XYPEX AUSTRALIA

SULPHATE RESISTANCE ON
XYPEX ADMIX C-1000NF
MODIFIED COMMERCIAL CONCRETES

AUSINDUSTRY START RESEARCH PROJECT

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1. INTRODUCTION

A substantial research program was undertaken at the The Australian Centre for Construction Innovation of the University of New South Wales with financial support from AUSINDUSTRY under a START Graduate Research Grant. The primary aim of this research was to determine the benefits resulting from the use of Xypex Admix C-1000NF as an integral component of concrete required to demonstrate superior durability in aggressive environments.

This program used commercial concretes which contained conventional water reducing admixture, different types of supplementary cementitious materials and Xypex Admix C-1000NF at various dose rates,

This abtract outlines test results on **Sulphate Resistance** using test method **AS2350.14**. Assessment of these test results indicates that, whilst concrete performance was influenced by cement type, Xypex Admix C-1000NF also significantly improves the sulphate resistance of concrete in aggressive environments regardless of cement types.

2. MATERIALS

To minimise the difference in performance between “lab concrete” and “site concrete”, and to ensure relevance for construction applications, commercial concrete batches were used in this research. One of three types of cement was used in each of the concrete mixes, i.e. AS3972 Type-GP (SL) Portland cement only, or AS3972 Type-GB fly ash blend with 20% fine fly ash (Type F) or AS3972 Type-GB slag blend with approximately 38% slag.

All concrete batches were supplied by a ready-mix plant based on 32 MPa grade commercial concrete mixes. AS1478.1 Type-WR admixture (neutral set) was added as required to achieve a target slump of 80mm. Xypex Admix C-1000NF was dosed at 0.8% or 1.2% in accordance with manufacturer’s directions.

3. TEST RESULTS AND DISCUSSIONS

Test results are summarised and shown in Table 3-A.

Table 3-A Summary of Test Results

Mix Code	W/C Ratio	Cement Type and Content (kg)	Xypex Admix (% of Cement Content)	Compressive Strength		Sulphate Expansion
				3 days	28 days	
GPC	0.55	GP (330)	Nil	24.1	43.8	Control
GPX1	0.55	GP (330)	0.8% C-1000NF	26.1	46.0	Similar
GPX2	0.55	GP (330)	1.2% C-1000NF	27.2	46.8	- 15%
FAC	0.50	20% Fly Ash (360)	Nil	25.4	42.0	Control
FAX1	0.50	20% Fly Ash (360)	0.8% C-1000NF	25.4	44.6	- 7%
FAX3	0.48	40% Fly Ash (380)	0.8% C-1000NF	21.1	39.3	-
FAX4	0.50	20% Fly Ash (360)	1.2% C-2000NF	30.4	48.9	- 27%
SC1	0.55	38% Slag (330)	Nil	17.4	40.2	Control
SX1	0.55	38% Slag (330)	0.8% C-1000NF	17.8	42.7	- 58%
SX2	0.48	60% Slag (380)	0.8% C-1000NF	20.2	50.3	-

3.1 TYPE-GP (SL) CEMENT

Fig 3.1-A shows the length change of mortar samples sieved out of Type-GP concretes and measured according to AS2350.14. Similar performance was found between the Xypex Admix modified concrete (Mix-GPX1 at 0.8% Xypex Admix C-1000NF) and the control. However, Xypex Admix modified mix (Mix-GPX2 with 1.2% Xypex Admix C-1000NF) had expansion 15% lower than the control.

Concretes made with Type-GP cement generally have lower sulphate resistance in comparison to both blended cements containing fly ash and high proportions of slag. The use of blended cement can result in reduction availability of calcium hydroxide resulting in lower permeability in the concrete. However, concrete Mix-GPX2 with addition of 1.2% Xypex Admix C-1000NF had shown significantly lower sulphate expansion with a reduction of 15% when compared with control mix.

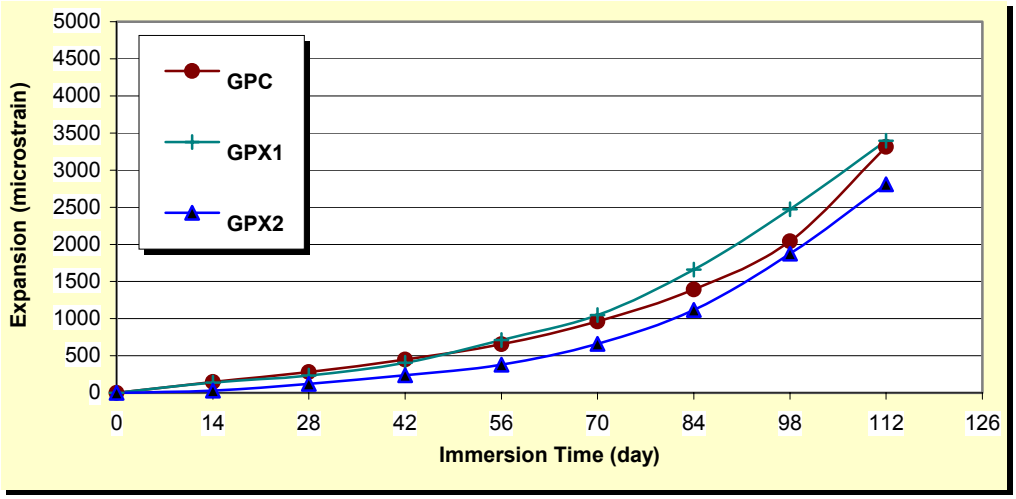

Fig. 3.1-A Expansion in Sulphate Solution of Type-GP Concrete

3.2 TYPE-GB (20% FLY ASH, TYPE F)

Length changes in the sulphate solution of samples made from fly ash concrete mixes are shown in Fig 3.2-A. The two 20% fly ash cement concretes (Mix-FAC and Mix-FAX1) recorded excellent sulphate resistance with expansions of less than 500 microstrains.

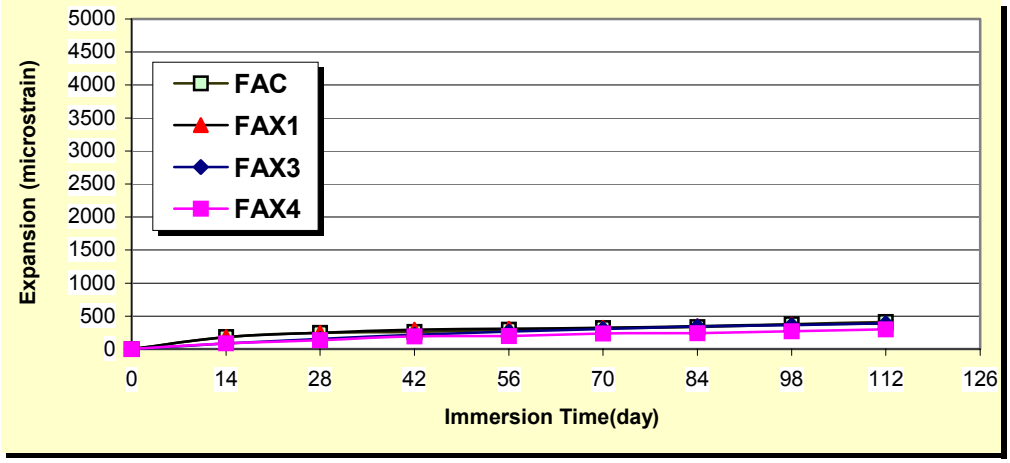

Fig. 3.2-A Expansion in Sulphate Solution of Fly Ash Concrete Samples

While the Xypex Admix C-1000NF (at 0.8%) modified concrete Mix-FAX1 had 7% less expansion than control mix, the Xypex Admix C-2000NF (at 1.2%), Mix-FAX4 had a very low expansion of only 302 microstrain which was 27% less then control Mix-FAC. The outstanding sulphate resistance of Mix-FAX4 together with its higher early strength were considered to be beneficial to the durability performance of fly ash

concretes modified with Xypex Admix. The 40% fly ash concrete Mix-FAX3 modified with Xypex Admix C-1000NF (at 0.8%) also had excellent sulphate resistance with a low expansion of 391 microstrains.

3.3 TYPE-GB (38% SLAG)

Fig. 3.3-A shows length changes of samples made from slag cement concretes. The Xypex Admix modified concrete (Mix-SX1) had an expansion of less than half (with 58% reduction) of that of the control (Mix-SC) after 16 weeks immersion. The Xypex Admix C-1000NF modified Mix-SX2 with 60% slag in cement had shown excellent sulphate resistance with total expansion of only 501 microstrain at end of 16 weeks.

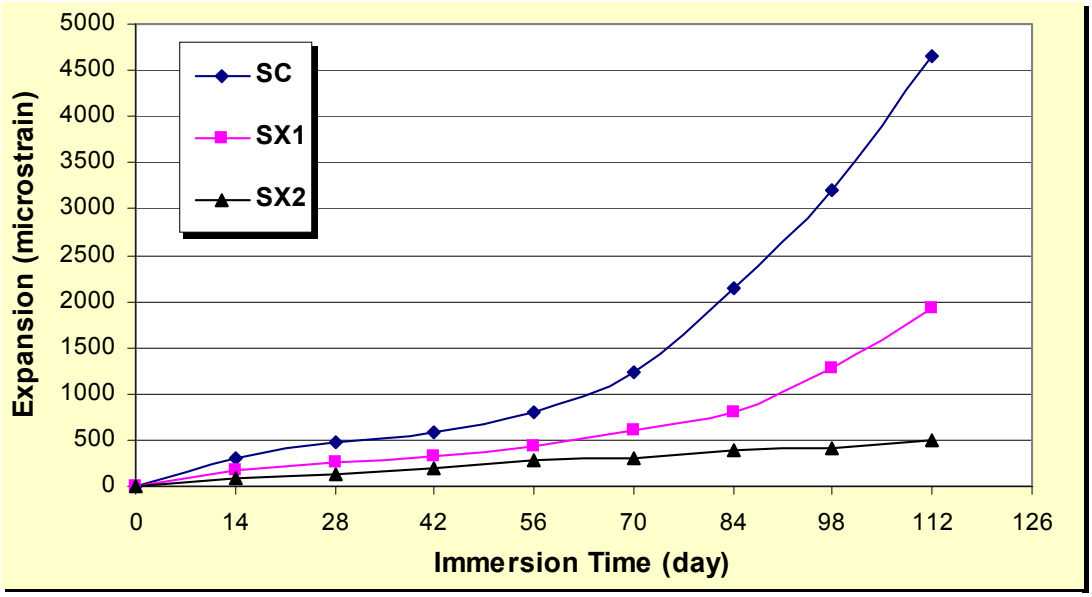

Fig 3.3-A Expansion in Sulphate Solution of Slag Concrete Samples

4. CONCLUSION::

This brief report outlines test results on sulphate resistance using method AS2350.14 on Xypex Admix C-1000NF modified concretes. Xypex Admix C-1000NF with two dosage rates of 0.8% and 1.2%, were used with three different types of cement in commercial concretes with nominal strength of 32MPa.

1. Type-GP (SL) concretes:

i. Xypex Admix C-1000NF at a dosage rate of 1.2% has reduced the sulphate expansion by 15% compared with the control.

2. **Type-GB (20% fly ash) concretes:**
    i. Xypex Admix C-1000NF dosed at 0.8% has resulted in a further reduction of sulphate expansion by 7% compared to the already low sulphate expansion of the control.
    ii. Xypex Admix C-2000NF at dosage rate of 1.2% has shown excellent sulphate resistance by having a 27% reduction in sulphate expansion in comparison to the control.
    iii. High fly ash concrete modified with Xypex Admix C-1000NF has reduced overall sulphate expansion of to less than 400 microstrains.

3. **Type-GB (38% slag) concretes:**
    i. Xypex Admix C-1000NF dosed at 0.8% has demonstrated excellent resistance to sulphate attack by reducing 58% of overall sulphate expansion compared with the control.
    ii. Xypex Admix C-1000NF has shown excellent improvements in concrete containing 60% slag with Mix-SX2, in having the lowest sulphate expansion in the group.

Overall from the test results, Xypex Admix C-1000NF has shown significant improvements in sulphate resistance of commercial concretes (32 MPa) in aggressive environments regardless of cement types.