THE UNIVERSITY OF NEW SOUTH WALES

AUSTRALIAN CENTRE FOR
CONSTRUCTION INNOVATION

TESTING PROPERTIES OF A COMMERCIAL CONCRETE MIX MODIFIED WITH PENETRON ADMIX

FOR

INFRASTRUCTURE SERVICES AUSTRALIA PTY.

THE UNIVERSITY OF NEW SOUTH WALES

Report Prepared by

The Australian Centre for Construction Innovation

University of New South Wales

on

TESTING PROPERTIES OF A COMMERCIAL CONCRETE MIX MODIFIED WITH PENETRON ADMIX

for

Infrastructure Services Australia Pty Ltd

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Testing Properties of A Commercial Concrete Mix Modified with Penetron Admix

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1. INTRODUCTION

The Australian centre for Construction Innovation (ACCI) was requested by Infrastructure Services Australia Pty Ltd to undertake laboratory testing of a range of properties of a commercial concrete mix using Type GP cement and modified with Penetron Admix.

According to Infrastructure Services Australia Pty Ltd, Penetron Admix is a crystalline waterproofing admixture manufactured by ICS Penetron International in New York, USA. Penetron Admix is produced in powder form and the recommended dose range is 1% ± 0.2% by weight of the cementitious content of a concrete mix. Penetron Admix is added to a concrete mix at the time of batching.

This report summarises the test results of the investigation of the Penetron Admix modified concrete.

2. CONCRETE MIX

The concrete mix used in this investigation is a commercial 32MPa concrete containing 320kg of Type GP (SL) cement per cubic metre. The concrete Mix contained 1% by weight of cement of Penetron Admix which was weighed separately and placed in the mixer prior to the addition of the cement, sand and coarse aggregate. Infrastructure Services Australia Pty Ltd dosed the Penetron Admix into the concrete batch at the ready-mix concrete plant as per manufacturer's recommendations. No other admixtures were added into this concrete mix.

3. TEST METHODS

A summary of the test methods used in this investigation is as follows.

3.1 Slump (AS 1012.3.1)

Slump test was undertaken with fresh concrete according to AS 1012.3.1 with the designed target slump of 80mm.

3.2 Compressive Strength at 3, 28 and 91 days (AS 1012.9)

Concrete cylinder specimens were cast, cured and tested according to the procedures of AS 1012.9. The compressive strength of the concrete mix is determined at the testing age of 3, 28 and 91days after standard curing as required by AS 1012.9.

3.3 Drying Shrinkage (AS 1012.13)

Drying shrinkage of concrete prism specimens was measured under the standard conditions according to AS 1012.13 to 56 days and extended to 91 days under the constant temperature of 23 ºC ± 2 ºC and relative humidity of 50% ± 5%.

3.4 Water Absorption and AVPV (AS 1012.21)

Water absorption and the Apparent Volume of Permeable Voids (AVPV) of hardened concrete specimens were determined according to the procedures of AS 1012.21. The cylinder samples were cured in limewater for 14 days followed by air curing for 42 days at 23 ºC until tested. For testing water absorption, the specimens were oven-dried at 105 ºC and immersed in water for at least 48 hours. For testing AVPV, the specimens were boiled in a water bath for 5 to 6 hours, then oven-dried and followed by immersion in water for at least 48 hours.

3.5 Length Change in Sulphate Solution (AS 2350.14)

Three prism specimens were made with mortar sieved out of fresh concrete according to the procedure of AS 2350.14. The length change of prism specimens is measured every two weeks up to 16 weeks during the immersion period in the specified sulphate solution according to AS 2350.14.

4. TEST RESULTS AND COMMENTS

4.1 Concrete Slump (AS 1012.3.1)

The slump test of fresh concrete was carried out at the time of arrival of the concrete truck at the ACCI laboratory. The slump of the concrete batch was measured to be 80mm.

4.2 Compressive Strength at 3, 28 and 91 days (AS 1012.9)

Cylinder specimens were cast from concrete batch and the specimens were initially cured in moulds covered with wet hessian in a temperature-controlled room at 23 °C. They were removed from the moulds at approximately 24 hours after casting and then cured in a limewater tank at 23 °C. The

compressive strength was tested with cylinder specimens according to the AS1012.9. The following Table-1 summarises the compressive strength results at the age of 3, 28 and 91 days.

Table-1. Compressive Strength of Concrete at 3, 28 and 91 Days

Concrete Age (day)	3	**28**	91
Compressive Strength (MPa)	22.2	**39.6**	43.5

The compressive strength of the Penetron Admix modified mix was 22.2 MPa at 3 days and 39.6 MPa at 28 days. The ratio was 0.56 between the strength at 3 days and that at 28 days. This early strength gain of the Penetron modified concrete was fairly high for normal concrete of 32 MPa grade. The benefit of higher early strength gain allows to strip formwork at an earlier concrete age.

4.3 Drying Shrinkage (AS 1012.13)

Drying shrinkage of the concrete was measured with three prism samples according to AS 1012.13. The monitoring of changes in the specimen length due to drying shrinkage was extended from a normal period of 56 days to 91 days. The results of standard drying shrinkages of the concrete are shown in the following Table-2 and plotted in Fig-1.

Table–2. Drying Shrinkage of Concrete (AS 1012.13)

Drying Age (day)	**0**	**4**	**7**	**14**	**21**	**28**	**56**	**91**
Drying Shrinkage (microstrain)	0	121	169	269	355	404	**530**	598

The drying shrinkage after 56 days was recorded to be 530 microstrains. It is noted that this shrinkage value is lower than the allowed maximum shrinkage of 700 microstrains under exposure classification B1 and B2, and 600 microstrains under exposure classification C in the RTA (NSW) QA Specification B80 for "Concrete Works for Bridges". The exposure classification B2 and C are described in AS3600 as "permanently submerged in sea water" and "in tidal or splash zones" respectively. The exposure classification B1 includes several exposure environments less aggressive than B2 and C to concrete.

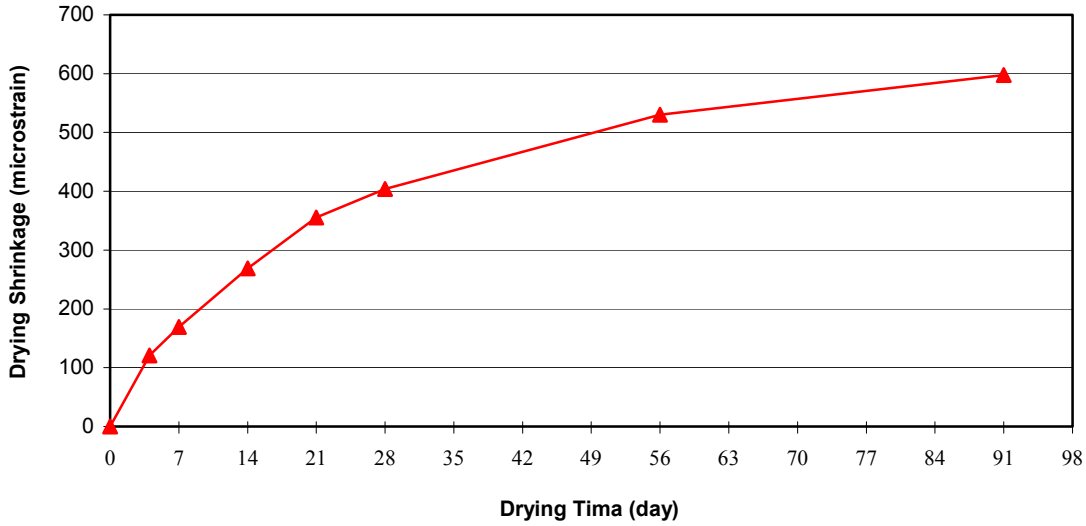

Fig-1. Drying Shrinkage of the Concrete

4.4 Water Absorption and AVPV (AS 1012.21)

The water absorption and the apparent volume of permeable voids (AVPV) in hardened concrete were tested according to AS 1012.21. The test results are shown in Table-3.

Table–3. Water Absorption and AVPV (AS 1012.21)

Water Absorption	6.00%
Apparent Volume of Permeable Voids	13.62 %

According to the acceptance criteria of VICROADS based on AVPV for concrete in various exposure classifications, the acceptable AVPV value for exposure classification B1 and B2 is less or equal to 15% and 14% respectively. It is noted that the Penetron Admix modified concrete satisfied both criteria. The exposure classification B2 is described in AS3600 as such “permanently submerged in sea water” and the classification B1 includes several exposure environments less aggressive than B2.

4.5 Length Change in Sulphate Solution (AS 2350.14)

The length change in sulphate solution was measured with three mortar samples sieved out of the concrete and according to the procedures of AS 2350.14. The changes in the specimen length due to expansion in the sulphate solution were measured over 16 weeks in this standard test. The average expansion of the samples against immersion time is shown in Table-4 and plotted in Fig-2.

Table–4. Expansion of Concrete in Sulphate Solution (AS 2350.14)

Immersion Time (week)	0	2	4	6	8	10	12	14	16
Expansion (microstrain)	0	132	166	241	324	422	523	661	848

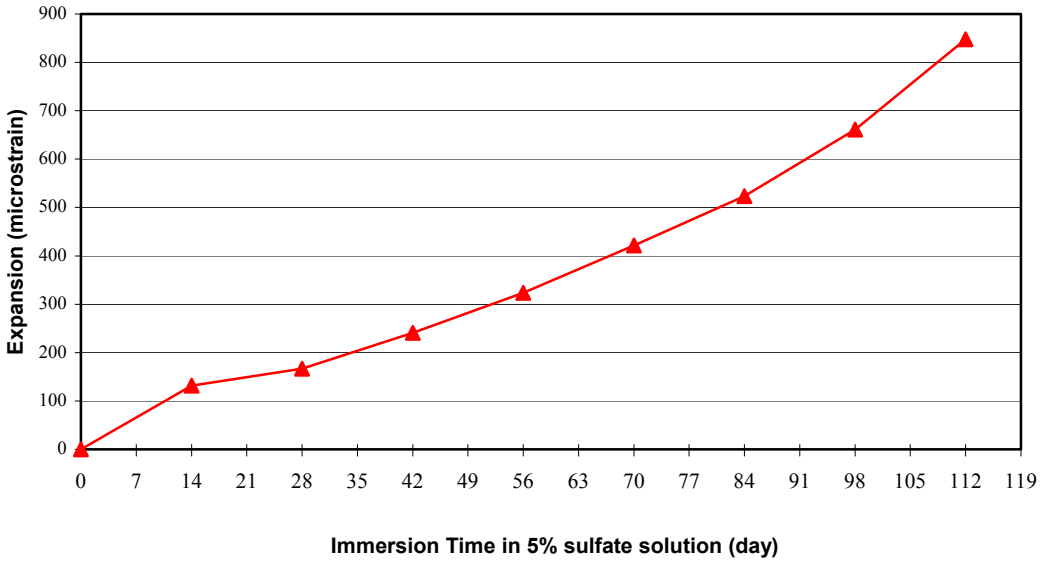

Fig -2. Length Change of Mortar Samples in Sulphate Solution

The proposed assessment criterion of the AS 2350.14 test for acceptable sulphate resistance is that the expansion should be no more than 900 microstrains after 16 weeks immersion in the sulphate solution. The expansion of samples of the Penetron modified concrete mix in this test was less than the expansion limit of the proposed criterion.

5. SUMMARY

A 32 MPa grade commercial concrete mix using Type GP (SL) cement and modified with Penetron Admix is investigated for a range of concrete properties including slump, compressive strength at 3, 28 and 91 days, drying shrinkage, water absorption and AVPV, and length change in sulphate solution. In general, the test results indicated the Penetron Admix modified concrete mix had satisfactory performance in all the tested properties based on the relevant performance criteria.