# TESTING OF SAMPLES

# FOR SLIP RESISTANCE

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Your ref: Jacqueline Christ
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**TESTING OF SAMPLES FOR SLIP RESISTANCE**

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## 1. Introduction

We were instructed by you to test three of your products in order to determine their slip resistance.

## 2. Samples

Six samples were supplied by yourselves.

## 3. Tests

The TRL Pendulum tests were carried out in accordance with the procedure detailed in BS 7976 Part 2 : 2002 and the UK Slip Resistance Group Guidelines, Issue 3. The Pendulum was shod with Four S rubber and tests were conducted in wet and dry conditions. The samples were tested in three directions: along the sample, across the sample and at 45° to the previous directions.

## 4. Tests results

| | | | | | | | | PTV |
|---|---|---|---|---|---|---|---|---|
| **Sample no. 1** | | ***CatWalk*** | | | | | | |
| Four S (As delivered) | Dry | Along | 51 | 51 | 51 | 51 | 51 | 51 |
| | | Across | 49 | 49 | 50 | 49 | 49 | 49 |
| | | 45° | 47 | 47 | 47 | 47 | 48 | 47 |
| Four S | Wet | Along | 41 | 41 | 41 | 40 | 40 | 41 |
| | | Across | 35 | 35 | 34 | 34 | 34 | 34 |
| | | 45° | 36 | 35 | 35 | 35 | 35 | 35 |
| Four S (Clean) | Dry | Along | 56 | 58 | 58 | 58 | 58 | 58 |
| | | Across | 56 | 57 | 57 | 57 | 58 | 57 |
| | | 45° | 57 | 58 | 58 | 57 | 58 | 58 |

| | | | |
|---|---|---|---|
| Average | Four S | Dry (as delivered) | 49 |
| | | Wet | 37 |
| | | Dry (clean) | 58 |

| | | | | | | | | | PTV |
|---|---|---|---|---|---|---|---|---|---|
| **Sample no. 2** | | ***TexWalk*** | | | | | | | |
| Four S | Dry | Along | 43 | 43 | 43 | 43 | 43 | | 43 |
| (As delivered) | | Across | 44 | 45 | 45 | 44 | 44 | | 44 |
| | | 45° | 41 | 41 | 43 | 42 | 43 | | 42 |
| Four S | Wet | Along | 37 | 36 | 35 | 35 | 35 | | 36 |
| | | Across | 38 | 38 | 37 | 37 | 36 | | 37 |
| | | 45° | 39 | 38 | 37 | 36 | 35 | | 37 |
| Four S | Dry | Along | 55 | 56 | 57 | 57 | 57 | | 56 |
| (Clean) | | Across | 56 | 57 | 57 | 58 | 58 | | 57 |
| | | 45° | 56 | 57 | 57 | 57 | 58 | | 57 |
| | | Average | Four S | | | Dry (as delivered) | | | 43 |
| | | | | | | Wet | | | 37 |
| | | | | | | Dry (clean) | | | 57 |
| **Sample no. 3** | | ***AsphaltArt*** | | | | | | | |
| Four S | Dry | Along | 43 | 45 | 44 | 42 | 43 | | 43 |
| (As delivered) | | Across | 45 | 47 | 47 | 47 | 47 | | 47 |
| | | 45° | 47 | 45 | 46 | 48 | 49 | | 47 |
| Four S | Wet | Along | 46 | 46 | 45 | 45 | 45 | | 45 |
| | | Across | 47 | 47 | 47 | 45 | 45 | | 46 |
| | | 45° | 44 | 44 | 44 | 44 | 44 | | 44 |
| Four S | Dry | Along | 58 | 58 | 59 | 56 | 58 | | 58 |
| (Clean) | | Across | 59 | 59 | 60 | 59 | 59 | | 59 |
| | | 45° | 58 | 58 | 59 | 59 | 59 | | 59 |
| | | Average | Four S | | | Dry (as delivered) | | | 46 |
| | | | | | | Wet | | | 45 |
| | | | | | | Dry (clean) | | | 59 |

Date of test 25th March 2014
Temperature 20°C
PTV = Pendulum Test Value
Pendulum Test Machine Number 9225

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## SLIP CRITERIA

The criteria which are used for slip resistance values are based on the level of friction that people need when walking. They are not arbitrary but the result of significant research. It should be understood that it does not matter whether the person is wearing normal shoes or trainers or whether conditions underfoot are wet or dry - he or she will still require the same degree of friction to be developed to ensure that he or she does not slip. It is for the test itself to replicate the footwear and the conditions, not the criteria.

There is as yet no single British Standard relating specifically to slipping on the whole range of floor surfaces. However BS 8204, for in situ floor surfaces, does contain accepted guidelines. These have been taken primarily from the work of the GLC as described below combined with the work carried out by the Building Research Station in the late 1950s.

Much of the current work on Slip Resistance is based on the work of the GLC in the 1960s, in which they correlated readings taken by the TRL Pendulum with the known slipping history of the floor concerned.

The following is an extract from Bulletin No. 43 (2nd Series) Item No. 5 'Slip Resistance of Floors, Stairs and Pavings'. GLC Department of Architecture and Civil Design: March 1971.

*Measure of Slip Resistance*

*The method employed by the Council's Scientific Adviser is the use of the Road Research Laboratory skid resistance tester, shod with rubber. Results of this test are quoted in figures, high values indicating good slip resistance and low values poor resistance. Tests are made under wet and dry conditions and both values are normally quoted.*

*Assessment of Slip Value*

*The Council's Scientific Advisers definitions, which are in line with other opinions, are as follows:*

a) *'Dangerous' - 19 or below. This condition is quite unsafe and, where it exists immediate action should be taken to replace or treat the surface to an acceptable standard.*

b) *'Marginal' - 20 to 39. The surface is below the recommended safe level and methods of improving the condition should be considered and carried out as soon as reasonably possible. Some remedial treatments have only temporary effect and will need to be repeated at regular intervals; in the long term, the substitution of an alternative finish may be more economic. In the meantime, warnings should be given to all using the building that care must be observed.*

c) *'Satisfactory' - 40 to 74.*

d) *'Excellent' - 75 and above. This condition, though desirable in many situations, is required in certain special cases, such as railway platform edges and crowded public stairs.*

While I would not claim that the Pendulum replicates exactly all the factors involved in pedestrian slipping I would submit that it comes acceptably close to doing so. My own research (Ref. 4) and

experience over many years together with that of the GLC has shown a close correlation between the readings given by the instrument and the known history of the floor surface concerned.

Four S and TRL rubbers often give very similar results in wet conditions but they can differ. Unfortunately there is no simple explanation for this nor can one predict which rubber will give the higher result when they do differ. The subject of how water lubricates the action between the heel and the floor surface is complex and not widely understood. However, if a more detailed explanation is required, the author of this report can provide this on request.

The UK Slip Resistance Group has proposed the following criteria for assessment of results.

| | | |
|---|---|---|
| PTV | 0 - 24 | High risk/potential |
| | 25 - 35 | Medium risk/potential |
| | 36 + | Low risk/potential |

The value of 35 is based on the BRE work (see below) and is for straight walking situations. However, if turning and other similar higher frictional demand activities take place on a floor (as is usual) then a minimum PTV of 40 is required for safety - in other words in line with the original GLC proposals and work by several other authorities on the subject. The 35/36 criteria can only be justified in those situations where there is no likelihood of turning taking place.

It is nowadays common to consider slipping in terms of risk. Thus the GLC criteria can be regarded as

| | | |
|---|---|---|
| Dangerous | = | High risk of slipping |
| Marginal | = | Medium risk of slipping |
| Safe | = | Low risk of slipping. |

The boundaries between each 'zone' are not to be taken as clearly defined, thus there is essentially no significant difference between a slip resistance of 19 and one of 20, albeit the former is in the high risk zone while the latter is in the medium risk. They might both be considered to be medium/high risk. The various criteria are based on the BRE work which considered the slip resistance requirements of a wide range of people. This varied considerably from person to person but when analysed statistically the following table was able to be constructed.

For normal ambulatory activity ...

1 person in 1,000,000 requires a minimum PTV of 40 for safety
1 person in 100,000 requires a minimum PTV of 38 for safety
1 person in 10,000 requires a minimum PTV of 34 for safety
1 person in 200 requires a minimum PTV of 31 for safety
1 person in 20 requires a minimum PTV of 27 for safety
1 person in 2 requires a minimum PTV of 20 for safety

NB. This is based on the BRE work and is for turning as well as straight walking. Although turning to the left gave slightly different results from turning to the right in the tests, there is no ergonomic reason why this should be so. Hence the values in the table are based on the higher values obtained in the tests.

It is possible for people to change their gait so that if they are warned of danger by a sign or they recognise the floor as slippery because it is wet or shiny, they can require less slip resistance from the floor/shoe interface to walk across that area of flooring.

If the floor is on a slope then those walking down the slope will require higher slip resistance than if the floor was on the level. It is usually considered that for a slope of 1 in x one needs a slip resistance of 40 + (100/x). For a typical pedestrian ramp, for example, which could have a 5° (1 in 12) slope, a slip resistance of 48 would give the same level of safety as a slip resistance of 40 on a level surface.

## Useful References


1. 'Instructions for using the portable skid resistance tester.'
   Road Note 27 Transport and Road Research Laboratory. HMSO 1969.

2. Bulletin No.43 (2nd Series) Item No.5 'Slip Resistance of Floors, Stairs and Pavings.'
   GLC Department of Architecture and Civil Design. March 1971.

3. 'Stairs Ladders and Walkways' BS 5395: Parts 1 and 3: 1977/1985 BSI.

4. 'The Measurement of Slip Resistance of Floor Surfaces.' Dr M Bailey.
   Construction and Building Materials Volume 2, No.3, September 1988. (Also given as a lecture to the Society of Chemical Industry 21/9/89.)

5. 'Slipping Accidents.' Dr M Bailey, Building Technical File, No.28. January 1990.

6. 'The Forces Applied to the Floor by the Foot in Walking.'
   National Building Studies, Research Paper 32. HMSO London 1967.

7. BS 8204: Part 3. In Situ Floorings.
   Code of Practice for Polymer Modified Cementitious Wearing Surfaces.

8. The Assessment of Floor Slip Resistance. The UK Slip Resistance Group Guidelines.
   Issue 3 - 2005.

9. BS 7976. Method of Operation and Calibration of the Pendulum Tester.

10. The TRL pendulum slip resistance tester, the reasoning for its acceptance in the UK' Dr M Bailey.
    Contemporary Ergonomics 2005.

11. 'Roller coaster slip tests putting slip testing back on the rails!'. K Hallas et al. Contemporary Ergonomics 2005.


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