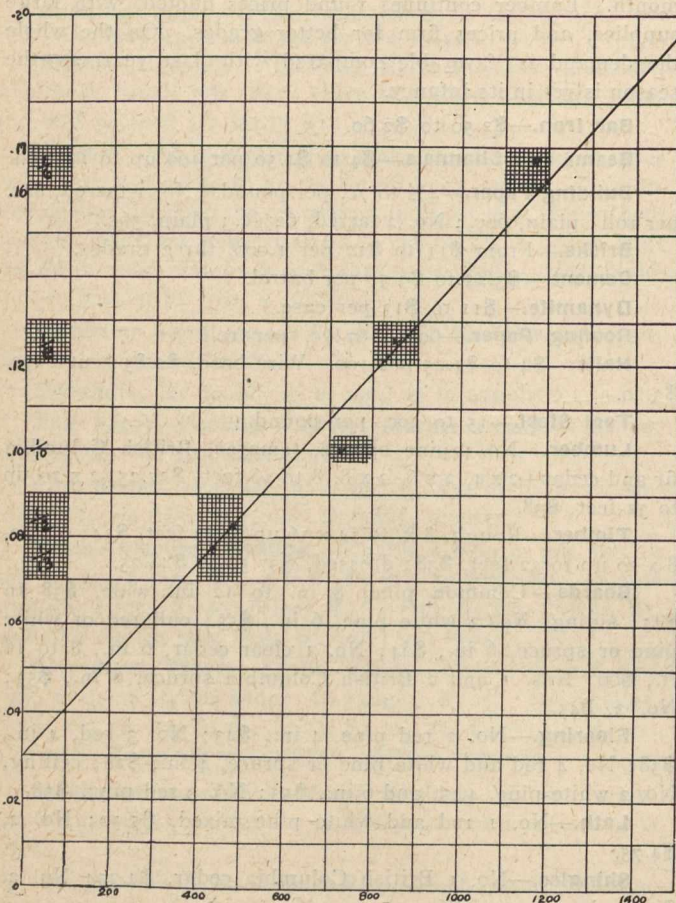


## RELATIONS BETWEEN AMOUNT OF CEMENT AND STRENGTH OF CONCRETE.

In a recent paper on "Proportions Used and Methods of Mixing Concrete," Mr. Leonard C. Mason, President of the Aberthaw Construction Co., Boston, Mass., presents from actual tests some interesting facts regarding the effect of the amount of cement upon the strength of concrete. His statement is as follows:—

"The necessity of thorough mixing has been universally known for many years. The loss of strength from poor mixing is not, perhaps, so well known in figures. There were some private tests made at the Watertown Arsenal about eight years ago, in which the writer was interested, which throw some light upon improper mixing. On a large job a certain type of mixer was disapproved of by the supervising engineer, who insisted upon a comparative test of machine and hand-mixed concrete. All concrete was made with proportions of one part of cement, three of sand, and five of broken stone, ranging from  $2\frac{1}{2}$  inches to  $\frac{1}{2}$ -inch, and was moulded into one foot cubes. A full size batch was first made with machine without any previous dry mixing of the aggregates. As the material was dumped from



the mixer a cone was allowed to form, down the sides of which quite a quantity of stone rolled, separating from the mortar and accumulating around the base of the cone. A second batch was made, the cement and sand being thoroughly dry-mixed before adding the stone, and then thoroughly mixed together when in the mixer. No cone was allowed to form. A third batch was mixed by hand, being turned five times, the engineer with a hoe throwing into the mass stones which became accidentally separated from it. In filling the moulds the engineer insisted that from the first batch stone be shovelled up from around the base of the cone. The rest of the batch which remained properly mixed was filled into other moulds, four cubes and two beams being made from each batch. The first cube averaged only  $2\frac{1}{3}$  pounds, or about 2 per cent. lighter than the other three cubes, due to lack of mortar. Nevertheless, it gave a result 28 per cent. below that of the average

of the other three, the figures being 3.081 pounds per square inch as against 4.263 pounds per square inch, the average of the other three. Age of all specimens was ninety days. The average of the four cubes which were dry-mixed before mixing in the machine was 4.123 pounds. The hand-mixed specimens averaged 3.187 pounds.

It will be seen that there is an advantage in machine-mixed concrete over that made by hand of  $25\frac{1}{4}$  per cent., and that that which was not dry mixed before putting into the machine gave  $3\frac{1}{3}$  per cent. greater strength than that which was. The machine used in this case was the portable Gravity Concrete Mixer. It is safe to assume that these specimens were more carefully made than under ordinary commercial conditions, which they tried to reproduce, and the marked weakness of the specimen which lacked but a small amount of mortar is very significant. The weakness is doubtless due to the voids in the material, reducing the cross-sectional area. Ten years ago another series of experiments was conducted by the writer at the Watertown Arsenal, giving the relative merits of machine and hand-mixed concrete and the strength of various mixtures.

Diagram showing the relation between amount of cement used and the strength of the concrete:—

Volume of cement.

Ordinates =  $\frac{\text{Volume of cement}}{\text{Volume of concrete}}$

Volume of concrete.

Abscissa = Ultimate strength in lbs. per sq. in.

$y = mx + b$ ,  $y = .00011x + .03$ , or  $x = 9091y + 273$ .

These were specimens, one foot square and varying from six to fourteen feet in length. They were all made in mid-winter in an open lumber shed, and remained in the open air until tested, which accounts for the low ultimate strength. The modulus of elasticity of the hand-mixed specimens, with proportions of 1:3:6 and average age of forty-three days at a stress of 700 pounds per square inch was 2,500,000; the machine mixed, 2,870,000, an increase of  $12\frac{1}{2}$  per cent. of the modulus. The ultimate strength of the hand-mixed was 921 pounds; the machine-mixed, 1,111 pounds, an increase in the ultimate strength of 17 per cent., due to machine mixing.

The hand-mixed specimens in this case were somewhat better than commercial conditions, because, in order to fill the moulds, the concrete was handled several times more than would be necessary in placing ordinary work. Each handling was equivalent to a mixing. It will be seen, therefore, that there is a marked improvement in strength due to machine mixing, and, as the machine is positive, we can be assured of obtaining this concrete uniform, whereas with hand work it is likely to be anything but uniform, while a little carelessness makes a big difference in the final strength.

A series of specimens were made, one foot square, six feet long, machine mixed, identical in every way except the amount of cement used. There were two specimens, each 1:3:6, 1:4:8, 1:5:10, 1:6:12, 1:7:13. The results of each pair were averaged, and are shown in the accompanying diagram. While these tests are not extensive enough to be conclusive, they indicate that the strength is directly proportional to the amount of cement used. Be careful to note the difference between the ratio of **parts** of cement to **parts** of stone and the ratio of **volume** of cement to **volume** of concrete."

## DOMINION LAND SURVEYORS.

The increased cost of living has led to an amendment of the scale of fees to Dominion land surveyors. The ordinary surveyors will receive \$8 a day instead of \$6.50, while those in charge of surveys on block outlines are increased from \$7.50 to \$10. Inspectors of surveys, whose employment is continuous, will receive \$9 a day when in the field, and \$5 a day when engaged in office work.