LABORATORY TESTING OF SHRP SPS-2 P.C.C. MIXES

Final Report
For
MLR-94-5

April 1995

Project Development Division

Iowa Department of Transportation

Final Report for MLR 94-5

LABORATORY TESTING OF SHRP SPS-2 P.C.C. MIXES

by

Chengsheng Ouyang
515-239-1088

Office of Materials
Project Development Division
Iowa Department of Transportation
Ames, Iowa 50010

April 1995

TECHNICAL REPORT TITLE PAGE

1. REPORT NO.	2. REPORT DATE
MLR-94-5	April 1995
3. TITLE AND SUBTITLE	**4. TYPE OF REPORT & PERIOD COVERED**
Laboratory Testing of SHRP SPS-2 P.C.C. Mixes	Final Report from 6-94 to 4-95
5. AUTHOR(S)	**6. PERFORMING ORGANIZATION ADDRESS**
Chengsheng Ouyang Transportation Engineer Assoc.	Iowa Department of Materials Materials Department 800 Lincoln Way Ames, Iowa 50010

7. ACKNOWLEDGEMENT OF COOPERATING ORGANIZATIONS

8. ABSTRACT

This research evaluated the concrete strength of two mixes which were used in the Polk County project NHS-500-1(3)--10-77 and were developed to meet a contract requirement of 900 psi third-point 28-day flexural strength. Two concrete mixes, the Proposed Mix and the Enhanced Mix, were tested for strength. Based on the experimental results, it was found that the addition of 50 pounds of cementitious materials did not significantly increase concrete strength. The requirement of 900 psi 28-day third-point flexural strength (MOR-TPL) was not achieved by this amount of addition of cementitious materials.

9. KEY WORDS	10. NO. OF PAGES
Cement factor, concrete Modulus of rupture, SHRP	8

TABLE OF CONTENTS

DISCLAIMER

INTRODUCTION

This research is to evaluate the concrete strength of two mixes which were used in the Polk County project NHS-500-1(3)--10-77 and were developed to meet a contract requirement of 900 psi third-point 28-day flexural strength. The Proposed Mix, developed by the Contractor, was found to meet the required design strength in laboratory tests, but did not meet the design strength when batched for a trial section prior to being produced for the SHRP research test sections. The mix was enhanced with an additional 50 pounds of cement in an attempt to bring it up to the specified strength. Tests of the actual mix used in the SHRP research resulted in strengths below the specified values.

The objective of this research is to determine the strength increase resulting from the addition of 50 pounds of cementitious materials (cement and fly ash) to the mix which was proposed for the SHRP SPS-2 research test sections.

MATERIALS AND MIX PROPORTIONS

A Type II cement from Ash Grove, Louisville, NE and a fly ash (Type C) from Midwest Council Bluffs were used. The coarse and fine aggregate used are from Martin Marietta, Ferguson Quarry (T-203 No. A64002) and from Hallet Materials, University Plant (T-203 No. A77542), respectively. These materials were actually used on the SHRP project. The gradations of both coarse and fine aggregates used in this laboratory study were essentially the same as those used on the SHRP project.

Two mixes, the Proposed Mix and the Enhanced Mix, listed in Table 1 were tested.

EXPERIMENTAL PROGRAM

A total of thirty six 6" x 6" x 20" beams, eighteen from each of the two mixes, were cast. Six beams for each mix were tested for modulus of rupture (MOR) at ages of 7-day, 14-day and 28-day, respectively. Three beams were subjected to center-point loading (CPL), whereas the other three beams were subjected to third-point loading (TPL). After the flexural test, 4" diameter cores were taken from the broken beam ends. These 4" cores were tested for compressive strength. A total of eighteen 4.5" x 9" cylinders, nine from each of the two mixes, were also cast. Three cylinders for each mix were tested for compressive strength (f'_c) at ages of 7-day, 14-day and 28-day, respectively.

RESULTS AND DISCUSSION

The average strengths experimentally measured for the two mixes are given in Table 2. These strength values are also plotted against specimen age in Figs. 1, 2 and 3 for MOR-CPL, MOR-TPL and f'_c, respectively. As expected, all strengths increase with increasing specimen age. The Enhanced Mix has generally higher values of MOR-TPL than the Proposed Mix as shown in Figure 2. From the values of MOR-TPL given in Table 2, the average ratio of 1.06 for three different ages was obtained between the Enhanced Mix and the Proposed Mix. The Enhanced Mix has almost the same values of MOR-CPL compared to the Proposed Mix as indicated in Figure 1. The 28-day compressive strength of the Enhanced mix is even about 5% lower than that of the Proposed mix.

As a part of the SHRP testing procedure, six 14-day cores and five 28-day cores have been cut from the test sections constructed with the Enhanced Mix. The cores have been tested for

compressive strength and the obtained values are listed in Table 3. The average compressive strengths of the field-cores cut from different sections of the Enhanced Mix are 5350 psi for the 14-day age and 5760 psi for the 28-day age, respectively. On the other hand, compressive strength of the 4" cores taken from the broken ends of the laboratory cast beams are given in Table 4 for the Enhanced Mix. The average strengths of these 4" cores are 6300 psi for the 14-day age and 7150 psi for the 28-day age, respectively. The laboratory-cores have average 17% higher compressive strength than the field-cores.

CONCLUSION

Based on the above experimental results, one may conclude that the addition of 50 pounds of cementitious materials did not significantly increase concrete strength. The requirement of 900 psi 28-day third-point flexural strength (MOR-TPL) was not achieved by this amount of addition of cementitious materials.

Table 1 Test Program and Mix Proportion

Test No.	Cement (lb)	Fly Ash (lb)	Coarse aggregate (lb)	Fine aggregate (lb)	Water (lb)	Water/cement
The proposed mix	680	120	1556	1312	294	0.433
The enhanced mix	723	127	1532	1278	306	0.423

Table 2 Summary of Experimental Results

Mix No.	Cement content (lb/cu yd)	Slump (in.)	Air content (%)	Age (days)	Average strength (psi)		
					MOR-CPL	MOR-TPL	f'_c
The proposed mix	680	2	6.0	7	830	700	5310
				14	950	710	5820
				28	1010	820	7010
The enhanced mix	723	2	6.0	7	840	720	5370
				14	910	790	5740
				28	1010	860	6660

Table 3 Compressive Strength of Cores Cut from the SHRP Test Sections (the Enhanced Mix)

Section No.	Core No.	Compressive strength (psi)	
		14-day	28-day
K2	CP59	5730	5860
K4	CP83	4930	5950
K6	CP67	5900	6070
K8	CP75	5170	5720
K10	CP51	4810	-
K12	CP91	5570	5220
Average		5352	5764

Table 4 Compressive Strength of 4" Cores Cut from the Broken Beam Ends After the Flextural test (the Enhanced Mix)

Core No.	Compressive strength (psi)	
	14-day	28-day
1	5810	7100
2	6710	6880
3	6140	6980
4	5660	6770
5	6920	7450
6	6640	7390
7	6680	6850
8	5970	6740
9	5850	6700
10	6290	7380
11	6350	8150
12	6620	7390
Average	6303	7390

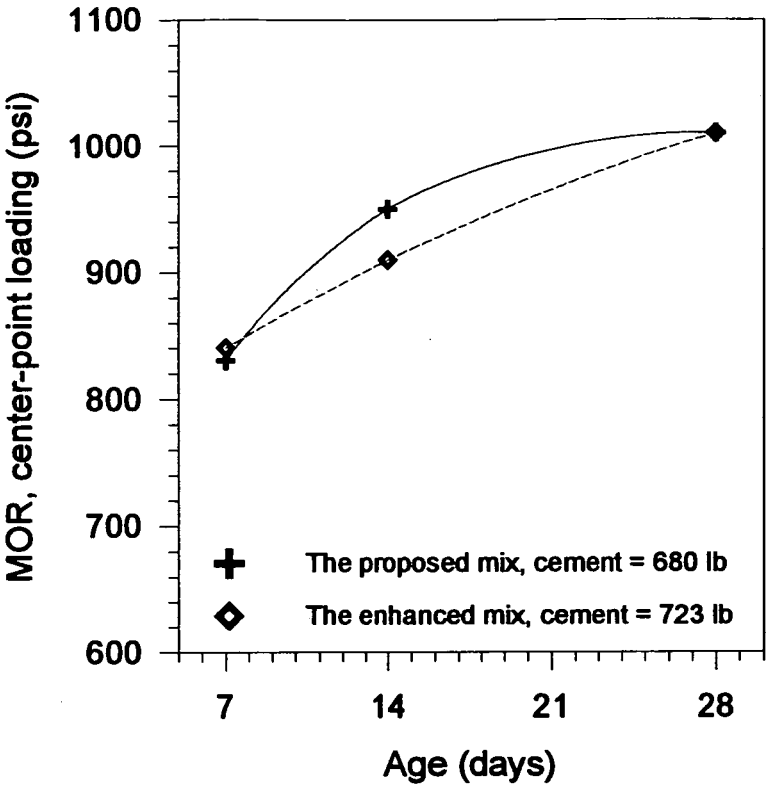

Fig. 1 Relationship between MOR and specimen age (Center-point loading)

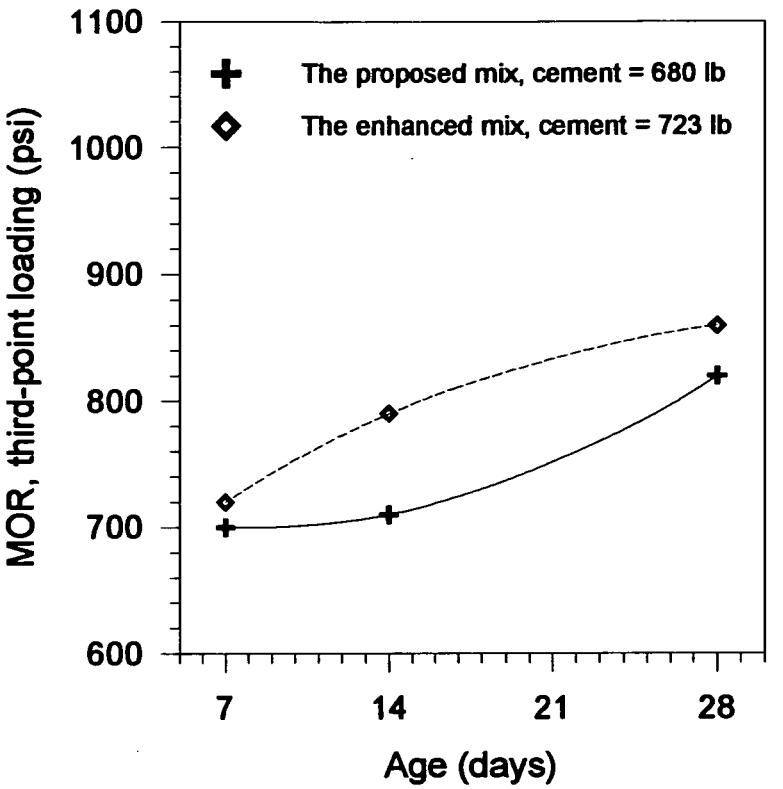

Fig. 2 Relationship between MOR and specimen age (Third-point loading)

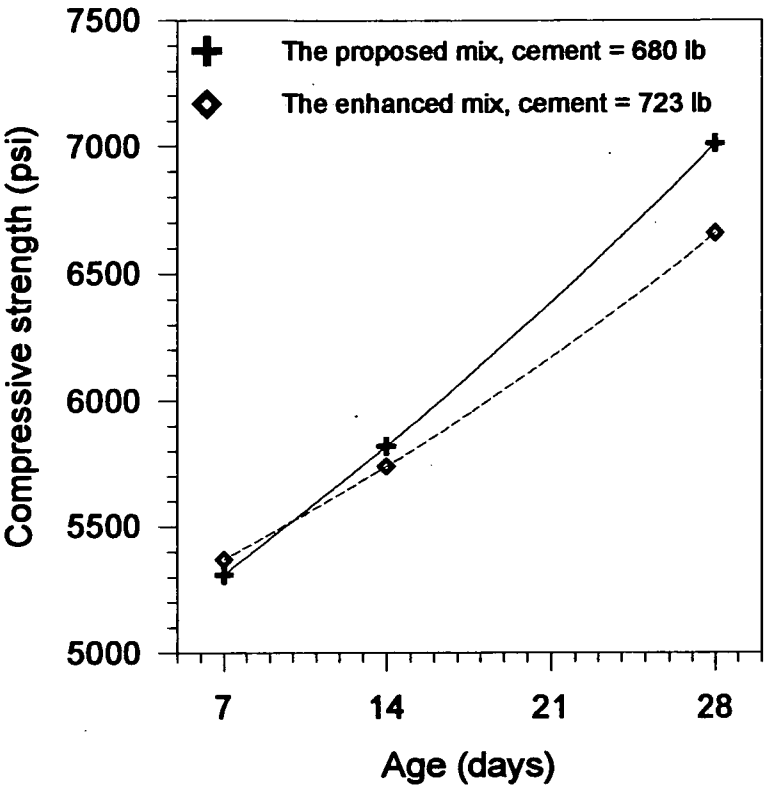

Fig. 3 Relationship compressive strength and specimen age