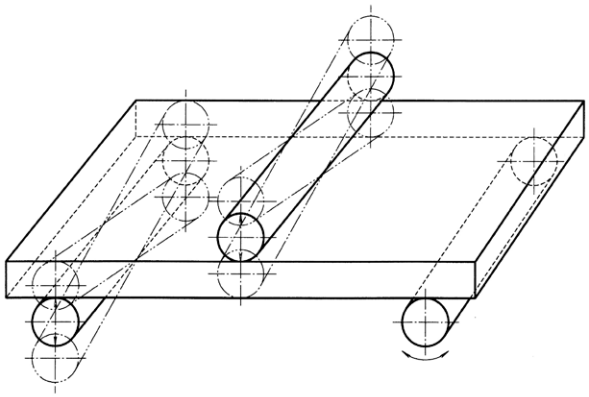
Mosa
Load-bearing capacity

Introduction
Among the requirements set in the harmonized European standard for ceramic tiles, BS-EN 14411, are those for the physical properties of breaking strength and bending strength. The physical properties depend in part on the geometric properties of length, width, and thickness. Together they determine the applicability of tiles under given conditions and load. It is important here to distinguish between static and mobile (dynamic) loads. In addition, the European standard EN 1991-1-1+C1 (Eurocode 1) provides insight into the requirements with regard to the load capacity of structures, of which ceramic tiles can be an integral part.

The aim of this technical data sheet is to provide general insight into the different requirements and guidelines with regard to the load capacity of ceramic tiles, and the underlying applications. For all other properties, standards and tolerances of ceramic tiles please refer to the Technical Product Sheet for Ultragres Unglazed Tiles.

Static load and mobile (dynamic) load
In this regard, static load is when pressure is exerted on a structure (e.g. a floor) without resulting in movement in the structure (for example, when placing a machine). Mobile (dynamic) load is when there is a mobile object that moves over the surface. Examples of this are vehicles, mobile boom lifts, pallet trucks, etc.

Static load-bearing capacity
As regards the static load-bearing capacity of ceramic tiles, the breaking strength and bending strength of EN 14411, point load and compression strength (neither of which are standardized) and the load classes in EN 1991-1-1 + C1 are covered in this context.



EN 14411: breaking strength and bending strength
The European standard for ceramic tiles EN 14411 sets requirements for minimum breaking strength (S) and bending strength (R). Both are determined by means of a so-called three-point bending test in accordance with ISO 10545-4. Here the tile lies on two sides on supports with a prescribed diameter and is then loaded from above over the entire width. The edges of the tile both extend 10 mm beyond the supports. The maximum weight supported by the tile before it breaks is called the breaking load (F). This is expressed in Newtons (N).

The breaking strength (S) is determined by multiplying the breaking load by the distance between the support points (L) and dividing this by the width of the tile (b).

$S = F \times L / b$

The breaking strength says something about the strength of the material. This depends on the thickness, regardless of length, and width. This enables the strength of tiles or other materials to be compared with each other in relation to thickness, but regardless of length and width.

The bending strength (R) is determined by dividing the calculated breaking strength (S) by the square of the thinnest point along the break line (h) in mm and is expressed in N/mm^2 with the formula:

$R = 3 \times S(N) / 2 \times h2$

It can also be calculated directly from the breaking load (F) with the formula:

$R = (3 \times F(N) \times L) / 2 \times w \times h2$

In which
L = the distance between the support points in mm
w = width in mm
h = thickness in mm

The bending strength shows the capacity of the tile to resist deformation under load. In theory, the thinnest point is the weakest, so that is where the tile will break first. By determining the bending strength, you can compare the load bearing capacity of different materials or tiles regardless of their size or thickness.

Mosa
Load-bearing capacity

Point load
A point load is a load that acts on a structural part, where the surface area of the contact point is small in relation to the structural part. Point load is not a property specified in the European standard EN 14411, but is, among other things, a factor in determining the load capacity of structures as described in the European standard EN 1991-1-1 + C1 (Eurocode1), of which tiles may be a part.

For the extent to which ceramic tiles are able to resist deformation, please refer to the bending strength (R).

Compression strength
Compression strength is the extent to which a material can withstand compressive forces without losing its integrity and disintegrating (so-called brittle deformation), expressed as force divided by area (Newton/mm²). Due to their composition and production method, ceramic floor tiles produced according to EN 14411 achieve a very high density, resulting in extremely high compression strength. Because of this material-specific property, no requirement has been defined for this in the EN 14411 standard. Ultragres tiles from Mosa achieve average values of 300 N/mm².

EN 1991-1-1+C1 Load classes
The European standard EN 1991-1-1 + C1 (Eurocode 1) describes the minimum requirements for load capacity with which structures must comply. The individual Member States may impose additional requirements per class in a National Annex. The British National Annex to BS-EN 1991-1-1 + C1 standard states the loads that apply to categories for specific use in buildings in the United Kingdom. A number of classes have been defined and subdivided into areas of application. Load per square metre (q_k) and a point load (Q_k) have been prescribed for each of these areas. The following tables show the general use classes according to the British national Annex (table 1) and the specific minimum load requirements for application in the United Kingdom (table 2).

Table 1. Use classes according to the UK National Annex to EN 1991-1-1+C1

Category of loaded area	Specific use	Sub-category	Example
A	Areas for domestic and residential activities	A1	All usages within self-contained dwelling units (a unit occupied by a single family or a modular student accommodation unit with a secure door and comprising not more than six single bedrooms and an internal corridor) Communal areas (including kitchens) in blocks of flats with limited use (see Note 1). For communal areas in other blocks of flats, see A5, A6 and C3
		A2	Bedrooms and dormitories except those in self-contained single family dwelling units and in hotels and motels
		A3	Bedrooms in hotels and motels; hospital wards; toilet areas
		A4	Billiard/snooker rooms
		A5	Balconies in single family dwelling units and communal areas in blocks of flats with limited use (see Note 1)
		A6	Balconies in hostels, guest houses, residential clubs and communal areas in blocks of flats except those covered by Note 1
		A7	Balconies in hotels and motels
B	Office areas	B1	General use other than in B2
		B2	At or below ground floor level
C	Areas where people may congregate (with the exception of areas defined under category A, B and D)	C1	Areas with tables

Mosa
Load-bearing capacity

Category of loaded area	Specific use	Sub-category	Example
C		C11	Public, institutional and communal dining rooms and lounges, cafes and restaurants (see Note 2)
		C12	Reading rooms with no book storage
		C13	Classrooms
		C2	Areas with fixed seats
		C21	Assembly areas with fixed seating (see Note 3)
		C22	Places of worship
		C3	Areas without obstacles for moving people
		C31	Corridors, hallways, aisles in institutional type buildings not subjected to crowds or wheeled vehicles, hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by Note 1
		C32	Stairs, landings in institutional type buildings not subjected to crowds or wheeled vehicles, hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by Note 1
		C33	Corridors, hallways, aisles in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to crowds
		C34	Corridors, hallways, aisles in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to wheeled vehicles, including trolleys
		C35	Stairs, landings in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to crowds
		C36	Walkways — Light duty (access suitable for one person, walkway width approx 600 mm)
		C37	Walkways — General duty (regular two-way pedestrian traffic)
		C38	Walkways — Heavy duty (high density pedestrian traffic including escape routes)
		C39	Museum floors and art galleries for exhibition purposes
		C4	Areas with possible physical activities
		C41	Dance halls and studios, gymnasia, stages (see Note 5)
		C42	Drill halls and drill rooms (see Note 5)
		C5	Areas susceptible to large crowds
		C51	Assembly areas without fixed seating, concert halls, bars and places of worship (see Note 4 and Note 5)
		C52	Stages in public assembly areas (see Note 5)
D		D1	Areas in general retail shops
		D2	Areas in department stores

Source: NA to BS EN-1991-1-1 + C1, published by the British Standards Institution

Mosa
Load-bearing capacity

With regard to the use of Mosa Ultragres tiles, it is important to establish the class of the surface to be loaded, and whether the possible loads can be borne by the structural parts of this surface. If there is uncertainty about this, you should first consult a builder.

A floor tile has no structural value and should therefore not be included as a structural component in determining the load-bearing capacity of a structure.

In order to be able to withstand the expected load within the pre-defined class, it is very important that the tile is correctly bonded to the substructure, so that forces exerted on the floor tile can be directly transferred to this. In the event of poor bonding, in which the adhesion of the floor tile to the substrate is insufficient, there is a greater risk of damage caused by load.

Dynamic (mobile) load
An estimate can be made of the dynamic load-bearing capacity of ceramic tiles based on research published in the German *Merkblatt hoch belastingete Beläge* published by the German Tile Trade Association. Depending on size (shape), thickness and bending strength, an indication of the maximum dynamic load in Newtons per mm² (N/mm²) can be given, depending on the size and material type of the wheels. In general, steel wheels are not recommended and small-diameter wheels made of hard materials such as polyamide should be avoided. Softer materials such as rubber, in combination with a large contact surface ensure better load distribution. Square sizes are better than rectangular sizes.

Table 2. Minimum load requirements for application in the United Kingdom

Category of loaded area		**q_k - kN/m²**	**Q_k - kN**
Category A	A1	1,5	2,0
	A2	1,5	2,0
	A3	2,0	2,0
	A4	2,0	2,7
	A5	2,5	2,0
	A6	Same as the rooms to which they give access but with a minimum of 3,0	2,0 (concentrated at the outer edge)
	A7	Same as the rooms to which they give access but with a minimum of 4,0	2,0 (concentrated at the outer edge)
Category B	B1	2,5	2,7
	B2	3,0	2,7
Category C	C11	2,0	3,0
	C12	2,5	4,0
	C13	3,0	3,0
	C21	4,0	3,6
	C22	3,0	2,7
	C31	3,0	4,5
	C32	3,0	4,0
	C33	4,0	4,5
	C34	5,0	4,5
	C35	4,0	4,0
	C36	3,0	2,0
	C37	5,0	3,6
	C38	7,5	4,5
	C39	4,0	4,5
	C41	5,0	3,6
	C42	5,0	7,0
	C51	5,0	3,6
	C52	7,5	4,5
Category D	D1/D2	4,0	3,6

Source: NA to BS EN-1991-1-1 + C1, published by the British Standards Institution

Mosa
Load-bearing capacity

Tiles are grouped into the load groups I to V on the basis of their breaking loads. The breaking load is calculated according to bending strength, which is known and documented as a standardized property (see also the technical product sheet for Mosa Ultragres unglazed tiles), and the size and thickness of the tile. The table below shows the Mosa sizes assigned to the load groups, including the maximum dynamic load to which they can be exposed.

Tiling
The substrate to be tiled must be sufficiently flat, stable and dimensionally stable in accordance with the applicable building regulations and taking into account the intended use and expected load.

When working with group III (dynamic load), it is preferable to construct the entire floor (concrete/structure, cement screed and/or mortar, adhesive contact layer and tiles) in one piece without disconnecting pieces. This is due to the high load that can be exerted on such floors. Floating screeds conduct transportation forces through the substrate to a lesser extent, resulting in a greater risk of damage.

Mosa recommends full-surface bonding to prevent damage due to gaps in the adhesive bed; this is a precondition for optimum load-bearing capacity. In the case of tiles with sides larger than 30 centimetres, this is achieved by using the so-called 'buttering and floating' method. In this, the back of the tile is smeared with glue with the flat trowel, and ridges of adhesive are applied with a glue comb, after which the tile is placed in the adhesive bed with a twisting movement.

See **www.mosa.com/services** for full installation advice.

Load groups and applicable Mosa formats

Load group	Breaking load F(N) (ISO 10545-4)	Example of application	Mosa size in centimetres
I	≥ 1,500	Housing construction or similar, e.g. hotel rooms and health care	
II	1,500 – 3,000	Suitable for pneumatic tyres in kitchens, canteens, traffic areas, car showrooms, retail, etc. **Up to 2 N/mm² pressure**	10x10 15x15 30x30 (8mm)
III	3,000 – 5,000	Commercial and industrial floors, suitable for solid rubber tyres, etc., e.g. wholesalers and shopping centres **2 to 6 N/mm² pressure**	5x60, 10x60, 15x60, 20x60, 30x60, 40x60, 60x60 15x30 30x30 (10mm) 45x45 75x75
IV	5,000 – 8,000	Commercial and industry; the same as III, but passable with polyamide wheels **6 to 20 N/mm² pressure**	10x90, 20x90, 30x90, 45x90, 60x90, 90x90 20x120, 30x120, 40x120, 60x120 100x100
V	> 8,000	Heavy commercial and industry; heavy transport with polyamide wheels. E.g. factories and assembly halls, steel works, machine building **> 20 N/mm² pressure**	

Source: Merkblatt hoch belastete Beläge, published by Fachverband Deutsches Fliesengewerbe