

The usual method adopted for constructing macadam roads is to dump the broken stone on the road and roll to the form of the road, putting a certain amount of binder on top and wetting. The result is generally an uneven surface and rapid erosion after traffic has been upon it for a short time. Very seldom are large stones placed on edge on a proper camber of foundation, as brought out by Telford, although by so doing it will stand heavier traffic. As in all pavements the roadway should be rolled before the stone is placed upon it to the proper camber, and not more than ten inches (10") of stone placed before rolling with a fifteen (15) ton roller. This stone should be hard and not all of one size, although such a clause will be found in many specifications. Sufficient small limestone binder should be added and flushed and rolled until the voids are filled and the surface in the proper form. After two or three days the street may be opened for traffic. If it be desired to provide a practically waterproof and dustless macadam then after about ten days' time the roadway should be swept to remove loose material, and a distilled coal tar heated to a temperature of about 250 degrees Fahrenheit should be sprayed using about $\frac{3}{4}$ of gallon per yard, and immediately covering with about $\frac{1}{4}$ -inch of sand, or stone screenings. After rolling once upon the following day a second coating of about $\frac{1}{2}$ -gallon per yard should be applied cold and again sanded. In about ten days' time the roadway will have the general appearance of an asphalt pavement, the penetration of the tar being from one to two inches.

The advent of the automobile has made necessary the protection of the macadam surface from unravelling, and removing of the binding material in the form of dust. Oils of various kinds have been in use for several years—more or less successfully. Crude petroleum which contain the largest proportion of pure asphaltum give the best results. The petroleum having a paraffin or naphtha base are useless as they will not bind besides making a greasy slime and having an ill odor. It has been a common thing for an official to whom all oils look alike to purchase carloads of oil of unknown quality, sprinkle it from watering cars instead of spraying in unrestricted quantity regardless of the road condition, or weather. As a consequence slimy mud has been caused by sudden rainfalls which forms an emulsion with the oil, and the oil has pooled in depression in the roadway. It is necessary for the roadway to be first swept clean, be thoroughly dry, and have the oil heated and applied upon warm days.

From plain macadam roads to oil and tar painted, and on to tar macadam is but a step. Some years ago in Hamilton tar macadam pavements were extensively laid and these were successful in some cases, but not in others. The failures were partly due to using a limestone which was not tough or hard enough, and partly through the variable nature of the coal tar supplied. If tar used be not sufficiently refined the light oils and ammoniacal liquors will disintegrate. If it be heated too much it becomes brittle and forms black dust. There are now tar preparations on the market which give a reliable uniform product. In every city having a gas works using various grades of coal the quality of crude tar from a given tank will vary. Even with the coal constant the tar drawn from the bottom of a full tank will often differ materially from that taken from the same tank when nearly empty. Most failures in using crude tar may thus be traced to the variable nature of the tar

which would not have occurred by using tar refined to the proper uniformity.

The tar macadam pavements which failed as such in Hamilton were not, however, total failures. The pavements were levelled up with concrete and asphalt binder, and a sheet asphalt top placed on it at very small comparative cost and with excellent results. These tar macadam pavements cost from 97 cents to \$1.06 per square yard.

By the use of asphalt instead of tar a suitable pavement may be secured. The asphalt is applied in either of two ways, by penetration or pouring, or by mixing, as in the case of the tar macadam just mentioned. Using the penetration method, and after the foundation course has been rolled, there is placed a wearing surface of two inches thick (after compression with a road roller) of stone passing a two-inch ring. If there is already a foundation of concrete, old brick, block or macadam of sufficient strength no other foundation course will be necessary. On this wearing surface of compressed stone no water should be used but with suitable distributors from one and a half to two gallons per square yard of an approved asphalt binder should be poured depending upon the character of the broken stone. This binder should have a temperature ranging from 300 to 350 degrees Fahrenheit, and applied when stone is dry. Stone screenings are placed then on top sufficient to fill all surface voids, and the surface again rolled until smooth and true to cross section. Approximately one cubic yard of this material will cover 50 yards of roadway surface. A squeegee coat of approved asphalt from $\frac{1}{2}$ to $\frac{3}{4}$ gallons per yard is then applied, and again sufficient screenings and rolling when the roadway is open for traffic.

In the mixing method the $1\frac{1}{2}$ -inch stone is dried and mixed with asphalt at the plant at a temperature not less than 300 degrees Fahrenheit, and spread on the prepared foundation to a depth of three inches after compression with a roller while the mixture is still hot, however, and before rolling stone chips, or sharp coarse sand free from dust should be spread over the surface. It is important that the rolling be thorough, especially about manholes, etc. As for the penetration a squeegee coat is spread and re-rolled as in the previous method. By this latter method an asphalt plant either portable or stationary is necessary. The crown of these bituminous pavements should be flatter than for macadam; in fact should be about $\frac{1}{2}$ -inch per foot of width where the grade will allow as in cold weather, it is apt to be somewhat slippery. The average cost of macadam in Hamilton was 60 cents, and for bituminous pavements as described, the cost would be from 25 to 40 cents more.

From bituminous macadam we naturally drift into bituminous concrete, where the stone is varied in size from sand to stone one inch in size graded to have as few voids as possible. Under this head come proprietary pavements, as Westrumite Bitulithic, and Warrenite. The ingredients are combined and mixed at the plant and spread about two inches thick upon the foundation which is usually of concrete roughened on the surface. The following mortar has been used successfully in Chicago:—

Bitumen	18.8%
Passing 200 mesh	11.0%
“ 80 “	10.6%
“ 40 “	36.6%
“ 10 “	23.0%
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100.0%	