Effect of Pavement Surface Characteristics on Skid Resistance

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Abstract - *A crucial component of highway safety is skid resistance, which is a result of the frictional force produced at the interface between the tyre and the road surface. Surface texture is one of the many aspects of a pavement's skid resistance that engineers may control. Microtexture of the pavement surface is a result of aggregate asperities, whereas macrotexture is a result of aggregate placement and inclination at the pavement surface. Macrotexture is often assessed using a variety of volumetric and optical methods, with the findings represented as texture or profile depths. Numerous research revealed that the pavement's macrotexture and the aggregate's polished stone value had an impact on skid resistance. The macrotexture values in terms of mean texture depth and skid resistance values in terms of british pendulum number have been computed in this study using the sand patch test and the British pendulum tester respectively. IFI parameters were then calculated using the MTD and BPN values. Finally, a number of findings on the impact of macro- and microtexture on skid resistance have been presented.*

Key Words: **Microtexture, Macrotexture, International Friction Index, Skid Resistance.**

1. INTRODUCTION

A force known as skid resistance is created when a tyre begins to slide and stops rolling on the road surface. Dependent on the mechanical and physical features of the tyre and the surface properties of the road, tyre-road interaction affects how a vehicle drives. It has been discovered that the crash rate lowers as the frictional coefficient rises. Road surface's skid resistance is very essential, especially in rainy situations. A research found that 20% of all road crashes take place in wet conditions.

Road texture refers to the road surface's deviations from a truly plane surface as a result of the randomly arranged surface aggregates and roughness of the surface. Both favourable effects—high skid resistance—and bad effects—discomfort and vehicle wear—can result from the pavement's texture and how it interacts with the tyre. Road's frictional aspects and tyre-pavement noise can both be controlled by adjusting the macro- and microtexture. Macrotexture is mainly affected by the coarse aggregate's gradient, shape and size, whereas microtexture is mainly affected by the aggregate's mineral composition, which further impacts the aggregate's texture and the ability to retain its texture during its interaction with vehicular movement and environment changes leading to aggregate polishing. Skid resistance of pavement also depends on aggregate resistance towards polishing.

In this paper, a correlation between mean texture depth values and british pendulum number (in dry and wet conditions) values with friction values at various slip speeds have been established.

1.1 Objectives

A pavement surface's ability to offer adequate skid resistance for traffic movement in wet weather is a crucial aspect of road safety. Frequent assessments and inspections are necessary to make sure there is sufficient skid resistance availability for safe traffic movements because a skid resistance of a pavement reduces with time as a consequence of moving traffic. It is of ultimate practical significance and uttermost engineering need to be able to provide a thorough and proper analysis and depiction of the pavement's skid resistance in order to ensure traffic safety. The purpose of this study is to examine the effects of road surface micro- and macrotexture on skid resistance. By modifying these road surface qualities, the skid resistance may be regulated.

2. METHODOLOGY AND DATA COLLECTION

Data was first collected for this study at roughly 20 places throughout the Delhi and NCR regions. Two tests have been carried out at each area. Using a British Pendulum Tester (ASTM E 303-93) and Sand Patch test (ASTM E 965-15), the mean texture depth (MTD) and skid resistance (represented as BPN) of the surfaces have been measured. In both dry and wet situations, the skid values have been recorded. Following that, the BPN and MTD data were used to generate the International Friction Index (ASTM E1960-07), which consists of the speed gradient coefficient (Sp) and friction number (F60). In order to determine the impact of road texture on the skid resistance, the MTD and BPN values have finally been correlated to the friction values obtained at various slip speeds.

Fig -1: British Pendulum Tester

Fig -2: Data collection using British Pendulum Tester

Two tests, the sand patch test and the skid resistance test, have been conducted for the purpose of gathering data. British pendulum tester was used to obtain the skid resistance values. Four BPT measurements in a row were recorded in dry conditions at each location. Four successive readings were then recorded to simulate wet weather conditions after applying water to the same region. The pavement's temperature was also measured. The methodology of this study is presented in the the form of a flow chart shown in figure 3.

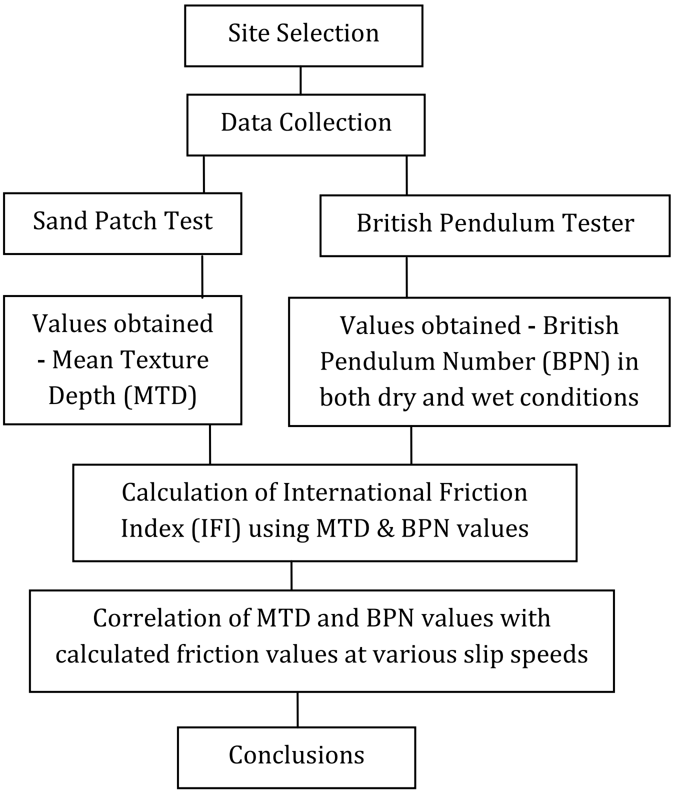

Fig -3: Study Methodology

Fig -4: Sand Patch Test

Table -1: Friction values for various slip speeds for the locations selected

F10	F20	F30	F40	F50	F60	F70	F80	F90	F100
0.58	0.52	0.46	0.41	0.37	0.33	0.30	0.27	0.24	0.21
0.53	0.48	0.44	0.40	0.37	0.33	0.30	0.28	0.25	0.23
0.61	0.55	0.50	0.45	0.41	0.37	0.34	0.30	0.28	0.25
0.53	0.48	0.44	0.39	0.36	0.32	0.29	0.26	0.24	0.22
0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16
0.60	0.56	0.51	0.47	0.43	0.40	0.37	0.34	0.31	0.29
0.58	0.52	0.46	0.40	0.36	0.31	0.28	0.25	0.22	0.19
0.75	0.72	0.70	0.68	0.66	0.64	0.62	0.60	0.58	0.56
0.72	0.54	0.40	0.30	0.22	0.17	0.12	0.09	0.07	0.05
0.54	0.48	0.43	0.39	0.35	0.31	0.28	0.25	0.22	0.20
0.57	0.52	0.47	0.43	0.39	0.36	0.33	0.30	0.27	0.25
0.48	0.45	0.41	0.38	0.35	0.32	0.30	0.27	0.25	0.23
0.50	0.45	0.40	0.35	0.31	0.28	0.25	0.22	0.20	0.18
0.73	0.56	0.43	0.33	0.25	0.20	0.15	0.12	0.09	0.07
0.56	0.48	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14
0.53	0.48	0.44	0.39	0.36	0.32	0.29	0.26	0.24	0.21
0.59	0.56	0.53	0.51	0.48	0.46	0.44	0.41	0.39	0.37
0.62	0.55	0.49	0.43	0.38	0.34	0.30	0.27	0.24	0.21
0.61	0.56	0.51	0.47	0.43	0.39	0.36	0.33	0.30	0.28
0.57	0.52	0.47	0.43	0.39	0.36	0.33	0.30	0.27	0.25

Table -2: Correlation coefficients between MTD and BPN (dry and wet) values and friction values at various slip speeds

R^2	F10	F20	F30	F40	F50	F60	F70	F80	F90	F100
MTD	0.03	0.42	0.76	0.86	0.89	0.90	0.91	0.93	0.94	0.95
BPN (Dry)	0.68	0.38	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00
BPN (Wet)	0.65	0.99	0.83	0.63	0.51	0.45	0.42	0.40	0.39	0.39

Sand from Kunnur (Tamil Nadu), which was allowed to pass through a 300-micron sieve and be held on a 150-micron sieve, was used for the sand patch test (MORTH 5th REVISION). The road surface was subjected to receive 25 ml of sand at each place, which was then spread with a spreading tool into the shape of a circle. The circle's diameter was then measured at four different points on the circle.

3. DATA ANALYSIS AND RESULTS

The MTD and BPN values (in wet conditions) were used to calculate the speed gradient coefficient Sp, adjusted values of friction at 60 kmph FR(60), and friction number F60 for the International Friction Index (IFI). As indicated in table 1, the friction values at different slip speeds were estimated using the calculated friction values for slip speed 60 kmph (F60). The table makes it very evident that the value of friction reduces as speed rises. Additionally from table 2, MTD is observed to have a weak link with friction values at lower speeds, but a strong correlation with friction values at higher speeds. This demonstrates how macrotexture affects the pavement's ability to resist skidding at high speeds. Figure 6 depicts the graph for correlation between MTD and F60 values.

Due to the instrument's low speed and the dry pavement, the BPN readings in dry conditions are closely linked to microtexture. It is displaying a moderate correlation for low speed, pointing to the role of microtexture at low speed and dry conditions. Figure 7 depicts the graph for correlation between BPN (Dry condition) and F10 values.

According to table 2, the correlation between wet BPN readings and computed friction values increases for slip speeds between 10 and 20 kmph before diminishing. Overall, there is a medium to stronger correlation between the BPN values (in the wet situation). It can be said that if pavements exhibit greater BPN values when they are wet, larger friction values will likewise be observed.

Fig -5: Data collection using Sand Patch Test

4. CONCLUSIONS

The pavement's capability to withstand sliding has a significant impact on the driver's ability to control a vehicle's movement in situations that could endanger their safety. Values for skid resistance change over time and are impacted by a number of factors. The values normally fall as road usage duration increases because with time the road roughness deteriorates and smooths out. Increased levels of skid resistance are often found in the fall and winter, while rainfall and seasonal variations also have an impact. Since it affects road safety, it's essential to ensure an acceptable degree of skid resistance by controlling the influencing elements that may be governed: the condition of the road and the roughness of the road surface. According to this, road agencies must evaluate the pavement's condition in terms of skid resistance in order to guarantee a sufficient level of road safety. To provide optimal skid resistance on the roads, it is essential to maintain a suitable macrotexture and microtexture on the road surface.

The findings from this investigation are summarised in the following lines–

1. Lower speeds are indicating a weak relation between the mean texture depth values and friction values, whereas higher speeds are showing a strong correlation. This demonstrates how macrotexture affects the pavement's resistance to skidding at high speeds.

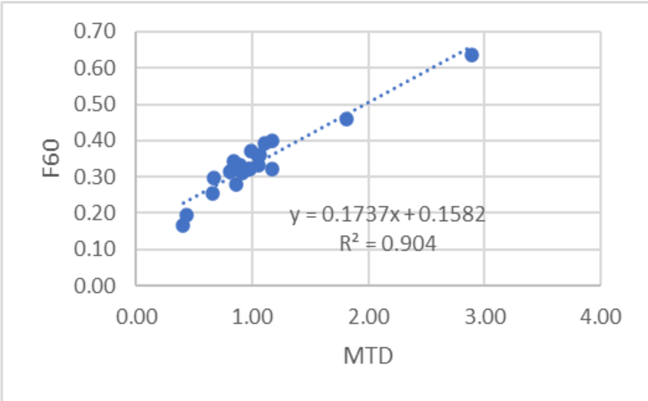

Fig -6: Graph for correlation between MTD and F60 values

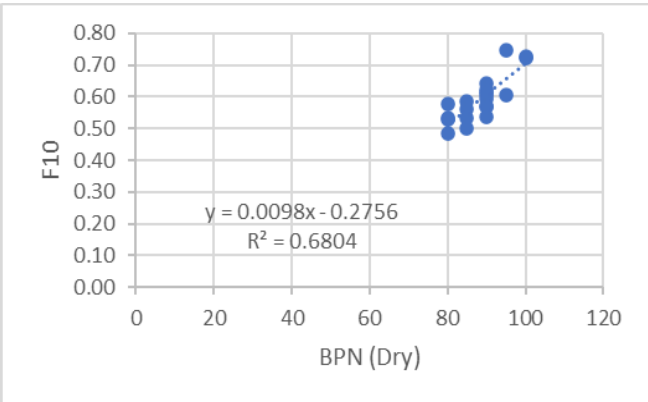

Fig -7: Graph for correlation between BPN (Dry) and F10 values

2. As the instrument (BPT) is having a slow pace and the road surface is dry, the BPN measurements in dry conditions are closely related to microtexture. It is displaying a moderate correlation for low speeds,

pointing to the role of microtexture at low speeds and in dry conditions.

3. In wet conditions, there is a first growing (between 10-20 km/h) and then a decreasing relation between BPN readings and computed friction values. Overall, the BPN values (in wet situation) exhibit a moderate to strong relation. So, it can be said that the obtained friction values will likewise be higher with higher BPN values.

Other variables, such as traffic volume, weather, and water film thickness, may be taken into account for more precise predictions. Additionally, larger data sets could be gathered to obtain stronger correlation.

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