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“The Lateral Pressure of Liquid Concrete.”

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WHILE there are many circumstances to be taken into account in arranging falsework for concrete structures, the question of pressure is usually the most important consideration. The want of uniformity found in its design and construction, together with the fact that the cost of the timber forms often amounts to a considerable portion of the total cost of a concrete structure, led the Author to carry out a series of experiments to ascertain the direct lateral pressure of liquid concrete. The first experiments were conducted about 5 years ago during the construction of a heavy retaining-wall, by placing boards between the uprights of the vertical forms and noting the deflections caused by the various heads of concrete.

These experiments, however, were thought to be somewhat unreliable, owing to want of refinement, and the Author has since carried out further experiments of a similar nature, but with an apparatus constructed to secure more accurate results. This consists of a strong cast-iron chamber, fitted with a sheet-rubber working face, and is arranged so as to be readily fixed in position on the forms. The chamber is filled with water or other suitable fluid, and the pressure exerted by the concrete against the working face is recorded on two sensitive low-pressure Bourdon gauges, conveniently situated behind the chamber.

In the apparatus as first used the chamber was formed of timber lined with zinc; this, however, became distorted when wet and was abandoned in favour of cast iron. A glass tube water-column was also fitted for recording the pressures, but it was thought that the movement of the pressure face caused by the displacement of the water was not conducive to accuracy, as it caused the concrete to arch over—a movement that does not occur when Bourdon gauges are used.

Numerous experiments were made on different types of concrete structure. In heavy walls, large piers and other members of fair

size, the lateral pressure exerted was found to be fairly uniform and practically constant for equal heads; but in reinforced-concrete columns of small dimensions, thin walls, and other light concrete work, the effect of friction between the more or less rough timber forms and the concrete, together with the arching action, was found to reduce the pressure considerably.

Two sets of experiments are recorded in *Fig. 1*, having been

Fig. 1.

LATERAL PRESSURE OF THOROUGHLY PLASTIC CONCRETE.

selected from a number made; they represent those in which the conditions were most favourable.

The first series of tests was made during the building of a long wall about 3 feet thick, constructed of concrete weighing 140 lbs. per cubic foot and composed of slow-setting cement, sand and crushed granite in the proportions of 1:3:6, by volume. In mixing sufficient water was used to bring it to a thoroughly plastic condition, requiring little or no tamping to consolidate. The concrete was laid more rapidly than is usual in this class of work, being carried up as rapidly as the mixing and placing would permit to a

height of 8 feet above the centre of the pressure face, during which time a light, iron bar provided with a turned-up end was used for churning the semi-liquid mass. Four complete sets of readings were taken, and each point on the curve represents the average value at that head.

The second series was carried out on large piers 4 feet square, the concrete in this case being a 1:2:4 mixture of cement, sand and Thames ballast, weighing 145 lbs. per cubic foot. The conditions as to mixing and laying were similar to those of the first tests, and the concrete was carried up to a height of 10 feet above the centre of the pressure face. Each point of this second series represents the average of six readings.

In the first series the temperature was fairly uniform throughout, while in the second considerable variation was experienced; but the effect of the differences in temperature on the lateral pressure cannot be traced, and would appear to be very small.

The general conclusion to be drawn from these and other experiments is that the lateral pressure of concrete for average conditions is equivalent to that of a fluid weighing 85 lbs. per cubic foot, as shown in *Fig. 1*. For concrete in which little water is used in mixing, the pressures are rather less, having an equivalent fluid value as low as 70 lbs. per cubic foot in very dry mixtures.

The Paper is accompanied by two drawings from which the Figure in the text has been prepared.