MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

October 30, 1950

TO: W. W. McLaughlin
Testing and Research Engineer

SUBJECT: Inspection of Marshall Creek Aggregate Pavement Group, US-2, Marenisco East and West. Research Project 47 A-7, Report No. 154.

During the week of September 11 to 15 the writer, accompanied by J. C. Brehler, made an inspection of a group of pavements constructed with fine and coarse aggregates from two pits in the Marshall Creek area to evaluate their performance in service. These two sources are listed in the 1950 Inventory as the Marshall Creek Pit and the Boniface Lumber Co. Pit and are located on opposite sides of M-64, 5.1 miles northeast of the east junction of M-64 and US-2. Both pits are within sight of the road, the Marshall Creek pit being on the north and the Boniface pit on the south side. According to laboratory reports at the time of construction, the aggregates from these two sources were similar in grading and physical characteristics but the two pits will be referred to specifically by their respective names throughout this report.

The occasion of the inspection was the proposed use of aggregates from the Marshall Creek pit in the construction of Project F 27-25, C7, Wakefield to Tula on M-28. Bank run samples were taken from the Marshall Creek pit to determine present characteristics of the material, but these samples will be superseded by produced material from the plant now in operation there.

Projects visited are shown in the sketch of Figure 1 and listed consecutively in Table 1, beginning at Wakefield and continuing east on US-2. Some of these pavements contained Champion aggregates from two separate sources and were included for comparison. Comments on the individual projects follow.

1. F-27-24, C3, Wakefield East. This pavement was built in 1939 with Champion fine and coarse aggregates from the Beechwood pit and Petoskey cement. The condition of the surface was generally good with little scale. See Figure 2.

2. NRH 27-29, C2. Continuing east from previous project, built with aggregates from the same source and 5 years older. This surface was also in good condition with very little scale, but contained about two or three transverse cracks per 100-ft. slab. Badger cement from Manitowoc was used here. See Figure 3.

General Remarks

Although the Marshall Creek and Boniface projects were not as uniformly durable as some of those where other aggregates were used, there is enough good pavement in the group to demonstrate that perfectly satisfactory concrete can be made with aggregates from these sources. Air entrainment should be particularly beneficial to these aggregates. The sand is quite coarse, with only about 5 percent passing the No. 50 sieve, and the air bubbles should supplement the grading sufficiently to produce a concrete of good workability.

Inadequate maintenance is a factor contributing to the deterioration of concrete at some of the joints. Most of the joints examined looked as though they hadn't been sealed in a long time.

Samples of both fine and coarse aggregates from the plant now in operation at the Marshall Creek pit are being sent to the Research Laboratory for durability tests in mortar and concrete. In addition, cores are being taken from each of the projects described above for examination and testing.

C. C. Rhodes
Research Laboratory
Testing and Research Division

CCR:shl

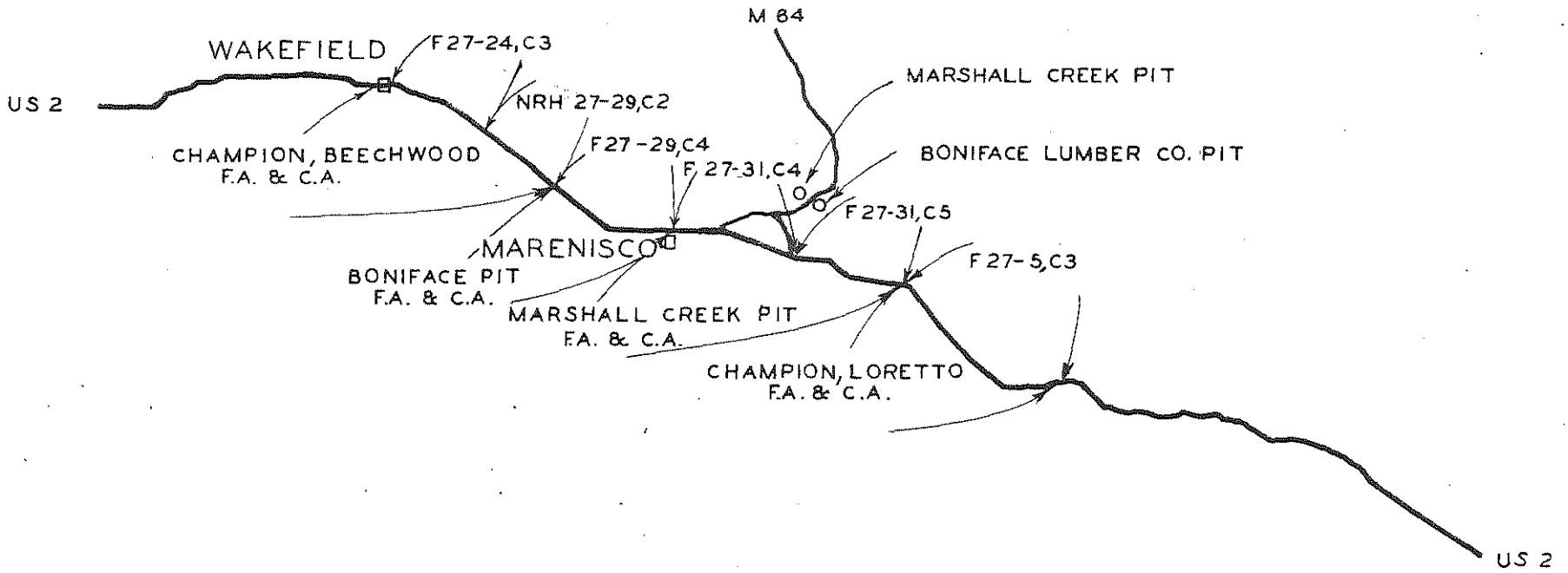

FIGURE 1. CONCRETE PAVING PROJECTS, US 2, WAKEFIELD EAST

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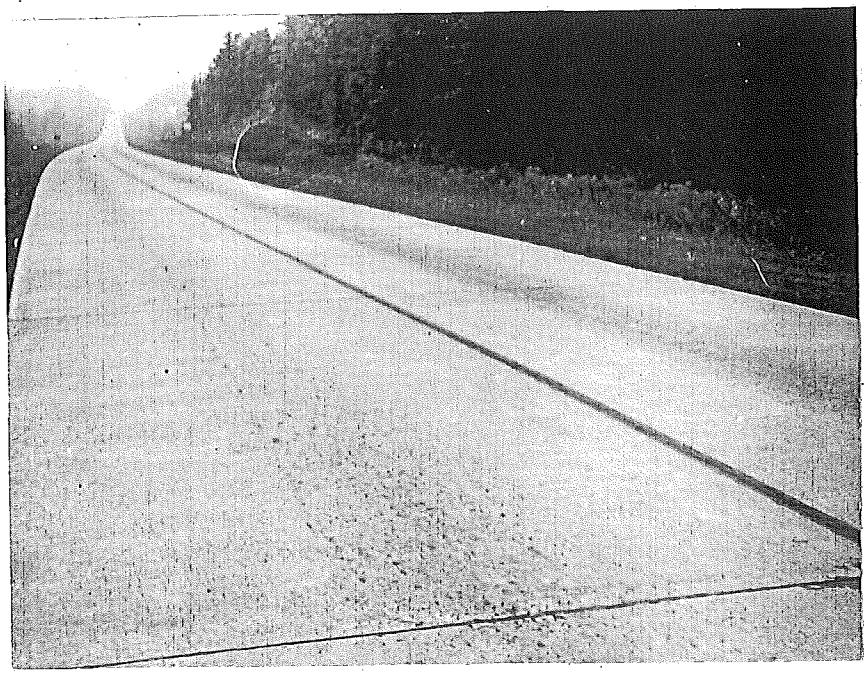

Figure 2. Project 27-24, C3, built in 1939. Champion fine and coarse aggregates, Beechwood. Good surface, little scale. General view west from Sta. 307+00.

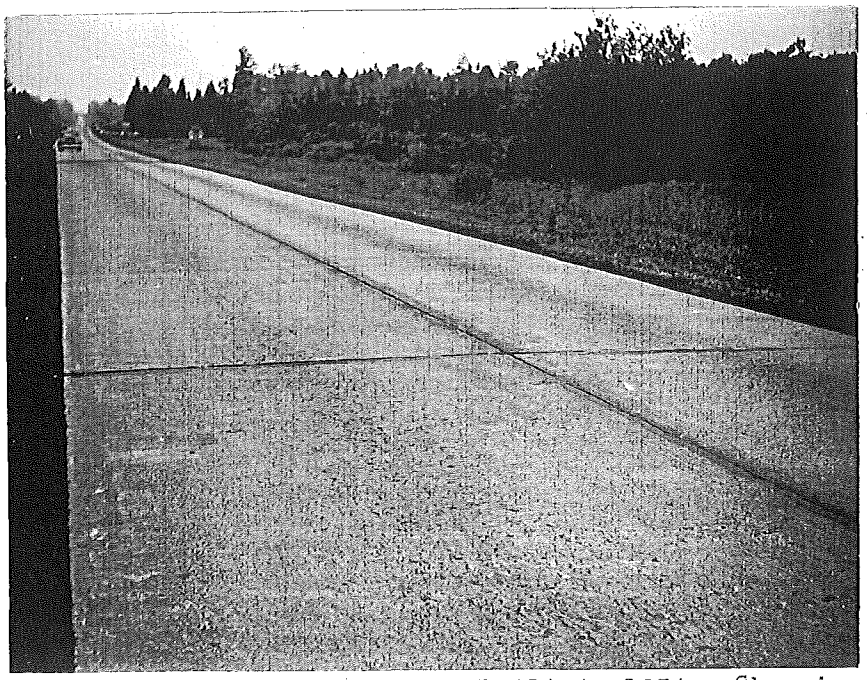

Figure 3. Project NRH 27-29, C2. Built in 1934. Champion fine and coarse aggregates, Beechwood. Surface shows little scale but has about two or three transverse cracks per 100-ft. slab. General view west from Sta. 447+00.

Figure 4. General view west showing junction of Project 27-29, C2 with Champion-Beechwood aggregates in background and 27-29, C4 with Boniface aggregates in foreground. Picture shows heavy scale at 622+50 on Project 27-29, C4.

Figure 5. Construction joint between pours of 10-15-35 (foreground) and 7-31-36, Project 27-29, C4, Boniface aggregates. Note difference in condition of concrete on opposite sides of joint, Sta. 720+70. Same condition exists at other end of day's pour.

Figure 6. Joint to bridge approach at Little Presque Isle River, Sta. 697+74, Project 27-29, C4. Boniface aggregates and Petoskey cement. Bridge approach in foreground.

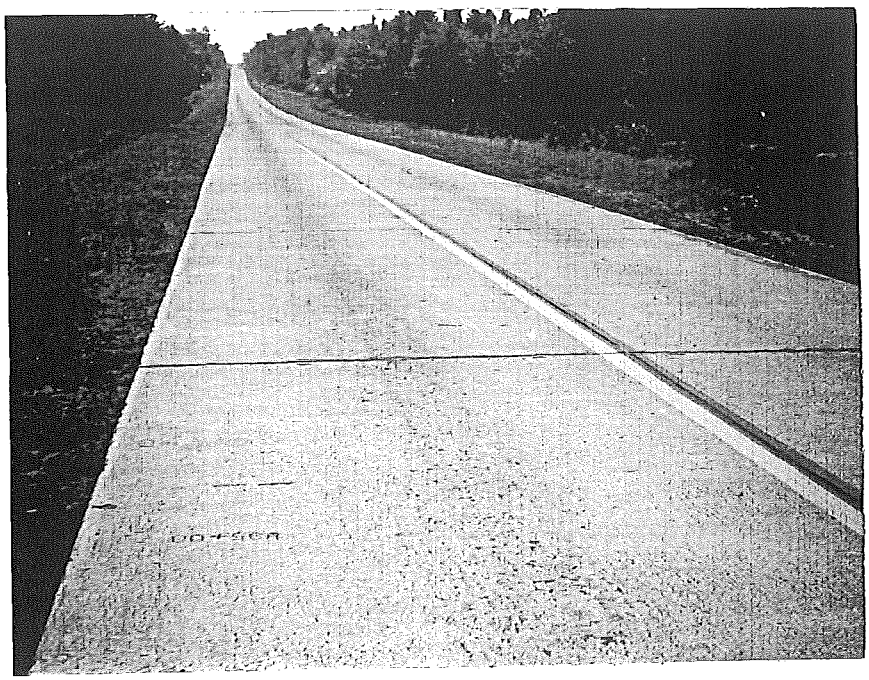

Figure 7. Looking west on Project 27-29, C4 from Sta. 896+00, showing general good condition of surface. Boniface aggregates.

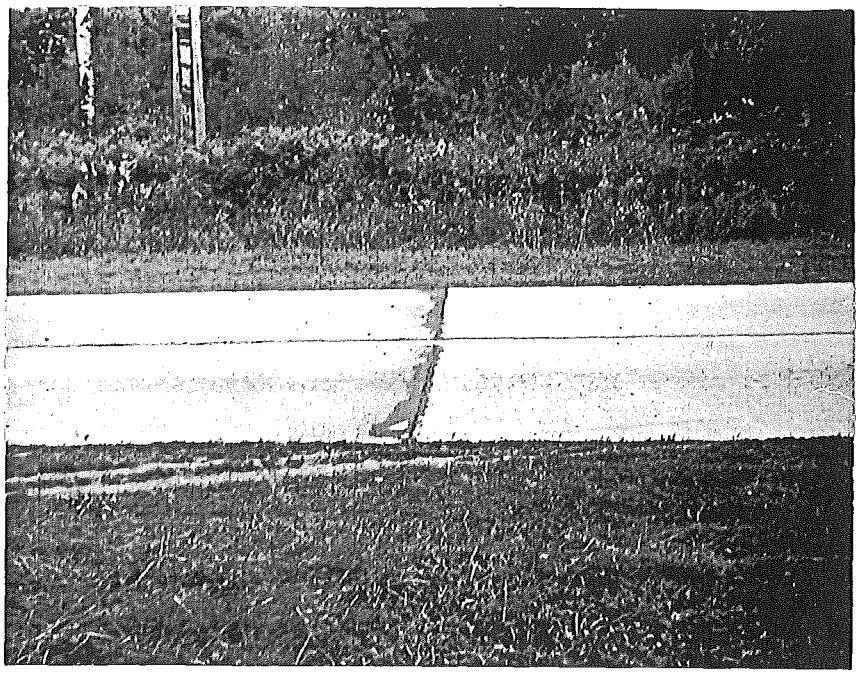

Figure 8. Junction of Projects 27-31, C5, left (Sta. 1470+13.2) and 27-5, C3, right. Marshall Creek aggregates on left, Champion of Loretto on right. Note difference in color of the two surfaces.

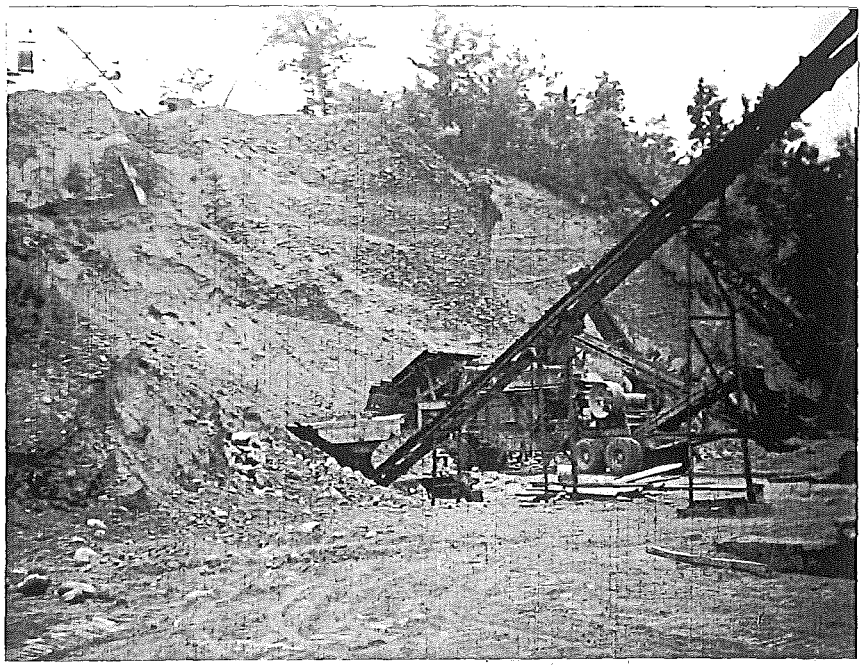

Figure 9. West Bank of Marshall Creek Pit.

November 16, 1951

TO: W. W. McLaughlin
Testing and Research Engineer

SUBJECT: Tests of Marshall Creek Aggregates and Cores from Pavements on US-2, Marenisco East and West. Research Project 47 A-7. Supplementing Report No. 154 dated October 30, 1950.

REPORTED BY: C. C. Rhodes

Just a year ago, we reported to you on an inspection of pavements on US-2 containing aggregates from the Marshall Creek area. The immediate purpose of the inspection was to evaluate the performance of pavements containing these aggregates with a view to their possible use in future construction, specifically Project F 27-25, C7, Wakefield to Tula. The inspection was supplemented by tests of cores from the projects involved and of processed aggregates sampled from the Marshall Creek pit, and it is the purpose of this supplementary report to give the results of these tests. All indications from these subsequent tests support the conclusion of the original report that satisfactory concrete can be made with Marshall Creek aggregates.

Core Tests

In all, 10 cores were taken from the Marshall Creek pavement group, which included two projects containing aggregates from the Marshall Creek pit, one project with Boniface aggregates, one project with Champion of Loretto, and two with Champion of Beechwood. These cores were first tested for static modulus of elasticity, then cut into three discs. The top and bottom sections were put in the freezing and thawing test and the center sections tested for compressive strength. At the end of 145 cycles of freezing and thawing, the test had progressed sufficiently to bring out the essential differences between the core sections and was discontinued to make way for other laboratory projects.

Results of the core tests are given in Table 1. Compressive strengths of all cores are satisfactory and quite uniform. Modulus of elasticity values at the three loads likewise are quite uniform and normal with the exception of two rather high values and one low one. One of the cores having a high modulus was from the project containing Loretto aggregates, but the other high value and the low one were obtained on cores from adjacent scaled areas on a project built with Boniface aggregates.

Keeing in mind the fact that none of these concretes contained entrained air, there are three points worthy of note in the freeze-thaw tests: 1) the bottoms of the cores almost invariably were much more durable than the tops; 2) there is a noticeable difference in quality of the concrete from the two Marshall Creek projects, 27-31, C4 and 5: and 3) the quality of the concrete from the latter of these two Marshall Creek projects compares very favorably with that of the concrete containing Loretto aggregates. These three points taken together, specially the uniformly high durability of the core bottoms, indicate that, with the entrainment of proper amounts of air according to present practice, Marshall Creek aggregates should produce acceptable concrete. Pictures of the core sections at 25 cycles of freezing and thawing are shown in Figure 1.

Tests of Laboratory Molded Specimens

In addition to the core study, two sets of mortar and concrete beams, one with regular and the other with an entraining cement, were made in the laboratory using processed fine and coarse aggregates from the Marshall Creek pit only. Grading of the aggregates is given in Table 2 and shows the characteristic coarseness of the sand. Results of the freezing and thawing tests of these beams are given in Table 3, and indicate the enormous improvement in durability imparted by air-entrainment to concrete containing aggregates of this kind. Durability of the concrete beams made with Type I cement was on the low side of the average for Michigan aggregates in the freeze-thaw test, but not excessively so. Good aggregates from Lower Peninsula sources have been going about 16 to 18 chcles in non-air-entraining concrete. So far, we haven't been able to account completely for the apparently much greater durability of mortars over concretes containing aggregates from the same source. This has been characteristic of all our concrete and mortar tests, and shows up again here in the high freeze-thaw record of mortar beams with both Type I and IA cements.

Concluding Remarks

All of our work in this investigation leads to the conclusion previously expressed that Marshall Creek aggregates, while not the best, are capable of producing specification concrete of good durability. With air entrainment especially, there should be no doubt about the satisfactory performance of these aggregates in future projects, provided principles of good practice are followed in construction.

This concludes our work on the Marshall Creek aggregates.

E. A. Finney
Ass't. Testing & Research Engineer
in charge of Research

EAF-em

cc: C. H. Cash
J. C. Brehler

TABLE I

SUMMARY OF CORE TESTS

Core No.	Project	Station	Aggregate Source	Year Built	(1) Comp. Strength psi.	Secant Modulus 10^6 psi., at: 500 psi.	1000 psi.	2000 psi.	(2) Cycles F&T to Failure: top	bottom	Remarks
1052	27-24, C3	437+97	Beechwood	1939	7,220	3.69	3.97	4.37	55	145+	
1053	27-29, C2	444+97	Beechwood	1939	5,150 (3)	----	----	----	85	(4) 30	
1054	27-29, C4	714+75	Boniface	1936	6,755	4.31	4.56	4.86	45	125	
1055	27-29, C4	715+62	Boniface	1936	5,660	7.23	6.90	6.16	30	145	Scaled area
1056	27-29, C4	718+45	Boniface	1937	6,030	2.53	2.85	3.25	25	135	Scaled area
1057	27-31, C4	945+12	Marshall Creek	1937	6,465	4.26	5.89	5.00	35	145+	
1058	27-31, C4	974+10	Marshall Creek	1937	6,055	4.04	5.93	4.77	35	145+	
1059	27-31, C5	1252+02	Marshall Creek	1937	6,195	5.55	5.73	5.30	115	145+	
1060	27-31, C5	1299+17	Marshall Creek	1937	6,700	4.38	4.71	4.99	130	145+	
1061	27-5 , C3	393+20	Loretto	1929	7,285	6.78	6.80	6.85	145+	135	

(1) Compressive strength determined on center sections of cores and corrected to conform to a cylinder whose height is twice its diameter.

(2) Frozen and thawed in plain water to complete disintegration.

(3) Honeycombed on bottom, not suitable for test.

(4) Bad bottom; see preceding note.

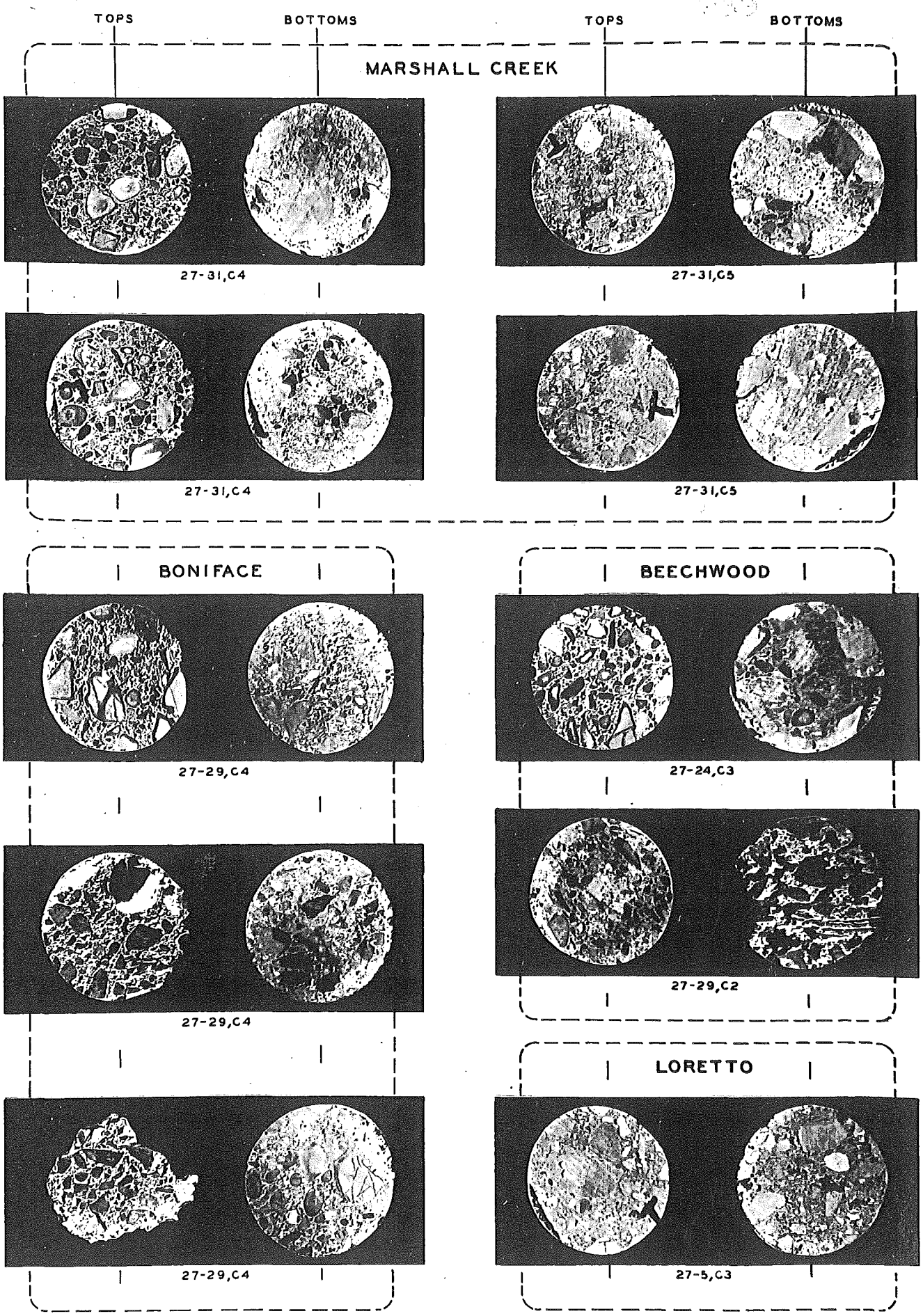

FIGURE 1 CONDITION OF CORE SECTIONS AFTER 25 CYCLES OF FREEZING AND THAWING IN WATER

TABLE II

PHYSICAL CHARACTERISTICS OF MARSHALL CREEK AGGREGATES

	Specification		
	4A	10A	2NS
Total passing:			
Sieve	Percent	Percent	Sieve / Percent
2½ in.	100	-----	3/8 in. 100
2 in.	100	-----	No. 4 91.8
1½ in.	76.4	100	No. 8 75.4
1 in.	11.1	95.0	No. 16 52.7
½ in.	0.6	43.4	No. 30 26.4
3/8 in.	0.4	-----	No. 50 7.3
No. 4	-----	3.2	No. 100 2.1
No. 200	0.2	0.2	No. 200 1.5
Absorption, percent	0.93	0.96	1.24
Sp. Gr., Bulk, wet basis	2.76	2.73	2.72
Organic Plate	-----	-----	I
Fineness Modulus	-----	-----	3.44

TABLE III

SUMMARY OF CONCRETE AND MORTAR TESTS
MARSHALL CREEK FINE AND COARSE AGGREGATES

Type of Cement	Air Content, Percent	Cycles F. & T. to 50 percent Reduction in Modulus
	Concrete Beams, 3 x 3 x 15 in.	
I	1.8	13.2
I-A	5.1	200 +
	Mortar Beams, 2 x 2 x 12 in.	
I	2.9	200 +
I-A	6.6	200 +