

Concrete Roads.—During the last five or six years quite a large amount of roads have been constructed having a wearing surface of cement concrete. It was thought at first that this would not give satisfactory results, as it was feared that the concrete would be so affected by the changes in temperature as to crack in cold weather or bulge in warm weather; also that it would be difficult to keep in repair.

Possibly the best and best known examples of concrete roads are located in Wayne County, Michigan, in the vicinity of Detroit. The writer had an opportunity of driving over these roads last summer, and he was very much surprised at their good condition. One in particular that was only 9 ft. wide and half a mile long had been in use five years, and had cost during the entire five years but \$26 for repairs. It is true that on this section the traffic was not great, but on another road, where the pavement had also been laid five years under quite heavy traffic, the concrete was still in good condition. The cost of these pavements varied according to conditions, as practically all of the material had to be brought from out of the state, and the cost of even the water was great, as many of the roads extended into the country long distances from any watermain. The concrete for these roads was generally laid to a depth of about 6 ins., and the cost on the average was about \$1.35 per sq. yd. On Michigan Avenue, however, the concrete was laid an average depth of 7 ins., mixed in the proportion of 1 part cement, 1½ parts of sand, and 3 parts of gravel. In this particular case the cost of the concrete was \$1.47 per sq. yd.

In Massachusetts the cement concrete roads laid in 1914 were of an average depth of 7¼ ins., and cost from \$1.40 to \$1.55 per sq. yd., while in New York State, with a mixture of 1 part of cement, 1½ parts of sand and 3 parts of broken stone, averaging 6 ins. in thickness, they cost \$1 per sq. yd.

Concrete roads are sometimes covered with a thin coat of bitumen, the idea being to prevent the wear of the concrete and get a more resilient and a less noisy road. There has been some difficulty in making the bitumen adhere to the concrete. The practice of using the bitumen has not yet become general.

Brick Roads.—In the Central West, where paving brick is cheap and good, a great many brick roads have been laid. This is especially true of Ohio, and particularly around Cleveland. The writer in 1914 made an examination of many of these roads; while some of them showed defects, probably due to lack of drainage, as a whole they were in extremely good condition and must be a great boom to the farmers and other people living in the vicinity of Cleveland. It happened that the time the inspection was made was soon after a rain, when the clay of that country was in exceedingly wet and sticky condition, so that, when sometimes it became necessary to take an unimproved road to get from one brick road to another, the value and convenience of the brick roads were especially appreciated. These roads are expensive, as all of the material has to be transported for quite a distance, and much of it by horse-drawn or motor vehicles, as the roads are sometimes quite a distance from the railroads. The cost in Ohio for brick on concrete averages about \$1.80 per sq. yd.

In New York State, in 1914, brick cost \$1.55 per square yard.

It sometimes happens that, on account of the heavy traffic in the vicinity of cities, roads are constructed that are practically street pavements. In New York State, in the eastern district, some asphalt block pavement was laid in 1914 at a cost of \$1.40 per sq. yd.

It does not seem necessary or pertinent at this time to go into the merits or descriptions of the different kinds of road pavements, as that would mean an extended discussion.

Type to be Selected.—Which one of the foregoing methods of improved road construction is to be used depends upon several conditions. The first of these is the ability of the county or state to pay for the work, and then there must be considered the amount of traffic which will use the road, and its character. There is absolutely no use to plan a road, no matter how well adapted it is to conditions, if there are no funds to pay for it. With a limited amount of money the problem is to obtain results with that money, and in order to do this a complete investigation must be made of both the amount and character of traffic, because if the road is to be used by heavy vehicles, a different form of construction is required from what would be called for if the same tonnage were to be drawn over the road in smaller loads. It is possible that heavy loads may be so infrequent that they can be left out of consideration entirely, but if considered, upon their frequency will depend the treatment that should be given to the road.

If, however, funds are available to build the best road, from an economic standpoint, the problem is somewhat different, as the matter of first cost is not so important as ultimate cost. In considering the ultimate cost and assuming that the roads are built out of the proceeds of a bond issue, as they are in New York State, the expense is not the first cost, but the interest on the first cost, the cost of repairs, and the amount of money to be paid in each year for a sinking fund that will pay off the bonds when they become due. And in this connection it should be said that in any bond issue made for a road improvement, or for any other improvement, the term of years for which the bonds are issued should be equal to the life of the improvement as nearly as it can be estimated.

It is also necessary that the deciding official should understand fully the properties of each one of the different roads so that he will know the ability of each one to sustain the traffic that he finds will be applied to it when constructed. He must understand, too, that a road when improved is likely to attract traffic, and that as a general rule the traffic will be much greater after a road is improved than before.

Having determined the type of road to be used, the exact material must be determined. This is an engineering proposition, and the availability of the material must govern the choice to a great extent. Trap rock, for instance, might work out as the most economical from a general standpoint, but might be prohibitive on account of the cost of transportation. It often happens that a less valuable material will prove more economical, on account of its propinquity to the road, than a better material which must be transported some distance.

In this consideration it must be understood that there is a natural as well as a traffic life to road material, that is, gravel, stone or brick will have a life according to the traffic as they are not acted upon by atmospheric conditions, while, on the other hand, asphalt, coal tar, or other bitumens are acted upon directly by the atmosphere, and, even without traffic have a certain life.

A careful study must be made as to all of these conditions, the first cost and the cost of repairs of the different kinds of wearing surfaces, together with their characteristics, as well as the availability of the different materials. With all these items before him, an official can determine pretty accurately which is the best surface to be used.