Relationship of Tire Design and Composition to Skidding

Report of the Subcommittee on Factors in Tires that Influence Skid Resistance to the First International Skid Prevention Conference, September 9, 1958

WHAT WE KNOW

● THE FUNCTION of a tire is complex, and the requirements may be diammetrically opposed. The total tire design must effect a compromise of control, stability, comfort, noise, skid resistance, and treadwear characteristics meeting the majority of driving requirements.

For example, a soft sponge-like tread composition with a highly slotted design might be best for skid resistance on some road surfaces, but would wear so fast that any advantage would be quickly lost.

The Effect of Tread Design

The tread design is one of the most effective features of the tire in influencing its resistance to skidding on most common road surfaces when they are wet. Note we are talking about "wet" pavement. The elements of an anti-skid design which contribute to its skidding resistance or increase the coefficient of friction on wet surfaces, are the following, which in effect, reduce the lubricating action of the fluid by removing it.

Grooves. These provide a venting or a void to which the fluid at the interface of the tire and the road can be displaced by the pressure between them. Circumferential grooves can improve the skid resistance from 20 to 100 percent on wet surfaces depending on its coefficient.

Edges. These provide a wiping action over wet road surfaces and more effectively remove the fluid between them and the tire. On extremely low coefficient road surfaces the effect of the wiping action of the edges made with molded slots and cut slits can improve skid resistance up to 100 percent. For most road surfaces in the range of coefficient 0.4 to 0.5 the improvement is 20 to 25 percent.

The extent to which the design features influence the resistance to skidding is summarized in Figures 1 and 2.

The tire industry has made a very marked improvement in skid resistance on wet pavements in recent years by the use of highly slotted anti-skid designs. This is made possible by tread compound improvements which increase the tear resistance and permit the same highly slotted tire to be driven at turnpike speeds for long periods of time without failure.

A comparison between the degree of slotting used in present designs and those of 12 to 15 years ago is given by Figure 3 and Figure 4 for highway-type tires. A similar comparison for mud and snow types is given by Figures 5 and 6.

It should be noted that while relatively large percentage improvements on very smooth low coefficient wet surfaces can be obtained by anti-skid designs or treatments, skidding distances are still very large and hazardous. For example, an improvement of 33 percent in changing the coefficient from 0.3 to 0.4 changes the skid distance at 30 mph only 25 ft from 100 to 75 ft. This is still a very long and hazardous slide, especially if the vehicle cannot be controlled.

The rapid loss of skid resistance on wet surfaces as the tire approaches a worn out condition emphasizes the hazards of operating on such smooth or bald tires.

Figure 7 shows the loss of skid resistance with decreasing anti-skid depth. On the extremely low coefficient surface of wet ice it is found that the edges provided by grooves, slots or slits are effective to approximately 20 or 25 percent.

Now consider dry pavement. On dry pavement the most effective tire is the one having the largest net contact area with the road, that is, the "bald" tire. Grooves or slots, in general, provide edges which tear or decompose with the high temperatures

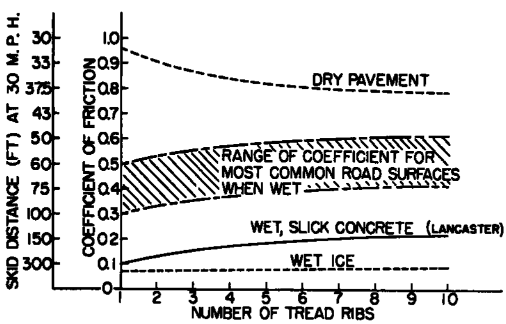

Figure 1. Coefficient vs number of tread ribs; highway-type passenger tires, comparisons at 30 mph.

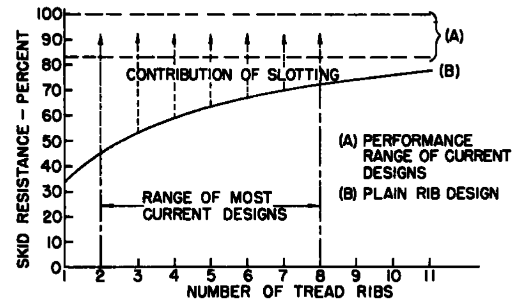

Figure 2. Skid resistance of passenger tires; effect of tread ribs combined with slotting, wet slick concrete (Lancaster test surface).

developed at the interface in dry skidding and this action diminishes the resistance to skidding.

The comparison between the coefficients of friction realized on dry pavements with and without tread ribs on the tire is shown in Figure 1.

Modern mud and snow tires provide an improvement of the order of 25 percent in skid resistance on winter surfaces over present conventional highway types of tires, utilizing the maximum edges, grooves and slots—but at a sacrifice at treadwear. The comparison between the performance of highway and snow type is shown in Figure 8.

Tread treatments of mud and snow tires such as "tractionizing" and the use of corn grit treads are effective in improving skid resistance on winter surfaces by approxi-

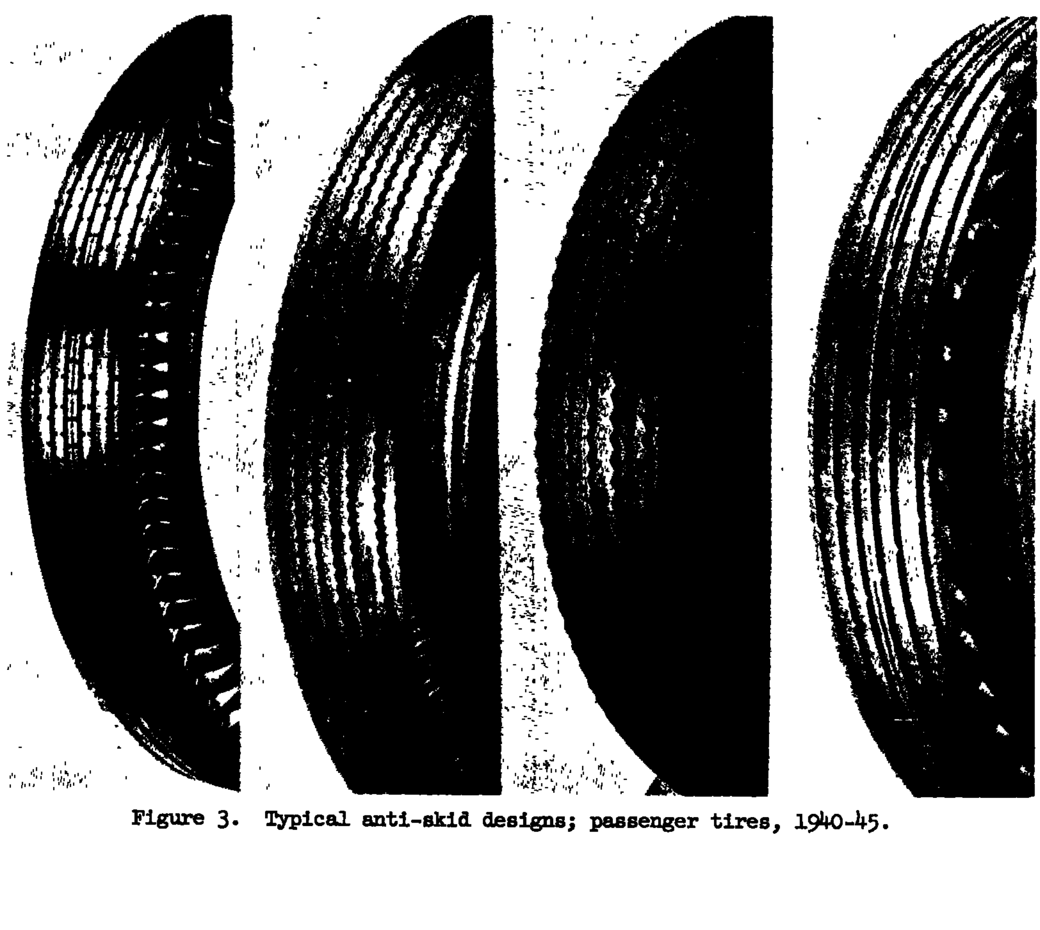

Figure 3. Typical anti-skid designs; passenger tires, 1940-45.

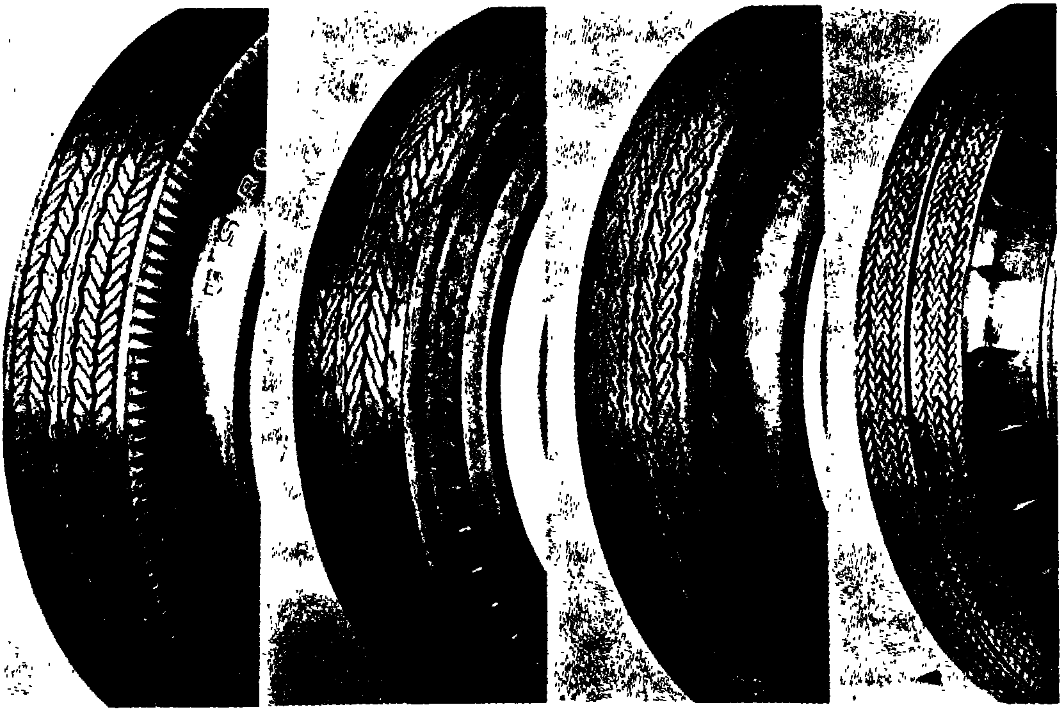

Figure 4. Typical anti-skid designs in passengers tires, 1957-58.

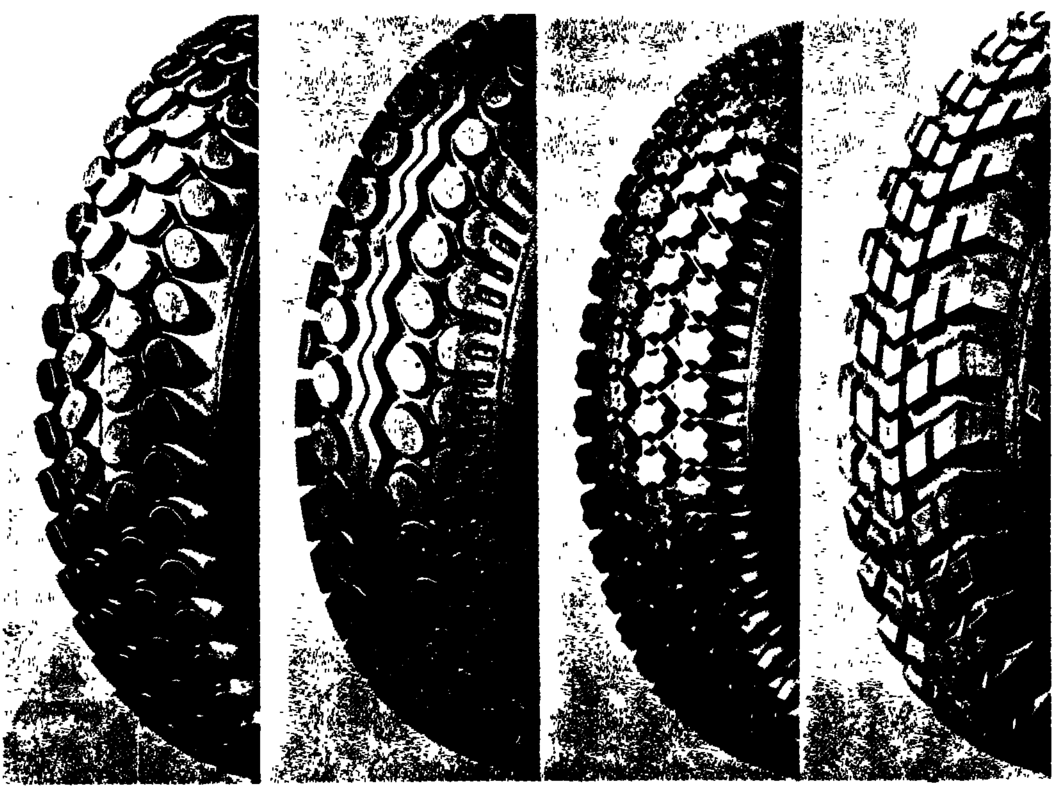

Figure 5. Representative mud and snow tires, 1948-49.

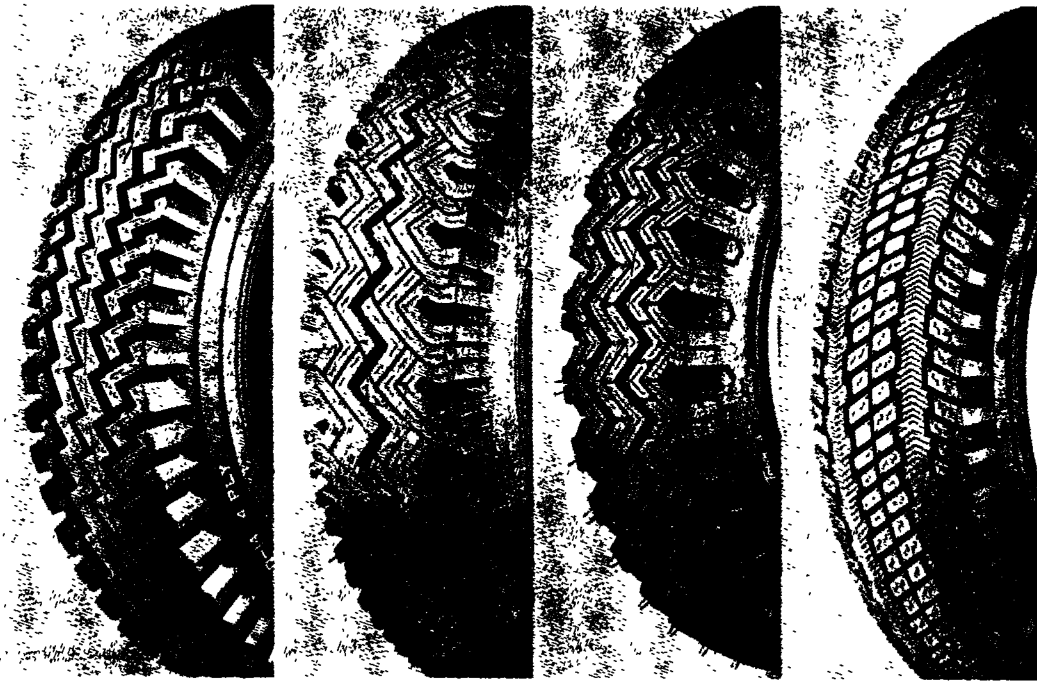

Figure 6. Representative mud and snow tires, 1956-57.

mately 10 percent. These treatments are limited because they can be done only to a degree that does not result in tread tearing and subsequent failure at present day driving speeds.

Typical examples of the tread treatments such as "tractionizing" and "corn grit treads" are shown in Figures 9 and 10.

May we emphasize that poor tire maintenance, causing excessive or uneven wear, such as underinflation and misalignment, can quickly destroy the skid resistance value of any design.

The Effect of Carcass Construction and Tire Size

The data shows the effect of carcass construction features such as cord angle, number of plies; also tire size, does not have a significant effect on skid resistance.

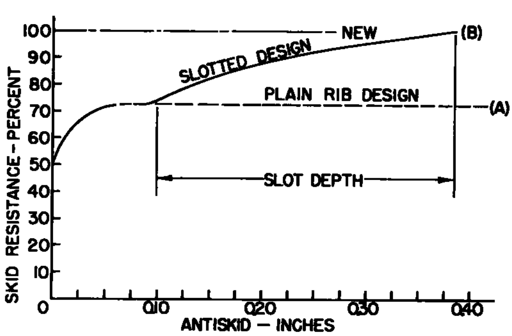

Figure 7. Skid resistance vs anti-skid depth; wet slick concrete (Lancaster test surface).

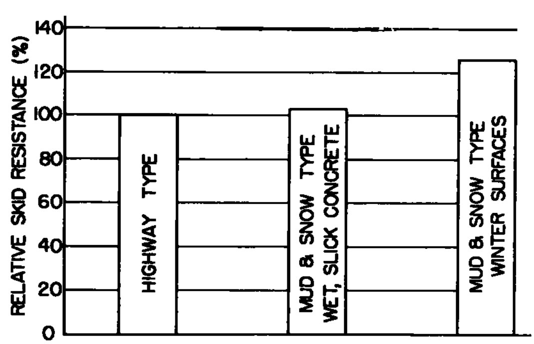

Figure 8. Relative skid resistance; mud and snow vs highway-type passenger tires.

Figure 9. "Tractionized" tread treatment.

The Effect of Tread Composition

The effect of tread composition on skid resistance is very important. However, of equal importance are wear resistance and weathering; ozone, deterioration, and cracking resistance; and low heat build-up, good ride, low noise, stability, etc. Almost without exception, compound alterations which improve one or more of the essential service characteristics adversely affect the others. Further, a compound giving the best skid resistance on dry pavement may not be satisfactory for wet surfaces on ice and snow.

The superior skid resistance of GRS synthetic rubber, which is now the standard in all USA passenger tread compounds, is well established—especially in high speed, locked wheel panic stops on dry surfaces. This is primarily due to the fact that GRS's initial melting point is about 100 deg higher than natural rubber.

Figure 10. Tread stock with corn grits.

Special winter tread rubber provides a substantial improvement in frictional coefficient on ice and snow, as has been pointed out, at an appreciable sacrifice in treadwear.

Effect of Load, Inflation, and Speed

The load and inflation affect the coefficient of friction, but the effect is relatively minor.

Speed and application of power, factors entirely under control of the driver, create forces of enormous magnitude.

Even under the best possible dry road conditions, the tire-road surface reaction may be insufficient for vehicle control.

Certainly on low friction surfaces the available tire-road forces can easily become entirely inadequate.

Under such conditions, there is no choice but for the driver to reduce speed and power factors into a range of safe vehicle control.

NEED

1. A standard skid test tire is necessary to develop and correlate road surface friction measurements.
2. Strictly controlled studies will have to be undertaken to assure that a given type of standard skid test tire will give reproducible measurements on each type of surface friction measuring device, and will produce accurate correlations.

METHODS OF FULFILLING THE NEED

1. Tire manufacturers have a vital interest in skid prevention, the experience, facilities, manpower, and the technology to push forward research in tire-road friction reaction.

Competition has resulted in major progress as demonstrated by new mud-snow designs. This research will continue to produce results.

2. The Technical Advisory Committee of the Tire and Rim Association has authorized this committee to prepare a standard skid test tire specification subject to the approval of the Association. These tires may be manufactured by any member and offered for sale in limited sizes.

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