than the bottom, and they can appear circular or oval, and it is worth noting that some of these basins can be filled with water and others are empty, (Darwish, November 9, 2022)

- **Procedural Definition: (Technical Specifications for Ceramic Tiles):** It is a descriptive condition for the stability of ceramic tiles used in cladding operations for swimming pools, as well as a set of readings produced through physical and chemical tests of ceramic tiles before installation in a research that is suitable for architectural constructions in terms of natural conditions and factors and suitable for the buildings in which the ceramic tiles are installed.

### Previous Studies

The researcher is not aware of any previous studies linking the relationship between the technical specifications of ceramic tiles with aesthetic values and their installation in swimming pools

### Chapter Two: Introduction

The ceramic tile industry is considered one of the most important industries on the global level, it has won the attention of many countries of the world as a basis for economic development in the short and long term. The interest in this industry is no longer limited to developed countries only, but also extended to include countries that have a large stock of raw materials that help in the sustainability of the ceramic tile industry, such as Egypt, the UAE and Saudi Arabia, and industrial facilities that keep pace with the latest technological sources in production are a factor that helps to gain consumer confidence in this industry.

Several important changes have emerged that pose many challenges, such as the emergence of financial, commercial and industrial globalization, as well as the globalization of services. The importance of knowledge and technology in the economy has grown until it became one of the characteristics of this century. There is no doubt that technological and industrial progress has become vital to the progress of countries, and the progress of countries depends to a large extent on their technological progress, especially in the industrial field, so the use of technology, and determining the technical specifications of the tiles in the industrial facility has become necessary, as the environmental and design dimension of ceramic tiles has become one of the most important variables that industrial facilities take into account before installation in architectural facilities, especially swimming pools, as ceramic tiles for swimming pools Swimming pools require high precision in production and the achievement of high technical and technical specifications to suit the weather conditions as well as to be compatible with the spatial environment for the design of swimming pools to ensure the achievement of real sustainable development that is embodied in the cleanest or least impactful production on the environment to achieve a green industry.

### **1- Specifications of Ceramic Tiles in Architectural Constructions**

One of the most important standard specifications for ceramic tiles is to be free of defects, so 98% of the tile must be free of visible defects that distort the external appearance of the surface. The criterion for evaluating the quality of the tile surface is determined by the extent to which it is free of cracks, cracks, surface unevenness, protrusions, holes, poor glaze gloss, stains, pollution, non-glazing errors and decoration errors, shading, triangular edges, abraded corners, according to EN 98 (European Standard Specification) (Appendix 1 British Standards,1998) and that the ceramic tiles belong to the family of ceramic tiles. Porcelain tiles that ceramic tiles belong to the Stone Ware family are characterized as high hardness materials in terms

of high molecular cohesion and porosity, and if there is a technological division of the types of floor tiles and porcelain, it is based on the property of water absorption and its gradual decrease until it is not vitreous.

1. Absolutely deaf porosity Very Vitreous - absorption from 0% to 0.5% (porcelain) and (porcelain stoneware).
2. Vitreous porosity - more than 0.5% and less than 3% (floor tiles).
3. Semi Vitreous porosity more than 3% and less than 7% (floor/wall tiles).

(Nelson, 2012, p4)

Contemporary architecture was characterized by the diversity of materials used in its construction, including ceramic tiles, and thanks to the specifications and characteristics of "the technology and resources in the first place and the concepts that achieve the moral and spiritual human specificity in solidarity and interaction with the function and what the ceramic tiles achieve from integrated dimensions, so it gains this characteristic of the civilizational return to the artistic and intellectual products of man in the manufacture of tiles used in architecture and interior design", (Darwish, November 9, 2022). Therefore, ceramic tiles are a means of organizing building relationships to reveal the form and composition in the artwork, as well as revealing the internal relationships and relationships of the ceramic work product to its external surroundings and the image of meaning to the consumer, so the specifications of ceramic tiles were characterized by an appropriate design quality dating back to previous times (near or far), not only because of their historical and artistic importance, but because they carry a memory in society, and are a living and honest expression of the human experience in building civilizations for any era, " Thought first realized the meeting point between form and function in the history of architecture and its complements, arriving at the idea of cutting the floor spaces into linear systems, taking planning as an image for the foundation of the architectural

mass and the materials available in nature to employ in that architecture, including the material of burnt clay". (Zuhair, 2009, P18).

Therefore, the specifications for ceramic tiles were used to achieve protection and achieve privacy and reliably from external influences if swimming pool cladding facades are used in a way that is "compatible with the building and the overall structure, whether it is a public or multi-storey building or a family residential unit, and using a set of factors that achieve specifications of high quality and durability through which the swimming pool shape suitable for use and architectural design compatible with the surrounding environment is determined, including the materials and resources that help to achieve the installation of ceramic tiles," (Goncalves,2020, R. S., Palmero-Marrero, p701).

There are a number of parameters to consider in the design of swimming pools that are directly related to the type of ceramic tiles:

### **1- Sloping Ceramic Tiles in the Floor of Swimming Pools**

The slope of the ceramic tiles installed in the floor of the pools should be uniform and the slope ratio in the floor in the shallow part should not exceed 10:1, and the slope from the first point of change of the slope from the shallow part to the deep part should not exceed 3:1.

### **2- Diving Area**

There should be barriers extending from the sides of the bathrooms to the floor covered with ceramic tiles

### **3- Walking Area around Swimming Pools**

The walking area around the swimming pools should be continuous, and ceramic tiles with rough surfaces should be installed to avoid slips while walking and turning around the swimming pools. Finally, " the quality of ceramic tiles can be

determined by a set of key characteristics that characterize this type of ceramic products:

- 1- Hardness & wear and abrasive resistance
- 2- Bending strength and compressive strength
- 3- Frost resistance.
- 4- Stain resistance.
- 5- Chemical resistance except hydrofluoric acid (HF).
- 6- Ease of cleaning.
- 7- It does not represent a favorable environment for the growth of microbes and bacteria
- 8- It is not affected by electro static charges", (Stefanov, 1<sup>Ste</sup> Fn. & Batschwarov, 2000, p22)

## 2- Swimming Pool Cladding Organization Technique

The organization of the technique is one of the constructional processes to achieve sovereignty in the unity of the design parts and to achieve a quality technique in which the various and unique success factors are achieved, it is systems and methods applied to show the technical performance of the work of swimming pools, and since the design of swimming pools is an organization of interconnected parts and the designer's expression of them in the form of visual forms felt in the design of swimming pools, and therefore the effect of the surrounding environment and the effect of the quality of "the climate in the regions must be taken into account Whether (cold, hot and temperate regions) and therefore must provide appropriate thermal insulation for swimming pools by using hinged facades made of high-temperature ceramic tiles whose function and compatibility with the general climate are determined within a technique subject to the spatial environment to suit the components and achieve compatibility and proportionality in the quality of



manufactured swimming pools and by using cladding that achieves the aesthetic and functional form of swimming pools, we will obtain a technique with scientifically studied finishes from the aesthetic and functional point of view", (Smith, C. C. C., L~f, G. & Jones, 1994, p10-12). The ceramic tiles used in swimming pools are not just stacked tiles, but a design and technical idea that simulates the environment for this spatial space, as the technical specifications of the tiles form a state of aesthetic, technical and environmental integration, as shown in Figure (1), Here we see that ceramic tiles decorated with oriental Islamic decoration on the sides revive the place designed in the Eastern Islamic style, the difficulty is apparent through the entrance and arches inside the swimming pool.



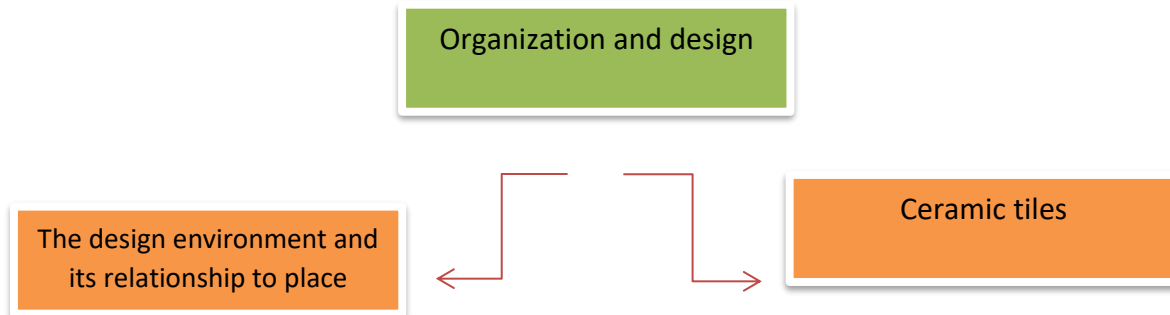
Figure (1): Oriental style swimming pool

### 3- Ceramic Tiles between Quality of Organization and Design

"That form and organization are the style and method on which the process of organizing the structure of the general shape of the design of the basins is based, in order to achieve a meaning of general significance resulting in an organized and

harmonious manner with the design using ceramic tiles to produce various and different shapes of basins", (Al-Bazaz, 2002, p81). Therefore, it is necessary to enhance the display of the aspect of shape and the function of the structure in the design. And since the organization of the structure produces complete shapes with related relationships with its parts, and what the consumer perceives is not limited to these parts and elements only, but includes design relationships with a structural nature." We can consider the form as the homogeneous structure in which a number of perceived elements are present and related in proportionate and compatible relationships for perception, specifications, and general characteristics. Where the latest techniques work to display resources and use suitable materials for shape and organization in the structure. For example, ceramic tiles are made from a mixture of several types of white clay, kaolin, feldspar, and quartz, and coloring occurs due to the addition of pigments to the composition, which are mostly metallic oxides. Therefore, any production of ceramic tiles, regardless of its function or effectiveness, and the purpose of its design will not be successful unless there is a successful structure within that design structure of the basins and pools. And this design structure is the basis of the relationship between the shape and organization of that design at its location and its surroundings, which is the basis of the shape and structure for the design that appears in it, so most of the time ceramic tiles are used to enhance and showcase the shape of the design. "Ceramic tiles are designed as a facing layer for the ventilation facade, to protect the frame, insulation layer, walls, and floor of the pools from the negative effects of the external environment, and to give the pool walls a suitable appearance that blends with its surroundings and is perfectly handled. In addition, there are several types of ceramic tiles with distinctive design features used for covering pool basins, including fully glazed ceramic tiles with a water absorption rate of no more than 0.3%, glazed ceramic tiles with a water absorption rate of no more than 4%, and terracotta tiles with a water absorption rate of no more than 10%. Ceramic tiles come in various colors and shapes", (Abdel

Wahab, 2004, p44). Including rectangular, square, and hexagonal, with multiple sizes and dimensions, as shown in diagram plan number (1).



Plan (1): the study illustrates the level of technical specifications organization / researcher planning

#### 4- The Level of Organization of the Technical Specifications for Design Formations:

The level of organization of the technical specifications used in pool basins is determined according to configurationally design relationships, "highlighting the importance of studying and understanding the analysis of design formations within the level of technical specifications with a dual nature, from reinforcement steel to concrete pouring and finally tiling", (Sherezad,1985,p215). Therefore, when studying the level of organization of technical specifications, the following should be taken into consideration:

- 1-4 Scientific requirements: represented by the actual processes in processing and shaping the materials and resources used and studying their impact on the structural construction properties, as well as the importance of their aesthetic aspect
- 2-4 "Aesthetic ideals that meet the requirements of achieving the objective aesthetic goal and achieving the purposes of the design of swimming pools with ceramic

tile cladding, based primarily on several factors including balance, dominance, and unity in the artistic work parts, in addition to benefiting from studying the results of their relationship. Therefore, it is necessary to know the emotional state of the consumer, his way of thinking, and the nature of the place (where the swimming pools are located)", (Aldajili, 1999, p10) whether external or internal, as the place has great importance in determining the type of design and technical specifications, as the environmental context is the fundamental pillar in the design of swimming pools and also the tiles used as shown in figure (2) and the nature of the senses that receive that influence, in addition to the previous aesthetic information and experiences possessed by the recipient. Design formations depend on determining the measurement location in relation to the space included in the design of the pools according to the spatial division that enhances the value and beauty of the place, according to an organized plan in distributing the masses."



Figure (2): Designing pools inspired by the environment

### 5- Types and Specifications of Tiles Used in Swimming Pool Basins

Tiles are one of the most beautiful parts of swimming pools. Ceramic tiles can be chosen for their low cost, high-quality technical features, and a variety of colors and designs for swimming pools. Although each type of tile has different characteristics,

it depends on the consumer's preference and overall aesthetics when designing the outdoor or indoor space. Here is a range of tiles used in swimming pool basins:

### **5-1 Ceramic and Porcelain Tiles:**

Ceramic and porcelain tiles are the most commonly used options for swimming pool bathrooms. In addition to being easy to install and clean, swimming pool ceramic tiles can be handcrafted or factory-made, and are characterized by a smooth texture, making swimmers safe from any scratches inside the pool. Ceramic tiles do not absorb heat, making them the best choice in terms of technical and technological specifications inside swimming pools and pool deck paving.

### **5-2 Glass Tiles:**

While ceramic and porcelain are common choices for pool tiles at reduced prices, small glass tiles are a relatively expensive option. Glass tiles are small square tiles made from recycled glass to create a shiny surface. Therefore, they are environmentally friendly and have low water absorption and low porosity, making them more durable against environmental conditions than any other type of pool tiles. Despite the aesthetic value of glass tiles, their installation in pools requires high precision and skill, as it may take four weeks to complete and finish. These tiles are used in both hot and cold climate areas. Shown in figure (3).

### **5-3 Stone Tile (Installed in the Vicinity of the Side Pool without Basins)**

Stone is another primary choice for pool tiles. Natural stone tiles work best to create an architectural look in the vicinity of swimming pools. They have a textured finish that blends with other natural elements in the overall design of the pools. Since stone tiles are porous with high or medium porosity for water

absorption, they need to be sealed every few years to prevent pollution or water damage.



Figure (3): Installing tiles on the walls

#### 5-4 Mosaic Tiles

Mosaic tiles are used to enhance the aesthetic element of the swimming pool design. They are characterized by a variety of colors and patterns to complement the swimming pool spaces. Mosaic tiles are different pieces of glass, ceramic, or porcelain that are laid or assembled to form a design that is easy to install on the bottom or sides of pool basins. Common drawbacks include algae growth, mold, and chemical adhesion from cleaning materials.

#### 5-5 Brick Tile

Although not modern, these tiles are durable and resilient like stone tiles. They are characterized by their red color. A common drawback of this type of tile is that they are highly porous. Therefore, regular maintenance is carried out to ensure that water does not leak inside the tiled basins. It is necessary to protect the tiles from mold and algae growth.

At the end of this axis, the researcher confirms that design integration is achieved when the ceramic tile elements used to cover pool basins come together as one unit. The demonstration of integration depends on the selection of foundations and design elements within the appropriate subject scope for the design process, including aesthetic qualities, primarily relying on sensory understanding and mutual interaction between the recipient and the design structure for pool basin design. The ceramic tile used to cover pool basins is the most prominent means of organizing elements, in addition to its role in shaping and forming swimming pool designs. The role of technology is the foundation for the basic design work, and the level of organization of design formations contributes to presenting pool basins in an artistic and design-oriented manner according to the requirements, whether these requirements are aesthetic within actual operations in shaping and modifying materials that contribute to the construction process. This may be determined based on the space focused on studying aesthetic ideals and actual scientific requirements. Therefore, determining the technical specifications of ceramic tiles varies according to response conditions, which include the interaction of the design form related mechanisms concerning the apparent and latent shape properties. This depends on the nature of the consumer's future senses and the experience of the viewer, as well as what aesthetically and technically interests them.

### **Chapter Three: The Research Methodology**

This research relied on the empirical and laboratory testing approach to test the sample within the theoretical framework as a standard in physical tests.

### Research Community

The research community has included a study of samples for pool photographers. A group of tiles from the local Iraqi markets (Middle East Ceramic Complex) was intentionally selected to achieve the research objectives.

### The Tool of Search, Accuracy, and Stability

The tool of search, accuracy, and stability The researcher relied on a set of tools in testing the samples, including those mentioned in the theoretical framework, which are the technical specifications of ceramic tiles, achieving aesthetic, functional, and environmental aspects, and the researcher's opinion and the opinions of the experts who were presented with the research community to select the samples according to the above-mentioned data. Therefore, the research community was presented to experts from Egypt to achieve the highest level of tool accuracy and stability. The researcher also used laboratory devices as a tool to achieve the research goals, such as the fracture strength device and water absorption device, as well as relying on mathematical calculations to extract the percentage ratios of water absorption, porosity, and fracture coefficient for the tested tiles. The "Kooper" equation was adopted to determine the agreement ratio through calculating the stability coefficient between the researcher's analysis and the external experts. The average stability coefficient was as follows:

- \* Stability ratio between the first expert and the researcher: 80%.
- \* Stability ratio between the second analyst and the researcher: 92%.
- \* Stability ratio between the first and second analysts: 85%.

Thus, the average stability ratio between the first and second analysts and the researcher reached 86%, which is a very good ratio that can be relied upon.



## Research sample

The research sample consists of four tiles selected from a total of ten tiles according to the experts' opinion based on the technical specifications of the ceramic tiles used in covering pool basins and achieving aesthetic and functional aspects.

## Procedures

Four ceramic tiles have been selected from local markets for use in pool basins and to determine some of their technical specifications through physical tests to confirm their artistic specifications, were:

- 1- Blue, turquoise, and green tiles were selected based on the theoretical framework indicators, as these colors are commonly used in the Iraqi environment, representing the historical significance of the color blue, which was used in the Ishtar Gate tiles. The selection of tile colors was also based on the opinions of appointed experts.
- 2- Measuring some natural specifications of the tiles to select the most suitable for pool basins - water absorption - fracture strength coefficient.
- 3- Placing the tiles in the water absorption measurement device: This device is used to measure the amount of water absorbed by the samples. The weights are attached to the back of the ceramic tiles, then placed inside the device. The device door is then closed, and the process continues for an hour and a half, during which the air is removed from the device to open the pores. The device is then filled with water automatically. At the end of the process, the device is emptied of water, and then the assemblies are weighed again and their weights are reattached to calculate the absorption rate. shown in figure (4).



Figure (4): water absorption measurement device

- 4- Placing the tiles in the fracture coefficient measurement device: The device is used to measure the durability of ceramic tiles and their resistance to external pressure applied to them. The breaking strength is measured in relation to the dimensions and thickness of the tiles to determine the force applied to them. The unit of measurement is  $\text{kg/cm}^2$ . . shown in figure (5)



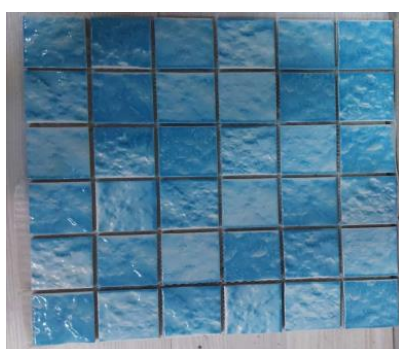
Figure (5): fracture coefficient measurement device

5- Porcelain Tiles (Research Sample)

*Sample Number 1*

Description: Porcelain tiles divided into small squares within a single unit used to cover swimming pool basins coated in dark blue color

Dimensions of the tile used: 30cm x 20cm

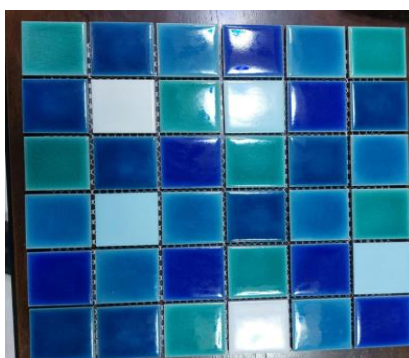


*Sample number 2*

Description: Ceramic tiles used to cover swimming pools coated in light blue and turquoise colors

used: 30 cm × 20 cm

Dimensions of the tile



***Sample number 3***

Description: Porcelain tiles (shiny porcelain) used to cover swimming pools coated in light blue and light green colors

Dimensions of the



tile used: 10 cm x 10 cm

***Sample Number 4***

Description: Glossy ceramic tiles divided into rectangles within a single unit used to cover swimming pools coated in blue color. Dimensions of the tile used: 30cm x 20cm



## Tests

1- The researcher conducted laboratory tests to calculate the absorption ratio after immersing the samples (ceramic tiles) in a water absorption testing device for an hour and a half. The samples were weighed before and after immersion in water, then dried and reweighed to determine the absorption ratio according to the following equation.

$$\text{Water absorption rate \%} = \frac{B - A}{B} \times 100$$

A= Sample weight when wet

B= Sample weight when dry

2- The tiles were examined on a fracture force measurement laboratory device, where a force of 300 kg / cm was applied to the ceramic tiles through the movable arm, and when the tiles are broken, the device measures the strength of the tiles.

## Results

Tests on the models revealed the following:

- 1- There is an inverse relationship between water absorption, porosity and fracture strength modulus.
- 2- Ceramic tiles with high porosity have a low modulus of fracture strength, and this is due to the specifications of the tiles and their ability to absorb high water due to the quality of the clay and the period of fire to which they were exposed inside the ceramic kilns, and this was observed in sample No. (2), (1).
- 3- Tiles with low porosity have a high coefficient of fracture strength due to the ability of the tiles to absorb a small amount of water, and this was observed in sample No. (3), (4).

The ceramic tiles that are suitable for installation at the bottom of swimming pools are sample No. (3) due to their very low water absorption due to their close porosity and almost complete closure due to the quality of the clay and the temperature of the fire inside the kiln, as they were exposed for a longer time inside the ceramic kilns

Samples	porosity	water absorption	Fracture strength
1	%11	%5	17keg/cm <sup>2</sup>
2	%15	%8	15 keg/cm <sup>2</sup>
3	%0.6	%0.3	28 keg/cm <sup>2</sup>
4	%9	%4.5	19 keg/cm <sup>2</sup>

## Conclusions

- 1- Ceramic tiles used in swimming pools should have low porosity because low porosity makes them more resistant to moisture and water shocks.
- 2- Sample No. 1, 3, 4 can be used in swimming pool walls due to their high porosity, so they are more suitable for the walls.
- 3- All samples are in blue colors, whether light or dark, to give a sense of psychological connection between swimming pools and nature

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## Appendix 1

British and International Standards for Ceramic Tiles (Flooring) 1998.

British Standards and Codes of Practice for the Installation of Wall & Floor Tiles

الرمز Symbol	الخواص الفنية Technical Characteristics	طرق الاختبار Standard Test Methods	حدران ISO13006 Group BIII	أرضيات ISO13006 Group BIIa	موصفات بلاط الخزف السعودي Saudi Ceramics Specifications
	التفاوت في الأبعاد Size variation (%)	SSA 1030 ISO10545 Part 2	± 0.50	± 0.50	± 0.50
	التفاوت في الإستواء Flatness deviation (%)	SSA 1030 ISO10545 Part 2	± 0.50	± 0.50	± 0.35
	التفاوت في السماكة Thickness deviation %	SSA 1030 ISO10545 Part 2	± 10.0	± 5.0	Gp BIII ± 10.0 Gp BIIa ± 5.0
	إمتصاص الماء Water Absorption (%)	SSA 1030 ISO10545 Part 3	≥ 10 up to 20	3<E>E</E>6	Gp BIII 16±2 FT 3 · 5
	معامل التمدد بالحرارة Coefficient of Linear thermal Expansion	SSA 1030 ISO10545 Part 8	Test method available	Test method available	< 8×10 <sup>-6</sup> °K <sup>-1</sup>
	مقاومة البري Resistance to Surface abrasion (Class)	SSA 1030 ISO10545 Part 7	Manufacturer to state abrasion class	Manufacturer to state abrasion class	2-5
	صلابة السطح (حسب مقياس موهز) Hardness Moh's scale (Class)	SSA 1030	≥ 3	≥ 5	Gp BIII ≥ 3 Gp BIIa ≥ 5
	معامل الكسر بالإنحاء Modulus of Rupture MOR (N/mm <sup>2</sup> )	SSA 1030 ISO10545 Part 4	≥ 12	≥ 22	Gp BIII ≥ 16 Gp BIIa ≥ 25
	مقاومة تشقق الطلاء الزجاجي Crazing Resistance	SSA 1030 ISO10545 Part 11	Required	Required	مقاوم Resistant
	مقاوم للبقع Resistance to stains (Class)	SSA 1030 ISO10545 Part 14	Min. 2	Min. 2	Min. 2
	مقاوم لمواد التنظيف المنزلي Resistance to household chemicals (Class)	SSA 1030 ISO10545 Part 13	Min. B	Min. B	A
	مقاومة الأحماض والقلويات Resistance to Acids & Alkalis	SSA 1030 ISO10545 Part 13	Manufacturer to state classification	Manufacturer to state classification	مقاوم Resistant
	مقاومة الصدمات الحرارية Thermal shock resistance	SSA 1030 ISO10545 Part 9	Test method available	Test method available	مقاوم Resistant