

14 July 2003

Allstone Pty Ltd  
319 Flinders Street East  
ADELAIDE SA 5000


Attention: Mr. Peter Wood

## EVALUATION OF SAND DUNE SANDSTONE

CLIENT REFERENCE Request P. Wood

AMDEL REFERENCE 03MAAD05456

INVESTIGATING OFFICER James P. Mann

  
Monty Luke  
Group Leader  
Materials Services

Amdel Limited shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Amdel Limited be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Samples will be stored for thirty days.  
Ref: c:\winnt\profiles\jmann\desktop\03maad05456allstone-sanddune.doc

Page 1 of 5

## 1. INTRODUCTION

Amdel Limited was requested by the client to carry out a series of tests on supplied samples of Sand Dune sandstone.

## 2. TEST PROGRAM

The following testwork was undertaken:

- Bulk Specific Gravity
- Water Absorption
- Modulus of Rupture
- Durability (Resistance to Salt Attack)
- Abrasion Resistance

Bulk specific gravity and water absorption were determined in accordance with ASTM C97-02 "Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone". The specimens had been dried at  $60 \pm 2^\circ\text{C}$  for 48 hours followed by soaking at  $22 \pm 2^\circ\text{C}$  for a further 48 hours.

Modulus of Rupture was determined in accordance with ASTM C99-87 (2000) "Standard Test Method for Modulus of Rupture of Dimension Stone". The dry specimens had been dried at  $60 \pm 2^\circ\text{C}$  for 48 hours prior to testing. The soaked specimens had been immersed in water for 48 hours at  $22 \pm 2^\circ\text{C}$ .

Resistance to salt attack was determined according to Method A of AS/NZS 4456.10:1997 "Masonry Units and Segmental Pavers- Methods of Test- Method 10: Determining Resistance to Salt Attack". This involved subjecting the specimens to 15 cycles of soaking in a 14% sodium sulphate solution for a period of 2 hours followed by overnight drying at  $65^\circ\text{C}$ . On completion of the cycling the weight loss was determined by filtering the residue collected.

Index of Abrasion Resistance was determined in accordance with ASTM C1353-96 "Test Method for Abrasion Resistance of Dimension Stone by the Taber Abraser". Three representative specimens were subjected to 1000 cycles using H-22 wheels with a 1kg load.

### 3. RESULTS

Results are summarised in the table below; the typical physical properties of Wondabyne and Mt. White are included as a comparison<sup>1</sup>. Full test data are detailed in Appendix A of this report.

Property	Sand Dune Sandstone	Wondabyne Sandstone	Mt. White/ Somersby Sandstone
<b>Bulk Specific Gravity (t.m<sup>-3</sup>)</b>	2.28	2.29	2.27
<b>Water Absorption (mean)</b>			
➤ % by weight	3.4	3.8	4.4
➤ % by volume	7.7	8.6	10.0
<b>Modulus of Rupture (MPa)</b>			
Broken perpendicular to bedding			
➤ average dried	6.3	9.6	8.9
➤ average soaked	6.3	4.5	2.5
<b>Resistance to Salt Attack (%)</b>			
Weight loss after 15 cycles	1.1	Typically ~ 0.2%	Typically ~ 7%
Mode of failure	Slight to moderate pitting		
<b>Abrasion Resistance</b>			
Abrasion Index	9	Not known	Not known

<sup>1</sup> All physical properties for Wondabyne and Mount White (except durability) have been taken from the Gosford Quarries web site.

## 4. DISCUSSION

### 4.1 Water Absorption / Bulk Specific Gravity

The mean water absorption of the Sand Dune sandstone was determined to be 3.4% by weight. This compares favourably with both Wondabyne and Mount White sandstone, which have typical (higher) absorption levels of 3.8% and 4.4% respectively. A lower water absorption capacity generally reduces the risk of staining and the establishment of biological growths as well as assisting in the stone's durability.

The mean bulk specific gravity of the Sand Dune sandstone was determined to be 2.28 tonnes/metre<sup>3</sup>. This is in line with typical values for both Wondabyne and Mount White sandstone.

### 4.2 Modulus of Rupture

The mean modulus of rupture for the Sand Dune sandstone was determined to be 6.3MPa in both a soaked and dried condition. A "serviceable" sandstone will typically have a maximum 50% reduction in strength when soaked, in this case the variability in strength in a dried (4.9–7.2MPa) and soaked (4.4–7.0MPa) condition has resulted in no apparent reduction in strength when soaked. Because of the variability of the material tested it is considered likely that the soaked specimens that achieved a 6 to 7 MPa strength would have achieved a dried strength of approximately 9 to 12 MPa. These values would give the stone a superior dried strength. The mean soaked strength of 6.3 MPa is well above the typical value for both Wondabyne and Mount White.

### 4.3 Resistance to Salt Attack (Durability)

The mean weight loss of the Sand Dune sandstone was determined to be 1.1% by weight with the weight loss of the individual samples being 0.2%, 0.4% and 2.0%. A weight loss of less than 1% gives the stone an *A grade* durability classification that is considered suitable for all standard construction uses and would comply with most commercial specifications including use as a veneer cladding. With careful selection of material the stone could be considered comparable in durability with Wondabyne sandstone.

### 4.4 Abrasion Resistance

The Sand Dune sandstone was found to have a mean Abrasion Index of 9, the stone is considered to have moderately low abrasion resistance; suitable for light commercial and domestic flooring situations. Although no typical abrasion values are quoted in the results summary for Wondabyne or Mount White, an Abrasion Index range of 5 to 7 is typical for Sydney sandstones; these values would make the stone considered only suitable for light external traffic situations.

## 5. SUMMARY

From the testing carried out the following comments can be made regarding the Sand Dune Sandstone.

- The sandstone has a bulk density and water absorption comparable to Wondabyne sandstone and superior to Mount White. Careful selection of the material may give a water absorption value as low as 2.8% by weight.
- The mean modulus of rupture (dried strength) is lower than that typically achieved by Wondabyne and Mount White, but careful selection of the material may give a dried strength in the order of 9 to 12 MPa, which, at a minimum is comparable with both stones.
- The mean weight loss after the resistance to salt attack test is inferior to that typically achieved by Wondabyne, but considerably superior to Mount White. Careful selection of the material may reduce the weight loss to 0.2 - 0.3%, which is comparable with Wondabyne.
- The mean abrasion resistance index is likely to be slightly higher than that typically achieved by Sydney Sandstone's. Careful selection of the material may increase the abrasion resistance index to approximately 13, which would give the stone a *moderate* abrasion resistance and make the stone suitable for all surfaces except high traffic prestige commercial flooring<sup>2</sup>.

---

<sup>2</sup> According to D. West 'Stone in Modern building'

# **Appendix A**

## **Test Data**

Amdel Limited  
A.C.N. 008 127 802  
MATERIALS TECHNOLOGY GROUP  
Certified to AS/NZS ISO 9001

35 - 37 STIRLING STREET  
THEBARTON SA 5031

Telephone 61 8 84165200  
Facsimile 61 8 82342760

## DIMENSION STONE TESTING LABORATORY

### TEST CERTIFICATE

TEST: Index of Abrasion Resistance  
TEST METHOD: ASTM C1353-98  
SAMPLE: Sand Dune Sandstone (SA)  
CLIENT: Allstone Pty Ltd  
DATE OF TEST: 18-Jun-03  
TESTED BY: J Mann  
OUR REF.: 03MAAD05456

BULK DENSITY: 2.28

SURFACE FINISH: Diamond Sawn  
RELATIVE HUMIDITY: 50 % RH

#### ABRASION RESISTANCE

Test Number	Specimen identification	Total Cycles	Initial mass (g)	Final mass (g)	Weight loss (g)	Index of abrasion resistance
A0417	SA/19	1000	332.353	320.48	11.87	7
A0418	SA/20	1000	329.338	322.90	6.44	13
A0419	SA/21	1000	350.692	336.44	14.25	6

AVERAGE: Index of Abrasion Resistance: 9

Approved Signatory:



Date: 20-Jun-03

Name: James P. Mann  
Accreditation No. 730





Amdel Limited  
A.B.N.300 008 127 802  
MATERIAL SERVICES  
Certified to AS/NZS ISO 9001

35-37 Stirling Street  
THEBARTON  
SOUTH AUSTRALIA 5031

Telephone 61 8 84165200  
Facsimile 61 8 82342760  
www.amdel.com

## DIMENSION STONE TESTING LABORATORY TEST CERTIFICATE

TEST: Absorption and Bulk Specific Gravity of Dimension Stone  
TEST METHOD: ASTM C97-02  
TEST DATE: 16-20 June 2003  
CLIENT: Allstone Pty Ltd  
OUR REF : 03MAAD05456

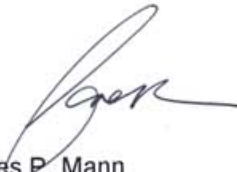
SAMPLE: Sand Dune Sandstone  
QUARRY LOCATION: Not known  
SAMPLING LOCATION: Not known      SAMPLING DATE: Not known

SPECIMEN PREPARATION METHOD: Diamond sawn

Test Number	Specimen Identification	Dried Mass (g)	Suspended Mass (g)	Soaked Mass (g)	Bulk Specific Gravity (t.m-3)	% Absorption by Volume	% Absorption by Weight
W1863	SA/1/W	273.26	163.66	282.96	2.29	8.13	3.55
W1864	SA/2/W	271.90	162.31	281.51	2.28	8.06	3.53
W1865	SA/3/W	267.21	157.66	279.32	2.20	9.95	4.53
W1866	SA/9/W	283.71	168.42	291.60	2.30	6.41	2.78
W1867	SA/10/W	284.21	168.54	291.85	2.30	6.20	2.69
<b>AVERAGE:</b>					<b>2.28</b>	<b>7.75</b>	<b>3.42</b>

COMMENTS (Including variations to procedure): nil

Approved Signatory:



Date:

20/06/03

Name: James P. Mann  
Registration No.: 730

Amdel Limited  
 ABN 300 008 127 802  
 MATERIALS SERVICES  
 Certified to ASNZS ISO 9001

35-37 Stirling Street  
 THEBARTON SA 5031

Telephone 61 8 84165200  
 Facsimile 61 8 82342760

## DIMENSION STONE TESTING LABORATORY

### TEST CERTIFICATE

**TEST:** Determining Resistance to Salt Attack  
**TEST METHOD:** AS/NZS 4456.10:1997  
**SAMPLE:** Sand Dune Sandstone (SA)  
**CLIENT:** Allstone  
**DATE TESTED:** 16 June - 4 July 2003  
**TESTED BY:** J. Mann & P. Hovey  
**OUR REF:** 03MAAD05456  
**SOLUTION USED:** 14% sodium sulphate

Test No.	Specimen	Initial mass (grams)	Residue (grams)	Loss after 15 cycles (%)	Mode of Decay
X0603	SA/4	272.582	5.53	2.0	MD SP
X0604	SA/7	288.950	0.48	0.2	SL SP
X0605	SA/8	290.355	1.05	0.4	SL SP
<b>Mean</b>				1.1	

#### Key to Mode of Decay

Degree	SL= Slight	Type	SP= Surface pitting
	MD= Moderate		CE= Crumbling of edges
	SV= Severe		CR= Cracking
			DL= Delamination
			EX= Exfoliation

Comments/Compliance/Variations:

Approved Signatory:

Date: 7-Jul-03

Name: James P. Mann  
 Accreditation No. 730