

BITUMINOUS MACADAM*

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A BITUMINOUS macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

Such pavements were built in a rather crude manner in England and France in the early part of the nineteenth century, but were nowhere extensively built until little more than ten years ago, when the change in vehicular traffic and consequent increased destruction of waterbound macadam pavements made necessary the construction of a surface to withstand the new destructive forces on the roads. In the United States, the year 1908 marks the real beginning of this type of pavement, although a few small experiments or attempts were made previously. The first results achieved, while at the time appearing successful, were not durably satisfactory, due to the fact that improper materials and workmanship were used. Further experimental construction and careful observation of results obtained by varying the character of material and method used have resulted in a widespread use of this type of pavement at the present time, and when properly constructed it has proved to be an economical type where the vehicles to be propelled over it are not extremely heavy.

Preparation of Foundations

In the construction of this pavement, as in that of any so-called permanent type, proper drainage and foundations are absolutely essential. Moisture and frost action under the road crust are just as destructive as in the cheapest or most expensive pavements.

If the subsoil is a gravel or suitable sand, no artificial foundation may be necessary, but if of clay or other improper material, a foundation course consisting of stone or coarse gravel should be placed. If of stone, the interstices should be thoroughly filled with gravel to prevent the clay subsoil from gradually working up and filling the voids in the stone, thereby permitting the moisture to permeate and destroy the foundation and pavement during frost action.

Upon the properly prepared natural or artificial foundation the first course of broken stone should be spread evenly and to sufficient depth to be of the desired thickness after rolling. No universal rule can be made covering the thickness of this course, as the local conditions vary so extensively. For example, in some localities, the subsoil is of such nature, and the materials available in the immediate vicinity are of such nature, that an artificial foundation of stone ten inches or more in depth may be laid and the first course of the pavement need be only about two inches in thickness. This is economical and satisfactory in localities where suitable stone for foundation is plentiful, but stone suitable for the first course of the macadam has to be imported at considerable expense. On the other hand, if the subgrade is a proper one so that artificial foundation is not necessarily used, the first or bottom course of the macadam should be not less than four inches in thickness after rolling, and, if heavy loads are to be sustained, a thickness of six inches is desirable.

Laying First Course

The stone in this course should be of uniform and good quality, and should be spread in such manner that there may be no segregation of large or small stone. The stones composing this course may vary in size from one-half inch to three inches in their longest dimensions, provided, however, that the percentage of the small size shall be very small. If the course is four inches or less in thickness, the best results are obtained, however, by using stone varying in size from one and one-quarter to two and one-half inches. The same minimum size is preferable in a six inch course, but the maximum size may then be three inches.

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In laying this course the same methods should be used as in the laying of ordinary waterbound macadam, including thorough compaction by rolling, and securing a uniformly smooth surface. Unlike the first course in waterbound macadam, however, the voids in this first course must be filled with stone dust, fine gravel, or sand, in order to prevent wasting of bitumen by penetration into this course during the construction of the top course. It is essential that the surface of the bottom course be even and without depressions before laying the top course. After the construction of this course is completed, all surplus dust and fine material should be swept off, leaving the upper stones bare to receive the second or bituminous course.

Laying Second Course

After the completion of the first course as above set forth, the second course is spread at such thickness that it will be two inches thick after rolling if for medium or light vehicular traffic, or three inches thick if for heavy vehicles in large volume.

It is extremely important that the stone used in this course be of good quality, uniform in character, and so spread that there is no segregation or large or small sized stones. If building for light weight vehicles only, the stone used may have a French coefficient of wear as low as eight and a hardness value of eight, but for heavy vehicles a better quality of stone should be obtained if possible, using in such case a stone having a French coefficient of not less than twelve, and preferably even greater, and a correspondingly higher hardness value.

The best and most lasting results are obtained if the sizes of the stone in this course vary from three-quarters inch to two and one-half inches, with the larger sizes predominating. This has been proven; even though it appears inconsistent to use a two and one-half inch stone in a course two inches thick.

Extreme care should be had in the laying and rolling of this course to have it uniform in its component sizes of stone and rolled to a uniform thickness. The rolling should be thorough, in order to reduce the voids and make the surface hard and smooth, although not as thorough as in the case of water bound macadam roads.

After rolling, the bituminous material should be applied at a temperature of 250° to 300° F., with a mechanical distributor that will force the material onto the surface uniformly, such force being equivalent to that obtained under a pressure of thirty pounds or more to the square inch. The amount of bituminous material used per square yard in this application will vary from one and one-half gallons on a two inch course to about two and one-half gallons on a three inch surface. Great care must be had in the distribution of the bitumen to prevent getting too much or too little material in spots or streaks, otherwise "bunches" or depressions, as the fault may cause, will soon develop.

Surfacing With Bitumen

After spreading the bitumen, it should be lightly but completely covered with pea stone ($\frac{1}{2}$ -in. stone) and thoroughly rolled, using a fifteen ton roller if available, and if the stone is of hard quality, or a somewhat lighter roller if of a poorer quality stone. Success will not be obtained if this course is not thoroughly rolled.

A seal coat of the same quality of bitumen is then applied, using one half gallon of bitumen to the square yard for this application, then covering again with pea stone and finishing with the heavy roller.

When the bitumen is applied the stone should not be wet but may be moist, and in all cases must be absolutely clean and free from dust. The bitumen used may be an asphalt or tar product, and as this paper is somewhat limited, the details of specifications for this material are necessarily omitted.

Whether of asphalt or tar, the bitumen should be properly refined and prepared for use in this type of construction, its properties varying slightly with the climatic condition of the territory in which it is to be used.

In northern climates like that in the New England States and lower Canada the best and most lasting results: