

SPECIFICATIONS FOR PENETRATION MACADAM ROADS

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We generally consider the term *specifications* as applying only to the actual materials to be furnished and the work to be done under the proposed contract. Nearly all road building in this state is done under the Three Mile Road Law, by the provisions of which the engineer is one of the three viewers of the road to be improved. These viewers file a report which includes not only the plans and specifications for the work to be performed, but also the width of the right of way, the alignment of the road, and the width of the pavement to be built.

I believe we should use more care in determining the width of the right of way for the road to be improved. In a great many cases we permit easily movable structures to narrow down the specified right of way so as to prevent proper grading and drainage. As the engineer usually prepares the greater part of this report, I feel that he is largely to blame for this condition. Before preparing any part of this report, I think we should make a complete survey of the proposed improvement, including accurate cross sections, and provide for a width of right of way that will allow not less than five feet beyond the toe of slope in the deepest fill, or five feet beyond the top of slope in the deepest cut. The width of the right of way might well vary on different sections of road to meet different situations. In making the survey we should also consider whether any changes in the alignment are possible which might improve the safety of the travelling public along the road. A change in alignment will result in a considerable decrease in the cost. We have all seen roads built on the existing alignment where the decrease in length resulting from a change would have paid the damages to the land.

We should also be very careful in our consideration of the drainage situation, not only with respect to the road to be improved, but the general surface drainage of the land on each side of the road. Considerable difficulty is often encountered in connection with surface drainage which at first seems to have no connection with the improvement. We would suggest that each land owner who contemplates building drains either across the road or parallel with the road and within the limits of the proposed right of way be interviewed before the specifications are finally completed and an agreement made as to how the existing drains are to be taken care of during the

progress of the work and what the final arrangement will consist of. Any connecting or crossroad should be considered from a drainage standpoint as well as from the standpoint of the grade.

Building the Berms

As the penetration type of road does not usually have any curb at the edges, it is necessary to build up the berms before the pavement is laid. The specifications should provide for berms at least 5 feet in width, and these berms should be thoroughly rolled so as to prevent the side movement of the stone while it is being rolled. The most practical way to roll these berms is to begin at the outer edge of each berm, and work back and forth towards the center at the same time that the stone is being rolled. The top of the berm should be built up to the finished grade of the road. At each low point in the grade, French drains should be built on both sides of the road to carry the water through the berms. On grades longer than 400 feet, intermediate French drains should be built, the distance between them depending on the character of the old roadbed and on drainage conditions in general. **The roadbed must have ample drainage.**

Salvaging Old Roads

One of the advantages of the penetration type of road is that the existing road may be used as a base, providing that it has sufficient strength. Nearly all of our roads have been graveled or stoned several times and have varying thicknesses of metal. Where we have 8 inches of well compacted metal we do not consider it necessary to build any base. Usually the surface is rough and does not have the proper crown so that it is necessary to scarify the road and use a grader to smooth the surface and provide the proper crown. If at any place the metal is less than 8 inches in thickness or narrower than the proposed pavement, the specifications should provide for the building of a 4-inch water-bound course on top of the metal over the old roadbed or for the building up of the edges with two 4-inch water-bound courses so that the base will be solid for the entire width of the road. The penetration course itself is not intended to carry the entire load, and the base must be solid and smooth if we are to have a smooth riding surface. The French drains heretofore mentioned should be built low enough to drain the base course thoroughly. These drains can often be built of rejected stone or stone which has failed during the rolling, and while the cost is small the value to the road is great.

After the base has been made smooth and solid and brought to the proper crown, a layer of good quality stone should be applied by some spreading device attached to a truck, or by

hand if dumped outside the limits of the road. The thickness of this course may be varied depending on the solidity of the base. It should be not less than $2\frac{1}{2}$ inches or more than $3\frac{1}{2}$ inches, both of these dimensions referring to the compacted thickness or the thickness after rolling. If less than 3 inches thick, it should be of No. 2 stone; and if 3 or more inches thick, of No. 1 stone. Before the stone is applied, forms should be placed on each edge of the road. These forms should be set to true line and grade so that a crown board passed over them will give a uniform thickness of stone over the entire road.

The stone should then be rolled with a self-propelled, three-wheeled roller (weighing not less than 10 tons) until solid, and any depressions which show up during the rolling should be filled by additional stone of the same grade and size as the original stone. It must be kept in mind that the finished surface of the road is now being placed and that very little change can be made in the surface after the bituminous material has been applied. If at any point the stone has been crushed by the roller so as to fill the voids or the corners have been broken off the stone so that it is impossible to compact it, then that portion of the stone must be removed and new stone applied and rolled as before. When the stone has been brought to a uniform smooth surface and is thoroughly compacted, it should be cleaned of all leaves, sticks, or any other material which may be upon it and which would interfere with proper penetration.

Applying Bituminous Materials

When the surface has been thoroughly cleaned as outlined above, a bituminous binder of either tar or asphalt should be applied to the surface by means of a power pressure distributor. No matter whether tar or asphalt is used, the specifications should require that the material conform to the specifications of the Indiana State Highway Commission for the grade to be used. Each car should be tested by an accredited testing laboratory to make certain that it does meet these specifications. Considerable time will be saved if it can be arranged to have the car sampled at the point of loading, the car sealed, and the tests made while the car is en route. If the material meets the tests, it is then available for use as soon as it arrives on the work. The temperature of the atmosphere and of the bituminous material should be carefully watched. No bituminous material should be applied when the air temperature is below 40°F .

If tar is used, it should be heated to a temperature of about 250°F . before application to the road and asphalt should be heated to about 350°F . About 1.5 gallons of bituminous material per square yard should be applied as a first coat.

Immediately after this has been applied, enough No. 4 keystone should be spread over the road to fill the voids and the road should be again thoroughly rolled. This stone should be obtained from stock piles placed along the road before the surface course of stone was spread. Only enough of this No. 4 keystone should be used to fill the voids, as an excessive amount would be crushed on top of the larger stone and interfere with the second application of bituminous material. The rolling at this time will depend largely on the temperature of the atmosphere and the size of the keystone used.

When the road has again been rolled until it is solid, it should be swept with brooms to remove any dust or excess stone, and a second application of about $\frac{1}{2}$ gallon per square yard of bituminous material should be made in the same manner as the first coat. The road should then be covered with a coating of No. 6 stone and again thoroughly rolled. This stone should be used in such quantity as to fill any surface voids but not to form a mat on the road. After this has been thoroughly compacted, a final coat of $\frac{1}{3}$ gallon per square yard of bituminous material should be made in the same manner as the first and second coats. After this application, a light coat of No. 6 stone should be spread evenly over the surface of the road and the road opened to traffic.

Summary

As a summary of the important points in the specifications for this type of road, I would suggest the following:

1. Specify a width of right of way that will permit ample berms and ditches.
2. Specify ample drainage for both road and right of way.
3. Specify berms of not less than 5 feet in width.
4. Specify laboratory tests on all materials used.
5. Give special attention to the application of the bituminous materials and the fine stone used between the applications.
6. If any question arises as to the amount of bituminous material required, always use the smaller amount.
7. Since the use of trade names in specifications is illegal, use only Indiana State Highway Commission nomenclature for bituminous materials, if detail physical properties are not available.