

on every gravel road in the country. Roadmen should be educated in its use and in the knowledge of the right times to use it. Its operating-cost is so small that it can be used very frequently. The best time to use it is after a shower, just as the road is beginning to dry. There are many unsatisfactory gravel roads upon which more money is spent carting fresh materials to fill ruts and potholes than would be necessary to maintain the same roads in good condition by means of the road-drag. The pamphlet "The Road-drag and how it is used," prepared by the Bureau of Public Roads in the United States, should be in the hands of every road engineer, road overseer, and road foreman in the Dominion.

MAINTENANCE OF MACADAM ROADS.

The theory of the old macadam road was that the abrasive effect of traffic on the larger stones produced just sufficient fine material to bond the larger stones and replace the original filler as fast as it was removed.

The introduction of the motor-vehicle has meant that (1) more of the filler is quickly removed, and (2) the abrasive effect on the larger stones is absent, on account of the rubber tires. It is quite evident, therefore, that the old theory fails and the road-surface rapidly disintegrates. If a macadam road is to be maintained to carry a reasonable amount of motor traffic, the obvious thing to do is to endeavour to replace the binding-material as fast as it is removed, or to provide such small fragments of suitable material on the surface of the road so that the reduced amount of steel-tired traffic can by abrasion and impact increase the supply of binder to replace the excessive amount removed by rubber tires.

A ½ in. layer of fine gravel, coarse sand, or fine screenings is effective. As it is thrown off the road by motor traffic, it must be replaced by dragging or scraping. The filling of potholes and depressions in macadam roads should receive close attention. A most important point is that each hole should be excavated until it is sufficiently deep to take satisfactorily the size of the stone used in repairs. The edges of the hole should also be cut out vertically, and the thickness of the patch should be uniform. The same kind of stone as exists in the road-surface should be used, and it should be compacted, rolled, or thoroughly tamped, and watered just as if it were new construction. To enable a patch to stand the traffic more satisfactorily, cold bituminous mixtures are often used to coat the metal. Tar or bituminous surfacing the whole of a water-bound macadam road is really a form of maintenance, as under much traffic it is usually necessary to replace such a surfacing annually or biennially.

MAINTENANCE OF CONCRETE ROADS.

I would like to mention that the greatest of caution must be used in accepting maintenance figures for concrete pavements in cities as any criterion of what maintenance per mile on a concrete rural highway is likely to cost. It must be remembered that with a rural concrete road the ditches and culverts still have to be attended to, and the shoulders really have to receive more attention than in the case of other types, on account of the difference in hardness and rigidity of the contiguous surfaces. For example, in 1919, in Wisconsin, the following were the average costs of maintenance per mile for various types of road: Earth, \$223; gravel, \$212; water-bound macadam, \$516; penetration macadam, \$252; concrete, \$337. Of the latter figure only \$62 per mile was spent on the concrete surfacing itself. Again, in Minnesota, in 1923, of the total annual expenditure on the maintenance of concrete pavements, only 9 per cent. was for the maintenance of the slab proper.

TESTING OF ROAD-MATERIALS.

Testing of road-materials is carried on very elaborately in the United States. The Bureau of Public Roads publishes regularly the results of the tests carried out in its laboratory in Washington, D.C., which I had an opportunity of inspecting. The information given concerning a sample of stone includes its locality, geological classification, weight per cubic foot, absorption in pounds per cubic foot, French coefficient of wear, hardness, and toughness. Now that the main-highways scheme is under way in New Zealand it is most important that similar classified information be obtained about our roadmaking materials. The tests are not infallible, but they form an excellent guide for highway engineers.

The following table, compiled by the Bureau of Public Roads, shows the limiting-values for rock suitable for the wearing-course of a water-bound-macadam road:—

			French Coefficient:	Toughness.	Hardness.
			Per Cent. of Wear.		
Light traffic	..	..	5 to 8	5 to 9	10 to 17
Medium traffic	..	..	9 to 15	10 to 18	Over 14
Heavy traffic	..	..	Over 15	Over 18	Over 17.

If cementation tests are made the cementing-value should be over 25.
An English interpretation of physical tests on road-stones follows:—

		Deval Abrasion Test (per Cent. of Wear).	Impact Test (Number of Blows for Failure).	Hardness Test.	Cementation Value (Number of Blows for Failure).	Absorption of Water (Pounds per Cubic Foot).
Very good	..	2 and under	19 and over	19 and over	over 100	0-10 and under
Good	..	2-1-2-5	16-18	17-18-9	76-100	0-11-0-40
Fairly good	..	2-6-3-1	13-15	16-16-9	26-75	0-41-1-00
Rather poor	..	3-2-4-0	8-12	15-15-9	10-25	1-01-3-00
Poor	..	Over 4-0	Under 8	Under 15	Under 10	Over 3-0