LAKE MICHIGAN BEACH SAND AS AGGREGATE FOR CONCRETE

Thesis for the Degree of B. S.

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Lake Michigan Beach Sand
as
aggregate for Concrete.

A

Thesis

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by

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THESIS

Preface

The author in the selection of this thesis did so with the following objects in mind.

First: That a mixture of sand and cement would give a sufficient strength and economy in using along the Lake Front.

Second: That by adding Lake Sand to a mixture, the strength and the bullsing of the concrete would be increased sufficiently to offset the extra cost.

The thesis itself consists of compressive tests run with different mixes of the sand and cement; and tests on the different persents of the sand added to a 1:2:4: mix of concrete.

Indroduction.

In the western part of the state, there is an abundance of sand along the Lake. There is also in certain districts a shortage of coarse aggregate or gravel; that is it must be shipped in either on flat-boats or cars. The fine aggregate is dredged in certain parts of the lake and also shipped in.

This material must be bought, shipped, and drawn to the job, thus malsing the cost more expensive than if it could be hauled right from the pit. The beach sand can be easily taken and hauled to the job in one operation, and cutting down the cost by omitting the screening and washing.

This sand is very fine and can be mixed with the materials that are used to increase bullsing and water tightness; if the tests fulfill the theory.

This thesis contains a 28 day test run with a sand and cement mix; and a 14 day test run with the sand as an admixture to a 1:2;4 mix. Lack of time due to the difficulty in getting the sand here, prevented any further tests.

Test No. 1 Sand.

The sand used in this thesis was taken near Grand Haven, and passed the following tests.

1. Fineness

sieve No.	%Retained	%Passing
14	0	100.
28	0.38	99.43
48	56.29	43.14
100	43.13	.01
Pan	0.01	. 0
	99.81	242.58

Fineness Modulus = 1.21

2. Percent of silt = 0

3. No organic Matter

4. Wt. per cubic ft. = 102#

Test No. 2. Sand as Aggregate

In the first step, that of determining a mix of sand and cement to stand a compressive test of 2000 lbs., the mixes used were; 1:2, 1: 2½ 1;3; 3½, 1:4, and 1:5. That is 1 part of cement and 2 part of sands, ect., according to volume. The water used in each case was equal to volume of cement used plus 1% of the sand to allow for absorption.

The material for each mix was weighed and determined in the following manner.

A 1:2 mix is used as an example.

	Amt. used.	Wt. per cu. ft.	Wt. used
Cement	1 cu. ft.	94#	9.4#
Sand	.2 cu. ft.	102#	20.4#
Water	.102 cu. ft.	62.4	6.3648
		Total Wt.	36.1648#

Four cores of each of the mixes mentioned above were used for test purposes. These were kept in a moist chamber and sprinkled with water every day for the curing. At the end of 28 days they were tested and gave the following results.

Mix	Compressive Strength Pounds per Sq. in.
1:2	2520
1:2½	1400
1:3	980
1:3	718
1:4	620
1:5	513

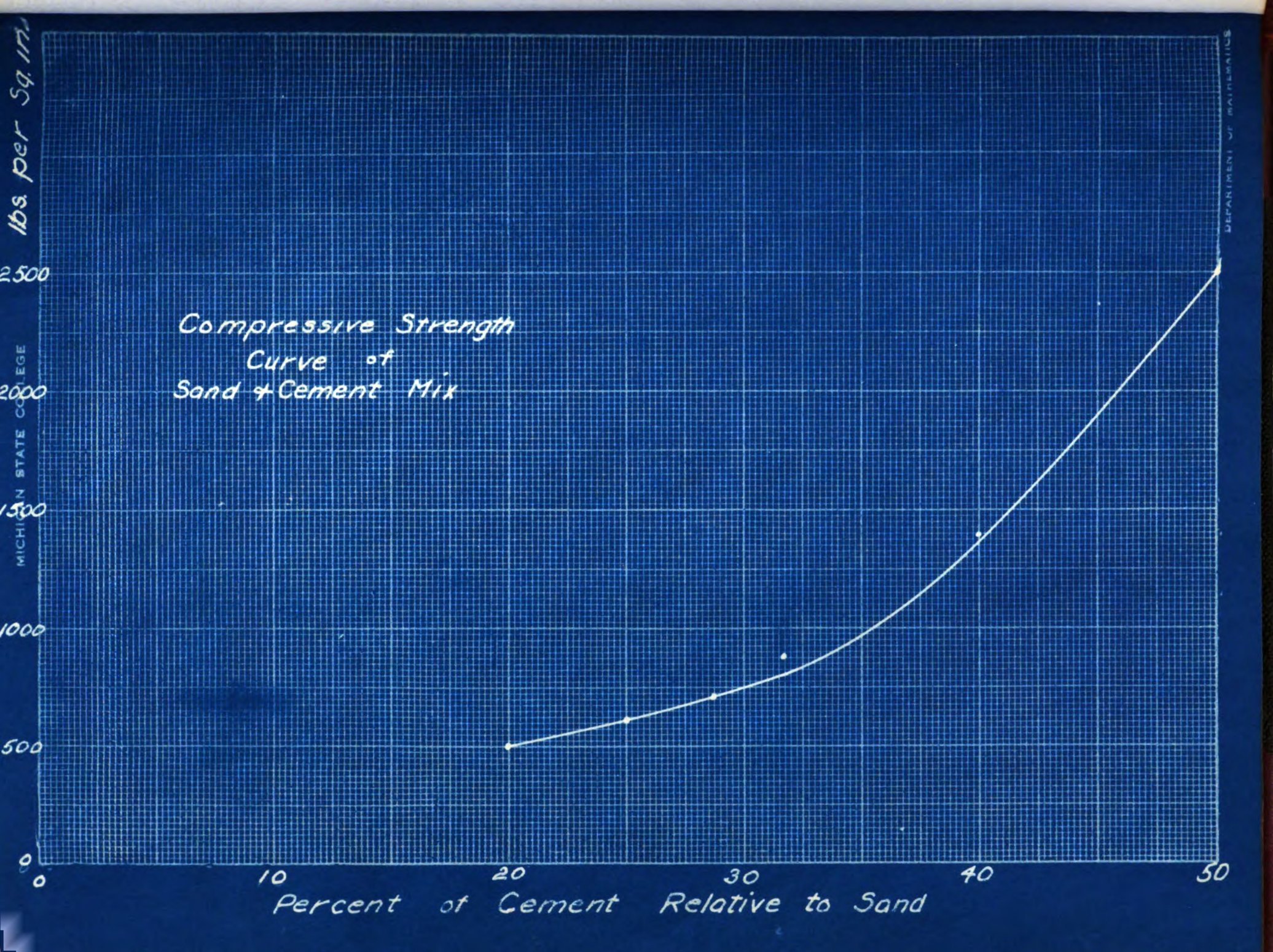
Results are Average of 4 cylinders

In order to plot a curve to express the strength relative to the mix, it was necessary to express the mix in terms of the cement relative to the sand. The table below shows the transfer.

Mix	Percent of Cement
1:2	50
1:2½	40
1:3	33.33
1:3½	28.6
1:4	25
1:5	20

This data is plotted on the curve and from that it is seen that a 2000 lb. concrete must have a mix of 46.25% cement. This is equivalant to a 1:2¼ mix.

In dertermining the cost of concrete made from this material a 1:2 mix was used, and the amount of material needed for 1 cu. yd. was computed. With this mix it was found that 1th. cu. ft. of the concrete weighed. 16.#


lbs. per Sq. In.
2500
2000
1500
1000
500
0
0
10
20
30
40
50
Percent of Cement Relative to Sand
Compressive Strength
Curve of
Sand + Cement Mix
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The total amount of material weighed was 36.165#. The volume of concrete obtained from the 1:2 mix was 36.165 Over 160 equals .225 cu. ft.

The cost of the material to make 1: cu. yd. of concrete would be as follows:

	Amount	Cost
Cement 1 over .225 times 27 equals 12 cu. ft.	3bbls.	3 times $2.60 equals $7.80
Sand . over .225 times 27 equals 24 cu. ft.	24 over 27 times .75 equa	6 .67
		$8.47

In these figures the cement was quoted at $2.60 a barrel and the sand was estimated to cost $.75 per cu. yd. The cost of the material used in a 1: 2: 4 mix, taken from a reliable contractor was $5.00. Thus it would be unprofitable to use a sand and cement mix.

Test No. 3 Sand as an Admixture

In determining the effect of adding Beach sand to a 1: 2: 4 mix of concrete, sand was added ranging from 0 to 50% of the volume of cement.

The unit weight of the fine and coarse aggregated was found, and the materials used in the mix were weighed.

The following table gives the mix and the weights:

	Vol. used cu.ft.	Wt. per cu. ft.	Wt. used.
Cement	.1	94#	9.4#
Fine Agg.	.2	92#	18.4#
Coarse Agg.	.4	104#	41.6#
Water	.106	62.4#	6.6#
			76.0#

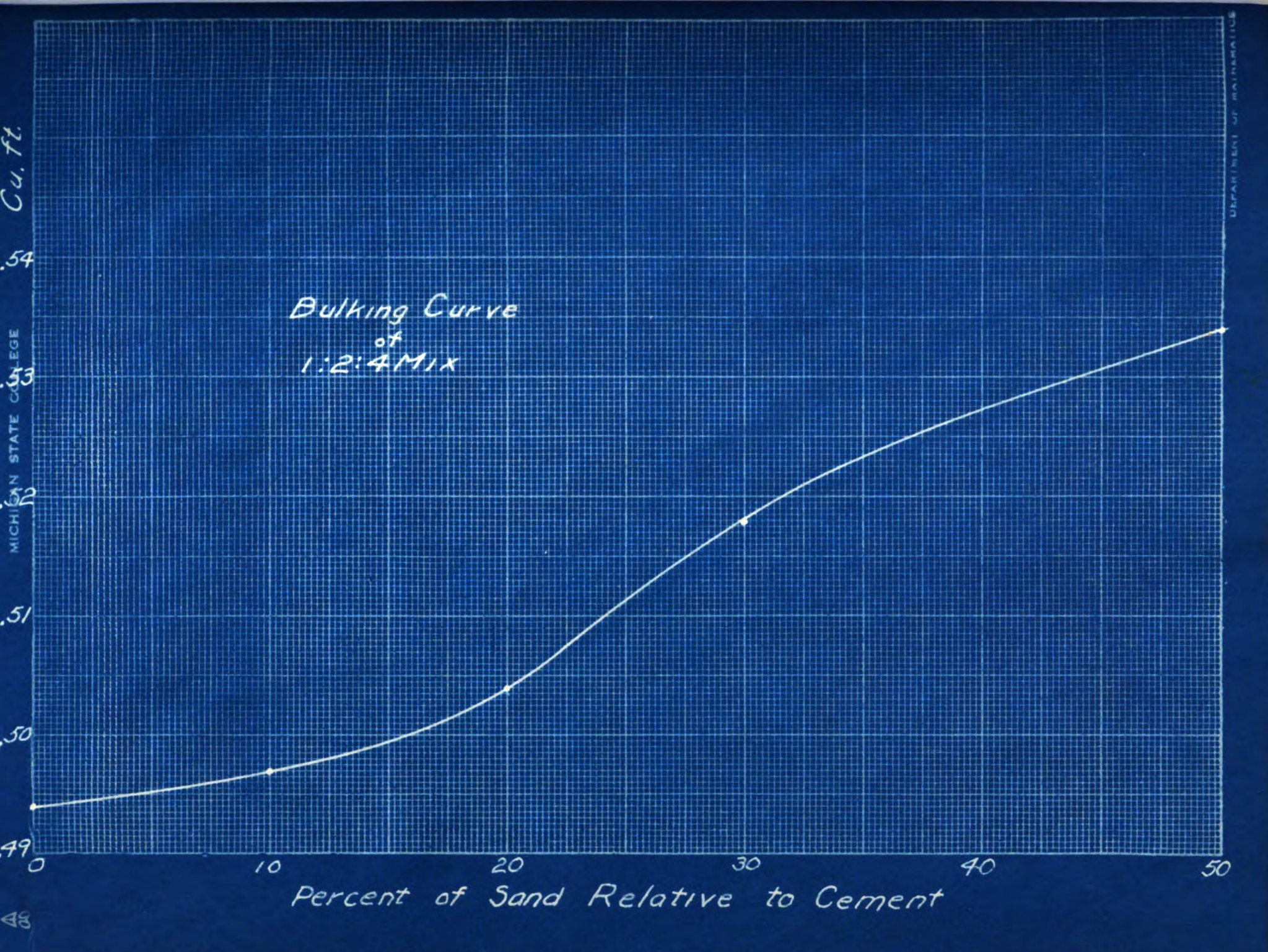
For each increase of 10% of the sand 10% of the cement was added or .01 cu. ft. Expressed in pounds this becomes .01 x 102 equal 1.02.

The unit weight for each mix was found and the amount of concrete was computed by dividing the weight of the material by the weight per cu. ft. of the concrete.

The table gives these results.

Percent of Sand	Wt.	Wt. per cu. ft.	Vol. cu. ft.
0	76	154	.494
10	77.02	154.9	.497
20	78.04	155	.504
30	79.06	152.4	.518
50	81.10	152	.534

Four cylinders of each mix were made and tested for compressive strength at the end of 14 days. The table following gives the strength in pounds per sq. in.


Cu. ft.
.54
.53
.52
.51
.50
.49
Bulking Curve
of
1:2:4 Mix
0
10
20
30
40
50
Percent of Sand Relative to Cement
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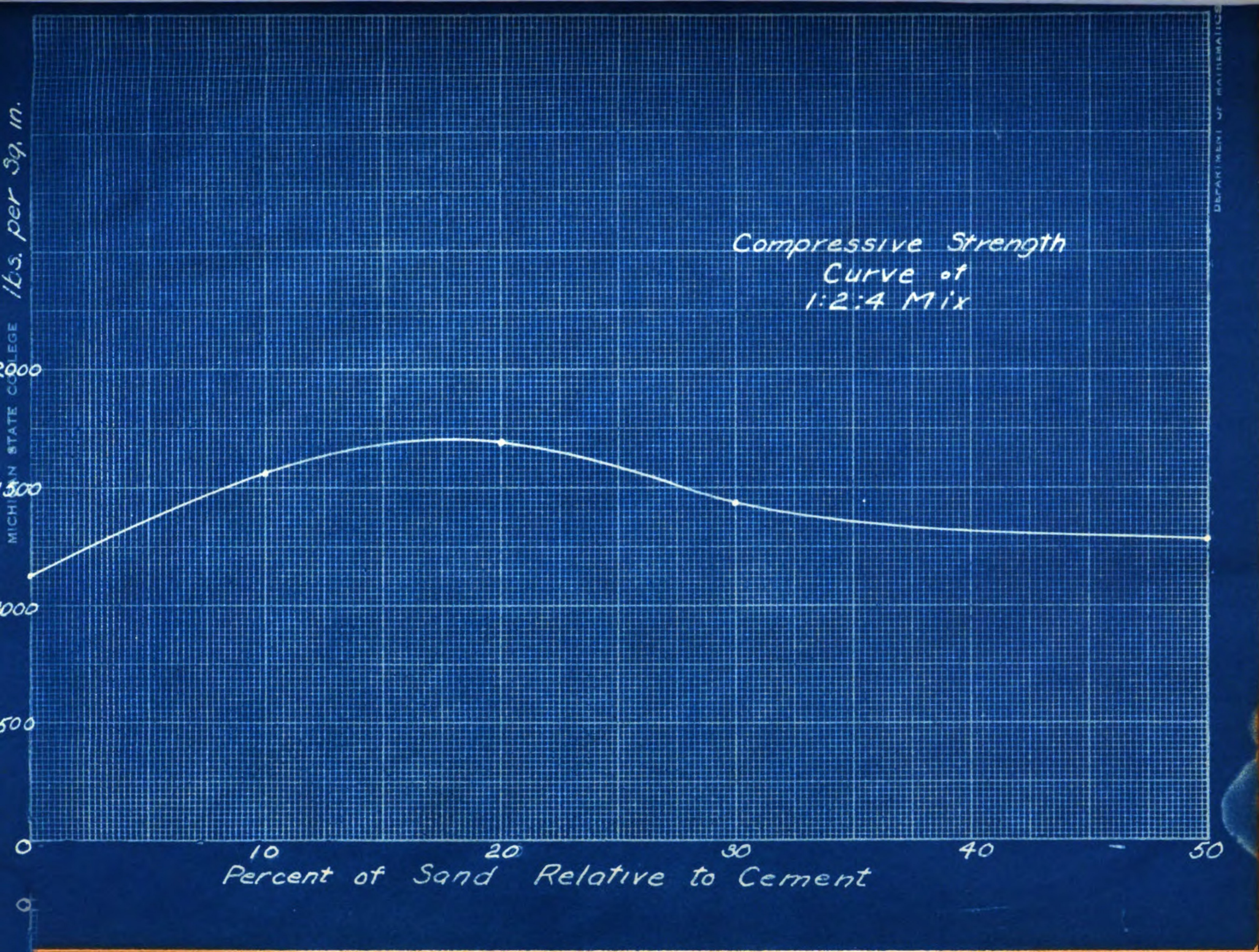
Percent of Sand	Strength lbs/sq. in.
0	1180
10	1560
20	1700
30	1440
50	1290

From the curve giving the strength, it is seen that by adding 20% of sand, the strength is increased from 1180# to 1700#. Assuming that the concrete gains the same relative strength as it ages, it will be seen that a less amount of cement can be used when a 20% addition of the sand is used. The amount of cement used to make 1 cu. yd. of concrete without sand equals .1x27/494 equal to 5½ cu. ft. or 5½ bags. The amount of cement used with 20% of sand would be 1180/1700 x5.5 equals 3.8 bags. This would make a saving of 1.7 bags for every cu. yd. The amount of sand used in the mix would be .20x5.5 equals 1.1 cu. ft.

With cement at $2.60 bbl. and assuming the beach sand to be delivered for $1.50 cu. ft., the cost of the 20% mix would be 3. 8x$65 plus 1./27x$1.50 equals $2.46 plus $.06 equals $2.52 for the sand and cement. In the normal mix the cost of the cement would be 5.5x$.65 equal $3.58, The saving by using beach sand in the concrete would be $1.06 on one cu. yd.

From the bullsing curve it will be seen that the concrete increases from .494 cu. ft. to .534 cu. ft. when a 50% addition of sand is used The strength of the 50% sand mix is also greater than that of the normal concrete. This represents a saving of .8% of all material used in the concrete to get the same volume. The cost of the sand,


Compressive Strength
Curve of
1:2:4 Mix
lbs. per Sq. in.
2000
1500
1000
500
0
10
20
30
40
50
Percent of Sand Relative to Cement
0
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however, in this case would be about 15 cents, while only 7 cents would be saved by using it.

Conclusion.

Take Sand as an aggregate is of no practical value, but as an admix has very good possibilities. The tests show in this thesis that a great saving can be made by using the sand and cutting down the amount of cement.

I also noticed that 43% of this sand passed a 48 mesh screen. It may be possible to work out an addmix with this 43%. Whether this w would give satisfactory results remains to be proven, but in my opionion it would leave a favorable effect on both the strength and segregation.

[redacted]