Substituting values of x and t in equation (2), $\frac{b^1}{b} = 1 + \frac{6.5^2(13-11.25)}{(3\frac{3}{4})^3} = 2.4$; therefore $b^1 = 2.4b$.

Substituting values in equation (5)

$$A_c = 6.5b + [3.75\ (2.4b - b)\ (2 - \frac{3.75}{6.5})] = 13.971\ b.$$

Substituting in equation (6)

$$722{,}000 = \frac{13.971\ b \times 650 \times 15.292}{2}$$

whence $b = 10.398''$ and $b^1 = 24.955''$.

Now, if b^1, as derived, is permissible, having regard to span and spacing; and if b provides a stem sufficiently strong in shear, then the section is acceptable and may be completed by solving for A_s. If both conditions are not satisfied, the trial must be repeated with a new value for x.

The dimensions derived above satisfy conditions, and the completed section might be as shown in Fig. 2.

THE LOW COST ROAD.*

By Philip P. Sharples, New York City.

THE road problem should be considered from rather a broad standpoint. We have a problem; we wish to know what is the most economical road to build in any one situation. It is not an easy, but a very difficult problem, one that has many ramifications. Not only must we think of the exact economical situation, but we must think of the social aspect of the situation, as road builders are rather apt to neglect it on the whole. It is, however, a very important consideration. In addition to hauling our goods to market, and doing it in a way to bring biggest returns, we also must consider our wives and children. The road should, therefore, so provide for them that they can have easy intercourse with their neighbors, so that they can go to school easily, and get some little enjoyment out of life as well as bare existence. In considering the road problem, therefore, we should take this social aspect into consideration, and oft times build a little higher class road than we otherwise would, from a pure economy standpoint.

We wish ultimately to have roads over which we can travel during every month of the year in any kind of vehicle that may be good for that season, and to do this—as a general rule—we must choose a little bit higher type road than would suit the bare necessities of the case. When we come to choosing the type, we have quite a large range to choose from. From a cost standpoint we start with the dirt road which can be put in shape and kept passible for as little expenditure as $10 or $12 per mile per year; then we have the gravel road, costing to build about $1,200 a mile; then we take quite a jump to the macadam road, which costs about $7,500, and the tar macadam at $9,500. Then there is also the concrete road which would cost us perhaps $14,000 to $16,000 per mile, or, with a 2-in. bituminous top on it, $18,000 to $20,000 per mile; then we have the brick road, costing perhaps $25,000 per mile, or thereabouts. These figures are very general, but what I want to illustrate is that we have a series of roads for which we can pay almost anything we wish. We have a wide range, but must choose the one particularly suited to the conditions to be provided for. We must look at the use the road is going to be put to, the amount of money we have to spend, and also the amount of money we can get to maintain the road. In choosing along this wide range we want to keep down the cost of the roads as much as possible, and choose as low a type as will do the work we want to do.

It is a great mistake, economically, to choose a type of road that is better than we need for the purpose. It it a little hard to illustrate this point without going to extremes. In New England temporary roads are built for hauling logs out of the woods in winter time, and perhaps the road will only be used one winter. Naturally not much money can be spent on it. On the other end of the scale let us take the main street of a very large city, say the approach to the Brooklyn Bridge in New York City. That thoroughfare receives perhaps more travel than any other in the United States, and it would be economy to build the very best type of pavement regardless of cost. These are the two ends of the problem, and any local engineer must choose a road somewhere between those two types.

In this country, you must choose the low types very often, but it pays to put in the best of the type and to provide for excellent maintenance. It is a great mistake to neglect the low cost roads. It often leads to extravagance in the community. I have seen districts where high cost roads have been built just because the low cost roads were not properly maintained. The low cost roads, kept in condition, would have answered the needs of the community and as a greater mileage could be built and maintained than with the high cost section built, the whole community would have been better off.

It is not to be expected that such a community will take care of the high cost road. In a few years the wreck of the high cost section will probably, for the sake of a little maintenance, be on a par with the other poor roads.

Instead of stepping on to the next high cost road, it often pays to put more maintenance on the next lower type. For instance, instead of building a gravel road you could get along with a dirt road, if you kept it in good shape, and you are able to keep a good many miles of dirt road for what it would cost to put in a gravel road. Perhaps where a macadam road would be useful you could put in a gravel road and keep it up well, and make it answer.

In the same way a macadam or tar macadam properly maintained will do the work of the high cost roads. It is necessary, however, to provide for the proper maintenance of whatever type is chosen. This I realize more and more as I look at the road problem throughout this country, and as I have seen it in France, England and Scotland. Over abroad this subject of maintenance has been more thoroughly learned and they appropriate money for it rather freely. In England, for instance, it costs them $600 to $700 a mile for maintenance of macadam roads. In this country you do not find many places where they appropriate money for road maintenance freely. It is now being done in Massachusetts. It is necessary, with the new style of traffic, to spend considerable money in upkeep in order to make macadam roads resist. In Massachusetts, macadam roads require annual maintenance somewhere along $600 per mile per year, or about the same as in England for the same traffic.

Gravel roads can be made and maintained cheaper where they can be used, but traffic conditions in the above

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