OFFICE MEMORANDUM

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

October 19, 1964

To: E. A. Finney, Director
Research Laboratory Division

From: M. G. Brown

Subject: Summary of Laboratory Evaluation of "Silexore" Protective Coatings for Concrete. Research Project R-63 NM-101.
Research Report No. R-479.

The following memorandum summarizes chemical and physical tests performed in the Research Laboratory on the subject material to evaluate its use as a protective coating on horizontal surfaces of concrete structures, in accordance with a decision of the July 30, 1963 meeting of the Committee for the Investigation of New Materials. The Silexore material was reported by its distributor, J. W. Rylands Co., of Southfield, Michigan, to have promise as a coating protecting structural concrete surfaces from the action of ice removal salts.

Silexore is described in company literature as a two-caot system for masonry or concrete surfaces and reportedly has been used in Europe for about 100 years primarily as a masonry coating on exterior walls of numerous buildings. Silexore is a clear viscous liquid, weighing about 9.8 lb per gal, and is brushed or sprayed on the clean surface to be coated, as a clear coat or with added colored pigments. The second coat consists of Silexore with 4 percent by volume of clear "Impexore" solution added, with or without colored pigment. The Impexore is described as a waterproofing silicone additive. Normal rates of application per coat described are 150 sq ft of rough masonry surface per gal of Silexore or Silexore-Impexore liquid. Pigment reportedly is used at 10 to 20 lb per gal of Silexore liquid.

Summary of Chemical Tests

In late 1963 a gallon each of clear Silexore and Silexore containing Impexore, plus 6 lb of a No. 6 pale gray pigment were received for testing. Analysis of these samples by the Spectroscopy and Photometry Section disclosed that both of the clear Silexore liquids are water solutions containing 25-percent potassium silicate by weight. The Impexore additive in the Silexore second coat imparted 1 percent silicone solids, by weight, to the stock liquid. Trace amounts of sodium silicate, chloride, and sulfate were found which were normal for technical grade potassium silicate. Analysis of the No. 6 pale gray pigment resulted in the following percentages:

Calcium Carbonate ($CaCo_3$)	56.7
Silica (SiO_2)	24.3
Zinc Oxide (ZnO)	17.3
Iron Oxide (Fe_2O_3)	1.4
Loss on drying	0.2

Summary of Physical Tests

Three types of physical laboratory tests were performed on concrete specimens coated with both clear and pigmented Silexore to assess their value in protecting structural concrete from the destrictive action of ice removal salts and water in freeze-thaw exposures. Specimens made with both non air-entrained and air-entrained concrete were tested using 6.0 sacks of cement per cubic yard of concrete and a 3/4-in. maximum size gravel coarse aggregate.

The attached four tables contain the results of tests performed on these concrete specimens coated with clear and pigmented Silexore, a boiled linseed oil-naphtha mixture for comparison, and on uncoated control specimens. All specimens were made according to approved methods, moist cured 14 days, and air cured in the laboratory 7 days prior to application of the test coatings. Tests were started after specimens cured a total of 28 days (14 moist and 14 in laboratory air).

Table 1 contains results of absorption tests run on specimens totally immersed in water for intervals of 6 hr, and 1, 2, 3, and 7 days. Specimens used were 4- by 8-in. cylinders, tested in duplicate with all surfaces coated. The cylinders were immersed on their sides in water at 75 F so that the upper portion was covered with 1/2-in. of water. Surfaces of specimens were wiped free of water, weighed, and replaced in water for continuation ot the test.

Tables 2 and 3 contain results for cut sections of cast beams coated on all six faces and completely immersed in 3-percent sodium and calcium chloride solutions while being subjected to one cycle per day of slow freezing and thawing between 0 and 70 F. The beam sections for test were approximately 3- by 3- by 4-in. Failure was indicated when the concrete began to crumble or crack and excessive weight loss occurred.

Table 4 gives results of scaling tests performed on 8- by 12- by 2-in. slabs of non-air-entrained concrete (about 2.0-percent air) covered with approximately 1/4-in. of a 3-percent sodium chloride solution. These were exposed to one daily cycle of slow freeze-thaw between 0 and 70 F. The surfaces were rated periodically on a 0-to-10 scale for degree of scaling, with 0 denoting no scale and 10 denoting 100-percent heavy or deep scale.

Summary

The data presented in Table 4 indicate that the double coat system of clear Silexore had an equivalent rating to the double application of linseed oil-naphtha in inhibiting the scaling of non-air-entrained concrete exposed to deicing salts in these tests. The gray pigmented Silexore did not appear to offer much benefit. Also, when using the pigmented Silexore the pigment content had to be reduced to about 5 and 10 lb per gal of clear Silexore liquid for the first and second coats, respectively, since the 20 lb suggested in company literature for the second coat was definitely too high for workability and brushing consistency.

Although the scaling slab results in Table 4 indicate clear Silexore and linseed oil-naphtha surface treatments to be comparable, the data for the early absorption and freeze-thaw durability tests of immersed specimens in Tables 1, 2, and 3, show the clear Silexore (and also the pigmented) to have a slightly inferior rating to the linseed oil-naphtha coating. These laboratory tests were run on both air-entrained and non-air-entrained concrete specimens.

The two-coat clear Silexore system would cost about 11.4 cents per sq ft of surface for material when applied at the prescribed rate of 150 sq ft per gal for each coat. This compares with only 2/3 cents per sq ft or 6 cents per sq yd for the linseed oil-naphtha treatment when applied at 300 sq ft per gal for each coat.

OFFICE OF TESTING AND RESEARCH

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TABLE 1
WATER ABSORPTION TESTS
4- by 8-in. Cylinders

Series		Coating	Percent Absorption - Immersion Period*				
			6 hr	1 day	2 days	3 days	7 days
Non-Air-Entrained Concrete (1.9-percent air)	K	Blank-Control	1.6	2.1	2.3	2.4	2.5
	D	Linseed Oil-Naphtha (2 coats)	0.3	1.7	2.1	2.2	2.3
	C	Clear Silexore (2 coats)	1.6	1.7	1.9	2.0	2.1
	G	Gray Silexore (2 coats)	1.8	2.0	2.1	2.2	2.3
Air-Entrained Concrete (6.5-percent air)	K	Blank-Control	1.6	1.8	2.0	2.1	2.3
	D	Linseed Oil-Naphtha (2 coats)	0.4	1.2	1.5	1.7	2.0
	C	Clear Silexore (2 coats)	1.5	1.4	1.6	1.7	1.9
	G	Gray Silexore (2 coats)	1.5	1.4	1.5	1.6	1.7

* Each percentage figure is average of two specimens.

TABLE 2
FREEZE-THAW TESTS IN BRINE
Non-Air-Entrained Concrete (2.0-percent air)

	Series	Coating	Specimen Weight after Total Cycles Indicated, grams					
			Initial	5	10	15	20	25
Immersed in 3-percent Sodium Chloride Solution	K	Blank-Control	1161	1160*	--	--	--	--
			1206	1173	--	--	--	--
	D	Linseed-Naphtha	1199	1209	1211	1216	1217	1221
			1253	1261	1265	1272	1271	1266
	C	Clear Silexore	1229	1247	1243	--	--	--
			1164	1192	--	--	--	--
	G	Gray Silexore	1171	--	--	--	--	--
			1174	1198	1186	1147	--	--
Immersed in 3-percent Calcium Chloride Solution	K	Blank-Control	1171	1163	--	--	--	--
			1187	1171	--	--	--	--
	D	Linseed-Naphtha	1206	1213	1217	1219	--	--
			1305	1314	1318	1324	1325	--
	C	Clear Silexore	1236	1254	--	--	--	--
			1103	1117	1110	--	--	--
	G	Gray Silexore	1207	1216	1215	1172	--	--
			1151	1167	1164	1087	--	--

* Last weight figure in grams for each pair of test blocks indicates failure for given number of cycles due to excessive cracking or weight loss.

TABLE 3
FREEZE-THAW TESTS IN BRINE
Air-Entrained Concrete (6.6-percent air)

Series		Coating	Specimen Weight after Total Cycles Indicated, grams							
			Initial	5	10	15	20	30	40	50**
Immersed in 3-percent Sodium Chloride Solution	K	Blank-Control	1092	1114	1218*	--	--	--	--	--
			1131	1163	1152	--	--	--	--	--
	D	Linseed-Naphtha	1121	1130	1135	1143	1144	1146	1148	1148
			1126	1154	1155	1163	1163	1164	1165	1161
	C	Clear Silexore	1209	1226	--	--	--	--	--	--
			1142	1174	1174	1180	1178	1177	1177	1175
	G	Gray Silexore	1164	1185	1185	1185	1185	1189	--	--
			1111	1143	1139	1137	1137	1137	--	--
Immersed in 3-percent Calcium Chloride Solution	K	Blank-Control	1178	1199	1200	1206	1204	1206	1207	1205
			1115	1143	1141	1151	1150	--	--	--
	D	Linseed-Naphtha	1162	1172	1177	1186	1186	1188	1190	1186
			1106	1130	1136	1142	1142	1163	1145	1140
	C	Clear Silexore	1169	1187	1189	1193	1194	1194	1198	1194
			1131	1159	1161	1166	1165	1165	1170	1165
	G	Gray Silexore	1177	1198	1196	1196	1198	1203	--	--
			1128	1165	1162	1160	--	--	--	--

* Last weight figure in grams for each pair of test blocks indicates failure for given number of cycles due to excessive cracking or weight loss.

** All specimens that had not failed before 50 cycles continued to 70 cycles without failure.