THE UNIVERSITY OF NEW SOUTH WALES

AUSTRALIAN CENTRE FOR
CONSTRUCTION INNOVATION

Report

on

MICROSCOPIC EXAMINATION OF CRYSTALLINE PRODUCTS IN THREE XYPEX ADMIX MODIFIED CONCRETES AND MORTAR

FOR

XYPEX AUSTRALIA PTY LTD

Commercial in Confidence

This report is Privileged and Confidential and has been prepared for the Client below for the purposes of the Client obtaining legal advice.

Report Prepared by:

THE AUSTRALIAN CENTRE FOR CONSTRUCTION INNOVATION
(INCORPORATING BUILDING RESEARCH CENTRE)
THE UNIVERSITY OF NEW SOUTH WALES

ACCI

On:

MICROSCOPIC EXAMINATION OF CRYSTALLINE PRODUCTS IN THREE XYPEX ADMIX MODIFIED CONCRETES AND MORTAR

For:

XYPEX AUSTRALIA PTY LTD

ACCI Reference: **JI-176**

Prepared By: **Zhen-Tian Chang (Senior Engineer)**

Checked by: **Robert Munn (Adjunct Professor)**

Dated: **28 July 2003**

UNSW

ABN: 57 195 873 179

MICROSCOPIC EXAMINATION OF CRYSTALLINE PRODUCTS IN THREE XYPEX ADMIX MODIFIED CONCRETES AND MORTAR

INTRODUCTION

The Australian centre for Construction Innovation (ACCI) was requested by XYPEX Australia to undertake a Scanning Electron Microscope (SEM) examination of samples of three Xypex Admix modified concretes or mortar for evidence of crystalline products due to reactions between the Xypex Admix and cement hydration products.

According to XYPEX technical literature, Xypex Admix (C-1000 NF and C-2000 NF) are concrete waterproofing admixtures which consist of portland cement and various active proprietary chemicals; these active chemicals react with the moisture in fresh concrete and with the by-products of cement hydration to cause a catalytic reaction; this reaction generates a non-soluble crystalline formation in the pores and capillary tracts of the concrete which seals the concrete and prevents the penetration of water and other liquids. The recommended dose range of Xypex Admix C-1000 NF or C-2000 NF is 0.8% to 1.2% by weight of the cementitious content of the concrete mix. Xypex Admix is added to a concrete at the time of batching.

This report presents the SEM examination results of samples of three concretes and mortar modified with Xypex Admix C-1000 NF or C-2000 NF.

SAMPLE DESCRIPTION AND PREPARATION

The samples of three concretes or mortar examined in this investigation include:

Type-1: Samples of concrete using 60% slag blended cement and 0.8% Xypex Admix C-1000 NF by weight of the cement. The concrete specimens were cast approximately two years ago at the ACCI laboratory and had been immersed in a natural seawater

tank from age 28 days until examined in this investigation. The compressive strength of the concrete at 28 days was 50.3 MPa.

Type-2: Samples of concrete using 30% flyash blended cement and 1.2% Xypex Admix C-2000 NF by weight of the cement. The concrete specimens were cast approximately eight months ago and the compressive strength of the concrete was 65 MPa at 28 days.

Type-3: Samples of a mortar mix using 38% slag blended cement and 0.8% Xypex Admix C-1000 NF by weight of the cement. The mortar specimens were cast approximately twelve months ago and the compressive strength of the mortar was 47 MPa at 28 days.

Specimens of the three Xypex Admix modified concretes and mortar were sliced and split into small samples satisfying the requirements for the microscopic examination. These samples were dried at 60 °C and coated with a thin layer of gold by evaporation in vacuum from a tungsten basket while rotating the samples. The gold-coated samples were then stored in desiccator ready for use in SEM examinations.

RESULTS OF MICROSCOPIC EXAMINATIONS

A field emission scanning electron microscope (SEM) was used for this investigation. The SEM facility can be used for microscopical analysis of a very wide range of materials and is capable of obtaining images of very high resolution (up to 2 nm).

The main purpose of the SEM examination was to identify evidence of crystalline products in the Xypex Admix modified concretes and mortar. Some crystalline products with very special characteristics were observed on these samples during the SEM examination.

Type-1 Concrete (60% slag cement and 0.8% Xypex Admix C-1000 NF)

Fig-1 shows a typical image of characteristic crystalline products found on the Type-1 (60% slag cement) concrete samples at X500 magnification. Fig-2 and Fig-3 present further details of the crystalline products at magnifications of X2000 and X5000 respectively.

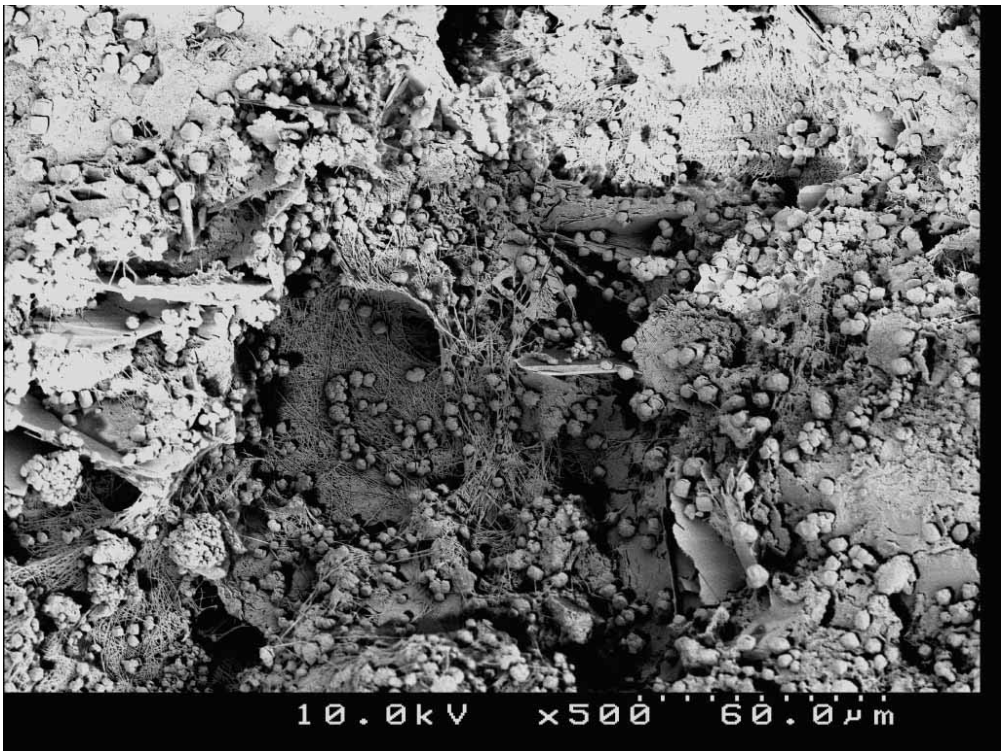

Fig 1. A Typical Crystalline Product Site on Type-1 Concrete Sample (at X500)

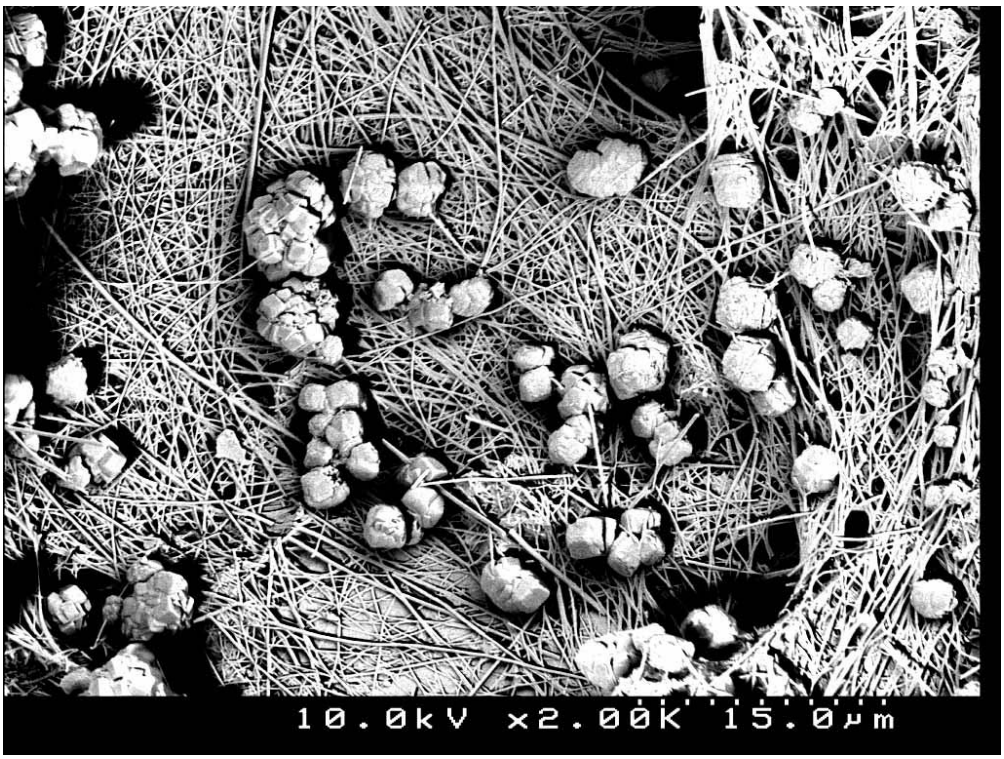

Fig 2. Crystalline Products in Type-1 Concrete at X 2000 Magnification

Fig 3. Crystalline Products in Type-1 Concrete at X 5000 Magnification

The characteristic threadlike crystalline products in Fig-1 to Fig-3 have not been reported in previous SEM examinations of concrete samples. It appears that these were produced as the result of special reactions between Xypex Admix C-1000 NF and the cement hydration products in the modified slag cement concrete.

Type-2 Concrete (30% flyash cement and 1.2% Xypex Admix C-2000 NF)

Fig-4 shows a typical image of characteristic crystalline products found on the Type-2 (30% flyash cement) concrete samples at X500 magnification. Fig-5 and Fig-6 present further details of the crystalline products at magnifications of X2000 and X5000 respectively.

The characteristic threadlike crystalline products in Fig-4 to Fig-6 are very similar to those found in Fig-1 to Fig-3. It appears that these were also produced as the result of special reactions between Xypex Admix C-2000 NF and the cement hydration products in the modified flyash cement concrete.

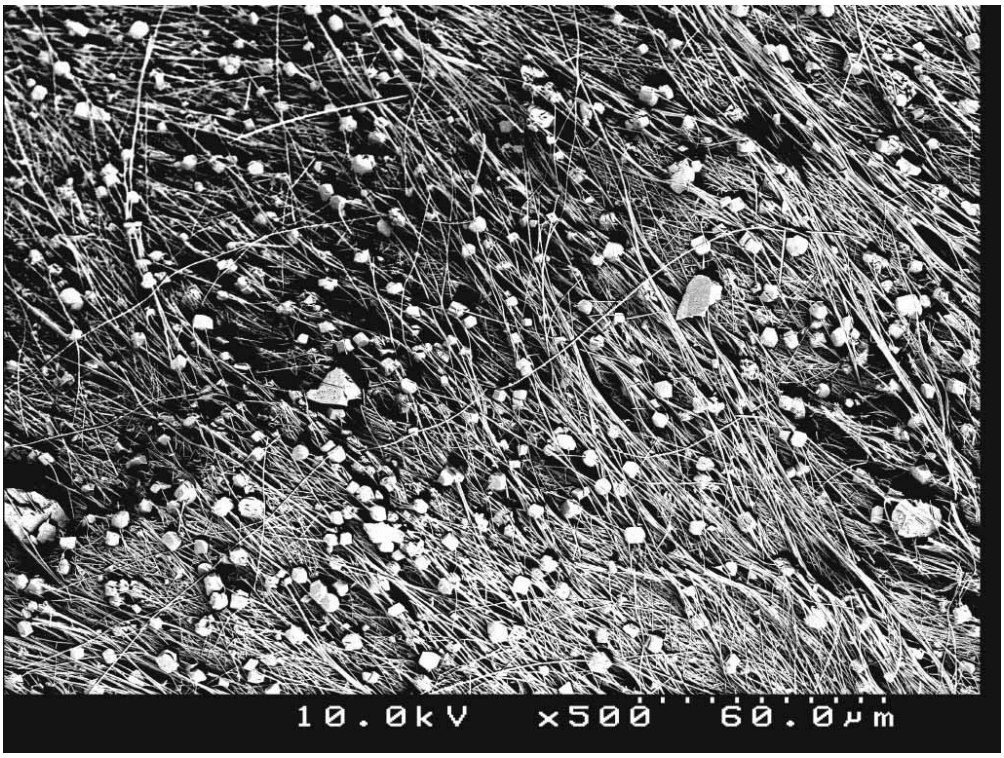

Fig 4. A Typical Crystalline Product Site on Type-2 Concrete Sample (at X500)

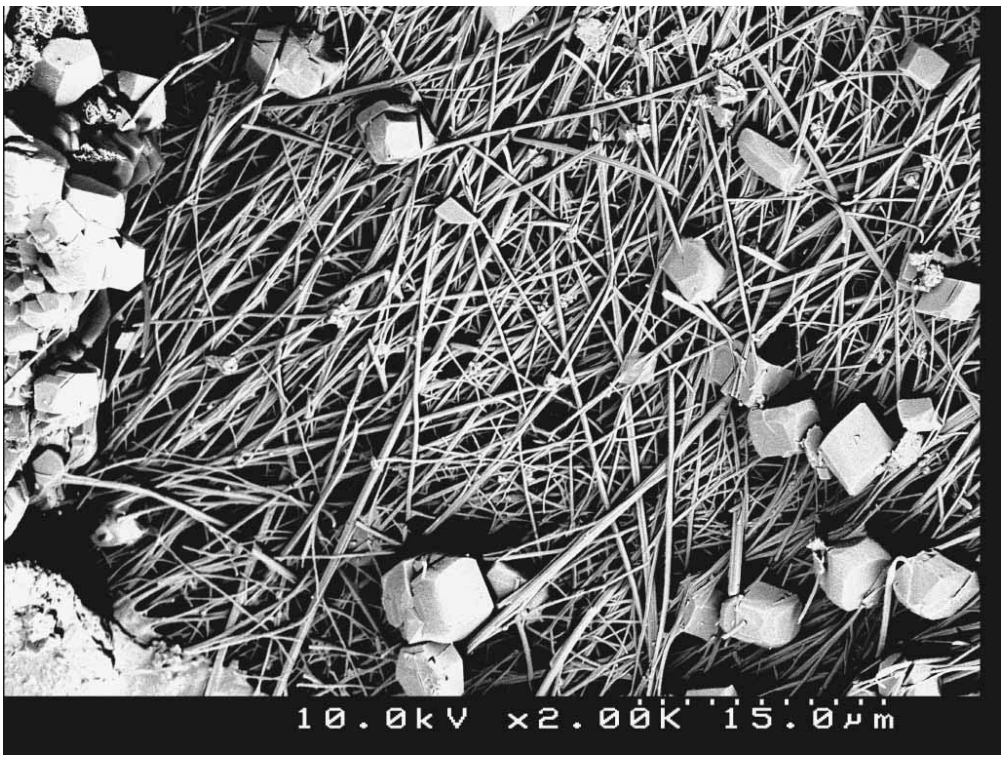

Fig 5. Crystalline Products in Type-2 Concrete at X 2000 Magnification

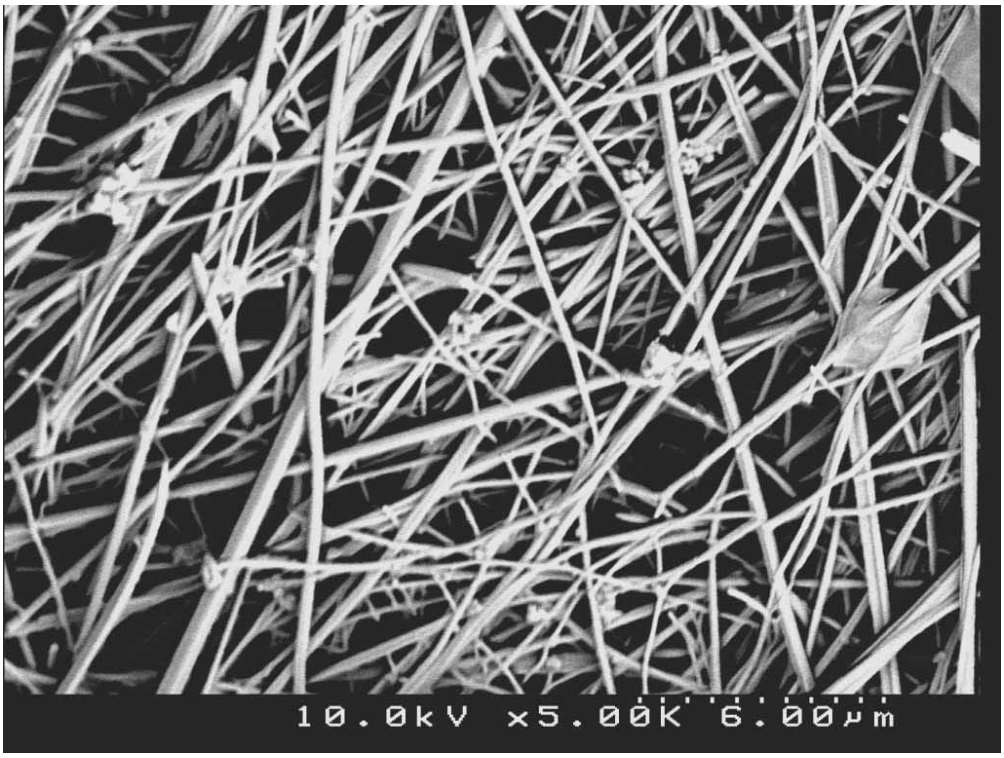

Fig 6. Crystalline Products in Type-2 Concrete at X 5000 Magnification

Type-3 Mortar (38% slag cement and 0.8% Xypex Admix C-1000 NF)

Fig-7 is a typical image at X500 magnification on the Type-3 (38% slag cement) mortar samples showing some special crystalline products. Fig-8 presents further details of the crystalline products at X2000 magnification.

There were traces and patterns of threadlike crystals on the mortar samples as shown in Fig-7 and Fig-8. However, instead of the clearly visible threadlike crystalline products in Fig-1 to Fig-6, the crystalline products in Fig-7 and Fig-8 appeared to have been covered by a layer of small globular crystals. This might be because that a further crystallisation forming the globular crystals had occurred over the threadlike crystals. A significant amount of globular masses consisting of small crystals was also noted in Fig-1 to Fig-6 together with the threadlike crystals on these concrete samples. This suggests that if the mortar samples had been examined using SEM at earlier ages, threadlike crystals similar to those found on the concrete samples might be clearly shown.

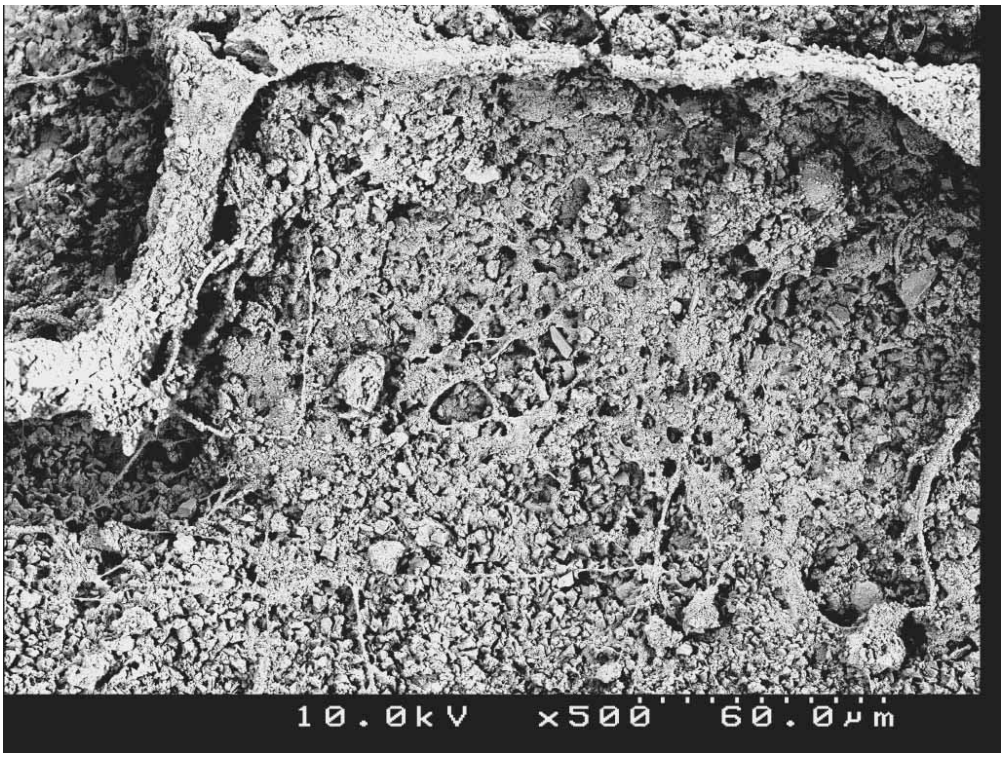

Fig 7. A Typical Crystalline Product Site on Type-3 Mortar Sample (at X500)

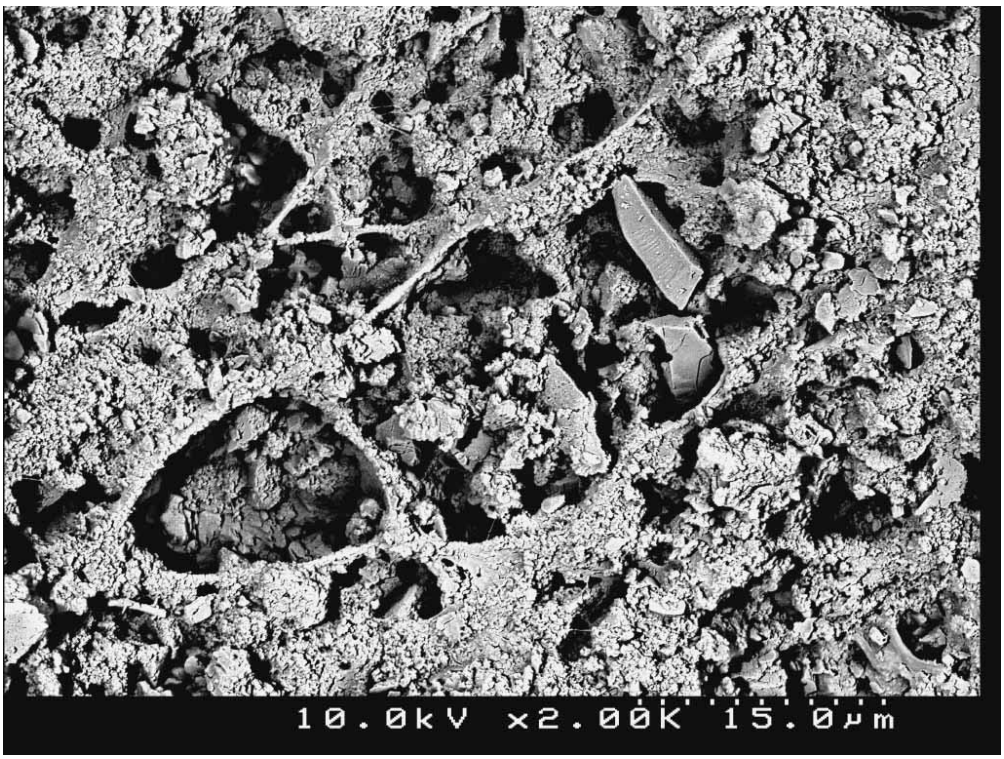

Fig 8. Crystalline Products in Type-3 Mortar at X 2000 Magnification

SUMMARY AND CONCLUSIONS

A comprehensive microscopic examination has been undertaken using the SEM technique to investigate crystalline products in three types of concretes or mortar modified with Xypex Admix C-1000 NF or C-2000 NF. These included a slag cement concrete (60% slag and 0.8% Xypex C-1000 NF), a flyash cement concrete (30% flyash and 1.2% Xypex C-2000 NF) and a slag cement mortar (38% slag and 0.8% Xypex C-1000 NF).

Characteristic threadlike crystalline products were observed on the samples of both the slag and flyash concretes modified with the Xypex Admix. These crystalline products appeared to be produced as the result of special reactions between Xypex Admix C-1000 NF or C-2000 NF and the cement hydration products in the modified slag and flyash cement concretes.

Traces and patterns of the characteristic crystalline products were observed in the mortar samples but the crystalline products appeared to be covered to a large extent by a layer of small globular crystals. These globular crystals might be the subsequent crystallisation products after formation of the threadlike crystals in the mortar modified with Xypex Admix C-1000 NF.

The observations from this SEM examination demonstrate significant evidence of a crystallisation mechanism by which the Xypex Admix C-1000 NF or C-2000 NF reacts with cement hydration products in either a slag blended cement concrete or a flyash blended cement concrete to form characteristic crystalline products which have potential to seal cracks in the modified concretes.