OPUS

527920.14-1

Pedestrian slip resistance testing:

AS/NZS 3661.1: 1993

For Resene Paints Ltd.

Resene Walk-On

Prepared by Tiffany Lester

Reviewed by Vince Dravitzki

Test Report 527920-14-1W			
Wet condition Pedestrian Slip Resistance Testing:			
RESENE WALK-ON			
Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE

	7/14/03	
Sampling	Two specimens prepared by client	
Coating	**Resene Walk-On** **Two coats applied at 10 m²/L**	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

WET CONDITION TESTING

AS/NZS 3661.1: 1993 Slip Resistance of Pedestrian Surfaces – Requirements

Appendix A Method for the Measurement of the Coefficient of Friction of Wet Surfaces

AS/NZS 3661.1: 1993 section 5.1.1 requires that when tested wet the pedestrian surface shall have a **mean coefficient of friction not less than 0.40,** and no specimen in that sample shall have a mean coefficient of friction less than 0.35.

Preparation	A4 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and requirements is given on following pages.

WET CONDITION RESULTS

Test	1	2	3	4	5
Mean coefficient of friction	0.47	0.46	0.49	0.43	0.44
SAMPLE MEAN WET COEFFICIENT OF FRICTION IS 0.46					
ACCORDING TO AS/NZS 3661.1: 1993 THE SAMPLE IS SLIP RESISTANT WHEN WET					

COMMENTS

1. These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2. Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its wet pedestrian slip resistance.

Test Report 527920-14-1D			
Dry condition Pedestrian Slip Resistance Testing:			
RESENE WALK-ON			
Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE		
	7/14/03	
Sampling	Two specimens prepared by client	
Coating	**Resene Walk-On** **Two coats applied at 10 m²/L**	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

DRY CONDITION TESTING

AS/NZS 3661.1: 1993 Slip Resistance of Pedestrian Surfaces – Requirements

Appendix B Method for the Measurement of the Coefficient of Friction of Dry Surfaces

AS/NZS 3661.1: 1993 section 5.1.2 requires that when tested dry the pedestrian surface shall have a **mean coefficient of friction not less than 0.40**, and no specimen in that sample shall have a mean coefficient of friction less than 0.35.

Preparation	B5 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and requirements is given on following pages.

DRY CONDITION RESULTS

Test	1	2	3	4	5	6
Mean coefficient of friction	0.78	0.66	0.71	0.82	0.78	0.76

SAMPLE MEAN DRY COEFFICIENT OF FRICTION IS 0.75
ACCORDING TO AS/NZS 3661.1: 1993 THE SAMPLE IS SLIP RESISTANT WHEN DRY

COMMENTS

1 These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2 Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its dry pedestrian slip resistance.

This information is provided so as to direct users when using the pedestrian slip resistance testing results.

AS/NZS 3661.1: 1993

The testing that was applied was in accordance with the joint Australian and New Zealand Standard AS/NZS 3661.1: 1993 "Slip Resistance of Pedestrian Surfaces - Requirements". Though superseded as a Standard[1], for verification of slip-resistance performance the New Zealand Building Code states measurement of the coefficient of friction shall be in accordance with AS/NZS 3661.1 and the expected conditions of use.

The scope of AS/NZS 3661.1: 1993 states that these test methods are appropriate to determine the characteristics of surface materials either in the laboratory, under conditions in which the surface materials are intended to be installed, or in situ following installation.

The test methods enable characteristics of surface materials to be determined in either wet or dry conditions. The test method is selected on the basis of whether the material is to be used in either a wet or dry area. The wet condition shall be used for all external pedestrian surfaces and those internal pedestrian surfaces that have a reasonably foreseeable risk of the presence of wet substances such as water, grease and oil. There is little or no correlation between a surface's pedestrian slip resistance performance in the dry condition and that performance in the wet condition.

The test method for the wet condition is set out in Appendix A "Wet Pendulum Test Method". Testing for the wet condition uses a pendulum friction tester. The particular type of pendulum friction tester used is known as a British Pendulum Tester or the Transport Road Research Laboratory (TRRL) portable skid-resistance tester.

The "Method for the Measurement of the Coefficient of Friction of Dry Surfaces" is set out in Appendix B of the standard. Testing for the dry surface condition uses the Tortus Floor Friction Tester.

The British Pendulum Tester

The British Pendulum Tester has a rigid swinging arm, approximately 450 mm long, which contacts the test surface with a spring loaded rubber slider (about 75 mm by 20 mm) mounted on a weighted foot. The pendulum arm swings the foot downwards through 90°, so the foot strikes the test surface when the pendulum arm is near vertical. The pendulum arm length is set so the rubber slides along the test surface for a distance of between 125 and 127 mm, losing energy as it does so, and that energy loss being related to the frictional resistance of the test surface. After sliding the rubber along the test surface, the pendulum arm then swings upwards alongside a British Pendulum Number (BPN) scale to provide a direct reading of the BPN. A higher BPN implies a more slip resistant surface. From the BPN, the coefficient of friction can be calculated.

For AS/NZS 3661.1: 1993, the British Pendulum Test uses a rubber slider known as the Four S rubber slider (Slider #96) which is made of a standard simulated shoe sole rubber. With this rubber, the British Pendulum Tester delivers, as far as possible, a response that is representative of a "typical" pedestrian wearing suitable footwear. The test speed of the rubber slider over the test surface is approximately 2 m/s. People typically walk at speeds of 65 to 90 m/minute, about 1.0 to 1.5 m/s, so the instrument is regarded as

---

[1] AS/NZS 3661.1: 1993 has been superseded as a Standard in both New Zealand and Australia. In New Zealand, the current Standard for "Slip resistance measurement of existing pedestrian surfaces" is AS/NZS 4663: 2004 and the current Standard for "Slip resistance classification of new pedestrian surface materials" is AS/NZ 4586: 2004. In Australia, the current Standard for "Slip resistance measurement of existing pedestrian surfaces" is AS 4663: 2013 and the current Standard for "Slip resistance classification of new pedestrian surface materials" is AS 4586: 2013. The test methods in the current Australian Standards differ slightly from those in the current New Zealand Standards, which differ slightly from AS/NZS 3661.1: 1993.

equating the action of pedestrians walking in unconstrained level spaces, possibly hurrying a little or turning abruptly.

The British Pendulum Tester is capable of performing tests on steep gradients and in the presence of crossfall. On gradients, although the sliding length is slightly displaced from the central position, there is no change in the load between the rubber slider and the test surface and no appreciable change in the speed of sliding. Therefore, the British Pendulum Tester operates correctly whether tests are performed uphill or downhill.

The relationship between BPN (with the Four S rubber slider) and coefficient of friction is:

$$\mu = \frac{3 \times BPN}{330 - BPN}$$

where μ is the coefficient of friction

BPN is the British Pendulum Number

The Tortus Floor Friction Tester

The Tortus is a power-driven cart with a weighted foot that is suspended on a leaf-spring arrangement. The base of the foot is a 10 mm diameter slider of Four S (#96) rubber which, during a run, drags on the test surface. As the cart crawls forward at 16 to 17 mm/s, the foot is displaced backwards by the dragging action. This displacement of the foot is gauged providing a continuous trace of the dynamic coefficient of friction over the length of that run, which would typically be at least 800 mm. During the run the coefficient of friction is displayed via a needle display on the Tortus. Also the output during the run is recorded to a computer for subsequent processing. On a computer, the recorded data is reviewed to confirm the run was valid and a mean coefficient of friction determined for that run.

Friction requirements on sloped surfaces

The coefficient of friction required for a sloped surface is related to the coefficient obtained on a horizontal surface by:

$$\mu_m = \frac{100\mu + M}{100 - M\mu}$$

where μ_m is the coefficient of friction required for a sloped surface

μ is the coefficient of friction obtained on a horizontal surface

M is maximum gradient of slope, in percent

527920.14-2

Pedestrian slip resistance testing:
AS 4586: 2013
For Resene Paints Ltd.
Resene Walk-On

Prepared by Tiffany Lester

Reviewed by Vince Dravitzki

Test Report 527920-14-2W			
Wet condition Pedestrian Slip Resistance Testing:			
RESENE WALK-ON			
Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE		
	7/14/03	
Sampling	Two specimens prepared by client	
Coating	**Resene Walk-On** **Two coats applied at 10 m²/L**	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

WET CONDITION TESTING			
AS 4586: 2013 Appendix A Wet pendulum test method			
Preparation	A6 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and classification of results is given on following pages.

WET CONDITION RESULTS					
Test	1	2	3	4	5
Mean BPN	45	44	46	41	42
SAMPLE MEAN PENDULUM SLIP RESISTANCE VALUE IS 44					
ACCORDING TO AS 4586: 2013 TABLE 2 THE SAMPLE IS CLASSED AS P3					

COMMENTS	
1	The Standard AS 4586: 2013 does not provide for the conditioning of specimens to account for in-service wear. These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.
2	Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its wet pedestrian slip resistance.

Test Report 527920-14-2D
Dry condition Pedestrian Slip Resistance Testing:
RESENE WALK-ON

Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE

	7/14/03
Sampling	Two specimens prepared by client
Coating	**Resene Walk-On:** **Two coats applied at 10 m²/L**
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne
Size	≈ 400 x 1200 mm

DRY CONDITION TESTING

AS 4586: 2013 Appendix B Dry floor friction test method

Preparation	B5 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and classification of results is given on following pages.

DRY CONDITION RESULTS

Test	1	2	3	4	5	6
Mean coefficient of friction	0.78	0.66	0.71	0.82	0.78	0.76

SAMPLE MEAN DRY COEFFICIENT OF FRICTION IS 0.75

ACCORDING TO AS 4586: 2013 TABLE 3 THE SAMPLE IS CLASSED AS D1

COMMENTS

1. The Standard AS 4586: 2013 does not provide for the conditioning of specimens to account for in-service wear. The results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2. Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its dry pedestrian slip resistance.

This information is provided so as to direct users when using this pedestrian slip resistance report.

AS 4586: 2013

The testing that was applied was in accordance with the Australian Standard AS 4586: 2013 "Slip Resistance Classification of New Pedestrian Surface Materials". HB 197 "An Introductory Guide to the Slip Resistance of Pedestrian Surface Materials" provides guidelines for the selection of slip-resistance pedestrian surfaces classified in accordance with AS 4586: 2013.

AS 4586: 2013 provides test methods for classifying pedestrian surface materials according to their frictional characteristics. The test methods enable characteristics of surface materials to be determined in either wet or dry conditions. If a pedestrian surface is liable to become wet, and remain wet and unattended for any significant length of time, it should be tested and classified for the wet condition. There is little or no correlation between a surface's pedestrian slip resistance performance in the dry condition and that performance in the wet condition.

AS 4586: 2013 provides four test methods:

- Wet pendulum test method;
- Dry floor friction test method;
- Wet-barefoot inclining platform test method; and
- Oil-wet inclining platform test method.

The inclining platform test methods require specialised equipment not widely available and not used in the testing reported here. These methods and the equipment will not be discussed further in this report. The wet pendulum test method is set out in Appendix A of AS 4586: 2013 and utilises a pendulum friction tester. The dry floor test method is set out in Appendix B of the Standard and utilises a floor friction tester.

Rubber slider material

Both the dry floor test method and the wet pendulum test method bring a rubber slider in contact with the pedestrian surface under test. The rubber slider material for the dry floor test method is known as Slider 96 (or Four S rubber). The wet floor test method can use the Slider 96 or another rubber known as Slider 55 (or TRL rubber).

Slider 96 is harder than Slider 55. Slider 96 was specifically developed as a standard simulated shoe sole rubber. It is considered to provide greater discrimination between smoother pedestrian surfaces.

Slider 55 is softer than Slider 96. It has traditionally been used for testing outdoor surfaces. The performance of this softer rubber slider is dependent on temperature, producing higher results in temperatures below 18°C and lower results in temperatures 24°C and above. The wet floor test method in AS 4586: 2013 includes a table of temperature corrections for results obtained using the Slider 55.

The rubber sliders are conditioned prior to testing of a sample. For the dry floor test method, the rubber slider is conditioned over Grade P 400 wet and dry abrasive paper. For the wet pendulum test method, the rubber slider is conditioned over Grade P 400 wet and dry abrasive paper followed by further conditioning over a 3 micron lapping film. The foreword to AS 4586: 2013 explains the lapping film conditioning enables better differentiation between pedestrian surfaces, particularly smoother surfaces.

The floor friction tester

The floor friction tester we use is the Tortus Floor Friction Tester. The Tortus is a power-driven cart with a weighted foot that is suspended on a leaf-spring arrangement. The base of the foot is a 10 mm diameter slider of Four S (#96) rubber which, during a run, drags on the test surface. As the cart crawls forward at 16 to 17 mm/s, the foot is displaced backwards by the dragging action. This displacement of the foot is gauged providing a continuous trace of the dynamic coefficient of friction over the length of that run, which would

typically be at least 800 mm. During the run the coefficient of friction is displayed via a needle display on the Tortus. Also the output during the run is recorded to a computer for subsequent processing. On a computer, the recorded data is reviewed to confirm the run was valid and a mean coefficient of friction determined for that run.

Pendulum friction tester

The pendulum friction tester we use is the British Pendulum Tester, also known as the Transport Road Research Laboratory (TRRL) portable skid-resistance tester. It has a rigid swinging arm, approximately 450 mm long, which contacts the test surface with a spring loaded rubber slider (about 75 mm by 20 mm) mounted on a weighted foot. The pendulum arm swings the foot downwards through 90°, so the foot strikes the test surface when the pendulum arm is near vertical. The pendulum arm length is set so the rubber slides along the test surface for a distance of between 125 and 127 mm, losing energy as it does so, and that energy loss being related to the frictional resistance of the test surface. After sliding the rubber along the test surface, the pendulum arm then swings upwards alongside a British Pendulum Number (BPN) scale to provide a direct reading of the BPN. A higher BPN implies a more slip resistant surface.

The test speed of the rubber slider over the test surface is approximately 2 m/s. People typically walk at speeds of 65 to 90 m/minute, about 1.0 to 1.5 m/s, so the instrument is regarded as equating the action of pedestrians walking in unconstrained level spaces, possibly hurrying a little or turning abruptly.

AS 4586: 2013 classifications and HB 197: 2014

HB 197: 2014 is "An introductory guide to the slip resistance of pedestrian surface materials". It provides guidelines for the selection of pedestrian surfaces classified in accordance with AS 4586: 2013.

The pedestrian slip resistance testing described in this report uses the wet pendulum test method and the dry floor friction test method. Wet pendulum test results are classified according to Table 2 of AS 4586: 2013 and dry floor friction test results (expressed as the coefficient of friction, COF) are classified according to Table 3 of AS 4586: 2013. The classifications and required results as per Table 2 and Table 3 are shown here.

AS 4586: 2013 Table 2 Classification of pedestrian surface materials according to the AS 4586 wet pendulum test		
Classification	Pendulum slip resistance value	
	Slider 96	Slider 55
P5	> 54	> 44
P4	45 – 54	40 – 44
P3	35 – 44	35 – 39
P2	25 - 34	20 - 34
P1	12 – 24	< 20
P0	< 12	

AS 4586: 2013 Table 3 Classification of pedestrian surface materials according to the AS 4586 dry floor friction test	
Classification	Floor friction tester mean value
D1	≥ 0.40
D0	< 0.40

Friction requirements on sloped surfaces

The pendulum slip resistance values and floor friction tester mean values in AS 4586: 2013 Table 2 and Table 3, respectively, represent the slip resistance for the test surface in the horizontal plane.

Appendix F of AS 4586: 2013 provides tables that can be used to calculate the slope design value and slope correction value for ramps or other sloped pedestrian surfaces.

The BPN result obtained with the British Pendulum Tester represents the slip resistance value for the test surface in the horizontal plane. If the Pendulum slip resistance value for a pedestrian surface in the horizontal plane has been established, then, for a wide range of potential slope angles, AS 4586: 2013 Table F1 gives the reduced slope corrected value of that pedestrian surface at the slope angle. If the design value

for a sloped pedestrian surface is specified, then the table can be used to establish the required (horizontal plane) Pendulum slip resistance value.

If the dry coefficient of friction for a pedestrian surface in the horizontal plane has been established, then, for a wide range of potential slope angles, AS 4586: 2013 Table F2 gives the reduced coefficient of friction of that pedestrian surface at the slope angle. If the coefficient of friction required on a sloped pedestrian surface is specified, then the table can be used to establish the required (horizontal plane) floor friction tester value.

AS/NZS 4586: 2004

In Australia, AS 4586: 2013 supersedes AS/NZS 4586: 2004 which is the version of that Standard still current in New Zealand. AS/NZS 4586: 2004 shares much with AS 4586: 2013 however the Table 2 and Table 3 classifications are different; and the wet pendulum test method in AS/NZS 4586: 2004 does not require the further conditioning of the rubber slider over lapping film.

HB 197: 1999 was the version current when AS/NZS 4586: 2004 was published.

OPUS

527920.14-3

Pedestrian slip resistance testing:
AS/NZS 3661.1: 1993
For Resene Paints Ltd.
Resene Walk-On with SRG Grit

Prepared by Tiffany Lester

Reviewed by Vince Dravitzki
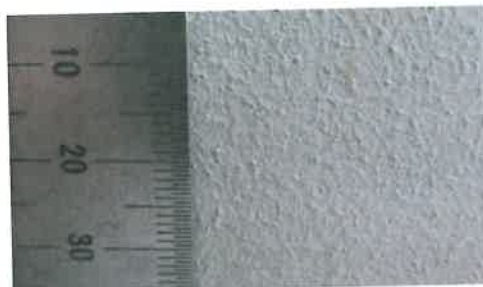
Opus International Consultants Ltd
33 The Esplanade, Petone 5012
PO Box 30845, Lower Hutt 5040
www.opus.co.nz

© Opus International Consultants Ltd 2014

Test Report 527920-14-3W			
Wet condition Pedestrian Slip Resistance Testing:			
RESENE WALK-ON WITH SRG GRIT			
Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE

	7/14/04	
Sampling	Two specimens prepared by client	
Coating	**Resene Walk-On with SRG Grit (500 g/L)** **First coat applied at 20 m²/L** **Second coat applied at 10 m²/L**	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

WET CONDITION TESTING

AS/NZS 3661.1: 1993 Slip Resistance of Pedestrian Surfaces – Requirements

Appendix A Method for the Measurement of the Coefficient of Friction of Wet Surfaces

AS/NZS 3661.1: 1993 section 5.1.1 requires that when tested wet the pedestrian surface shall have a **mean coefficient of friction not less than 0.40**, and no specimen in that sample shall have a mean coefficient of friction less than 0.35.

Preparation	A4 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and requirements is given on following pages.

WET CONDITION RESULTS

Test	1	2	3	4	5
Mean coefficient of friction	0.81	0.78	0.76	0.78	0.72

SAMPLE MEAN WET COEFFICIENT OF FRICTION IS 0.77

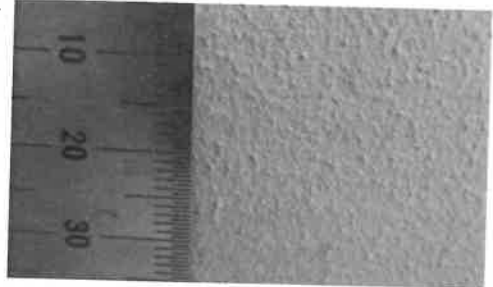**ACCORDING TO AS/NZS 3661.1: 1993 THE SAMPLE IS SLIP RESISTANT WHEN WET**

COMMENTS

1. These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2. Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its wet pedestrian slip resistance.

Test Report 527920-14-3D
Dry condition Pedestrian Slip Resistance Testing:
RESENE WALK-ON WITH SRG GRIT

Test and report Review	Tiffany Lester Vince Dravitzki	Prepared for Contact	Resene Paints Jeff Jurlina

SAMPLE

	7/14/04	
Sampling	Two specimens prepared by client	
Coating	Resene Walk-On with SRG Grit (500 g/L) First coat applied at 20 m²/L Second coat applied at 10 m²/L	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

DRY CONDITION TESTING

AS/NZS 3661.1: 1993 Slip Resistance of Pedestrian Surfaces – Requirements
Appendix B Method for the Measurement of the Coefficient of Friction of Dry Surfaces

AS/NZS 3661.1: 1993 section 5.1.2 requires that when tested dry the pedestrian surface shall have a **mean coefficient of friction not less than 0.40**, and no specimen in that sample shall have a mean coefficient of friction less than 0.35.

Preparation	B5 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and requirements is given on following pages.

DRY CONDITION RESULTS

Test	1	2	3	4	5	6
Mean coefficient of friction	0.91	0.85	0.76	0.69	0.78	1.00

SAMPLE MEAN DRY COEFFICIENT OF FRICTION IS 0.85

ACCORDING TO AS/NZS 3661.1: 1993 THE SAMPLE IS SLIP RESISTANT WHEN DRY

COMMENTS

1. These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2. Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its dry pedestrian slip resistance.

This information is provided so as to direct users when using this pedestrian slip resistance report.

AS/NZS 3661.1: 1993

The testing that was applied was in accordance with the joint Australian and New Zealand Standard AS/NZS 3661.1: 1993 "Slip Resistance of Pedestrian Surfaces - Requirements". Though superseded as a Standard[1], for verification of slip-resistance performance the New Zealand Building Code states measurement of the coefficient of friction shall be in accordance with AS/NZS 3661.1 and the expected conditions of use.

The scope of AS/NZS 3661.1: 1993 states that these test methods are appropriate to determine the characteristics of surface materials either in the laboratory, under conditions in which the surface materials are intended to be installed, or in situ following installation.

The test methods enable characteristics of surface materials to be determined in either wet or dry conditions. The test method is selected on the basis of whether the material is to be used in either a wet or dry area. The wet condition shall be used for all external pedestrian surfaces and those internal pedestrian surfaces that have a reasonably foreseeable risk of the presence of wet substances such as water, grease and oil. There is little or no correlation between a surface's pedestrian slip resistance performance in the dry condition and that performance in the wet condition.

The test method for the wet condition is set out in Appendix A "Wet Pendulum Test Method". Testing for the wet condition uses a pendulum friction tester. The particular type of pendulum friction tester used is known as a British Pendulum Tester or the Transport Road Research Laboratory (TRRL) portable skid-resistance tester.

The "Method for the Measurement of the Coefficient of Friction of Dry Surfaces" is set out in Appendix B of the standard. Testing for the dry surface condition uses the Tortus Floor Friction Tester.

The British Pendulum Tester

The British Pendulum Tester has a rigid swinging arm, approximately 450 mm long, which contacts the test surface with a spring loaded rubber slider (about 75 mm by 20 mm) mounted on a weighted foot. The pendulum arm swings the foot downwards through 90°, so the foot strikes the test surface when the pendulum arm is near vertical. The pendulum arm length is set so the rubber slides along the test surface for a distance of between 125 and 127 mm, losing energy as it does so, and that energy loss being related to the frictional resistance of the test surface. After sliding the rubber along the test surface, the pendulum arm then swings upwards alongside a British Pendulum Number (BPN) scale to provide a direct reading of the BPN. A higher BPN implies a more slip resistant surface. From the BPN, the coefficient of friction can be calculated.

For AS/NZS 3661.1: 1993, the British Pendulum Test uses a rubber slider known as the Four S rubber slider (Slider #96) which is made of a standard simulated shoe sole rubber. With this rubber, the British Pendulum Tester delivers, as far as possible, a response that is representative of a "typical" pedestrian wearing suitable footwear. The test speed of the rubber slider over the test surface is approximately 2 m/s. People typically walk at speeds of 65 to 90 m/minute, about 1.0 to 1.5 m/s, so the instrument is regarded as

---

[1] AS/NZS 3661.1: 1993 has been superseded as a Standard in both New Zealand and Australia. In New Zealand, the current Standard for "Slip resistance measurement of existing pedestrian surfaces" is AS/NZS 4663: 2004 and the current Standard for "Slip resistance classification of new pedestrian surface materials" is AS/NZ 4586: 2004. In Australia, the current Standard for "Slip resistance measurement of existing pedestrian surfaces" is AS 4663: 2013 and the current Standard for "Slip resistance classification of new pedestrian surface materials" is AS 4586: 2013. The test methods in the current Australian Standards differ slightly from those in the current New Zealand Standards, which differ slightly from AS/NZS 3661.1: 1993.

6 August 2014

Opus International Consultants Ltd

527920.14-4

Pedestrian slip resistance testing:

AS 4586: 2013

For Resene Paints Ltd.

Resene Walk-On with SRG Grit

Prepared by Tiffany Lester

Reviewed by Vince Dravitzki

Opus International Consultants Ltd
33 The Esplanade, Petone 5012
PO Box 30845, Lower Hutt 5040
www.opus.co.nz
© Opus International Consultants Ltd 2014

Test Report 527920-14-4W		
Wet condition Pedestrian Slip Resistance Testing:		
RESENE WALK-ON WITH SRG GRIT		
Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE	
	7/14/04
Sampling	Two specimens prepared by client
Coating	**Resene Walk-On with SRG Grit (500 g/L)** **First coat applied at 20 m²/L** **Second coat applied at 10 m²/L**
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne
Size	≈ 400 x 1200 mm

WET CONDITION TESTING			
AS 4586: 2013 Appendix A Wet pendulum test method			
Preparation	A6 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and classification of results is given on following pages.

WET CONDITION RESULTS					
Test	1	2	3	4	5
Mean BPN	70	68	67	68	64
SAMPLE MEAN PENDULUM SLIP RESISTANCE VALUE IS 67					
ACCORDING TO AS 4586: 2013 TABLE 2 THE SAMPLE IS CLASSED AS P5					

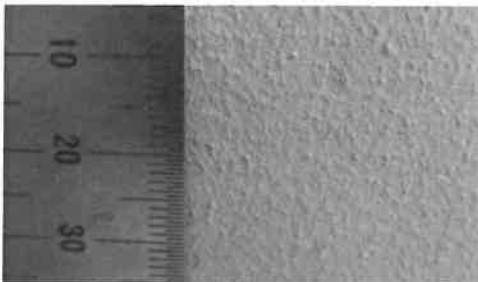| COMMENTS	
1	The Standard AS 4586: 2013 does not provide for the conditioning of specimens to account for in-service wear. These results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.
2	Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its wet pedestrian slip resistance.

Test Report 527920-14-4D
Dry condition Pedestrian Slip Resistance Testing:
RESENE WALK-ON WITH SRG GRIT

Test and report	Tiffany Lester	Prepared for	Resene Paints
Review	Vince Dravitzki	Contact	Jeff Jurlina

SAMPLE

	7/14/04	
Sampling	Two specimens prepared by client	
Coating	**Resene Walk-On with SRG Grit (500 g/L)** **First coat applied at 20 m²/L** **Second coat applied at 10 m²/L**	
Substrate	Fibre cement board primed with Resene Quick Dry Waterborne	
Size	≈ 400 x 1200 mm	

DRY CONDITION TESTING

AS 4586: 2013 Appendix B Dry floor friction test method

Preparation	B5 for laboratory testing	Slider	4S rubber slider (#96)
Date of testing	6 August 2014	Air temperature	20°C

Background to the testing and classification of results is given on following pages.

DRY CONDITION RESULTS

Test	1	2	3	4	5	6
Mean coefficient of friction	0.91	0.85	0.76	0.69	0.78	1.00

SAMPLE MEAN DRY COEFFICIENT OF FRICTION IS 0.85
ACCORDING TO AS 4586: 2013 TABLE 3 THE SAMPLE IS CLASSED AS D1

COMMENTS

1. The Standard AS 4586: 2013 does not provide for the conditioning of specimens to account for in-service wear. The results are only valid for this material for the condition in which it was received. Manufacturing process variations have not been evaluated. Most surfaces wear under foot trafficking and the friction coefficient can change. Other factors, such as contamination, dirtying, or cleaning procedures, even fine dust, may also alter the surface properties and consequently its pedestrian slip resistance.

2. Tests were conducted in different directions across, along, and diagonally on the sample. The sample is homogenous in terms of directionality of testing and its dry pedestrian slip resistance.

This information is provided so as to direct users when using this pedestrian slip resistance report.

AS 4586: 2013

The testing that was applied was in accordance with the Australian Standard AS 4586: 2013 "Slip Resistance Classification of New Pedestrian Surface Materials". HB 197 "An Introductory Guide to the Slip Resistance of Pedestrian Surface Materials" provides guidelines for the selection of slip-resistance pedestrian surfaces classified in accordance with AS 4586: 2013.

AS 4586: 2013 provides test methods for classifying pedestrian surface materials according to their frictional characteristics. The test methods enable characteristics of surface materials to be determined in either wet or dry conditions. If a pedestrian surface is liable to become wet, and remain wet and unattended for any significant length of time, it should be tested and classified for the wet condition. There is little or no correlation between a surface's pedestrian slip resistance performance in the dry condition and that performance in the wet condition.

AS 4586: 2013 provides four test methods:

- Wet pendulum test method;
- Dry floor friction test method;
- Wet-barefoot inclining platform test method; and
- Oil-wet inclining platform test method.

The inclining platform test methods require specialised equipment not widely available and not used in the testing reported here. These methods and the equipment will not be discussed further in this report. The wet pendulum test method is set out in Appendix A of AS 4586: 2013 and utilises a pendulum friction tester. The dry floor test method is set out in Appendix B of the Standard and utilises a floor friction tester.

Rubber slider material

Both the dry floor test method and the wet pendulum test method bring a rubber slider in contact with the pedestrian surface under test. The rubber slider material for the dry floor test method is known as Slider 96 (or Four S rubber). The wet floor test method can use the Slider 96 or another rubber known as Slider 55 (or TRL rubber).

Slider 96 is harder than Slider 55. Slider 96 was specifically developed as a standard simulated shoe sole rubber. It is considered to provide greater discrimination between smoother pedestrian surfaces.

Slider 55 is softer than Slider 96. It has traditionally been used for testing outdoor surfaces. The performance of this softer rubber slider is dependent on temperature, producing higher results in temperatures below 18°C and lower results in temperatures 24°C and above. The wet floor test method in AS 4586: 2013 includes a table of temperature corrections for results obtained using the Slider 55.

The rubber sliders are conditioned prior to testing of a sample. For the dry floor test method, the rubber slider is conditioned over Grade P 400 wet and dry abrasive paper. For the wet pendulum test method, the rubber slider is conditioned over Grade P 400 wet and dry abrasive paper followed by further conditioning over a 3 micron lapping film. The foreword to AS 4586: 2013 explains the lapping film conditioning enables better differentiation between pedestrian surfaces, particularly smoother surfaces.

The floor friction tester

The floor friction tester we use is the Tortus Floor Friction Tester. The Tortus is a power-driven cart with a weighted foot that is suspended on a leaf-spring arrangement. The base of the foot is a 10 mm diameter slider of Four S (#96) rubber which, during a run, drags on the test surface. As the cart crawls forward at 16 to 17 mm/s, the foot is displaced backwards by the dragging action. This displacement of the foot is gauged providing a continuous trace of the dynamic coefficient of friction over the length of that run, which would

typically be at least 800 mm. During the run the coefficient of friction is displayed via a needle display on the Tortus. Also the output during the run is recorded to a computer for subsequent processing. On a computer, the recorded data is reviewed to confirm the run was valid and a mean coefficient of friction determined for that run.

Pendulum friction tester

The pendulum friction tester we use is the British Pendulum Tester, also known as the Transport Road Research Laboratory (TRRL) portable skid-resistance tester. It has a rigid swinging arm, approximately 450 mm long, which contacts the test surface with a spring loaded rubber slider (about 75 mm by 20 mm) mounted on a weighted foot. The pendulum arm swings the foot downwards through 90°, so the foot strikes the test surface when the pendulum arm is near vertical. The pendulum arm length is set so the rubber slides along the test surface for a distance of between 125 and 127 mm, losing energy as it does so, and that energy loss being related to the frictional resistance of the test surface. After sliding the rubber along the test surface, the pendulum arm then swings upwards alongside a British Pendulum Number (BPN) scale to provide a direct reading of the BPN. A higher BPN implies a more slip resistant surface.

The test speed of the rubber slider over the test surface is approximately 2 m/s. People typically walk at speeds of 65 to 90 m/minute, about 1.0 to 1.5 m/s, so the instrument is regarded as equating the action of pedestrians walking in unconstrained level spaces, possibly hurrying a little or turning abruptly.

AS 4586: 2013 classifications and HB 197: 2014

HB 197: 2014 is "An introductory guide to the slip resistance of pedestrian surface materials". It provides guidelines for the selection of pedestrian surfaces classified in accordance with AS 4586: 2013.

The pedestrian slip resistance testing described in this report uses the wet pendulum test method and the dry floor friction test method. Wet pendulum test results are classified according to Table 2 of AS 4586: 2013 and dry floor friction test results (expressed as the coefficient of friction, COF) are classified according to Table 3 of AS 4586: 2013. The classifications and required results as per Table 2 and Table 3 are shown here.

AS 4586: 2013 Table 2 Classification of pedestrian surface materials according to the AS 4586 wet pendulum test		
Classification	Pendulum slip resistance value	
	Slider 96	Slider 55
P5	> 54	> 44
P4	45 – 54	40 – 44
P3	35 – 44	35 – 39
P2	25 - 34	20 - 34
P1	12 – 24	< 20
P0	< 12	

AS 4586: 2013 Table 3 Classification of pedestrian surface materials according to the AS 4586 dry floor friction test	
Classification	Floor friction tester mean value (COF)
D1	≥ 0.40
D0	< 0.40

Friction requirements on sloped surfaces

The pendulum slip resistance values and floor friction tester mean values in AS 4586: 2013 Table 2 and Table 3, respectively, represent the slip resistance for the test surface in the horizontal plane.

Appendix F of AS 4586: 2013 provides tables that can be used to calculate the slope design value and slope correction value for ramps or other sloped pedestrian surfaces.

The BPN result obtained with the British Pendulum Tester represents the slip resistance value for the test surface in the horizontal plane. If the Pendulum slip resistance value for a pedestrian surface in the horizontal plane has been established, then, for a wide range of potential slope angles, AS 4586: 2013 Table F1 gives the reduced slope corrected value of that pedestrian surface at the slope angle. If the design value

for a sloped pedestrian surface is specified, then the table can be used to establish the required (horizontal plane) Pendulum slip resistance value.

If the dry coefficient of friction for a pedestrian surface in the horizontal plane has been established, then, for a wide range of potential slope angles, AS 4586: 2013 Table F2 gives the reduced coefficient of friction of that pedestrian surface at the slope angle. If the coefficient of friction required on a sloped pedestrian surface is specified, then the table can be used to establish the required (horizontal plane) floor friction tester value.

AS/NZS 4586: 2004

In Australia, AS 4586: 2013 supersedes AS/NZS 4586: 2004 which is the version of that Standard still current in New Zealand. AS/NZS 4586: 2004 shares much with AS 4586: 2013 however the Table 2 and Table 3 classifications are different; and the wet pendulum test method in AS/NZS 4586: 2004 does not require the further conditioning of the rubber slider over lapping film.

HB 197: 1999 was the version current when AS/NZS 4586: 2004 was published.

equating the action of pedestrians walking in unconstrained level spaces, possibly hurrying a little or turning abruptly.

The British Pendulum Tester is capable of performing tests on steep gradients and in the presence of crossfall. On gradients, although the sliding length is slightly displaced from the central position, there is no change in the load between the rubber slider and the test surface and no appreciable change in the speed of sliding. Therefore, the British Pendulum Tester operates correctly whether tests are performed uphill or downhill.

The relationship between BPN (with the Four S rubber slider) and coefficient of friction is:

$$\mu = \frac{3 \times BPN}{330 - BPN}$$

where μ is the coefficient of friction

BPN is the British Pendulum Number

The Tortus Floor Friction Tester

The Tortus is a power-driven cart with a weighted foot that is suspended on a leaf-spring arrangement. The base of the foot is a 10 mm diameter slider of Four S (#96) rubber which, during a run, drags on the test surface. As the cart crawls forward at 16 to 17 mm/s, the foot is displaced backwards by the dragging action. This displacement of the foot is gauged providing a continuous trace of the dynamic coefficient of friction over the length of that run, which would typically be at least 800 mm. During the run the coefficient of friction is displayed via a needle display on the Tortus. Also the output during the run is recorded to a computer for subsequent processing. On a computer, the recorded data is reviewed to confirm the run was valid and a mean coefficient of friction determined for that run.

Friction requirements on sloped surfaces

The coefficient of friction required for a sloped surface is related to the coefficient obtained on a horizontal surface by:

$$\mu_m = \frac{100\mu + M}{100 - M\mu}$$

where μ_m is the coefficient of friction required for a sloped surface

μ is the coefficient of friction obtained on a horizontal surface

M is maximum gradient of slope, in percent