

Paul A. Stringer  
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27<sup>th</sup> June 2005

Dear Paul,

**Measurement of surface slipperiness.  
Treated and Untreated Ceramic Tiles - Oltco Ltd.  
Non-HSE Contract JC 4600124, PED/LET/05/22**

Further to your request for the assessment of the slipperiness of the treated and untreated ceramic tiles supplied to HSL, the results of pendulum tests and surface roughness measurements undertaken by Mr Graeme Hunwin (HSL) on the 21<sup>st</sup> and 22<sup>nd</sup> April 2005 are detailed below.

A laboratory slipperiness assessment of eight ceramic tiles was undertaken using standard HSL / HSE techniques. Slipperiness measurements were undertaken on eight ceramic tiles, four treated with EtchGrip and four untreated. These measurements were taken in accordance with the Guidelines recommended by the United Kingdom Slip Resistance Group, (Issue 2, 2000) where applicable, and due regard was also given to the protocols outlined in BS7976:2. Data generated during the assessment is reproduced in Appendix A; tables allowing simple interpretation are given in Appendix B.

Measurement of the tiles' "Slip Resistance Value" (SRV) were made using a calibrated Stanley Pendulum instrument. Measurements were taken in three complimentary directions in order to account for any directionality in the ceramic tiles. Data was generated before and after application of low volumes of potable water to the tiles by hand-spray. The test slider material used was *Four-S* rubber (Standard Simulated Shoe Sole, developed by the UKSRG to represent a footwear material of moderate performance). The pendulum slider was conditioned according to the UKSRG guidelines. Results are presented in Appendix A.

Further tests were undertaken, where possible, using a calibrated Surtronic Duo surface roughness transducer set to the R<sub>z</sub> parameter (results are presented in Appendix A). The publication, 'The assessment of pedestrian slip risk: The HSE Approach' (Slips and Trips 1) should be used to interpret the pendulum SRV results and also the surface microroughness results (provided in Appendix B).



The test results presented relate only to the tiles under study at the time of testing. The performance of installed materials may change significantly during their lifetime; slip resistance is critically dependent on the level and type of contamination, treatment, wear, maintenance and effective cleaning subsequent to installation.

Don't hesitate to get in touch if you would like to discuss the results.

Yours sincerely,

Dr. Marianne Loo-Morrey BSc. (Hons), MSc. PhD.

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**RESTRICTED: COMMERCIAL**

This report and the work it describes were undertaken by the Health and Safety Laboratory under contract to Oltco Ltd.. Its contents, including any opinions and/or conclusions expressed or recommendations made, do not necessarily reflect policy or views of the Health and Safety Executive.

## Appendix A: Test Data

### Sample number PED/05/27 Light Brown Stone Effect Tile Treated

**Rz Surface Roughness:** 17.1  $\mu\text{m}$  (mean)

#### **Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	60
As-found	Dry	Direction II:	61
As-found	Dry	Direction III:	61

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	44
As-found	Water-wet	Direction I:	44
As-found	Water-wet	Direction III:	43

### Sample number PED/05/28 Light Brown Stone Effect Tile Untreated

**Rz Surface Roughness:** 20.6  $\mu\text{m}$  (mean)

#### **Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	57
As-found	Dry	Direction II:	55
As-found	Dry	Direction III:	55

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	23
As-found	Water-wet	Direction II:	22
As-found	Water-wet	Direction III:	24

**Sample number PED/05/29 Terracotta Coloured Tile Treated**

**Rz Surface Roughness:** 24.0  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	65
As-found	Dry	Direction II:	64
As-found	Dry	Direction III:	62

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	56
As-found	Water-wet	Direction II:	56
As-found	Water-wet	Direction III:	52

**Sample number PED/05/30 Terracotta Coloured Tile Untreated**

**Rz Surface Roughness:** 19.9  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	58
As-found	Dry	Direction II:	57
As-found	Dry	Direction III:	58

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	32
As-found	Water-wet	Direction II:	30
As-found	Water-wet	Direction III:	33

**Sample number PED/05/31 White Riven Ceramic Tile Treated**

**Rz Surface Roughness:** 12.1  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

Condition	Contamination	Test Direction	SRV
As-found	Dry	Direction I:	62
As-found	Dry	Direction II:	62
As-found	Dry	Direction III:	63

Condition	Contamination	Test Direction	SRV
As-found	Water-wet	Direction I:	39
As-found	Water-wet	Direction II:	38
As-found	Water-wet	Direction III:	38

**Sample number PED/05/32 White Riven Ceramic Tile Untreated**

**Rz Surface Roughness:** 10.0  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

Condition	Contamination	Test Direction	SRV
As-found	Dry	Direction I:	57
As-found	Dry	Direction II:	55
As-found	Dry	Direction III:	55

Condition	Contamination	Test Direction	SRV
As-found	Water-wet	Direction I:	14
As-found	Water-wet	Direction II:	14
As-found	Water-wet	Direction III:	15

**Sample number PED/05/29 Smooth White Tile Treated**

**Rz Surface Roughness:** 6.2  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	70
As-found	Dry	Direction II:	70
As-found	Dry	Direction III:	69

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	40
As-found	Water-wet	Direction II:	41
As-found	Water-wet	Direction III:	38

**Sample number PED/05/30 Smooth White Tile Untreated**

**Rz Surface Roughness:** 6.0  $\mu\text{m}$  (mean)

**Pendulum SRV (Four-S Rubber Slider)**

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Dry	Direction I:	68
As-found	Dry	Direction II:	66
As-found	Dry	Direction III:	61

<b>Condition</b>	<b>Contamination</b>	<b>Test Direction</b>	<b>SRV</b>
As-found	Water-wet	Direction I:	13
As-found	Water-wet	Direction II:	13
As-found	Water-wet	Direction III:	14

**Note: Acid Etching**

Recent research by the Health and Safety Executive's Health and Safety Laboratory (Lemon et.al., '99) has suggested that the slip potential of vitrified and glazed ceramic products may be reduced substantially by the use of proprietary acid etching techniques. However, it is strongly advised that, before such treatments are applied to problem areas, tests are carried out on samples (or inconspicuous areas) of flooring in order to assess the reduction in slip risk achieved by the use of such techniques. The effectiveness of such treatments should be assessed using the "Pendulum" slip resistance instrument, operated to the guidelines published by the UK Slip Resistance Group. HSL are in a position to undertake such tests, or will supply contact details of other suitably qualified forensic scientists on request.

Acid etching techniques should be used with care, as adverse effects may include damage to grouting / expansion joints and severe reductions in the aesthetic quality of treated floorings. Furthermore, little knowledge currently exists relating to the longevity of the reductions in slip potential produced on the applications of acid etch treatments (etc.). It is therefore advised that, if an acid etching technique is used, its effectiveness is assessed regularly using the tests outlined above. As the temporal stability of the effects of surface treatments is unknown (and is wholly dependent on flooring type, traffic level, use and maintenance) it is advised that slipperiness assessments should, ideally, be carried out immediately after treatment, weekly for the following month, monthly for the following year, and six-monthly thereafter. Potentially hazardous situations may only be identified by taking such proactive action.

The methods used to apply hydrofluoric acid / ammonium bifluoride etching products must be carefully assessed and controlled. Material Safety Data Sheets concerning typical floor etching products stress that the active ingredients (hydrofluoric acid or ammonium bifluoride) may cause permanent damage to eye tissue, are harmful on skin contact and inhalation, and may lead to internal organ damage. UNDER NO CIRCUMSTANCES should such products be applied using bare hands. Appropriate personal protective equipment should be used, including appropriate gloves/gauntlets, eye protection, and respiratory protection in poorly ventilated areas. As a result, it is not thought to be practical for cleaning staff / contractors to be permitted to apply dilute etch products as an infrequent 'deep-clean' measure; it is advised that such products be applied by a suitable specialist contractor. Furthermore, the harmful and corrosive nature of the product may necessitate application during 'closed hours'.

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**Appendix B - The assessment of pedestrian slip risk: The HSE Approach.**