

mixture to which has been added from 15 to 25 per cent. of stone passing a $\frac{1}{4}$ -inch screen and retained on a 10-mesh screen, and 10 per cent. or less of stone passing a $\frac{1}{2}$ -inch screen and retained on a $\frac{1}{4}$ -inch screen. When well made and laid, however, its surface is practically no rougher than sheet asphalt. Owing to the somewhat lower percentage of bitumen which it contains and the fact that it is usually laid without a binder course, it is somewhat cheaper than sheet asphalt. It is, however, a more difficult pavement to lay satisfactorily. Theoretically the coarse stone particles which it contains should make it a more stable pavement and one less liable to shoving and wave formation. As a matter of fact, however, a slight excess of bitumen renders it much more unstable than even an inferior sheet asphalt pavement and liable to extreme displacement under traffic. This is probably due to the fact that it does not contain sufficient stone to permit the larger particles to be closely keyed together. When the mixture becomes plastic through heat these large particles are therefore relatively free to move, the only restraint to such movement coming from the relatively fine sheet asphalt mixture in which they are embedded. Owing to their size, a pressure tending to displace them acts with a greater total force than it would exert on, for example, a sand grain $\frac{1}{10}$ of an inch in diameter, in addition to which in many cases there is a distinct leverage action. Too little bitumen will make a Topeka mixture open and water absorbent and a variation of one-half of 1 per cent. of bitumen above or below its proper content is about the limit of safety. Double this variation in a sheet asphalt pavement will not seriously affect it. For medium and light traffic the writer believes that a not too dense sheet asphalt mixture, laid the same thickness under the same conditions as the Topeka will give at least as satisfactory service and will be much safer to lay in the long run. The Topeka mixture appears to him to be a hybrid possessing vices and weaknesses peculiarly its own and not as good as either of the types which it is intended in part to supplant.

For very heavily travelled city streets sheet asphalt on concrete foundation is undoubtedly the best type of bituminous pavement. When sheet asphalt is laid on very light traffic streets a somewhat coarser sand should be used than for heavy traffic streets. As the number of particles decrease, the surface area to be covered with bitumen also decreases. In this way, without increasing

the percentage of bitumen in the mixture, a thicker coating of bitumen is obtained on each grain of sand and the pavement will not crack as readily under minimum traffic as will a standard heavy traffic mixture. All sheet asphalt pavements are improved and their life prolonged by the passage over them of sufficient traffic to exercise a constant kneading action and equalize the internal stresses set up by contraction and expansion.

A comparative table showing the average composition of the various bituminous surface mixture discussed herein is given below.

Summarizing the foregoing brief discussion of the various principles and considerations involved in the different types of bituminous construction, we have the following:—

Foundation.—Old Macadam: Suitable for light traffic under favorable climatic and drainage conditions but only when properly constructed and drained. Thickness and character of stone layer and method of construction should be determined by test holes before adopting it. Road must be carefully shaped and graded, preferably by the building-up process, before laying any bituminous top upon it. Inferior to concrete.

Broken Stone: Suitable for light traffic but only under favorable climatic and drainage conditions. Inferior to well constructed old macadam and to concrete.

Concrete: Four to six inches thick, depending upon traffic and character of subsoil. This is much the best type of foundation and is the least expensive to resurface.

Coarse Aggregate.—Penetration Method: Suitable for light traffic only; gives a rough surface; best results cannot be obtained except with skilled labor. Should only be carried on in hot weather and stone should be at a uniform temperature not below 60° F. when binder is applied. No plant required, melting kettles being all that is necessary. Extreme care needed to prevent rich spots and bleeding. Stone must be carefully spread and fine material rigidly excluded from lower course, otherwise penetration of bituminous binder will not be satisfactory and uniform. Bituminous binder must not be overheated and must be at proper temperature and uniformly applied.

Cold Mixtures: Suitable for light traffic only; gives a rough surface. Stone must be clean and carefully graded. Bituminous cement must be of proper consistency, otherwise mixture will not be workable. Should not be laid at a lower temperature than 40° F. Work should preferably be done in warm weather.

Can be manufactured at the quarry from which the rock is obtained and shipped ready to lay to the work. Rolling should be continued until maximum possible compression is obtained. Especially suitable for repair work done by patrol gangs on coarse aggregate surfaces.

Hot Mixtures: Suitable for light and medium traffic only; gives a rough surface. Stone must be clean and carefully graded to secure best results. Can be laid at any time of year. Heating and mixing plant must be within hauling distance of the work. Rolling should be continued until maximum compression is obtained.

Fine Aggregates.—Topeka Mixture: Suitable for light and medium traffic. Gives a comparatively smooth surface. Heating and mixing plant must be within hauling distance of the work. Great care must be exercised to keep bitumen contents

COARSE AGGREGATE.			FINE AGGREGATE.				
Bituminous Concrete.			Topeka.	Sheet Asphalt.			
Hot mixture.			Cold mixture.	Light traffic.	Heavy traffic.		
Bitumen.....			7.0%	6.5%	8.5%	10.5%	11.0%
Passing 200 mesh			5.0%	4.5%	8.5%	10.5%	14.0%
" 100 "			4.0%	1.5%	6.0%	10.0%	14.0%
" 80 "			2.0%	1.5%	6.0%	10.0%	13.0%
" 50 "			5.0%	1.5%	6.0%	14.0%	19.0%
" 40 "			4.0%	1.5%	10.0%	14.0%	11.0%
" 30 "			4.0%	1.5%	10.0%	13.0%	10.0%
" 20 "			3.0%	3.0%	9.0%	10.0%	5.0%
" 10 "			5.0%	5.5%	6.0%	8.0%	3.0%
" 8 "			3.0%	5.0%	6.0%	.....	.....
" 4 "			7.0%	8.0%	14.0%	.....	.....
" 2 "			20.0%	40.0%	10.0%	.....	.....
" 3/4 " "			14.0%	11.0%	.....	.....	.....
" 1 " "			12.0%	9.0%	.....	.....	.....
" 1 1/2 " "			5.0%	....	.....	.....	.....
			100.0%	100.0%	100.0%	100.0%	100.0%