Pumice Pozzolan Improves Durability in Glass Fiber Reinforced Concrete:

Summary of Research on Hess UltraPozz

by the Department of Civil Engineering, Washington University in Saint Louis

Tom Harmon, Clifford Murphy Professor of Civil Engineeering, on behalf or Nippon Electric Glass Co., led a study using Hess UltraPozz (NCS-3) as an agent to mitigate the loss of strength and ductility in glass fiber reinforced concrete (GFRC) due to the interaction of alkalinity with AR glass.

Washington University in St. Louis

Durability of GFRC with the Addition of a Natural Pozzolan

Objective

Using accelerated aging testing (per ASTM C1560-03), and repeated stress and strain testing (per ASTM C947-03), four GFRC test panels, each with a different amount of pumice pozzolan additive, were used to determine improvement in GFRC durability imparted by an ultrafine pumice pozzolan.

Experimental Processes

Nippon Electric Glass Co. prepared four GFRC boards for the tests, each formulated with a different amount of pozzolan additive (Table 1). The panels were then cut into 2-inch by 12-inch strips and placed in hot water tanks. Strips from each panel type were kept in separate tanks. Temperatures were maintained at 50°C (122°F). At scheduled 10-day intervals over a 90-day period, six strips were removed from the tanks and subjected to four-point bending tests (Figure 1) using a split-test method: performed form-side up on three strips, and form-side down on the three remaining strips.

Test Results

Addition of 15% and 20% pozzolan—Did not show a strength improvement. Had little effect on ductility as measured by either stress or strain ratio.

Addition of 25% pozzolan—Performed very well and had the highest PEL, MOR, stress ratio, and strain ratio values over time. Surprisingly, the performance improved convincingly over the last month of the testing period, raising interesting questions regarding longer test periods and perhaps higher doses of pozzolan.

No pozzolan (Control)—The control mix demonstrated the highest initial ductility ratio (ratio of deflection at the MOR value to deflection at the LOP value), but the ductility ratio deteriorated over time to values significantly less than the value of the mix with 25% pozzolan.

HESS POZZ GRADES

Hess StandardPozz DS-325

PARTICLE SIZE SPECIFICATION	
Dx	Micron Size
D50	14-16

Hess UltraPozz NCS-3

PARTICLE SIZE SPECIFICATION	
Dx	Micron Size
D50	2 - 4

CHEMICAL COMPOSITION

Common Name: Pumice
Chemical Name: Amorphous Aluminum Silicate
Silicon Dioxide - 87.4%
Aluminum Oxide - 10.52%
Ferric Oxide - 0.194%
Ferrous Oxide - 0.174%
Sodium - 0.128%
Potassium - 0.099%
Calcium - 0.090%
Titanium Dioxide - 0.0074%
Sulfate - 0.0043%
Magnesium Oxide - 0.126%
Water - 1.11%

TEST PANELS

Four GFRC test boards were prepared by Nippon Electric Glass Co. with the following amounts of pumice pozzolan additive:

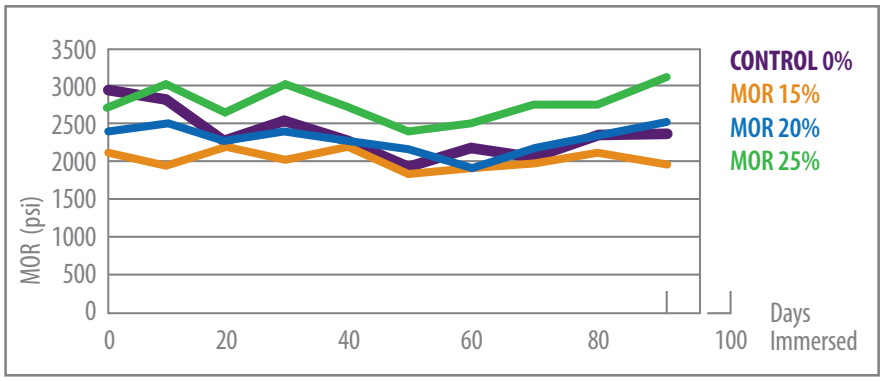
PANEL	POZZOLAN
1	None
2	15%
3	20%
4	25%

TABLE 1

Hess POZZ
IDAHO USA
1.800.767.4701 x 111
pozzinfo@hesspumice.com
www.hesspozz.com

MODULUS OF RUPTURE (MOR) STRESS

VERSES **TIME AGED AT 50°C**



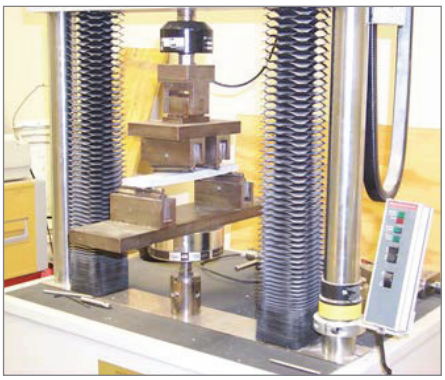
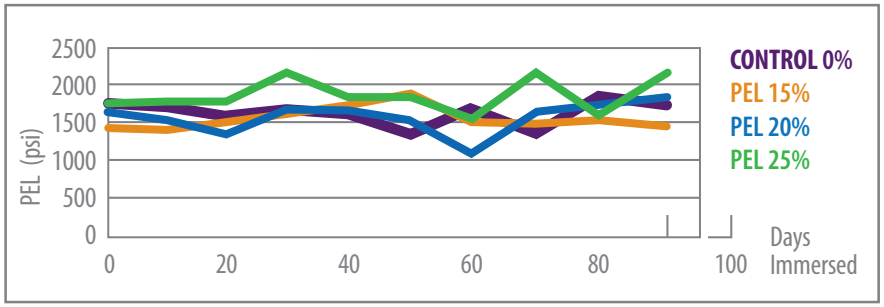


Figure 1 • Flex Test Setup

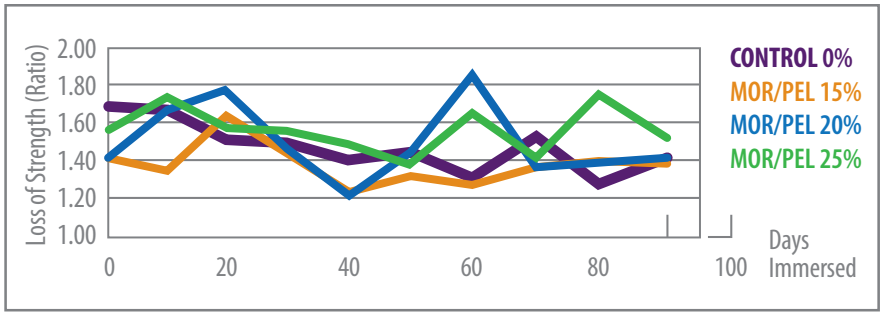
PROPORTIONAL ELASTIC LIMIT (PEL) STRESS

VERSES **TIME AGED AT 50°C**



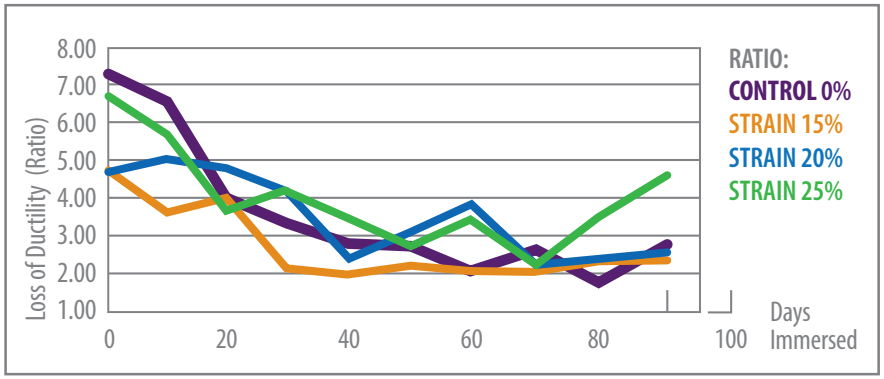
RATIO OF MOR STRESS TO PEL STRESS

VERSES **TIME AGED AT 50°C**



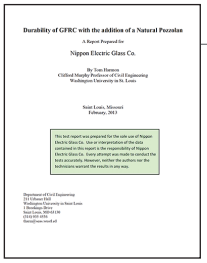
RATIO OF MOR STRAIN TO PEL STRAIN

VERSES **TIME AGED AT 50°C**



NOTE: See the full report from the Washington University in St. Louis for complete tabular data (10 tables, one each for 0 thru 90 days) of the test results quantifying:

- YIELD (load a yielding peak/maximum load),
- DISPLACEMENT (displacement at either yield or peak),
- PEL (maximum tensile stress corresponding to yield load)
- PEL STRAIN (strain corresponding to PEL),
- MOR (maximum tensile stress corresponding to peak load),
- MOR STRAIN (strain corresponding to MOR),
- MOR/PEL (ratio of MOR to PEL: a measure of the loss of strength due to aging), and
- MOR STRAIN/PEL STRAIN (ratio of MOR strain to PEL strain: a measure of the loss of ductility due to aging)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A Report Prepared for

Nippon Electric Glass Co.

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This test report was prepared for the sole use of Nippon Electric Glass Co. Use or interpretation of the data contained in this report is the responsibility of Nippon Electric Glass Co. Every attempt was made to conduct the tests accurately. However, neither the authors nor the Institutions warrant the results in any way.

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A PDF copy of the report can be downloaded at **www.hesspozz.com**

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Have questions?
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