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

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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

expected from standard static and kinetic friction tests on other substances, that the coefficient of impending skid is greater than the coefficient of sliding friction

In investigating the frictional resistance of concrete surfaces it is important that the critical coefficients be developed Impending skid coefficients, comparable to static coefficients in mechanics, are the highest and must be exceeded before any skidding can take place The sliding or kenetic friction is below the impending values and introduces another factor that may be of considerable consequence, namely, the difference in the two values With only a small difference, the speed of the car will not be changed materially and the same degree of control can be exercised With a large difference in the two values, the car will accelerate materially and thus increase the difficulty of control

It is obvious that slipping cannot occur until after the impending skid values are exceeded The case is more clearly shown by referring to static and kinetic friction tests in mechanics One method of finding these values is to make an incline of one of the materials and place a block of the other material on it The incline is raised until the block is ready to slip, and this determines the static coefficient The block cannot move down the plane or start in motion until after the static value is exceeded

This illustrates the condition found on the highway with a car in continuous motion A wheel, though rolling, has not reached the static friction value until just before rolling stops or the wheels lock This is comparable to the stationary block described above When the wheel is no longer rolling, but locked and stationary, the kinetic friction values prevail

The foregoing will show the importance of determining whether the impending or sliding skid coefficients govern From a practical standpoint, this is necessary since the gripping action of rubber tires when rolling, may be appreciably different than when they are slipping and generating heat A texture that may be most efficient in building up resistance to rolling may not be the most efficient in building up resistance to slipping

No criterion has been established for safe values of coefficient of friction, but from theoretical analysis Moyer[1] deduced that to be reasonably free from the danger of skidding a road surface when wet should have a straight skid coefficient of 0 4 or higher at 40 miles per hour and a static or side skid coefficient of 0 5 or higher at 30 miles per hour In the tests[1] reported by Moyer, portland cement concrete developed coefficients within these limits except that in the case of straight skidding of some old tires worn smooth, slightly lower values were obtained

It may be possible that concrete surfaces can be so constructed that

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

they will have higher impending and sliding coefficients than prevail under normal practice today Some state highway departments have adopted simple finishing procedures which give a textured surface. These states feel that such textures are desirable for a number of reasons, including better light reflection at night, removal of inert materials and increase of skidding values These finishes are obtained by using a burlap drag or brooms as a final finishing operation It is possible that even more desirable surface finishes can be obtained by other equally simple, inexpensive methods

With this thought in mind it is suggested that studies be made of the production of various types of transverse surface textures by the use of canvas, burlap and brooms of varying weight and coarseness together with observations as to the most desirable time in the hardening period for applying the process The surface textures produced will consist of transverse ridges which will vary in width and height, depending on the type of equipment used and the time at which the surface is finished

The investigation into this subject might well be directed at first toward determining whether the impending skid coefficient, sliding skid coefficient or the difference between the two is the primary factor in skidding accidents This should then be followed by the determination of impending and sliding skid coefficients of various surface textures. Particular attention should be given to the correlation of these results as the surface texture giving the highest impending skid value may not give the highest sliding coefficient of friction The various surfaces should be studied to insure the production of a texture that does not increase tire wear unduly under normal driving conditions

Since the highest coefficients are needed on horizontal curves, the investigation can extend to the practical application of these textures to such points together with investigations into crown, superelevation and other design features of horizontal curves

Theoretical consideration of the relation between coefficients and speeds indicates that there will be a limit imposed on speed by the skidding coefficients Whether these ultimate speeds are 40, 60 or 100 miles per hour will be determined by the maximum practical coefficients that can be developed. Therefore, maximum practical values should be determined for concrete and other surfaces and correlated with design to determine maximum safe driving speeds After these speeds are determined, the motor manufacturers and the public can be educated on safe driving speeds and the reason therefor It should also be remembered that many accidents are due to unusual conditions such as ice, snow, mud, oil, etc , on the surface which illustrates again the importance of the difference in impending and sliding skid coefficients