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Technical Report

WATER-RESISTING ADDITIVES IN CONCRETE MASONRY UNITS

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Project 2326

ELASTIZELL CORPORATION OF AMERICA
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INTRODUCTION

At the request of Mr. M. P. Rosenthaler of the Besser Company, the Elastizell Corporation of America sponsored tests at the Alpena Cement Products Company involving the use of several water-resisting additives in concrete masonry units. These tests were conducted under the direction of Professor L. M. Legatski of The University of Michigan.

SUMMARY

The tests were started on January 5, 1957, at which time 7 different batches of concrete masonry units were manufactured using 3 different commercially available water-resisting additives—Kreelon 4G, calcium stearate, and Elastimulse.

Testing of specimens was limited to 3 tests, as follows:

1. Compressive strength based on gross area
2. Water absorption when submerged 24 hours
3. Water absorption when placed in 1/4 inch of water for 24 hours

Tests 1 and 2 showed little difference between the effect of the various additives on compressive strength and on water absorption of a submerged specimen.

Test 3, which simulates more nearly than does Test 2 the usual exposure condition of masonry units in a wall, showed that units treated with Kreelon absorbed 26% as much water as untreated units. Those treated with calcium stearate absorbed 27% as much and those treated with 4% Elastimulse absorbed 62% as much as untreated units.

MIX PROPORTIONING

The tests were designed to give a comparison of the effectiveness of the 3 additives when used in commercial production; therefore, the normal proportioning of the Alpena Cement Products Company was not altered in any way (see Table I).

TABLE I

PROPORTIONING OF TEST BATCHES

Batch No.	Batch Size	Cement lb	Sand lb	Pea Stone lb	Water gal	Additives		
						Name	Add/Cement	Quantity
1	Full	500	3000	1500	10*	Kreelon 4G	---	5 tbls.
2	1/2	250	1500	750	7**	Elastimulse	.01	2.5 lb
3	1/2	250	1500	750	6**	Elastimulse	.02	5.0 lb
4	1/2	250	1500	750	6**	Elastimulse	.03	7.5 lb
5	1/2	250	1500	750	6**	Elastimulse	.04	10.0 lb
6	1/2	250	1500	750	6**	None	0	0
7	1/2	250	1500	750	6**	Cal. Stearate	.0096	2.39 lb

*Measured by Alpena Cement Products Meter
**Measured by Elastizell Corporation Meter

CURING

The concrete masonry units were cured in the usual commercial manner which consists of 8 hours in a steam kiln with temperatures up to 180°F, after which they are allowed to air-dry for several weeks.

TESTING

Specimens were selected at random for testing but any specimen that displayed cracks or other serious defects was rejected. Tests 1 and 2 were patterned after ASTM Designation C 140-55, entitled "Sampling and Testing Concrete Masonry Units."

TEST 1

Compressive Strength of Gross Area.—Five specimens from each batch were capped with Hydrastone to provide plane bearing surfaces and were broken at The University of Michigan Structural Laboratory, yielding strengths as shown in Table II.

TABLE II
(TEST 1)
COMPRESSIVE STRENGTH OF GROSS AREA

Batch No.	Block No.	Dry Weight grams	Ultimate Load lb	Ultimate Strength psi	Avg. Dry Weight grams	Avg. Ult. Strength psi
1	A	17,910	241,700	2,025		
1	B	17,820	249,000	2,090		
1	C	17,710	227,000	1,905	17,732	1,997
1	D	17,800	231,200	1,940		
1	E	17,420	241,500	2,025		
2	A	17,250	154,000	1,295		
2	B	17,195	163,750	1,375		
2	C	17,050	157,000	1,320	17,187	1,331
2	D	17,210	159,000	1,335		
2	E	17,230	158,500	1,330		
3	A	17,450	206,500	1,735		
3	B	17,395	199,000	1,670		
3	C	17,480	191,500	1,610	17,436	1,638
3	D	17,435	193,500	1,625		
3	E	17,420	184,750	1,550		
4	A	17,270	177,000	1,485		
4	B	17,355	190,000	1,595		
4	C	17,210	178,500	1,500	17,353	1,520
4	D	17,590	179,800	1,510		
4	E	17,340	179,800	1,510		
5	A	17,040	172,500	1,450		
5	B	17,430	216,000	1,810		
5	C	17,075	200,500	1,680	17,353	1,662
5	D	17,570	188,500	1,580		
5	E	17,650	213,300	1,790		
6	A	17,370	195,300	1,640		
6	B	17,100	167,000	1,435		
6	C	17,300	180,000	1,510	17,276	1,501
6	D	17,310	171,500	1,440		
6	E	17,300	176,500	1,480		
7	A	17,565	221,500	1,860		
7	B	17,440	214,500	1,800		
7	C	17,400	202,400	1,700	17,386	1,700
7	D	17,125	199,000	1,670		
7	E	17,400	175,000	1,470		

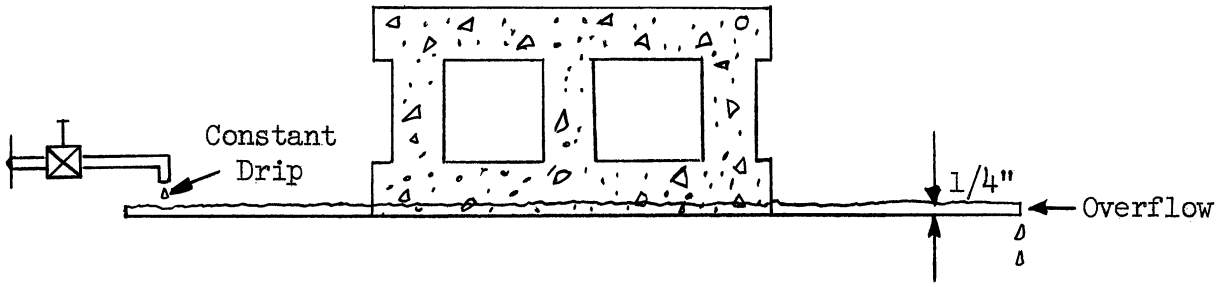
TEST 2

Water Absorption - Submerged 24 Hours.—Five specimens from each batch were submerged in water for 24 hours and were weighed while suspended with metal wire and completely submerged. After removal from the water, they were allowed to drain for one minute, visible surface water being removed with a damp cloth, and immediately weighed. The results of this test are as shown in Tables III and V.

TEST 3

Water Absorption by Capillary Action - Faces of Units in 1/4 Inch of Water for 24 Hours.—This test is not a standard test for concrete masonry units, but it is believed by the director of this project and also by the author of this report that such a test more closely represents the water conditions encountered in concrete masonry construction than does Test 2. The results of Test 3 are shown in Tables IV and VI.

The specimens were exposed to water as shown in the sketch below, for Test 3.



DISCUSSION OF TEST RESULTS

The results of these tests followed a logical pattern in that strength generally increased with density for the units containing Elastimulse and absorption decreased as the quantity of Elastimulse was increased.

Considering only units containing either Kreelon, calcium stearate, or 4% of Elastimulse, absorption varies from 3.81% to 4.22% of the dry weight when submerged for 24 hours and from 0.325% to 0.779% of the dry weight when placed in 1/4 inch of water for 24 hours. Test 2 is not conclusive but Test 3 clearly indicates that Kreelon is the best of the three additives used, followed by calcium stearate and 4% Elastimulse in that order.

TABLE III
(TEST 2)
WATER ABSORPTION - SUBMERGED 24 HOURS

Batch No.	Block No.	Dry Weight grams	Suspended Weight grams	Wet Weight grams	Absorption PCF	Absorption Percent
1	F	17,820	10,200	18,520	5.25	3.93
1	G	17,720	10,114	18,430	5.33	4.01
1	H	17,890	10,170	18,525	4.74	3.55
1	J	17,485	9,945	18,130	4.91	3.69
1	K	17,720	10,128	18,405	5.11	3.87
2	F	17,157	9,630	17,930	5.82	4.51
2	G	17,252	9,715	18,040	5.91	4.57
2	H	16,865	9,520	17,645	5.99	4.63
2	J	17,085	9,656	17,950	6.52	5.06
2	K	16,860	9,640	17,660	6.23	4.74
3	F	17,090	9,710	17,885	6.07	4.65
3	G	17,340	9,815	18,080	5.58	4.27
3	H	17,100	9,700	17,852	5.75	4.40
3	J	17,405	9,890	18,140	5.56	4.22
3	K	17,160	9,720	17,875	5.48	4.17
4	F	17,420	9,790	18,060	4.83	3.67
4	G	17,395	9,820	18,110	5.38	4.11
4	H	16,950	9,620	17,745	6.11	4.69
4	J	17,255	9,725	18,015	5.72	4.41
4	K	17,250	9,800	18,025	5.88	4.49
5	F	17,535	9,915	18,195	4.97	3.76
5	G	17,130	9,740	17,860	5.60	4.26
5	H	17,150	9,790	17,990	6.39	4.89
5	J	17,495	9,950	18,225	5.51	4.17
5	K	17,460	9,890	18,085	4.76	3.58
6	F	17,395	9,980	18,210	6.18	4.68
6	G	16,995	9,775	17,855	6.64	5.06
6	H	17,330	9,960	18,205	6.62	5.04
6	J	17,395	9,997	18,220	6.25	4.74
6	K	17,395	10,010	18,280	6.68	5.09
7	F	17,190	9,785	17,890	5.39	4.07
7	G	17,580	9,990	18,250	5.06	3.81
7	H	17,360	9,915	18,175	6.15	4.70
7	J	17,510	9,967	18,270	5.71	4.34
7	K	17,565	10,030	18,300	5.55	4.18

TABLE IV
(TEST 3)
WATER ABSORPTION - CAPILLARY ACTION - 24 HOURS

Batch No.	Block No.	Dry Weight grams	Wet Weight grams	% Absorption (% of Dry Wt.)
1	L	17,885	17,930	0.252
1	M	17,878	17,943	0.363
1	N	17,670	17,710	0.226
1	O	17,975	18,033	0.323
1	P	17,930	18,013	0.463
2	L	16,829	17,045	1.283
2	M	16,757	16,970	1.271
2	N	17,259	17,445	1.078
2	O	17,277	17,467	1.101
2	P	17,164	17,365	1.172
3	L	17,140	17,380*	1.40
3	M	17,452	17,620	0.964
3	N	17,444	17,578	0.768
3	O	17,098	17,280	1.064
3	P	17,083	17,265	1.065
4	L	17,298	17,480	1.052
4	M	17,337	17,487	0.807
4	N	17,066	17,230	0.961
4	O	17,394	17,522	0.736
4	P	17,036	17,215	1.050
5	L	16,836	16,985	0.812
5	M	17,514	17,707	1.102
5	N	17,460	17,535	0.429
5	O	17,524	17,662	0.787
5	P	17,521	17,655	0.765
6	L	17,312	17,520	1.202
6	M	17,285	17,475	1.100
6	N	17,490	17,685	1.115
6	O	17,330	17,555	1.297
6	P	17,410	17,680	1.550
7	L	17,572	17,670	0.559
7	M	17,533	17,595	0.353
7	N	17,562	17,612	0.285
7	O	17,309	17,360	0.295
7	P	17,172	17,208	0.210

*Rejected from average - cracks in exposed face

TABLE V
(TEST 2)
WATER ABSORPTION - SUBMERGED 24 HOURS

Batch No.	Additive Used	Avg. Dry Weight grams	No. of Specimens Averaged	Average Absorption (% of Dry Wt.)
1	Kreelon 4G	17,727	5	3.81
2	1% Elastimulse	17,044	5	4.70
3	2% Elastimulse	17,219	5	4.34
4	3% Elastimulse	17,254	5	4.27
5	4% Elastimulse	17,354	5	4.13
6	None	17,302	5	4.92
7	Cal. Stearate	17,441	5	4.22

TABLE VI
(TEST 3)
WATER ABSORPTION - CAPILLARY ACTION - 24 HOURS

Batch No.	Additive Used	Avg. Dry Weight grams	No. of Specimens Averaged	Average Absorption (% of Dry Wt.)
1	Kreelon 4G	17,868	5	0.325
2	1% Elastimulse	17,057	5	1.181
3	2% Elastimulse	17,269	4	0.965
4	3% Elastimulse	17,226	5	0.921
5	4% Elastimulse	17,371	5	0.779
6	None	17,365	5	1.253
7	Cal. Stearate	17,430	5	0.340

For the units containing Kreelon, calcium stearate, or 4% of Elastimulse, strength varies from 1662 psi to 1997 psi, with the highest strength group varying approximately 12% from the average and the lowest strength group approximately 7% from the average. These differences are not great enough to conclude that any one of the additives has any more effect on strength than either of the others.

In concrete masonry production, density and strength are partially dependent on proper proportioning. Throughout the mixing of the test batches, the water requirement was determined by the operator. His determination of correct water content depended on the appearance of the cement in a sample of the batch which was rubbed against a metal pipe. This method does not take into account the changes in appearance of the cement through the addition of additives with which the operator is unfamiliar and may therefore result in improper proportioning.

CONCLUSIONS

A study of the test data leads to the following conclusions.

1. Within rather narrow limits the masonry units containing Kreelon 4G showed greater strength and density than similar units containing either calcium stearate or Elastimulse. In general, the compressive strength varied directly with density. The variation in density cannot be said to be caused by the additive used, since the water was varied according to the judgment of the operator. The variation in water alone is enough to account for the differences in density and strength.

2. If water absorption is measured (as in Test 3) as the percent of dry weight absorbed when one face of the unit is immersed in water, Kreelon 4G is found to be the most effective of the additives tested, followed by calcium stearate and Elastimulse in that order. Test 3 seems to be a more reasonable way to measure water resistive of blocks than tests like Test 2 which require complete immersion of the unit. The conditions of Test 3 more nearly simulate actual conditions of use.

3. After observing the mixing of the concrete and the manufacture of the blocks used in these tests it is apparent that accurate proportioning of materials is most important in the manufacture of high quality block. Total water in the mix should be carefully measured. The effectiveness of any additive can be largely cancelled by inaccurate proportioning.