

ROAD MAINTENANCE METHODS

By B. C. Tiney,
Maintenance Engineer, Michigan State Highway Department.

Michigan is maintaining a 6900-mile system of state highways, which are classified by type, approximately as follows:

Gravel	3,700 miles
Macadam	700 miles
Concrete	1,400 imles
Asphalt	200 miles
Unimproved and other types...	900 miles

The gravel road is naturally our greatest maintenance problem, but this type, when properly maintained and rendered dustless, has excellent riding qualities. The smoothness of the gravel depends upon the preservation of a thin cushion of loose, fine gravel uniformly distributed over the surface. This floating cover, ranging in size up to one-half or three-quarters of an inch, is moved back and forth daily by patrol graders, keeping the depressions filled.

Regular corrugations or "chatter-bumps" must be removed at intervals by heavy blading and this is best accomplished following a rain when the gravel is workable. We consider it good practice to float the loose cover to the outside edges of the road after rains and leave it there in a ridge for a day or so until the road begins to dry out, at which time it is again floated back over the surface. If the cover is left distributed over the road while wet, it may consolidate under traffic and be lost for floating purposes.

The presence of large stones in a gravel road, near the surface, adds greatly to the difficulty of proper maintenance. Until about three years ago our gravel roads were built under a specification which permitted stone up to two and one-half inches in size, but we are now using a maximum size of one inch.

The older roads were built with a high crown, making it difficult to hold resurfacing gravel on them. To correct these faults, we scarify the gravel to considerable depth, rake out the larger stone and reshape with a heavy grader. It is advisable to harrow the road after scarifying in order to bring the over-size stones to the top. After reshaping, a light resurfacing of clean, fine gravel gives an excellent surface for floating. The cost of this work, exclusive of resurfacing, is from \$60.00 to \$100.00 per mile and the results are very satisfactory.

It is probably true that in breaking up this old road crust, the road is rendered less stable during the early spring break-up, but we believe that this is more than offset by the improved riding quality and greater ease of maintaining during the balance of the year. It is not recommended that a road be scarified late in the fall.

Patrol Equipment

The patrol equipment used on gravel roads in Michigan is largely motorized. The two most approved types are the truck with a spring blade attached underneath and the tractor and grader combined in a one-man unit. The truck is operated at a speed of about eight miles per hour, making a round trip on a thirty- to thirty-five-mile section daily. This equipment is used mainly for floating loose cover, although considerable cutting of the solid gravel can be done at slower speed, especially after rains. The truck is also used to carry a load of gravel for patching holes and light resurfacing of bare spots.

The one-man tractor-grader operates at a speed of two and one-half to four miles per hour, making a round trip on twelve to fifteen miles of road. It is usually equipped with a rigid blade which does heavier cutting than the truck blade. This type of machine is very efficient in eliminating "chatter-bumps" and makes a good combination with truck patrols. The tractor-grader is used with a spring blade in some of our counties and this permits greater speed in floating but less efficiency in cutting.

The heavy grader with scarifier attachment, pulled by a ten-ton tractor, is used for scarifying and reshaping. We regard this unit of equipment as almost indispensable in the reshaping of gravel roads after the spring break-up and at intervals throughout the season. One unit may be made to do service in two or three counties and the tractor used in the winter for snow removal.

Michigan's large mileage of gravel road presents a serious problem in elimination or reduction of dust. We regard dust control as desirable on roads carrying a daily traffic of 300 to 500, and as almost a necessity for traffic of more than 500.

Our practice in this work has been along two distinct lines:

First. The application of dust palliatives which afford a temporary reduction of dust.

Second. The application of bituminous surface treatments which afford a complete elimination of dust.

Dust Palliatives

As dust palliatives, the two types of material which have been used are Calcium Chloride and Light Asphaltic Oil. We have found that any attempt to apply either of these materials in sufficiently large quantities to eliminate all dust will cause the floating gravel on the surface to solidify under the traffic. This forms a surface crust upon which the patrol graders have little or no effect, and which, under traffic, soon develops into holes. In such cases, it is necessary to scarify the surface lightly in order to restore its smoothness. If dust palliatives are applied more frequently, but in smaller quantities per square yard, they may be made to reduce the dust to such a degree that it is not objectionable to traffic and at the same time will not mat the surface or injure its riding qualities. The preparation of a surface for application of calcium chloride or oil involves a uniform distribution of the floating cover and the supplying of cover on any bare sections.

The quantities of calcium chloride recommended for application on roads having one-half to one inch of loose gravel on the surface are:

First application—1 pound per square yard.

Second application— $\frac{1}{2}$ pound per square yard.

For fairly heavy traffic, a third application of one-half pound per square yard is usually required. These applications are made at intervals of four to six weeks and a total of two pounds per square yard is usually ample for the season.

The quantities of light oil recommended for use are:

One-fifth gallon per square yard for the first application, followed after an interval of about six weeks by a second application of one-eighth gallon per square yard. The two applications are considered sufficient for a season.

Calcium chloride and light oil not only reduce the dust but conserve the gravel on the road. We find that roads which are constructed of gravel with a sand filler are very difficult to hold intact under traffic in dry weather and this is especially true if the road is built on a sandy subgrade. On these sections calcium chloride is of particular benefit, functioning not only as a dust palliative, but as a bonding agent to prevent raveling and to keep the gravel in a moist and workable condition for the efficient operation of patrol graders.

Summarizing our experience with dust layers, we feel that they are very essential to the proper maintenance of gravel roads; that the formation of a crust or mat must be avoided by application of the dust layer in small quantities and that the road, prior to application, must be uniformly covered with a thin layer of loose gravel.

The cost of dust palliatives in Michigan is about \$300

per mile per year. We do not wish to give the impression that they are applied to all of our gravel roads on which traffic conditions would warrant their use. Our appropriations for this purpose have never been sufficient to finance the treatment of more than about 800 miles of the 2,300 miles which our department would like to treat. Public sentiment, however, is becoming more insistent every year in its demand for dust elimination.

Bituminous Surface Treatments

A further solution of the dust problem lies in the bituminous surface treatment of gravel roads. Our practice in doing this work is very similar to that involved in the surface treatment of water-bound macadam. We have attempted these treatments mainly on gravel roads containing a high percentage of stone, thoroughly compacted, and the nearer this approaches a macadam in structure, the better will be the results of treatment. Full thickness of metal and proper drainage are important factors.

As soon as the ground is free from frost in the spring, the road is shaped with a grader and, if necessary, scarified lightly to eliminate all ruts and holes. Traffic is then allowed to compact the loose material and a true cross-section is maintained by intensive patrol work for a period of a couple of weeks or until such time as weather conditions are suitable for applying the treatment.

The surface is then swept and light tar or asphalt is placed in two applications of approximately a quarter of a gallon per square yard each. A covering material of pea gravel, crushed stone or slag is used at the rate of twelve to eighteen pounds per square yard.

We have used cold application bituminous materials entirely for first-year treatments and the bulk of our work has been done with tars. Last year we gave one road a second-year treatment with a heavier, hot application material with very satisfactory results. It would appear that the mat thus produced has sufficient body to be carried for a couple of years without re-treating, and at the same time is not so thick that it will wave under traffic.

While the idea of alternating hot and cold treatments on gravel roads has not been thoroughly tried out in our state, we have followed this practice successfully in our surface treating of macadam.

Patrol patching, following the treatment, is very necessary. More scaling of the surface may be anticipated, especially during the first year, than would take place on the average macadam road. These small breaks must be patched

soon after their appearance, and for this purpose a mixture of coarse sand with the same bituminous materials used in the treatment, is employed. This mixture is made in the ratio of 14 to 17 gallons of bituminous material to one cubic yard of sand. The patching is handled by one man with a wheelbarrow from stock piles along the road or by a small gang with a light truck working from a central yard.

Our experience in surface-treating gravel roads would indicate that they must be treated on an average of three times in four years and the average cost per mile per year over this period, including patching, is about \$850. This appears to be economical maintenance for roads carrying a daily traffic of 800 vehicles or more, and compares favorably with the cost of maintaining such roads with patrol graders, applying dust palliatives and the necessary resurfacing of gravel.

Michigan had about 122 miles of surface-treated gravel road on the trunkline system in 1925 and it is planned to increase this mileage in 1926. These treatments convert the gravel road into a higher-type surface and eliminate all dust.

We are coming to regard this method of maintenance as a desirable intermediate step between the gravel road and the pavement on heavy-traffic sections where pavement cannot be financed for several years.

In the surface treatment of macadam roads, our department has used both tar and asphalt. Competitive bids are received annually for a season's supply of these materials, based on standard specifications of the A. S. T. M. and the U. S. Bureau of Public Roads. We recommend the use of a light tar, cold application for the initial treatment and this may be followed, the second year, with a heavier hot-application tar or asphalt. With hot treatments a larger size of chip is used for cover and the finished treatment is sometimes rolled once over to embed the chips. The use of larger chips tends to stabilize the mat and prevent it from waving under the traffic.

The hot treatment will normally carry the road for two or more seasons and is then followed with a thin seal coat of light tar or asphalt.

In patching macadam roads, the shallow breaks are given a paint coat of tar and a covering of stone chips. Deeper holes are tamped full of tar cold-patch mixture, which is made up at a central yard and allowed to cure before using.

Hot patching by the penetration method is frequently used where large replacements are to be made.

In making concrete replacements, Lumnite cement or a 2% addition of calcium chloride to Portland cement is used to give quicker service to traffic.