

Re-Treatments:

The road is now ready for traffic and, if the tar has been applied very evenly, it should not require any patching the first season and very little patching the first part of the second season. It will probably require a light treatment over the entire surface during the later part of the second season in order to hold it over the second winter.

Bituminous Material:

For our work in Wayne county, we used Tarvia B which is very similar to the Indiana State Highway Specifications for Tar TC.

The gravel which we used was bank-run or washed river gravel from which we had screened the boulders. During 1925 we used stone chips for our second treatment. The use of stone as compared to gravel should be decided in each case according to the conditions existing in the particular locality.

**SURFACE TREATMENT OF GRAVEL AND STONE
ROADS**

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Prior to the year 1926, a few small sections of state road had been surface treated with tar and known as surface treated gravel and stone roads. Early in 1926, it was decided to surface treat about 12.6 miles of a gravel road lying between Lebanon and Frankfort now known as State Road No. 39.

This particular job will be described, not because it is an ideal piece of work but because a recital of all the errors and defects together with the commendable features may be helpful to those contemplating similar work.

Our old roadbed was about 20 to 22 feet wide which proved hardly enough to accommodate a treated surface of 20 feet and leave sufficient shoulder to hold the metal base. We obtained, however, in most places the additional width of right-of-way needed to permit us to go forward with our shoulder work in a satisfactory manner.

About February 15th, we began to look forward to getting our gravel base in condition to receive the tar in the spring. We patched the places which showed signs of weakness and at the same time eliminated the waves which had been in the surface for some time. Before we had progressed very far along this line, the spring thaw set in after which we found ourselves up against a real job in handling twelve miles of road, a half of which had broken through. Although we had

made no extensive tests to determine the depth of the old metal on the road, we had been reasonably sure that it was at least 8 to 10 inches. Where that condition existed, we had very little trouble, but in many places the depth of the old metal ran as low as 4 inches and of course there we had trouble.

Placing Coarse Stone

Owing to the soft condition of the road, it was necessary that we resurface its entire length in order to get sufficient base to withstand the heavy traffic and make it suitable for the proposed tar treatment. This we did with stone as a base course using mostly our 2½" to 1½" crushed limestone. The depth of the stone varied depending on the condition of the particular stretch of road on which it was placed. In some cases we placed as much as 12 to 15 inches of stone and still had a spongy condition.

This stone was placed on the road with our own trucks and distributed as evenly as possible, taking into consideration, those places needing more than others on account of the wavy surface. Rather than do any extensive scarifying on the high places, we deemed it better to fill up the low spots. The only scarifying that we did was where the old surface was caked and hard. We used the scarifier to a depth of about one inch in order that the large stone might have a tendency to embed itself. After this heavy stone had been placed on the surface, it was smoothed down with a drag or a grader and then rolled with a ten-ton roller. We found it better to confine the rolling to short stretches of road rather than to go long distances before turning.

After the surface had been rolled the first time, some waves were noticeable. The low places were filled with large stone and then rerolled. The traffic, which we did not detour, and the drags loosened up some of the stone after it had been rolled, but by rolling continuously the stone was finally compacted and firmly established.

Inasmuch as we were only planning to treat about twenty feet in width, we confined the metal to that width by setting line stakes and throwing a berm up against the stone along the twenty-foot line. These berms were mutilated somewhat by the traffic turning out into the shoulders, but were repaired and kept lined up.

In applying the heavy stone, we aimed to get as much as possible on the road while the surface was wet and soft, and so did not attempt to apply any binder until all the heavy material was on the road. Furthermore we wanted the heavy stone to be packed, so far as possible, before applying the finer aggregate. Our aim was to get a hard, but somewhat porous surface, and yet have as smooth a riding surface as possible. *A hard, compacted, slick surface will not take tar and where*

such surfaces existed, even though the road seemed to be in good condition, it was necessary to apply some 1½-inch stone to get the roughened porous surface desired. Stone with dust cannot be used. *Tar will not penetrate limestone dust.*

As mentioned before, we had some soft, spongy places that did not heal up until the first part of May. Underneath the metal there was a layer of soft plastic clay, ranging from 8 to 16 inches in depth. Underneath this clay was hardpan which held the water and prevented the top layer from drying. We kept adding large stone to these places but without much success and finally resorted to the pick and shovel. This clay was dug out and thrown to the side of the road and the depressions filled with dry stone. I believe a small drain tile leading from the edge of the metal through the shoulder, to the ditch will aid in remedying this condition.

Applying Gravel

After spreading the crushed stone, we began to place gravel over the surface. We used both a washed material and a dipped, pit-run gravel. The pit gravel worked well where the crushed stone was deepest. Although there was a small amount of dirt in this pit run gravel, we did not deem it to be a serious objection, since the rains washed it out. It was necessary not to get the pit gravel too heavy, as it had a tendency to create a slick surface when packed. The washed gravel, providing it was not too coarse, worked well as a filler on the crushed stone where it had become fairly well packed. Too much sand is undesirable.

Dragging and rolling should be continued after the gravel is applied. A long drag is essential in taking out the waves and much can be done along this line after the gravel is applied. We used a four-bladed drag of the wooden type, which was 24 feet long and about 8 feet wide. We had expected to pull it with a five-ton caterpillar tractor but found that nothing less than a ten-ton tractor would suffice. It proved to be a very valuable piece of equipment, especially in eliminating the short waves or dips of not more than ten to fifteen feet in length. Our 12-foot grader was useful also in smoothing the gravel and stone surface. One foreman had a six-foot grader hitched immediately behind the 10-ton tractor pulling the loose material from the edge of the road to prevent it from getting into the ditch. Behind the small grader, with a separate hitch to the tractor, was a 12-foot grader smoothing down the material brought in by the small grader. This arrangement worked very successfully and was very useful in filling the short dips.

While the larger trucks were busy hauling gravel for the more extensive resurfacing, we had one and sometimes two of the smaller trucks hauling gravel and the finer stone and spotting up the small depressions and dips which could not be

taken care of very well with the larger trucks. It was frequently necessary to place only a few shovels of material in each place. The time to do this particular kind of work is immediately after a rain or, better still during the rain. Continuous dragging should be maintained. The old saying is "make hay while the sun shines." Here we will say "make smooth surfaced roads while it rains."

After having applied approximately 8,800 cu. yds. of stone, 3,400 cu. yds. of washed and plant gravel and 1,500 cu. yds. of local gravel on 12.6 miles of road, averaging 1,096 cu. yds. per mile for all material, we were ready to begin the application of the light grade of tar known as Tar TC in our State specifications.

Applying the Tar

The tar was shipped to the nearest railroad station in tank cars of about 10,000 gal. capacity. Before being unloaded, several measurements of the car were taken to determine the gallonage. The temperature of the tar in the tank was also taken, it usually being from 100 to 105 degrees Fahrenheit. As our contract with the tar company states that the gallonage applied shall be computed on a basis of 60 degrees Fahrenheit, it was necessary to take the temperature data.

Since each tank car was sampled at the plant by R. W. Hunt Co., and samples sent to our testing laboratory at Indianapolis, it was not necessary for us to take samples from each car. We did take a sample however, from every fifth car, taking one-third of one quart from the top, the same amount from the center and the same amount from the bottom of the car. This mixture gave us one quart total as a sample to be tested, as a check on previous tests. However we went ahead and applied the tar without waiting for the results of the check tests.

The distributor used, was of the pressure type and had a capacity of 750 gallons. It was equipped with an oil heater, the tar being heated to a temperature of from 115 to 120 degrees F. before being applied.

After the surface of the road had been smoothed with a maintainer or drag, the first load of tar was applied about June 22nd, the air temperature being about 90 degrees F.

One half of the road was treated at a time. The first application was made on the loose gravel or stone surface after the twenty foot roadway had been given the proper crown with our crowning drag. Three-eighths of a gallon per sq. yd. was applied first, one distributor load covering about 2,000 sq. yds. or 1,800 linear feet over a 10-foot width.

After the first application had been allowed to penetrate from 1 to 1½ hours, the loose material was scraped or turned from one half the road over to the other half, leaving the hard

bare surface exposed. It is advisable, when scraping the loose material from one side to the other, to get well beyond the center line of the road in order that the distributor may be sure to cover the entire width with the two spreads it makes on the bare surface. The moving of this loose material was done with a grader pulled by a truck, care being taken not to get beyond the gravel or stone line at the edge of the road so that no dirt would be mixed with the gravel and stone. In the meantime, the distributor had applied tar on another 1,800 foot strip or perhaps on two strips on the loose gravel, depending on the length of the dead haul to the tank car.

Three-eighths of a gallon per sq. yd. was now applied as a second coat, on the surface that had been scraped bare of the loose material. After this application had been allowed to penetrate $1\frac{1}{2}$ to 2 hours, we then reversed the scraping and moved the loose material over just beyond the center line of the road.

We now had a ridge of loose material, mixed with tar, resembling a sweet potato ridge near the center of the road and were ready to apply the second coat of tar on the second half of the road. This completed the first 1,800 linear feet of road as far as the application of the tar was concerned, except for a little spotting up which was done after the road was finished as explained later on.

After not less than two hours we were ready to spread the ridge of tar coated gravel and stone over the entire 20 feet of treated surface. It was very essential that we spread the material uniformly. We first used a No. 7 grader with a 12-foot mould board. The blade was set at right angles to the road and to the grader itself, which allowed it to spread the ridge evenly on each side of the center line of the road. The first trip with the grader did not, however, get the material entirely out to the edge of the treated surface and it was necessary to make two or more trips over the surface to insure a fairly even distribution of the stone and gravel. The loose material was about 1 to $1\frac{1}{2}$ inches deep over the entire surface, but was not true to the crown of the road and therefore not ready to be rolled. We used our home made wooden crowning drag, which is made with two parallel blades about six feet apart and twenty feet long, or just the right length to reach over the entire width of the treated surface. We had a crown cut in the blades, conforming to the crown wanted and which was $2\frac{1}{2}$ inches higher in the center than at the outside edges. This drag was pulled very slowly with a truck, great care being taken to keep the center line of the drag at the center line of the road. Two men followed the truck, in front of the drag, and with shovels, kept the loose material evenly distributed along the front face of the blades of the drag. This caused the surface to be uniform and true to

crown. It is very important not to have a shoulder on either side that is even the least bit higher than the metal itself. If this happens, the ends of the drag will ride this high surface and destroy the uniform crown, which is so essential. If water is allowed to stand on the finished treated surface, it will shorten the life of the tar and cause it to disintegrate in a short time.

Rolling

After we had pulled the crowning drag over the surface three times, we used a ten-ton roller to roll the finished surface beginning at the outer edge of the road. If the loose material is a little light near the shoulders and the tar a little heavy, the roller will tend to pick up the mat. This can be avoided by putting a small amount of water on the wheels of the roller by having a tank of water located on top of the roller, above the wheels and allowing the water to drip as needed. If the tar still picks up under the roller, some loose dry material should be sprinkled over the surface.

After the surface had been thoroughly rolled, we called it finished and opened it to traffic on the next day. It is better to try to completely finish a stretch of road in one day, for a certain amount of setting will take place overnight so that the material will not work so well or give quite as good results as if worked continuously. Never if it can be avoided, should uncompleted road lay over Sunday as mentioned above. It so happened that we were compelled to do this in one or two instances with the result that these parts of the road proved to be too dry, necessitating the application of a third coat of tar later. This extra coat of tar may be a source of trouble as described later.

Shoving and Waving of Mat

In order to play safe against any further picking up of the mat, we had a few stock piles of gravel and stone placed along the roadside to apply on the bleeding places, which are sure to develop with this kind of surface treatment. We used very little gravel however, since we found that 7/8-inch or even 1-inch stone, free from dust, answered the purpose much better. We placed this stone on the bleeding surfaces, with a truck if the space was long enough to use a truck load, otherwise it was done by hand. A truck load of three cubic yards, covered 1,500 to 2,000 linear feet of road for a width of half the road. We also had a few barrels of tar stored along the road to take care of the spots that seemed to be too dry or spots where the mat started to ravel. This we sprinkled over the dry spots, covering it with a very light coat of stone chips. Where holes developed, we used a lean mixture of stone and tar for patching.

After the tar had been down on the road for a few weeks, we noticed, in places, that the mat was rolling or pushing

ahead of the traffic. This would indicate that we either had too much tar, too heavy a mat of loose material or an excess of sand in the gravel. No doubt too much tar and too much sand were used. As a remedy, we spread 7/8-inch and 1-inch stone over these places, letting the traffic pack it into the tar mat. This was repeated a second and third time with reasonably good results. In many places this was not done until too late, as the shoving and waving had already developed. Where the shoving was excessive, we cut off the high places with a grader. Examination showed that the mat at these places had not adhered at all to the hard base of the road and in some places it was necessary to remove it entirely.

We have a road treated 20 feet wide, free from dust and, where the work was properly done, it has a riding surface equal to the average pavement. We expect this road to need attention this coming spring; in fact it is very probable that we will have to give it another light treatment for next summer.

Conclusions

1. It is very evident that an excess of tar will cause shoving and waving in the surface while an insufficient amount of tar will cause ravelling.

2. It is easier to correct the deficiency in the tar than it is to correct the excess as it is always possible to add a small amount of tar where needed.

3. The condition from excess tar can be corrected by covering the surface repeatedly with comparatively coarse covering material, say 3/4 inch to 1 1/4 inches, permitting the traffic to hammer the covering into the soft surface. By doing this frequently enough, it would seem that the waving and shoving from an excess of tar can be very greatly reduced if not entirely prevented.

The county hauled heavy loads of gravel by team and wagon from a local gravel pit for a distance of about 3 miles over this road for approximately two months. This hauling broke up the surface to a considerable extent as this type of surface is not suitable for heavy traffic with steel tired vehicles.

The following is an estimate of the cost per mile of work described, *not including* the building up of the sub-base, which would have been necessary whether we treated the surface or not:

250 cu. yds. clean, washed gravel applied prior to treating	
@ \$2.50 per cu. yd.....	\$625.00
Dragging and preparing the surface.....	100.00
8,700 gal. tar applied, 20 ft. wide.....	1,000.00
Labor, rolling and smoothing treated surface.....	150.00
30 cu. yds. No. 4 stone applied as covering coat @ \$2.50	
per cu. yd.....	75 00
Total	\$1,950.00

It may be interesting to note the difference in maintenance cost per mile of this section of road for six months after the surface treatment as compared with the maintenance cost for the six months prior to treatment.

Six months prior to treatment:

200 cu. yds. gravel applied @ \$2.50.....	\$500.00
Labor, dragging daily @ \$1.50 per mile.....	175.00
Miscellaneous expenditures	25.00
Total	\$700.00

Six months after treatment:

50 cu. yds. of covering applied @ \$2.50 per yd.....	\$125.00
50 gal. tar @ \$0.20 delivered.....	10.00
Labor, patching small holes and miscellaneous work.....	75.00
Total	\$210.00

Comparing the preceding costs and considering the benefits of a dustless road we consider a surface treated road a good investment.

CITY PLANNING AS AN AID TO TRAFFIC

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Inability to efficiently control traffic, prevent traffic congestion and lessen the number of traffic accidents, especially in our large centers of population, cannot generally be charged against city officials. With funds entirely inadequate to perform the major operations on the civic structure which are necessary to afford permanent relief of the traffic congestion; with the number of vehicles increasing rapidly; and with building operations in the highly congested areas ever on the increase, it is hardly possible for them to keep pace with the problem. In fact, when we stop to analyze the situation, we are forced to the conclusion that with conditions as they are it is really surprising that the problem is not much more acute. City officials and police departments have done and are doing good work and have contributed a great deal to the science of traffic control. However, we must not lose sight of the fact that regulation of our traffic of today on our streets of today is the problem which these officials are attempting to solve. What about tomorrow and next year or ten years from now?

This query brings us to the subject matter of this paper which is pertinent to the title "City Planning as an Aid to Traffic."