THE HOT-MIX METHOD OF BITUMINOUS CONSTRUCTION, USING AN ASPHALTIC BINDER.*

By Francis P. Smith, Ph.B., M.A.S.C.E., M.A.I.C.E.

FROM among the wide variety of bituminous pavements known at the present time it is almost always possible to select one type which will satisfactorily answer any given set of climatic and traffic conditions. Bituminous pavements, therefore, come nearer to being the universal and ideal type of pavement than any other which has yet been devised by man.

Bituminous pavements, especially those with fine mineral aggregates, are smooth, non-productive of dust, almost noiseless, waterproof, non-absorbent and easy to clean. They are capable of sustaining very heavy traffic, and also last well under light traffic. They are, therefore, well adapted for business and residence streets, and the facility with which they may be kept clean makes them especially desirable in tenement districts. They are easy to repair and offer but slight resistance to traffic. They are somewhat softer in summer than in winter, but when properly laid never become too soft for use, even in the hottest weather. When dry and clean they are not slippery, and their slipperiness in moist or drizzly weather is largely due to the presence of a thin film of mud caused by the collection of street detritus, and this can be greatly reduced by washing or keeping them clean. For this reason they are less slippery in a heavy rain than in a drizzle. Horses accustomed to granite block pavements instinctively put their hoofs down and slide them until they obtain a foothold in the crevices of the pavement. As there are no such crevices in a bituminous pavement, it takes a little time for them to become accustomed to it, but they soon learn to adapt themselves to a smooth surface.

While sheet asphalt will sustain a very heavy traffic, this statement applies more especially to a traffic largely composed of quick-moving, light-to-medium loaded vehicles, such, for instance, as prevails on Fifth Avenue, New York. It is not the most suitable type of pavement for a very dense, slow-moving, heavily-loaded traffic. Wood block and granite block will outlast it under these conditions. It will not give satisfaction where there is practically a total absence of traffic, as it then is liable to develop cracks, apparently requiring the kneading action of traffic to equalize the stresses set up by contraction and expansion and to keep it in proper condition. It is entirely suitable, however, for traffic varying from the light delivery traffic of residence streets to the dense but quick-moving traffic of Fifth Avenue, New York, or the Thames Embankment, London.

On account of their smoothness, sheet asphalt pavements are not suitable for use on excessive grades. Generally speaking, streets carrying a fair amount of traffic can be paved with asphalt if the grade does not exceed 6 per cent. In some cases, where the traffic was very light and a smooth pavement was considered essential, it has been laid on grades running up to 10 per cent. and 12 per cent., but this is rather exceptional. Where the traffic is heavy, a 3 per cent. to 4 per cent. grade is usually considered as the limit. In most of the largest cities of the United States the maximum grades on which this type of pavement is laid vary from 4½ per cent. to 8 per cent., regulated largely by the traffic and climatic conditions.

Depending upon the size of the mineral aggregate used, they may be considered as bituminous mortars or bituminous concretes, differing from ordinary mortars and concretes in having a cementing material which is plastic, and which may be classed as a semi-fluid or semi-solid. For this reason greater care must be taken in the selection of the mineral aggregate and its grading than if a rigid cementing material were employed.

The pavements produced by these mixtures are to a certain extent malleable and yielding, thus minimizing the wear of the mineral particles and making them more acceptable to horse-drawn traffic. In summer these qualities are more noticeable than in winter, for at very low temperatures the asphaltic binder becomes practically rigid. This very quality of flexibility or plasticity makes it necessary to provide a stable foundation. If the foundation is unstable and sinks after the pavement has been put down, the pavement will gradually sink with the foundation, thus forming a depression in which water will collect and eventually destroy it. The wheels of vehicles passing over such depressions will drop into them, the force of the blow depending upon the weight of the load, and this will still further exaggerate the depression by forcing up a portion of the pavement immediately in front of it. It will also set up a vibration in the springs of the vehicle, which will cause successive blows to be dealt to the pavement until the spring vibration returns to the normal. This action, especially in commercial vehicles, where the springs are short and stiff, results, sooner or later, in wave formation, which is unpleasant to ride over, and which, when it once sets in to any considerable extent, rapidly increases until it becomes necessary to re-surface the street or road.

Hot-mixed bituminous pavements differ from each other chiefly in the size and kind of the mineral aggregate, the bituminous cement or binder being substantially the same in each case. Sheet asphalt pavements have a mineral aggregate which contains no particles which would be retained on a one-quarter-inch sieve. Topeka mixture pavements consist of a standard sheet asphalt mixture to which has been added from 15 to 25 per cent. of stone passing a one-quarter-inch screen and retained on a ten-mesh screen and 10 per cent. or less of stone passing a half-inch screen and retained on a one-quarter-inch screen. It is really a type of bituminous concrete pavement, although in certain sections this term is only applied to pavements having a mineral aggregate consisting wholly or largely of stone of varying sizes, from 1½ inches down. The coarser the aggregate used, the rougher will be the surface of the finished pavement. On grades, therefore, where the traffic is not excessively heavy, coarse aggregates are to be preferred. Generally speaking, the heavier the traffic the finer should be the mineral aggregate used, owing to the fact that the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent rapid deterioration of the pavement will ensue, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperatures to re-bond and re-coat the fractured particles.

This brief consideration of some of the characteristics of bituminous pavements is necessary in order to intelligently discuss the question of proper foundation and the selection of the mineral aggregate to be used.

The character of the foundation required will depend upon the traffic, climate, character of subsoil and drain-

*Read before the 3rd Canadian and International Good Roads Congress at Montreal, March 6-10.