

BS 8445:2012



BSI Standards Publication

# Bath and shower mats – Testing – Assessment of slip resistance properties

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## Contents

Foreword *ii*

|    |                                                         |   |
|----|---------------------------------------------------------|---|
| 1  | Scope                                                   | 1 |
| 2  | Normative references                                    | 1 |
| 3  | Terms and definitions                                   | 1 |
| 4  | General requirements                                    | 2 |
| 5  | Classification according to performance                 | 2 |
| 6  | Test principle                                          | 3 |
| 7  | Test operators                                          | 3 |
| 8  | Test apparatus                                          | 3 |
| 9  | Test solution                                           | 4 |
| 10 | Standard surface                                        | 4 |
| 11 | Test specimen conditioning, examination and preparation | 4 |
| 12 | Verification of standard surface                        | 4 |
| 13 | Testing of the mat                                      | 5 |
| 14 | Product marking                                         | 6 |
| 15 | Informative labelling                                   | 6 |
| 16 | Packaging                                               | 7 |
| 17 | Test report                                             | 7 |

### Annexes

Annex A (informative) Foot motions 8

Annex B (informative) Dynamic coefficient of friction based on a low incident risk 8

Bibliography 9

### List of figures

Figure A.1 – Foot motion walking forwards 8

Figure A.2 – Foot motion walking backwards 8

### List of tables

Table 1 – Performance level of bath/shower mat slip potential 2

### Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 10, an inside back cover and a back cover.

## Foreword

### Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2012. It was prepared by Technical Committee PRI/60, *Resilient floor coverings*. A list of organizations represented on this committee can be obtained on request to its secretary.

### Information about this document

The British Standard has been developed to set minimum performance standards for bath and shower mats to help reduce the number of slip related instances. It does this by specifying testing on an inclinable ramp by at least two operators walking forwards and backwards over a mat.

Mats that achieve the performance levels specified by this standard offer a greater degree of protection against the potential to slip than a standard bath or shower tray without the mat in place.

This British Standard assumes that a mat has greater slip resistance properties than a stand-alone bath or shower tray surface (i.e. not fitted with a mat).

### Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

### Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

## 1 Scope

This British Standard specifies the classification (according to slip characteristics), test methods, marking and instructions for bath and shower mats intended for use inside bath or shower trays during bathing or showering.

It is applicable to bath and shower mats used in the domestic, self-catering and hotel environment, where the surfaces of the baths or shower trays are made from standard construction materials including acrylic, enamel and porcelain. The use of bath and shower mats in hospitals and care home environments is outside the scope of this standard.

The British Standard is applicable to mats that may or may not incorporate suction cups in their bases. The methods of assessment specified are designed to test two modes of slip failure, i.e. foot slippage and mat slippage, with failure occurring irrespective of the mat material, design and overall construction.

The mats covered by this British Standard are not designed for use on profiled textured surfaces. The standard also covers mats containing additional features (e.g. foot massagers, pillows).

Very small padded surfaces that do not meet the dimensional requirements of 5.1, e.g. splats, are not considered to be mats and are therefore outside the scope of this standard.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 263, *Sanitary appliances – Crosslinked cast acrylic sheets for baths and shower trays for domestic purposes*

BS EN 360, *Personal protective equipment against falls from a height – Retractable type fall arresters*

BS EN 361, *Personal protective equipment against falls from a height – Full body harnesses*

BS EN ISO 4287, *Geometrical and product specification (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

## 3 Terms and definitions

### 3.1 angle of insecurity

angle at which the slip occurs or the operator feels unsafe

### 3.2 comfort mat

mat that has moderate slip potential, with an angle of insecurity greater than 14° or the angle of insecurity for the acrylic sheet, whichever is the greater, and 19°

### 3.3 dynamic coefficient of friction (COF)

ratio of the frictional force divided by the normal force

### 3.4 failure mode

point at which the operator slips on the mat surface (foot slippage) or the mat slips on the standard base surface (mat slippage)

- 3.5 frictional force**  
force parallel to the surface and against the direction of movement arising when the foot slides over the mat or the mat slides over the acrylic surface
- 3.6 normal force**  
force applied to the foot, perpendicular (90°) to the surface
- 3.7 slip**  
loss of traction causing the user or test operator to lose his/her footing
- 3.8 slip resistance**  
ability of a surface to provide traction and to counteract slipping
- 3.9 standard surface**  
sanitary grade acrylic sheet that simulates the base of a bath or shower tray

## 4 General requirements

When inspected visually, the bath/shower mat to be tested shall be free from inclusions of foreign matter or any other defect (e.g. tears, blisters) that could adversely affect the performance of the mat.

The bath/shower mat shall be sufficiently flexible to conform to the shape of the bath or shower tray under its own weight when fitted in accordance with the supplied manufacturer's instructions, without presenting any additional hazards to the user (e.g. trip hazard).

*NOTE The dimensions of any bath or shower mat should not adversely affect the mat's ability to conform to the shape of the bath or shower tray.*

The bath/shower mat shall be of sufficient size to provide an adequate area for a person to stand comfortably while showering/bathing. The mat shall have a minimum uninterrupted standing area of at least (300 x 300) mm after conditioning (see Clause 11) by placing a (300 ±1 x 300 ±1) mm square template on its surface without the template extending beyond the edge of the mat.

Shower mats shall be a minimum of (450 x 450) mm and bath mats shall be a minimum of (450 x 300) mm. Compliance shall be confirmed after conditioning (see Clause 11).

## 5 Classification according to performance

Depending on the outcome of the tests in Clause 12 and Clause 13, the bath or shower mat shall be classified in accordance with Table 1.

Table 1 Performance level of bath/shower mat slip potential

| Angle of Insecurity | Dynamic COF | Slip potential | Level          |
|---------------------|-------------|----------------|----------------|
| 0                   |             |                |                |
| 14 – 19             | 0.24 – 0.36 | Moderate       | Comfort        |
| 20+                 | > 0.36      | Low            | Slip resistant |

*NOTE Two levels of performance exist for classifying bath and shower mats. Mats meeting the slip resistant mat classification are deemed to offer the greatest slip resistance, while comfort mats are intended to provide comfort to the user without necessarily significantly increasing the slip resistance offered by the bath/shower surface.*

## 6 Test principle

The mat is positioned on a test ramp, onto which the test liquid is applied at a constant rate using spray jets designed to provide a continuous even spread of liquid on both the upper and lower surfaces of the mat. The operator performs a series of walks over the mat in time to a metronome while incrementally increasing the angle of the test ramp between each walk. The test is continued until failure mode is reached or the operator feels that it could be unsafe to continue the test at a greater angle.

The motion involves walking forwards and backwards over the mat using steps of half a foot in length (see Annex A). This half step motion is mandatory but there is flexibility at the end of each forwards/backwards walk to allow the operator to bring his/her feet back together in a standing position in order to aid operator comfort and help maintain the rhythmic motion with the metronome as shown in Figure A.1 and Figure A.2.

## 7 Test operators

The test operators shall be able-bodied adults, who are able to maintain the walking motion, understand this test procedure and competent in the use of a test ramp. Operators shall meet the verification requirements of 12.1.

*NOTE* Operators should be changed regularly to avoid operator fatigue affecting test results.

## 8 Test apparatus

**8.1 Inclinable ramp surface** of a rigid, hard, flat and non-warping torsion-free construction, which is free from bouncing/deflection and has the following characteristics.

- a) Capable of holding a base surface of a minimum width of 500 mm and a minimum length of 1 000 mm. If the bath or shower mat does not fit on the surface then it may be cut evenly on each side.
- b) An inclination adjustable in the longitudinal direction and measurable to 0.1° with an accuracy of 0.2° through the range of 0° to 45°. The display of the angle of inclination is not visible to the operator.
- c) Sanitary grade acrylic sheet, which conforms to BS EN 263, to simulate the base of a bath or shower tray.

**8.2 Full body harness and suitable fall arrest system** (where an inertia reel is used the harness and fall arrest system shall conform to BS EN 361 and BS EN 360, respectively) which allows the unrestricted movement of the operator during testing without affecting the operator's gait.

**8.3 Railings of adequate strength and rigidity** fitted along the longitudinal sides of the test apparatus at a height of (1 000 ±100) mm, which:

- a) allows the operator to manually arrest falling in conjunction with the harness systems described in 8.2;
- b) is suitably padded to protect against operator injury; and
- c) is not be used to support the operator during testing.

**8.4 Suitable means of safe access to and from the machine.**

**8.5 A means of supplying a constant delivery of aqueous wetting agent** at a rate of (6 ±1) L/min, measured prior to the outlet nozzle to both the top surface of the mat under test and also the acrylic test surface, and capable of maintaining

the wetting agent at a temperature of  $(30 \pm 3)$  °C at a position immediately prior to the exit nozzles, e.g. multiple outlets spaced equidistant across the width of the test ramp.

8.6 A *metronome* that is capable of producing an output of 144 bpm and that is clearly audible to the test operator.

## 9 Test solution

Potable water with a uniform concentration of 0.01 wt% sodium lauryl sulfate shall be used as a wetting agent.

The test solution shall be prepared immediately prior to testing using general laboratory grade (GPR) or greater purity sodium lauryl sulfate, and continuously mixed. Sufficient quantity shall be made to allow calibration and/or full testing on a single test item to be carried out.

Test liquid shall not be reused.

*NOTE Test liquid needs to be discharged to waste in accordance with local waste regulations.*

## 10 Standard surface

Care shall be taken to ensure that the acrylic sheet does not become scratched during installation, use or storage. The standard surface shall be protected during storage and replaced if there is wear or damage present in the testing area. The surface in contact with the mat shall have a roughness value ( $R_z$ ) of not greater than 1.7  $\mu\text{m}$  when assessed in accordance with BS EN ISO 4287.

## 11 Test specimen conditioning, examination and preparation

The mat shall be conditioned by removal from its packaging and being laid flat on a horizontal flat surface for a minimum of 16 h at a temperature of  $(23 \pm 3)$  °C prior to testing.

A visual examination shall be carried out and any defects, including manufacturing faults, blisters, tears, inclusions or foreign matter, shall be recorded. Particular reference shall be made to those defects that could affect the safety or performance of the mat.

## 12 Verification of standard surface

12.1 The sanitary grade acrylic sheet shall be examined prior to use to ensure that it is clean and free from any surface defects or contaminants. The surface roughness shall be measured to verify that it conforms to Clause 10. If wear or damage is identified, the acrylic sheet shall be replaced.

12.2 The temperature and flow rate of the test solution shall be confirmed before verification of the standard surface is undertaken.

12.3 Each test operator shall soak his/her feet in potable water at  $(30 \pm 3)$  °C for a minimum of 10 min immediately prior to testing.

12.4 The test solution supply shall be turned on, and allowed to form a uniform film over the standard surface.



**12.5** The operator, wearing the correctly adjusted fall arrest system, shall mount the test ramp and stand centrally on the base surface, with the test solution outlet behind them. The operator shall look at his/her feet.

**12.6** The operator shall test the standard surface by taking steps of a half foot length backwards and forwards (see Annex A) over the standard surface in time with the metronome set at 144 bpm, while continuing to look at his/her feet and assessing the security of his/her step.

**12.7** The operator shall increase the inclination of the ramp by an amount he/she feels appropriate to the test condition. If at the previous angle the operator felt secure, the angle increase may be several degrees. However, if the operator felt insecure because the angle of insecurity was approaching, then the increase in ramp angle may only be one degree or less.

**12.8** The operator shall repeat steps **12.6** and **12.7** until he/she slips on the standard surface. The angle of insecurity when the slip takes place shall be recorded.

Once a slip occurs the walk shall be repeated at the angle of slip and if a further slip occurs then this angle shall be recorded. If there is no second slip the test shall be continued, raising the angle by a small amount until two slips occur at the same angle.

*NOTE The walking style has to be maintained throughout to ensure consistent results.*

**12.9** The operator shall return the ramp to the horizontal position. The test shall be repeated as per **12.6** onwards until five results have been obtained. The mean of the five results shall be calculated. Testing shall be repeated by the second operator.

**12.10** If the mean values of the two operators differ by more than 2°, a third operator shall repeat the test. Testing shall be repeated until the mean results of two operators are within 2° of each other.

**12.11** The verification values shall be recorded.

## 13 Testing of the mat

**13.1** Each test operator shall soak his/her feet in potable water at (30 ±3) °C for a minimum of 10 min immediately prior to testing.

**13.2** The operator, wearing the correctly adjusted fall arrest system, shall mount the ramp which shall be set in the horizontal position, and position the mat centrally onto the wetted standard surface. The operator shall then apply a downwards force over the top surface of the mat using his/her feet to ensure that any suction cups or fixation devices are activated and the mat is secured.

**13.3** The test solution supply shall be turned on, and allowed to form a uniform film over the standard surface and the mat.

**13.4** The operator shall stand with the test solution outlet behind them, looking at his/her feet. The metronome shall be set at 144 bpm.

**13.5** The operator shall test the mat by taking steps of a half foot length backwards and forwards (see Annex A) over the mat in time with the metronome, while continuing to look at his/her feet and assessing the security of his/her step.

**13.6** The operator shall increase the inclination of the ramp by an amount he/she feels appropriate to the test condition. If at the previous angle the

operator felt secure, the angle increase may be several degrees. However, if the operator felt insecure because the angle of insecurity was approaching, then the increase in ramp angle may only be one degree or less.

**13.7** The operator shall repeat steps **13.4** to **13.6** until failure mode or an angle of 25° is reached.

Once a slip occurs the walk shall be repeated at the angle of slip and if a further slip occurs then this angle shall be recorded. If there is no second slip the test shall be continued, raising the angle by a small amount until two slips occur at the same angle.

The angle of insecurity and the failure mode shall be recorded.

**13.8** The test operator shall return the ramp to the horizontal position. The test shall be repeated as per **13.5** onwards until five results have been obtained and the mean calculated. Testing shall be repeated by the second operator.

If the mean values of the two operators differ by more than 2°, a third data set shall be obtained using one of the original operators. Testing is repeated until the mean results of two operators are within two degrees of each other.

## 14 Product marking

Each bath/shower mat shall be legibly and permanently marked for the foreseeable lifetime of the product with the number and date of this British Standard, i.e. BS 8445:2012<sup>1)</sup> and, additionally, with:

- a) the name, trade mark or other means of identification of the producer or distributor; and
- b) the product reference and, where applicable, the batch of products to which it belongs.

## 15 Informative labelling

Each mat shall be accompanied by the following information.

- a) The identification of the European producer, or the UK distributor for bath/shower mats manufactured outside the EC.
- b) Product-specific warnings and cautions, such as material content, e.g. "This bath/shower mat contains natural rubber latex".
- c) Instructions regarding pre-use activities specified by the manufacturer, such as conditioning or washing before use.
- d) Instructions for the safe fitting of the mat, such as suitable and unsuitable surfaces and checks to be carried by the user directly before use. Examples include, but are not restricted to:
  - 1) "Not suitable for use on textured and non-slip baths or shower trays";
  - 2) "Ensure the bath or shower tray is clean prior to fitting the mat";
  - 3) "Position the mat in the bath or shower tray. Press down firmly and ensure the mat is secure before stepping onto it".
- e) Instructions for the safe use of the mat, such as substances that should not

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<sup>1)</sup> Marking BS 8445:2012 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

be allowed to come into contact with the mat and other relevant safety related instructions. Examples include, but are not restricted to:

- 1) "Always check the water temperature before entering a bath or shower";
  - 2) "Do not use with bath oils or other additives that may affect the performance";
  - 3) "When stepping on to the mat, tread carefully on to the centre";
  - 4) "Never leave small children unattended in the bath or shower".
- f) Instructions for the safe care and maintenance of the mat, such as washing and storage related instructions. Examples include, but are not restricted to:
- 1) "After use rinse the mat thoroughly and allow it to dry naturally";
  - 2) "Wash the mat periodically by hand in warm soapy water";
  - 3) "Check the mat regularly for damage or excessive wear. Do not use the mat if it is damaged or worn";
  - 4) "Store away from direct sunlight";
  - 5) "Avoid contact with direct heat sources such as radiators".
- g) Instructions for the safe end-of-life disposal of the mat and its packaging. Examples include, but are not restricted to:
- 1) "Do not burn";
  - 2) "Recycle where facilities exist".

## 16 Packaging

If a flexible film bag is used for packaging, a warning statement similar to the one below shall be printed on the film.

"PLASTIC BAGS CAN BE DANGEROUS. TO AVOID DANGER OF SUFFOCATION KEEP THIS BAG AWAY FROM BABIES AND CHILDREN."

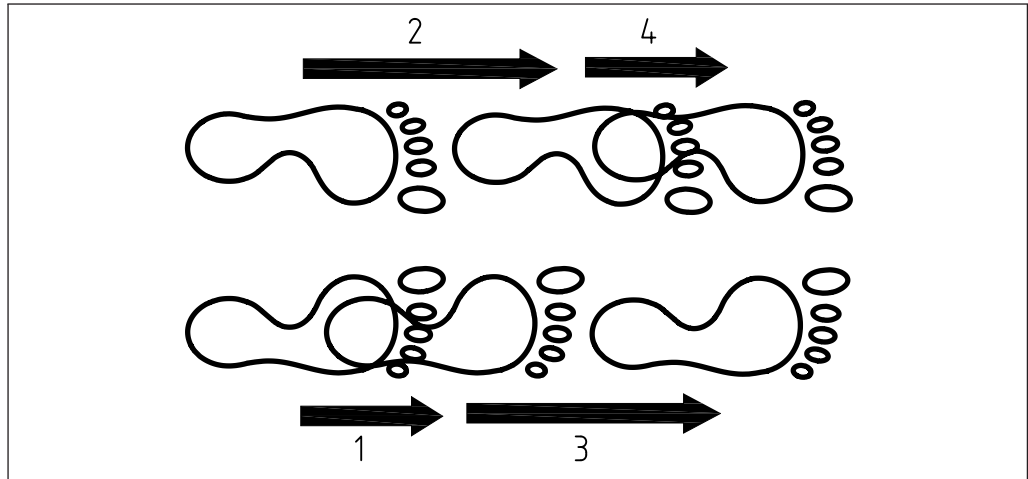
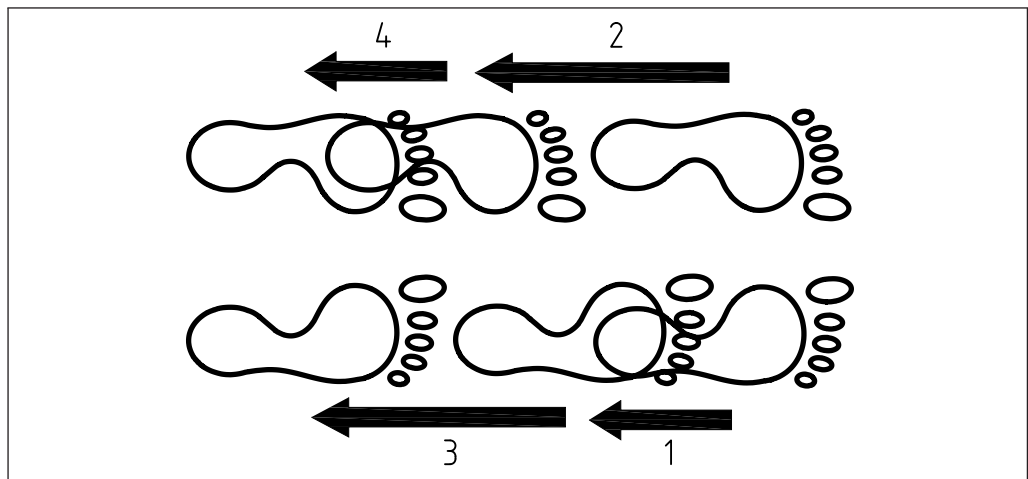
## 17 Test report

The test report shall include the following information.

- a) Reference to this British Standard, i.e. BS 8445:2012.
- b) Description of the bath/shower mat tested, i.e. manufacturer or producer (when known), colour and material and dimensions as measured.
- c) Photographic identification of the product prior to testing.
- d) Observations from the visual examination of the mat.
- e) Verification angle of standard surface.
- f) Raw test data, test operator means and final test result.
- g) Overall performance level and classification obtained.
- h) Mode of failure(s).
- i) Assessment of labelling, marking and packaging.
- j) Additional relevant observations.
- k) Date tested.
- l) Any deviations from this standard that might influence conformity.

Annex A  
(informative)**Foot motions**

Figure A.1 and Figure A.2 demonstrate, respectively, the forwards and backwards foot motion for use in verification of the standard surface (Clause 12) and testing of the mat (Clause 13).

Figure A.1 **Foot motion walking forwards**Figure A.2 **Foot motion walking backwards**Annex B  
(informative)**Dynamic coefficient of friction based on a low incident risk**

The angle at which slip occurs is mathematically related to COF as follows.

Calculation of COF from the ramp angle is achieved by taking the tangent of the angle (so, for example, a ramp angle of 10° is a COF of 0.18).

The angle of 14° required for a comfort mat is approximately equal to a COF of 0.24, while 20° equates to 0.36.

The friction requirements are taken from original work by Pye and Harrison at BRE in the 1960s [1].

When walking in a straight line at a COF of 0.24 the risk of slipping is 1 in 20, while at a COF of 0.36 the risk is 1 in a million.

## Bibliography

### Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

DIN 51097:1992, *Testing of floor coverings – Determination of anti-slip properties – Wet-loaded barefoot areas – Walking method – Ramp test*

DIN 51130:1992, *Testing of floor coverings – Determination of anti-slip properties – Workrooms and work areas with increased risk of slip – Walking method – Ramp test*

### Other publications

[1] Pye, P.W., Harrison, H.W. BRE Report 460. *BRE Building Elements: Floors and flooring – Performance, diagnosis, maintenance, repair and avoidance of defects* (Second edition). Bracknell: BRE Press: 2003.

### Further reading

*Slip resistance guidelines*. Issue 4. United Kingdom Slip Resistance Group. 2011.

*Assessing the slip resistance of flooring: A technical information sheet*. Information Sheet [Slips and trips 1 (rev1)]. Health and Safety Executive. 2007. Web version only at [www.hse.gov.uk/pubns/web/slips01.pdf](http://www.hse.gov.uk/pubns/web/slips01.pdf)





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