

no drainage, no road, and no matter what you may do, whether your road cost you ten dollars or a hundred thousand dollars, if you don't have proper drainage for sub-grade work and proper surface drainage, and have the carrying off of the water after it gets off the road properly and intelligently taken care of, the length of life of that road is very short.

Discussion

The President: It is every road-builder's experience that the greatest mistakes made in road-building are due to improper drainage. We have all seen thousands of dollars wasted by neglect of this important question.

B. Michaud: Do you think there is any type of stone foundation that is equal in value to the Telford foundation and more economical?

Mr. MacDonald: I don't think so. The question of foundation is like butter—good, better, best.

Mr. Michaud: I put the question because I find that with us it is impossible to lay the Telford foundation on rural roads because skilled labor is so scarce, and we have to lay our foundations out of crushed stone, arranged from four to five inches, and to roll it and fill it.

Mr. MacDonald: I thought I had made it plain in my address that the Telford base not only answered the purpose of drainage, but also of foundation. In this great question of highway construction I have always appreciated the fact that poor people have poor ways, and in all my talks I have always tried to bring in not the sword, but peace, and so I have recommended on every platform, use the material that you have in your own locality in preference to importing material, if that material will take care of the traffic that that particular road or improvement is called upon to sustain.

I have used sand foundation, I have used flat stones to make a sustainer. In the early days we used to build a calico road and lay it across the sand foundation, and put the stone on that, and afterwards we learned to use a light roller and put on water and gradually beat it down until it would sustain the weight of metal. I have built splendid foundations of gravel which took care of the road.

Of course, the foundation of a road is simply determined by the traffic it is called on to sustain, so that it is "many men, many minds." I confess that the finest road, for resiliency and comfort, is a well-built gravel road, and I like a gravel road, and I have built it in two-inch courses of the coarser gravel as a bridging and a finishing course, putting in a foundation of two to three inches, longest diameter of the stone, and rolling that down three or four inches, and then putting on another treatment of gravel, from one to two inches longest diameter of the stone, and in that course having eighty per cent. gravel and twenty per cent. binding material.

Then I finish it up with a two-inch treatment of sixty per cent. gravel and forty per cent. binding material, rolling each course in so that when finished it would be homogeneous and monolithic in character. I have sometimes put down on shifty foundations a treatment of branches and things of that kind as a hold-up, and I have taken field stones out of the meadows. I have taken broken brick. In other words, I have utilized everything that I could find in that particular locality so as to save the prohibitive price that would occur in bringing foreign materials in. And so I would advocate here. Some of the finest roads I have seen have been built with a lighter foundation than the Telford. In the early days the farmers would go in, and thought that their Telford foundation consisted of digging a great drain, the entire width

of the road, three or four feet deep, and taking the oxen and stoneboat and dragging in great boulders.

There was no outlet for the water or attempt to change grade. They felt that was the way to build a good, solid road, and they did it, and when we came to build a grade and change the alignment, it was the most expensive road we had to contend with, because it was almost impossible to get those boulders up. This is the day of the veneer in everything. We have to learn to utilize what we have and make it do. And I believe the scientific treatment of roads will result in a lighter construction, but more dense, and a greater attention to the question of underdrainage. Take care of that and you will be surprised what a lighter construction will stand up and give good service.

Mr. Fraser, Quebec: With regard to the question of side drainage, one of the difficulties we have met with is to provide an outlet. Very often they have to be put three feet below the sub-grade and it is hard to provide an outlet.

Mr. MacDonald: As your roads become more popular you will have to resort to one of two things. Either put in a system of side drains underneath, which are reached by drops, or you will have to put up guard-rails. With us we have many a man with a thirty dollar horse and a four dollar wagon who is looking for an opportunity to get an easy living at the public's expense by going into these ditches. You will find your machines skidding over into them, and probably there will be loss of life. And as the road becomes popular you will have your speeding, and that will lead up to accidents, and so the question is whether it would not be more economical to drain it out to a side drain. Sometimes we have to go into some convenient meadow and make pockets—well holes to seep out the water in the road and discharge it so as to take care of it.

Frost and Blind Drains

You are in a splendid position to-day, for you have all the mistakes and all the waste of money that we have shown in the handling of this great question. Every man should have access to his home, and there never should be anything done in the way of public improvement paid for out of the public purse for which an abutting owner is taxed, whether it is a farm or building lot, if it is for the public good.

Mr. Fraser: What do you think of the trench stone-lined drain? The cross lines were built across the road, three feet deep and one and a half feet wide, with no outlet.

Mr. MacDonald: Any drain that will keep the water off the roadbed and keep it from heaving will do good. But I never had a great deal of use for a blind drain by reason of the fact that the frost makes all kinds of trouble, going down sometimes five feet and heaving the road, the water staying in and freezing. But where you have nothing else to do and no way to accomplish anything else, the end justifies the means until a better provision is made.

Mr. Gray, Ottawa: Have you had any experience in draining a road with agricultural tile?

Mr. MacDonald: Yes; we have taken that and put in the drains where we could not get the stone by putting down a plank on the bottom and putting in the tile on top of the plank, and then arranging with nailing or some other way of fastening so that the joints would not dodge, and then cover with gravel or broken stone. We have never laid it on the dirt because the leakage would allow the joints to dodge and press it down.