HIGHWAY BRIDGES AND CULVERTS.*

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THE agitation of late years for better highways has involved much more than the grading and surfacing of the roads, as one of the most important items to be looked into and dealt with has been the question of highway bridges and culverts. That this is so is due to two causes. One of these is that when permanent improvements are to be put on any section of highway many of the old structures are found too far gone to be of service and have to be renewed because of their old age. There is, however, a second very important factor entering into the matter, and that is the size of the load which has to be taken care of at the present time, due primarily to the advent of the motor truck and its rapid development, and in consequence of the heavy individual loads carried by these vehicles, structures which were thought to be built permanent enough to render good service for many years have to be replaced, not being thought safe enough to carry traffic.

On any length of highway the bridges are the spots of special danger, and it, therefore, becomes necessary to take the greatest care to make these crossings as safe as they can be made in order to carry traffic without accident. A bridge, to be satisfactory, must fulfil three main requirements: It should be strong. It should be durable. It should be sightly and of pleasing appearance. The first of these requirements is altogether a matter of design, and almost any structure can be made strong enough if enough material is used in building it and it is properly placed. The second desirability that the structure should be durable can also be readily obtained by building only of durable material. The third condition, however, is the one in which so many of our structures fail, as sufficient care is not taken in the designing of the bridges to obtain that result or effect which makes all the difference between something pleasing to the eye, and which blends with nature, and something in which the discord is so great that it cannot help but be noticed.

Steel Bridges.—In the province of Nova Scotia the construction of steel bridges was commenced in the year 1883, and since that time upwards of 800 steel bridges of different spans have been erected. Previous to the year 1883 the bridging in the different counties was under the control of the municipal authorities, and the bridges up to that date had practically all been built of wood, and in most cases the substructure for these bridges was also built of cribwork. Steel has been substituted for these wooden structures almost altogether since that date, and at the present time only a few samples of the original constructions in wood are to be found throughout the province. Some of these bridges have been in use about fifty years and are still in a state of good preservation, and are doing good service at the present time.

In the specifications in use in the province of Nova Scotia the steel bridges are divided into three classes as regards live loads:—

Class "A"—For bridges subject to heavy city traffic.

Class "B"—For bridges on country roads with heavy traffic.

Class "C"—For bridges on country roads with light traffic.

The live loads for which they are designed are respectively 15 tons, 12 tons and 8 tons. In the construction of steel bridges the types preferred are as follows:—

For spans up to 30 feet... Rolled beams.
For spans from 30 to 80 feet Riveted pony strusses or plate girders.
For spans from 80 to 200 feet ..... Riveted trusses.
For spans over 200 feet... Either riveted or pin-connected trusses.

All steel bridges are now designed to carry concrete floors with wood block or bituminous wearing surface, although at the present time these materials are not used universally, as it is found that with the present prices of materials plank can usually be delivered at the bridge site for $20 per M., or under, and in consequence a double floor of planking can be maintained at cheaper cost than the more permanent concrete floor and wearing surface. On all more important bridges, however, it is intended to use concrete flooring.

The concrete floor is heavy and adds very considerably to the amount of dead load of the bridge, and, consequently, increases the weight of the steel required in the trusses. One great advantage of concrete floors in addition to their durability, is that they distribute the concentrated load very much better than the wood, as the weight of passing traffic is spread over a greater area of the bridge structure. The structure is also much stiffened when a reinforced concrete flooring is used.

After a steel structure has been erected and properly field painted, it should remain in good condition for a period of from four to five years, depending largely on the condition of the surface of the steel, the quality of the paint, and the care taken in its application.

The best practice in purchasing bridges would undoubtedly be to first determine just what type and form the new structure will be, and then to prepare the necessary stress sheets and drawings, so that all who intend tendering for the structure will do so on the same basis. For this work it is best to secure the services of a competent bridge engineer. The cost of the plans prepared in this way is a little more than if they were prepared in the department office by members of the regular staff, and in addition the benefit is obtained of greater experence and the consequent assurance of safety.

Concrete Bridges.—Concrete for bridge substructure has been used very largely in the province of Nova Scotia since the year 1883. Dr. Martin Murphy, who was at that time and for many years after the Provincial Government Engineer for the province of Nova Scotia, is regarded by the profession as one of the pioneers in concrete construction, and many of the structures erected of that material bear witness to the wisdom of Dr. Murphy's choice of material.

A paper on the subject of "Bridge Substructure and Foundations in Nova Scotia" by Dr. Martin Murphy, which was read before the Engineering Congress at the Columbia Exposition in 1893, elicited much favorable comment at the time, and also affords much valuable information relative to the employment of concrete in bridge work.

The experience so far gained in the employment of concrete for bridge substructure in the province of Nova Scotia would go to show that it is eminently suited for the work for which it has been used. At the same time it cannot truthfully be said that none of the construction has so far shown signs of deterioration. It is the case that concrete has been employed in Nova Scotia in as

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