



OFFICE MEMORANDUM

DATE: March 15, 1976

TO: L. T. Oehler
Engineer of Research

FROM: H. L. Patterson

SUBJECT: Strength Comparison Between Water Reducer Concretes of Portland-Pozzolan and Type 1A Cements. Research Projects 71 NM-284 and 72 B-91. Research Report No. R-993.

Research work conducted in the laboratory and field between 1972 and 1974 produced two new concepts with respect to pavement and base course concrete: first, in an April 2, 1975, letter to you on "Water Reducers in Concrete Pavement," M. G. Brown reported that a cement reduction could be effected without loss of strength when a water-reducer admixture was used with Type 1A cement; second, in my March 4, 1975, letter to you on "Recommendations for Acceptance of Pozicon and 1P Pozzolanic Concrete as Equal Alternates for Use in Slip-Formed Concrete Pavements and Median Barriers," I reported that an approved portland-pozzolan cement could be substituted for Type 1A cement without any loss of strength or performance. Both of these recommendations were approved by the Engineering Operations Committee but some concern was expressed regarding the possibility that the same cement reduction allowed for water-reduced Type 1A cement would also be applied to portland-pozzolan cements. The cement reduction inherent in the portland-pozzolan proportioning plus the further reduction permitted by water-reducers had not been evaluated for pavement concrete.

The Engineering Operations Committee decided that until further test work established the equality between water-reduced portland-pozzolan and 1A cements that only a reduction in Type 1A cement would be approved. The Supplemental Specification dated May 28, 1975, followed this policy.

Additional laboratory work was undertaken to determine the comparability of Type 1A and portland-pozzolan cements when used at a reduced level with water-reducing admixtures. The work consisted of determining the 7 and 28-day compressive strengths of the corresponding mixes that had comparable slumps and entrained air levels. Six 4 in. by 8 in. cylinders were cast and continuously moist cured until three each were tested at the age of 7 and 28 days. The portland-pozzolan cements used were the Dundee Type 1P cement and a mixture of Huron Type 1 cement and "Pozicon," the beneficiated fly ash produced by Michigan Ash Sales. These cements were then

tested against their respective control cements: Dundee Type 1A and Huron Type 1. Table 1 shows the mix design, the entrained air and slump measurements of the fresh concrete, and the 7 and 28-day compressive strength values from the test cylinders. These results indicate that, in general, the portland-pozzolan cements performed very favorably in comparison to their controls. No explanation is available for the strength gain characteristics of the Dundee Type 1A cement which showed very low gain from the 7 to 28-day cure. These results are in basic agreement with the median barrier project (IS 25032-05292A) which also used a water-reducer in conjunction with a portland-pozzolan cement. The results of tests made on cores taken from that project are shown in Table 2. The report of that project has been written and is awaiting processing.

No freeze-thaw specimens were included with the work shown in Table 1 because all laboratory and field work accomplished to date indicate that portland-pozzolan concretes are superior in freeze-thaw durability to their corresponding conventional concretes.

On the basis of the favorable results from this work, I believe that we can now extend to the portland-pozzolan cements, the same cement reduction associated with water-reducers that we have allowed for the Type 1A cements. This would apply to either a Type 1P (1PA) cement or the proper combination of Type 1A and fly ash. This reduction, however, should be confined to the pavement concretes, as an independent study is currently in progress to evaluate the field performance of portland-pozzolan concretes in bridge structures.

TESTING AND RESEARCH DIVISION


Physical Research Engineer
Concrete and Surface Treatments Group

HLP:bf

TABLE 1
MIX DESIGN AND STRENGTH COMPARISON OF WATER-REDUCED
CONTROL AND POZZOLAN CONCRETES

Grade	Type of Concrete	Concrete Mix Design Components Per Cubic Yard											Fresh Concrete Properties			Average Compressive Strength (psi)	
		Cement		Pozicon	Mix Water Ratio	Aggregate			6.5 Percent Entrained Air, cu ft	Admixtures		Slump, in.	Entrained Air, percent	7 Day	28 Day		
		Units	lb			FA TA Ratio	Fine 2NS	Coarse 6AA Gravel		W-R Pozz, 82, fl oz	AE MBVR, fl oz						
Type 1 Huron Cement with Pozicon Fly Ash																	
30P	Control	Wt	5.2	489	--	214.2	0.438	1149	---	2018	--	20.8	1.3	2	7.1	3530	4750
		Vol	---	2.50	--	3.43	---	7.14	0.370	12.16	1.77						
	Pozzolan	Wt	4.8	451	68	208.8	0.463	1124	---	2018	--	19.2	2.4	1-3/4	6.7	3590	4660
		Vol	---	2.30	0.44	3.35	---	6.98	0.365	12.16	1.77						
35P	Control	Wt	5.6	526	--	215.7	0.410	1169	---	1963	--	22.4	1.4	2-1/2	5.6	3950	5230
		Vol	---	2.68	--	3.46	---	7.25	0.380	11.83	1.77						
	Pozzolan	Wt	5.1	480	72	208.8	0.435	1148	---	1963	--	20.4	2.6	2-1/4	6.1	3660	5050
		Vol	---	2.45	0.47	3.35	---	7.13	0.376	11.83	1.77						
Type 1A and Type 1P Dundee Cements																	
30P	Control	Wt	5.2	489	--	215.2	0.440	1146	---	2018	--	20.8	---	2-3/4	7.6	3110	3470
		Vol	---	2.50	--	3.45	---	7.12	0.369	12.16	1.77						
	Pozzolan	Wt	5.2	489	--	215.2	0.440	1127	---	2018	--	20.8	5.2	2-3/4	6.5	2870	4340
		Vol	---	2.62	--	3.45	---	7.00	0.366	12.16	1.77						
35P	Control	Wt	5.6	526	--	217.2	0.413	1166	---	1963	--	22.4	---	2-1/2	6.3	3590	3640
		Vol	---	2.68	--	3.48	---	7.24	0.380	11.83	1.77						
	Pozzolan	Wt	5.6	526	--	217.2	0.413	1143	---	1963	--	22.4	5.6	2-3/4	5.4	3660	5020
		Vol	---	2.82	--	3.48	---	7.10	0.375	11.83	1.77						

TABLE 2
 POZICON CONCRETE CORE FIELD EVALUATION
 SLIP-FORMED CONCRETE MEDIAN BARRIER
 Project IS 25032 05292A

Concrete	Set No.	Pour Date and Time	Station	Fresh Concrete Data		Core Strength Average of 3, psi	Surface Concrete Properties 2-1/2 in. Depth			Interior Concrete Properties		
				Slump, in.	Air, percent		ASTM C642					
							Absorption, percent	Specific Gravity, dry bulk	Perm. Voids, percent	Absorption, percent	Specific Gravity, dry bulk	Perm. Voids, percent
Control	1	10-4-73 3:10 p.m.	855+50	7/8	4.3	3220	5.7	2.25	12.8	6.2	2.23	13.8
	2	10-4-73 4:00 p.m.	859+00	3/4	5.3	3120	5.6	2.23	12.4	5.8	2.21	12.9
	3	10-5-73 11:07 a.m.	882+50	1-1/4	7.7	2690	5.2	2.19	11.4	6.0	2.17	13.0
	Average				1	5.8	3010	5.5	2.22	12.2	6.0	2.20
Pozicon	4	10-6-73 10:20 a.m.	920+25	3/4	7.1	3220	4.8	2.23	10.6	5.2	2.23	11.6
	5	10-6-73 12:50 p.m.	929+00	1-1/8	6.3	4250	4.6	2.29	10.5	5.4	2.24	12.0
	6	10-6-73 2:10 p.m.	933+50	3/8	5.3	4310	4.7	2.30	10.5	5.1	2.25	11.5
	Average				3/4	6.2	3930	4.7	2.27	10.5	5.2	2.24