

# Mosa.

## Walking safety

### Introduction

Moisture or dirt may make floors slippery, leading to an increased risk of slipping accidents. This is why international requirements have been established for the slip resistance of floor materials such as tiles. The aim of this information sheet is to provide as accurate a description as possible of the test methods accepted in Europe for determining the anti-slip properties of hard floor-covering materials, as described in the European Technical Specification CEN/TS 16165, and the relevant national standards, guidelines and specific limit values derived from it. Mosa tiles are also tested according to these methods where applicable. This information sheet provides insight into the results for the Mosa Ultragres unglazed tile range for floor application, with its different surface types and specific application areas.

The methods described in CEN/TS 16165 as technical specifications are not obligatory as a standard would be. Some countries use different methods and assessment criteria, which are not dealt with in this document.

For all other characteristics, standards, and tolerances, please refer to the Porcelain tiles, unglazed technical product sheet.

### About CEN/TS 16165 - Determination of slip resistance of pedestrian surfaces

The European Technical Specification CEN/TS 16165 describes in separate annexes the four accepted and most widely used methods for determining the slip resistance of pedestrian surfaces\* in Europe. These four methods are:

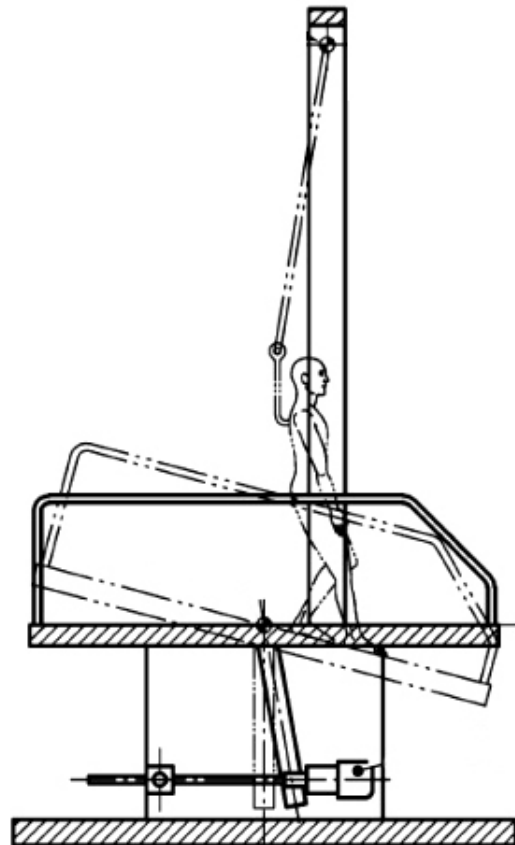
- Annex A - Ramp method, for floors that are walked on barefoot, tested with water and soap as the medium;
- Annex B - Ramp method, for floors in public spaces and the working environment, tested with footwear and with oil as the medium;
- Annex C - Pendulum friction method, for wet and dry applications with specific rubber sliders;
- Annex D - Tribometer method, for wet and dry applications with specific rubber sliders.

Methods A and B can only be performed in the laboratory. Methods C and D can be used for measuring on-site.

### Annex A - Ramp method, for floors that are walked on barefoot

In this, two test persons, secured in a safety harness, walk barefoot over the surface to be tested, which is continuously wetted with a soap and water solution. The test subjects walk up and down the ramp, facing downwards. The angle of the ramp is gradually increased until the test subject slips. Each test subject walks four times until they slip, with the average of the eight tests being recorded. If there are individual values with a difference greater than 2° of this average, the test is repeated. This average is the final average critical gradient of the tested surface. Before the test subjects are allowed to perform this test, they must qualify by walking on three calibration surfaces within a specified range of gradient; if a test subject does not succeed in this, they are disqualified from performing the test.

Figure 1 - Schematic drawing of the ramp method



\* Sports floors and paving materials for vehicles are outside the scope of CEN/TS 16165.

### Annex B - Ramp method, with footwear

This method is identical to the method described above for Annex A, however the subjects now wear special safety shoes ('reference' shoes) and a layer of 10W30 engine oil is applied evenly on the surface before the test. Here, every test person carries out the test three times. Before the test subjects are allowed to perform this test, they must qualify by walking on three calibration surfaces within a specified range of gradient; if a test subject does not succeed in this, they are disqualified from performing the test. The calibration surfaces are different from those of method A.

A classification is assigned to the surface depending on the critical gradient achieved by method A or B. This serves as a basis for choosing the right surface for floors where specific requirements are set for slip resistance. Aspects that are important in determining the minimum class for an area of application include local conditions and the expected nature and quantity of contamination. This test is not mobile, so it can only be performed in a laboratory. In principle, it is used only for product specifications: selecting the floor with the right properties for the intended use.

### Advantages and disadvantages of the ramp method (annex A and B)

#### Advantages

- It is the method best suited to human gait.
- It is reproducible in terms of the prescribed gait and speed.
- It can be applied to all surface types, even those with profound relief.
- The use of calibration surfaces provides the operator with increased objectivity.
- It is usable on the basis of classification linked to intended use.

#### Disadvantages

- It is a laboratory test; on-site testing is not possible.

### Annex C - Pendulum friction method

In this method, a rubber slider of a specified hardness is attached to the end of the pendulum arm by means of a spring mechanism. The pendulum is released from a 90° angle. This method measures the loss of energy that occurs when the slider is dragged and decelerated over the surface to be tested, which affects the swing of the pendulum. This maximum swing is read on a scale; the smaller the swing, the higher the score and the lower the risk of slipping. The test is performed in at least two directions, eight times in each direction, with the average of the last five measurements recorded.

The test can be carried out wet and dry as standard, and with two types of rubber sliders:

- Slider 57\* (soft rubber) simulates barefoot use;
- Slider 96 (hard rubber) simulates use with footwear.

This test can be carried out either in a laboratory or on-site, and can be used to choose the right floor for the intended use and to monitor risks during use of the floor.

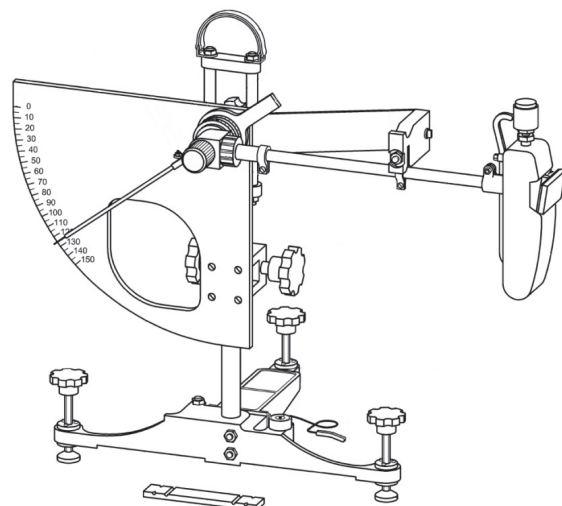
#### Advantages

- The measurement is mobile; on-site testing is possible.
- It is easily reproducible if properly adjusted and used by a skilled operator.

#### Disadvantages

- The device is sensitive to incorrect adjustment and requires regular calibration; a high level of expertise is required at the institution.
- The measuring surface of the slider is very small.
- The measurements can be strongly influenced by individual elevations in the floor and are therefore not readily applicable to surfaces with deep relief.

Figure 2 - Schematic drawing of the pendulum device



\* Formerly Slider 55, see also BS 7976:2 later in this technical information sheet.

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### Annex D - Tribometer method

A device with a specified weight, equipped with sliders of a specified material and shape, is pulled over the surface to be tested at a constant speed by reeling a steel ribbon. The so-called dynamic friction coefficient ( $\mu$ ) of the surface is calculated by dividing the force required to draw the weight horizontally by the vertical force exerted on the surface by the body. This test can be used in both wet and dry conditions.

This test can also be carried out both in a laboratory and on-site, and can be used to choose the right floor for the intended use and to test and monitor the risk of slipping during use.

### Advantages

- The device is mobile; it can be used both in a laboratory and on-site.
- The method has good reproducibility and is less dependent on the operator than the other methods.

### Disadvantages

- Surfaces with deep relief cannot be measured as they adversely affect the even movement of the device.
- Surfaces that are very smooth can show apparently high slip resistance due to 'stiction' (strong friction between the test surface and the sliders).

### Combined use of methods

The different test methods can be used separately, but also to complement each other; a floor material can be chosen on the basis of ramp methods A or B and the classification derived from them, and then measured immediately after installation on-site using methods C or D. This so-called baseline measurement allows the effect of use and maintenance on slip resistance to be monitored.

Comparisons of the values of different methods are not permitted because they are based on different physical principles.

Theoretically, the dynamic friction coefficient ( $\mu$ ) can be determined by calculating the tangent of the gradient; the result of this can be represented as a dimensionless number in  $\mu$ .

However, as the table below shows, after conversion using the tangent, a tile classified as R10 on the basis of the ramp method in accordance with DIN 51130, and which would therefore be well suited for indoor applications under clean or slightly dirty conditions, would be classified as 'unsafe' or 'reasonably safe' ( $0.20 - 0.44 \mu$ ) and would have to be supported by additional risk-reducing measures. For application in a wet area, where  $0.44 \mu$  is the lower limit according to DIN 51131, a tile with bare-foot classification C would have to be used, although according to the ramp method in accordance with DIN 51097 a B value would be sufficient.

Such a comparison can therefore lead to under-specification or over-specification. The different methods can therefore only be used independently or in addition to each other for specifications and monitoring.

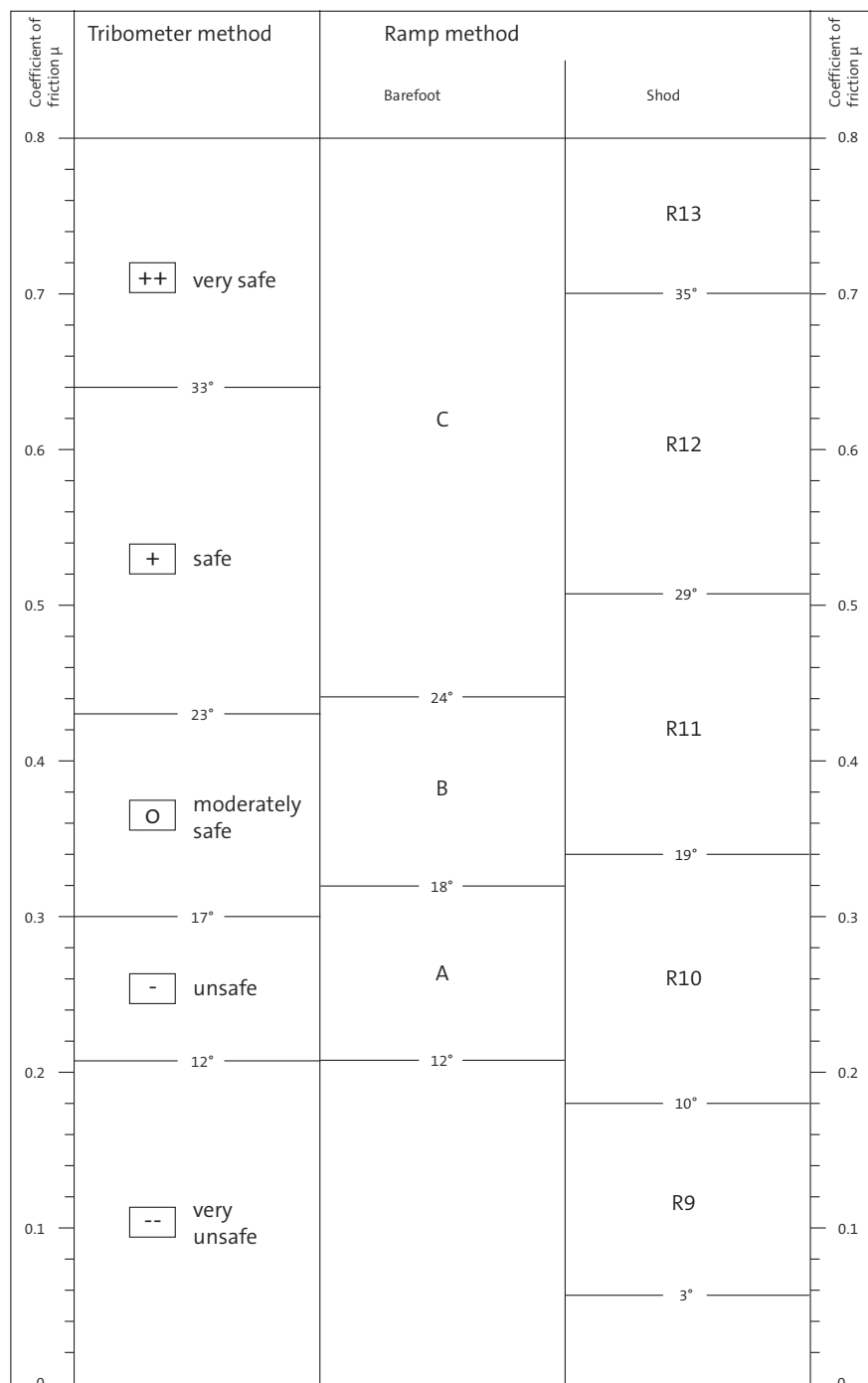
Figure 3 - A tribometer



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**Table 1 - Comparison between  $\mu$  and R and ABC values**



Source: ErgoMed (1995); Das Bewerten der Rutschhemmung von Fußböden, R. Skiba, Wuppertal.

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### National standards

The methods described above are based on years of experience with national standards and guidelines within the European Member States. Not every Member State has its own standards or guidelines and often, in determining the suitability of floor covering materials, reference is made to the relevant standards or guidelines of Member States where these have already been laid down. Sometimes other criteria and methods are applied nationally in their own guidelines. These methods not described in CEN/TS 16165 are not discussed in this document.

### NEN 7909

NEN 7909 is the Dutch standard that is based on the method described in Annex D of the CEN/TS 16165 tribometer test. In addition to the determination method, this standard also includes application criteria and relates to horizontal and inclined pedestrian surfaces in public and working areas. NEN 7909 is a private law standard, which means that the requirements of the standard are only binding if agreed between the contracting parties.

**Table 2 - Overview of the standards on which Mosa Ultragres tiles have been tested and classified**

Standard	Country of origin	CEN/TS 16165 method	Property	Classification	Limits
NEN 7909	The Netherlands	Annex D - tribometer	Dynamic friction coefficient $\mu$	<ul style="list-style-type: none"><li>• dry application</li><li>• wet application</li><li>• wet application in swimming pool</li></ul>	$\mu \geq 0.30$ $\mu \geq 0.40$ $\mu \geq 0.45$
DIN 51097	Germany	Annex A - ramp, barefoot	Critical gradient $\alpha$	<ul style="list-style-type: none"><li>• A</li><li>• B</li><li>• C</li></ul>	$\alpha \geq 12^\circ$ $\alpha \geq 18^\circ$ $\alpha \geq 24^\circ$
DIN 51130	Germany	Annex B - ramp, safety footwear	Critical gradient $\alpha$	<ul style="list-style-type: none"><li>• R9</li><li>• R10</li><li>• R11</li><li>• R12</li><li>• R13</li></ul>	$6^\circ \leq \alpha < 10^\circ$ $10^\circ \leq \alpha < 19^\circ$ $19^\circ \leq \alpha < 27^\circ$ $27^\circ \leq \alpha < 35^\circ$ $\alpha \geq 35^\circ$
DIN 51131	Germany	Annex D - tribometer	Dynamic friction coefficient $\mu$	<ul style="list-style-type: none"><li>• insufficient rigidity, special measures* required</li><li>• sufficient rigidity, additional measures** recommended</li><li>• sufficient rigidity, additional measures** recommended</li><li>• sufficient rigidity</li></ul>	$\mu < 0.30$ $\mu < 0.30$ , but meets R rating $0.30 \leq \mu < 0.44$ $\mu \geq 0.45$
BS 7976:2	United Kingdom	Annex C - pendulum	Pendulum Test Value (PTV)	<ul style="list-style-type: none"><li>• high slip potential</li><li>• moderate slip potential</li><li>• low slip potential</li></ul>	PTV 0-24 PTV 25-36 PTV 36+

\* Examples include handrails, safety shoes, post-treatment of the surface or replacement.

\*\* For example doormats, increased cleaning supervision, etc.

### DIN 51097

DIN 51097 underlies Annex A of CEN/TS 16165 and describes:

- the specifications of the test installation;
- the requirements to be set for the operator;
- the way of walking;
- the arithmetical determination of the critical gradient.

A classification is assigned to the tested surface based on the critical gradient achieved. The standard does not describe areas of application. Furthermore, the use of calibration surfaces to qualify the test subject is not yet included in the German standard as it is still subject to research.

In Germany, the areas of application have been established by the joint statutory occupational health insurers on the basis of risk analyses and set down in the guidelines GUV-I 8527. These describe the class that floor-covering materials to be applied in barefoot applications (public swimming pools, washing facilities) must at least satisfy, and are legally binding in Germany.

### DIN 51130

DIN 51130 underlies Annex B of CEN/TS 16165 and describes:

- the specifications of the test installation;
- the requirements to be set for the operator;
- the method of calibration;
- the way of walking;
- the arithmetical determination of the critical gradient.

A classification is assigned to the tested surface depending on the critical gradient achieved. The standard does not describe areas of application.

The areas of application are based on the probability of contamination present, the nature of the contamination, and the impact of the contamination on slip resistance in public areas and working environments (entrance areas of public buildings, in shops, in workshops and canteens for instance). This has been established by the joint statutory occupational health insurers in Germany and laid down in guideline GUV-R 181. This is legally binding in Germany.

Below you will find an overview of some common applications and the appropriate Mosa floor tiles.

**Table 3 - Overview of requirements, available Mosa surface finishes and areas of application**

Class	Average gradient	Suitable for (amongst other things)	Mosa version (size)
A	$\alpha \geq 12^\circ$	<ul style="list-style-type: none"> <li>• areas in which people walk barefoot, mainly dry</li> <li>• changing rooms</li> <li>• pool floors &gt; 80-centimetre water depth</li> </ul>	<ul style="list-style-type: none"> <li>• V</li> <li>• VV</li> </ul>
B	$\alpha \geq 18^\circ$	<ul style="list-style-type: none"> <li>• shower areas</li> <li>• swimming pool surrounds</li> <li>• paddling pool</li> <li>• pool floors <math>\leq</math> 80-centimetre water depth</li> <li>• stairs - max. 1 metre wide with handrail on both sides - leading into the water</li> </ul>	<ul style="list-style-type: none"> <li>• AS (30 x 30 cm)</li> <li>• CR</li> <li>• LS</li> <li>• MR</li> <li>• RM</li> <li>• RQ</li> </ul>
C	$\alpha \geq 24^\circ$	<ul style="list-style-type: none"> <li>• sloping pool surrounds</li> <li>• stairs leading into the water (not covered by B)</li> <li>• wading pools</li> </ul>	<ul style="list-style-type: none"> <li>• AS (15 x 15 cm)</li> <li>• MZVR, MZVV</li> <li>• RL</li> <li>• TS</li> <li>• WS</li> </ul>

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### Volume displacement (V)

The V value (volume displacement) describes the extent to which the tile relief allows the displacement of moisture and dirt. This value is expressed in cm<sup>3</sup> of dirt per dm<sup>2</sup> of floor area. If volume displacement is sufficient, the dirt in the relief will be displaced and the tops of the relief will provide sufficient contact and slip resistance.

This value is important in specific areas where larger quantities of substances that increase the risk of slipping are present, such as in meat or fish processing companies. This value may be required in addition to the R value.

V4 at least 4 cm<sup>3</sup> / dm<sup>2</sup>

V6 at least 6 cm<sup>3</sup> / dm<sup>2</sup>

V8 at least 8 cm<sup>3</sup> / dm<sup>2</sup>

V10 at least 10 cm<sup>3</sup> / dm<sup>2</sup>

Below you will find an overview of some common applications and the appropriate Mosa floor tiles.

**Warning:** The displayed slip resistance value on delivery is indicative and may vary in particular cases. Upon request, Mosa can provide a certification with a more precise value for each individual batch of tiles.

### BS 7976:2

BS 7976 underlies Annex C of CEN/TS 16165 and describes:

- the requirements set for the operator and calibration tools;
- the method of calibration;
- the adjustment of the device;
- the method of performing the test.

In this standard, the term 'Slider 55' is used for the soft rubber, also known as 'TRL rubber'. The limit values have been determined by the British national health and safety authorities. Based on these, a floor covering material can be classified into the following categories:

- high slip potential PTV 0-24
- moderate slip potential PTV 25-35
- low slip potential PTV 36+

**Table 4 - Overview of requirements, available Mosa surface finishes, and areas of application**

Class	Average gradient	Volume displacement	Suitable for (amongst other things)	Mosa version
R9	$6^\circ \leq \alpha < 10^\circ$		<ul style="list-style-type: none"> <li>• entrance areas, inside</li> <li>• stairs, inside</li> <li>• canteen, dining area</li> </ul>	<ul style="list-style-type: none"> <li>• whole range</li> </ul>
R10	$10^\circ \leq \alpha < 19^\circ$		<ul style="list-style-type: none"> <li>• bathroom facilities</li> <li>• dry food processing</li> <li>• laboratories and surgeries</li> </ul>	<ul style="list-style-type: none"> <li>• CR</li> <li>• MR</li> <li>• MZVR, MZVV</li> <li>• V</li> <li>• VV</li> </ul>
R11	$19^\circ \leq \alpha < 27^\circ$		<ul style="list-style-type: none"> <li>• entrance areas, outside</li> <li>• large kitchens &lt; 100 place settings per day</li> <li>• bakeries</li> <li>• cheese factories</li> <li>• fish processing</li> <li>• animal feed production</li> <li>• areas for medicinal baths, hydrotherapy</li> <li>• cold store, packaged goods</li> </ul>	<ul style="list-style-type: none"> <li>• AS</li> <li>• LS</li> <li>• RL</li> <li>• RM</li> <li>• RQ</li> <li>• TS</li> </ul>
R12	$27^\circ \leq \alpha < 35^\circ$	V4	<ul style="list-style-type: none"> <li>• rinsing area in large kitchen</li> <li>• large kitchens &lt; 100 place settings per day</li> <li>• frying, grill kitchens</li> <li>• fast food kitchens</li> <li>• cold stores, unpackaged goods</li> </ul>	<ul style="list-style-type: none"> <li>• WS</li> </ul>
R13	$\alpha \geq 35^\circ$	V10	<ul style="list-style-type: none"> <li>• abattoirs</li> <li>• meat processing</li> <li>• fish processing</li> </ul>	<ul style="list-style-type: none"> <li>• XS</li> </ul>

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### Use in the United Kingdom

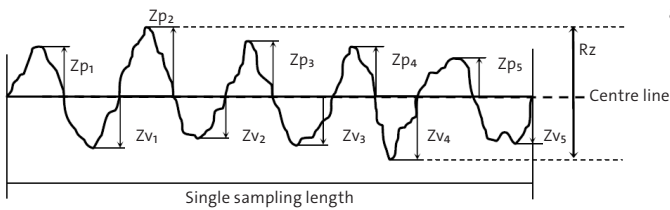
The most common method of determining the anti-slip rating of floors in the United Kingdom is based on the use of two tools:

- a pendulum device in accordance with BS 7679:2 to determine the friction coefficient (see also above, and under CEN/TS 16165 Annex C);
- a micro-roughness gauge (not specified in CEN/TS 16165).

This method has been developed by the Health and Safety Laboratory (HSL) in collaboration with the UK Slip Resistance Group (UKSRG) and the British Standards Institution and is the preferred method for the UK Health and Safety Executives (HSE) in assessing and improving slip resistance in public and working areas.

In the case of contamination by water, the micro-roughness of the surface should be determined by means of a micro-roughness gauge. With this, the so-called Rz value is determined, which gives an indication of the surface roughness as the average of several peak to valley measurements. See figure below.

**Figure 4 - schematic representation of Rz measurement**



Source: SlipSTD Public Available Specification

Based on the Rz value, the slip potential of the material can be classified as follows.

**Table 5 - Classification of slip potential on the basis of Rz value**

Rz surface roughness	Potential risk
$< 10 \mu\text{m}$	high slip potential
10 - 20 $\mu\text{m}$	moderate slip potential
20 > $\mu\text{m}$	low slip potential

The use of a micro-roughness gauge has its limitations: for example, in the case of surfaces with deep relief, the relief has a more significant impact on slip resistance than micro-roughness.

Determining the Rz value does not come under the scope of CEN/TS 16165 Annex C and is not actively communicated by Mosa. Test reports with pendulum values and Rz values are available on request.

In addition to the method described above, specification based on the ramp method in accordance with DIN 51097 and DIN 51130 is also frequently used and accepted.



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### Total overview Mosa

Below you will find an overview of Mosa surface designations and their anti-slip results.

### Installation and maintenance

When installing tiles with relief, extra attention must be paid to removing residual mortar and grout from the recessed parts of the relief. This is important in order to allow the colour and relief to show up better and to guarantee the functional properties.

Floor tiles with relief and tiles with raised designs are more sensitive to dirt and generally require more intensive maintenance than smooth tiles. Cleaning products and methods should be adjusted to meet the particular conditions. The choice of detergent and cleaning method should not have a negative effect on the anti-slip

properties of the floor tiles. Choose a scrubbing disc that is sufficiently flexible (such as a white disc) or a brush that is capable of adjusting to the texture of the floor. See [www.mosa.com](http://www.mosa.com) for the latest maintenance recommendations.

N.B.: Third-party anti-slip treatment for Mosa floors - either chemical or mechanical - may have a negative impact on the optical and physical properties of the floor tiles. Mosa does not accept any liability for this.

### General questions

For general questions and questions relating to slip resistance, or to obtain test reports, please contact our Customer Service Department at [info@mosa.com](mailto:info@mosa.com) or on +44 203 936 35 52.

**Table 6 - Total overview of Mosa surface versions and their anti-slip ratings**

Surface	Size (in centimetres)	R rating	ABC rating	$\mu$ rating	PTV rating		UNE
					Slider 96	Slider 55	
AS	15 x 15	R11	C		55		
	30 x 30	R11	B		55	≥ 42	Class 2
CR	30 x 60, 60 x 60, 90 x 90	R10	B		40	≥ 33	Class 2
LS	15 x 15, 30 x 30	R11	B		48	≥ 31	
MR	15 x 15, 60 x 60	R10	B	0.42	39	≥ 34	
MZVR, MZVV	30 x 30	R10	C				
RL	30 x 30, 30 x 60, 45 x 45, 60 x 60, 60 x 120, 90 x 90	R11	C		54	≥ 52	Class 1
RM	15 x 15	R11	B	0.50		≥ 62	
RQ	30 x 60, 45 x 90, 60 x 60, 90 x 90	R11	B		52	≥ 49	Class 2
TS	15 x 15	R11	C			≥ 25	
V	10 x 10, 15 x 15, 30 x 30, 30 x 60, 45 x 45, 45 x 90, 60 x 60, 60 x 120, 90 x 90, 100 x 100	R10	A	≥ 0.39	39	≥ 25	Class 1
VV	15 x 15	R10	A	≥ 0.39	39		
WS	15 x 15	R12/V4	C				
XS	15 x 15	R13/V10					

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