

be tar-treated within the next five years, without a dollar of bonded indebtedness involved.

We do not consider that this type of tar treatment is permanent or that it does not require a certain amount of maintenance. We have our maintenance crew well organized and properly equipped for taking care of any breaks that may appear on the surfaces, but we have less work to do on the whole system than we formerly had on a few of the untreated roads.

As an illustration, the Wilson Road, 4.4 miles in length, treated in the spring of 1930, has had but one light retreatment, in the fall of 1931; and the total maintenance cost, aside from this retreatment, was less than \$10.00. Our truck went out one morning with two men and in three hours had repaired all breaks in this entire road.

With this type of tar treatments we have demonstrated to our entire satisfaction the following facts:

Property values have been increased on farms adjacent to these tar-treated highways.

Taxpayers feel that their tax money is being economically and wisely used.

We have created a dustless, smooth-riding, non-skid, all-the-year-round highway system, without creating any bonded indebtedness.

### BITUMINOUS MULCH SURFACE

By C. W. Siniff, Allen County Highway Superintendent

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Bituminous mulch surface can be built with various kinds of materials. In most all cases local materials can be used, the resulting reduction in cost being to the interest of the taxpayers. Although in our county at present the people are asking relief in taxation, as they are in almost every other county, it is my opinion that a large share of our tax burden is due to the demands of the taxpayers themselves.

We have several miles of high-grade pavement laid on roads in our county that could not be termed secondary roads before construction. Such roads are petitioned for by a group of local taxpayers; viewers are appointed and sent out to view these roads and are supposed to take into consideration their location and importance. They decide as to the kind of material best fitted for any particular road; but regardless of the importance and location and amount of traffic carried, viewers usually recommend in their report a very high-grade, costly pavement. Bonds are issued on which the taxpayers have to pay over a considerable period of years.

Taking into consideration the conditions mentioned above, we found it necessary to give some thought to cheaper meth-

ods of road construction. The commissioners and I worked out a road program determining the importance of various roads in the county. We then decided on the type of surface to be used and, after due consideration as to location and importance and the amount of traffic carried, we built 54 miles of what is called "bituminous mulch" or "mixed-in-place" surfaces. Our program was begun in 1930 and finished in 1931, and if such a program is contemplated in other counties, I would suggest that the program be worked out a year before beginning actual construction of this type of surface. This seems to me very important because it gives the highway department a chance to prepare the road for a bituminous mulch surface. Great care should be taken in preparing the sub-base for strength, and this preparation is always much easier and less costly if done a year in advance. After sub-base conditions have been corrected, then great care should be taken in building a good cross-section. A good cross-section can be obtained if the man in charge of maintenance is properly instructed and impressed with the importance of getting a good cross-section for this particular type of road.

In building a bituminous mulch surface, smoothness is very important. Several things must be taken into consideration before a smooth surface can be obtained. Equal distribution of metal on the surface of the road is very important. If the road has been properly maintained and a uniform distribution of metal secured before the application of bituminous material, a smooth riding-surface is assured. If care is not taken in applying metal and securing uniform distribution, bad results will very probably follow after the bituminous material is applied. I would say that from 1 to 1½ inches of metal, spread uniformly on the surface, is about the proper amount.

If your metal varies and you have 1 to 4 inches on the surface, bad results will come from raveling. At all times uniformity is very important. A definite amount of bituminous material is usually specified. The men in charge of the distributor are told the amount to be applied; but, if the surface varies in depth of loose material, even by using a definite amount of bituminous material to the square yard, it would be impossible to get a uniform mix. In our case, we applied 0.35 gallon to the square yard for first application.

The material should be thoroughly mixed on the road surface by use of a grader or multiple-blade maintainer. We used both very effectively. After the first application of bituminous material was applied over the entire surface of the road, we immediately made preparations for the application of our second or prime coat. A 10-ton tractor and 10-foot grader were used, moving all loose material to the sides of the road; and we were careful to remove *all* loose material before applying the second application or prime coat. The

bituminous material was tar and we found it excellent in building a bituminous mulch surface.

After the prime coat was applied, we then proceeded to mix material in place, using a 10-foot grader and mixing back and forth on the surface until the metal was thoroughly coated. After the metal had attained a good, black color, we graded it out to a flat surface and used a maintainer for leveling. In the process of leveling, we were careful to get as smooth a surface as possible. We found the use of a 20-foot straight edge very effective in locating high and low spots in the surface. If high spots were found, we eliminated them with a maintainer.

After the first and second applications and the mixing and leveling of material were completed, we then opened the road for traffic. After traffic had used the surface for possibly 20 days, we then applied the third application, using  $\frac{1}{4}$  gallon of the material and about 40 pounds of stone chips per square yard. This third application is known as the seal coat.

A smooth riding-surface is very important in road construction or maintenance, and this can be easily obtained if proper methods are used with this particular type of surface. I think this type of surface is bound to be attractive, especially on secondary roads. Methods of construction are very simple if care is taken in preparing the surface. If a road has been properly maintained, you will find it necessary to add but very little material to the surface although it should have at least 1 inch of loose material. This particular type of surface eliminates the dust nuisance and provides a smooth riding-surface at low cost. Our average cost per mile was \$1,119, including all labor and material.

### EXPERIENCE WITH THREE-INCH BITUMINOUS GRAVEL MIXTURE

By S. T. Hollingsworth, Howard County Highway  
Superintendent

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The extraordinarily easy-riding quality of a well constructed and properly maintained gravel road has been widely noted and commented upon by engineers as well as the traveling public. Most of these gravel roads are at their best when the gravel is moist but not saturated with water. If they could be kept permanently in this condition, their traffic-carrying capacity would be much higher and the cost of maintenance would be greatly reduced. The same result has been noted of what have been termed "traffic-bound broken-stone roads," composed of small-sized broken-stone fragments, together with fines produced at the crushing plant, and constructed in the same manner as gravel roads, being compacted