THE RECONSTRUCTION OF STATE ROADS WITH BITUMINOUS SURFACES.

By W. K. O'Neill,
District Engineer, Indiana State Highway Commission.

The reconstruction of some of our state highways with bituminous surfaces has entailed the practical reconstruction of the road, including the rebuilding or lengthening of bridges and culverts, widening the roadbed and surface, the easing of curves and grades, and the re-surfacing with water-bound macadam preparatory to the application of a surface treatment, or a bituminous macadam surface.

When we found that the road was wide enough to accommodate traffic, that the bridges and culverts were in good condition and of sufficient width, that the foundation and surface were standing up under heavy loads at all seasons, and that there were no prohibitive grades; we repaired the depressions and irregularities by cold mix patches and paint patches and gave it a surface treatment.

The enormous increase in traffic, and especially truck traffic, has placed upon the roads a burden so much greater than was contemplated when they were built, that the foundation is not of sufficient strength even where the surface is properly maintained. I have in mind one particular section of road in southern Indiana which had been for years a toll road. It serves a number of towns in a length of 40 miles which have no railroad or interurban facilities, and as a result all freight and passenger traffic is concentrated on this highway. It was well located and built, but in spite of maintenance had been slowly breaking down under the increased traffic. For one year we tried to maintain it as a macadam road by applying stone and dragging. We succeeded in bringing the surface back to where it was smooth and fast, but at a cost for maintenance of about $1000.00 per mile per year.

During 1920 we applied a first aid treatment to the foundation. We sledged large stone into the places where the road had completely failed and then applied smaller stone and dragged. When we began our construction in 1921 we were pretty well satisfied that the foundation was heavy enough.

The work consisted of the construction of an 18 foot water-bound macadam surface which we intended to maintain as a surface treated type. It was done entirely by our own forces under the supervision of our local superintendent. The stone was crushed at a local plant two miles from the job and was hauled by truck. We specified No. 1 stone (3½” to 2½”) for
the base course, and No. 2 stone (2 1/2" to 1 1/2") for the wearing course.

Owing to the fact that we could find no suitable detour, this work was done under traffic. This multiplied our troubles and increased the expense, besides making it very difficult to obtain the smooth surface we desired. Our experience has shown that all traffic should be kept off the road when any water-bound construction is going on. It is almost impossible to avoid irregularities in the surface if traffic is allowed to rut the large stone after it has been rolled. Small depressions, say 18 to 24 inches long, are not so serious since they are not objectionable to the occupants of a car traveling at the average speed. However, the longer depressions from 6 to 10 feet, are very noticeable. Again the smaller depressions can be eliminated by paint patches and successive surface treatments, while the longer waves require a lot of careful patching to bring about a smooth surface.

The length of time that must be allowed between the completion of the wearing course and the first surface treatment depends upon a number of factors. If made of very hard, poor cementing stone, traffic will blow off the screenings in a much shorter time than if made from a comparatively soft stone of a high cementing value. Light, high speed traffic will suck the screenings from between the large stone more quickly than slow moving trucks. The work I have in mind was completed in October and was surface treated the following July. It was built of a hard stone of poor cementing value and as a result it was necessary to spread screenings on the surface during the fall and winter to prevent possible raveling of the surface. We have surface treated some water-bound patches a week after they were completed.

A surface is ready for treatment when it has a pitted appearance and the sharp angles of the stone are exposed. If you cannot bring about this condition by exposure to traffic, and sweeping and cleaning the surface, the treatment had better be omitted to avoid wasting money. In any case, no matter how long the surface has been exposed to traffic, it should be gone over with a mechanical sweeper, brooms and shovels to remove mud and other foreign material, especially along the edges of the metal.

The first treatment was applied at the rate of 0.4 of a gallon per square yard in two courses of 0.2 gallon each. To avoid traffic interference as much as possible, one half the road surface was treated at a time. As the weather was very warm, no chips were spread on the first application in order to secure as complete an absorption of bitumen by the road surface as possible. The second application was covered with stone chips, size 3/4" to 1/4", at the rate of 12 1/2 pounds per square yard. These chips
had been placed along the road in piles of about \( \frac{1}{4} \) cu. yard. each. The bituminous material, which met our specification for Tar T. M., was applied by means of a pressure distributor at a temperature of 140 degrees F.

The next year this section of road was given another treatment at the rate of 0.3 gallon per square yard, put on in two applications. Since this was a second treatment, just enough chips were spread on the first application to absorb the excess bitumen. A common fault with some surface treatments is a too liberal use of covering material. It is always possible to add chips when the surface begins to bleed; but it is impossible to take away the excess chips when the surface begins to lose its life and disintegrate.

Last year we let a contract for the construction of eight miles of bituminous macadam construction. The maintenance forces undertook to rebuild the eight miles preparatory to the construction of the wearing course. This involved extending a number of small pipe and box culverts, the construction of two slab top culverts and some short retaining walls. In addition, the bridge department rebuilt three pony trusses whose length totaled 164 feet. The roadbed was widened to 28 feet, some of it through heavy rock cuts and on high fills. Sharp curves were eased off, and irregularities in grades were eliminated by building up the low spots with heavy stone and replacing the bumps at changes of grade with vertical curves.

The first three miles of this road is hill-side location, with a maximum grade of 6½% and an average of 5%. In order to eliminate the excessive crown, (which was good practice on heavy grades with the old type of road), and to obtain the necessary super-elevation on curves; the roadbed and base course were built up as much as 3 feet at some points.

Our specifications for the wearing course called for a width of 18 feet and a crown of 2" except on curves and grades. As we approached curves we raised the outside half of the roadway until the necessary super-elevation was obtained. Beginning with a 2" crown on flat or very light grades, we decreased the crown in proportion to the increase in the rate of grade until on a 5% grade we had a flat section.

The work was carried on under the supervision of our local Superintendent and an Engineer-Inspector. They directed the work of a grade foreman, a bridge foreman, a foreman in charge of the construction of the base course, and a truck foreman responsible for the delivery of stone to the contractor by our own trucks. In addition to the above, we had a light grading crew that built the earth shoulders.
Our equipment for heavy grading consisted of a Holt 10 ton caterpillar tractor, an Adams 12 foot Road King grader, slip and wheel scrapers, road plows and necessary small tools. We also organized a rock drilling gang and rented a portable compressor and jack hammer. The stone blasted out of rock cuts was placed under the base course where it was necessary to raise the elevation of the road, or where a change of location made a heavy foundation necessary.

Our equipment for building the base course consisted of two Acme gasoline rollers, two 600-gallon water tanks mounted on Quad trucks, a road harrow, a small grader, form boards, stone rakes and other small tools. One piece of equipment, which we insisted on the foreman using, was an 18 foot combination straight edge and template. We were trying to get a smooth surface, true and uniform as to grade and crown, and tried particularly to avoid a wavy surface.

We let contracts for stone to be crushed at two plants located along the road. The work of building up the base course was expected to take between 9,000 and 10,000 cu. yds., in addition to the amount called for in the wearing course. We used from 14 to 18 trucks hauling stone to our forces and to the contractor. These trucks were under the supervision of a truck foreman, whose duty it was to give each truck a daily inspection, and to dispatch trucks from both plants to deliver stone as it was needed at the various points.

The base course was built of No. 1 stone (3½” to 2½”), No. 2 stone (2½” to 1½”), and screenings. We used the No. 1 size along the edges where the high crown on the old road made a heavy patch necessary. On the lighter patches and in the center of the road the smaller stone was used.

Our specifications for stone used in the top course called for the No. 1 size for coarse aggregate and size No. 3 (1½” to 1/4”) and size No. 4 (¾” to 1/4”) for the coarse and fine covering respectively. The large stone was spread and raked to a depth of 4 inches for the full 18 feet, requiring 1,200 cu. yds. per mile. The covering material was hauled and dumped alongside the road in one yard piles ahead of the large stone, so that our trucks were kept off the large aggregate after it was spread. The keystone was delivered at the rate of 160 cu. yds. and the fine covering at 140 cu. yds. per mile.

To avoid waves and ruts in the surface, the contractor was required to harrow the large stone thoroughly before rolling. This also served to bring the larger stone to the surface. Earth shoulders had been built to a height of 4” above the top of the surface and the rolling was commenced with the outside drive wheel covering this shoulder and the metal, gradually working
toward the center of the road. Any depressions which developed during the rolling were eliminated by loosening the stone and adding a small amount of new metal.

The amount of rolling needed to get the best results depends on the size and hardness of the stone. No specific rule can be given. Observation and experience are your only guide. However the rolling should be stopped before the voids are closed enough to prevent free and uniform penetration of the bituminous material.

The contractor used three 10 ton rollers. One roller was used to compact the stone ahead of the distributors. When a sufficient length for a day's run for the distributors had been shaped up, it was brought back to assist the other two rollers which were kept continually rolling the treated top.

The bituminous material used on this work met our asphalt specification A-2. We specified an application of 2 3/4 gallons per square yard; 2 gallons on the first application and 3/4 gallon on the second. The bituminous material was applied by means of a self propelled pressure distributor at a temperature of 340 degrees F. One half of the 18 foot width was treated at a time.

After the first application, just enough covering was applied to prevent the roller wheels from picking up the bitumen. The surface was then rolled until the voids were completely closed and the covering material incorporated with the bitumen. In extremely warm weather it may be well to allow the bituminous material to harden slightly before rolling. When the weather is cooler the rolling must be begun immediately to ensure the closing of all voids, and obtain a solid compact surface.

The remaining voids in the surface that were not closed by the rolling were then filled by brushing chips over the surface and going over them once with the roller.

The seal coat (3/4 gal. per sq. yd.) was applied as soon as this rolling was finished. Care was taken to see that all loose stone, leaves and other foreign matter were cleaned off the surface. After this coat was applied the surface was covered with No. 4 chips at the rate of one cubic yard to each 75 square yards of surface and thoroughly rolled.