

STUDIES IN ROAD CONSTRUCTION.

(Concluded from last week.)

[This is the last of a series of articles abstracted from a valuable course of lectures on road construction for county road superintendents and engineers. These lectures were delivered under the auspices of the Ontario Office of Public Highways, at the Parliament Buildings, Toronto, in February.]

Culverts.—By R. M. Smith, B.Sc.

Steel, whether smooth, twisted or corrugated, may be used for reinforcing. Some engineers take exception to the use of smooth steel. The adhesion of concrete to steel is so great, however, that any steel may be used with safety. The bars are generally placed about twice their diameter from bottom of slab or beam. They should be placed close to bottom of beam in order that they shall take all the tension that may occur, and that their resisting power shall be as great as possible. All reinforcing should be clean, free from dirt or rust. Once embedded, the rods are air-tight, consequently free from oxidation, therefore cannot rust.

In building reinforced concrete, material is mixed as for plain concrete and placed in practically the same manner, after reinforcing has been put in place. The whole floor should be placed in one day if possible, to enable the entire slab to set as one mass. If impossible to do this, then concrete should be placed that each day's work will form a slab.

The forming can be done with 2-inch lumber. The thinner the lumber the more bracing required. The floor upon which the slab rests also should be 2-inch lumber well supported. Particular care should be taken in building forms to get smooth finished surface. So many culverts throughout the province have been spoiled by rough, unfinished appearance.

Culverts of spans less than 2 feet can be built without reinforcing, but the saving by not reinforcing is slight. It is easier and better to build them with a solid concrete bottom than to put heavy foundation under the walls. It is best to build with flat top which is easy to form and takes less head room. Oftentimes old steel can be used to advantage in the tops of these small culverts. Old rods, woven wire fencing, or heavy wire of any kind embedded in the bottom of the slab and in the side walls will give the culvert additional strength and help to prevent any temperature cracks.

Some of the counties of the province have standard forms for different spans required, some being for arches and others for square or box culverts. One thing the writer noticed particularly in going over the roads was that in a great many places where culverts are being built the new structure is generally made the same span as the the wooden one being replaced. We can see that this is very often not necessary and is a waste of material, when we remember that these wooden affairs were constructed with practically no thought of design or proportion. Some data should be collected to determine size of culvert required. Note should be taken of floods of previous years; the area of country the stream will be required to drain; also whether it is heavily wooded and whether run-off in spring is fast or slow.

No matter how well a culvert is put in or how accurately designed it is, it will become useless if it is choked with dirt, leaves or rubbish so that it cannot serve the purpose for which it was built.

It should be the care of the road superintendent in each county to see that all culverts and bridges have a clear and unobstructed channel, at all times. They should be cleaned with special care just before the spring breaks

up so that the water can be quickly carried away as the snow and ice melt. A little care in keeping culverts open at this and other times would often result in a much quicker drying up of the roads.

Designers of both highway bridges and culverts are urged not only to investigate the safety and durability of proposed design, but to consider their aesthetic feature as well. When these are constructed of permanent materials the designer should bear in mind that any aesthetic defects that may be present now will become more and more apparent as the community develops. For example, a culvert, the defects of which are hardly noticeable, when surrounded by dilapidated fences and buildings, may become a veritable eyesore, if these features of the landscape are sufficiently improved. A design may be in excellent taste, however, and yet be almost totally devoid of ornament. A few simple panels and copings are usually sufficient to lend an attractive appearance to the structure. Special care should be given to proper proportioning of parts.

CONCRETE ROADS. By H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission.

The speaker emphasized the necessity of drainage in each and every type of road or pavement. He considered it the most important factor. Next in importance came the selection of materials. Sand should be hard and well graded, as the quantity of cement necessary for good mortar depends thereon. The best type of stone is a matter depending upon the class of traffic to be taken care of. Its uniformity, however, is an important characteristic. Trap is an ideal material in the matter of toughness, hardness and abrasive qualities, and may well be used where possible.

Relative to construction, the speaker dwelt upon the importance of compactness of subgrade, including shoulders. In accepted practice the subgrade should be level, *i.e.*, not crowned. It should be moist when the concrete is placed upon it. The concrete must be thoroughly and uniformly mixed. The mix under present practice is 1:1½:3, although sand is often in excess of this proportion.

Tarpaulins should be used to protect the freshly laid concrete from sun and wind. Traffic must be kept off and it should be allowed to set slowly. The tarpaulins are then removed and the concrete is sprinkled so as to retain the moisture. Mr. Van Scoyoc expressed himself of the opinion that traffic should be kept off for at least three weeks, or longer if indications warrant it, to allow the concrete to gain sufficient strength.

Joints were placed about 35 ft. apart. It was explained that they were not to take care of expansion due to temperature changes, as had been previously thought. It is now believed that expansion is due to moisture rather than temperature change. While these expansion joints were previously made 1 inch in width, they are now as low as ¼ of an inch, according to present practice.

It was stated that hydrated lime might be used with cement up to about 10%. Its value lay in a more easily worked mortar. Another claim for it is that it acts efficiently as a waterproofing.

The author referred to steel vs. bituminous joints, and pointed out several important factors to be kept in mind.

Regarding maintenance, the speaker did not claim, as some enthusiasts are disposed to do, that maintenance was a negligible factor in concrete roads. Maintenance was small, it is true, but had to be looked after, nevertheless. An important item in this regard was the attention that should be paid to ditches.