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**DURABILITY OF EXPOSED AGGREGATE
WALL PANELS**

by

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MINERAL PROCESSING DIVISION

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DURABILITY OF EXPOSED AGGREGATE WALL PANELS

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F. E. Hanes* and N. G. Zoldners**

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SUMMARY OF RESULTS

Exposed aggregate wall panels of various mix designs composed of stucco topping rendered on a concrete base were tested by freezing and thawing cycling. A test period of 100 cycles was prescribed to assess the bonding characteristics between the stucco topping and the concrete base.

The exposed aggregate stucco topping showed a high degree of durability during the test.

The bond between the concrete and plain stucco mix was sound.

Samples containing Daraweld as a bonding agent and as an admixture in the stucco mix showed signs of efflorescence, cracking and separation.

Test results indicate that a sound bond between the stucco and concrete can be obtained with a low w/c ratio. It is also evident that care must be exercised where additives are to be used.

*Senior Scientific Officer and **Head, Construction Materials Section, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

Several samples of exposed aggregate wall-facing panels were submitted by the Schokbeton Quebec Inc., St. Eustache, P.Q., on May 6, 1964, for assessment of their durability. The two-inch thick concrete base slab was covered with a half-inch exposed aggregate stucco topping, prepared in different ways. The behaviour of the concrete base course during the test was of no consideration.

This type of stucco finishing has been proposed for the precast concrete wall panels designed for the additional multi-storey building to be erected at the Place Ville Marie development in Montreal.

Schokbeton Quebec Inc. requested freezing and thawing tests be made to assess the bond characteristics of the exposed aggregate stucco finish.

TEST SPECIMENS

A total of seven 12 x 12 in. wall test panels were received for testing. A covering letter of May 6 from Mr. J. Skrastins stated that the 2-in. thick concrete base slabs were cast on May 1, using an 8-bag mix with white cement and gravel aggregate. The mix was slightly retarded to secure a better bond with the 9.5 x 9.5 x 0.5 in. stucco layer which was rendered on the base course within 22 to 24 hours. Stucco was prepared with imported granitic pea-gravel exposed on the surface.

Panels were prepared as follows:

- (a) Two samples No. 1 - plain, no bonding agent used when stucco was applied.
- (b) Two samples No. 2 - Daraweld* added to the bonding paste.

*Daraweld - bonding agent, manufactured by Dewey and Almy Chemical Division of W.R. Grace & Co., Montreal 32, P.Q.

- (c) Two samples No. 3 - Daraweld added to the bonding paste and to the stucco mix.
- (d) One sample No. 4 - plain, as in No. 1, except that the concrete base was cured for 1 month.

TEST PROCEDURE

To study the effect of preparation methods on the relative durability of exposed aggregate stucco wall panels, test specimens were subjected to cycles of freezing and thawing applied according to a modified procedure based on ASTM Designation C 291-61T*. The nominal period of the freezing- and -thawing cycle is about 3 hours consisting of alternately lowering and raising the temperature between 0 and 40°F, producing about 8 cycles in a 24 hour period.

The standard procedure for this test method was altered by shortening the initial moist-curing time and by special arrangement of the test specimens in the freeze-thaw cabinet.

As soon as the test panels were received they were pre-soaked for 24 hours before being placed in the freeze-thaw cabinet. Cycling commenced on May 8.

Four of the test panels were placed vertically in a rack inside the freeze-thaw cabinet so as to be half-submerged during the thawing period of the cycles. Figure 1 shows two panels in the vertical test position; two have been removed for observation.

Three companion panels were placed, as shown in Figure 2, stucco-side up, so as to be completely submerged during the thawing cycle. Also shown are two thermocouples for temperature control.

*A Tentative Method of Test for Resistance of Concrete Specimens to Rapid Freezing in Air and Thawing in Water.

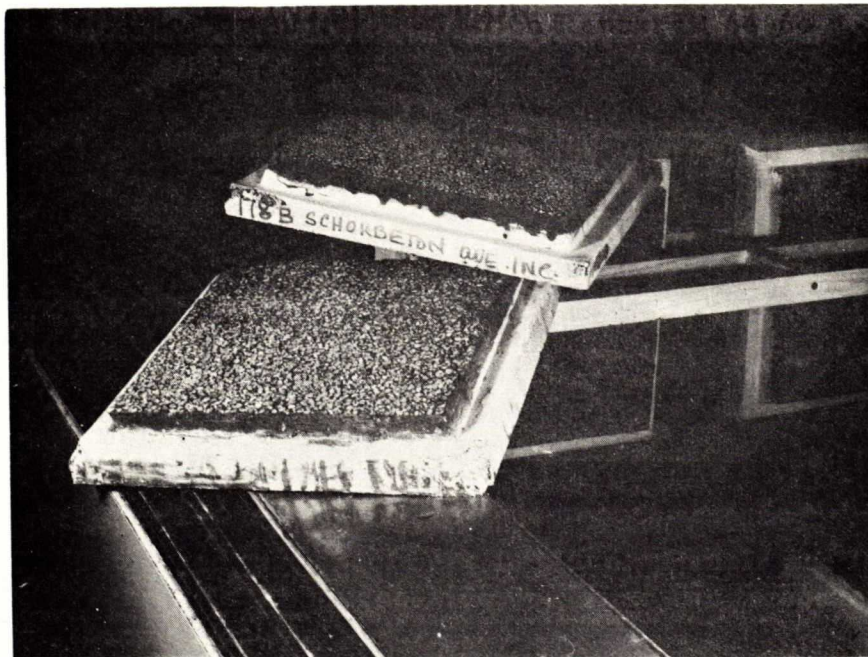


Figure 1. Half-submerged test specimens. Two samples are in vertical test position. Two are removed for observation.

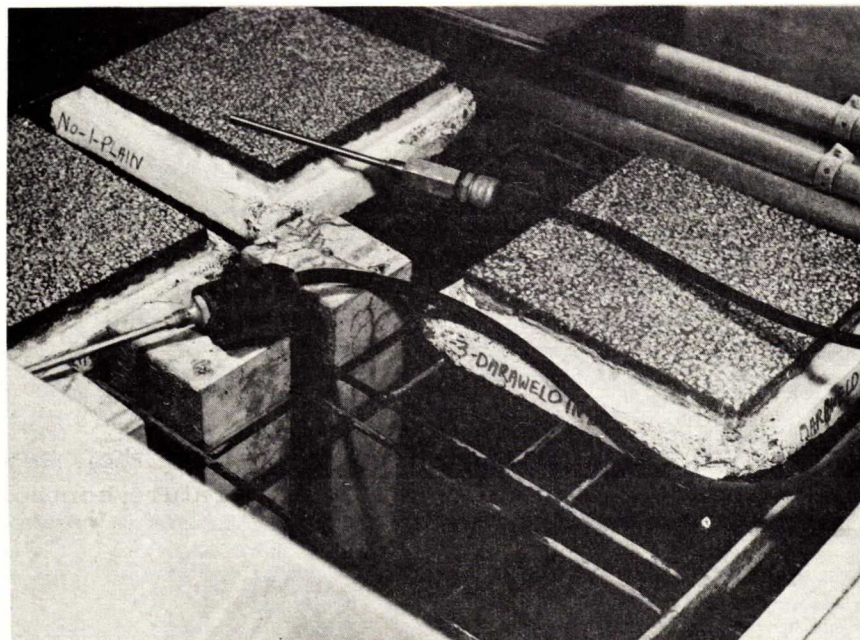


Figure 2. Submerged test specimens in place. Panels are located on racks with the stucco-side up. Note two temperature control thermocouples.

By this arrangement, each type of sample was tested in a half-submerged position, and all but one sample (No. 4), were tested completely submerged during the thawing cycles.

Because of the time limit set by Schokbeton (completion of testing was scheduled for the end of May) it was determined that 100 cycles of freezing and thawing would be sufficient to assess the relative durability of the stucco panels and the bonding between the stucco and concrete base.

TEST RESULTS

The test was completed on May 29, 1964, after 108 cycles of freezing and thawing. Upon completion of testing the panels were removed and inspected visually.

The half submerged and the totally submerged test panels were arranged in two groups, photographed and carefully examined for signs of deterioration.

The exposed aggregate surface of No. 3 (submerged) panel was examined under stereomicroscope petrographically.

The results of the examination are as follows:

General Evaluation

Exposed aggregate stucco in all cases was in good, sound condition after 108 cycles of freezing and thawing. Figure 3 shows the darker coloured area of the saturated submerged portion of the test panels.

The concrete bases were, for the most part, badly deteriorated, except for the non-saturated, upper portions of the half-submerged test specimens, as shown in Figure 4.

Bond of Stucco to the Base Course

The results of a detailed examination of the bond between the exposed aggregate stucco topping and concrete base course are compiled for the half-submerged test panels in Table 1 and for the fully-submerged panels in Table 2.

TABLE 1

Bond Failures - Half-Submerged Test Panels

Sample No.	Type of Stucco Mortar	Observations
1	Plain mortar	No visual cracks. Bond appears to be in excellent condition.
2*	Daraweld used in bonding paste.	Bond failure evident. Separation prominent and show of efflorescence along the cracks in the submerged portion of the sample (See Figure 4).
3*	Daraweld used in bonding paste and stucco mix.	Bond failure less evident; Fine cracks developing along the submerged portion with efflorescence deposited in hairline cracks.
4	Plain mortar on old concrete.	No visible cracks. Bond appears to be in excellent condition.

* Stucco mixed with Daraweld shows cloudy appearance on the surface of the exposed aggregate topping due to the presence of efflorescence.

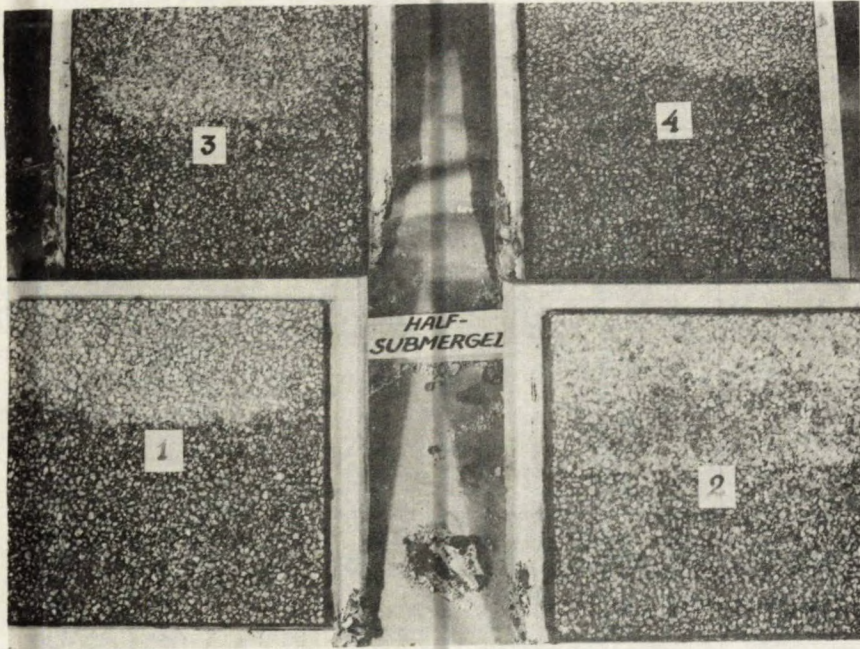


Figure 3. Specimens after test showing darker colour on the saturated lower half of the exposed aggregate stucco panel.

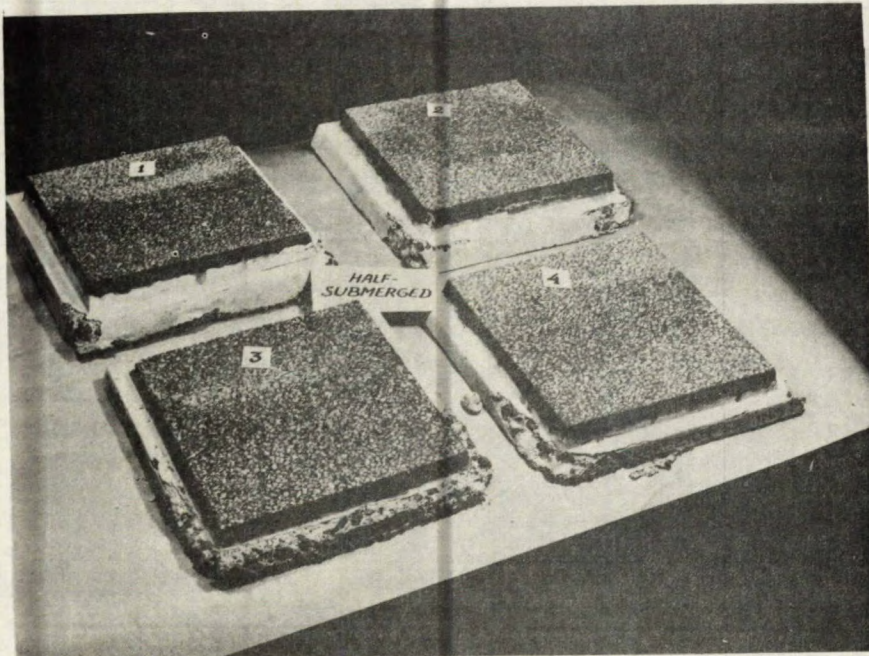


Figure 4. Specimens after test showing deterioration of the submerged portion of the concrete base slab.

TABLE 2

Bond Failures - Fully-Submerged Test Panels

Sample No.	Type of Stucco Mortar	Observations
1	Plain mortar	No visual cracks. Bond appears to be in excellent condition.
2	Daraweld used in bonding paste.	Efflorescence outlines fine cracking at the bond plane. No separation evident. (See Figure 5).
3	Daraweld used in bonding paste and stucco mix.	Cracks developing in stucco topping. Evidence of separation in several places with deposits of efflorescence along cracks. (See Figure 6).

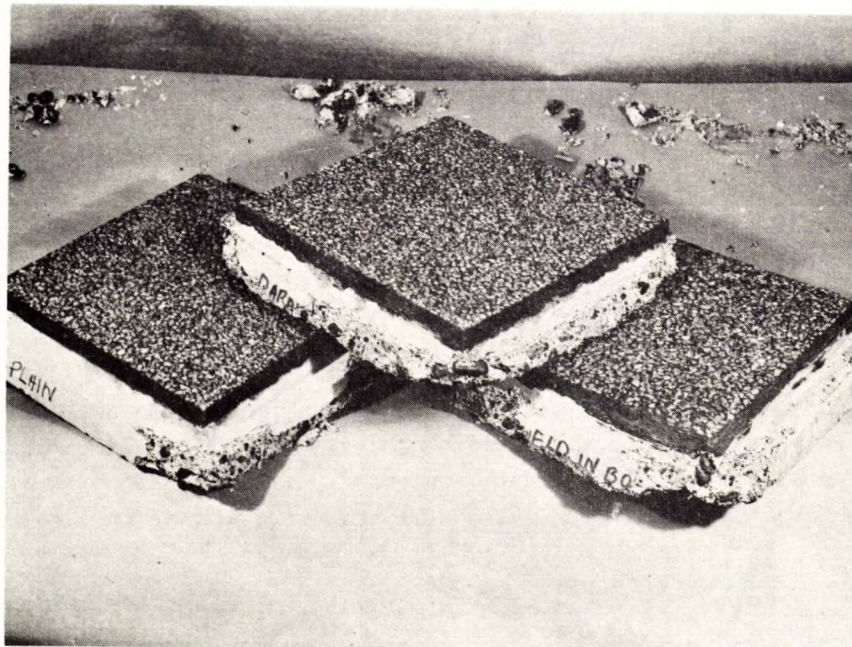


Figure 5. Fully-submerged specimens after test showing undamaged stucco finish and badly disintegrating concrete base slab.

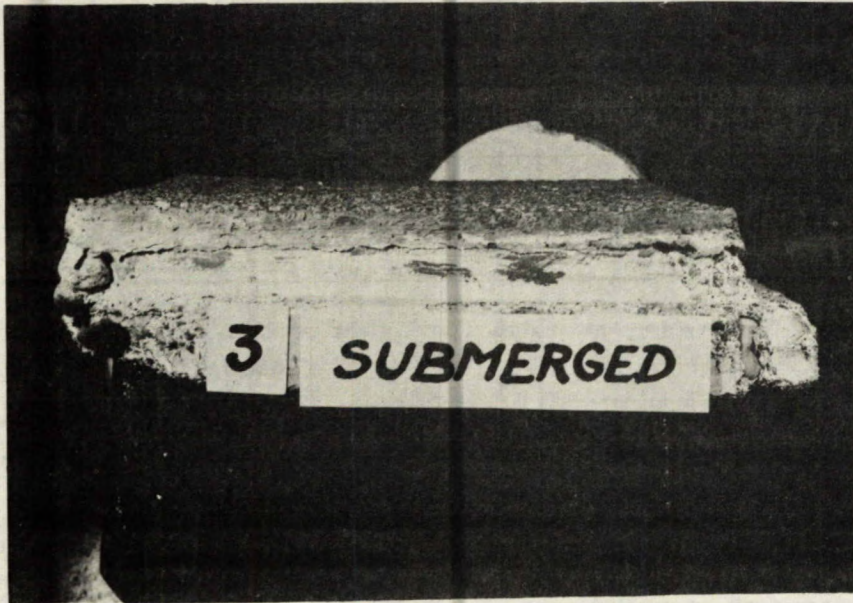


Figure 6. Fully-submerged No. 3 panel after test has developed bond crack and shows separation of the stucco layer.

PETROGRAPHIC EXAMINATION*

The exposed aggregate stucco layer showed no sign of weakness either from cracking or particle dislodgement. The mortar was tenacious and unfriable. The aggregate, graded roughly from 3/8 to 1/8 in. in size, consists of particles of sound granitic material. Linear traverses across a panel gave the approximate mineralogical analysis shown in Table 3.

*By J. A. Soles, Petrologist, Ore Mineralogy Section, Mineral Processing Division.

TABLE 3

Mineralogical Composition of Exposed Aggregate

Mineralogical Constituents	Approximate Percentage
Quartz	36
Potassium Feldspar	34
Sodium Feldspar	24
Amphibole	2
Biotite	2
Muscovite	1
Miscellaneous dark minerals	1
Total	100

The general composition of this aggregate is that of a granite. No breakdown of aggregate under normal weathering conditions would be expected.

DISCUSSION

The stucco layer showed no sign of shrinkage cracking. Apparently a very low w/c ratio was used in both the concrete base course and in the stucco layer. If larger panels are planned, it would be advisable to check on the differential shrinkage stresses between base course and topping.

These tests showed that good bond may be achieved also with topping placed on an old concrete base.

The use of Daraweld as a bonding compound does not appear to be advisable. Efflorescence resulted when it was incorporated in the bonding paste and in the stucco mixture.

A concrete low in frost-resistant properties should not be exposed to freezing temperatures in a saturated condition. The wall panel backing normally is not subjected to such conditions.

CONCLUSIONS

Based on experience with the samples submitted to us, the following conclusions appear to be valid:

- 1) The exposed aggregate topping is durable and can be used for external wall panels. The bond between the concrete and plain stucco mix was sound.
- 2) Samples No. 2 and No. 3 containing Daraweld (as indicated by the Company when samples submitted), showed degradation after 108 cycles of freezing and thawing. Cracking and efflorescence and, in some cases, separation of the mortar-stucco layer from the base course was sufficient to question the use of Daraweld under similar circumstances.
- 3) A stucco mix with a low water-cement ratio will also make a good bond with an old concrete base.

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