2.2 CLASSIFICATION ACCORDING TO DIN EN 14411

2.2.1 TERMS AND CLASSIFICATION ACCORDING TO DIN EN 14411

All our tiles consist of natural raw materials such as clay, quartz sand and feldspars, which are processed, refined and fired. Depending on the application they are manufactured with a glazed (GL) or unglazed (UGL) surface. They can be classified in accordance with DIN EN 14411 as follows:

Classification of the ceramic tiles according to their groups of water absorption (E) and their shaping

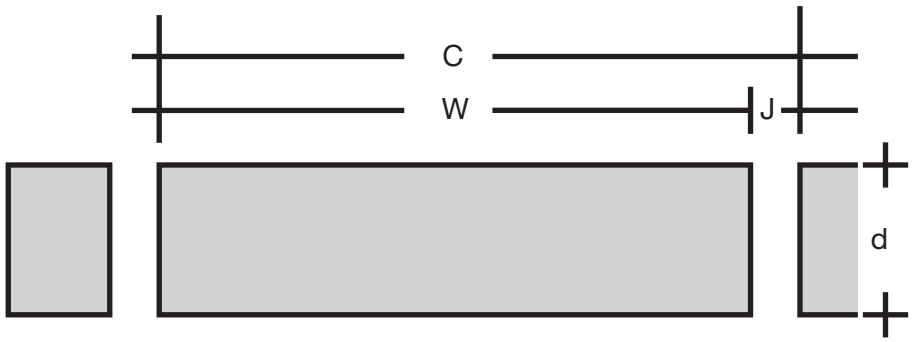
Shaping	**Group I** (E ≤ 3%)	**Group II_a** (3% < E ≤ 6%)	**Group II_b** (6% < E ≤ 10%)	**Group III** (E > 10%)
A Extrueded tiles	Group AI_a E ≤ 0,5% (Annex M)	Group AII_{a-1} [a] (Annex B)	Group AII_{b-1} [a] (Annex D)	Group AIII (Annex F)
	Group AI_b 0,5% < E ≤ 3% (Annex A)	Group AII_{a-2} [a] (Annex C)	Group AII_{b-2} [a] (Annex E)	
B Dry-pressed tiles	Group BI_a E ≤ 0,5% (Annex G)	Group BII_a (Annex J)	Group BII_b (Annex K)	Group $BIII_b$ [b] (Annex L)
	Group BI_b 0,5% < E ≤ 3% (Annex H)			

a) The groups AIIa and AIIb are subdivided into two parts (parts 1 and 2) with different product requirements.
b) Group BIII essentially applies to glazed tiles. There is a small number of dry-pressed unglazed tiles manufactured with a water absorption of more than 10 % to which this product group does not apply.

Traditionally the following terms are used:

Extruded tiles (marked with A)
Tiles that are cut off with a certain length from a bar formed from the plastic mass by means of an extruder.
Dry-pressed tiles (marked with B)
Tiles that are formed from a finely ground and subsequently granulated mass by pressing under high pressure.
Split tiles are frost-resistant, extruded double-tiles which are fired at a temperature of up to max. 1280 °C in upright position.
Stoneware tiles are frost-resistant, single extruded vitrified tiles with a firing temperature of appr. 1260 °C.
KerAion® is the unique extruded ceramic large-size panel from AGROB BUCHTAL.
Vitrified dry-pressed tiles are frost-resistant, single dry-pressed tiles with a firing temperature of up to 1200 °C.
Porcelain stoneware stands for especially densely sintered tiles with a water absorption of < 0.5 %.
Mosaics are small (porcelain) stoneware tiles stuck onto sheets.
Earthenware tiles are non-frost-resistant, single dry-pressed tiles with a firing temperature of up to appr. 1100 °C.
The water absorption E in weight-% is determined in accordance with DIN EN ISO 10545-3.

DESCRIPTION OF DIMENSIONS



Coordinating dimension
(C) in cm = Werkmaß (W) + Fuge (J)
Work size
(W) in mm = Maße der Ansichtsflächen und Dicke (d)

2.2.2 DIMENSIONS AND SURFACES

1-5. DIMENSIONS | DIN EN ISO 10545-2

All dimensions are determined in accordance with the standard.

Permissible length and width tolerances corresponding to the product standards						
DIN EN 14411	Group AI_a / AI_b (25 x 12,5 cm)		Group AII_a (25 x 12,5 cm)		Group BI_a / BI_b (30 x 30 cm)	Group BIII (10 x 10 cm)
	"Nature"	"Precision"	"Nature"	"Precision"		
Deviation from the work size	±2%	±1,0%	±2%	±1,25%	±0,6%	±0,5%
Deviation from the average side length	±1,5%	±1,0%	±1,5%	±1,0%	±0,5%	±0,5%

The work sizes of our **special pieces** are given according to visual sides.

6. SURFACE QUALITY | DIN EN ISO 10545-2

The surfaces of 1 m2 or 30 pieces are tested at 300 lux for visible defects at a distance of 1 m.

7. COLOR DEVIATIONS | DIN EN ISO 10545-16

Glazed mono-colored products with values of △ Ecmc < 0.75 are considered as identical in color; the value of 1.0 applies to unglazed mono-colored products.

7.1. COLOR SHADE GRADING

The color shade code is stamped on the box. Only identical color shades will result in a uniform surface look. In the case of rustic split tiles greater color deviations are normal. During laying, tiles from different boxes should be mixed.

8. SIZE GRADING

The production sizes vary for technical reasons. The production size is coded and stamped on the box. Only boxes with the same coding should be laid together. According to VOB, the differences are evened out in the joints.

! All references to as well as quotations from product and test standards are to be considered as information which is not binding. The latest versions apply.

2.2.3 PHYSICAL PROPERTIES

1. WATER ABSORPTION | DIN EN ISO 10545-3

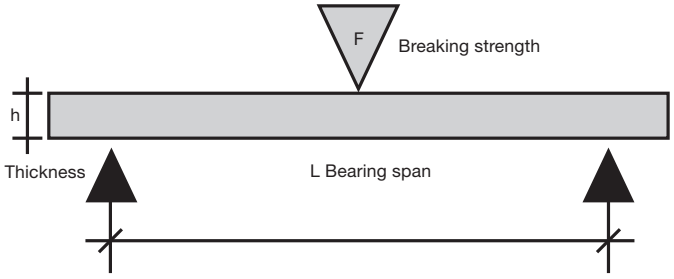
The water absorption (E) gives the weight increase as compared to the dry weight of samples saturated with water under vacuum.

1.1 APPARENT DENSITY | DIN EN ISO 10545-3

It gives the ratio between mass and external volume.

2. MODULUS OF RUPTURE | DIN EN ISO 10545-4

The breaking strength F is determined on samples by means of the three-point load in N. From this, the modulus of rupture and the breaking load are calculated according to the following formula.



Modulus of Rupture

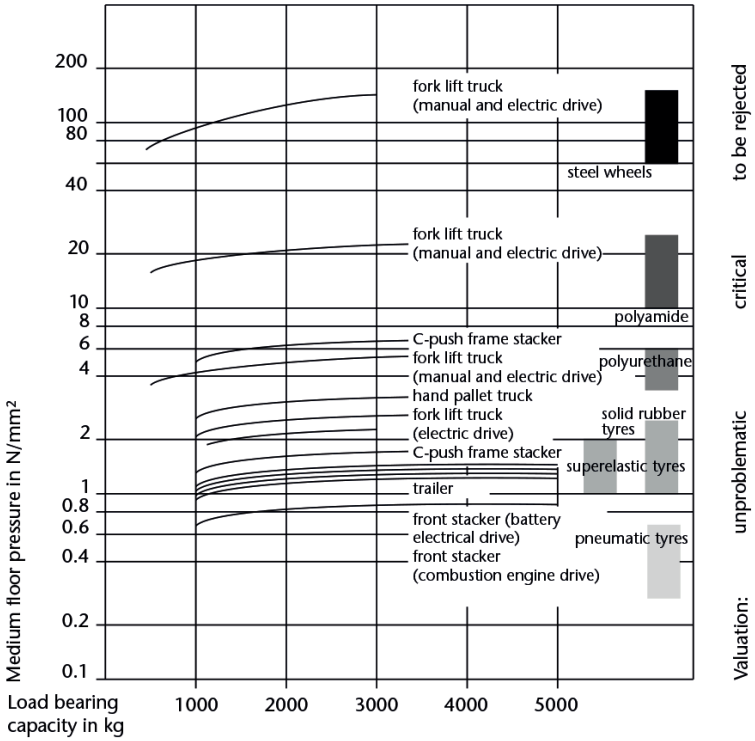
$$R = \frac{3 \times F \times L}{2 \times b \times h^2}$$

Breaking Load

$$S = \frac{F \times L}{b}$$

F = breaking strength in N
L = bearing span in mm
b = width in mm
h = thickness in mm
R = modulus of rupture

Beaking Strength	Possible Applications	Stress Group
Breaking Strength under 1.500 N	Housing construction and floor coverings subject to comparable mechanical stress, e.g. hotel bathrooms, rooms in the health service sector	1
Breaking Strength 1.500 – 3.000 N	Administration, trade and industry (practicable with vehicles with pneumatic tyres), e.g. canteen kitchens, canteens, traffic zones, car exhibition and maintenance areas, sales rooms, always without industrial truck traffic **Floor pressures up to 2 N/mm²**	2
Breaking Strength 3.000 – 5.000 N	Trade and industry (industrial truck traffic with superelastic, solid rubber and vulkollan tyres), e.g. in food retailing and wholesaling, non-food retailing and wholesaling, shopping malls **Floor pressures up to 6 N/mm²**	3
Breaking Strength 5.000 – 8.000 N	Trade and industry; areas of application as in group 3, but practicable with polyamide rollers **Floor pressures 6 to 20 N/mm²**	4
Breaking Strength above 8.000 N	Trade and industry; heavy-duty areas with industrial truck traffic with polyamide rollers; runners of metal parts, such as e.g. in factory buildings, assembly halls and storerooms, repair workshops for machines and heavy equipment **Floor pressures > 20 N/mm²**	5



Floor pressure in N/mm² of industrial truck wheels according to a FMPA test in Stuttgart
The table illustrates the floor loads and indicates the effect of the different wheel types: steel wheels should be rejected and polyamide (Nylon and Perlon) is not advisable. Softer tyres (≤ 75 Shore-A-Hardness) as well as larger wheel diameters and wider supporting surfaces are especially advantageous.

Mechanical Strength
Deutsche Steinzeug offers tiles in thicknesses from 5 up to 20 mm for extreme loads in industrial and commercial areas. The breaking load values of our products partly are by far better than the values required by DIN EN 14411 (the relevant test certificates will be made available on request).

The calculated breaking load indicates the suitability for floors subject to mechanical loads. The stress itself is caused by bending rather than by pressure. The “extra strong” tiles from our programme with their high pressure, breaking and bending strength values are the ideal covering for floors subject to heavy loads. They withstand the wheels of industrial trucks, fork lift trucks and platform lift-trucks with their high floor pressure. They are especially suitable as floor coverings for industrial logistics, hyper- and supermarkets.

3. COMPRESSIVE STRENGTH
The compressive strength of tiles is not standardized. In the case of vitrified dry-pressed tiles it reaches values of up to 150 N/mm². The following conversion table shows the importance of a perfect and professional embedding of the tiles on site. The relatively low values for cement and thin-bed mortar can only be compensated by special and professional laying (mortar composition, water/cement value and manual or mechanical compression).

!

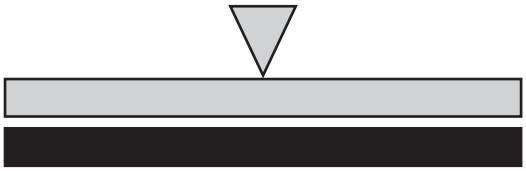
The “application possibilities” are of course only recommendations, as the method and quality of laying are decisive factors. Our recommendations are based on conventional, professional laying. With increasing mechanical load as well as harder tyres a thicker tile is required.

4. RESISTANCE TO SHOCK, | DIN EN ISO 10545-5
Rebound measurement with 5 samples.

5. RESISTANCE TO DEEP ABRASION | DIN EN ISO 10545-6
With regard to the deep abrasion on unglazed tiles, the abrasion is determined by means of fusion corundum and a rubbing plate. The lower the value, the higher the wear resistance of the material.

6. GLAZE ABRASION | DIN EN ISO 10545-7
The abrasion class of glazed tiles is established in the wet test. Artificial abrasion is produced with the help of aluminium oxide grains, steel balls and the addition of water in an eccentrically revolving system. The number of revolutions at which a visible change of the test surface occurs results in the following classification:

Resistance to Surface Abrasion	
Class	**Revolutions**
0	100
1	150
2	600
3	750 / 1500
4	2100 / 6000 / 12000
5	> 12000*
* Must pass the stain test according to DIN EN ISO 10545-14.	



Vitrified material has a compressive strength approx. 10 - 20 times higher than cement mortar, cast plaster floors and reinforced concrete.

Conversion table for different materials			
Types of Material	**N/mm²**	**N/cm²**	**kN/cm²**
Vitrified dry-pressed tiles	100 – 150	10.000 – 15.000	15 – 30
Extruded split tiles	180 – 250	18.000 – 25.000	18 – 25
Cement mortar Gr. III	10	1.000	1
High-grade cement mortar	20	2.000	2
Thin-bed mortar	15 – 30	1.500 – 3.000	1,5 – 3
Epoxy resins	60 – 75	6.000 – 7.500	6 – 7,5
Cement screed CT, C12 (ZE 12)	12	1.200	1,2
Cement screed CT, C20 (ZE 20)	20	2.000	2
Cement screed CT, C30 (ZE 30)	30	3.000	3
Mechanically resistant floor 65	65	6.500	6,5
Reinforced concrete C20/25 (B 25)	25	2.500	2,5
Reinforced concrete C30/37 (B 35)	35	3.500	3,5

Class 0
The use of glazed tiles of this class for floor coverings is not recommended.

Class 1
Floor coverings in areas mainly walked on in soft footwear or barefoot and not exposed to abrasive dirt (e.g. bathrooms and bedrooms without direct access from outside).

Class 2
Floor coverings in areas occasionally walked on with soft or normal footwear and exposed to only little abrasive dirt (e.g. rooms in living areas of houses, except kitchens, entrances and similar heavily frequented rooms). This does not apply to special footwear such as e.g. hobnailed boots.

Class 3
Floor coverings in areas frequently walked on with normal shoes and exposed to little abrasive dirt (e.g. kitchen-cum-living-rooms, halls, corridors, balconies, loggias and terraces). This does not apply to special footwear such as e.g. hobnailed boots.

Class 4
Floor coverings walked on regularly and exposed to little abrasive dirt, so that they are subject to greater stress as in the case of class 3 (e.g. commercial kitchens, hotels, exhibition and sales rooms).

Class 5
Floor coverings subject to heavy pedestrian traffic over long periods of time and exposed to little abrasive dirt, so that they are subject to the most extreme stress under which glazed tiles can be applicable (e.g. public areas such as shopping centres, entrance halls of airports, hotel foyers, public footpaths and industrial applications).

Every floor covering is subject to wear. This depends on the area of application and the frequency of use, the kind and degree of dirt as well as the hardness and resistance to wear of the covering material. While unglazed vitrified floor tiles can be used practically anywhere, glazed floor tiles have to be categorized according to stress groups. Scrapers, mats and the like help to remove dirt and abrasives and to protect glazed floor coverings. Something of this kind has to be provided especially in rooms with direct access from outside or from the garden.

Extreme Stress
For such areas we recommend the use of integrally colored, unglazed tiles, which are available in a wide range of colors and sizes. Examples: floors subject to high traffic loads, e.g. in supermarkets, hotels, schools, administrative buildings, railway stations, hospitals, passageways, etc., taking into account the mechanical load.

7. COEFFICIENT OF EXPANSION | DIN EN ISO 10545-8
The coefficient of expansion is ascertained between room temperature and 100°C. The measured values are at around 6.0 x 10-6 m/ (mxK) in the case of vitrified materials and at around 8.0 x 10-6 m/ (mxK) in the case of porcelain stoneware. At 8 m length and 50° temperature difference the result is a change in length of approx. 2.4 mm in the case of vitrified materials

8. THERMAL SHOCK RESISTANCE | DIN EN ISO 10545-9
The thermal shock resistance is tested between 15° and 145°C.

9. MOISTURE EXPANSION | DIN EN ISO 10545-10
The moisture expansion is determined between tempered and water-saturated samples.

10. RESISTANCE TO GLAZE CRACKING | DIN EN ISO 10545-11

This test takes place in the autoclave at 500 KPa with subsequent color control. Glazes with hair cracks/crazes are marked as such and require the wetting of the covering prior to pointing to avoid deposits of fine particles of the pointing mortar in the hair cracks. Colored pointing compounds are not suitable in the case of these glazes. The glaze surfaces must not be marked with felt-tip pen and the like.

11. THERMAL CONDUCTIVITY ETC.

Thermal conductivity, heat radiation and storage capacity as well as the thermal resistance are not standardized. Vitrified material produces the following approximate values:
Thermal conductivity: 1 W/mK
Heat storage capacity: 0,8 kJ/kgK
Heat radiation: 5,3 W/m2K4
Thermal resistance: 0,01m2 K/W

12. ELECTRICAL LEAKAGE RESISTANCE

With a volume resistance of > 1010 Ohm (DIN EN 1081), our ceramics is insulating in dry condition. With the series Eladuct and KerAion ELA 10.6, however, we offer ceramics for floors capable of discharging static electricity. The glaze of ELA 10.6 has a surface resistance of approx. 106 Ohm according to DIN EN 1081. The discharge of static electricity is effected from the glaze via conductive joints and tile adhesive into copper strips to be connected to earth, which are laid on the base to be tiled. In the case of Eladuct, the complete tile body is capable of discharging static electricity. The volume resistance according to DIN EN 1081 is approx. 108 Ohm. Here, conductive joints are not required; apart from that, the base has to be carried out as described for ELA 10.6.

13. STEAM DIFFUSION RESISTANCE

According to DIN EN ISO 12572 the steam diffusion resistance is approx. μ 120,000 in the case of vitrified material/split tiles and μ 100,000 in the case of earthenware (excluding joints).

14. RESISTANCE TO FROST | DIN EN ISO 10545-12

The test for frost resistance is carried out on 10 samples or > 0.25 m2 samples. After water saturation under vacuum the samples are checked for defects after 100 frost-thaw alternations. The resistance to frost of an outdoor flooring, however, does not only depend on the quality of the ceramic tiles used. Professional construction and laying are essential. For this, please refer to our specifications and the notice of the umbrella organization of the German building

15. LIGHT AND COLOR FASTNESS

Both glazed and unglazed ceramics are light- and color-fast according to DIN 51094.

16. LUMINANCE

The lightness value of a tile describes the brightness of the surface as perceived by the human eye. The measuring value Y = 100 corresponds to the brightness of an absolutely white surface, and Y = 0 to that of an absolutely black surface. The lightness value is determined for mono-colored tiles.

17. BEHAVIOUR IN FIRE

Ceramic tiles are classified A 1 according to EN ISO 13501-1 and DIN EN 14411. Therefore, they are generally non-combustible and thus fire-resistant. Also in the case of fire they do not release any toxic emissions.

All references to as well as quotations from product and test standards are to be considered as information which is not binding. The latest versions apply

2.2.4 CHEMICAL PROPERTIES

1. RESISTANCE TO CHEMICALS | DIN EN ISO 10545-13

Resistance to Household Chemicals and Bath Water Additives
Household chemicals Ammonium chloride solution 100g/l
Bath salts Sodium hypochlorite solution 20mg/l

Classes: A/B/C*

Resistance to Acids and Alkalis
Low concentration (L)
a) Hydrochloric acid solution 3% (V/V)
b) Citric acid solution 100g/l
c) Potassium hydroxide solution 30g/l
High concentration (H)
a) Hydrochloric acid solution 18% (V/V)
b) Lactic acid solution 5% (V/V)
c) Potassium hydroxide solution 100g/l

Classes: LA/LB/LC or HA/HB/HC*

Acid Protection and Apparatus Engineering
The resistance for acid protection engineering DIN EN 993-16 or chemical apparatus engineering DIN 28062 is subject to individual tests.

* Class A shows the highest resistance to chemicals, which decreases more and more towards C.

2. STAIN RESISTANCE | DIN EN ISO 10545-14

Stain Forming Substances
Stain forming substances, leaving traces
Green stain forming substances in oil
Red stain forming substances in oil
Chemical stain forming substances
Lodine, 13g/l in alcohol
Stain forming substances, forming a film
Olive oil

Cleaning (within the framework of the test)
Cleaning agent
Hot water (+55 °C)
Weak cleaning agent
Strong cleaning agent
Solvent
Hydrochloric acid solution 3% (V/V)
Potassium hydroxide 200g/l
Acetone

Classes: Cl. 5 / Cl. 4 / Cl. 3 / Cl. 2 / Cl. 1*

3. LEAD AND CADMIUM DELIVERY

The glazed surfaces are exposed to a 4 percent acetic acid solution. Then, the quantity of the delivered lead and cadmium is determined.

* Class 5 shows the highest stain resistance, which decreases more and more towards 1.