Iowa Department of Transportation
Highway Division
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Special Report

EVALUATION OF THE CONCRETE ADMIXTURE GLA-ZIT

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ABSTRACT

A concrete admixture, Gla-Zit, was evaluated in 1970 by the Iowa State Highway Commission and found to be lacking in providing beneficial effects to conrete.

This current evaluation is similar to that conducted in 1970 with slight modifications in the actual concrete mixes studied. At the request of the manufacturer, all concrete mixes containing Gla-Zit were non-air entrained. Concrete properties examined were compressive strength, salt scaling resistance, absorption, resistance to chloride penetration, and freeze-thaw durability.

The differences found in the mixes studied are much more attributible to air entrainment, or the lack thereof, than the influence of Gla-Zit. The study re-affirms that it is necessary to have properly air entrained concrete to lessen the detrimental effects of freeze and thaw and scaling caused by salting.

There is no data in the study to suggest that Gla-Zit has any significant effect on any of the concrete properties examined.

Background

In 1970 a concrete admixture identified as Gla-Zit was submitted to the Iowa State Highway Commission for testing. The product was identified as being manufactured in Iowa Falls, Iowa by the Cle-Vac Company.

Concretes with and without Gla-Zit were tested to determine the effects of the product on various physical properties of the concrete. Specific properties evaluated were concrete strength, absorption, freeze-thaw durability, and salt scaling. It was concluded that Gla-Zit did not provide significant beneficial effects to concrete and specifying its use would be inappropriate.

In the latter half of 1982 it came to the attention of the Iowa D.O.T. that letters to the editor of the Cedar Rapids Gazette stated that the Department had been unresponsive by not using Gla-Zit. After subsequent correspondence a meeting was arranged to discuss the relative merits of this concrete admixture.

On October 22, 1982, a meeting was held in Ames between Mr. Bernard Brown, Testing Engineer, Iowa D.O.T. and Mr. O. M. Rogness, H & Q Sales Division of Gla-Zit Inc. It was Mr. Rogness' opinion that previous tests of Gla-Zit were unfair for various reasons including using a blended cement and evaluating the product in air entrained concrete. It was also asserted that D.O.T. technicians did not follow manufacturer's instructions in using the admixture.

While there was not agreement that the 1970 investigation was biased, it was agreed that a new evaluation would be made. It was Mr. Rogness' contention that Gla-Zit should be used and evaluated in non-air entrained concrete. There was a discussion and general disagreement over the benefits of air entrainment. It was finally agreed that the product would be used in non-air entrained concrete as Mr. Rogness proposed. Prior to any evaluation written agreement on the procedures to be used was obtained. It was agreed that Gla-Zit would be evaluated for it's effect on the strength, durability, absorption, chloride penetration, and salt scaling properties of concrete.

CURRENT EVALUATION

Concrete Mixes

Three concrete mixes were studied for all properties. Specimens were prepared from a basic C-3 paving mix with a cement factor of 604 lbs./yd.^{3}, as well as comparable non-air entrained mixes of the same cement factor with and without the Gla-Zit. Design absolute volumes of the mixes are as follows:

	Control Mixes		Gla-Zit Mix
	Air Entrained	Non-Air Entrained	
Cement	.114172	.114172	.114172
Water	.153840	.153840	.153840
Air	.060000	.000000	.000000
Fine Agg.	.301895	.331895	.331895
Coarse Agg.	.370093	.400093	.400093
	1.000000	1.000000	1.000000

The basic mix usually used by the D.O.T. Central Laboratory to evaluate concrete admixtures is an air entrained C-3 paving mix. Since any differences in concrete properties between the C-3 mix and the non-air entrained Gla-Zit mix may be due to the difference in the air void system rather than the admixture, it was necessary to also fabricate specimens from a non-air entrained mix that did not contain Gla-Zit. In this way the effect of either the Gla-Zit or the air entrainment can be isolated.

The normal approval method for concrete water reducing admixtures is to compare the compressive strength of a C-3 mix to a companion mix containing the water reducer and an 8% cement reduction. In this study an additional non-air entrained mix was prepared with Gla-Zit and an 8% cement reduction.

The design absolute volume of this mix is as follows:

Cement	.105038
Water	.141533
Air	.000000
Fine Aggr.	.339043
Coarse Aggr.	.414386
	1.000000

Materials

Materials used in the various concrete mixes were as follows:

Coarse Aggregate

Montour Quarry - Tama County

Specific Gravity 2.63

Absorption 1.78%

Gradation

Sieve No.	% Psg.
1 1/2"	100
1"	99
3/4"	84
1/2"	59
3/8"	39
No. 4	9.8
No. 8	3.5
No. 200	1.2

Fine Aggregate

Hallett Pit - Ames

Specific Gravity 2.67

Absorption 0.50%

Gradation

Sieve No.	%Psg.
3/8"	100
4	94
8	80
16	63
30	39
50	9.6
100	1.4
200	0.7

Cement

Type -- Type I
Mfg. -- Northwestern Cement Co. - Mason City, IA

Air Entraining Agent

Type -- Vinsol Resin
Brand -- Ad-Aire
Mfg. -- Carter Waters Corp. - Kansas City, MO

Water

City of Ames, IA

Admixture Under Study

Brand -- Gla-Zit
Mfg. -- Gla-Zit Inc. - Iowa Falls, IA
Iowa D.O.T. Lab No. - ACI2-244

Iowa D.O.T. Analysis

Solids	24.5%
Specific Gravity	1.22
Weight per Gallon	10.2 lbs.
Chloride Content	14.97%

All materials used, except for the Gla-Zit, complied with current Iowa D.O.T. specifications.

Mixing Procedure

All concrete mixes were batched in a 1 3/4 $ft.^3$ capacity open pan type Lancaster mixer. The mixing procedure consists of mixing for 3 minutes after all ingredients are added, resting, while covered, for an additional 2 minutes, followed by an additional 3 minutes of mixing. When Gla-Zit was used it was added in concentrated form at the beginning of the final 3 minute mixing period. The additional rate of the Gla-Zit was 4 fl. oz. per 100 lbs. of cement.

Coarse aggregate was in a saturated-surface dry condition prior to mixing. The fine aggregate was added in an air dry conditon.

The slump of all batches was controlled at 2 ± 1/2". The air content was controlled at 6.5 ± 0.5% when air entrained concrete was required. Mix temperatures were 70-75°F.

RESULTS

Compressive Strength

Six 6" X 12" horizontal compressive strength specimens were cast from each mix. All specimens were moist cured after removal from their molds after approximately 18 hrs. Three specimens were tested at 7 days and three at 28 days. Results are as follows:

Mix No. 1 - Air Entrained C-3 Control
Slump-2.0", Air Content 7.0%, w/c Ratio 0.435

Age-Days	Comp. Str.-P.S.I.
7	3410
	3480
	3520
	Ave: 3470
28	4240
	4390
	4470
	Ave: 4370

Mix No.2 - Non-Air Entrained Control
Slump 1.75", Air Content 2.0%, w/c Ratio 0.530

Age-Days	Comp. Str.-P.S.I.
7	4120
	4050
	3980
	Ave: 4050
28	5340
	5750
	5430
	Ave: 5510

Mix No. 3 Non-Air Entrained Gla-Zit
Slump 1.75",Air Content 2.0%, w/c Ratio 0.521

Age-Days	Comp. Str.-P.S.I.
7	3890
	4300
	4220
	Ave: 4140
28	5200
	5270
	5730
	Ave: 5400

Mix No. 4 Non-Air Entrained Gla-Zit
8% Cement Reduction, Slump 2.0", Air Content 2.0%, w/c Ratio 0.540

Age-Days	Comp. Str.-P.S.I.
7	3750
	3880
	Flaw in third cylinder
	Ave: 3820
28	4600
	4600
	5000
	Ave: 4730

Mix No. 5 Non-Air Entrained, No Admixtures
8% Cement Reduction, Slump 1.75", Air Content 2.6%,
w/c Ratio 0.576

Age-Days		Comp. Str.-P.S.I.
7		3540
		3680
		3550
	Ave:	3590
28		4880
		4690
		5180
	Ave:	4920

The standard C-3 paving mix represented by Mix No. 1 has lower strengths than the proposed Gla-Zit Mix No. 3 at both 7 and 28 days. Since one of the mixes is air entrained and the other is not, it has not been proven whether the strength difference is due to the Gla-Zit or to the different air-void systems.

To isolate the effects of the Gla-Zit on the compressive strength of concrete Mix No. 2 must be compared to Mix No. 3. Any strength differences between these mixes is minor (4050 p.s.i. vs. 4140 p.s.i. @ 7 days & 5510 p.s.i. vs. 5400 p.s.i. @ 28 days).

Comparing mixes 4 and 5 with an 8% cement reduction shows no significant difference in strength between concretes with and without Gla-Zit. Neither mix is as strong as the non-air entrained control (Mix No. 2).

The general conclusion that can logically be drawn after reviewing the strength results from the five mixes studied is that any strength differences shown in this study are directly related to the air entrainment properties of the concretes. There is no evidence to suggest that Gla-Zit has any significant effect on the strength of the concretes investigated.

Resistance to Salt Scaling

Salt scaling studies were conducted on the C-3 air entrained paving mix as well as comparable non-air entrained mixes with and without Gla-Zit.

Two 12" square slabs were cast for each conrete being studied. The slabs were 2 inches thick with the surface concaved to hold a salt solution. After an initial 24 hr. moist cure, the slabs were air cured an additional 6 days. After the curing period a 5% calcium chloride was placed on the specimens. The slabs containing the solution were placed in the freezer overnight and removed from the freezer for thawing during the day. One freeze-thaw cycle was accomplished each working day. The slabs were flushed every 5 cycles and a fresh solution applied.

The slabs were visually inspected and rated after 10, 20, and 25 freeze-thaw cycles. The rating scale used assigns the numerical values shown for various degrees of scaling.

Rating	Scale
0	No scaling
1	Slight scaling
2	Slight to moderate scaling
3	Moderate scaling
4	Moderate to heavy scaling
5	Heavy scaling

After 25 cycles, the control air entrained slab had a rating of 1 while both the Gla-Zit and control non-air entrained slabs had a rating of 5. It was originally intended to continue the test for 100 cycles, however the non-air entrained slabs had deteriorated to the point that the solution would leak through the slabs after 25 cycles causing an abrupt end to this portion of the evaluation.

It is concluded that Gla-Zit has no effect upon the scaling resistance of non-air entrained concrete. To effectively protect against salt scaling it is imperative that properly air entrained concrete be used.

Absorption & Resistance to Chloride Penetration

Gla-Zit is purported to impart waterproofing properties to concrete either when used as an admixture or when used in a cementitious coating. Materials that waterproof also generally prevent the intrusion of chloride ions.

A method for testing the absorption and chloride screening properties of concrete and concrete coatings was devised by Wiss, Janney, Elstner & Associates Inc. of Northbrook, Illinois and detailed in National Cooperative Highway Research Program Report 244. The method used to evaluate Gla-Zit is shown in Appendix C of NCHRP Report 244 with a 5 day air drying period. The method consists of casting two 4" cubes for each mix to be studied. After stripping the molds at age 1 day, the cubes are sealed in plastic bags. At the age of seven days the cubes are lightly sandblasted and weighed. After weighing the cubes are immediately returned to the plastic bags for 14 more days of curing. At age 21 days, the cubes are removed from the plastic bags and air dried. If a coating is applied to the cubes it will be applied after 5 days of air drying. At a total age of 52 days the cubes are immersed in a 15% NaCl solution for 21 days followed by an additional 21 days of air drying. Weighings are made during the drying and soaking process to establish absorption rates of the concretes. One of the two cubes for each conrete is crushed at age 94 days and the chloride content determined.

The specific mixes subjected to this evaluation were:

1. C-3 air entrained paving mix.
2. Non-air entrained mix with same cement factor as Mix 1.
3. Same as Mix 2 except the concrete contains Gla-Zit.
4. Identical to Mix 1 except the cubes were coated with a mixture consisting of 1 part Gla-Zit, 8 parts water, and sufficient Type 1 cement to obtain a mixture of paint like consistency. Prior to application of the coating the cube surfaces were thoroughly wetted. Two coats of the mixture were applied.

Results of the absorbtion and chloride tests are shown in Tables 1 and 2.

TABLE 1
AVERAGE WEIGHT CHANGE AFTER DRYING
IN AIR AT 70-75°F, 50 PERCENT R.H.

Mix No.	Weight Change After Days, % Days of Drying - Beyond 28 Days of Age				
	3 Days	8 Days	13 Days	20 Days	24 Days
1	-0.13	-0.24	-0.33	-0.42	-0.60
2	-0.17	-0.28	-0.36	-0.47	-0.52
3	-0.24	-0.28	-0.38	-0.50	-0.57
4	-0.65	-0.71	-0.79	-0.87	-0.91

Mix No. 1 - C-3 Air entrained paving mix
Mix No. 2 - Non-Air entrained, same cement factor as Mix No. 1
Mix No. 3 - Same as Mix No. 2 except containing Gla-Zit
Mix No. 4 - C-3 Mix coated with Gla-Zit mixture

TABLE 2
AVERAGE WEIGHT CHANGE DURING
SOAKING & DRYING PERIODS AND CHLORIDE CONTENT

Mix No.	Weight Change After Days of Soaking, %							Weight Change After Days of Drying, %						Chloride Content lb/yd^3
	3	6	10	12	14	18	21	3	6	10	14	18	21	
1	3.04	3.13	3.23	3.23	3.26	3.30	3.30	2.54	2.19	1.91	1.72	1.57	1.49	11.5
2	3.03	3.07	3.14	3.15	3.18	3.19	3.19	2.43	2.09	1.82	1.16	1.47	1.38	12.1
3	2.56	2.63	2.71	2.71	2.75	2.72	2.74	2.06	1.78	1.56	1.38	1.25	1.17	11.8
4	3.18	3.26	3.35	3.36	3.36	3.40	3.39	2.45	2.09	1.81	1.60	1.46	1.40	12.5

Mix No. 1 C-3 Air Entrained Paving Mix
Mix No. 2 Non-air entrained, same cement factoras Mix No. 1
Mix No. 3 Same as Mix No. 2 except containing Gla-Zit
Mix No. 4 C-3 Mix coated with Gla-Zit mixture

Chloride Content of Unsoaked C-3 Concrete 0.3 lb/yd^3
Chloride Content of Unsoaked Gla-Zit Concrete 0.5 lb/yd^3

The absorption of the concrete containing Gla-Zit was slightly less than concrete not containing the Gla-Zit, as shown in the 21 day soaking tabulation in Table 2. The difference, (2.74% vs. 3.30% & 3.19%) however, is not considered to be significant to the degree that the product would normally be thought of as an effective water proofer. The Gla-Zit when applied in a coating mixture also did not prove to be effective.

The chloride content of the cubes after soaking as shown in Table 2 confirms the ineffectiveness of all the concretes regarding absorption. The 11 to 12 lb/yd^3 chloride contents obtained are ten times higher than what is normally regarded as the chloride content necessary to initiate corrosion of reinforcing steel.

The results of this study can be compared to results of concrete coated with what are considered to be effective concrete sealers. Effective sealers will typically show absorptions of less than 1% and chloride contents of less than 1 lb/yd^3 when tested in a similar manner. Comparing this to the results obtained in this study of approximately 3% absorption and 11 to 12 lb/yd^3 of chloride provides another basis for concluding the Gla-Zit is ineffective as a water proofer.

Freeze-Thaw Durability

The freeze-thaw durability of the C-3 air entrained paving mix and companion non-air entrained mixes with and without Gla-Zit was determined.

Freeze-thaw testing is done in accordance with ASTM C-666, "Resistance of Concrete to Rapid Freezing and Thawing", Method B, except the specimens are 18 inches long and the specimens are moist cured 90 days prior to the beginning of the freeze-thaw testing. The average durability factor is calculated for each concrete mix.

The durability factors for the C-3, non-air entrained control and non-air entrained Gla-Zit mixes were 81, 3, and 7 respectively. This is a classic example of how properly air entrained concrete increases the freeze-thaw resistance of concrete. While the non-air entrained Gla-Zit concrete had a slightly higher durability factor than the non-air entrained control (3 vs. 7) the difference is insignificant when compared to the benefits of air entrainment.