THE PROPER USE OF GRAVITY CHUTES.*

THE concrete gravity plant has had a very rapid development because of its undoubted economy in the time and labor cost of distributing concrete and its practically universal adaptability to all classes of concrete structures. The straight lift in a tower for the vertical distance between the mouth of the mixer and the top of the forms, and then an additional lift of about 1 foot for every 3 of horizontal distance between the two before turning the concrete over to gravity to carry it across from the tower to the forms, is about as near to Nature's absolute foot-pound requirement as can well be devised.

Like any new process which, because of easily apparent advantages, comes rapidly into general use, its use has outrun the rules of practice which a more conservative introduction would have established for it, with the result that every user has made his own rules with little guidance except his own experience and with as variable a product as this procedure might suggest. It is well, therefore, that some thought be given to the statement of some of the fundamental conditions which must obtain to insure a good concrete, which is of absolute importance, as well as to realize the largest ultimate factor of economy in operation, these two ends being obtained by the same means, the one depending on the other, the best concrete being the most economical to handle.

The typical plant consists of a tower with a hoist bucket which takes the batch of concrete from the mixer, a receiving hopper with a controllable gate near the top of the tower into which the batch is dumped from the hoist bucket, and a series of chutes or troughs which carry the concrete to the forms. The tower is frequently as high as 200 feet and the line of chutes may carry the concrete as far as 500 feet from the tower; and by using a relay tower the concrete is placed in the forms at 1,000 feet from the mixer. The chutes may be connected in a straight continuous line from the hopper to the forms, or this line may be interrupted by line gates through which the concrete is dropped a vertical distance through a closed pipe and then to the forms; or by an assembly of horizontal swivel-connected chutes it may travel in a more or less zigzag path, dropping from the end of one chute into the swivel head of the chute below as it proceeds.

The matter of first importance to the successful operation of the gravity plant, as well as of any method of distribution, is the condition of the concrete when it is discharged from the mixer. Concrete is in proper condition for the gravity plant when it has been subjected to the action of a well-designed mixer long enough to thoroughly incorporate all of the aggregates, the batch being assembled with the proper amount of water to hold all of the aggregates in suspension, the resultant mixture being a viscous, homogeneous mass. As to how long the batch should stay in the mixer and as to the amount of water in percentages which this requires, our interest, so far as the chutes are concerned, must be confined to resultants and we must consider these questions as proper subjects for separate discussion. The concrete should not be so dry that it will not level off on top as it stands in the bucket, nor should it be wet enough to show water on top of the bucket if left standing for an appreciable length of time, nor to allow a stone to sink much over its thickness when placed on top of the mass.

Too dry concrete limits unnecessarily the range of distribution from a tower of a given height by requiring a steeper chute to carry it. A wet concrete which allows the heavier aggregates to settle to the bottom will separate in travel and is to be avoided as one of the unpardonable sins. By all means let the concrete be too dry rather than too wet; but there is the right consistency which avoids both extremes. But these problems are problems of mixing, however vitally they may affect the economy of the distributing plant. Properly assembled and well mixed concrete will maintain its integrity by whatever method it may be distributed, and concrete which is too wet will allow the stone to settle to the bottom of the form and the mortar will come to the top regardless of the means used to carry it there, while concrete properly assembled, but too hastily mixed, will be very much improved by the movement through a line of chutes as against any other method of transportation. It must be borne in mind, however, that the gravity plant is a plant for distribution and not for mixing and that the concrete must be good concrete, well mixed when it is delivered to the hoist bucket, or it cannot be expected to be good concrete when the forms are removed.

If the concrete reaches the chutes as a homogeneous mass the slope of the chutes is not of vital importance. That slope is generally the best which will allow the concrete to flow with the least velocity which will insure its passage, although a vertical drop in a closed pipe is a feature of many installations on important work. Such vertical lines, however, should have baffles every few feet to arrest the drop and the concrete should be distributed at the bottom by means of a horizontal chute whenever possible and not directly from the vertical line into the forms. The required minimum slope to carry the concrete properly will vary with the character of the aggregates, the average slope for small, round gravel being 1 of rise to 3 of run, or an angle of about 18 degrees with the horizontal; the slope for 1-inch stone, about 1 to 2¾, or 20 degrees; for 1½-inch stone, 1 to 2½, or 22 degrees; and for 2-inch stone, 1 to 2¼, or 24 degrees with the horizontal. It is better practice on a long line to hang the chutes with a gradually and very slightly increasing grade as they travel toward the lower end, such a grading being less likely to cause an overflow in the chutes than the reverse. The final distributing section which places the concrete in the form should retard the concrete to as slow a movement as will carry it at all.

In the travel through the chutes the concrete should flow in a constant, uniform stream so far as possible. The man on the tower at the hopper gate is a very important member of the operating crew. An intermittent rush of concrete is apt to congest the chutes, causing overflows, shut-downs, the retaining of concrete in the tower hopper for an undesirable length of time, and damaged work.

The concrete should be placed by the chute as closely as possible at the point where it is to remain. For floors and shallow beams the final chute section should be easily portable with the mouth close to the forms and the concrete travelling as slowly as it can be made to run. For column forms and deep girders the gravity plant provides a closed, flexible drop pipe with frequent baffles or arresters for placing the concrete in the bottom of the form, obviating the objectionable practice of dropping it in the open from the top. If concrete is dropped from the top of a column form in the open, or even in a closed pipe without obstruction, the kinetic energy of the stones in the aggregate will drive them toward the bottom of the mass, separating them from the mortar; while if frequent baffles are places in the vertical pipe the mass will retain its homogeneous character.

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