cation of the convexed starlings of cutwaters, it being found that a circular end above the cutwater permitted of a shorter base. This form of cutwater, in addition to being a more massive form for concrete work is probably the only practicable one which offers least resistance to the current.

There are altogether 29 bridges, with steel superstructures, and although four of these are of considerable magnitude, there are no lattice spans, plate girders being used exclusively up to 110 feet length of girder. This feature in the design of the larger structures imparts to them the appearance of strength and stability.

The station buildings and terminals are built in conformity with the substantial character of the work already described. The entire road is laid with 80 lb. rail, and excellent ballast was available at convenient intervals along the line.

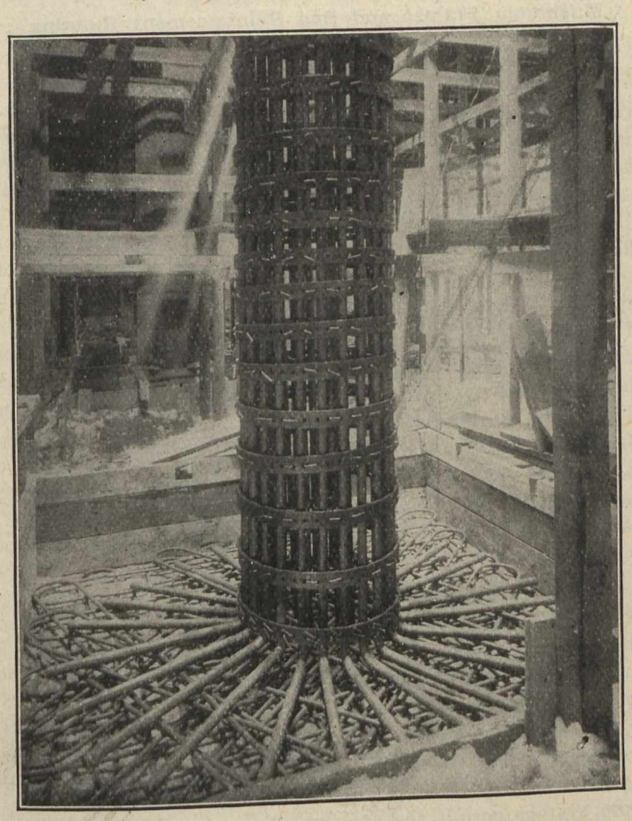
The whole work was carried out under the direction of Mr. P. A. Peterson, as chief engineer, Mr. J. M. Leonard being president of the company. The organization of the engineering staff being an assistant engineer and accountant at headquarters, one divisional engineer and two residences to each 20 miles of line. For construction purposes the work was divided into 10 mile sections. The contractors for sections 1, 4, 5 and 6 were Messrs. Campbell & Folinsbell, Strathroy, Ont., and for sections, 2, 3, 7 and 8, M. A. Pigott & Company, Hamilton, Ont.

THE MUSHROOM SYSTEM OF REINFORCED CONCRETE.

BY C. A. P. TURNER.*

In his treatise on "Reinforced Concrete Construction" Chas. F. Marsh makes these interesting observations: "When properly combined with metal, concrete appears to gain properties which do not exist in the material when by itself, and although much has been done by the various experimenters in recent years to increase our knowledge on the subject of the elastic behavior of reinforced concrete, we are still very far from having a true perception of the characteristics of the composite material.

"It may be that we are wrong from the commencement in attempting to treat it after the manner of structural iron work, and that although the proper allowances for the elastic properties of the dual material is an advancement on the



A Reinforcement for a Column, Designed to Carry a Working Load of 1,000 Tons.

empirical formulae at first employed, and used by many constructors at the present time, yet we may be entirely wrong in our method of treatment.

"The molecular theory, i.e., the prevention of molecular deformation by supplying resistances of the reverse kind to the stresses on small articles may prove to be the true method of treatment for a composite material such as concrete and metal. This theory is the basis of the Cottancin construction which certainly produces good results and very light structures, and M. Considere's latest researches on the subject of hooped concrete are somewhat on these lines."

The writer's experience in the design of several million dollars worth of reinforced concrete work for a great variety of purposes leads him to heartily endorse the opinion of Mr. Marsh regarding economic construction and to add thereto the statement that "his experience and observation further justifies the assertion that a fair regard for the lives of the workmen and the safety of the work during construction demands a type of construction in which the work is so tied together that a sudden collapse cannot occur after the concrete has had even six or seven days in which to set.

In no type of building construction can the materials be as promptly obtained and the work more rapidly constructed than reinforced concrete, in skillful hands. In the writer's experience in steel construction for the last fifteen or twenty years, there have been quite a number of men who have lost their lives from time to time in the course of the erection of the work, while in reinforced concrete construction, we have not had a single accident to a workman employed on this class of construction. We attribute our success in this respect primarily to the type of design used together with the fact that the workmen have a solid floor upon which to work at all times instead of a grid of steel beams, from which, the least carelessness on the part of the workmen, results in a serious and too often a fatal fall.

The system of reinforced concrete which it is the object of this article to describe is novel in the following respects: It consists essentially of slabs supported directly by columns, the slabs being reinforced directly and diagonally from column to column, thus forming a plate with the reinforcement so arranged that it will act approximately along the lines of the flat plate theory, the distortion in the concrete by compression due to one system of rods being offset, to a certain extent, and reduced by the compression due to another system. Again, carrying the reinforcement over the mushroom head where the moment in the slab is negative fixes the slab rigidly at the supports.

A feature of this new construction from which it derives its name is the formation of a so-called mushroom at the top of each column by extending its reinforcing rods laterally some four feet or more out into the slab in a radial direction and supporting on these ring rods which in turn carry the lighter reinforcement for the slab construction. The top of the column is enlarged, forming a neat capital, which assists in taking the additional stress which comes upon it in supporting the entire slab at this point. The slab reinforcement consists of parallel rods of small diameter running between adjacent mushrooms, both at right angles and diagonally, and of a width equal to the diameter of the mushrooms. The slab rods are strung over the mushroom frames and are given the necessary sag to bring them near the bottom of the slab between the columns. They are further wired together at their intersections to hold them securely in place, while the concrete is being poured. In

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