

hauling distance, however, it will be advisable to consider the use of other metal; since gravel is not found in the immediate locality, and therefore expensive in transportation, will frequently be found less economical in final cost than a better, though higher priced, stone.

It may take several months before a gravel surface is thoroughly compacted, no matter how well it may have been rolled during construction. During this period careful attention should be given to the road, and the ruts and hollows should be patched as they are formed. In times of wet weather or of frost, a gravel surface will be soft and rut very easily. As in the case of earth roads, the road drag is one of the best tools with which to maintain a gravel road. Where a road grader would unnecessarily disturb the surface, the road drag serves to simply smooth up the road, fill in the hollows and put just enough of the material towards the centre to maintain the crown.

An essential part of the maintenance work is to keep ditches, drains and culverts clear to provide for the removal of the water which falls onto the road.

In conclusion, perhaps the greatest advantage peculiar to gravel comes from the presence of the binder which possesses the power of quickly reconsolidating the material under traffic, even after the first bond has been broken, thus reducing repairs and maintenance to a comparative minimum.

MAINTENANCE AND REPAIR OF HIGHWAYS.

By Charles Talbot, County Engineer of Middlesex.

Maintenance was referred to in this paper as applying to the up-keep of a road after construction, so as to continuously meet the requirements of the traffic to which it is subjected. The author pointed out that no attempt had been made in this respect toward the maintenance of public highways in the rural municipalities of Ontario. Almost without exception the new or reconstructed roads were left to take care of themselves after construction until they were in such a condition as to require rebuilding, before it was considered advisable, or just to other sections of the municipality, to spend further money upon them. The fallacy of such a practice was strongly pointed out. The author observed that the Legislature, while encouraging road construction by the offer of one-third of the cost of the work, had not encouraged maintenance, other than calling attention to the immediate and constant necessity of taking care of the highway after construction. No financial aid was given towards maintenance and the representatives invariably considered it more advantageous to apply the whole of their available funds to construction. A third reason was that the man in charge of maintenance would be working continuously on a job where neither the necessity of the work nor the result produced was apparent to the casual observer.

The author referred to that portion of the Municipal Act requiring townships to construct and maintain all roads within their municipality, and pointed out that townships adjacent to large cities and shipping stations had an unreasonable burden to bear in this respect. It was observed that the Highway Commission, recognizing this condition, had made recommendations to adjust the matter, bringing relief to such townships. The author suggested that a step farther might well be taken, requiring the county councils to assume their share of the responsibility.

The Highway Commission had also recognized the need of the Legislature contributing toward the maintenance of highways, and if their recommendations are

adopted they will remove the second reason for lack of maintenance, as mentioned above.

To overcome the third reason, the author commended the plan suggesting that the management of the road be removed from direct control of local influence, as provided for in the proposed Act.

It was recommended that every county having supervision of highways should have a permanent officer in charge of the work, with his duties clearly set forth, and with complete supervision of all work, including absolute control of all employees. The county roads should be divided into sections of from five to ten miles, according to traffic, and a man placed in charge of each section, with log drag or heavy grader. Under the advice and direction of the engineer, he would be responsible for the maintenance of his section. He should have supervision of all contracts and of all day labor work and should at all times keep proper time sheets and records of material. This road foreman should be given power to employ men and teams as required, and should be responsible for the care of all road machinery.

The author went on to state that the average rural road once properly graded, drained and metalled requires comparatively little attention to keep it in excellent repair. The little it does require must be applied promptly and before the necessity is apparent to an uninterested person. The greater part of the actual labor necessary will consist of the timely use of the road grader or drag, the delivering and placing of the necessary gravel or stone to maintain the crown, repairing tile and open drains, cutting weeds and shovelling snow. All of this work, except the operating of the grader and the placing of the metal can be attended to by ordinary labor and teamsters, which are at all times available in such numbers that the work can be quickly done and at a very moderate cost if properly directed by a competent foreman.

With a superintendent and foreman working in harmony with the council there is direct and efficient control of every mile of road either for constructing a new road, reconstruction of an old road or for maintenance of one already completed.

On a stone road, ruts will develop on certain sections, while other portions remain solid and firm. Except for a slight wearing of the stone and the removal of a part of the binder exposing the surface of the larger stone, little effect is noticeable upon the road for a few years. What are the conditions that produce the different results?

Except where very heavy travel exists it will be found where a stone road ruts, the rut is not caused by a wearing of the stone, but by the weight of the wheel traffic forcing the stone into the grade beneath. From this, one must conclude the foundation was defective. Sub-soils composed of a rich black loam, although reasonably well drained, will still lack the carrying capacity of the firmer soil and hence the rut. Firmer soils with insufficient drainage will produce the same results.

If the trouble is caused by an open and yielding sub-soil the ruts should be cleaned, tar painted and stone tamped to position, repeating the operation as often as necessary to form a firm foundation. If the original depth of stone is obviously too thin, a second coat should be applied and finished with the steam roller.

If the trouble is with the drainage, sufficient drains must be placed in the road. If the sides are previously tiled and drains in working order, as they should be in every case where clay or loam or other damp sub-soil exists, it will almost invariably pay to open the centre of the road and construct a tile drain from 2 ft. to 2 ft. 6 in.