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EVALUATION OF SURFACE CHARACTERISTICS OF ROAD PAVEMENTS FOR TRAFFIC SAFETY ANALYSIS

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ABSTRACT

The Pavement's wearing course has the function of assuring a safe, comfortable and economic travel to its users. To fulfill that purpose it is necessary that its functional properties, such as the coefficient of friction and texture depth, present good levels, especially in adverse weather and drivability conditions. In the last few years it has been given a greater importance to the pavement's surface characteristics, resulting in the improvement of asphaltic material's performance and in the arising of new techniques. Two practical case studies are presented: one concerning the application of anti skid surfacing, where surveys were made to evaluate the functional properties of the wearing course, and another with the purpose of analyzing the coefficient of friction before and after the improvement with shot blasting. From the analysis of the results, it is clear the improvement of the functional properties (coefficient of friction and texture depth) in comparison with standard bituminous concrete pavement. Therefore it is possible to conclude that both solutions introduce gains in skidding resistance, allowing pavement to be safer.

This project deals with the evaluation of surface characteristics of road pavements for traffic safety analysis. To fulfill that purpose it is necessary that its functional properties, such as the coefficient of friction and texture depth, present good levels, especially in adverse weather and drivability conditions.

Keywords: Surface Characteristics, Bituminous Concrete, Skid Surfacing.

I. INTRODUCTION

The road user wants a level where they can drive safe and secure. This wants a pavement structure with enough stiffness, a fast run-off from the rain, an honest level, an honest level, an honest reflection of sunshine at the level and a restricted production of noise among the contact space between the vehicle tyre and additionally the level. These properties got to rather be gift throughout associate extended quantity of some time, e.g. throughout the time period of the pavement structure. Among consecutive paragraphs the desired level characteristics area unit mentioned.

1.1 Skidding Resistance

A vehicle is in a position to drive on a road attributable to the friction within the contact space between the tyres and therefore the paved surface. The skidding resistance is outlined because the friction constant measured in line with a homogenous methodology. The friction force between the rubber tyre and therefore the paved surface could also be composed of three elements, which are:

- The adhesion or stick element that happens through molecular attraction between the tread of the tyre and also the paved surface. On a dry paved surface this element is that the most significant one. This element decreases with increasing texture of the paved surface.
- The physical phenomenon or deformation part that happens through deformations of the tyre. This part will increase with the texture of the paved surface and it's the foremost vital part on a wet paved surface.
- The cohesion or wear part that happens through the resistance of the rubber against breaking of the interior coherence.

1.2 Influencing Factors

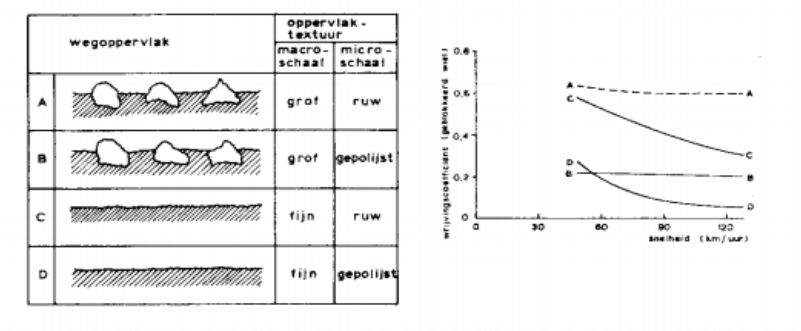
The most important factors that affect the friction coefficient are:

1. Road surface,
2. Tyre,
3. Weather conditions,
4. Vehicle speed,
5. Wheel slip and drift angle.

1.2.1 Road Surface

The texture is that the geometry of the paved surface. 2 texture scales area unit distinguished, i.e. a macro scale and a small scale. The feel at macro scale is needed to get rid of on a wet paved surface, particularly at higher vehicle speeds, the water from the contact space between the tyre and therefore the paved surface.

The macro texture is decided by the dimensions of the mixture particles at the paved surface. The small texture is decided by the roughness and angularity of the surface of the mixture particles. The small texture ensures the removal 232 of the last traces of water from those locations wherever high contact pressures between the mixture and therefore the tyre area unit gift.



Different road surface textures

1.2.2 Tyre

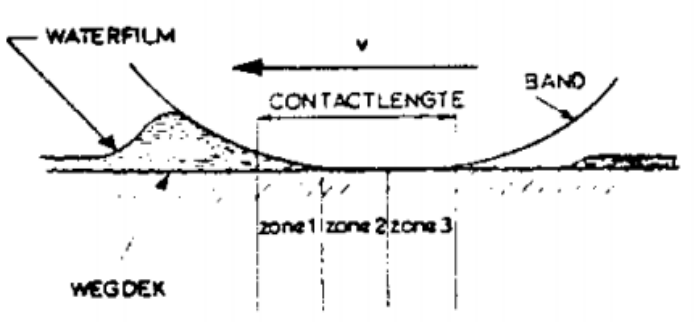
The tread of luxury automotive tyres is mostly fabricated from rubber. Compared to natural rubber the rubber yields a bigger friction constant owing to a bigger adhesion and physical phenomenon. The disadvantage of the rubber is additional development of warmth. For economical reasons (less wear) truck tyres are sometimes fabricated from natural rubber. The tread of the tyre ought to have such a profile that the water within the contact space between the tyre and therefore the paved surface will disappear quickly. Each the form and therefore the depth of the tyre profile are relevant.

1.2.3 Weather Condition

At skidding resistance measurements it's assumed that owing to winter maintenance the paved surface is freed from snow and ice. The influence of precipitation manifests itself as a decrease of the skidding resistance and therefore the risk for aquaplaning. Aquaplaning is that the development that a driving vehicles on tyres looses contact with the paved surface (as there remains a skinny layer of water within the whole 'contact' space between the tyres and therefore the road surface) through the 234 high vehicle speed, the thick water layer on the paved surface and therefore the scant tyre profile. Schematically shows however a rubber tyre rolls or slides over a wet paved surface. Three zones square measure distinguished:

1. Zone one (no contact),
2. Zone a pair of (local contact) and
3. Zone three (dry contact).

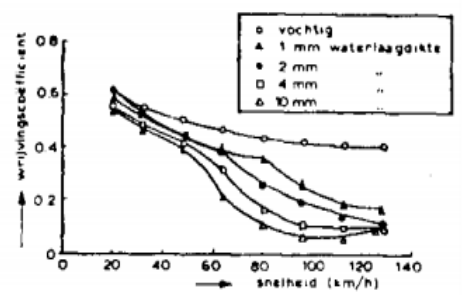
Once zone one enlarges the friction constant decreases, finally leading to aquaplaning. This impact is intense if a standing wheel is delivered to rotation terribly quickly; this happens at a landing craft wherever the development of aquaplaning was determined first. zone one enlarges the friction constant decreases, finally leading to aquaplaning. This impact is intense if a standing wheel is delivered to rotation terribly quickly; this happens at a landing craft wherever the development of aquaplaning was determined 1st.



Schematic representation of a rolling tyre on a wet road surface

1.2.4 Vehicle Speed

On a dry paved surface the influence of the speed of the wheel (vehicle) on the friction constant generally is restricted. However, on a wet paved surface the friction constant powerfully decreases with increasing vehicle speed and increasing thickness of the water layer. The friction constant only becomes larger if the driving force slows down or if the thickness of the water layer decreases (e.g. through a larger cross-fall).



The relationship between the friction coefficient and the vehicle speed as a function of the thickness of the water layer (100% wheel slip, profiled radial tyre, concrete road with a fine texture)

1.2.5 Wheel Slip and Drift Angle

A wheel will be braked off in such the simplest way that entirely forces within the longitudinal direction occur within the contact space between the tyre and also the paved surface. If w1 is that the rotary speed of the braked wheel and ω0 is that the rotary speed of a strictly rolling wheel, then the share of wheel slip is ((W0-W1)/W0)×100. The magnitude of the longitudinal force varies with the share of wheel slip. A braking wheel also can have a supposed drift angle with the direction of travel (e.g. braking in an exceedingly curve). The occurring transverse braking forces square measure enthusiastic about the magnitude of the drift angle.

II. LITERATURE REVIEW

Farnsworth evaluated the consequences of pavement shaping on five sections of CA highways. Farnsworth measured the coefficients of friction before shaping and when shaping and located that pavement shaping enhanced the coefficients of friction, ever-changing the friction values from below essential to on top of essential. Analysis of accident information unconcealed a discount in wet-pavement accidents at every of the sites.

Neumann et al. discuss normally terms specific countermeasures that will be enforced to enhance skid resistance. These could embody changes to the pavement aggregates, adding overlays, or adding texture to the pavement surface. They state that the effectiveness of the step not solely depends on the live hand-picked, however conjointly varies with relevance location, traffic volume, rain propensity, road pure mathematics, temperature, pavement structure etc. They indicate that once choosing sites for skid resistance programs, it's vital to somehow management for the quantity of wet-pavement exposure.

Torbic et al. discuss pavement shaping. Pavement shaping could be a technique by that longitudinal or crosswise cuts are introduced on a surface to extend skid resistance and to scale back the amount of wet-weather crashes. The grooves increase skid resistance by rising the voidance characteristics of the pavement and by providing a rougher pavement surface. Many studies showed that grooved pavements scale back wet-weather crashes between fifty five and seventy two p.c though the analysis strategies applied don't seem to be thought of progressive by today's standards.

Zipkes. Analyzed the frequency of accidents and therefore the share of accidents on wet and dry pavement surfaces throughout a 7-year amount to gauge the result of pavement shaping. Accident information was obtained for a 44-km (27-mi) section of main road close to Geneva, European country. Cross wise grooves were

taking the pavement with varied groove distances over a 2-km (1.2-mi) section of main road. shaping of the polished road surfaces reduced the hazard of accidents once voidance conditions were unfavourable. Zipkes indicated that the advantage of shaping is that the reduction of water-film thickness, that ends up in higher contact between the tire and therefore the paved surface for the transmission of forces.

III. METHODOLOGY

3.1Initial Considerations

Asphalt mixtures applied in sporting course act as structural and purposeful prevailing the purposeful characteristics (coefficient of friction, texture depth, evenness and tire-pavement noise) once concerning a safe and comfy travel. There has been a development in asphalt mixtures and new techniques of pavement's purposeful rehabilitation in recent years, with the aim of up the pavement performance.

In Portugal the a lot of common asphalt mixtures for versatile sporting courses are hydrocarbon concrete, porous asphalt concrete, friction asphalt concrete and ultra- thin asphalt concrete layer, being application of the hydrocarbon concrete the foremost generalized. With the intent of up existing hydrocarbon concrete the foremost generalized. With the intent of up existing hydrocarbon's properties afterward emerged the changed bitumen with polymers, most ordinarily utilized in porous and friction asphalt concrete. A lot of recently it return up the modified hydrocarbon with rubber (MRB), used principally in friction asphalt concrete and open texture surfaces By comparison the constant of friction values of a hydrocarbon concrete with different wearing courses (Table one.1), these last typically present minor results, with the consequence that these days, in new roads, and bituminous concrete has been replaced by different techniques that offer higher purposeful performance.

Examples of coefficient of friction results on roads, measured with "grip-tester" (50 km/h; 0.5mm film of water):

Wearing course type	Conditions	GN
Bituminous concrete	3 -8 years in services	0.40 – 0.70
Porous asphalt concrete	New	0.80 – 0.90
Open textured mixtures with MRB	5 years in service	0.60 - 0.70
Friction asphalt concrete layer	3 – 8 years in service	0.50 – 0.65

New techniques, like anti-skid regression and shot blasting, originate necessary edges in tire/ pavement adhesion, in decrease wear, followed by quicker and fewer high-ticket applications, providing these approach better results.

3.2 Anti-Skidding Emergence Case Study

Anti-skidding emergence could be a technique applied on pavement's sporting course, not being necessary any structural intervention, if the structure is in smart conditions. This is often a straightforward application technique and when mistreatment alternated lanes, it ends up in minimum constrains of traffic.

In European nation, the anti-skidding emergence could be a recent technique developed to boost tire/pavement adhesion. In alternative countries, like the uk, this pavement is employed to forestall accidents, and it's certified. Due to the great results obtained once resisting skidding, the anti-skidding emergence may be a decent solution in areas at risk of accidents or probably dangerous so as to cut back accidents. Increasing the constant of friction, the tire-pavement adhesion improves, preventing loss of management and diminishing accidents.

3.3 Site work description

To study the anti-skidding emergence experiments were conducted on two Hyderabad municipal roads wherever this technique was applied: EM 603 and EM 539-2. EM 603 connects Uppal x road and Nagole has two lanes, one in every direction, low traffic flow and hydrocarbon concrete sporting course. The applying of the anti-skidding emergence was created in September 2007, on an extension of concerning 350m, primarily in curve. The prevalence of accidents light-emitting diode Hyderabad municipal council to intervene, deciding to use this anti-skidding emergence to reduce the quantity of accidents that happened within the curve. The most reason for the registered accidents was speed in excess, considering the sort and also the pure mathematics of the road.

The second case study is concerning the EM 539-2, located between Taranaka and Lalapet the application of the anti-skidding emergence was created in might 2008. Just like the pervious case, the pavement on that this resolution was applied as a hydrocarbon concrete.

This road has two lanes, one in every direction, once more primarily curve. Concerning 100 m when the curve within the Taranaka direction there is a pedestrian's crossway. The new pavement was an invitation of Hyderabad municipal council to enhance vehicle adhesion to the pavement, increasing friction within the curve and close to the pedestrian's crossroad, to forest all accidents.

The roadway in between Uppal x road and Nagole

The roadway in between Taranaka and Lalapet

However, one considers that the appliance on the pavement ought to are extended for a few more meters, up to the pedestrian's intersection within the direction to extend friction, reducing the breaking distance, still as within breaking distance, still as within the other way, wherever the anti skidding emergence ought to begin before the curve initiates, for a flight with higher adhesion. By observation it absolutely was terminated that this road includes a high traffic flow, of that a substantial proportion area unit significant vehicles.

In each sites the appliance of the anti skidding emergence was created cold and by hand. The anti skidding emergence was applied on the asphalt pavement, employing a two component ployure than resin and a granite combination with an excellent size appliance of, each with red color, being the ensuing thickness four millimeter

Application of the anti skidding surfacing to the pavement

3.4Tests

This project purpose is to gauge the useful properties of the opposed skidding emergence by measurement coefficient of friction and texture's depth victimization normal ways. The instrumentation that was used was made on the market. To live the constant of friction Brits setup was used and to determinate the feel depth was created the sand patch test. In every section were created two tests with every equipment within the right wheel path rut, where the friction includes a tendency to be unfavorable owing to the traffic, and within the middle of the lane for comparison.

The survey on EM 603 was created seven months when the appliance of the anti-skidding emergence. Three segments were chosen for tests: the primary one situated on the pervious hydrocarbon concrete, simply before the opposed skidding emergence, as a illustration of existing conditions before the appliance of pavement; the opposite two were conducted on the opposed skidding emergence in numerous road pure mathematics conditions – one in an exceedingly straight alignment and therefore the different one in an exceedingly curve. Each tests were conducted in Uppal x road and Taranaka roads were conducted in direction, that corresponds to the curve's side.

Sand patch test results of Uppal x road and Nagole road:

		Friction (PTV)	Temperature (^{o}c)	Corrected friction (PTV)	Texture (mm)
Old pavement	Rut	0.60	20	0.59	0.75
	Half of lain	0.55	18	0.52	
Anti skid surf. Str. Line	Rut	0.80	16	0.68	1.68
	Half of lain	0.82	18	0.69	1.50
Anti skid curve	Rut	0.84	20	0.72	1.45
	Half of lain	0.82	22	0.70	1.30

In EM 539-2 were chosen 3 points for trials (5 m except every other) all of them within the portion of the road with the anti skidding emergence. It wasn't doing able to conduct any tests on the curve, due to high traffic flow and poor visibility. These tests were created two months when the appliance of the new pavement. The selection to perform three tests in zones with similar characteristics served to amplify the sample and manufacture additional consistent conclusions.

Sand patch test results of Taranaka and Lalapet road:

		Friction (PTV)	Temperature (^{o}c)	Corrected friction (PTV)	Texture (mm)
Anti skid surf. Str. Line 1st point	Rut	0.77	30	0.80	1.75
	Half of lain	0.8	32	0.82	
Anti skid surf. Str. Line 2nd point	Rut	0.67	34	0.77	1.75
	Half of lain	0.75	30	0.70	
Anti skid surf. Str. Line 3rd point	Rut	0.74	32	0.76	1.75
	Half of lain	0.73	36	0.74	

Analysis of the results

From examining, it's evident the coefficient of friction increment once the application of the opposed skidding regression the bituminous concrete. Contrary to what would be expected, one will see that friction on the wheel path rut space isn't forever under within the middle of the lane, which can flow from to drivers mechanical phenomenon. The same justification is equal to the bituminous concrete a result of the tests were conducted close to an intersection and therefore the wheel path rut wasn't well outlined. By examination the tests results with the reference values for the constant of friction referred within the Portuguese specifications Manual of Roads (0,55 PTV) (EP, 1998), one verifies that friction on the pervious pavement was below minimum suggested values.

The applying of the new pavement shows good results, with values twenty fifth beyond the reference. If examination with the pervious pavement, the anti skidding regression brought an improvement of roughly v-day within the wheel path rut section and 500 in the middle of the lane, that represents respectable results. The surface properties of the EM 539-2 were evaluated within the starting of its usage, when pavement was two months previous, where as EM 603 trials were conducted 7 months once gap to traffic. It shows a twelve-tone system distinction between the two things, which may be explained by the five months amount between the two applications.

IV. CONCLUSION

From the analysis of the two study cases, one concludes that in each situations there was a considerable improvement of the pavement's useful properties (coefficient of friction and texture depth), when comparing with the existing hydrocarbon concrete. The is truth diode to the thought that opposing skidding surfacing and shot blasting constitutes smart solutions to improve tire/pavement adhesion conditions and during this method facilitate pavement become safer.

Friction and texture depth values that were obtained in tests once the enhancements area unit way superior to the Portuguese specifications in roads. It absolutely was potential to verify that in each cases constant of friction and texture depth previous to the interventions already respected stipulated limits, that will mean that reference values area unit low hard in things where risk of accident by skidding is higher (small radius curves, descendent gradient or approaching to pedestrian crossroads).

One verifies that texture depth increase sometimes corresponds to friction increases, as a result of it improves pavement's macro texture. Comparing with the results of different sporting course solutions, these two techniques might deliver the goods way superior skidding resistance results.

In Portuguese republic there area unit different sporting course answers that show smart useful properties – porous asphalt concrete, mixtures with changed rubber bitumen and friction asphalt concrete mixtures. It is necessary, however, to monitor frequently the pavement to judge long term behaviour, facing traffic and adverse climatic conditions.

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