

Pedestrian slip resistance test report

Client	Premier Group New Zealand		
Testing	Iain McIver	Review	Murray Forbes
Office	WSP Research, Petone	File	527920.00/524G21.00
Report date	30 July 2021	Issue	A

Slip resistance testing in the wet condition

Method	AS 4586: 2013 Slip resistance classification of new pedestrian surface materials Appendix A Wet Pendulum Test Method (A6 for laboratory testing). The mean British Pendulum Number (BPN) for each test specimen is reported and the Slip Resistance Value (SRV) is the mean BPN value for the sample. The SRV is reported and classified using AS 4586: 2013 Table 2 "Classification of Pedestrian Surface Materials According to the AS 4586 Wet Pendulum Test".
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Comments

These results are only valid for the condition in which the samples were tested. Factors such as preparation of individual samples, pedestrian or other trafficking, wear, contamination, dirtying, and/or maintenance procedures may alter the in-service friction characteristics.

Information on the pedestrian slip resistance testing and requirements is on pages 2-3.

Sample

Description	Concrete flagstone: Milano 450x450x30mm, manufactured 12/04/2021. WSP lab ref 4-21/860, received 7/7/2021.		
Sampling	Five specimens of the sample were prepared and provided by the client. . Nominal areal dimensions of each specimen were 445 mm x 445 mm. The samples did not have any directional patterns in texture and were tested in only one direction.		
Test date	30 July 2021	Location	Laboratory, WSP Research Petone
Slider	Slider 96	Air temperature	23 C

Test results:

	Specimen	1	2	3	4	5
	Mean BPN	44	41	45	45	45
	For the sample, the mean BPN value is 44 using Slider 96					
	AS 4586	The sample is classified as P3 using AS 4586: 2013.				
	NZBC	The sample meets the NZBC "access routes" requirement for mean BPN value of not less than 39 using Slider 96.				

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The following information is provided to direct users of this test report to some of the more relevant documents. It does not necessarily represent all slip resistance requirements potentially applicable and it is not intended to replace reading of the documents referred to.

Test method

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”. Handbook HB 198 “Guide to the specification testing of slip resistance of pedestrian surfaces” provides guidance on slip resistance of pedestrian surfaces including guidance and commentary on 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. The dry floor test method is set out in Appendix B of the Standard and utilises a floor friction tester. 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. The method utilises a pendulum friction tester and provides the procedure for determining the Slip Resistance Value (SRV) for a sample. The SRV is classified according to Table 2 of AS 4586: 2013, reproduced here. (Slider 96 and Slider 55 are described overleaf.)

AS 4586 Classification	Pendulum slip resistance value (SRV)	
	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	

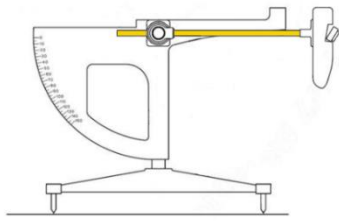
The British Pendulum Tester

The pendulum friction tester used in the testing reported here is known as a British Pendulum Tester or the Transport Road Research Laboratory (TRRL) portable skid-resistance tester.

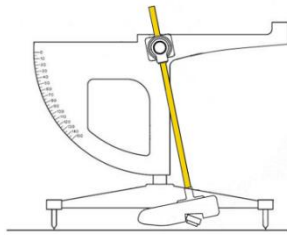
The pendulum friction tester has a rigid swinging arm, approximately 450 mm long, which contacts the test surface with a spring-loaded rubber slider (about 75 mm by 25 mm) mounted on a weighted foot. The pendulum arm swings the foot downwards through 90°, so the foot strikes the test surface when the pendulum arm is near vertical.

The pendulum arm length is set so the rubber slides along the test surface for a distance 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.

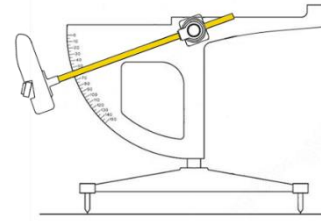
After sliding the rubber along the test surface, the pendulum arm then swings upwards alongside a scale to provide a direct reading of the British Pendulum Number (BPN). A higher BPN implies the surface has higher friction.



Pendulum arm horizontal ready to start swing



Rubber slider on pendulum arm about to contact ground



Height of pendulum arm swing against numerical scale

Rubber slider material

The wet pendulum test method brings a rubber slider in contact with the pedestrian surface under test. For AS 4586: 2013 wet pendulum test method, there are two possible rubber slider types that can be used; Slider 96 or Slider 55.

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.

For the wet pendulum test method, the rubber sliders are conditioned prior to testing of a sample. For the AS 4586: 2013 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 that the lapping film conditioning enables better differentiation between pedestrian surfaces, particularly smoother surfaces.

Potential slip resistance criteria

New Zealand Building Code Clause D1: Access Routes

An “access route” is defined in the New Zealand Building Code (NZBC) as “a continuous route that permits people and goods to move between the apron or construction edge of the building to spaces within a building, and between spaces within a building.” NZBC Clause D1 section 2.1.2 states level access routes expected to become wet with water in normal use shall have a slip resistance value (SRV) of not less than 39 when tested as described in Appendix A of AS 4586 using the Slider 96 rubber.

Ramps/sloping surfaces

The wet pendulum test results represent the slip resistance for the test surface in the horizontal plane.

NZBC Clause D1 section 2.1.5 states AS 4586: 2013 Appendix F shall be used to derive the appropriate slip classification for walking surfaces at various slopes. AS 4586: 2013 Appendix F relates slip resistance required in the horizontal plane to that required on a sloped plane using the relationship: Frictional requirement for a ramp $\approx$ frictional requirement in the horizontal plane + 0.0125S, where S is the slope (%) of the walking surface.

The original documents should be referred to for background and explanation of how this relationship is applied.

MASONRY COMPRESSIVE STRENGTH TEST REPORT



Premier Group New Zealand
PO Box 12172
Hamilton 3248

Attention: Jackson Powell

Project : -
Client : **Premier Group**
Product name* : **Milano**
Paver type* : **Concrete flagstone**
Colour* : **Natural stone**
Nominal work size* : **450 x 450 x 30mm**
Sampled by* : **Client**
Date manufactured* : **12/04/21**
Date received : **7/07/21**

Project No : 524G21.00
Lab Ref No : 4-21/861
Client Ref No : -

Test Results

		23/09/21									
		A	B	C	D	E	F	G	H	J	K
Date tested											
Specimen ID											
Height, as tested	(mm)	31.2	31.7	30.5	28.9	31.6	29.5	31.3	33.0	32.2	30.1
Width 1	(mm)	32.3	30.6	32.5	32.1	31.8	32.5	32.6	31.7	32.2	32.9
Width 2	(mm)	31.8	32.1	31.7	32.4	33.3	32.6	31.8	32.6	32.0	32.5
Maximum load	(kN)	37.0	34.6	42.8	41.0	41.6	45.5	37.9	40.1	40.5	42.6
Unconfined compr strength	(MPa)	25	25	29	28	27	30	26	27	28	28
Mean unconfined compr strength	(MPa)	27									
Standard deviation	(MPa)	1.6									

Test Methods	Notes
NZS 4456.4:2003 Method 4: Determining compressive strength of masonry units.	1. Unconfined compressive strength calculated using test specimen aspect ratio 1.0 and aspect ratio factor (K_a) of 0.7. 2. Specimens tested with load applied perpendicular to face marked "T". 3. Capping material was 12mm fibreboard. 4. Test specimens 30 x 30 x 30mm were cut from paver units by client.

Date reported : 23/09/21

D. Wong

Designation : *Concrete Technologist*

Date : 23/09/21

CSF 2093 (13/9/2006, modified 17/4/2009)

*** Sample information provided by the client.**

Results apply only to sample tested.

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**ABRASION RESISTANCE OF SEGMENTAL PAVERS
TEST REPORT**



Premier Group New Zealand
PO Box 12172
Hamilton 3248

Attention: Jackson Powell

Project*: -
Product name*: **Milano**
Paver type*: **Concrete flagstone**
Colour*: **Natural stone**
Nominal work size*: **450x450x30mm**
Manufacturer: -
Lot no.: -
Sampled by: **Client**
Productn. Date*: **12/04/21**
Date received: **7/07/21**

Job no. : 524G21.00
Lab Ref No : 4-21/863
Client Ref No : -

Test Results								
Specimen no.	1	2	3	4	5	6	7	8
Abrasion Index	4.5	4.9	4.9	4.8	5.0	5.3	5.1	5.0
Specimen no.	9	10	11	12	13	14	15	16
Abrasion Index	4.6	4.9	4.9	4.9	5.4	4.7	4.4	4.8
Mean Abrasion Index:	4.9							
Sample standard deviation:	0.3							
Date tested:	14/09/21							
Age at test:	155 days							
Test Method:	AS/NZS 4456.9: 2003							
Comments:	Specimens were tested in moisture condition 'as received'. Specimens 17 and 18 were used as controls. Test specimens approx. 230x120x30mm cut from paver units were supplied by client.							

Results apply only to sample tested.
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*Sample information provided by the client.

Name: J. Glen
Designation : *Laboratory Technician*
Date : 16/09/21

**BOW OF SEGMENTAL PAVERS AND FLAGS
TEST REPORT**



Premier Group New Zealand
PO Box 12172
Hamilton 3248

Attention: Jackson Powell

Project*: -
Location*: -
Client*: Premier Group
Product Name*: Milano
Paver type*: Concrete flagstone
Colour*: Natural Stone
Nominal work size*: 450 x 450 x 30mm
Sampled by*: Client
Date manufactured*: 12/04/2021
Date received: 7/07/2021

Project No : 5-24G21.00
Lab Ref No : 4-21/860
Client Ref No : -

Test Results										
Specimen ID:	1	2	3	4	5	6	7	8	9	10
Top wearing face, bow 1 (mm)*:	2.0	1.5	2.5	2.0	2.0	0.5	2.0	2.0	2.0	1.5
Top wearing face, bow 2 (mm)*:	1.5	2.5	1.5	2.0	1.0	1.0	1.5	2.0	1.5	1.5
Reverse face, bow 3 (mm)*:	-1.5	-1.5	-2.0	-1.5	-2.0	-1.5	-0.5	-2.0	-1.5	-1.5
Reverse face, bow 4 (mm)*:	-2.5	-1.5	-2.5	-2.5	-1.0	-1.5	-1.0	-1.5	-1.0	-1.0
Average (bow 1 & 2)*					1.50	mm				
Unbiased standard deviation					0.5	mm				
Average (bow 3 & 4)*					-1.5	mm				
Unbiased standard deviation					0.5	mm				
*A positive bow indicates hogging (convex surface); a negative bow indicates cupping (concave surface).										
Test Method										
AS/NZS 4456: 2003 Masonry units, segmental pavers and flags - Methods of test										
Method 19: Determination of bow										
Method 2: Assessment of mean and standard deviation										
Specimen dimensions were measured using the depth measuring device on digital callipers 5-126 readable to 0.01mm with an accuracy of ±0.01mm. An adjustable notched steel straight edge (Equipment No. 5-148) was fabricated and used for testing in accordance with AS/NZS 4456.19.										
Specimens were measured in moisture condition 'as received'.										
Bows 1 & 2 were measured on the upper wearing face; bows 3 & 4 on the reverse face.										
Notes										
Ten individual units 450 x 450 x 30mm were supplied by client for testing.										

Date tested : 07/10/21
Date reported : 11/10/21

* Sample information provided by the client.
Results apply only to sample tested.
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Designation : T. Wilson
Date : Graduate Engineer
11/10/21

DIMENSIONS OF SEGMENTAL PAVERS AND FLAGS
TEST REPORT



Premier Group New Zealand
PO Box 12172
Hamilton 3248

Attention: Jackson Powell

Project*: -
Location*: -
Client*: Premier Group
Product Name*: Milano
Paver type*: Concrete flagstone
Colour*: Natural Stone
Nominal work size*: 450 x 450 x 30mm
Sampled by*: Client
Date manufactured*: 12/04/2021
Date received: 7/07/2021

Project No : 5-24G21.00
Lab Ref No : 4-21/860
Client Ref No : -

Test Results			
Dimension:	<u>Width</u>	<u>Length</u>	<u>Height</u>
Nominal work size (mm):	450	450	30
Mean dimensions of the 20 specimens (mm):	449	449	31
Unbiased standard deviation (mm):	1	1	1
Test Method			
AS/NZS 4456: 2003 Masonry units, segmental pavers and flags - Methods of test Method 3: Determining dimensions, Method B - determination of measurements of individual units Method 2: Assessment of mean and standard deviation Specimen dimensions were measured using digital callipers (Serial No. 0028018) readable to 0.01mm with an accuracy of $\pm 0.05\text{mm}$.			
Notes			
AS/NZS 4456.3: 2003 Method B was selected so that the results can be compared with DPB requirements specified in NZS 3116:2002 table 1A and AS/NZS 4455.2:2010 table 2.2(B). Twenty individual units 450 x 450 x 30mm were supplied by client for testing.			

Date tested : 27/09/21
Date reported : 11/10/21

T. Wilson

Designation : Graduate Engineer
Date : 11/10/21

* Sample information provided by the client.
Results apply only to sample tested.
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