

SOTTER ENGINEERING CORPORATION
Floor Slip Resistance Consultants

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Email: info@SafetyDirectAmerica.com
www.SafetyDirectAmerica.com

Licensed by the State of California
Board of Professional Engineers
And Land Surveyors

Certified by the City of Los Angeles
as an official slip resistance testing
laboratory for flooring

CERTIFIED

ASTM E303-22 Pendulum Slip Resistance Test Method

Client: **Archatrak Inc.**

Report date: 4/8/24

Flooring: **Cenere – 2cm Porcelain Paver**

Page 1 of 4

Test no.: 2404-0824

Date tested: 4/8/24

How and when sample obtained: Supplied by client 4/4/24

Sample size: 12"x12"

Location of test: Sotter Engineering Test Laboratory in Mission Viejo, CA

Figure 1 shows the sample. Red, green, blue, and white color references are included, with a U.S. penny (1/16 inch thick) for scale. The back of the sample is included to aid in positive identification.

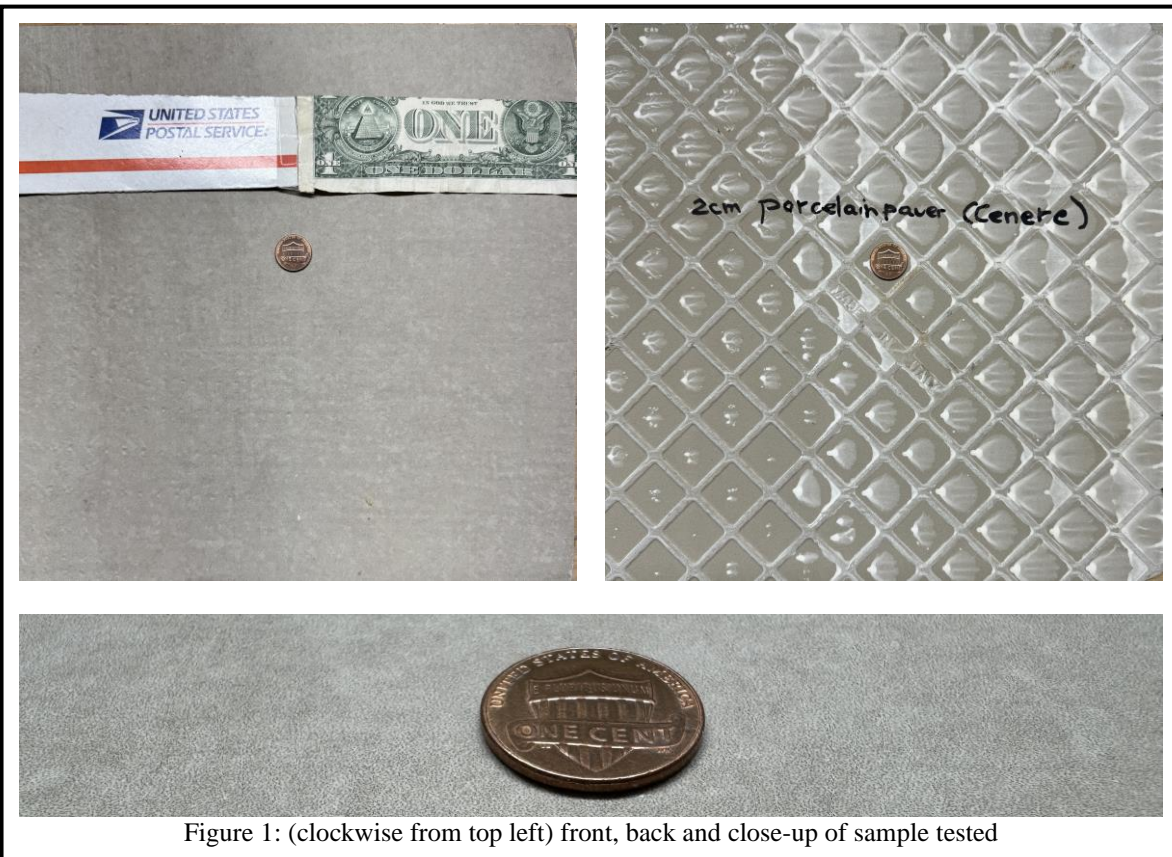


Figure 1: (clockwise from top left) front, back and close-up of sample tested

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Flooring: **Cenere – 2cm Porcelain Paver**

American Society for Testing and Materials Method E303-22 (2022), “Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester”

(<https://www.astm.org/e0303-22.html>)

The pendulum is the national standard test device for pedestrian slip resistance in at least 50 nations on five continents and has been endorsed by Ceramic Tile Institute of America since 2001. It has been in continuous use since 1970 for assessing slip resistance of pedestrian surfaces and is the most widely accepted slip resistance test device worldwide.

The trailing edge of a three-inch-wide spring-loaded rubber slider, which is attached to the end of a 20-inch pendulum arm, contacts the tested surface when the pendulum arm is released from a horizontal position. The slider contact path length is pre-set to five inches (or 124-127 mm). The pendulum arm pushes a pointer that stops and stays at the high point of the pendulum arm’s swing.

For testing flooring where pedestrians are likely to be wearing shoes, the typical rubber used is Four S rubber (Standard Shoe Sole Simulating), which has an International Rubber Hardness Degree (IRHD) of 96. For predominantly barefoot areas, and for road testing, the slider used is usually the TRL (Transport & Road Laboratory) soft rubber, which has an IRHD of 55. TRL rubber readings can be affected by temperature outside the range of 64-73 degrees Fahrenheit. Results for the TRL rubber below will have been adjusted for temperature using the adjustments table provided in the Australian pendulum standard – AS/NZS 4586. The ASTM standard does not yet acknowledge the fact that this rubber is temperature sensitive. The next revision of E303 will. Vice President John C. Sotter conducted the testing and drafted this report.

Pendulum Test Value (PTV), as received, with Four S (96) hard rubber slider:

Dry: 70 Wet: 65

Corresponding DCOF value = Wet: 0.74; Individual wet PTV values: 65, 66, 65, 65, 65

T= 67 degrees F; Relative humidity = 56%; Pendulum recalibration due September 28, 2024

Results apply only to sample(s) tested.

High Pendulum Test Values indicate potentially good traction. The ASTM E303 test method does not give recommendations on how to interpret the results, as ASTM test methods never do, but similar pendulum test methods from other nations do give safety criteria and guidance.

Australia’s AS HB 198: 2014 recommends a range of situation-specific minimum Pendulum Test Values as shown in the attached table below. The Ceramic Tile Institute of America (CTIOA) and United Kingdom Slip Resistance Group (UKSRG), with help from the United Kingdom’s Health and Safety Executive (HSE), make a more general recommendation and say that a **minimum pendulum test value of 36 for level floors is considered “low slip potential”**. According to CTIOA and UKSRG, values of 25-35 are classed as “moderate slip potential”, and values of 0-24 have “high slip potential”.

For flooring that has a slope, a mathematical calculation is made to adjust the safety criterion based on the degree of slope. For instance, a floor with a slope of 2° would need a minimum PTV of 39 to fall into the “low slip potential” category, a 4° slope would need a PTV of 42, and a 6° slope would need a PTV of 45.

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Slip resistance can be affected by factors such as floor coatings, abrasives, detergents, contamination, chemical treatments, and wear.

Respectfully submitted,
SOTTER ENGINEERING CORPORATION



J. George Sotter, P.E., Ph.D.
President



		Location or function of area	Minimum wet PTV (or BPN)	
Building or walkway type	Line no.		Hard rubber slider	Soft rubber slider
External pavements and ramps	1	External ramps with slopes steeper than 1 in 14 (4.1 degrees)	55	45
	2	External ramps, slopes less than 1 in 14	45	40
	3	Level surfaces: external sales areas (e.g. markets), external car parks, external colonnades, walkways, pedestrian crossings, balconies, verandas, carports, driveways, courtyards, roof decks	45	40
	4	Car parks, undercover	35	35
Hospitals and aged care facilities	5	Bathrooms and ensuites in hospitals and aged care facilities	35	35
	6	Wards and corridors in hospital and aged care facilities	25	20
Hotels, offices, public buildings, schools, kindergartens; entries and access areas including common areas, internal elevator lobbies	7	Dry area	12	NS
	8	Hotel bathrooms, ensuites and toilets	25	20
	9	Hotel kitchens and laundries	25	20
	10	Restroom facilities in offices, bars and shopping centers	35	35
	11	Transitional areas, intended to be kept dry	25	20
	12	Wet area	35	35
Kitchens (commercial), serving areas, cold stores	13	Commercial kitchens	55	45
	14	Serving areas behind bars in bars and clubs	45	40
	15	Cold stores and freezers	45	40
Loading docks	16	Loading docks under cover	55	45
Sports stadiums	17	Undercover concourse areas	35	35
Supermarkets and shopping centers	18	Dry areas in separate shops in shopping centers	12	NS
	19	Fast food outlets, buffet food servery areas, food courts and fast food dining areas in shopping centers	35	35
	20	Fresh fruit and vegetable areas in shops and supermarkets	35	35
	21	Shop entry areas with external entrances	35	35
	22	Supermarket aisles (except fresh food areas)	12	NS
	23	Wet areas in separate shops in shopping centers	35	35
Swimming pools and sporting facilities	24	Communal changing rooms	35	35
	25	Communal shower rooms	45	40
	26	Swimming pool decks	45	40
	27	Swimming pool ramps and stairs leading to water	55	45
Stairs	28	Dry treads or landings	35	35
	29	Wet treads or landings	45	40
NS - not specified				

Table 1. Recommended minimum PTV from the June 2014 Australian standard. The minimum values in this table are both more permissive (values below 36) and more conservative (values above 36) than the CTIOA and UKSRG standards discussed on the previous page. We consider the standard summarized on this page to be the world's most sophisticated. However, the choice between the two is left to the reader. One area not specifically mentioned above is tubs and showers in hotels and homes. For these high-risk areas, we recommend a surface with "low slip potential", or a minimum PTV of 36.

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ASTM E303-22 Pendulum Slip Resistance Test Method

Client: **Archatrak Inc.**

Report date: 4/8/24

Flooring: **Laguna – 2cm Porcelain Paver**

Page 1 of 4

Test no.: 2404-0822

Date tested: 4/8/24

How and when sample obtained: Supplied by client 4/4/24

Sample size: 12”x12”

Location of test: Sotter Engineering Test Laboratory in Mission Viejo, CA

Figure 1 shows the sample. Red, green, blue, and white color references are included, with a U.S. penny (1/16 inch thick) for scale. The back of the sample is included to aid in positive identification.

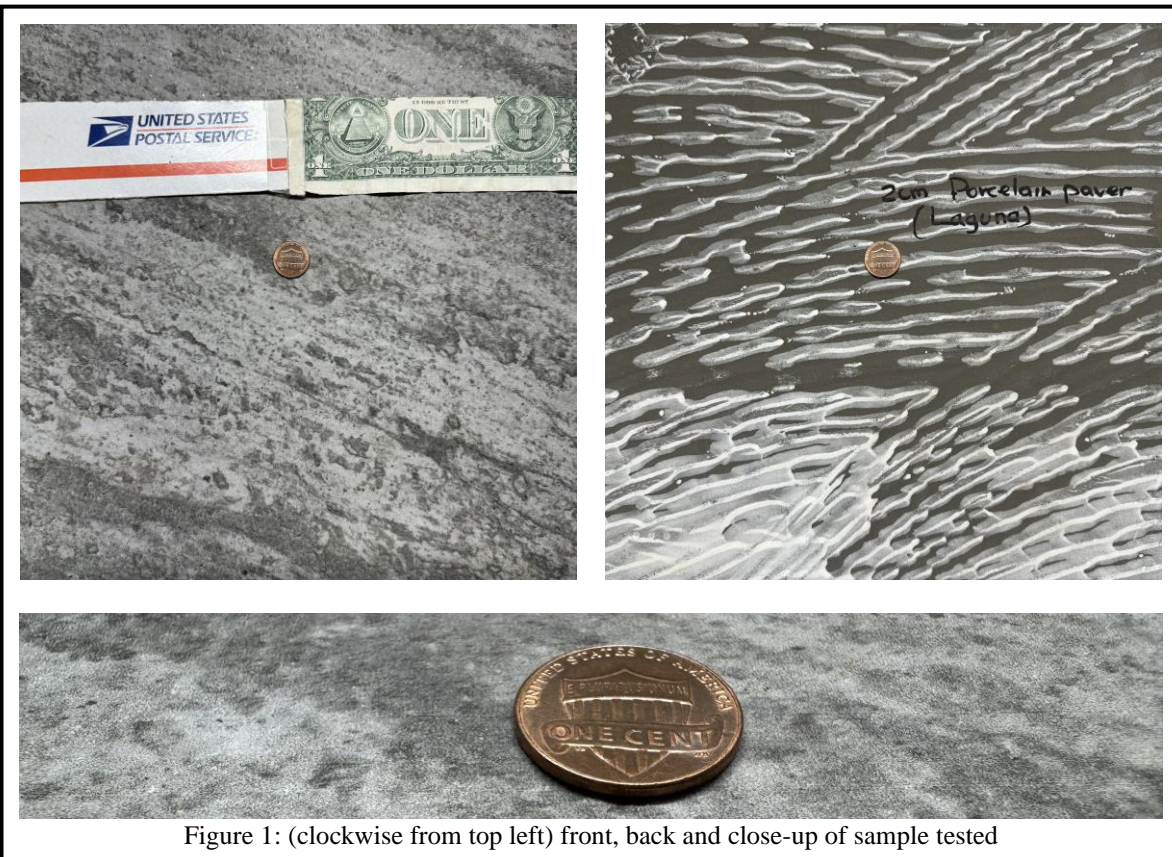


Figure 1: (clockwise from top left) front, back and close-up of sample tested

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Flooring: **Laguna – 2cm Porcelain Paver**

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The trailing edge of a three-inch-wide spring-loaded rubber slider, which is attached to the end of a 20-inch pendulum arm, contacts the tested surface when the pendulum arm is released from a horizontal position. The slider contact path length is pre-set to five inches (or 124-127 mm). The pendulum arm pushes a pointer that stops and stays at the high point of the pendulum arm’s swing.

For testing flooring where pedestrians are likely to be wearing shoes, the typical rubber used is Four S rubber (Standard Shoe Sole Simulating), which has an International Rubber Hardness Degree (IRHD) of 96. For predominantly barefoot areas, and for road testing, the slider used is usually the TRL (Transport & Road Laboratory) soft rubber, which has an IRHD of 55. TRL rubber readings can be affected by temperature outside the range of 64-73 degrees Fahrenheit. Results for the TRL rubber below will have been adjusted for temperature using the adjustments table provided in the Australian pendulum standard – AS/NZS 4586. The ASTM standard does not yet acknowledge the fact that this rubber is temperature sensitive. The next revision of E303 will. Vice President John C. Sotter conducted the testing and drafted this report.

Pendulum Test Value (PTV), as received, with Four S (96) hard rubber slider:

Dry: 62 Wet: 55

Corresponding DCOF value = Wet: 0.60; Individual wet PTV values: 56, 55, 55, 55, 54

T= 67 degrees F; Relative humidity = 56%; Pendulum recalibration due September 28, 2024

Results apply only to sample(s) tested.

High Pendulum Test Values indicate potentially good traction. The ASTM E303 test method does not give recommendations on how to interpret the results, as ASTM test methods never do, but similar pendulum test methods from other nations do give safety criteria and guidance.

Australia’s AS HB 198: 2014 recommends a range of situation-specific minimum Pendulum Test Values as shown in the attached table below. The Ceramic Tile Institute of America (CTIOA) and United Kingdom Slip Resistance Group (UKSRG), with help from the United Kingdom’s Health and Safety Executive (HSE), make a more general recommendation and say that a **minimum pendulum test value of 36 for level floors is considered “low slip potential”**. According to CTIOA and UKSRG, values of 25-35 are classed as “moderate slip potential”, and values of 0-24 have “high slip potential”.

For flooring that has a slope, a mathematical calculation is made to adjust the safety criterion based on the degree of slope. For instance, a floor with a slope of 2° would need a minimum PTV of 39 to fall into the “low slip potential” category, a 4° slope would need a PTV of 42, and a 6° slope would need a PTV of 45.

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President



		Location or function of area	Minimum wet PTV (or BPN)	
Building or walkway type	Line no.		Hard rubber slider	Soft rubber slider
External pavements and ramps	1	External ramps with slopes steeper than 1 in 14 (4.1 degrees)	55	45
	2	External ramps, slopes less than 1 in 14	45	40
	3	Level surfaces: external sales areas (e.g. markets), external car parks, external colonnades, walkways, pedestrian crossings, balconies, verandas, carports, driveways, courtyards, roof decks	45	40
	4	Car parks, undercover	35	35
Hospitals and aged care facilities	5	Bathrooms and ensuites in hospitals and aged care facilities	35	35
	6	Wards and corridors in hospital and aged care facilities	25	20
Hotels, offices, public buildings, schools, kindergartens; entries and access areas including common areas, internal elevator lobbies	7	Dry area	12	NS
	8	Hotel bathrooms, ensuites and toilets	25	20
	9	Hotel kitchens and laundries	25	20
	10	Restroom facilities in offices, bars and shopping centers	35	35
	11	Transitional areas, intended to be kept dry	25	20
	12	Wet area	35	35
Kitchens (commercial), serving areas, cold stores	13	Commercial kitchens	55	45
	14	Serving areas behind bars in bars and clubs	45	40
	15	Cold stores and freezers	45	40
Loading docks	16	Loading docks under cover	55	45
Sports stadiums	17	Undercover concourse areas	35	35
Supermarkets and shopping centers	18	Dry areas in separate shops in shopping centers	12	NS
	19	Fast food outlets, buffet food servery areas, food courts and fast food dining areas in shopping centers	35	35
	20	Fresh fruit and vegetable areas in shops and supermarkets	35	35
	21	Shop entry areas with external entrances	35	35
	22	Supermarket aisles (except fresh food areas)	12	NS
	23	Wet areas in separate shops in shopping centers	35	35
Swimming pools and sporting facilities	24	Communal changing rooms	35	35
	25	Communal shower rooms	45	40
	26	Swimming pool decks	45	40
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Stairs	28	Dry treads or landings	35	35
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NS - not specified				

Table 1. Recommended minimum PTV from the June 2014 Australian standard. The minimum values in this table are both more permissive (values below 36) and more conservative (values above 36) than the CTIOA and UKSRG standards discussed on the previous page. We consider the standard summarized on this page to be the world's most sophisticated. However, the choice between the two is left to the reader. One area not specifically mentioned above is tubs and showers in hotels and homes. For these high-risk areas, we recommend a surface with "low slip potential", or a minimum PTV of 36.

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ASTM E303-22 Pendulum Slip Resistance Test Method

Client: **Archatrak Inc.**

Report date: 4/8/24

Flooring: **Tectona – 2cm Porcelain Paver**

Page 1 of 4

Test no.: 2404-0823

Date tested: 4/8/24

How and when sample obtained: Supplied by client 4/4/24

Sample size: 12"x12"

Location of test: Sotter Engineering Test Laboratory in Mission Viejo, CA

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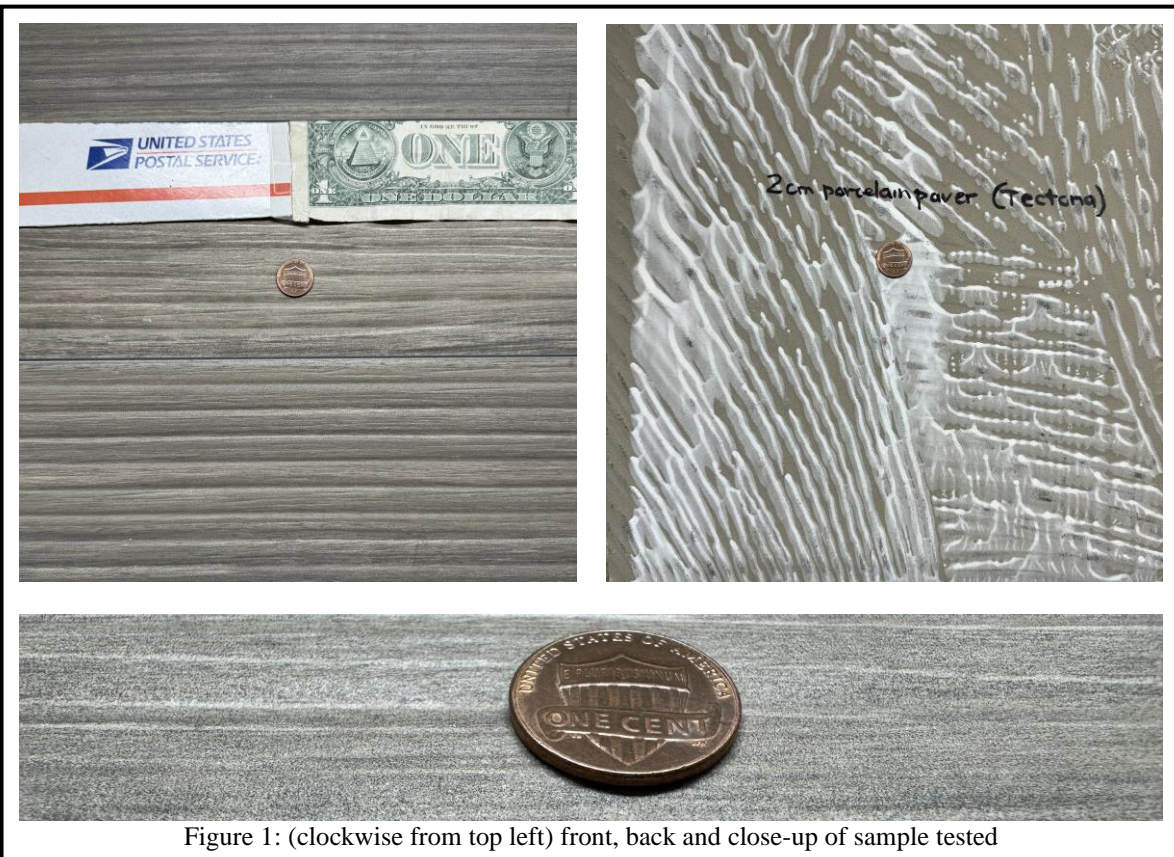


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Flooring: **Tectona – 2cm Porcelain Paver**

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Pendulum Test Value (PTV), as received, with Four S (96) hard rubber slider:

Dry: 60 Wet: 46

Corresponding DCOF value = Wet: 0.49; Individual wet PTV values: 46, 46, 46, 45, 45

T= 67 degrees F; Relative humidity = 56%; Pendulum recalibration due September 28, 2024

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