manent surfaces will become more popular, and while more expensive to construct, the decrease in maintenance will offset the increase in cost.

Subdrainage is required where the soil is so dense that the water lies in the ground and can be made dry only by drains placed under the ground deep enough to reach this water. The drains are intended to drain the subsoil only, and it is not intended that any surface drainage should be allowed to enter them. Underdrains lower the level of the water in the soil and thereby prevent the road surface from being disturbed by softening of the foundation.

Tile Replaces Older Drains

The older types of subdrains, such as the wooden box drain and drains built with flat stone, have been replaced in the present day by the use of tile. The layout of a subdrainage scheme depends upon the conditions found in the road to be drained. A study of the road should be made and inquiries made from old residents who have known the road for some time. The source and the amount of water should be determined, because this information, taken in conjunction with the grade which it is possible to give the tile, will determine the size of the tile required.

Tile should, as a rule, be laid on both sides of the road, but this may not always be necessary. Where the roadway is in a cut having a bank on one or both sides, the water will usually be found to come from these banks in the form of seepage or springs, and in these cases tile should be placed under the side ditch at the foot of the bank, which will prevent the water from passing under the roadway. Special attention should be given in grades, as springs frequently occur, and sometimes it is an advantage to cross-tap a road to prevent water seeping down the hill.

Care should be taken laying the tile. The trench should be dug in a straight line. The position of this trench must be determined by the road engineer. I am in favor, in ordinary cases, of placing the tile immediately under the shoulders of the road or slightly nearer the centre of the road than the side ditch. The tile should be laid true to grade. In shifting soil it may be necessary to lay the tile on inch-boards about four or five inches wide. This will ensure them against buckling, which often happens with tile laid in a quicksand bottom. The backfilling of the trench should be made with gravel or stone if possible.

Joints in Bad Soils

In bad soils it may be necessary to use a tar paper over the joints to prevent the silt entering the tile. Sawdust has been used very successfully for this purpose. Where the drains have a long run, catch basins should be used. These are used for inspection purposes; sediment will be trapped here if the bottom of the catch basin be constructed lower than the flow line of the tile. The bottom should be about 18 ins. below the tile. They also provide a vent to the drain. The outlets of all tile drains should be protected by concrete walls where the drains are deep, and by slabs placed over the tile where the tile is shallow.

While a great deal more may be said and written on the subject of drainage, it will be of no avail unless all persons engaged in road work be taught the benefits that a road derives from a good drainage system.

The annual report of the street cleaning department of the city of Toronto shows that 351,193 loads of garbage were collected last year in that city at a cost of $1.29 per load, compared with $1.23 per load in 1918, and $1.06 per load in 1917.

The newly organized Ontario Cement Co., Ltd., has purchased the plant of the Ontario Portland Cement Co. at Blue Lake, near St. George, Ont., and will remove the plant to Beachville, Ont., where the company has secured 170 acres. The Ontario Portland Cement Co. was organized in 1901 and was operated for 15 years, until its marl beds became exhausted.

INFLUENCE OF FAIR SPECIFICATIONS AND COMPETENT INSPECTION ON BIDDING PRICES*

By H. S. Mattimore
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THERE are many serious problems confronting highway officials at the present time. One of the main factors on which the accomplishment of this work depends is the securing of large reputable contractors to undertake construction of these highways. It is a pure business proposition with these companies, and there is no reason why they will not seek it, providing the highway officials make it attractive. This does not necessarily mean exorbitant prices. Fair prices with fair treatment, and intelligent, clear specifications with competent enforcement generally prove to be a greater incentive than high prices and extensive delays caused by incompetent inspection, indecision and indefinite specifications.

With very few exceptions, the modern contractor is a big business man, anxious to do good work and maintain friendly relations and thereby establish a good reputation. On the other hand, engineers are fairminded, or at least try to be, and their decisions are influenced only from the standpoint of obtaining what in their judgment is a good quality of work.

Now the causes of conflicts between the engineers and contractors are many and varied, but broadly they can be summed up as a difference in viewpoint. This is bound to exist so long as individuals are of different character and mind, and in fact the stronger the character the more the argument necessary to change the viewpoint. Do not confuse this with ignorant stubbornness. We must be broad enough to realize that there are many problems in highway work that have more than one correct solution.

Specifications Must be Clear

The highway official has full power to specify the character of work that the contractor must perform, and in justice to the state he must see that this work is performed according to these specifications. Now in my mind this is the source of many of the troubles arising during the progress of the work. The contract is taken by the contractor and he agrees to perform the necessary work in accordance with certain specifications. These specifications are written by the engineers and supposedly understood by the contractor. Now, is this latter always the case? Are all specifications clear? As an answer, consult articles in current numbers of engineering and contracting journals, also examine court records of state versus contractor on highway cases. In the latter you will find judge, jury and many legal authorities are trying to interpret various clauses in specifications. This, in itself, should convince us that the specifications must be clear. Make them concise if possible, but do not sacrifice clearness.

There is much to be said regarding specifications. In the first place, they must not be a product of one mind. A really clear and concise specification, if written by an individual, should be done so only after ideas are obtained from men directly connected with the details of construction. Good practice must be adhered to and all methods must be described as definitely as possible.

"Satisfaction of the Engineer"

Do not specify better quality or more detail than you expect to obtain. We have all seen specifications with many paragraphs or phrases which were apparently written to act as a club over the contractor. They were supposedly intended as an insurance against a dishonest contractor. Such an insurance leads to high bids, and large reputable contracting companies will hesitate before bidding under such specifications, and when they do bid it will be high enough to play safe.

Occasionally another type of specification is encountered which is so open and broad that it is dangerous. I refer to

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*Excerpts from paper presented at a convention of the American Association of State Highway Officials.