BONDING AGENTS FOR PORTLAND CEMENT CONCRETE AND MORTAR

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OFFICE OF MATERIALS
HIGHWAY DIVISION

Iowa Department of Transportation

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INTRODUCTION:

Structural repairs of bridge piers and abutments require patching concrete or mortar be placed at various thicknesses. Whether concrete or mortar is used depends upon the depth of the patch to be made. In some instances, the use of a liquid bonding agent has been specified in the mixes as well as in a grout scrubbed onto the surface to be patched prior to the mix placement.

Most of the bonding agents presently approved by the Iowa D.O.T. are polyvinyl acetate (PVA) or some type of latex.

In a general discussion with a consultant about various types of bridge repair materials and processes, the subject of bonding agents was discussed at some length. It was the opinion of the consultant that the usage of polyvinyl acetates should be discontinued because of possible deterioration of this material with time. Some of these materials apparently re-emulsify in a high moisture environment causing serious patch deterioration. As a result of this information, a study was initiated to determine the durability of these materials.

EVALUATION PROCEDURE:

Three 4"X4"X18" concrete beams were cast for each bonding agent to be evaluated. The concrete used in the beams was a standard C-3 paving mix with the following basic absolute volumes:

Cement	0.114172
Water	0.153840
Air	0.060000
Fine Aggregate	0.301895
Coarse Aggregate	0.370093

The slump was maintained at 2 to 2-1/2 inches. Materials used in the mixture were from the following sources:

Cement - Type I - Laboratory Blend
Fine Agg. - Hallett - Ames
Coarse Agg. - Lamont Quarry - Buchanan Co.
Water - City of Ames
Air Entraining Agent - Neutralized Vinsol Resin

The coarse aggregate from the Lamont Quarry was selected because of its record of high resistance to freeze and thaw when placed in concrete.

The beams were covered with plastic for the first 24 hours, moist cured an additional six days, followed by a 7 day laboratory air cure. After the air cure, one cast side of the beam was lightly sandblasted prior to application of the patching mortar.

When a bonding agent was used, the sandblasted substrate that was to receive the patch was moistened. After removing excess water, a bonding grout was scrubbed into the area to be patched using a stiff bristled scrub brush. The bonding grout consisted of undiluted bonding agent and Type 1 portland cement combined to produce a mixture of creamy paint consistency.

On the grouted surface was placed a 4"x10"x1/2" thick mortar containing the bonding agent (Fig. 1). The mortar proportions, by volume, were 5 parts Type 1 portland cement, 10 parts fine aggregate, and 1 part bonding agent. With the mixer running, the ingredients were added in the following order: bonding agent, aggregate, and cement. Water was added to produce a mix of trowelable consistency.

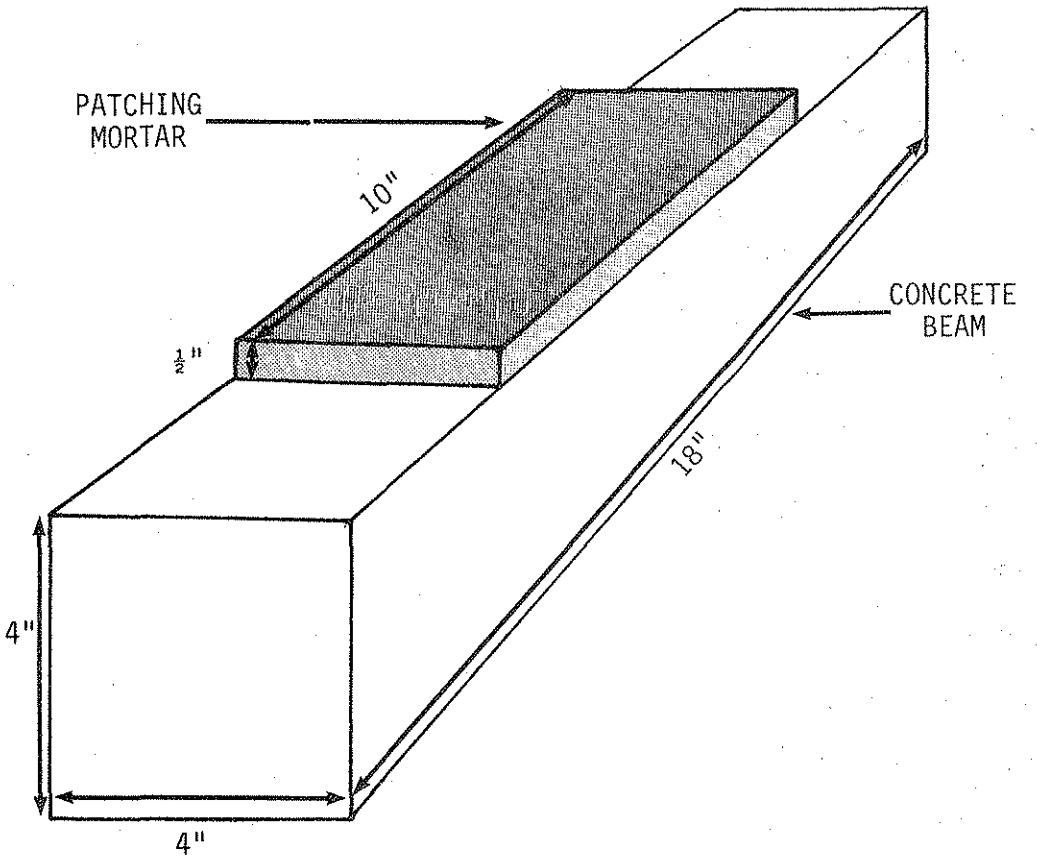

Fig. 1 Configuration of Patching Test Specimens

A control mix without a bonding agent was made for comparative purposes. The control mix bonding grout consisted of Type 1 cement and water. This grout was scrubbed into a dry substrate prior to placement of the mortar.

All patching mixes were covered with plastic for 48 hours followed by a 7 day laboratory air cure.

After the 7 day air curing period the specimens were immersed in water for 90 days. During the 90-day immersion, inspection of the patches were made periodically to note any signs of distress. Following the 90-day-water cure, the specimens were subjected to rapid freezing in air and thawing in water for 300 cycles utilizing Procedure B of ASTM C666. Visual inspection of the patching material was made at various times during the freeze-thaw test.

The following bonding agents were tested:

Brand	Manufacturer	Lab. No.	Manufacturer Description
Proweld D	Protex Industries	ACM3-1	Acrylic Latex
Intralok	W.R. Meadows In.	ACM3-2	Bonding Polymers
Daraweld C	W.R. Grace Inc.	ACM3-4	High Polymer Resin
Sikabond 131	Sika Chem. Co.	ACM3-9	Organic Polymer Latex
Acryl 60	Standard Drywall Prod.	ACM3-10	Acrylic Liquid Polymer
Hornweld	A.C. Horn Inc.	ACM3-11	Polymer Emulsion
Akkro 7T	Tammm's Industries	ACM3-12	Acrylic Polymer

It is the author's understanding that, even though product descriptions vary, all except one of the bonding agents evaluated are some type of polyvinyl acetate (PVA) formulation. The exception is Proweld D from Protex Industries which is an acrylic latex

RESULTS:

All patching materials looked intact after the 90-day-water immersion period. It was expected that the PVA containing materials would show some evidence of distress during this period from possible re-emulsification. This was not the case, however, and all specimens were sound.

Considerable distress was in evidence on all specimens, except the control, during the freeze-thaw portion of the evaluation. The distress ranged from debonding of the patching materials to complete disintegration. The longest any of the patches containing bonding agents lasted was 163 cycles before they were removed from the freeze-thaw apparatus.

The control specimens, which did not contain any of the commercial bonding agents, were in excellent condition upon removal from the freeze-thaw apparatus after the complete 300 cycles.

Number of cycles before being removed from the freezer are tabulated below:

Product	Cycle to Removal From Freezer
Acryl 60	47
Sikabond 131	77
Proweld D	77
Intralok	100
Akkro 7T	139
Daraweld C	163
Hornweld	163
Control (No Bonding Agent)	300+ (No deterioration)

Photographs of all specimens are shown in Figs. 2 thru 9.

CONCLUSIONS:

All bonding agents presently in use by the Iowa D.O..T. failed to exhibit

acceptable freeze-thaw durability when tested in a saturated condition. Since the control mix showed excellent durability, it is logical to conclude that the failures shown are a result of the bonding agent itself rather than in any of the other materials making up the mortar patch.

It is beyond the scope of this limited investigation to address the question of freeze-thaw durability in less critically saturated mortars. In all likelihood, less saturated mortar would have shown better durabilities. Whether they would be equivalent to the control is doubtful.

It is also beyond the scope of this study to address the question of adhesion of a patch to the concrete substrate with and without a bonding agent. Several tests have been made in the past to determine the shear value at the bondline when "scrubbed in" neat cement mortar has been used as a bonding grout. The shear strength has always proven adequate (500-1000 psi) for the intended application. The vast majority of applications using neat cement or a neat cement and sand blend for a bonding agent has been where the new concrete or mortar would be placed in a flat position. Although not proven, there may be better adhesion when using a commercial bonding agent for a trowel applied vertical patch.

RECOMMENDATIONS:

It is recommended that the types of commercial bonding agents used in this study be discontinued for structural patching with either p.c. mortar or p.c. concrete; especially if there is any possibility of the patch becoming saturated and exposed to a freeze-thaw environment.

A neat cement grout scrubbed into a clean, dry substrate is recommended for use in lieu of the commercial bonding agents.

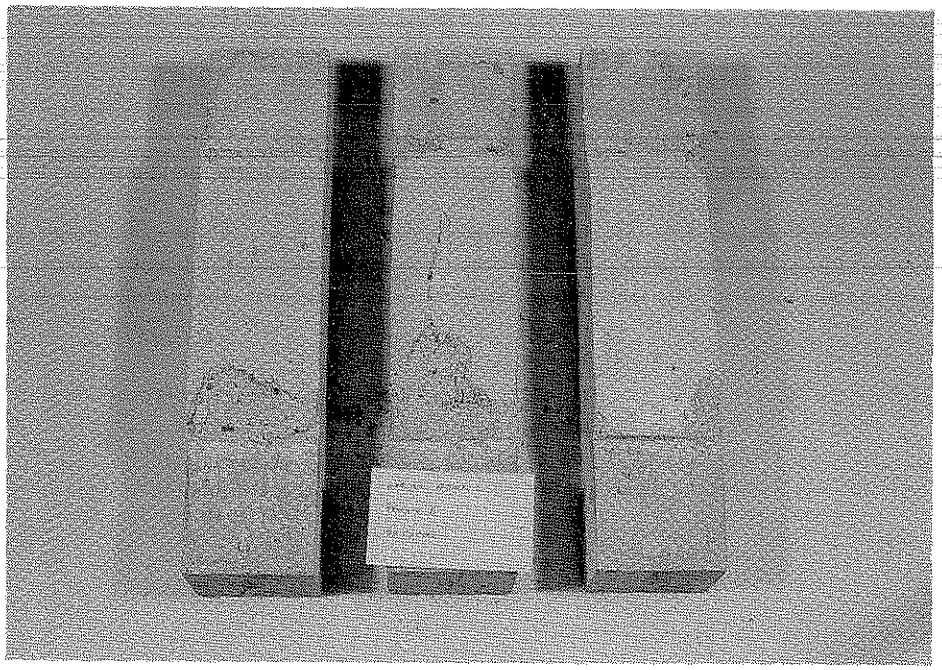

Fig. 2 Lab No. ACM3-1, Proweld D - 77 cycles

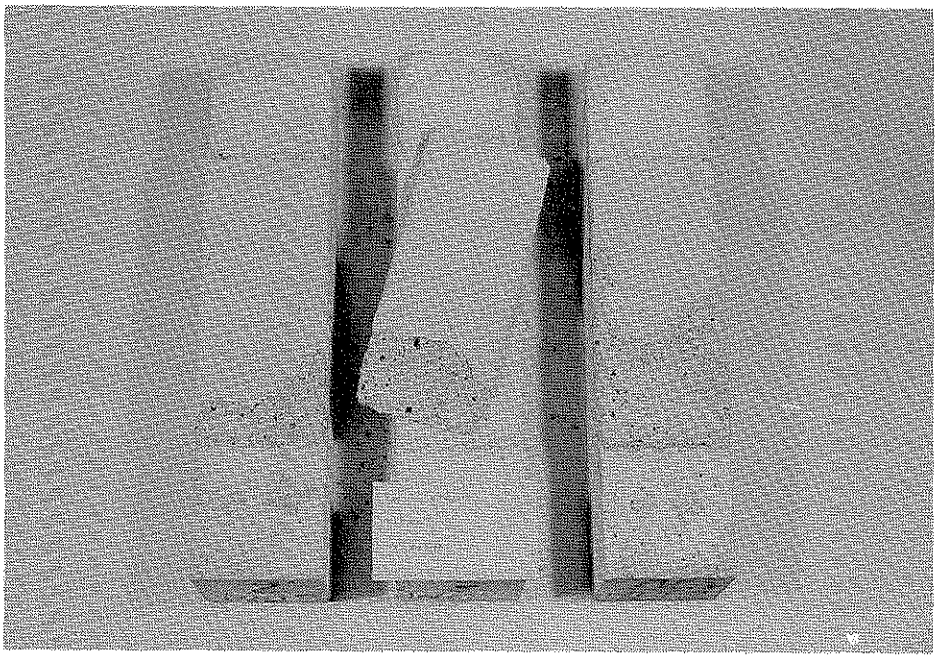

Fig. 3 Lab No. ACM3-2, Intralok - 100 cycles

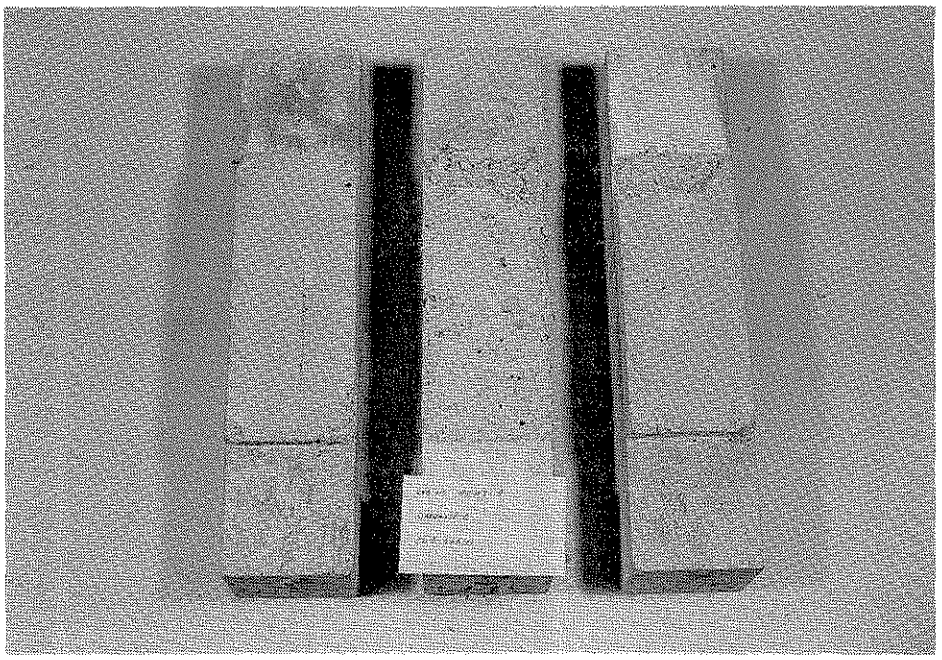

Fig. 4 Lab No. ACM3-4, Daraweld C - 163 cycles

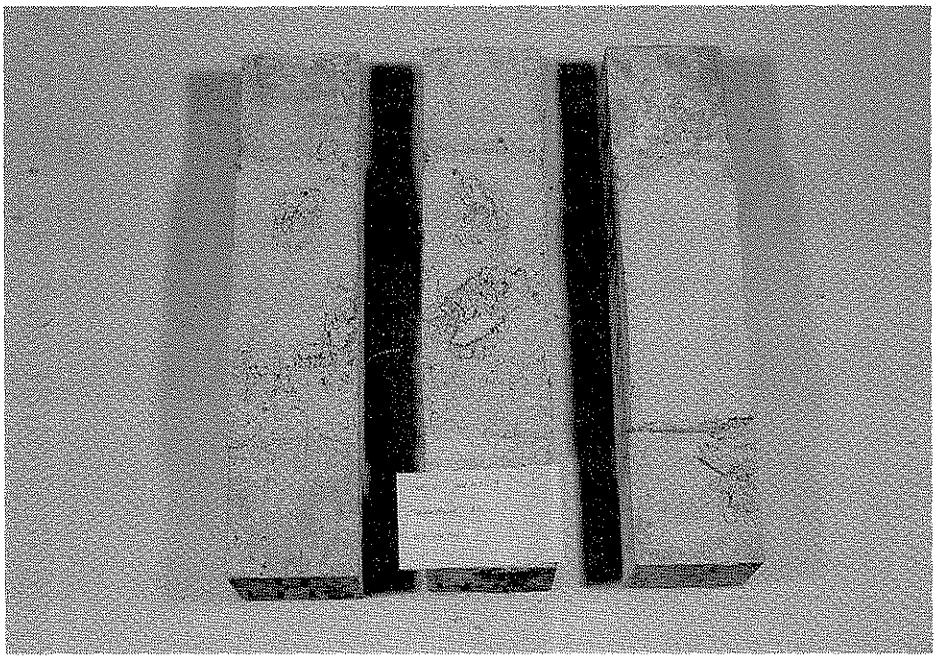

Fig. 5 Lab No. ACM3-9, Sikabond 131 - 77 cycles

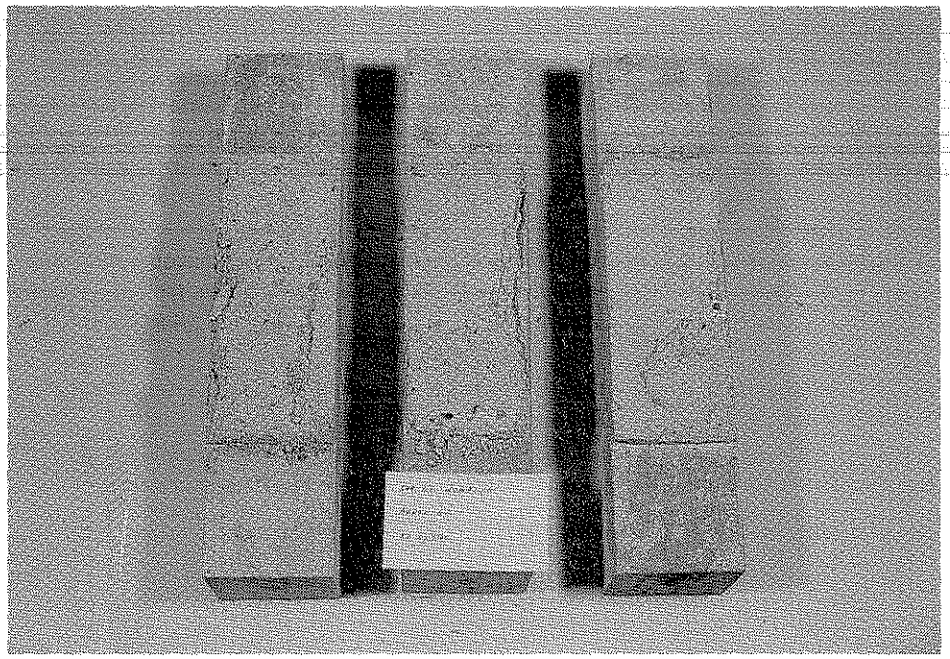

Fig. 6 Lab No. ACM3-10, Acryl 60 - 47 cycles

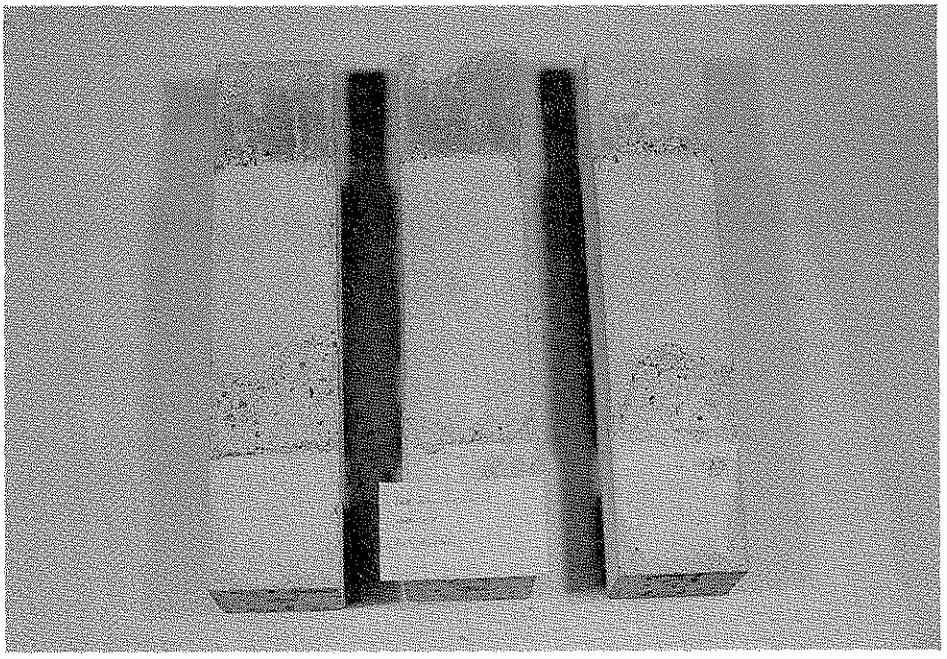

Fig. 7 Lab No. ACM3-11, Hornweld - 163 cycles

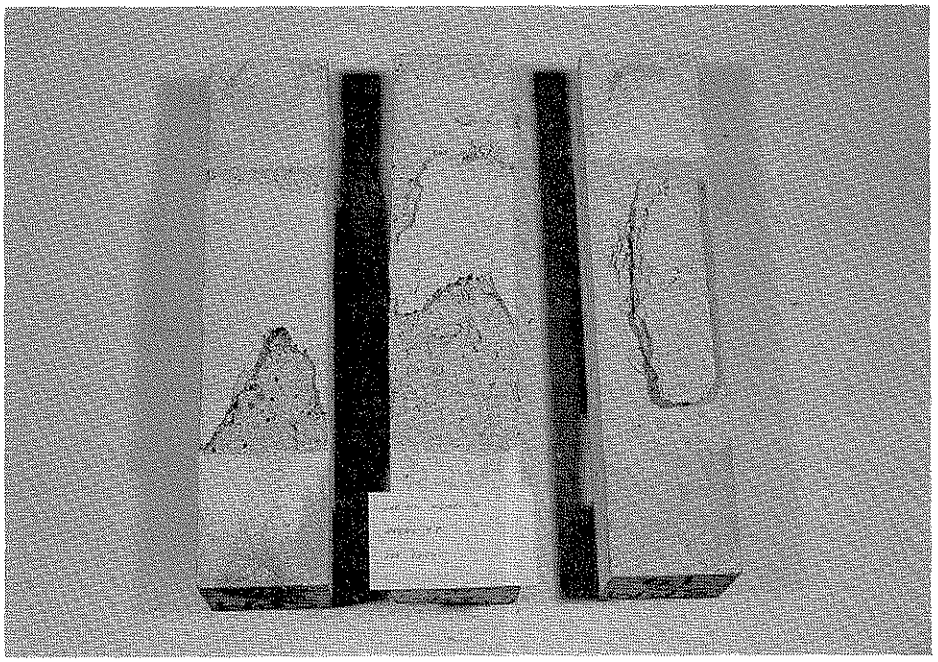

Fig. 8 Lab No. ACM3-12, Akkro 7T - 139 cycles

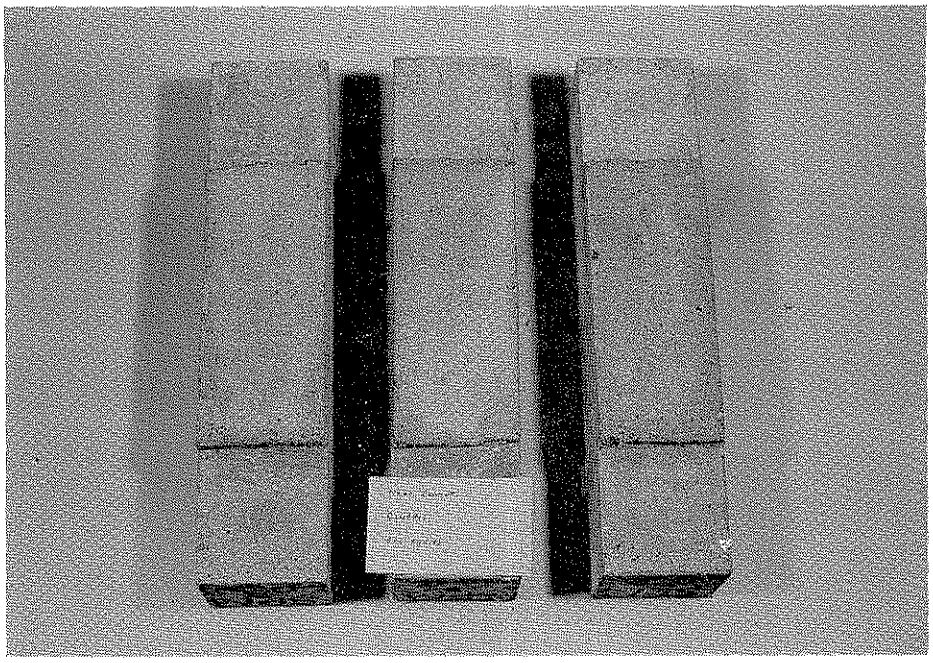

Fig. 9 Control - Neat Cement Grout - 300 cycles