

# OFFICE MEMORANDUM

R-290



MICHIGAN  
STATE HIGHWAY DEPARTMENT  
JOHN C. MACKIE, COMMISSIONER

April 14, 1958

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To: W. W. McLaughlin  
Testing and Research Engineer

From: E. A. Finney

Subject: Investigation of Use of Berylex as an Admixture in Concrete.  
Research Project 54 B-29. Research Laboratory Report No. 290.

Reported by: M. G. Brown

This study was initiated through the interest of the Michigan State Highway Bridge Maintenance Division in finding better methods of patching damaged concrete with fresh mortar or concrete. In January, 1957, S. M. Cardone, Bridge Maintenance Engineer, submitted a portion of a 50-pound sample of Berylex to the Research Laboratory for test purposes. This commercial powder was recommended by the manufacturer to be used in solution as a brush coat on old concrete and as an admixture in the patching mortar, both of which were to insure a good, permanent patch.

At the request of Mr. Cardone, two tests were proposed which would measure the performance of this material in bonding of mortar patches to old concrete. A bond test was proposed which would measure the shearing strength of a mortar patch, after proper curing, from the top of a six-inch-diameter concrete cylinder, as shown in Figure 1. This test is similar to one described in a paper by Earl Felt, of the Portland Cement Association, entitled, "Resurfacing and Patching Concrete Pavement with Bonded Concrete," and dated October, 1955. The freeze-thaw durability was tested using the rapid freeze in air-thaw in water, 0 to 40 F, ASTM Method C291, operating at eight cycles per day.

The concrete cylinders for both of these tests were made in the laboratory using  $5\frac{1}{2}$  sacks of Type 1 cement per cubic yard of concrete, gravel coarse aggregate with maximum size of one inch, and a two-to-three-inch slump. A total of eight cylinders six inches in diameter and six inches high were cast, and brushed after about four hours to simulate a scaled surface as shown in Figure 2. When the cylinders had been moist cured for 42 days they were capped with one inch of the following mortar mix:

Cement, Type I	9.4 lb
Sand, 2 NS spec.	28.2 lb
Water	4.7 lb
Darex, 1/2 ounce/sack	1.5 ml
Berylex, 6 ounces/sack	0.04 lb

Four of the cylinders were capped immediately after hand mixing the mortar several minutes, and the remaining four were capped after the mortar was pre-shrunk by standing two hours and then being remixed. Before capping,

the top of each cylinder was brushed with water and then with a Berylex solution containing two pounds per gallon of water. About a half ounce of cement was sprinkled on each cylinder top in with the Berylex solution.

After moist curing the capped cylinders for 35 days, four were tested for shear strength at the plane of bonding between the cylinder and mortar. The load necessary to break the mortar loose from the cylinder and at right angles to it, was divided by the area of the bonded surface to give the resulting bond strengths:

	<u>Bond Strength, psi</u>
Fresh mortar	712
	565
	<u>639 average</u>
Pre-shrunk mortar	664
	633
	<u>649 average</u>

Separate 3- by 6- in. cylinders showed the mortar to have a compressive strength of 4000 psi. at this same age of 35 days.

The other four cylinders were placed in the automatic freeze-thaw machine for rapid freezing in air and thawing in water, 0 to 40 F. After 152 cycles the cylinders showed the following changes from the initial weights:

	<u>Weight Change from Original, percent</u>
Fresh mortar	+0.91
	+0.89
	<u>+0.90 average</u>
Pre-shrunk mortar	+0.56
	+0.75
	<u>+0.66 average</u>

All of the mortar caps were solidly bonded to the base after these first 152 cycles of freeze-thaw. After 200 cycles of freeze-thaw the non-air-entrained base cylinders had broken up badly, leaving the Berylex mortar caps intact.


According to the earlier-mentioned PCA article by Earl Felt, a figure of 300 to 400 psi. is a good bond strength for capping materials on old concrete. The 640 psi. bond strength for the Berylex solution and Berylex mortar would appear to be very good. It has been found that this bond will hold for at least 150 alternations of freezing and thawing. Apparently it made very little difference whether the mortar was applied directly to the old concrete or allowed to shrink two hours prior to application.

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On the basis of these laboratory tests, we recommend a trial application in the field by the Bridge Maintenance Division to determine how well the Berylex treatment performs in actual service. Both the Research Laboratory and the manufacturer are willing to cooperate in such a test.

  
E. A. Finney, Director  
Research Laboratory

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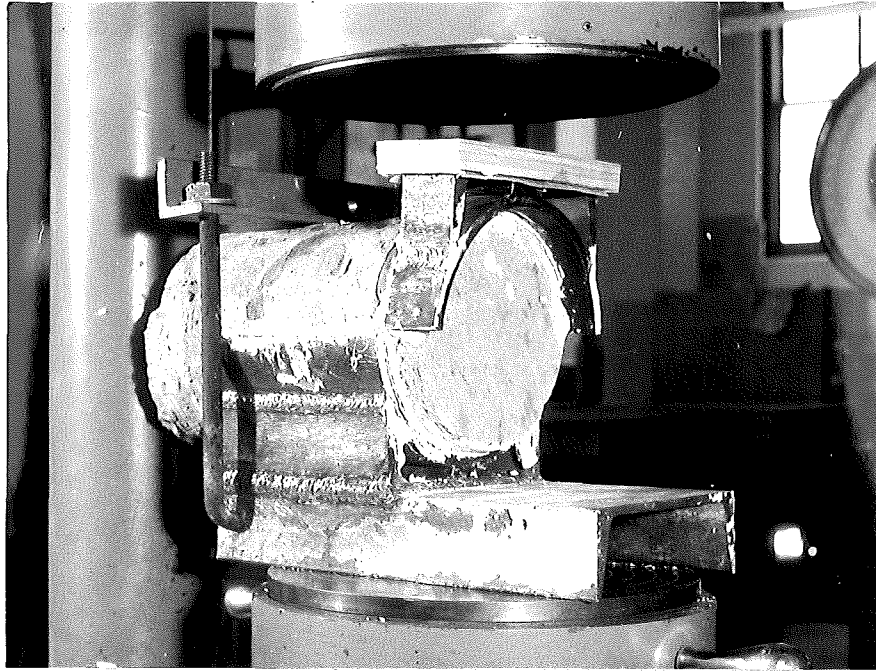


Figure 1. Test apparatus for shearing mortar cap from cylinder base.

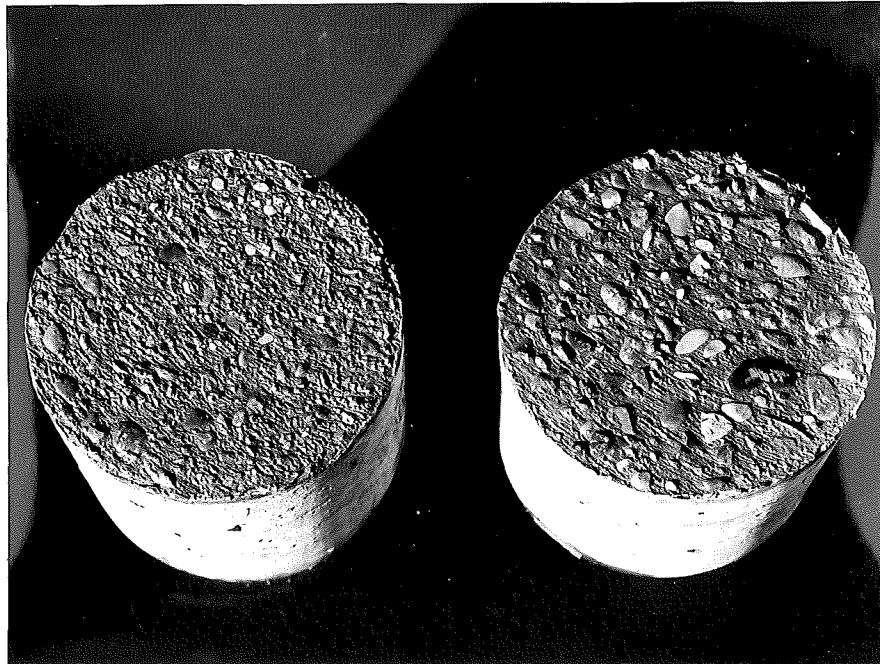


Figure 2. Typical surfaces formed by brushing laitance off of concrete cylinders after initial set.