



Testing and Consulting - from the ground up

26 August 2004

Layton Sandstone Pty Ltd
36-40 Market Road
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Attention: Mr. Peter Layton

EVALUATION OF *PREMIUM* STAWELL SANDSTONE

CLIENT REFERENCE

Request P. Layton

OUR REFERENCE

LAY0604-1 Part 1

INVESTIGATING OFFICER

James P. Mann & Nick Maloney

1. INTRODUCTION

A request was received from the client to carry out a series of tests on supplied samples of *Premium Stawell* sandstone.

2. TEST PROGRAM

The appropriate specimens were prepared by Stone Initiatives from the supplied samples and the following test work was undertaken:

- Water Absorption
- Bulk Specific Gravity
- Flexural Strength
- Compressive Strength
- Resistance to Salt Attack
- Resistance to Abrasion
- Dimensional Stability

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.

The flexural strength of each specimen was determined in accordance with ASTM C880-98 "Standard Test Method for Flexural Strength 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 $22 \pm 2^\circ\text{C}$.

Unconfined Compressive strength was determined in accordance with ASTM C170-90 (1999) "Standard Test Method for Compressive Strength 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 4456.10:2003 "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 6.2% sodium sulphate solution for a period of 2 hours followed by overnight drying at 65°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 C1353-98 "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.

Dimensional stability was determined in accordance with Standard Procedure SI-DIM-04. The specimens were subjected to ten cycles of soaking under vacuum followed by drying at $65 \pm 2^\circ\text{C}$. Dimensional change was measured using a calibrated dial micrometer (Serial No. 2119-50). The coefficient of dimensional stability was calculated as the change in length of the specimen as a proportion of the original length.

3. RESULTS

Results are summarised in the table below; typical results for Wondabyne Sandstone and Donnybrook Sandstone are given as a comparison. Full test data are detailed in Appendix A of this report.

Property	Stawell Premium Sandstone	Wondabyne Sandstone (typical)	Donnybrook Sandstone (typical)
Bulk Specific Gravity (t.m ⁻³)	2.51	~2.29	~ 2.33
Water Absorption (mean)			
% by weight	1.01	~3.7	~3.5
% by volume	2.52	-	-
Flexural Strength (MPa)			
- Dried Strength	14.3	7.1	~10
- Soaked Strength	10.7	4.5	~8
Compressive Strength			
- Dried Strength (MPa)	129.3	~55	~90
- Soaked Strength (MPa)	91.7	~30	~70
Resistance to Salt Attack			
Weight Loss (wt %)	0.07%	~ < 0.5	~ < 0.1
Mode of Decay	Very slight pitting	-	-
Resistance to Abrasion			
Index Number (mean)	43	-	-
Dimensional Stability (%)			
Total length change after 10 soaking cycles			
- parallel to bedding	+0.006	-	-
- perpendicular to bedding	+0.003	-	-
Total length change after 10 drying cycles			
- parallel to bedding	+0.001	-	-
- perpendicular to bedding	-0.001	-	-
- Classification	Stable – slightly expansive when wet	Stable – moderately expansive when wet	Stable – slightly expansive when wet

4. DISCUSSION

4.1 Water Absorption / Bulk Specific Gravity

The mean water absorption of the *Premium* Stawell sandstone was determined to be 1.0% by weight, this compares favourably with both Donnybrook and Wondabyne sandstone which typically have a higher absorption level of approximately 3%. 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 sandstone was determined to be 2.51 tonnes/metre³, this figure is superior to Wondabyne and Donnybrook sandstone.

4.2 Flexural Strength

The mean flexural strength of the *Premium* Stawell sandstone was found to be 14.3 MPa dried and 10.7 MPa in a soaked condition. These strengths are above both typical values for Wondabyne and Donnybrook. The results make the stone eminently suitable for commercial projects such as paving and curtain wall cladding. The relatively low reduction in strength when soaked is also a sign of the stone's durability (soaked:dried ratio of 0.75) and good performance; a ratio of greater than 0.5 is usually considered acceptable.

4.3 Compressive Strength

The mean compressive strength of the sandstone was found to be 129.3 MPa dried and 91.7 MPa in a soaked condition. These results are significantly higher than both Wondabyne and Donnybrook. Although compressive strength is not usually a problem, the high strength will assist in durability where the stone is used in locations such as stair nosings.

4.3 Resistance to Salt Attack (Durability)

The mean weight loss of the *Premium* Stawell sandstone was determined to be 0.07% by weight. A weight loss of less than 0.1% gives the stone an *AA Grade* durability classification that is considered suitable for all standard construction uses including pool coping and curtain wall cladding. Most commercial specifications require a weight loss of less than 1% (*A Grade*) for the stone to be used as a veneer cladding.

4.4 Abrasion Resistance

The *Premium* Stawell sandstone was found to have a mean Abrasion Index of 43, the stone is considered to have high abrasion resistance; suitable for all commercial and domestic flooring situations. Although no typical abrasion values are quoted in the results summary for Wondabyne, an Abrasion Index range of 5 to 9 is typical for Sydney sandstones; these values would make the stone considered only suitable for light external traffic situations. Donnybrook would have a Abrasion Index of around 20 which would make it suitable for most situations.

4.4 Dimensional Stability

The mean dimensional change of the sandstone after the first soaking was determined to be 0.005% perpendicular to bedding and 0.011% parallel to bedding. The mean dimensional change after ten drying cycles was determined to be -0.001% perpendicular to bedding and 0.001% parallel to bedding. These results classify the stone as *stable* and *slightly expansive when wet* and would comply with a typical commercial specification for stone to be used as curtain wall cladding or prestige paving.

5. SUMMARY

From the testing carried out the following comments can be made regarding the *Premium Stawell Sandstone*.

- The sandstone has a bulk density and water absorption superior to many other sandstones available on the market. The low water absorption will minimise the risk of staining and the establishment of biological growths.
- The durability of the stone, as shown by the resistance to salt attack test results show the sandstone is superior or at least comparable to many other sandstones available on the market and makes it suitable for use in most typical commercial and domestic applications.
- The flexural strength results make the stone suitable for use as curtain wall cladding or paving (given that proper engineering design is carried out).
- The sandstone was found to be dimensionally stable, which makes it a candidate for use in projects where it may be subjected to intermittent wetting and drying or fine engineering tolerances are specified.
- The mean abrasion resistance index is much higher than that typically achieved by most sandstones on the market. The stone is suitable for all surfaces including high traffic prestige commercial flooring.

Appendix A

Test Data

(6 pages)