

104 *PURDUE ENGINEERING EXTENSION DEPARTMENT*

of 10 feet and a depth of 10 inches. Except in special places, we have specified a 40-foot right-of-way and a grade width of 22 feet. In some places where heavy cuts and fills were encountered, the width of the right-of-way has been specified as 50 feet.

After the grade of the road has been completed according to the plans and specifications, a stone bed is cut to the depth of about 3 inches with a grader. Then 10-inch side boards are placed and aligned to the proper spacing of 10 feet. The stone is then put in to the full depth of 10 inches between the boards and banked with earth before the boards are carried ahead. No rolling is required and the road can be turned over to traffic as soon as the stone is placed.

The one-inch size of stone is ideal from the maintenance standpoint as the road does not mat or pack too quickly, giving the maintainer a chance to fill the small depressions and smooth out irregularities of the stone surface.

After the road is finished by the contractor and turned over to the maintenance department, an effort is made by the superintendent in charge to drag the road very often for the first 30 to 60 days to give the desired smoothness before it becomes packed too hard.

Roads of this type can be constructed very cheaply. The contract price of the few roads we built this last year are as follows: The Kirk Road, \$4665 per mile; The Hurley Road, \$4500; The Bernhardt Road, \$3878; The Clark Road, \$4550; The Fleming Road, \$4998, which included a rather extensive bridge repair; and The Schwanke Road, \$4461.

Three road contracts were let last month by the county commissioners for the following amounts: Kader Road, \$4100 per mile; The Parks Road, \$3742 per mile; and The Overton Road, \$3663 per mile. These sums include the grading, culverts, and bridge repairs in each case. The haul on all roads mentioned varied from 3 to 12 miles.

COMBINATION STONE AND GRAVEL ROADS

By B. C. Samples, Warrick County Engineer

Some two years ago the Warrick County Board of Commissioners was confronted with a problem of no slight significance, namely, that of being rushed by petitioners of township roads whose petitions had been filed nine to eleven years with the auditor. In the years in which the road petitions were filed it seems that the engineer and viewers were set upon waterbound macadam roads consisting of about 10 to 12 inches of 6-inch stone for a base course, then rolled and screened in

the usual manner. When the petitioners demanded action upon their petitions, of course the board, consisting of new members, sent for the engineer and asked what could be done.

The estimates for the roads were reviewed by the county surveyor and quite a number of interested remonstrators. In checking the estimated costs of construction and of materials to be used, it was found that upon two occasions bids had been asked for under the specifications but none were received, the chief reason being the cost of the 6-inch stone for the base course. This size was then costing more than had been figured upon under the estimated cost of construction as set out in the plans and specifications. The petitioners for the roads were insistent upon putting an improved type of road through their section of the township and demanded of the engineer some solution to the problem. These same petitioners were determined to have a rock base for their roads, but under the law we could change the types of materials and construction to fit the circumstances; hence we fell upon this idea of a combination stone base and gravel top for these roads. When checking the quantities of material required and cutting the size and depth or base stone down to 2½ to 4-inch stone, and to 7-inch loose depth, it was found that about 11 miles could be built each year.

The chief reasons for selecting this type of road were:

1. The petitioners were demanding action on their petitions.
2. The first cost was very small in comparison to higher types of road.
3. The township roads were secondary, light traffic roads.
4. The funds for township roads were very limited.
5. This type of road could be constructed in a short time with ease.

The design of the new type of township combination stone base and gravel top roads with a limit of funds available for construction became somewhat of a task, a "cut and try method." Some of the features entering into the design were:

1. A minimum 50-foot right-of-way was taken on all roads with increases where construction made it necessary.
2. A roadbed of 22 to 26 feet from shoulder to shoulder was specified.
3. A minimum depth of loose rock measure was set at 7 inches.
4. A metal surface of 14 feet in width was designated.
5. The base stone was No. 1 stone as set out in Indiana State Highway Maintenance Division specifications, screened with No. 3 stone, rolled, and waterbound in the usual manner.
6. A cover of 1½ inches of clay was placed upon the base course when completed, as specified by engineer and superintendent.

7. A cover course of Ohio River gravel of 12 to 15 cubic yards was specified for each 100 feet of road.

8. The slopes on cuts and fills was set at $1\frac{1}{2}$ to 1.

9. A quantity estimate was furnished by the engineer in the plans for each course of material.

In order to control the quantities of material used in construction and to put bidders on equal terms, the following regulating clauses were set out in the plans and specifications:

1. Before the contractor receives payment on the engineer's monthly estimate for construction of the road, he shall furnish the engineer and superintendent with the car weights of material placed on the road and these weights shall check the estimated quantities as given by the engineer.

2. When the road is completed and ready for final estimate, the contractor shall file and certify before the board of county commissioners the car weight bills of all material used in construction of the road, and these weights will be checked against the engineer's estimated quantities. A variation of 3% shall be allowed. A final settlement will not be made by the board of commissioners until 30 days after compliance with requirements above.

3. The set of plans, profile, cross-sections, bridges, culverts, etc., is complete as foreseen by the engineer and viewers and no compensation shall be allowed for extra work unless ordered in writing by the board of county commissioners or their authorized agent.

4. The total bid shall be for a road complete as specified in plans and specifications at the direction of the engineer and superintendent.

Some cost figures for this type of road in Warrick County are as follows: Assuming an average haul of 5 miles, excluding grading and draining, assuming a cover course of 12 cubic yards per 100 feet of Ohio River gravel, and a 7-inch loose base of No. 1 highway stone screened and waterbound with No. 3 keystone, the unit costs are:

1. Base course \$0.73 per square yard.
2. Base course \$6000 per mile.
3. Cover course \$2.70 per cubic yard on road.
4. Cover course \$2000 per mile.
5. Earth course \$1.00 per cubic yard on road.
6. Earth course \$400 per mile on road.
7. Total cost of metal surfacing per mile—\$8,400.

Our commissioners have observed that the results of this type have been very effective in the following ways:

1. The first cost of constructing this type of road is small in comparison with other higher types of road.

2. The maintenance cost is small for first few years, because light dragging of metal on surface and shoulders is all that is necessary.

3. This type of road satisfies the light, farm-to-market traffic and pleases the taxpayers of the community.

4. The bonding cost to the individual township is small.

5. The added mileage to the county highway system of improved roads at a small cost nets a gain in gasoline tax from state tax fund.

6. This method relieves the trustee of the township of further maintenance cost of the earth roads thus improved.

7. The combination stone and gravel roads serve to link the outlying communities closer together through a system of cheap, all-weather roads, and taxpayers are well satisfied.

I believe some 10 to 12 miles of this type of road have been completed during 1930. Very little data are yet available as to maintenance costs.

ROAD CONSTRUCTION WITH COUNTY EQUIPMENT

By Ralph Lebo, Fulton County Highway Superintendent

In dealing with gravel road construction there are three vital elements to be considered, namely: public necessity for the road, the kind of grade and material specified, and finally the quality of inspection which determines whether or not the taxpayers receive full value for the money expended.

Road construction is accomplished by various procedures. The method most used I suppose is by the contract procedure. At one time this method was by far the best, for it was about the only way in which to secure the grading and surfacing of our county roads in large mileage.

In our county about ten or fifteen years ago when the three-mile-road law went into effect, not only farmer A, but most of his neighbors carried a road petition affecting his property, and experienced little difficulty in securing signatures. These petitions were filed in the auditor's office and acted upon by the county commissioners; the roads were ordered built and bonds were sold; and there was not a dissenting voice.

The result—roads of varying quality, good, poor, and worse were soon constructed. Taxes went skyward; the people found they had mortgaged their governmental unit to the limit.

Just now our county is emerging from this burden of debt. The roads built thereby are now being repaired at considerable expense, and many of them should be rebuilt.

We are not growling at the apparent mistakes of the taxpayers of that time, but since these trunk lines are now controlled and maintained by the county we feel that the less important roads in the community can be properly built at a great deal less cost by other methods.