3 "The Surface Removal Method of Filler Application in Brick Pavement Construction," by O W Merrell, *Dependable Highways*, May–June, 1933
4 "Resurfacing 82 Foot Street at Richmond, Virginia with Vitrified Brick" by A Mason Harris, *Roads and Streets*, November 1934 This is descriptive of project on which a whitewash separating fluid was used
5 "Report of a Variety Survey in the Vitrified Paving Brick Industry for the year 1933," made at the request of the Department of Commerce of the United States
6 "Coefficient of Friction between Tires and Road Surfaces" by Karl W Stinson and Charles P Roberts, *Proceedings*, Highway Research Board Vol 13, 1933

BEST PRACTICE IN THE ACHIEVEMENT OF NON-SKID ASPHALT SURFACES

By B E Gray

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SYNOPSIS

The reports on skidding at the Thirteenth Annual Meeting of the Highway Research Board indicated that certain types of asphalt pavement had the highest coefficients of friction while other types had the lowest From this it is concluded that it is not the asphalt itself but rather the way in which it is employed that determines whether the pavement is non-skid A review of asphalt pavements and accident reports shows that improper cross sections are to blame for many accidents A contributing cause of skidding is the improper use of asphalt Right design and carefully controlled construction operations will produce the non-skid textures desired The paper divides modern asphalt surfaces into six principal groups (a) Dust layers (b) Surface treatments (c) Road-mix surfaces (d) Plant-mix surfaces (e) Penetration macadam (f) Asphalt block The important steps in construction procedure are noted for each type

Skidding accounts for only about five per cent of motor vehicle accidents, but even with this small percentage it was the major cause of 1,740 deaths and 44,510 accidents during 1931 the year which registered the peak in accidents on highways Even the threat of skidding produces a feeling of uneasiness and discomfort when no accidents result, and the psychology of the motorist when operating his car under conditions which appear dangerous is one of great uncertainty which in itself may contribute to accidents for others Many accidents resulting from skidding are due to careless driving, such as failure to slow down on curves and excessive use of the brakes, while others occur during Fall, Winter and Spring because of snow and ice or because of films of wet leaves or soft mud on the pavement For these conditions there is little remedy except the exercise of greater care by the driver

The highway engineer however is directly concerned with providing a pavement which is in the highest degree resistant to skidding so far as the cross section and surface texture are concerned A striking feature of the tests reported at the Thirteenth Annual Meeting of the Highway Research Board[1] by Professor R. A Moyer of the Iowa State College was the results on asphalt surfaces. The highest coefficients of friction (resistance to skidding) for all surfaces tested were obtained on high type asphaltic surfaces Also some of the lowest coefficients of friction were obtained on another type of asphalt surface Such results clearly indicated that it is not the asphalt per se which makes for either a non-skid road or a slippery road, but rather the way in which it is employed It was apparent that the "sandpaper" finish on certain surfaces was largely responsible for their high resistance to skidding There was also a definite indication that the hardness of the asphalt cement had some influence in making for these high coefficients It is therefore in the field of design, as well as in the construction and maintenance procedure, that the means of obtaining utmost resistance to skidding is to be obtained

INFLUENCE OF EARLY PRACTICE

Asphalt pavements have a long history and because of the great variety of ways in which asphaltic materials may be used, there has been some confusion as between different types of surface The first asphalt pavements in America were rock asphalt, soon followed by the sheet asphalt types similar to those employed today Practically all such pavements were in cities and as the traffic movement was relatively slow the need for particularly non-skid surfaces was not felt As a matter of fact every effort was made to obtain an extra "slick" surface, so that it could be washed and kept free from the dust and dirt brought in by horsedrawn traffic Even today, especially in the crowded streets where traffic movement is still relatively slow, the need for easy cleaning is an important consideration, and still influences design and construction practice, although much increased resistance to skidding may be easily obtained without any sacrifice of this desirable characteristic

The early improved rural roads were composed almost entirely of gravel or waterbound macadam, and to facilitate drainage were constructed with excessive crown, often as much as three-quarter inch per foot. Naturally there was no superelevation on curves These roads were built for a traffic speed of 15 miles per hour or less, and both from the standpoint of safety and durability were quite satisfactory, even for the early automobile As motor cars increased in number, the most apparent undesirable characteristic in the existing roads was dust, and all early improvement was directed toward its elimination. High speed or crowding were not yet important factors, and in consequence no attempt was made to modify the road crown or to improve alignment.

[1] "Skidding Characteristics of Road Surfaces" by R A Moyer, Proceedings Highway Research Board, Vol 13, p 123.

HIGH CROWN HARMFUL

At about the same time it was learned that a dustless surface could be most cheaply obtained by placing a carpet coat of bituminous material and within a short period thereafter practically all macadam roads were thus covered They preserved the surface, but they also preserved the high crown and the reverse elevation on curves, so that when speeds later increased this unchanged design of cross-section became one of the principal causes of skidding

USE OF INAPPROPRIATE MATERIAL

Also in these early treatments little attention was paid to proper technique of doing the work In fact very little was understood about it. Where asphalt was used the material was almost always a residual oil The writer recalls very well his own experiences in handling surface treatment work in 1909 when the procedure was to fill the pot-holes nearly full of this oil, and then to cover with dust and screenings This patching was followed by the application of as much as one-half gallon more oil to the square yard, and it in turn covered with coarse sand or sweepings The natural result was a film of soft oily material on the surface which was practically free of aggregate During warm weather this material was almost fluid and offered practically no traction when brakes were applied suddenly

As the number of motor cars rapidly increased, with continued demand for more improved highways, it was but natural to do the new building on the unimproved gaps, while the already improved roads were continued in use as they were. Even today there are thousands of miles of these original oiled surfaces, although some improvement in surface texture has been made by using more aggregate and harder asphalts in the retreatments.

ASPHALT CEMENT RESIDUES DESIRABLE

Residual oils are still employed in a large volume but usually in a different method of construction, principally in road and plant mix types where a sufficient amount of 200 mesh particles are present to absorb the oily constituents It is today definitely recognized that the asphalt cement (and by cement is meant one of under 350 penetration), is the correct basis for all asphalt construction For any class of work regardless of type, the development of an asphalt cement makes for the highest stability and with consequent maintenance of the desired relationship between binder and aggregate, which not only provides for a non-skid texture, but also produces the greatest degree of durability By using appropriate asphalt cements or liquid materials which become asphalt cements after manipulation has been completed, and by doing the work itself in the light of present knowledge of requisite construction and maintenance procedure, all danger of skidding so far as the surface texture is concerned is eliminated

This brief review of the transition period between the days of horse-drawn traffic and motor traffic is essential to an understanding of the reasons why such a large mileage of high crowned bituminous roads were in use, and only recently are being reconstructed In the judgment of the writer more skidding accidents occur because of improper crowns than for any defect in surface texture, while because of their greater age more bituminous pavements had these high crowns than any other type A progressive state engineer recently remarked that when he assumed office there were a number of signs in place on the state highways which read "Danger—Slippery When Wet" He stated that the matter was brought before a division engineers' meeting and it was agreed that the presence of such signs was a reflection upon the ability of the highway department, and that it was their duty to see that such hazardous conditions were remedied A pavement which is slippery when wet (except for ice) is a pavement which is either wrongfully constructed or is being wrongfully maintained, and it is the duty of the engineer to see that such condition is corrected

MODERN ASPHALT SURFACES

Over the years there have been gradually developed a variety of types calculated to meet every possible condition of traffic, every kind of available aggregate and every financial limitation They are listed in approximate order of cost and increasing ability to take traffic.

Dust layers
Surface treatments
Road-mix surfaces
Plant-mix surfaces
Penetration macadam
Block pavements

In general surfaces having the most non-skid texture also have the greatest stability and durability, so that improvements in technique to achieve the latter qualities produce the non-skid texture as a matter of course The fundamental principles underlying the design of surfaces are well understood, but the specifications which insure construction in accordance therewith have not yet been universally adopted. Uniformity is all important, and it is essential for proper work that absolute control of procedure be had at all times within the design limits The requirements are discussed briefly by types

DUST LAYERS

The first classification is of rather minor importance because the application of dust layer material is usually in small amount, so that the original texture of the surface is unchanged The principal use is on gravel or traffic-bound macadam roads which are in the process of stabilization and with new aggregate being gradually added where needed The oil impregnates the dust and prevents its removal from the surface Light asphaltic oils are used for this purpose with no mat formed, while the usual maintenance methods of blading and dragging the surface are employed

SURFACE TREATMENTS

There are approximately 40,000 miles of surface treated roads on the state highway system alone, and this mileage undoubtedly will be doubled and tripled within the next few years as a result of the very considerable mileage of gravel and other selected material surfacings which have been constructed in recent years The subject will be treated in two divisions, (1) new surface treatments, and (2) re-treatments

New Surface Treatment Prior to Professor Moyer's report there was a marked tendency toward the use of large sized aggregate for cover coat with view to obtaining a coarse open surface texture It is not necessarily these coarse fragments however that insure non-skid textures but rather the correct relationship of asphalt cement to aggregate, and marked economies may be obtained by giving greater attention to this fact and the selection of the appropriate grade of asphaltic material In original treatments, the first step is to prime the surface in such a way that the mat subsequently formed will not only be thoroughly knit together but also that instead of simply a layer of bituminous material dotted with aggregate, there shall be an actual impregnation of the road surface This procedure practically eliminates the possibility of later bleeding or flushing to the surface even under high summer temperatures For example, in a gravel road treatment, if a heavy asphaltic material is applied without a primer, there is simply a mat resting upon the gravel and not a part of it Any movement under this mat causes a pot-hole, while in warm weather the excess of asphalt floats to the surface free of aggregate On the other hand, if this same road is first treated with a priming asphalt, which is entirely absorbed by the road surface within 20 or 30 minutes, there is prepared a surface structure of such character that the later application of asphalt cement is held firmly in place among the aggregate particles, and any size of cover coat material may be used according to the texture desired. Figure 1 shows the contrast in the two methods of constructing a surface treatment and the different textures obtained Figure 2a is the surface of a gravel road treated with a light non-volatile road oil one year old Figure 2b represents a gravel road originally surface treated in 1931 and showing surface texture conditions as of that date and also of 1934 It is difficult to see that any change has occurred in this (b) series, and yet traffic during the hot summer months has reached as high as five thousand vehicles per day which should produce a flushing to the surface if it is at all possible.

The selection of the kind of asphaltic material for the seal coat depends largely upon the engineer himself as the same results may be obtained with a cut-back asphalt, an emulsified asphalt or a hot asphalt cement. There are two fundamental considerations; (1) the surface must first be primed, and (2) the material left in place as residue must be an asphalt cement and not a volatile material.

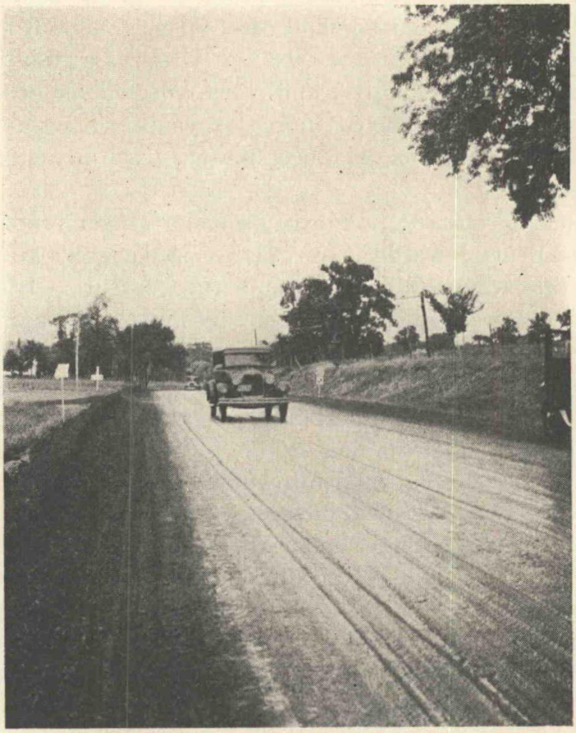

Figure 1. Excess Road Oil Treatment on Gravel

Retreatments. Probably the greatest error in retreatment work is the use of too much material per square yard. There is a tendency on the part of engineers to set up a retreatment program for the year, establish a certain rate of application and then to make this rate regardless of the road condition. The procedure is defended on the ground that it makes for less confusion in carrying on the work and the use of a single size aggregate for cover coat. However, the lesser cost and the non-skid surface texture obtainable would indicate a needed change in such procedure. Unless it is desired to add a definitely increased thickness to the surface, retreatment should merely provide for a reseal of the surface against moisture, and the formation of a granular or so-called sandpaper texture. If the surface is practically intact except for slight checking, then the least amount that will cover the surface should be applied with an appropriately sized aggregate for cover coat. Table I shows approximately the relationship of rates and size of aggregate.

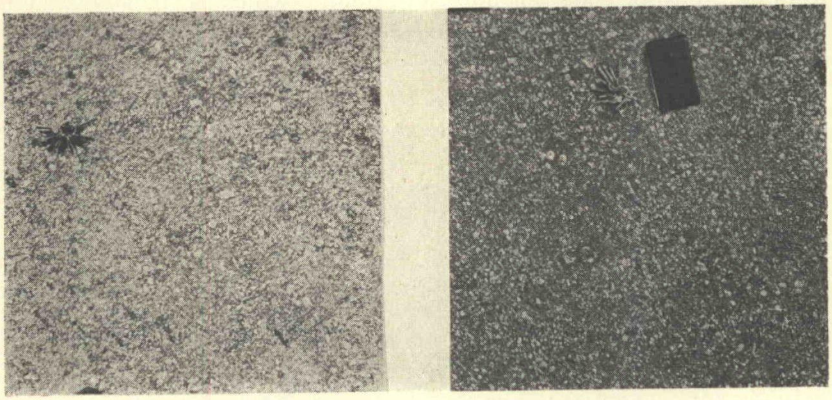

Figure 2. Gravel Road Surface Treated with Light Non-volatile Oil. A. Soon After Treatment with Cutback Asphalt, 1931. B. After Four Years Traffic on Original Treatment, 1934.

TABLE I

Gallons Per Square Yard	Size of Aggregate	Pounds Per Square Yard
	inches	
0.1	$\frac{1}{8} \times \frac{1}{4}$	10
0.2	$\frac{1}{4} \times \frac{3}{8}$	20
0.3	$\frac{3}{8} \times \frac{1}{2}$	30
0.4	$\frac{1}{2} \times \frac{3}{4}$	45
0.5	$\frac{5}{8} \times 1$	55

Note: Exact grading limits will of course extend both above and below those given, but the nearest commercial size should be selected that will give approximately 75 percent of the particles within these limits.

ROAD MIX SURFACES

Road-mix surfaces while of recent development constitute a rapidly increasing mileage, not only as entirely new surfaces but also as a means of salvage for old pavements or as a method for removing excess crown and surface irregularities. There are two distinct varieties, (1) macadam aggregate type where the smallest particle is retained on a $\frac{1}{4}$ inch screen, and (2) the dense graded aggregate type where as much as 70 per cent passes a $\frac{1}{4}$ inch screen. The first type is used principally as a resurfacing and salvage medium over old pavements, while the second is employed over either natural soil subgrades or sandy gravel surfaces.

The early work was an outgrowth of surface treatment procedure, with extra heavy applications of bitumen and cover, and with the fault of a non-uniform rate of aggregate with a uniform rate of asphalt, so that very spotty surfaces resulted. Much of the discussion concerning the amount of asphalt to be used in macadam aggregate road-mix arises from failure to provide this uniform rate of coating on the stone. For example, if an old road is being reconstructed with view to taking out excess crown, as well as irregularities, and the average amount of stone is 160 pounds per square yard, the stone often will be spread in such a manner as to be nearly four inches thick at the edge, and less than one

Figure 3. Asphalt Macadam-aggregate Road Mix

inch at the center. When followed by the distributor application of the liquid asphalt at a uniform rate, no amount of subsequent mixing will produce as heavy a film around the stone particles in the lower outside layer as will be on the center stone, and the chances are that the surface will be fat in the center and will ravel at the edge. The correct procedure is to spread the stone at a uniform rate per square yard regardless of contour, apply asphalt and make the mixture, and then spread the mix to produce the desired cross section. Some very excellent new equipment has been developed in the State Division shop at Chillicothe, Ohio, and work accomplished this past summer shows the value of attention in this respect; not only is uniform non-skid texture produced but it is done with less inconvenience to traffic and at lower cost.

The early work with the dense graded aggregates was done in the arid or semi-arid regions of the west, under which conditions non-volatile slow-curing road oils were satisfactory, primarily because of the absence of capillary pressure which might force the oil to the surface. Provided sufficient fines (200 mesh) are present to absorb the lighter oils, and there is a correct aggregate grading to produce stability the oil-aggregate relationship tends to remain constant under constant weather conditions. However, where rainfall is considerable or where severe winter conditions prevail, it is essential that the asphaltic material be such that it will definitely increase in viscosity to an asphalt cement which will resist

Figure 4. Dense Graded Aggregate Road-mix Surface

displacement. If light oils are used under such conditions, no matter how well mixed, extreme capillary moisture will displace the oil and force it to the surface, when it will appear as though the mix were too rich; and finally the surface will ravel. The medium-curing cut-backs develop the increased viscosity required to resist displacement, and are being adopted universally for such work.

In addition to the need for using an appropriate grade of asphalt, is the question of proportion. Too much emphasis can hardly be placed upon the use of the simple laboratory tests which will indicate the correct percentages of material to be used so as to obtain the utmost strength from a given aggregate, and which also insures the maintenance of a non-skid surface. These methods have been set forth in reports of the Bureau of Public Roads and The Asphalt Institute and will not be gone into here, but suffice it to say that by following recommended procedure, non-skid surfaces as constructed will stay that way.

PLANT-MIX SURFACES

Plant-mix surfaces include several varieties of both hot and cold mixes. They will not be gone into in detail but, simply coming back to the fundamental principle of proper relationship between aggregate and cement, several items will be discussed which have bearing upon control of this relationship It is stated without fear of contradiction that with certain types of asphalt plants, it is a matter of pure luck instead of engineering judgment that a suitable mixture is manufactured and placed on a road Assuming that the laboratory design is a proper one and that under suitable test a high stability is shown, the next consideration is to translate this design into day by day construction practice The laboratory samples are prepared by weighing the aggregate components and the asphalt cement on a pair of delicate balances. Suppose it is determined, for example, that 7.7 per cent of asphalt cement with certain percentages of aggregate will produce the most desirable mixture and that when the percentage of asphalt is materially greater or less than this amount, a lesser stability is obtained which usually means a less non-skid surface In spite of such knowledge the asphalt plant used for the large scale manufacture of the mixture may not be controlled within 10 or 15 per cent This may sound like a startling statement but to anyone who has inspected a number of asphalt plants and followed the mixtures as they come to the road it is simply a statement of fact Happily there has been a tendency in the last year or two to revise specifications so as to require certain minimum plant essentials It is obvious that in addition to having the right total relationship between asphalt and aggregate, there should be also a uniform distribution of both asphalt and the several sizes of aggregate throughout the entire mixture as otherwise there will be alternately fat and lean spots, and the fat spots will not have the non-skid qualities of the remainder of the pavement.

Accordingly, the first essential in plant control is the prevention of segregation of the different sizes of aggregate In many plants aggregates are dumped into the drier without any attempt to introduce even approximately correct proportions. The aggregate then goes from the drier to the hot elevator and to the screens where the surplus of one or more sizes may prevent proper separation Even if this does not occur the number of bins may be either inadequate in number or in capacity, so that as one size builds up a surplus, another size may be lacking entirely Furthermore, the bin construction may be of such character as to permit overflow from one bin to another, so that all the value of screening has been lost The specifications should provide for mechanical feeding of aggregates in appropriate proportions and with screening devices to obtain complete segregation, with subsequent storage in bins so constructed that overflow from one to another is impossible. There is a definite trend toward the use of square mesh screens of the vibrating type in place of the old circular screens. Having separated the aggregates into the proper sizes, recombination to make the total amount in the mix is then required, and the use of spring balances or single beam balances is not in accord with the exact procedure which should accompany modern mechanical methods. When the beam type is used there should be a separate beam with tell-type indicator for each size aggregate, and a tare beam for balancing the hopper, so that there is assurance of exact proportions.

Figure 5. Asphaltic Concrete Surface after Three Years Heavy Traffic

In many old plants, the weighing of the asphalt is done in a very crude manner with wide variation between batches. Furthermore, with the asphalt bucket exposed to the wind, chilling on one side affects the amount actually deposited in the mixer. These variations may be all overcome by providing that the bucket shall be either steam jacketed or electrically heated as well as the pipe lines which lead to it, and that either dial or beam scales be used so that the tare weight of the bucket and the net weight of the asphalt are exactly shown for each batch. Scales for aggregate should be sensitive to one-half per cent of maximum load required, while for the asphalt they should measure accurately within one per cent above or below the weight required.

Being assured of the proper amount of asphalt and aggregate in the batch, the next step is to obtain proper mixing of the two materials. This may be accomplished by providing that the mixer box be of proper construction, so that it will not leak during mixing, and will dump the mix without segregation at completion. Furthermore, it should be equipped with a time lock to insure accurate control of the mixing cycle. Modern mixer boxes are made nearly square and with the gates extending across the entire bottom, so that the mix is dropped as a whole mass. With equipment and control of this character, batch after batch is delivered to the roadbed in uniform condition. As regards finishing,

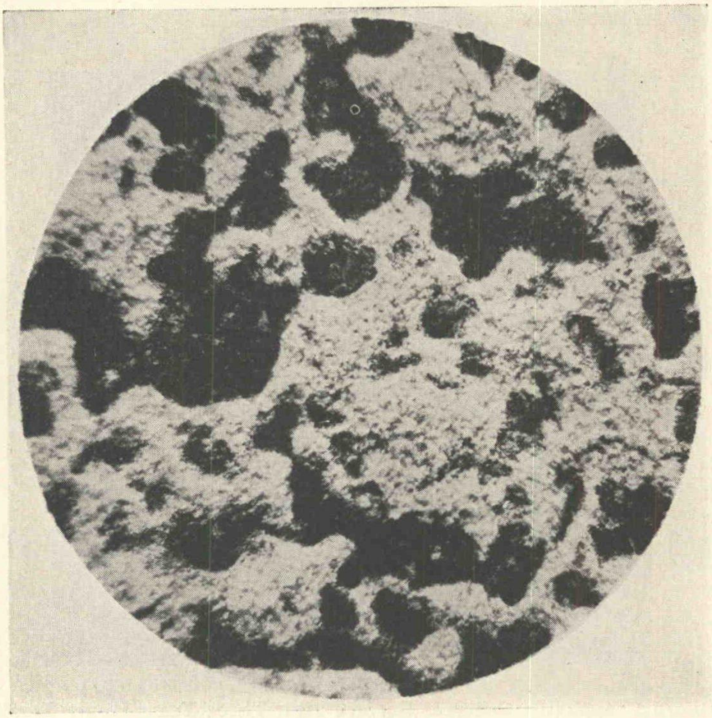

Figure 6. Sheet Asphalt (magnified 40×). White areas are dust filling surface voids.

hand raking and spreading are used in many cases, particularly for city construction, but mechanical finishing is replacing hand methods and is to be encouraged as there is no comparison in the quality of the work obtained by the two methods. However, it is not the hand raking that causes non-uniform surfaces but rather the non-uniform manufacture, and if the plant requirements as above outlined are insisted upon, little difficulty will be found in obtaining a uniform granular surface.

One desirable item in connection with sheet asphalt specifications is the elimination of the requirement for an application of dust over the compacted wearing course. It serves no useful purpose and materially reduces the natural non-skid characteristics of the mixture Furthermore, this application often is made to cover up poor work before final inspection, which is an additional reason for its elimination Figure 6, showing a sheet asphalt surface finished with dust clearly indicates the number of voids therein, the black particles being the coated sand grains (magnification 40 ×)

In addition to obtaining a highly non-skid surface by following careful construction methods, additional non-skid characteristics may be obtained by placing a light seal coat This consists of a hot, precoated aggregate broadcast over the surface after the initial rolling, and imbedded under the final rolling The rate of application is from 8 to 10 pounds per square yard, size of aggregate ¼ to ¾ in the asphalt coating from 1½ to 2 percent, applied at a temperature of not less than 275°F

PENETRATION MACADAM

This type is one of the oldest varieties of bituminous pavement, and was universally constructed as a high type pavement on rural roads around 1910 to 1915 Originating in the northeastern states where very hard stone was available as well as a good construction technique, the type was later adopted in other sections where sometimes because of the lack of one or both qualities, very inferior work was obtained It is fundamental to good results that the stone be of a quality and be so placed that the voids between the stone particles will be uniformly open, so that a given rate of application of asphalt will be uniformly absorbed If the stone is soft these voids will be non-uniform after rolling, and fat spots will be certain to develop For such aggregates a different type of surface should be designed

In the last few years there has been a revival of the type on a large scale as a result of its excellent service record, and long lived qualities The principal fault in the early construction was the practice of applying a heavy seal application of asphalt with fine aggregate cover, which coupled with a high crown made a surface which was unsatisfactory under fast driving in wet weather These faults are eliminated today by following a revised design, particularly as to certain details First, the thickness of wearing course is made 2½ inches instead of 3 inches as formerly Second, the aggregate is coarse, none under 1¼ inches and with the bulk around 2 inches Third, the rate of application of asphalt is reduced to 2 gallons for penetration and 0 4 gallon for seal coat Fourth, the cover coat aggregate size is increased and the amount diminished The result is a surface texture in which the coarse particles of stone are sharply outlined as in a mosaic, although the voids between are filled with asphalt Such surfaces cannot bleed, and the wear of traffic comes directly on the stone

As developed in Massachusetts, the surface is not only non-skid under summer temperatures, but because of the slight valley between stone particles, gives considerable tractive resistance even under heavy ice and sleet storms. Figure 7 contrasts the surface texture in the old and new types.

BLOCK PAVEMENTS

Asphalt block pavements are constructed for very heavy duty service, such as terminal areas, docks, industrial streets, or arterial highways. The blocks are formed under 3,000 to 4,000 pounds per square inch pressure from a special sand asphalt mixture. The early pavements were laid with sand filled joints which gave all necessary tractive resistance, but with the advent of fast motor traffic, it became necessary to fill the joints with a more durable binder, and emulsified asphalt and

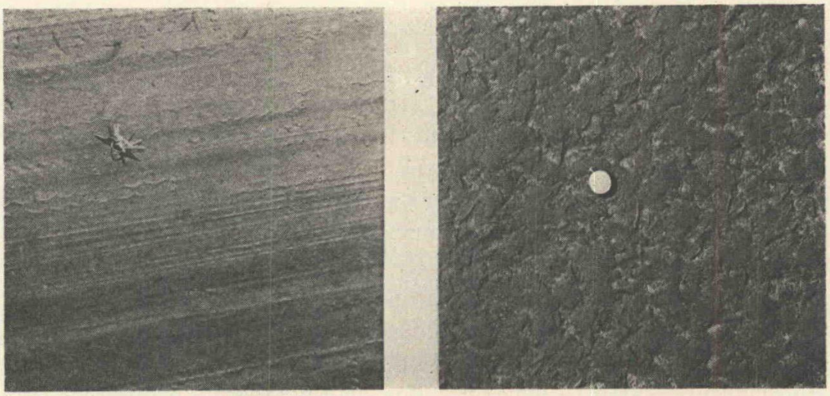

Figure 7. A. Excess Asphalt Seal on Penetration Macadam. B. Modern Type Penetration Macadam.

sand are used today for this purpose. Coupled with the sand texture of the block face there is provided a non-skid texture for ordinary grades. In recent years asphalt block pavements have been constructed on very heavy grades by reason of an unusually high tractive resistance obtained from a new manner of placing the block. This procedure in brief is as follows. First, the blocks are placed in transverse courses with wooden spacers, approximately $\frac{3}{8}$ inch wide between. Ordinary building lath are satisfactory. After the street has been laid the spacers are removed and filled with portland cement grout. About 30 minutes later when the grout has taken its initial set, the joints are raked to a depth of $\frac{1}{2}$ inch, which leaves a recess $\frac{1}{2}$ inch wide and $\frac{1}{2}$ inch deep between each row of blocks. This type has been very successful on the heavy grades leading from the Hudson River in New York City.

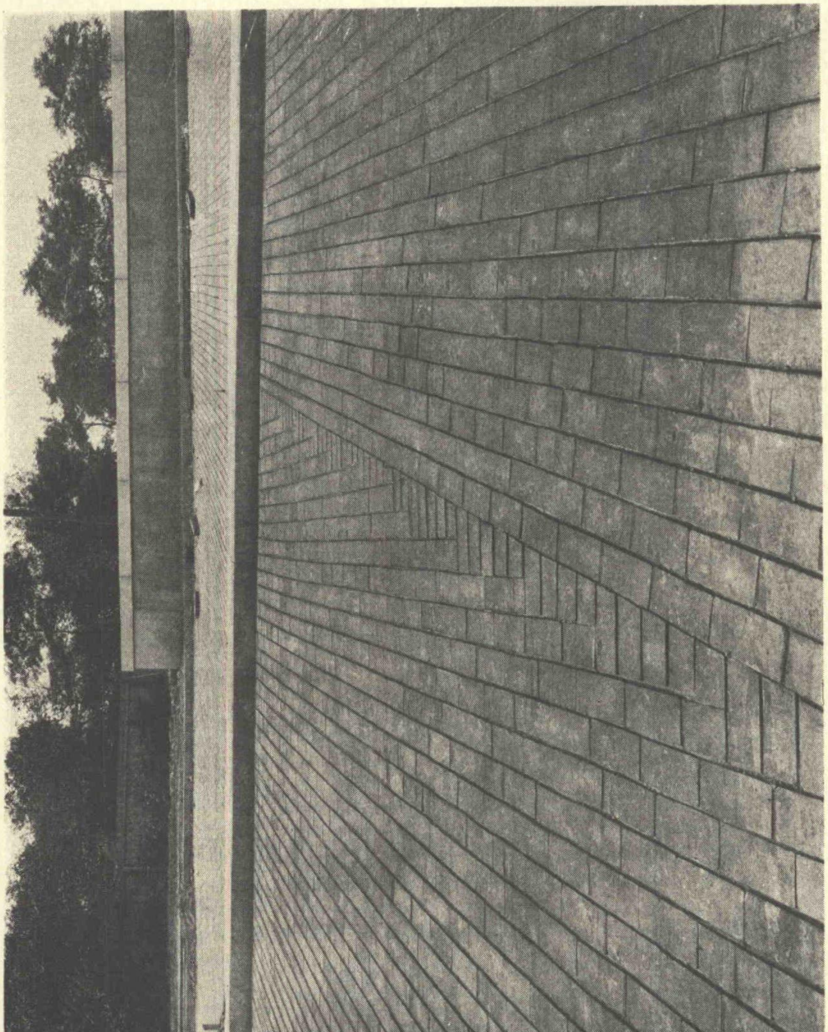

Figure 8. Close Up of Asphalt Block Pavement Showing Joint Construction for Non-skid Surface

CONCLUSION

The study of traffic behavior on asphalt surfaces, indicates definitely that with few exceptions it is the correct relationship between aggregates and asphalt *cement* that is the controlling factor in respect to non-skid characteristics This correct relationship is obtained when the finished pavement is composed of individual aggregate particles exposed to traffic, yet firmly bound together below the exposed surface by the asphalt cement in such a manner that no surplus of asphalt reaches the surface under the yearly temperature changes

Tests have indicated that the so-called "sand paper" surface texture has the highest coefficient of friction, and therefore this kind of surface should be constructed wherever rain alone is the worst weather condition to be met In many sections however, where snow and ice are found for considerable periods, or even in warmer areas, but where clay mud is tracked upon the pavement, it is a distinct advantage to have a surface of somewhat rougher texture The design of any given surface therefore may be a compromise between the ideal determined for clean wet pavements and that best adapted for surfaces that are expected to accumulate extraneous material which in itself would produce a slippery road It is for this reason that the larger sizes of aggregate cover have been recommended in this paper

COEFFICIENTS OF FRICTION BETWEEN RUBBER TIRES AND CONCRETE ROAD SURFACES

By E M Fleming

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SYNOPSIS

The question is raised as to whether the coefficient of impending skid, the coefficient of sliding friction or the difference between the two is the critical factor in road skidding, and suggestions for study of this problem are made Concrete pavements were found in most of Moyer's tests to have coefficients for straight and side skidding within ranges theoretically reasonably safe from danger of skidding Methods for producing surfaces which may have higher coefficients of friction are also discussed

Increased speeds of motor vehicle traffic as well as increased numbers of motor vehicles on our roads make it desirable for highway engineers to have first-hand knowledge of the factors influencing the coefficients of friction between rubber tires and concrete road surfaces

Field and laboratory investigations that have been conducted by the British Ministry of Transport, Iowa State College and Ohio State University have helped to clarify the subject and bring out the fact that two types of friction must be considered, first, coefficient of impending skid and coefficient of sliding friction. All tests indicate, as would be