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An investigation in concrete

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AN INVESTIGATION IN CONCRETE

BY

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A

THESIS

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INTRODUCTION.

It is generally accepted to be a fact that the coarser particles of cement are practically inert, and that it is only the finer particles that possess the cementing qualities. What percentage of the whole is active, or possesses the cementing qualities is not known. Practically no data is available as it seems as though very little experimental work has been conducted along this line. Grinding the cement to a finer degree than that required by standard specifications would in all probability change its physical qualities as well as increase the cost of production. There would be, perhaps an accelaration in the time of set and a modification in tensil and compressive strength. An increase in strength is desirable but the change in the other qualities may not be so. If, then, some method could be devised to make use of only the finer particles in a cement, an increase in strength and at least a decrease in the amount of cement necessary in an aggregate would result.

PURPOSE OF INVESTIGATION.

It is the purpose of this investigation to determine the effect of blending a portland cement with a fine silica sand. A blended cement such as this has been used successfully and economically in several important works. The United States Reclamation Service

and the Los Angeles Aqueduct Commission have made use of such a blended cement in several important structures. This dilution, so to say, of the cement results in a decrease in cost without a loss of strength. In this investigation it has been assumed that the cement retained on a #200 sieve is inert and may be replaced by a fine sand.

BLENDED CEMENT.

Blended cement is the resultant mixture produced by intimately incorporating in a standard portland cement a finely divided and practically inert material such as sand. The inert material used in this investigation was a natural sand all of which passed a #65 sieve. This sand is a very pure and clean natural sand obtained from the Ottawa Silica Co., Ottawa, Ills.

PREPARATION OF BLENDED CEMENTS.

The portland cement was first passed through a #20 sieve and placed in a storage bin. Only that part of the cement passing a #200 sieve was used and this was intimately mixed with the inert material in varying percentages. This mixing was accomplished by passing the two materials through a #40 sieve six (6) times. Lead shot were used to facilitate the work of sieving. Five blends were used in conducting the experiments as follows,-

U-100	(100%	cement
	(0%	sand
U-90	(90%	cement
	(10%	sand
U-80	(80%	cement
	(20%	sand
U-70	(70%	cement
	(30%	sand
U-60	(60%	cement
	(40%	sand

Universal Portland cement was used and the above nomenclature will be used throughout this report.

AGGREGATE.

The aggregate used was made up of limestone and local gravel and sand. The Ozark gravels and sands are notoriously poor for such a purpose. The "flaky" character of the chert and the flat, smooth surfaces are far from being well adapted to use in a concrete aggregate. While the materials available were not the best a careful sieve analysis of each was made and the following mix decided upon.

45% Stone passing 1" sieve.

30% Gravel " " "

15% Sand " " "

10% Blended cement

11% Water

It can be easily seen that this is a very lean mix but was used on account of the great amount of labor entailed in running the experiments. Particles larger than 1" in diameter were screened out but no attempt was made to remove the finer particles and dust.

PREPARATION OF TEST SPECIMENS.

The concrete was carefully mixed by passing it twice through a gravity mixer made up of three conical hoppers. The concrete was placed in the moulds in layers of about 2" and thoroughly tamped. After setting for 24 hours the cylinders were removed from the moulds and stored in damp sand until tested. The laboratory is well situated for maintaining a constant temperature and the test specimens were subjected to very uniform conditions during the storage period.

TESTING SPECIMENS.

The cylinders were tested for compressive strength in a 200,000# capacity Olsen type testing machine. The deformations were measured by means of an Olsen compressometer reading to 1/10,000 of an inch. No variation from the usual method of testing such cylinders was made.

RESULTS.

The ultimate strength of each cylinder was determined. Also from the compressometer readings and

loads a stress-strain curve plotted. From this curve the initial modulus of elasticity was calculated. The character of the failures was typical of such materials and the cylinders broke without any report. The ultimate strengths and modulae of elasticity are recorded in the following page.

CONCLUSIONS.

The results while negative in character are not conclusive. The extent of the experiments do not warrant any definite conclusions. The low ultimate strengths may be attributed to the poor quality of the aggregate as explained before. From the comparative table it seems as though the U-90 and U-80 blends will bear further investigation, but the U-70 and U-60 blends show such a marked decrease in ultimate strength as to make their parcticability for use very doubtful.

In conducting future experiments the work should be gone into more thoroughly, something prevented in this investigation by lack of time. The tests should be more extensive to base any definite conclusions upon.

COMPARATIVE RESULTS.

4-Week Tests.

Blend.	Av. Ult. Strength.	Av. Mod. of E.
U-100	1228.0	3,600,000
U-90	920.0	3,000,000
U-80	822.0	3,850,000
U-70	390.0	- - - - -
U-60	391.5	2,500,000

12-Week Tests.

Blend	Av. Ult. Strength.	Av. Mod of E.
U-100	1737.5	4,800,000
U-90	1435.0	5,300,000
U-80	920.0	6,250,000
U-70	795.0	4,350,000
U-60	590.0	6,000,000

Cylinder Number.	Blend of Cement	Age	Ultimate Strength #/sq.in.	Average	Modulus	Average.
14	U-100	4 weeks	1193	1228	4,200,000	3,600,000
20	"	"	1263		3,000,000	
5	"	12 "	2275	1737.5	3,600,000	4,800,000
10	"	"	1200		6,000,000	
11	U-90	4 weeks	1000	920	3,250,000	3,000,000
16	"	"	840		2,750,000	
1	"	12 "	1670	1435	4,700,000	5,300,000
6	"	"	1200		5,900,000	
12	U-80	4 weeks	1020	822	2,100,000	3,850,000
17	"	"	624		5,600,000	
2	"	12 "	1020	920	4,500,000	6,250,000
7	"	"	820		8,000,000	
13	U-70	4 weeks	400	390	-----	-----
18	"	"	380		2,500,000	
3	"	12 "	790	795	3,500,000	4,350,000
8	"	"	800		5,200,000	
15	U- 60	4 weeks	300	391.5	2,750,000	2,500,000
19	"	"	483		2,250,000	
4	"	12 "	680	590.	5,500,000	6,000,000
9	"	"	500		7,500,000	

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