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**A Guide to
Anti-slip Testing**

Ceram Guide to Slip Resistance Tests



The Workplace (Health, Safety and Welfare Regulations) 1992 require that floors must not be slippery so as not to put people's safety at risk. Prevention of accidents, caused by slipping, is down to correct choice of flooring media and good management (i.e. contamination prevention, cleaning regimes, type of footwear worn and an assessment of the surrounding environment). In order for management systems to be effective it is important that floor materials are suitable for the application and environment in which they are used, and an appropriate measuring method employed.

Although there are many methods to measure slip resistance there are two preferred slip resistance tests - the Ramp Test and the Pendulum Test. Ceram a leading materials technology consultancy with extensive experience in the building and construction industries, can offer both types of slip resistance tests. In addition, Ceram offers a full on-site consultancy service regarding skid and slip issues. Testing of floors and surfaces in situ can identify a significant number of factors that can influence the skid slip performance of flooring materials. For example, cleaning regimes, maintenance, integrity of substrate, wearing or weathering of the flooring surface, presence of any sealants on the surface of the floor and trafficking patterns can all significantly affect the performance of flooring materials.

Pendulum Ramp Testing

The choice of test is dependent on the material from which the flooring product is made, its surface profile and the environment in which it is being used.

The Pendulum Test

The Pendulum Test is the preferred method of the HSE and the UKSRG (UK slip resistance group) in the UK. The test is designed to simulate the action of a slipping foot; the method uses a swinging arm which contacts, via a dummy heel (rubber slider made of a standard rubber), a set area of flooring in a controlled manner. The slip resistance of the flooring is measured by the over-swing of the pendulum and is directly affected by the surface profile/roughness of the floor.



There are three main reasons for using Pendulum Testing:

1. The test is a good reproduction of the dynamics of an actual slipping foot.
2. It has been shown over many years that the pendulum test gives good correlation between instrument results and actual incidents of pedestrian slips (information obtained from the HSE).
3. The pendulum test itself is portable and so can be used in the laboratory or on site.



Standards that use the Pendulum Test include BS 7976, used for pedestrian surfaces, EN 1341, used for external paving and EN 14231, used for natural stone modular tiles. The standards vary slightly both in their procedures and in the type of rubber slider used. There are two types of rubber used, slider 96 (formally known as Four-S) rubber which simulates a standard shoe sole and slider 55 (formally known as TRRL) rubber which can be used to test barefoot areas or unusually rough surfaces. The type of material and its surface characteristics therefore dictate which standard is used and subsequently which rubber is used. This means that different products of a similar surface profile that are used for the same application can be tested in different ways, leading to different results. It would therefore be prudent to test using both rubbers, covering the product for its relevant standard for its application and to obtain as much information as possible for that particular surface.

The Ramp Test

The Ramp Test is split into DIN 51130 - Shod and DIN 51097 - Barefoot. This method of testing slip resistance involves the tester wearing standard soled boots (shod) on an oily floor surface or barefoot on a wet 'soapy' floor surface. The floor is inclined gradually until the test subject slips. The slipperiness is given a classification depending on the angle of inclination of the slip.

In addition to the standards listed above there is also a European standard for PVC flooring, EN 13845. This involves the ramp, the use of shoes with a standard rubber sole of slider 96 rubber, and a wet 'soapy' surface.



There are three main reasons for testing slip resistance using the Ramp Test:

1. The surface can be tested 'barefoot' and, as such, is ideal for wet areas such as swimming pools and shower/changing areas.
2. Heavily profiled surfaces, which are difficult to test using pendulum testing, can be assessed for slip resistance.
3. The test is useful in industrial areas which may become contaminated and where safety footwear is required.

In addition, different contaminants can be used to simulate different applications.

Test Results

Both the Pendulum Test and the Ramp Test will provide information as to how a surface will perform in a particular application. A combination of both tests will allow an assessment of the surface for all applications and indicate how that surface will perform under various conditions.



Results for both the Pendulum and the Ramp Tests can be categorised as follows:

Pendulum Testing Categories

Pendulum Numbers	Potential for Slip
<i>24 and below</i>	<i>High</i>
<i>25-35</i>	<i>Moderate</i>
<i>36-64</i>	<i>Low</i>
<i>65 and above</i>	<i>Extremely Low</i>

Shod Ramp Testing Categories**

R Value	Category	Angle of Inclination
9	<i>Low</i>	<i>6-10</i>
10	<i>Normal</i>	<i>>10-19</i>
11	<i>Above Average</i>	<i>>19-27</i>
12	<i>High</i>	<i>>27-35</i>
13	<i>Very High</i>	<i>>35</i>

Note: R9 is the lowest category

Barefoot Ramp Testing Categories**

Category	Angle of Inclination
<i>A</i>	<i>>12</i>
<i>B</i>	<i>>18</i>
<i>C</i>	<i>>24</i>

(Reference DIN 51130 and DIN 51097)

**Information and guidance on the areas suitable for the corresponding categories for both the shod and the barefoot tests can be obtained by contacting simon.hall@ceram.com or dave.vaughan@ceram.com, Tel: +44 (0)1782 764444.

It should be noted that, whichever method of slip resistance test is chosen, when working to standards, the tests are usually carried out on samples direct from production, i.e. samples that have not been in service. When evaluating results it is wise to allow a buffer zone as the surfaces will, when in use, wear. The extent of the wear will be dependent on the hardness of the material, the surface profile and the amount and type of traffic.

Ceram provides slip resistance testing to:

- Manufacturers - working with them to improve their products
- Architects - to advise on the slip resistance of specified products
- Contractors - to ensure that products are fit for application prior to installation
- End users - to advise on remedial work and to investigate slipping accidents.

We also provide an Expert Witness Service.



Summary - Slip Resistance Testing of Flooring Surfaces

- Workplace, health, safety and welfare regulations require that floors must not be slippery. Prevention of accidents, due to slipping, is down to correct choice of flooring media and good management practices.
- There is a duty of care to have materials tested for slip resistance before use.
- In the UK the preferred methods for measuring slip resistance are the Pendulum Test and the Ramp Test.
- The Pendulum Test can be used with two different types of rubber slider, Slider 96 (simulates a shoe rubber) and slider 55 (originally used to simulate car tyres but can also be used to simulate softer shoes or barefoot). The slider used is dependent on the type of material and on the relevant standard. Where materials are used in multi applications (e.g. a natural stone tile that can be used internally or externally, in dry areas and wet areas) Ceram would recommend that the test is carried out using both sliders.
- Results from the Pendulum Test will categorise the floor surface as having an extremely low, low, moderate or high potential for slip.
- The Ramp Test is useful in industrial areas, using the shod test, and in wet areas such as swimming pools, using the barefoot test. A wide range of materials can be tested using this method, including heavily profiled floor coverings.
- Results from the Ramp Test will categorise the floor surface as R9 to R13 (shod test where R9 has the highest potential for slip) and A, B or C (barefoot test where A has the highest potential for slip). These categories relate to suitable areas of use.
- It is important to realise that, whichever method is chosen, tiles will wear in use and so when aiming for a category allowance for the properties of the tile, the environment and type of traffic should be taken into account.



About Ceram

Ceram is an independent expert in innovation, sustainability and quality assurance of materials.

With a long history in the ceramics industry, Ceram has diversified into other materials and other markets including aerospace and defence, medical and healthcare, minerals, electronics and energy and environment.

Partnership is central to how we do business; we work with our clients to understand their needs so that we can help them overcome materials challenges, develop new products, processes and technologies and gain real, tangible results.

Headquartered in Staffordshire, UK, Ceram has approved laboratories around the world.

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