Report of Subcommittee on Pavement Chararacteristics

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Just before the First International Skid Prevention Conference in 1958, nine federal, state, and industry agencies conducted a skid-test correlation on four highway surfaces in Virginia. The small number of participants reflects the fact that at the time only a few organizations were interested in practical methods of identifying slippery surfaces. During the correlation, there were many delays in test runs because of malfunctioning equipment; and had not the engineers who designed the equipment been present and, in most cases, operating the equipment, the study would have been a failure because of equipment breakdown. As it was, the test equipment rated the skid resistance of the four surfaces in the same order, but differences in test values were extreme.

Before this cooperative undertaking there were no standard test tires, so the Tire and Rim Association designated the Goodyear Tire and Rubber Company to provide a special standard tire for the correlation.

In keeping with recommendations resulting from the first conference, the ASTM organized a committee on slipperiness, which during the intervening years has not only written specifications for a standard skid-test trailer and standard tire but also published nine other specifications. Also during this time the considerable research that has been conducted and sponsored by state and federal agencies has resulted in improvements in the ability to design, build, and maintain pavement surfaces with adequate wet-weather skid resistance. In addition, FHWA has set up two skid trailer calibration and correlation centers, one in Ohio and the other in Texas. As a result of a number of research efforts in the area of skid-resistance measurement, the calibration and correlation centers report that different trailers can now be expected to measure similar values when tests are performed by well-trained technicians. However, there are still deficiencies in interpreting seasonal variations in measured pavement skid resistance and hydroplaning potential. There is also some concern regarding the lack of a standard method for determining the pavement contribution to cornering on wet pavements. However, FHWA is sponsoring a great deal of research on seasonal variations that should provide useful knowledge within the next few years, and there is a strong possibility, when combined with standard skid trailer data, texture measurements and tests performed with the ASTM bald tire will provide added insight into hydroplaning. The imperfections noted are minor, and their elimination should be considered a refinement of a usable test system. The present skid trailers are durable and reliable and can be operated by technicians in grueling skid surveys over periods of days rather than by the design engineers for a few runs.

In contrast to the period before the 1958 conference, today most of the states in the United States and many foreign countries are monitoring pavement skid resistance. Before 1958 hydroplaning was an unrecognized phenomenon; today it is being combated through grooving old pavements and providing improved textures on new ones. Through the dissemination of research findings, there is widespread knowledge that high microtexture-low macrotexture surfaces provide the best skid resistance on low-speed roads and that high microtexture and macrotexture are best for high-speed roads. In 1958 only one state in the United States restricted the use of polish-susceptible aggregate in surfaces of high-speed roads; today many states do so. The advancement in the technology for providing safe road surfaces for wet-weather conditions is gratifying. There have been breakthroughs in blending aggregates: sprinkling polish-resistant aggregates onto freshly laid, polish-susceptible mixes; manufacturing open-graded and improved sand mixes; texturing concrete pavements; and in selecting the proper aggregates.

The technology for providing skid-resistant pavement surfaces is available, and the inclination to use it is becoming increasingly evident. Programs in England, Europe, Canada, and the United States are designed not only to correct locations that have experienced wet-pavement accidents or black spots as they are often referred to but also to identify conditions that cause black spots and to remedy deficiencies before they lead to accidents. These programs have built into them the potential for providing solutions to specific local problems through determining the degree and type of skid resistance needed, the availability of materials, the cost-benefit relation between improvements and accident reduction, and the setting of priorities to realize the greatest benefits. Research has shown that no single skid number is needed for all conditions. Specific conditions require any one of a family of surface types. Central governmental agencies of all nations, therefore, should prepare broad guidelines for the design of a program for reducing wet-pavement accidents that include at least the features reported on here. The guidelines should not set specific skid-resistance requirements, but should insist that each agency bearing prime responsibility for the construction and maintenance of highways design a program to reduce wet-pavement accidents that meets local needs through local solutions.

Because the knowledge needed to develop such programs is not absolutely complete, care should be taken to avoid too heavy a reliance on any one criterion for determining where pavement improvements should be made. It would be foolish at present to rely solely on skid-test values as the criterion dictating improvements. This does not imply that survey skid values should be ignored; sites for which low or borderline values are recorded should certainly be studied. In addition, one should not always assume that a pavement surface is adequate if it provides a high skid number, because the skid resistance could be high at the time the tests are performed but relatively low during some other time of the year. Rather than rely solely on skid-test values, the programs should consider characteristics of the paving materials, type of surface texture, geometrics, traffic conditions, speed limits, accident records, and cost-benefit data. These items all are adequately discussed in the literature, especially in the proceedings of the Second International Skid Prevention Conference.

Although it is recognized that current knowledge of the subject at hand is not without gaps, the gaps are not so extensive as to preclude initiation of programs to reduce wet-pavement accidents. Filling the gaps would, of course, lead to more perfect systems, and to encourage endeavors toward that end some of the needs are indicated below.

GENERAL

1. The people who work on the different aspects—tires, vehicles, safety, and human elements—of reducing wet-pavement accidents should maintain continual contact, preferably at the international level, to optimize the development of knowledge.
2. Road administrators and legislators should become familiar with the problems and responsibilities of pavement engineers.
3. Simplified methods of determining road surface characteristics should be developed for the use of those agencies who, because of limited resources, do not have access to highly specialized equipment.

PAVEMENT CONSTRUCTION

1. Accurate and high-speed test equipment should be developed for measuring surface texture. The U.K. Transportation and Road Research Laboratory has been working on this problem.
2. Additional experience is needed in the use of sprinkling techniques that enable the use of polish-susceptible aggregates in bituminous and portland cement concrete mixes. Methods are also needed for making use of poor-grade local aggregates, such as the blending of polish-susceptible and polish-resistant aggregates in bituminous mixes.
3. Further development of pervious bituminous mixtures should be promoted. Two types are now in use: the open-graded or "popcorn" mix and the sand-asphalt mix, which the state of Kentucky has greatly improved in recent years.
4. The skid-resistance characteristics of aggregate supplies should be determined. The British polished-stone value is one method that can be used.
5. Methods should be developed for producing low-cost, artificial aggregates on an industrial scale.
6. Geometric design characteristics should be optimized in relation to pavement skid-resistance knowledge, especially with respect to water layer thickness.
7. Pavement markers should be developed that have good visibility on wet roads, do not prevent water runoff, and have adequate skid resistance.

MAINTENANCE

1. Texture properties should be evaluated in detail with respect to rubber deposits on runways. Low-cost and quick maintenance procedures are desirable.
2. Simple methods are needed for locating and evaluating road sections, like transition zones and ruts, that have undesirable water accumulations. Additional criteria should be developed with respect to tolerable water layer thickness.
3. The relations between skidding and road-surface characteristics such as rutting and road roughness should be evaluated.

ACCIDENTS AND PAVEMENTS

1. Provision should be made for the translation of experience gained in improving the pavement at known locations where a high number of wet-pavement accidents occur, or black spots, into measures for ensuring against the construction of such black spots.
2. Provision should be made for feedback on the effect of remedial measures to the pavement engineer.

PROBLEMS IN ADJACENT AREAS

1. The interrelations among road surfaces, tires, and noise should be described in detail. The optimization of pavement textures should not be restricted by noise generation, unless the detriments from noise outweigh the benefits from improved textures.
2. The accuracy and reliability of friction measuring equipment should be improved. This implies no objection to the use of present equipment.
3. The accuracy of skid inventories should be improved by developing further knowledge on seasonal variations in skid resistance.
4. Predictions of pavement skid numbers, on the basis of parameters such as materials, climate, and average daily traffic, should be used to improve pavement design and maintenance planning.
5. More use of skid-resistance knowledge should be used in the development of pavement management systems.

Report of Subcommittee on Wet-Weather Accident Experience, Human Factors, and Legal Aspects

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IMPLEMENTATION KNOWLEDGE

A low skid resistance has a marked influence on accident levels at basically two types of road locations. The first is a location at which drivers are not required generally to take emergency action but at which nevertheless their friction demands may not be satisfied in wet-road conditions. An example of such an area is a curve without adequate superelevation and with a low skid resistance at which single-vehicle accidents predominate. The second type of location is that at which conflict accidents predominate. Examples of such accidents are rear-end collisions on freeways in saturation conditions and vehicle-pedestrian or vehicle-vehicle collisions at road intersections. Conflict situations cause the driver to take some form of emergency action such as braking or altering direction as a result of which his or her friction demand rapidly increases. Whether a collision occurs in this circumstance will be determined by the available friction resistance that controls the minimum