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TEST METHODS

It is recognised that there is no single device and method for reproducing and quantifying the *slipperiness* of a surface. Four methods currently coexist:

The one deriving from devices that measure the braking of the pendulum, testers that slide across a plane and measure the static and dynamic coefficients of friction, assemblies that imitate human walking, and actual walking tests with persons that use standard footwear or walk barefoot.

The failed international draft standard ISO/DIS 10545-17 included two of the four foregoing methods, with the variant in one of these of measuring the dynamic coefficient of friction [method **A**] or static coefficient of friction [method **B**], in order to satisfy the respective groups of experts that defended one variant or the other:

- The test method of the **floor friction tester** (FFT) or manual dynamic slider, known as the Tortus method, developed in the United Kingdom to measure the dry dynamic coefficient of friction of a floor [method **A**].
- The test method of the **static slider**, to measure the static coefficient of friction (at the moment of motion start), according to the North American ASTM C1028 method *[Standard test method for determining the static coefficient of friction of ceramic tile and other like surfaces by the horizontal dynamometer pull-meter method*], with the change in weight of the slider that goes from 22.7 to 4.5 kg [method **B**].
- The test method of the inclined plane, according to German standard DIN 51130 *[Testing of floor coverings. Determination of anti-slip properties. Workplaces with higher slip risk. Ramp test with the walking method*] [method **C**].

European ceramic tile manufacturers continue to reference products according to the **A** and **C** methods, though the **A** method is also applied to wet tiles. Generally speaking, the slip resistance of ceramic tiles that leave the factory is expressed as **classes 1** and **2** with respect to method **A**, while the codes deriving from the ramp test [**R9–R13**] and the *drainage capacity* of profiled tiles [**V4–V10**] are used for especially non-slip tiles.

This double reference was accepted by most markets until the pendulum test method was added, with European experimental standard **ENV 12633** (January 2003), prepared by the European Committee for Standardization CEN/TC 178 [*Paving units and kerbs*], whose Secretariat is held by BSI (United Kingdom).

The German ramp method is sufficiently consistent and widely recognised [Europe, Australia and New Zeeland, Singapore, the Ceramic Tile Institute of America (CTIOA) and its areas of influence] to deserve a specific section in this documentation.

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It is based on test methods **DIN 51130** and **DIN 51097** [*method for barefoot walking areas*]. It considers the *drainage capacity* of profiled tiles, measured by volume (cm^3) per unit surface area (dm^2). In addition, it classifies floor coverings according to slip risk, assigning them minimum slip resistance values and, in some cases, requiring a surface profile based on the following documents:

- **BGR 181** (May 2003) [*Floors in work rooms and work areas with slip risk*], an update of regulation **ZH 1/571** (October 1993), a regulation recognised by the German Association of Mutual Benefit Societies for Accident Prevention and Occupational Safety and Health (BG Regulations), as well as by the Mutual Benefit Society/Head Office for Accident Prevention and Industrial Medicine. This update assigns slip resistance **R10** to building areas with direct access from outside (likelihood of becoming wet when it rains), and introduces requirements for outside flooring and stairs [**R11** or **R10 V4**], etc.

- **GUV-I 8527** (former GUV 26.17) [*Code of Practice for floors in wet areas for barefoot use*], also an internationally recognised regulation, associated with the ramp test method for barefoot use, DIN 51097.

In addition, standard DIN 51130 has been updated by the replacement of Bottrop footwear (unavailable for some years) with *Lupos Picasso S1* boots, as well as by assignment of the **R9** code to a plane angle of inclination of 6 degrees.

The ensemble of test methods [DIN 51130 and DIN 51097] and regulations [BGR 181 and GUV-I 8527], with their updates, constitute a very solid (internationally recognised) basis for the specifications writer when it comes to assigning minimum slip resistance values as a function of the risk of the intended tile service application.

The normative development of Australia/New Zealand [by the non-governmental organisation, Standards Australia International Limited] must be considered paradigmatic in its approach to solving the problems associated with the safety of pedestrian traffic.

While draft standard ISO/DIS 10545-17 languished, Standards Australia and Standards New Zealand published standard **AS/NZS 3661.1** (1993) [*Slip resistance of pedestrian surfaces. Requirements*] as a test method for evaluating the slip resistance of both new tiles and installed floors (except carpeting and grates). This standard adopted:

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- The British test method of the dynamic floor friction tester (FFT) for the dry evaluation.
- The pendulum method for the wet evaluation, with Four S [standard simulated shoe sole] rubber and TRRL rubber sliders.
- The method of the inclined plane of standards DIN 51130 and DIN 51097

and was a valuable precedent for the later developments embodied in:

- The approval of standard **AS/NZS 4586** (1999) [*Slip resistance classification of new pedestrian surface materials*], applicable to all modular rigid materials (ceramics, terrazzo, natural stone, concrete) and other non-rigid materials (rubber, vinyl,…), which already officially included the four methods (floor friction tester (FFT), pendulum with Four S slider, DIN 51130, and DIN 51097)

TEST METHODS ENVISAGED IN AS/NZS 4586
► Dynamic dry coefficient of friction with the floor friction tester (FFT)
► Wet pendulum test method, with Four S and TRRL rubber sliders.
► Ramp method with standard footwear and oil-wet ramp (DIN 51130)
► Ramp method for barefoot use and water-wet ramp (DIN 51097)

- **Handbook HB 197** (1999) [*Introductory guide to the slip resistance of pedestrian surface materials*], with guidelines for the selection of slip resistant pedestrian surfaces.

- Standard **AS/NZS 4663** (2002) *[Slip resistance measurement of existing pedestrian surfaces*], which includes the dry floor friction tester (FFT) and the wet pendulum methods.

Work is currently ongoing to incorporate the surface roughness $\mathbf{R_Z}$ of the sliders used in the pendulum, in line with British standard BS 7976-2 (2002) [*Pendulum testers. Method of operation*], because of its influence on test results.

In relation to this subject, it is also necessary to go further into the classification of footwear with regard to its non-slip capacity on different surfaces (dry, dusty, wet, smooth, profiled, hard, soft, etc.) as a function of sole hardness, tread geometry, and microroughness of the material.

The test methods and diagnostic or evaluation criteria of already installed floors are also the subject of attention, in line with already drafted documents, such as the American standard ASTM F 1694 [*Standard Guide for Composing Walkway Surface Evaluation and Incident Report Forms for Slips, Stumbles, Trips and Falls*].

It is a shared concern to reach reference points (albeit not absolute and universal values), which help correctly specify flooring in publicly trafficked architecture with regard to safety in walking, foreseeing human disabilities, not only associated with handicaps but also with the decline in faculties as a result of aging.

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The European evolution and the situation in Spain remain to be provided, in the framework of the application of experimental standard ENV 12633 (January 2003).

Working group WG1 of CEN/TC 339 [*Slip resistance of pedestrian surfaces. Methods of evaluation*] has already prepared a draft standard [prEN 15673-1, April 2007] based on the ramp test method, with three procedures:

- Normal footwear with flat Four S sole, hardness 47±3 (Shore-D scale), water-wet ramp with an aqueous sodium sulphate solution (0.1%).
- Test for barefoot use with the same ramp-wetting fluids.
- Industrial footwear, with profiled sole and rubber of hardness 72±2 (Shore-A scale)

The first method involves testing with an abraded rubber sole.

On the other hand, European Committee for Standardization CEN/TC 134 [*Resilient, textile, and laminate floor coverings*] has prepared draft standard prEN 13845, entitled "Resilient floor coverings. Polyvinyl chloride floor coverings with enhanced slip resistance. Specification", which will use three ramp test methods: DIN 51130 (walking with footwear on an oil-wet surface), DIN 51097 (walking barefoot on a water-wet surface), and a new ramp test, using footwear without a heel assembly and with a Four S rubber sole and water-wet surface, derived from the RAPRA CH0001 test and the British ramp method of the Health and Safety Laboratory of (HSL).

Finally, the already approved European experimental standard ENV 12633, developed by Technical Committee CEN/TC 178 [*Paving units and kerbs*] whose Secretariat is held by the British Standards Institute (BSI). This standard has been designed for polished and unpolished concrete slabs and tiles, and is based on the wet pendulum test method, with rubber sliders (resilience at 20 ºC of 66-73% (ISO 4662) and IRHD hardness 59 ± 4 (ISO 48).

This test method has been adopted by Spain for measuring the slip resistance of all types of modular rigid materials, including ceramic tiles, in this case referencing the results on the C scale.

It is encouraging to think that the different methods already envisaged in some European draft standards might converge in a single document containing:

- The dynamic floor friction tester (FFT) or the British friction pendulum for the dry slip resistance evaluation, perhaps taking into consideration in the second device:
  - The type of rubber used in the sliders as a function of tile texture [hard Four S or soft TRRL rubber].
  - The microroughness of the slider surface.
- The British pendulum method for the wet evaluation, with the same considerations as in the foregoing case, with greater reason.
- The ramp methods, both the German ones and the one derived from RAPRA CH0001 and HSL, as a complement or alternative to the foregoing one, with special consideration in profiled tiles and/or tiles intended for floors with special slip risk.

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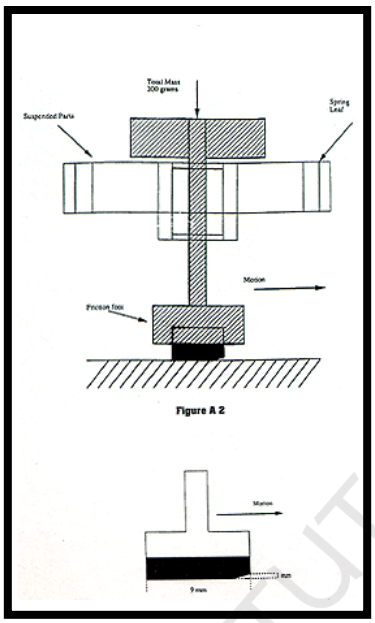
ISO/DIS 10545-17

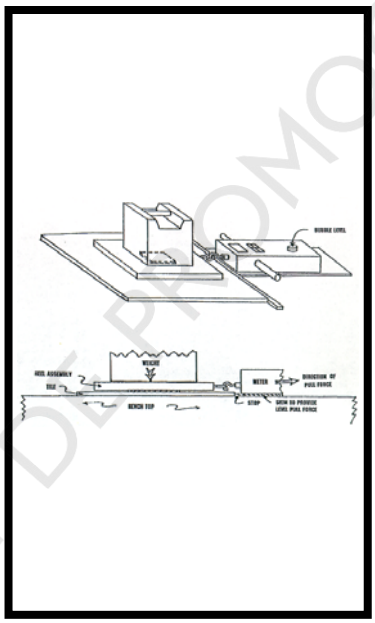
International draft standard ISO 13006 for ceramic tiles, approval of which is still pending for certain characteristics, proposed the evaluation of slip resistance through any of the following three methods, leaving the choice of method up to the manufacturer.

Methods envisaged in the draft standard:

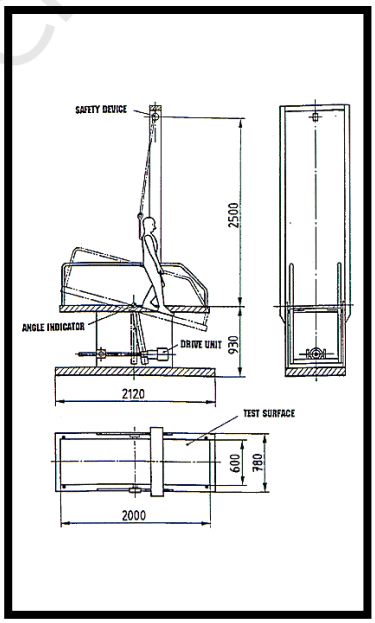
Method A: Dynamic slider. Measurement of the (wet and dry) coefficient of friction
Method B: Static slider. Measurement of the (wet and dry) static coefficient of friction
Method C: Inclined plane. Measurement of the critical angle



Method A



Method B



Method C

SLIP RESISTANCE CLASSES ACCORDING TO ISO/DIS 10545-17 ACCORDING TO TEST METHODS A AND B		
Class	**Coefficient of friction**	
	Dynamic (Method A)	**Static (Method B)**
COF. Class 1	< 0.4	< 0.5
COF. Class 2	≤ 0.4	≥ 0.5

NOTE: ISO/DIS 10545-17 includes dry and wet tests, it being necessary to state the results of the test in both cases. As a result, in their technical information, manufacturers need to specify the dry and wet coefficients of friction in addition to the method used to conduct the test.

Most manufacturers reference their ceramic tiles according to **Method A** for the measurement of the dynamic coefficient of friction, on both dry and wet tiles, in order to express tile non-slip capacity. For example, the following may be found in trade catalogues:

- Slip resistance: COF. Class 1 wet [Method A, ISO/DIS 10545-17]
- Coefficient of friction: ≥ 0.4 dry [Method A, ISO/DIS 10545-17]
- Friction coefficient: ≥ 0.4 wet [Method A, ISO/DIS 10545-17]

In Central Europe the non-slip capacity of ceramic tiles is referenced according to **Method C** of ISO/DIS 10545-17 for the inclined plane, since there is considered to be a better correlation with the slip resistance of people walking on a floor.

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AUSTRALIA/NEW ZEALAND

The slip resistance standards received a great push forward from the joint Standards Australia/Standards New Zealand Technical Committee BD-094 even before the failure of international draft standard ISO/DIS 10545-17, when standard AS/NZS 3661.1 (1993) was reviewed. Ten years later, a complete set of standards are already available, based on both the British and German standards. This set of standards comprises:

- Standard **AS/NZS 4586:2004**, *Slip resistance classification of new pedestrian surface materials*. Standard AS/NZS 4586:2004 includes, in the annexes, the test methods of the wet pendulum, the dry British slider [floor friction tester (FFT) for measurement of the friction coefficient], and the ramp [for barefoot use and with standard footwear].

- Standard **AS/NZS 4663:2004**, *Slip resistance measurement of existing pedestrian surfaces* (already installed), based on the British wet pendulum and the dry FFT slider tests, which provides an orientation, in the form of tables, on the slip risk as a function of the results of those tests, conducted on floors in service.

- In 1999, the CSIRO and Standards Australia published the document **HB 197**, an *Introductory guide to the slip resistance of pedestrian surface materials*. HB 197 provides a commentary on the results of the different test methods in their relation to the real slip risk of the floors, and tables that assign minimum slip resistance values according to type and location of building area. For the ramp test it reproduces the requirements of the German documents GUV 26.17 of 1996 and ZH 1/571 of 1993.

- Standard **AS/NZS 3661.2:1994**, which contains guidelines for the selection of materials, cleaning and maintenance of floors, as well as recommendations for reducing the slip risk in floors in service.

At the present time, revision is ongoing of standard AS/NZS 4586 (January 2007) in order to introduce all the improvements and modifications that have been proposed since 2004. The Handbook–Guide HB 197 (1999), for the selection of materials intended for floorings in regard to their slip resistance, is also being revised.

Some tables of the draft of new standard **AS/NZS 4586**, subjected to survey in the period 25/1/2007-8/3/2007, are included below in view of the valuable information they contain. Some tables from HB 197 of 1999 are also included.

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TEST METHODS AND THEIR DESCRIPTION IN AS/NZS 4586		
Test method	**Section of the standard**	**Classification of results**
Wet pendulum	Appendix **A**	**V**, **W**, **X**, **Y**, **Z** (Table **2**)
Wet pendulum and dry dynamic slider [FFT, coefficient of friction]	Appendices **A** and **B**	Combination of the codes in Tables **2** and **3**
Dry dynamic slider	Appendix **B**	**F**, **G** (Table **3**)(*)
Water-wet ramp test for barefoot use	Appendix **C**	**A**, **B**, **C** (Table **4**)
Oil-wet ramp test with Lupos Picasso footwear (Lupos Schuhfabrik GmbH)	Appendix **D**	**R9**–**R13** (Table **5**)
Displacement volume [drainage capacity of profiled tiles, expressed in cm^3/dm^2]	Appendix **E**	**V4**, **V6**, **V8**, **V10** (Table **6**)
Surface roughness measurement in textured tiles(**)	Appendix **F**	Measurement of the average height of the profile

(*) The tests solely performed with the dry slider only allow assignment, by default, of a wet pendulum classification with the Z code, yielding as a result the codes **ZG** or **ZF**.

(**) This is not applied to tiles with pronounced profiles.

Table 1

CLASSIFICATION OF THE RESULTS OF THE BRITISH WET PENDULUM TEST		
Class	**Value of the BPN[1] scale**	
	4S[2] rubber slider	**TRL[3] rubber slider**
V	> 54	> 44
W	45–54	40–44
X	35–44	35–39
Y	25–34	20–34
Z	< 25	< 20

[1] BPN: British pendulum number

[2] 4S (**s**imulated **s**tandard **s**hoe **s**ole) rubber, with IRHD hardness 96±2, at present designated **SLIDER 96** (slider of hardness 96)

[3] TRL (**T**ransport **R**esearch **L**aboratory) rubber, with IRHD hardness 55±5, formerly called TRRL and used on fired clay tiles and concrete. It represents better the non-slip capacity on surfaces for barefoot use and rough surfaces, because it is less hard than the 4S rubber. At present it is called **SLIDER 55** (slider of hardness 55)

Table 2

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CLASSIFICATION OF THE RESULTS OF THE DRY SLIDER TEST	
Classification code	**Dynamic coefficient of friction** (main value)
F	≥ 0.40
G	< 0.40

Table 3

CLASSIFICATION OF THE RESULTS OF THE WET RAMP TEST, FOR BAREFOOT USE			
Evaluation Group	**Minimum angle of inclination**		**Areas according to GUV-I 8527**
A	≥ 12º		- Walkways for barefoot use (mainly dry) - Communal and individual changing rooms and locker rooms - Swimming pool floors in non-swimmer areas, if the water in the entire area (of a swimming pool) is more than 80 cm deep
B	≥ 18º		- Walkways for barefoot use not classified in group A - Shower areas - Swimming pool surrounds - In the surroundings of disinfecting spray facilities - Swimming pool floors in non-swimmer areas, where the water is less than 80 cm deep. - Non-swimmer areas in wave pools - Elevating platforms - Swimming pools for young children - Ladders leading into water - Stairs leading into water with a maximum width of 1 m and handrails on both sides - Ladders and stairs outside the swimming pool area - Steps and benches for sitting and resting
C	≥ 24º		- Stairs leading into water, not classified in group B - Walk-through pools - Inclined swimming pool edges

Minimum requirements in floors for barefoot use according to GUV-I 8527 (former GUV 26.17) and evaluation groups as a function of the critical angle.

Table 4

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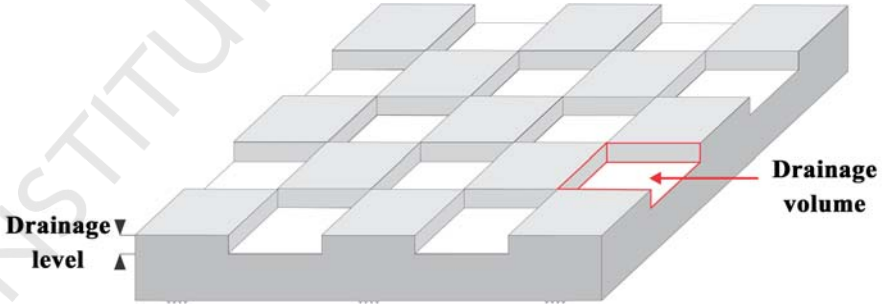
CLASSIFICATION OF THE RESULTS OF THE OIL-WET RAMP TEST, WALKING WITH FOOTWEAR[*]		
Evaluation group	**Result of the average values of the angle of inclination**	
R9	**From 6º to 10º**	
R10	**More than 10º to 19º**	
R11	**More than 19º to 27º**	
R12	**More than 27º to 35º**	
R13	**More than 35º**	

[*] Lupos Picasso, from Lupos Schuhfabrik GmbH

Table 5



THE CERAMIC TILE AS COLLECTING CHAMBER	
IDENTIFYING CODE	**MINIMUM VOLUME (CM^3/DM^2)**
V4	4
V6	6
V8	8
V10	10

Table 6

The new version of standard **AS/NZS 4586** also includes instructions for the measurement of slip resistance in profiled tiles (tactile surfaces) according to the British wet pendulum test, as well as an extensive table that provides the correction values of the result of the pendulum test (BPN no.), as a function of the inclination of sloped surfaces.

Table **H1** of Appendix **H** of standard **AS/NZS 4586** is included below, as a guideline for the minimum slip resistance requirement according to the intended tile service application, under normal conditions of use. In addition, it establishes a correlation between the results of the wet pendulum test and those of the ramp.

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PEDESTRIAN FLOORING SELECTION GUIDE FOR NORMAL CONDITIONS – MINIMUM PENDULUM OR RAMP RECOMMENDATIONS FOR SPECIFIC LOCATIONS			
Location		**Pendulum**	**Ramp**
Entries and access areas including hotels, offices, public buildings, shopping centres, shops, schools and kindergartens, common areas of public buildings, internal lift lobbies	Wet area[1]	**X**	**R10**
	Transitional area	**Y**	**R9**
	Dry area	**Z**	**R8**[2]
Internal ramps, slopes (greater than 1 in 20) - Dry		**X**	**R10**
Total facilities in offices, hotels, shopping centres			
Fast food outlets, buffet food servery areas, food court and fast food dining areas in shopping centres			
Undercover concourse areas of sports stadium			
Private, publicly inaccessible balconies			
Self catering areas or kitchenettes			
Shop and supermarket fresh fruit and vegetable areas			
Supermarket aisles except fresh fruit areas		**Z**[3]	**R9**
Residential garages		**X**	**R10**
Residential kitchens		**Y**	**R9**
Residential bathrooms, ensuites, toilets and laundries		**Y**	**A** o **R9**
Hotels, hospitals and aged care facilities	Wards and corridors	**Y**	**R9**
	Ensuites	**X**	**A** o **R10**
Accessible internal stair nosings – Handrails present	Dry	**X**	**R10**
	Wet	**W**	**B** o **R11**
External colonnade, walkways, pedestrian crossings, balconies, verandas, carports, driveways, court yards and roof decks, public car parks, school yards, external sales areas (e.g. markets).		**W**	**R11**
Private paths, primary access to premises, external stair nosings			
Serving areas behind bars in public hotels and clubs, cold stores, freezers			
External ramps (including sloping driveways, footpaths, etc.); slope of 1 in 20 to 1 in 14			
External ramps (including sloping driveways, footpaths, etc.); slope steeper than 1 in 14		**V**	**R11**
Loading docks			
Commercial kitchens			
Communal changing rooms		**X**	**A**
Swimming pool surrounds and communal shower rooms		**W**	**B**
Swimming pool ramps and stairs leading into water		**V**	**C**

1. Definitions:
   a) *Dry areas* – those areas in which appropriate control measures ensure an area remains dry and clean when in use.
   b) *Transitional areas* – those areas that are intended to be kept dry such as by the provision of design features (awnings, drains, mats, air locks, etc.) appropriate to the physical location, climate and general exposure to water, as maintained in a dry and clean condition by the facilities manager.
   c) *Wet areas* – those areas that are not defined as a dry or transitional area, which may be either constantly or intermittently wet or otherwise contaminated.
2. R8 is an artificial classification that has been used to indicate products that fail to obtain class R9.
3. Values of less than 12 BPN with Four S rubber would be most inadvisable.
4. All floors with a wet pendulum classification of Z or oil/wet ramp classification of R8 should have a dry floor friction classification of F, unless normal usage dictates that the floor should have a low dry coefficient of friction, e.g. dance floors.
5. Table 5 contains higher requirements for some specific types of shops and locations within them

Pedestrian flooring selection guide – minimum pendulum or ramp recommendations for specific locations.
Appendix H (Informative)
Table 7

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Handbook **HB 197** also provides tables that relate building areas to minimum slip resistance requirements. The table corresponding to floors without any special requirements is only reproduced here, because the tables devoted to building areas with special risk faithfully reproduce the German documents GUV 26.17 (April 1996) and ZH 1/571 (October 1993). Perhaps the next update of HB 197 will provide new tables related to **GUV-I 8527** and **BGR 181** (2003).

PEDESTRIAN FLOORING SELECTION GUIDE – MINIMUM PENDULUM OR RAMP RECOMMENDATIONS FOR SPECIFIC LOCATIONS		
Location	**Pendulum**	**Ramp**
External colonnade, walkways and pedestrian crossings	**W**	**R10**
External ramps	**V**	**R11**
Entry foyers hotel, office, public buildings – wet	**X**	**R10**
Entry foyers hotel, office, public buildings – dry	**Z**	**R9**
Shopping centre excluding food court	**Z**	**R9**
Shopping centre – food court	**X**	**R10**
Internal ramps, slopes (greater than 2 degrees) – dry	**X**	**R10**
Lift lobbies above external entry level	**Z**	**R9**
Other separate shops inside shopping centres	**Z**	**R9**
Other shops with external entrances – entry area	**X**	**R10**
Fast food outlets, buffet food servery areas	**X**	**R10**
Hospitals and aged care facilities – dry areas	**Z**	**R9**
Hospitals and aged care facilities – ensuites	**X**	**A** o **R10**
Supermarket aisles except fresh food areas	**Z**	**R9**
Shop and supermarket fresh fruit and vegetable areas	**X**	**R10**
Communal changing rooms	**X**	**A**
Swimming pool surrounds and communal shower rooms	**W**	**B**
Swimming pool ramps and stairs leading into water	**V**	**C**
Toilet facilities in offices, hotels, shopping centres	**X**	**R10**
Undercover concourse areas of sports stadium	**X**	**R10**
Accessible internal stair nosings (dry) – handrails present	**X**	**R10**
Accessible internal stair nosings (wet) – handrails present	**W**	**B** o **R11**
External stair nosings	**W**	**R11**

1. Appropriate measures need to be taken to exclude casual water from dry areas.
2. All floors with a wet pendulum classification of Z should have a dry floor friction classification of F unless normal usage dictates that the floor should have a low dry coefficient of friction, e.g. dance floors.
3. Table 5 contains higher requirements for some specific types of shops.
4. Refer to Tables 2, 4 and 5 in AS/NZS 4586 for derivation of classifications.

Table 8

Standard **AS/NZS 4663** (2004), devoted to test methods and classification of results, applicable to already installed floors that are in service, is also being revised. In this case, the British wet pendulum test (Appendix **A**) and the dry floor friction tester (FFT) (Appendix **B**) are chosen. It also includes tables for correction of the pendulum and coefficient of friction values on sloping surfaces, as a function of the inclination.

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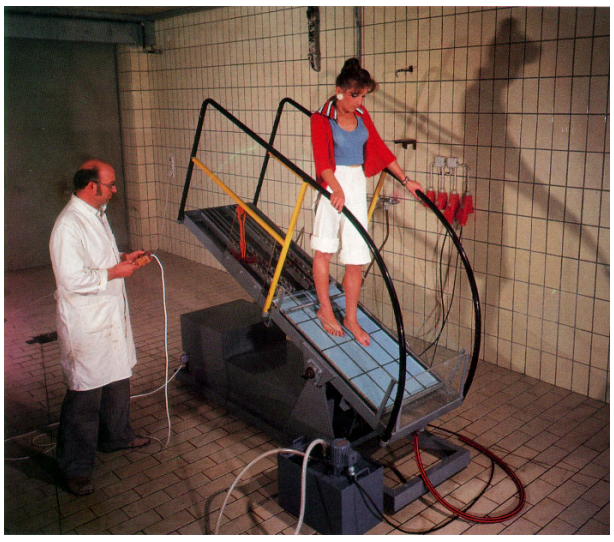
GERMAN RAMP METHOD

RAMP TEST ACCORDING TO DIN 51097			
Evaluation group	**Minimum angle of inclination**		**Areas according to GUV-I 8527**
A	≥ 12º		- Walkways for barefoot use (mainly dry) - Communal and individual changing rooms - Swimming pool floors in non-swimmer areas, when the water in the entire area is more than 80 cm deep - Sauna and rest areas (mainly dry)
B	≥ 18º		- Walkways for barefoot use that do not belong to group A - Shower areas - In the surroundings of disinfecting spray facilities - Swimming pool surrounds - Swimming pool floors in non-swimmer areas, when the water is less than 80 cm deep in partial areas. - Swimming pool floors in non-swimmer areas in wave pools - Elevating floors - Swimming pools for young children - Ladders leading into water - Stairs leading into water with a maximum width of 1 m and handrails on both sides - Ladders and stairs outside the swimming pool area - Sauna and rest areas that do not belong to group A
C	≥ 24º		- Ladders leading into water that do not belong to group B - Walk-through pools - Inclined swimming pool surrounds

Minimum requirements in floors for barefoot use according to document GUV-I 8527 (former GUV 26.17) and evaluation groups as a function of the critical angle.

In spaces exposed to water generally, from communal changing rooms to water or therapeutic facilities in bathing resort architecture, application of the ramp test method in the barefoot use mode allows evaluation of the slip risk, as set out in the document **GUV-I 8527** (former GUV 26.17).



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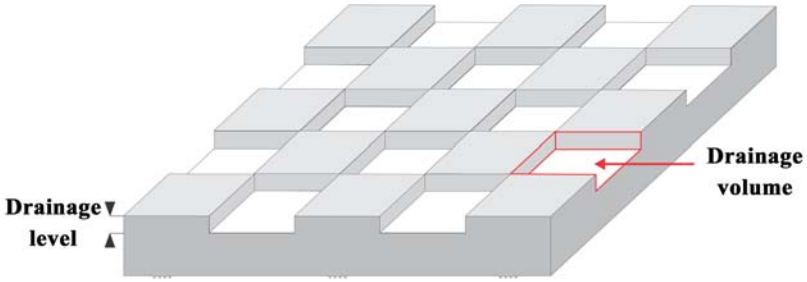

Measurement of the ceramic tile profile by the volume of liquid that can be held (in cm^3) per unit surface area (in dm^2).

THE CERAMIC TILE AS A COLLECTING CHAMBER	
IDENTIFYING CODE	**MINIMUM VOLUME (cm^3/dm^2)**
V4	4
V6	6
V8	8
V10	10

CLASSIFICATION OF SLIP RESISTANCE LEVELS ACCORDING TO DIN 51130		
Evaluation group	**Result of the average values of the angle of inclination**	
R9	**From 6º to 10º**	
R10	**More than 10º to 19º**	
R11	**More than 19º to 27º**	
R12	**More than 27º to 5º**	
R13	**More than 35º**	

Assignment of the average angles of inclination to the slip resistance evaluation groups

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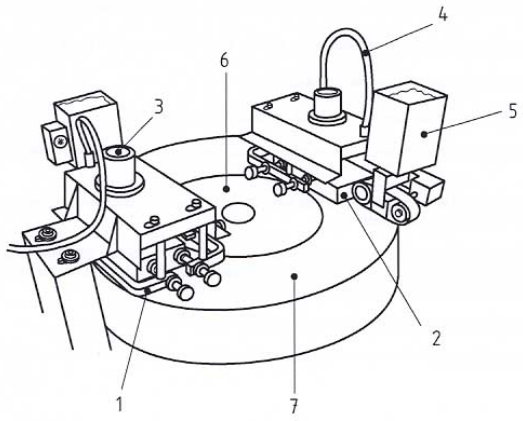
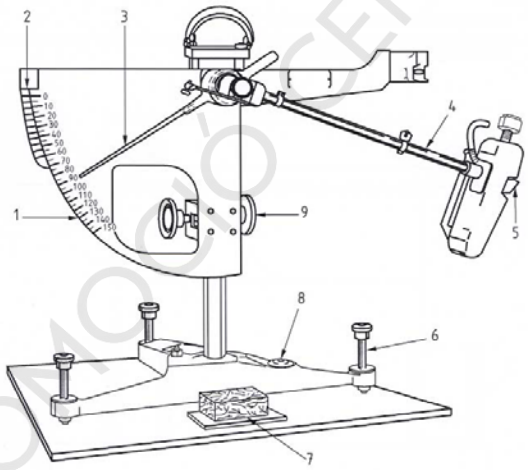
SUA 1 (CTE) AND ENV 12633 (SPAIN)

Approval of the Spanish **Technical Building Code** (**CTE**) has meant that all materials intended for common-use area floor coverings must meet the requirements of Document **SUA 1** (Safety against fall risk), which establishes the slip resistance classes of polished and unpolished floors, based on the test method described in European experimental standard **ENV 12633 (2003)**.



1 Sample holder
2 Sample
3 Adjustable mass
4 Water inlet
5 Adjustable abrasive hopper and dispensers
6 Polishing wheel
7 Rubber ring

Flat-bed polishing machine



1 Scale C (126 mm slip length)
2 Scale F (76 mm slip length)
3 Pointer
4 Pendulum arm
5 Rubber slider
6 Levelling screw
7 Test piece
8 Bubble level indicator
9 Vertical adjustment screw

Pendulum friction tester

The results of the test according to scale C of the slider are expressed as coefficient $\mathbf{R_d}$ (slip resistance), according to the following classes:

FLOOR CLASSIFICATION ACCORDING TO SUA 1	
Slip resistance R_d	**Floor classes**
$R_d \leq 15$	Class 0
$15 < R_d \leq 35$	Class 1
$35 < R_d \leq 45$	Class 2
$R_d > 45$	Class 3

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In Document **SUA 1**, floors are classified in terms of slip risk, as set out in the following table.

FLOOR CLASS AS A FUNCTION OF SLIP RISK	
Area	**Floor class**
Dry internal areas	
- surfaces with a slope of less than 6%	Class 1
- surfaces with a slope of 6% or higher and stairs	Class 2
Wet internal areas, such as bathrooms, kitchens, indoor swimming pools, etc.(1)	
- surfaces with a slope of less than 6%	Class 2
- surfaces with a slope of 6% or higher and stairs	Class 3
Internal areas in which, in addition to water, there may be agents that reduce slip resistance (grease, lubricants, etc.), such as industrial kitchens, slaughter houses, garages, areas of industrial use, etc.	Class 3
External areas. Swimming pools (2)	Class 3

(1) These include floor areas around building entrances from outside, except when direct accesses to dwellings or to areas of *restricted use*, as well as covered terraces, are involved.
(2) In areas intended for barefoot users and swimming pool floors, in areas not deeper than 1.50 m.

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