MODULUS OF RUPTURE
Test Certificate

TEST METHOD	ASTM C99M-18
TEST DATE	05-02-24
CLIENT	SAI Sandstone
OUR REFERENCE	SAS0224-1
SAMPLE	Porestone/Permeable Paving	**SAMPLE TYPE** Other
SAMPLE ORIGIN	SAI Stone :
SAMPLING DATE 05-02-24	
SHAPE and NOMINAL SIZE	Prism: 200mm x 100mm x 50mm
LOAD ORIENTATION TO FINISH	Perp to Wearing Face **FINISH IN TENSION** Underside
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)
M18625	O1956/1	180	Dried	Perp to Wearing Face	100.4	50.3	8676	9.2
M18626	O1956/2	180	Dried	Perp to Wearing Face	103.2	51.1	10543	10.6
M18627	O1956/3	180	Dried	Perp to Wearing Face	98.6	50.7	7532	8.0
M18628	O1956/4	180	Dried	Perp to Wearing Face	99.7	51.1	6843	7.1
M18629	O1956/5	180	Dried	Perp to Wearing Face	99.5	51.2	8958	9.3

MEAN DRIED MODULUS of RUPTURE (MPa): **8.8** ± 0.1 (U95)

Standard Deviation: **1.3**

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)
M18630	O1956/6	180	Soaked	Perp to Wearing Face	101.7	50.7	7993	8.3
M18631	O1956/7	180	Soaked	Perp to Wearing Face	100.7	50.7	7935	8.3
M18632	O1956/8	180	Soaked	Perp to Wearing Face	103.4	51.2	8185	8.1
M18633	O1956/9	180	Soaked	Perp to Wearing Face	101.4	51.5	6635	6.7
M18634	O1956/10	180	Soaked	Perp to Wearing Face	95.4	51.1	6534	7.1

MEAN SOAKED MODULUS of RUPTURE (MPa): **7.7** ± 0.09 (U95)

Standard Deviation: **0.8**

COMMENTS/VARIATIONS Modified Specimen thickness

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: C.Lynn & T.Baggs

APPROVED SIGNATORY:

NAME: James P Mann

ISSUE DATE: 08-Feb-24

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Porestone Permeable Paving
Determination of theoretical breaking load

Prepared for: SAI Stone

Attention: Bob Lu

Date: 9 February 2024

Client Reference: Request. Bob Lu

Our Reference: SAS0224-1 Part 2

Investigating Officer(s): Thomas Baggs

Report Prepared By: Thomas Baggs

James P Mann
Laboratory Manager

	Draft	Reviewed	Released
Name	TB	MM	TB
Date	9/2/24	9/2/24	9/2/24

Table of Contents

1.   INTRODUCTION

Stone Initiatives received a request from the client to determine the theoretical static point load bearing capacity of Porestone Permeable Paving in a variety formats, to be installed on either a mortar bed or on pedestals at the corners.

2.   EVALUATION

The investigation covers the following stone type:

- Porestone Permeable Paving (our reference: O1956)

The stone type is proposed for use in the following formats:

- 200mm x 200mm x 50mm installed on a mortar bed.
- 200mm x 200mm x 50mm supported by a pedestal at each corner.
- 300mm x 300mm x 50mm installed on a mortar bed.
- 300mm x 300mm x 50mm supported by a pedestal at each corner.
- 400mm x 200mm x 50mm installed on a mortar bed.
- 400mm x 200mm x 50mm supported by a pedestal at each corner.
- 600mm x 300mm x 50mm installed on a mortar bed.
- 600mm x 300mm x 50mm supported by a pedestal at each corner.

The 3-point bending strength (modulus of rupture) was determined in accordance with ASTM C99M-18 "Standard Test Method for Modulus of Rupture of Dimension Stone". Five specimens were tested in a dry condition after drying at 60±2˚C for 48 hours prior to testing. Five specimens were tested in a soaked condition after immersion in water for 48 hours at 22±2˚C. Specimen thickness was modified due to sample dimensions supplied.

3.   RESULTS

Results are summarised in the table below. Full test data are detailed in Appendix A of this report.

Property	Porestone Permeable Paving
Modulus of rupture	
• Mean – dry & soaked (MPa)	8.3
• Range of results (MPa)	6.7 – 10.6
• Standard Deviation – dry & soaked	1.2

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² Slider expiry date: 30 August 2024

4. THEORETICAL STATIC POINT LOAD CAPACITY OF PROPOSED PAVER SIZE

The modulus of rupture values attained have been used to determine the theoretical static point load capacity of the proposed stone slab sizes.

The theoretical static point load capacity is based on:

- Format sizes (mm): 200 x 200, 300 x 300, 400 x 200, and 600 x 300 each at 50mm thickness.
- Formula for calculation from 'SI-TBL Determination of theoretical breaking load of installed tiles & pavers.'
- The mean value for modulus of rupture of the stone (8.3 MPa).
- A 'variation factor', which is based on the co-efficient of variation calculated for the modulus of rupture test values of the stone (1.29).
- An 'installation factor' dependent on the format and installation method of the paver, found in 'SI-TBL Determination of theoretical breaking load of installed tiles & pavers – Table 1', shown below.

Installation Factor Table	Method of Installation (Table 1)		
Paver Length (mm)	Concrete with Adhesive or Screed	Unbound (paving over sand)	Pedestals
≤200	6	3	1
201 – 599	5	2.0	0.7
≥600	4	1.5	0.5

The breaking load results have been compared to the classes listed in 'SI-TBL Determination of theoretical breaking load of installed tiles & pavers – Table 2'. This table, shown below, presents a guide for the minimum static load capacity requirements for four different classes of traffic type.

Required Breaking Load Table (Table 2)		
Class	Minimum Breaking Load kgs	Typical Use
A	150	Pedestrian Area: Pedestrians, cyclists, hand pushed trollies, unpowered vehicles etc.
B	600	Light Vehicle Area (vehicles up to 2400kgs): Forklifts, scissor lifts, small cars etc.
C	1400	Medium Vehicle Area: Delivery vehicles, cars, emergency vehicles, limos etc.
D	2500	Heavy Duty Vehicle Area

The calculated theoretical static point load capacities are presented in the tables on the following pages.

4.1. Calculated theoretical static point load capacity for 200 x 200 Pavers

Porestone Permeable Paving Proposed Format	Installation Method	Modulus of Rupture (MPa) Mean[3]	Installation Factor	Theoretical static point load capacity (kg)	Class Guidance
200x200x50mm	Mortar Bed	8.3	6.0	6553	D
200x200x50mm	Pedestals at Corners	8.3	1.0	1092	B*

*Provided there is adequate pedestal strength and stability to support the weight of the paver and the imposed load.

4.2. Calculated theoretical static point load capacity for 300 x 300 Pavers

Porestone Permeable Paving Proposed Format	Installation Method	Modulus of Rupture (MPa) Mean[3]	Installation Factor	Theoretical static point load capacity (kg)	Class Guidance
300x300x50mm	Mortar Bed	8.3	5.0	5461	D
300x300x50mm	Pedestals at Corners	8.3	0.7	765	B*

*Provided there is adequate pedestal strength and stability to support the weight of the paver and the imposed load.

4.3. Calculated theoretical static point load capacity for 400 x 200 Pavers

Porestone Permeable Paving Proposed Format	Installation Method	Modulus of Rupture (MPa) Mean[3]	Installation Factor	Theoretical static point load capacity (kg)	Class Guidance
400x200x50mm	Mortar Bed	8.3	5.0	2731	D
400x200x50mm	Pedestals at Corners	8.3	0.7	382	A*

*Provided there is adequate pedestal strength and stability to support the weight of the paver and the imposed load.

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[3] Combined dried and soaked strength results of the 10 specimens tested used to calculate the overall mean.

4.4. Calculated theoretical static point load capacity for 600 x 300 Pavers

Porestone Permeable Paving Proposed Format	Installation Method	Modulus of Rupture (MPa) Mean[4]	Installation Factor	Theoretical static point load capacity (kg)	Class Guidance
600x300x50mm	Mortar Bed	8.3	4.0	2184	**C**
600x300x50mm	Pedestals at Corners	8.3	0.5	273	**A***

*Provided there is adequate pedestal strength and stability to support the weight of the paver and the imposed load.

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[4] Combined dried and soaked strength results of the 10 specimens tested used to calculate the overall mean.
[5] Guide to the specification and testing of slip resistance of pedestrian surfaces. See Table 3B.
[6] 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."

APPENDIX A
Test Certificates