

## THE BEST METHOD OF MIXING AND LAYING TAR MACADAM FOR STREET AND MAIN ROADS.

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(FELLOW.)

WHAT are the essential ends to be aimed at in all rational road-making? They may be briefly summarised as:—(1) Freedom from dust in summer and from mud in winter; (2) Freedom from the noise and clatter at present inseparable from many of our urban streets and main roads; (3) To be of an inclination, width, and cross-section suitable for the high-speed traffic of the future.

Now, until the evolution of an ideal road surface material (which the author by no means despairs of), tar macadam is, with certain limitations to be presently referred to, one of the few materials at present in use which most nearly fulfils the above requirements.

### FOUNDATION.

The first essential condition for a successful tar macadam road is a dry and strong foundation.

The author's practice is to under-drain where necessary the site of the proposed tar macadam road (whether a new road or for replacing old pavement on an existing road) with open-jointed 3-inch tile-drains, connected to the surface water gullies. Where a road is on sandy or light porous sub-soil, with sufficient natural drainage, under-drainage is, of course, unnecessary.

The under-bed is then formed to proper levels and contour, by means of a transverse sectional gauge, and is thoroughly rolled and consolidated under a steam roller, any inequalities being made up with sand-filling.

On the under-bed prepared as above, the foundation proper is then laid. It consists of rubble (grit, limestone, granite, or even good hard clinker, as may be most economical) 9 to 12 inches in length, 3 to 6 inches in width, and 7 to 9 inches in depth, laid on edge lengthwise across the road. The interstices are filled up with similar stone broken to  $2\frac{1}{2}$  to

3½ inches gauge, and the whole foundation is rolled, by a ten-ton steam road roller, to the correct cross sectional gauge or template above referred to, until the surface of the foundation presents the appearance of a well-rolled macadam road. On the foundation, prepared as stated above, the tar macadam, when mixed, is laid.

#### TAR MACADAM SURFACE.

The materials forming tar macadam are (a) suitable hard stone or slag to resist the wearing action of the traffic, and (b) a matrix impervious to moisture and sufficiently elastic and tough to bind the harder material together. The author has used extensively granite, blast furnace slag, and many varieties of limestone, as traffic-resisting materials, and has found most uniform satisfaction to follow from the use of a suitable grey or light-coloured limestone.

Granite, chiefly owing to its non-porous nature, is a somewhat uncertain material to use, although good results have been obtained from its use in certain instances.

Slag is open to objection chiefly because of the impossibility of procuring a uniform quality, however carefully the selection may be made. So many elements of uncertainty arise from the use of the different kinds of iron ore smelted, the nature of the limestone used as flux and of the coke as fuel, that the slag is left to come out as it may, since its quality is no concern of the iron smelter, and is merely a haphazard result. The proof of this is seen in the uneven way in which tar asphalt made of slag usually wears.

The stone, having been selected, must be broken to three sizes, 2¼, 1¼, and ¾ to ½ inch, and all dust, dirt, and smaller material most carefully screened out of it.

The matrix used by the author consists of suitable hard pitch properly tempered by impure carbolic acid, or dead oil, commonly known in the trade as creosote oil. Both of these substances are derived from the distillation of coal-tar, itself a most complex substance, and hence the necessity for chemical tests of both pitch and oil in order to make sure that the light oils (benzolene, naphthalene, etc.) have been properly removed in the process of distillation.

#### MIXING.

These materials are mixed in the proportion of about one gallon of oil to forty pounds of pitch, but this proportion may often require modifying, as the pitch and the oil vary in quality, and the mixture should be tested

when boiling by samples being taken out of the boiler and cooled to a temperature of about 60° F., and tested for elongation of about 30 inches, and for bending double without fracture.

The stones having been properly dried, so as to expel all the moisture, but not to injure the stone, the various sizes of stone are then separately covered with the asphalte composition while boiling hot, to which a small quantity of dry sand and lime is added in the buckets after it leaves the boiler, and stirred up by hand. There are several mechanical mixers now being used, but the author prefers hand-mixing on hot plates, so as to guarantee that while the entire surface of every stone is coated with the composition, there is not an excessive amount of the liquid, resulting in what is known among the workmen as making the asphalte too fat.

The asphalte having been mixed as above, is stored in separate heaps of various gauges, under cover, ready for use, but is distinctly improved by remaining in store exposed to the air, but protected from the rain, for a few days before it is laid in position.

#### LAYING.

The asphalte macadam should be laid on the foundation prepared as above described, in favourable atmospheric conditions. No asphalte macadam should be laid when rain is falling, nor immediately after rain has fallen, nor until the surface of the foundation is reasonably dry.

The prepared material should be spread in successive layers, that of the largest gauge in the bottom, that of 1½ inch gauge next, and that of the finest gauge on the top.

An allowance should be made of from twenty to twenty-five per cent. more depth than the ultimate depth aimed at after rolling. Thus, for a finished depth of five inches of tar macadam, at least six inches in depth should be spread. The thickness of the intermediate and top layers should not vary whatever the thickness aimed at, the variation should be all in the bottom layer of large-gauge stones.

All the layers having been put on, rolling with a steam road roller of from ten to fifteen tons, on a wheel-base of six feet, should be started at once, before the material has received any moisture or dust. The roller wheels should be properly cleaned before they are allowed on to the asphalte. The rolling should be continued until the rollers have passed at least twenty times over the entire surface of the road.

No traffic should be allowed on the road until at least forty-eight hours have elapsed after rolling is completed, so as to give the tar-macadam sufficient time to harden.

## LIMITATIONS OF TAR MACADAM ROADS.

The use of tar macadam for forming the surface of roads and streets must be confined within certain limitations, as follows:—

1. Not suitable for gradients steeper than one in twenty-four (half-an-inch in a foot), by reason of its slipperiness after wearing smooth.
2. Not suitable for heavy traffic. In any road, whether a street or main road, where the traffic exceeds an average of more than one hundred tons per yard of width of roadway per diem, tar macadam will be found to be more expensive to maintain than wood-paving, or even rock-asphalte.
3. On the other hand, for purely residential streets, whether front or back, where local traffic only, or a thorough traffic limited in amount to the extent indicated above, is expected, a tar macadam road surface will give unqualified satisfaction as being (a) impervious to moisture, and therefore always clean and free from dust and slops; (b) practically noiseless; (c) the most economical roadway known, considering its advantages.

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MR. R. READ (Gloucester) was glad that the author laid stress on the foundation, as that was the real road. 'There was an idea amongst the general public that tar macadam was a kind of universal panacea for bad roads. But there were no actual wearing properties in the tar, it only served to waterproof the road and prevented the rain from soaking in, rotting and destroying it by producing mud and consequently dust. To economise tar he had used small tar toppings to an ordinary coat of stone, working the tarred small stone into the joints of the larger stone after once rolling. This cemented the stone into a mass economically, but of course it did not make so good a job as when the whole coating of stone was tarred before laying.

MR. THOMAS READER SMITH (Kettering) said with reference to materials he would like to hear the experience of others as to granite, but he thought that if more pitch were put in the tar when those materials were used it would produce good results. Slag, as the author stated, was a variable material, but in some places was practically the only material available. It was not so much a bye product as it used to be, and at some furnaces great care was taken to produce a reliable material. Experience would show from which furnaces the better slag could be obtained, and its general quality could be relied on; it could also be supplied fresh from furnaces in sheeted wagons, avoiding the expense of drying on stoves.

As to the various gauges, the thicknesses of the different layers were not given, but he thought it a mistake to finish with a fine topping, especially on any appreciable gradient, as the surface became very slippery. A topping of  $1\frac{1}{2}$  inch stone, 3 inches thick, with smaller material, gave a good surface for foothold, but had the disadvantage that not being perfectly close, as it wore

down it began to break up sooner than a finer material which would roll more solidly together, and he found the best all round results to be given by slag broken to 1 inch gauge and containing smaller sizes, which made a good solid coating, the only fine material used for topping being untarred chippings about  $\frac{3}{8}$  to  $\frac{1}{2}$  inch gauge sprinkled on to close the interstices and form a close surface.

The author used creosote oil and pitch, and was able to check the quality by the aid of a chemist. In smaller towns authorities did not employ chemists, and surveyors had to rely on practical tests and observation, and on skilled workmen. It was most important in using tar that all light oils and water should be expelled by sufficient boiling before mixing.

As to rolling, he thought a 10 ton roller sufficient, and a lighter roller, say 6 tons, would frequently be better. He frequently finished the surface in hot weather by a prolonged rolling with a half ton water ballast roller, keeping the traffic off as long as possible.

MR. R. W. CASS (Farnham) asked whether, having regard to the additional cost in using tar macadam on roads, over that of ordinary waterset surfaces treated with a surface dressing of tar, oil, and pitch, the author considered that the use of tar macadam gave sufficient additional benefit to warrant its use.

Having maintained different sections of the same road for a period of three years under the following conditions, he found the cost results came out as follows (the cost was given at per square yard per annum on each section):—

A.—Waterset ordinary surface outside town . .	5·5 pence.
B.—Waterset surface, treated with tar, oil, etc.	4·2 pence.
C.—Coated with $4\frac{1}{2}$ ins. of tarmac, 3 ins. of $2\frac{1}{2}$ " gauge, 1 in. of $1\frac{1}{2}$ " gauge, $\frac{1}{2}$ in. fine topping, rolled with 10-ton steam roller . .	12·0 pence.

As regarded efficiency, B gave the best results over the whole period, and the tar macadam lasted no longer than the waterset surfaces treated with tar, etc., but longer, of course, than the ordinary untreated waterset surface.

As regarded chemical tests for tar before using, he did not think them necessary, as in the heating of the tar the light oils came off at known temperatures; it was a good thing for the purpose of preparing tar for use on roads that the light oils should be got rid of, and that a heavy oil and pitch should be added with a little lime and resin, which mixture, properly applied to good waterset surfaces, would secure all the advantages to be claimed for tar macadam, a section of which was far more liable to fail from a variety of causes difficult to avoid, than a good waterset surface properly treated as above suggested.

MR. G. WILLIAM LACEY (Oswestry) said further information was needed with reference to the use of granite for tar macadam. It seemed to him if the tar was of the proper quality and consistency the adhesion of the aggregate should be secured. He had had experience both with slag and limestone, and he was bound to say that although it could not be recommended for heavy traffic, the

latter gave a better foothold than the former, and formed a very good material. He agreed that the foundation was an important feature. If you had soft places or depressions hollows were formed, which, holding water, certainly tended to cause the macadam to perish. He had proved the value of tar macadam as against water-bound metalling. It was more economical in the long run, to say nothing of the comparative freedom from dust and mud, and he was about to lay down a considerable area of tarred granite macadam. He thought that a roller of ten tons in weight was ample, if not too much.

DR. S. RIDEAL (London) said the removal of water and light oils from tar could be easily ascertained by means of a glue-pot and piece of looking-glass. A properly boiled oil when heated in the glue-pot would not dim the cold mirror when held over it.

MR. A. E. NICHOLS (Folkestone) said that for light traffic (seaside town work) a very satisfactory tar road, he found, could be made from refuse clinker formed into tar-macadam with a surface of tar toppings, made from rag stone, granite chippings, or other suitable material, spread very thinly over the clinker bottoming for actual wearing purposes. This gave a clean and quiet road, which would go for years without appreciable wear.

Where a road of this description (which cost about 3s. per super yard) was too expensive, he had tried another method with success. An ordinary macadam road was scarified and the surface, screened of the finest dust, replaced and rolled down dry: after this thorough rolling, hot tar was swilled over the surface, percolating probably three or four inches down, and when the tar had somewhat settled, the surface was dusted over with the dust originally screened from the material.

The author laid stress upon the various layers of tar macadam being put on before receiving any moisture (he took it he meant in dry weather) necessary for the work. After the tar macadam foundation had been laid he had never found any ill effect due to subsequent layers having been put on in wet weather. This remark did not apply to the tar-painting of the surface of the roadway, where one could not be too careful about selecting a dry day for the treatment.

MR. JOHN S. BRODIE (Blackpool) said, in reply, he would like to impress on his brother surveyors that the methods of those good old surveyors, Telford and Macadam, were sufficient for their day, but would not serve at the present time. They must rise to the occasion and construct roads suitable for the new traffic which they had now to carry, otherwise it would be said that they were unequal to their opportunities, and were unworthy of being called the successors of road engineers such as he had mentioned.

COUNCILLOR T. RAMSEY also took part in the discussion.

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