stone initiatives

SAI Sandstone
5 Hamilton Street
Oakleigh VIC 3166

Attention: Bob Lu

28 September 2022

Evaluation of Grey Apricot Marble

Client Reference: Req. B. Lu

Our Reference: SAS0922-1

Investigating Officer(s): Kate Tonkin & Emily Tonkin

Report Prepared By: Kate Tonkin & Emily Tonkin

James P Mann
Laboratory Manager

	Draft	Reviewed	Released
Name	ET & KT	TB	KT
Date	27/9/22	28/9/22	28/9/22

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1. INTRODUCTION

A request was received from the client to carry out testing of a marble sample for use as wall cladding and flooring. The sample received was described as follows:

- Grey Apricot Marble – Sandblasted (our reference: M1285)

Plate 1: Appearance of Grey Marble with a sandblasted finish as received.

2. TEST PROGRAM

The following tests were carried out:

- Water Absorption and Bulk Density
- Modulus of Rupture
- Abrasion Resistance
- Impact Resistance
- Slip Resistance
- Stain Resistance

Water absorption and bulk specific gravity were determined in accordance with ASTM C97M-18 "Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone". The specimens had been dried at 60 ± 2°C for 48 hours followed by soaking at 22 ± 2°C for a further 48 hours. Specimen size was modified to 100 x 63 x 20 mm due to sample dimensions supplied.

Modulus of rupture was carried out in accordance with ASTM C99M-18 "Standard Test Method for Modulus of Rupture of Dimension Stone". The dry specimens had been dried at 60±2˚C for 48 hours prior to testing. The soaked specimens had been immersed in water for 48 hours at 22±2˚C.

Index of Abrasion Resistance was determined in accordance with ASTM C1353M-20 "Standard Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser". Three representative specimens were subjected to 1000 cycles using H-22 wheels with a 1kg load.

Impact resistance was determined in accordance with a modified AS4459.5 "Determination of impact resistance by measurement of coefficient of restitution". Six representative specimens were subjected to impact of a 19mm stainless ball from a height of one metre. Rebound height was measured to determine the coefficient of restitution (resistance to impact damage). The test is modified to test natural stone.

Slip resistance was determined in accordance with Appendix A of AS 4586:2013 "Slip resistance classification of new pedestrian surface materials". Testing was carried out at five sites on each sample in a wet condition using a British Pendulum fitted with a Slider 96 (4S) rubber slider.

Stain Resistance was determined in accordance with internal Stone Initiatives test method SI-STN: 2017. A series of typical staining agents are applied to the surface of sealed and unsealed surfaces and allowed to dwell for a period of 1 hour and 24 hours before attempts are made to remove the stain. The surface is then air dried and evaluated with regards to visibility of the staining agent and damage to the surface.

3. RESULTS

Results are summarised in the table below and compared with the ASTM specification for marble C503M-15. Full test data are detailed in Appendix A of this report.

Property	Grey Apricot Mean (range)	ASTM C503M-15 Specification for Marble
Bulk Specific Gravity • ($kg.m^{-3}$)	2715 (2711 - 2718)	2600 min
Water Absorption • (% by weight)	0.10 (0.06 - 0.12)	0.20 max
Modulus of Rupture • Dried (MPa) • Soaked (MPa)	17.8 (14.9 - 20.4) 14.0 (11.5 - 16.8)	6.9 min 6.9 min
Abrasion Resistance • Abrasion Index (Ha)	15 (13 - 17)	10 min
Impact Resistance • Coefficient of Restitution • Cahier Level (damage)	0.71 1 – Circular trace	- -
Slip Resistance - Sandblasted finish • Slip Resistance Value (SRV) • Classification	52 (51 - 52) P4	- -
Stain Resistance • **Stain Index (lowest Value)** o Unsealed o Stonetech Bullet Proof o Protect Guard o Tuscan Seal (Environex)	4.1 (*2.0 - Olive Oil*) 4.8 (*4.0 - Red Wine*) 4.1 (*3.0 - Red Wine & Coca Cola*) 5.0 (*5.0 - All agents*)	- - - -

4. DISCUSSION

4.1. Water absorption and bulk specific gravity

The bulk density of Grey Apricot meets the requirements for calcite marble as recommended by the ASTM C503M-15 specification for marble. At 0.10%, the water absorption capacity is below the maximum absorption by weight percentage for marble, meeting the requirement.

4.2. Modulus of rupture

The modulus of rupture results exceeds the minimum ASTM requirements for marble in both a dry condition and soaked condition. All individual soaked and dry specimens meet this requirement.

4.3. Abrasion resistance

The abrasion resistance exceeds the minimum ASTM requirements for marble. An abrasion index of 15.2 is considered a moderately high resistance, suitable for most uses including high traffic prestige commercial flooring.

4.4. Impact resistance

The impact test results indicate the stone has a moderately high coefficient of restitution. The six impact tests produced no results below the recommended minimum value of 0.55. All six impacts caused the development of small indentations suggesting the stone may have a sensitivity to stun marks (e.g. by dropping of hard implements).

Plate 2: Appearance of stun mark on the surface of Grey Apricot caused by impact testing. Indent is approx. 3mm radius. (specimen M1285/22)

4.5. Slip resistance

The Grey Apricot with a sandblasted finish achieved an SRV of 52 attaining a P4 classification (SRV 45 - 54). According to Table 3B of the Standards Australia handbook HB198-2014[1] a surface finish that achieves a P4 slip resistance classification is suitable for locations[2] that include:

- External ramps including sloping driveways, footpaths etc., under 1 in 14, external sales areas (eg markets), external carpark areas, external colonnades, walkways, pedestrian crossings, balconies, verandas, carports, driveways, courtyards, and roof decks.
- Serving areas behind bars in public hotels and clubs, cold stores and freezers.
- Swimming pool surrounds and communal shower rooms

[1] Guide to the specification and testing of slip resistance of pedestrian surfaces
[2] 5.2 of HB198 states: "The use of these values should be in the context of design, which also considers abnormal wear, maintenance, abnormal contamination, the presence (or otherwise) of water or other lubricants, the nature of the pedestrian traffic (including age, gait and crowding), the footwear (or lack thereof), slope lighting and handrails."

4.6. Stain resistance

The stain resistance of the finish was determined in the unsealed condition and following the application of the following impregnating sealers:

- Stonetech Bullet Proof (two coats applied by Stone Initiatives)
- Guard Industries - Protect Guard (two coats applied by Stone Initiatives)
- Environex - Tuscan Seal (two coats applied by Stone Initiatives)

The sealers were allowed to cure for a minimum of seventy-two hours. Following the curing period, the surface of the samples were subjected to twenty scrubbing cycles with a red nylon floor pad to simulate the initial cleaning process and removal of any excess sealer on the surface. The samples were allowed to air-dry before application of the following staining agents to the surface finish:

- Red Wine (acidic)
- Olive Oil (stain leaving a film)
- Black Coffee (stain leaving a trace & slightly acidic)
- Coca Cola (stain leaving a trace & slightly acidic)
- Soy Sauce (stain leaving a trace & slightly acidic)

Staining agents were allowed to dwell[3] on the surface for a period of one hour and twenty-four hours before attempts were made to remove the stain.

Cleaning was attempted firstly by rinsing the surface with running hot water for a period of five minutes followed by wiping with a damp cloth. Any stains still visible were then cleaned vigorously with a red nylon pad and neutral detergent and rinsed under hot water. The surface was air-dried and evaluated with regards to the visibility of the staining agent and any damage to the surface.

4.6.1 Results

Results of the stain resistance tests on the sandblasted finish are presented below.

	Unsealed		Stonetech Bulletproof		Protect Guard		Tuscan Seal (Environex)	
	1 hour	24 hour	1 hour	24 hour	1 hour	24 hour	1 hour	24 hour
Red Wine	5.0	5.0	4.0	4.0	3.0	3.0	5.0	5.0
Olive Oil	2.0	2.0	5.0	5.0	4.0	4.0	5.0	5.0
Black Coffee	4.5	4.0	5.0	4.5	5.0	4.0	5.0	5.0
Coca Cola	5.0	3.5	5.0	5.0	5.0	3.0	5.0	5.0
Soy Sauce	5.0	4.5	5.0	5.0	5.0	4.5	5.0	5.0
Score Averages:	4.3	3.8	4.8	4.7	4.4	3.7	5.0	5.0
Lowest Score	***2.0***		***4.0***		***3.0***		***5.0***	
Stain Index	**4.1**		**4.8**		**4.1**		**5.0**	
Visibility of Etching	None Visible		None Visible		None Visible		None Visible	

Legend:

5 - Stain removed after cleaning procedure (scrub with red nylon pad, detergent and hot water)
4 - Stain slightly visible
3 - Stain moderately visible
2 - Stain highly visible
1 - Permanent damage to surface finish of sample

[3] At nominal conditions of 50% R.H. & 20˚C.

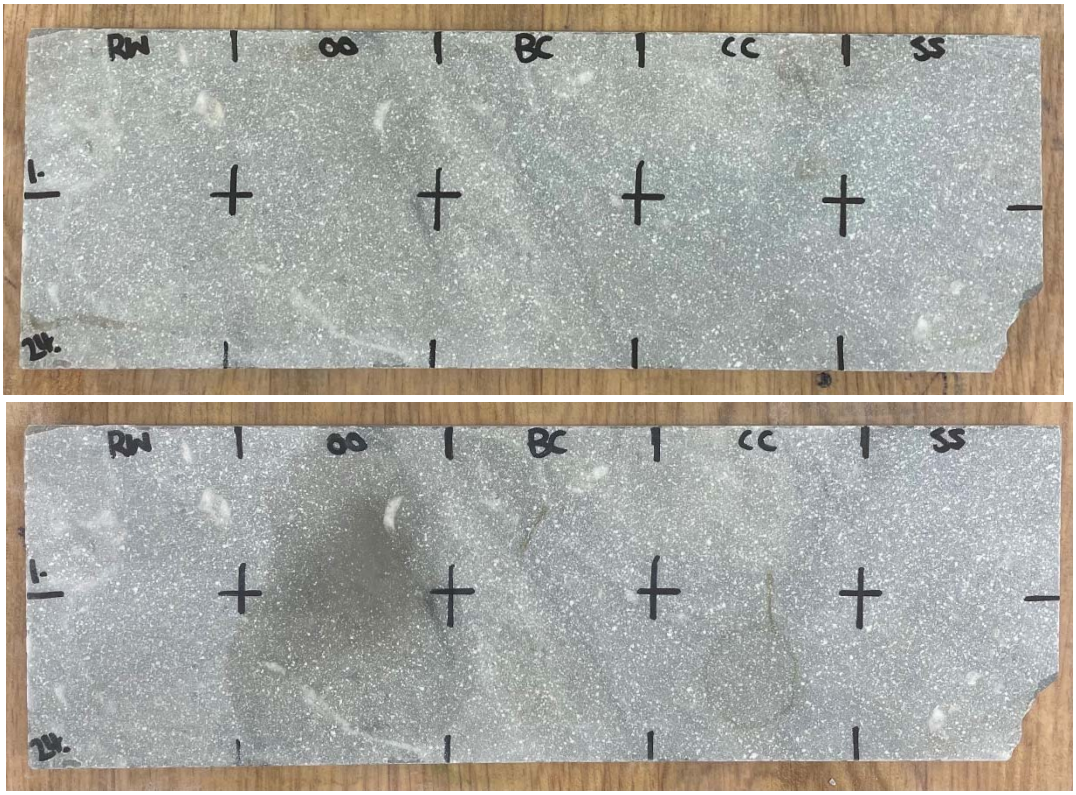

Plate 3: Appearance of samples of Grey Apricot Unsealed before staining (top) and after cleaning of staining agents (bottom).

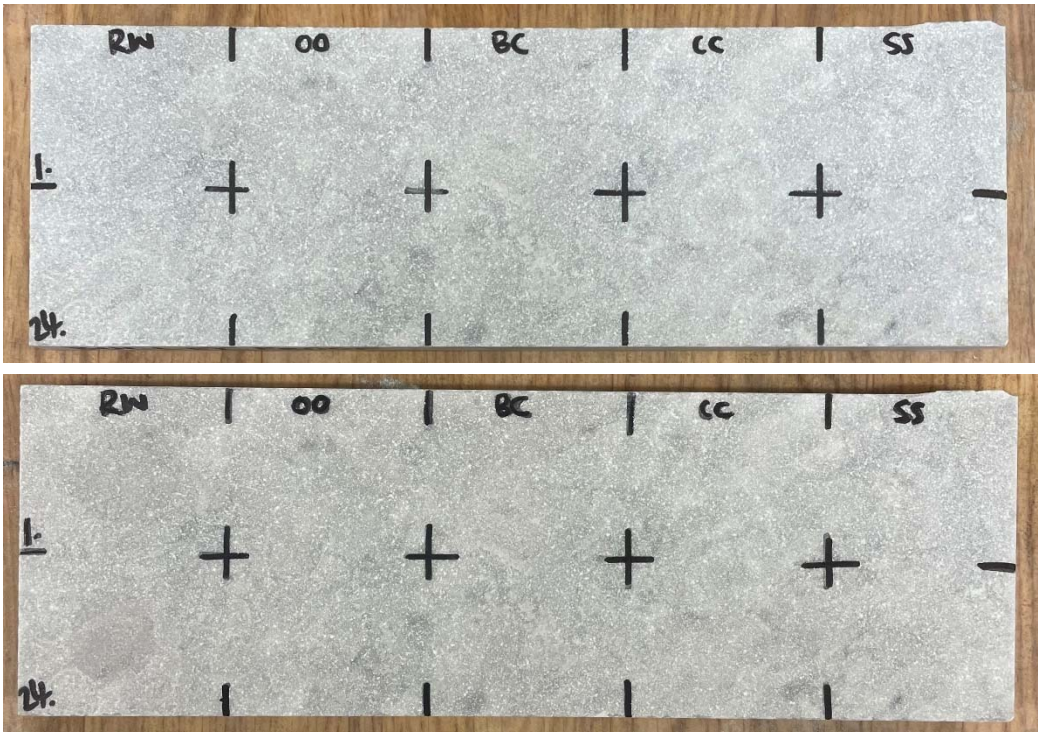

Plate 4: Appearance of samples of Grey Apricot sealed with Stonetech Bullet Proof sealer before staining (top) and after cleaning of staining agents (bottom).

Staining Agent Applied (1 hour top half / 24 hour lower half)				
Red Wine (RW)	Olive Oil (OO)	Black Coffee (BC)	Coca Cola (CC)	Soy Sauce (SS)

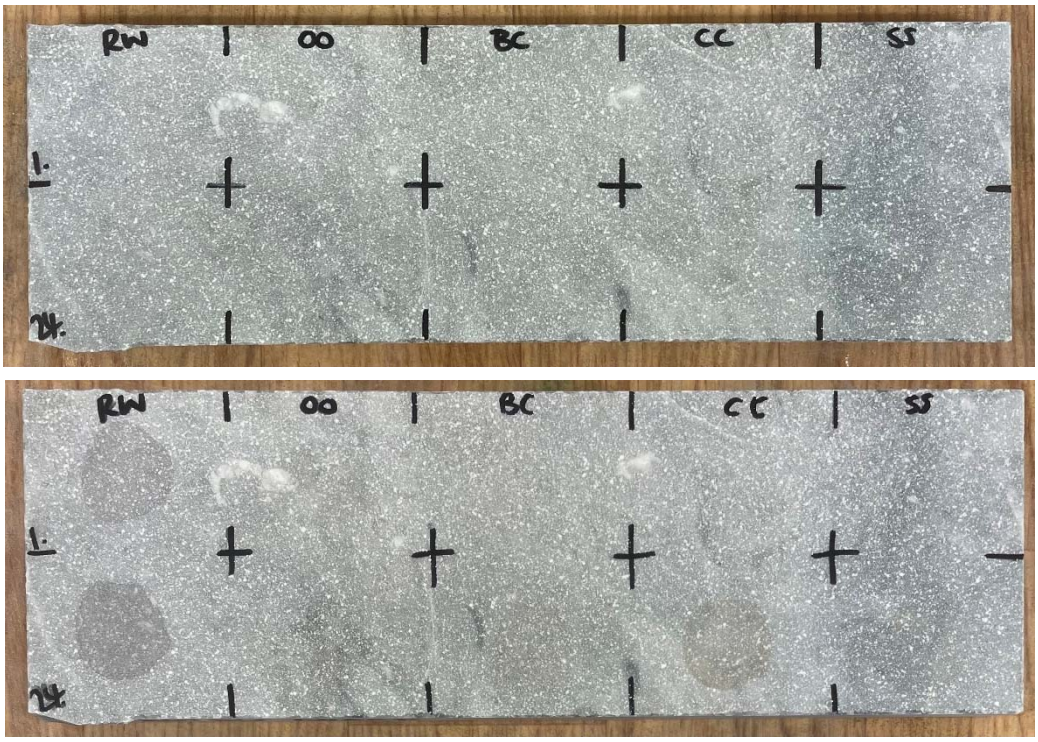

Plate 5: Appearance of samples of Grey Apricot sealed with Protect Guard sealer before staining (top) and after cleaning of staining agents (bottom).

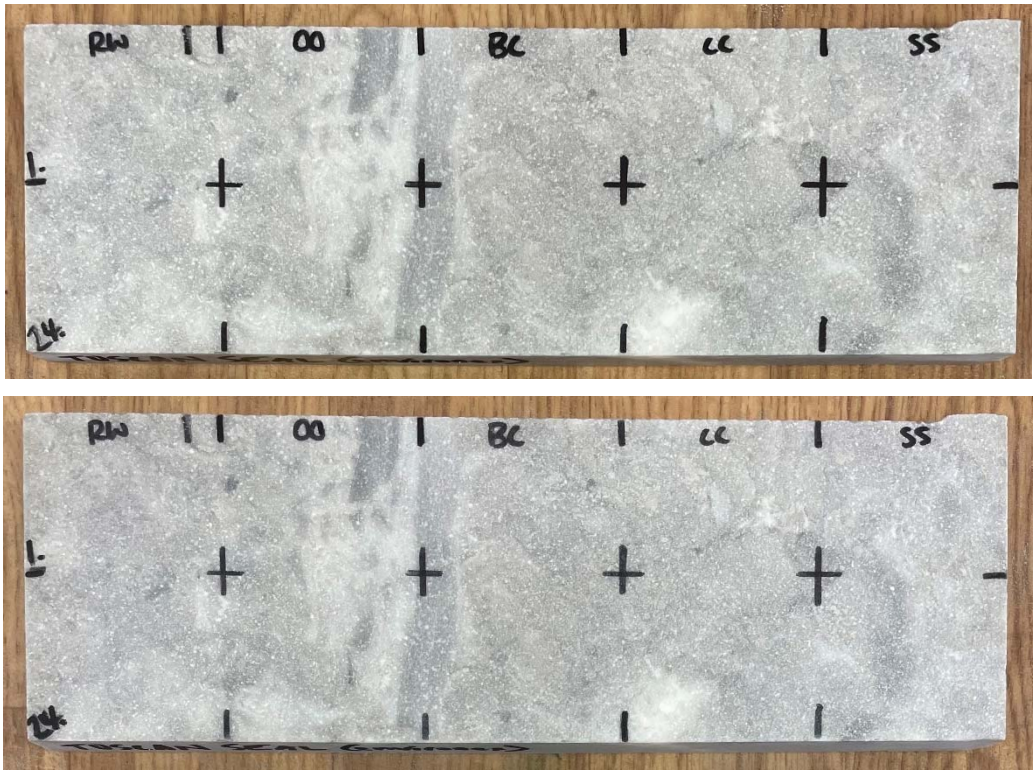

Plate 6: Appearance of samples of Grey Apricot sealed with Tuscan Seal (Environex) sealer before staining (top) and after cleaning of staining agents (bottom).

Staining Agent Applied (1 hour top half / 24 hour lower half)				
Red Wine (RW)	Olive Oil (OO)	Black Coffee (BC)	Coca Cola (CC)	Soy Sauce (SS)

4.6.2 Discussion

The unsealed Grey Apricot shows highly visible staining caused by olive oil after both a long and short dwell. While black coffee, Coca Cola and soy sauce produce a slight stain after a twenty-four hour dwell time.

The application of a penetrating sealer improves the stone's stain resistance. Protect Guard improves the stone resistance to oil, however this sealed sample continues to be stained by coffee, soy sauce and Coca Cola particularly after a long dwell, while red wine moderately stains the Protect Guard sealed surface.

Stonetech Bullet Proof appears to completely protect the stone from oil, Coca Cola and soy sauce stains with no visible trace of these staining agents after cleaning. Black coffee is also protected against when cleaned promptly with very slight staining visible if left to dwell. Red wine shows a slight trace after both a long and short dwell on the Bullet Proof sealed sample.

Tuscan Seal (Environex) sealer proved to be the best performing sealer with no visible staining from any of the staining agents.

To maintain the achieved stain resistance, spills should be attended to promptly and performance of the sealer will need to be monitored regularly (and reapplied as necessary) to maintain its effectiveness.

Appendix A
Test Certificates

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ASTM INTERNATIONAL MEMBER

WATER ABSORPTION, BULK SPECIFIC GRAVITY

Test Certificate

TEST METHOD	ASTM C97M-18
TEST DATE	14-09-22
CLIENT	SAI Sandstone
OUR REFERENCE	SAS0922-1
SAMPLE	Grey Apricot
SURFACE FINISH	Sandblasted
SAMPLE ORIGIN	Not Known :
SAMPLING DATE	07-09-22
SHAPE and NOMINAL SIZE	: 100mm x 63mm x 20mm

Conditioning: Dried min 48 hrs @ 60deg C / Soaked for 48 hours @ 22 deg C

Test Number	Specimen Identification	Dried Mass (g)	Soaked mass (g)	Suspended mass (g)	Bulk SG (kg.m-3)	% Absorption by Volume	% Absorption by Weight
W12606	M1285/1	327.12	327.33	206.90	2,716	0.17	0.06
W12607	M1285/2	318.43	318.79	201.42	2,713	0.31	0.11
W12608	M1285/3	348.63	349.05	220.80	2,718	0.33	0.12
W12609	M1285/4	314.42	314.65	198.69	2,711	0.20	0.07
W12610	M1285/5	339.35	339.71	214.78	2,716	0.29	0.11

MEAN BULK SPECIFIC GRAVITY ($kg.m^{-3}$) **2,715 ± 2** (u_{95})

STANDARD DEVIATION *3*

MEAN ABSORPTION BY Volume (%) **0.26% ± 0.10** (u_{95})

STANDARD DEVIATION *0.07%*

MEAN ABSORPTION BY Weight (%) **0.10% ± 0.04** (u_{95})

STANDARD DEVIATION *0.03%*

COMMENTS/VARIATIONS Modified specimen size

NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.

TESTED BY: Kate Tonkin

APPROVED SIGNATORY:

NAME: James P Mann

ISSUE DATE: 21-Sep-22

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ASTM INTERNATIONAL MEMBER

MODULUS OF RUPTURE
Test Certificate

TEST METHOD ASTM C99M-18
TEST DATE 14-09-22
CLIENT SAI Sandstone
OUR REFERENCE SAS0922-1
SAMPLE Grey Apricot **SAMPLE TYPE** Marble
SAMPLE ORIGIN
SAMPLING DATE 07-09-22
SHAPE and NOMINAL SIZE Prism: 200mm x 100mm x 20mm
LOAD ORIENTATION TO FINISH Unknown **FINISH IN TENSION** Sandblasted
TEST EQUIPMENT Electronic Universal Force Testing Machine, AssettID: S1114

Conditioning: Dried for minimum 48 hours @ 60 deg C

Test Number	Specimen Identification	Span (mm)	Test Condition	Load Orientation	Width	Thickness (mm)	Max. Load (Newtons)	Dried Strength (MPa)
M15816	M1285/6	180	Dried	Unknown	98.7	19.7	2671	18.8
M15817	M1285/7	180	Dried	Unknown	100.1	19.9	3001	20.4
M15818	M1285/8	180	Dried	Unknown	97.7	21.2	2855	17.5
M15819	M1285/9	180	Dried	Unknown	98.6	20.1	2567	17.5
M15820	M1285/10	180	Dried	Unknown	97.2	20.5	2252	14.9

MEAN DRIED MODULUS of RUPTURE (MPa): **17.8** ± 0.3 (u_{95})
Standard Deviation: **2.0**

Conditioning: Soaked for 48 hours @ 22 deg C

Test Number	Specimen Identification	Span (mm)	Test Condition	Load Orientation	Width	Thickness (mm)	Max. Load (Newtons)	Soaked Strength (MPa)
M15821	M1285/11	180	Soaked	Unknown	98.0	19.8	2032	14.3
M15822	M1285/12	180	Soaked	Unknown	95.0	19.8	2310	16.8
M15823	M1285/13	180	Soaked	Unknown	98.6	21.1	1865	11.5
M15824	M1285/14	180	Soaked	Unknown	97.0	20.3	2000	13.5
M15825	M1285/15	180	Soaked	Unknown	97.9	20.5	2100	13.7

MEAN SOAKED MODULUS of RUPTURE (MPa): **14.0** ± 0.2 (u_{95})
Standard Deviation: **1.9**

COMMENTS/VARIATIONS

NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.

TESTED BY: E. Tonkin & K. Tonkin
APPROVED SIGNATORY:
NAME: James P Mann

ISSUE DATE: 28-Sep-22

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ASTM INTERNATIONAL MEMBER

ABRASION RESISTANCE

Test Certificate

TEST METHOD	ASTM C1353-20
TEST DATE	14-09-22
CLIENT	SAI Sandstone
OUR REFERENCE	SAS0922-1
SAMPLE	Grey Apricot
SURFACE FINISH	Sandblasted
SAMPLE ORIGIN	Not Known :
SAMPLING DATE	07-09-22
SHAPE and NOMINAL SIZE	: 100mm x 100mm

Conditioning: Dried @ 60 deg C for 48 hours
Relative Humidity: 50%
Bulk SG: **2.72**

Test Number	Specimen Identification	Total Cycles	Initial Mass (g)	Final Mass (g)	Weight Loss (g)	Index of Abrasion Resistance
A8757	M1285/16	1000	501.28	493.74	7.54	13.2
A8758	M1285/17	1000	481.85	475.84	6.01	16.6
A8759	M1285/18	1000	477.44	471.12	6.32	15.9

MEAN INDEX OF ABRASION RESISTANCE: **15.2** **±0.1** (u_{95})
Standard Deviation: **1.8**

COMMENTS/VARIATIONS

NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.

TESTED BY: E. Tonkin & K. Tonkin
APPROVED SIGNATORY:
NAME: James P Mann

ISSUE DATE: 20-Sep-22

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ASTM INTERNATIONAL MEMBER

IMPACT RESISTANCE - COEFFICIENT OF RESTITUTION

Test Certificate

TEST METHOD	AS4459.5 (Modified)		
TEST DATE	20-09-22		
CLIENT	SAI Sandstone		
OUR REFERENCE	SAS0922-1		
SAMPLE	Grey Apricot		
FINISH IMPACTED	Sandblasted		
DROP HEIGHT (mm)	1000	**BALL DIAMETER/WEIGHT**	22.2mm/44.7g
SAMPLE ORIGIN	Not Known :		
SAMPLING DATE	07-09-22		

Conditioning:

Test Number	Specimen Identification	Rebound Height (mm)	Coefficient of Restitution	Description of Deterioration	Cahier Level
O7480	M1285/19	500	0.71	Circular trace	1
O7481	M1285/20	490	0.70	Circular trace	1
O7482	M1285/21	485	0.70	Circular trace	1
O7483	M1285/22	535	0.73	Circular trace	1
O7484	M1285/23	510	0.71	Circular trace	1
O7485	M1285/24	490	0.70	Circular trace	1

MEAN COEFFICIENT OF RESTITUTION: **0.71**

COMMENTS/VARIATIONS

Note: Cahier Level defined by Cahier 3515 of the French CSTB (light impact) based on the observation of visible damage.

TESTED BY: E. Tonkin & K. Tonkin

APPROVED SIGNATORY:

NAME: James P Mann

ISSUE DATE: 27-Sep-22

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ASTM INTERNATIONAL MEMBER

WET SLIP RESISTANCE (AS 4586:2013 APP A)

Test Certificate

TEST METHOD	AS 4586:2013 Appendix A (Wet Pendulum)
TEST DATE	20-09-22
CLIENT	SAI Sandstone
OUR REFERENCE	SAS0922-1
MANUFACTURER	--
SAMPLE	Grey Apricot
VENDOR CODE	--
SUPPLIER CODE	--
BATCH SHADE	--
SURFACE FINISH	Sandblasted
SAMPLE ORIGIN	Not Known
SAMPLING DATE	07-09-22
TEST LOCATION	Finishes Lab
NOMINAL SIZE	100mm x 300mm x 20mm
AIR TEMPERATURE	14.1 °C
SITE	SI Laboratory
WEATHER	Not Applicable
TEST TYPE	Unfixed
ANGLE OF TEST	Horizontal
SLIDER TYPE	Slider 96
SLIDER EXPIRY	26-04-23
SLIDER PREPARATION	Slider passed 3x over 400 grit paper, 10x over 3mic pink lapping film.
SURFACE PREPARATION	Washed with potable water and cloth

Test Number	Orientation	BPN Readings	Mean
S28777	M1285/29 Random	52, 51, 52, 52, 51	52
S28778	M1285/30 Random	52, 53, 51, 51, 50	51
S28779	M1285/31 Random	54, 54, 53, 52, 51	52
S28780	M1285/32 Random	51, 52, 51, 51, 51	51
S28781	M1285/33 Random	52, 53, 52, 52, 52	52

MEAN Wet SLIP RESISTANCE VALUE (SRV): **52** **±2** (u_{95})

SLIP RESISTANCE CLASSIFICATION: **P4**

COMMENTS/VARIATIONS

NOTE: The expanded measurement uncertainty values (u95) quoted in this report are at a confidence level of 95 % with a nominal coverage factor of 2.

TESTED BY: E. Tonkin & K. Tonkin

APPROVED SIGNATORY:

NAME: Kate A Tonkin

ISSUE DATE: 20-Sep-22

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Determination of Stain Resistance

TEST SPECIFICATION: SI-STN-18
TEST DATE: 15/9/22 - 21/9/22
CLIENT: SAI Sandstone
OUR REF : SAS0922-1

SUBSTRATE: Grey Apricot Marble
SURFACE TREATMENT:
M1285/1 Unsealed
M1285/2 Stonetech Bulletproof
M1285/3 Protect Guard
M1285/4 Tuscan Seal (Environex)

CONDITION: 20°C 50% RH

	Unsealed		Stonetech Bulletproof		Protect Guard		Tuscan Seal (Environex)	
	1 hour	24 hour	1 hour	24 hour	1 hour	24 hour	1 hour	24 hour
Red Wine	5.0	5.0	4.0	4.0	3.0	3.0	5.0	5.0
Olive Oil	2.0	2.0	5.0	5.0	4.0	4.0	5.0	5.0
Black Coffee	4.5	4.0	5.0	4.5	5.0	4.0	5.0	5.0
Coca Cola	5.0	3.5	5.0	5.0	5.0	3.0	5.0	5.0
Soy Sauce	5.0	4.5	5.0	5.0	5.0	4.5	5.0	5.0
Score Averages:	4.3	3.8	4.8	4.7	4.4	3.7	5.0	5.0
Lowest Score	***2.0***		***4.0***		***3.0***		***5.0***	
Stain Index	**4.1**		**4.8**		**4.1**		**5.0**	
Visibility of Etching	None Visible		None Visible		None Visible		None Visible	

Scoring Legend:
5 - Stain not visible - removed after cleaning procedure (scrub with red nylon pad, detergent and hot wate
4 - Stain very slightly visible (not noticeable upon casual viewing)
3 - Stain slightly visible (noticeable at close range at casual viewing)
2 - Stain moderately visible (conspicuous)
1 - Stain highly visible / permanent damage to surface (e.g. etching)

Note: Measurement of uncertainty of Stain Index: ± 0.5

Tested by: E. Tonkin & K. Tonkin **Approved Signatory:** K Tonkin

Date: 23-Sep-22 **Name:** K. Tonkin

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