Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 91 (2014) 459 – 463

Procedia Engineering

www.elsevier.com/locate/procedia

XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP) (TFoCE 2014)

Comparison of the Skid Resistance at Different Asphalt Pavement Surfaces over Time

Peter Kotek[a]*, Zuzana Florková[a]

[a]*Department of Highway Engineering, Faculty of Civil Engineering, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia*

Abstract

One of the basic safety requirements on roadways is the skid resistance. It plays very important role especially during wet and rainy conditions. It is a pavement surface characterization which describes interaction between vehicle wheel and road surface. Mainly insufficient skid resistance or its complete loss is a reason of slippery roads and therefore risk of traffic accidents rises. The article is concerned with examining varying values of skid resistance on selected long-time monitored road parts with different asphalt wearing courses in Slovakia.

Peer-review under responsibility of organizing committee of the XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP)

Keywords: skid resistance; pavement surface; macrotexture; microtexture; asphalt mixture

1. Analysis of friction properties

Friction on pavement surface plays an important role in keeping a vehicle safe on the pavement surface. It can dramatically influence braking distance and so contributes to safety of traffic. Friction on pavement surface is a force which obstructs relative movement between a tyre and a pavement surface. It can be also defined as a friction force rising in a contact area of tyre and pavement created due to vehicle motion. In other words, we can say that it is characterized as resistance against sliding of a wheel on a pavement surface. It is concerned about tangential reaction of pavement serving for transfer of driving force or brake force on the perimeter of a wheel. This resistant force is showed in figure 1.

The force can be described by non-dimensional coefficient of sliding friction, which is defined as a relation of tangential friction force F_T and normal force F_W between rubbers tread and pavement surface [1].

* Corresponding author. Tel.: + 421 41/ 513 5930; fax: + 421 41/ 513 5510.
E-mail address: peter.kotek@fstav.uniza.sk.

Peer-review under responsibility of organizing committee of the XXIII R-S-P seminar, Theoretical Foundation of Civil Engineering (23RSP)
doi:10.1016/j.proeng.2014.12.026

$$f = \frac{F_T}{F_W} \tag{1}$$

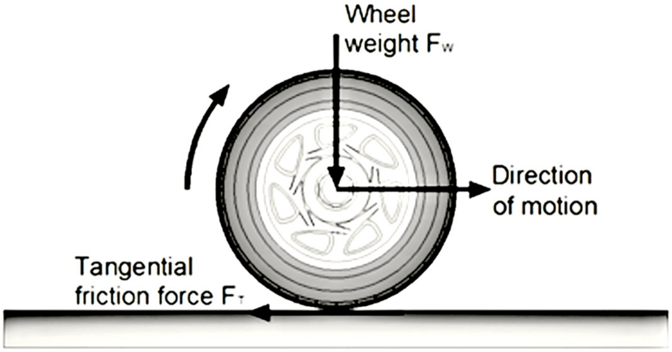

Fig. 1. Scheme of forces acting on rotating wheel.

A texture has the biggest influence on the skid number. It is a morphological order of pavement surface material. From the geometric point of view, the texture is created by shape of small prominences, depressions of cracks and irregularities. The texture is a basic element of interaction between tyre and pavement. It is set by microtexture of aggregate surface and macrotexture of pavement surface [2].

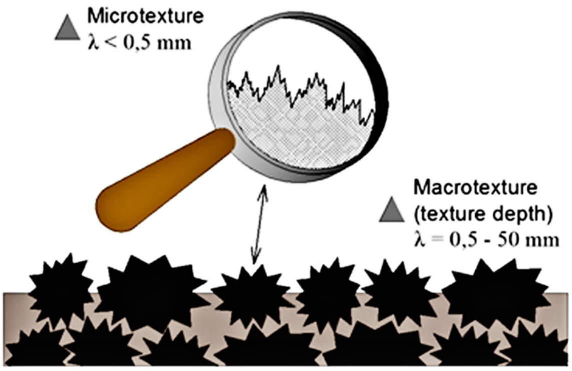

Fig. 2. Texture of pavement surface and differences between macrotexture and microtexture.

Microtexture of aggregate surface ensures elementary friction level and is important on dry surface at low speeds (up to 40 km/h). It reflects tiny prominences on aggregate grains and describes how the grains are smooth or rough and therefore the friction between a tyre and a pavement surface rises. Microtexture values are partially influenced by ability of aggregates to keep sharp edges and also a rough surface which should resist smoothing of vehicles as long as possible. Microtexture partially depends on structure of asphalt mixture either maximum grain size, amount of fine aggregates or content and type of bitumen.

Macrotexture of pavement surface is responsible for basic drain ability of pavement. It represents irregularities on pavement surface and describes a way in which single aggregate grains are ordered. Macrotexture is important for fast water diversion from a surface of wet pavement because the water acts as a lubricant and it shows in the friction between a tyre and a pavement. Macrotexture plays a serious role at middle and higher speeds of vehicle (over 40 km/h) [3].

Aspects influencing friction:

- geometric skid resistance of the pavement,
- tyre type and state (size, tread profile, tyre pressure rating),
- speed of vehicle (adequate).

Important features connected with the first aspect are characteristics of asphalt mixture used in a pavement wearing course and a laying technology of the layer. To reach positive skid resistance and its long-term persistence under traffic physical features of used aggregates in a wearing course are indispensable. Two material characteristics of vehicle tyre rubber are important. On one side it is rubber hardness and on the other side it is tyre behaviour by deformations. A tread design is usually used for water diversion from a contact surface of tyre. It is important especially on wet pavement surfaces with a smooth texture. A size of the contact surface and eventually a volume of forced out water depends on a tyre pressure. The higher inside pressure is, the smaller tyre track is [5].

Time of contacting tyre with a pavement surface gets shorter at higher speeds. This might have crucial influence on safe movement of vehicle from the sliding point of view. The coefficient of sliding friction on dry and also wet pavement surfaces decreases with speed rising.

2. Data analysis

The article concerns a long-term monitoring of friction coefficient on different asphalt pavement surfaces. Analyzed sections belong to a group of long-term monitored sections of Slovak Road Administration. The sections are situated in different specific conditions (traffic load, type of asphalt…):

a) The section Chocholná is situated on the highway D1 between Trenčín and Drietoma and was opened for traffic with SMA 11 wearing course in 1997.
b) The section Budimír is situated on the highway D1 between Prešov and Košice and was opened for traffic with AC 16 wearing course in 1988.
c) The section Žilina STK is situated on the road I/18 between Žilina and Nová Mojšová Lúčka. New AC wearing course was laid in 1992.
d) The section Šášov I/50 is situated on the road R1 between Kremnica and Zvolen. In 1993 the wearing course material was changed to asphalt AC II.

Measurements of the longitudinal friction on the sections have been performed by the measuring device Skiddometer BV11since 1998. Outcome of measurements is the value Mu. The measuring device consists of the single trailer pulled by delivery truck with the opened landscaped tipping body for transporting the equipment and a water tank. The device allows measurement of the longitudinal friction by recording shear resistance using independent measuring wheel with slip ratio of 17% [5].

The monitored sections have approximately the same length. Fluctuating of the *Mu* values in single years and their trend in the section Budimír D1 is shown in figure 3.

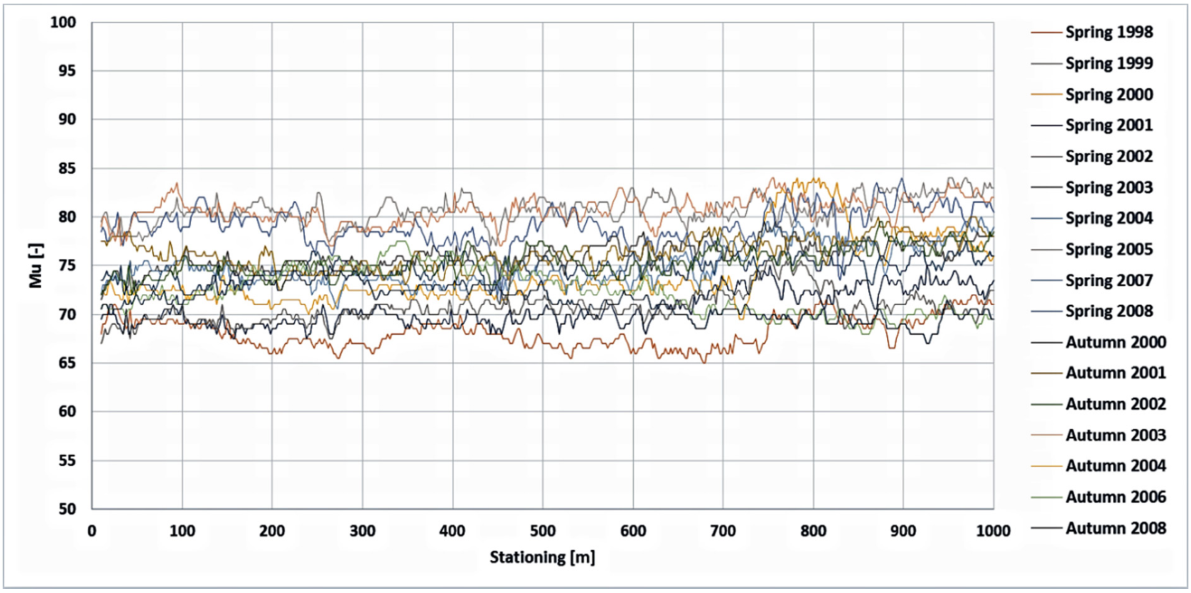

Fig. 3.Mu values trend of the long-term monitoring section of road Budimír D1 – PO from 1998 to 2008.

To compare values of longitudinal friction measurements the speed approximately 80 km/h have been chosen from the measurements performed during past years. The figure 4 shows the progress of Mu values of the section Chocholná D1 with measurements at approx. the same speed and with air temperature measured 20 cm above the surface.

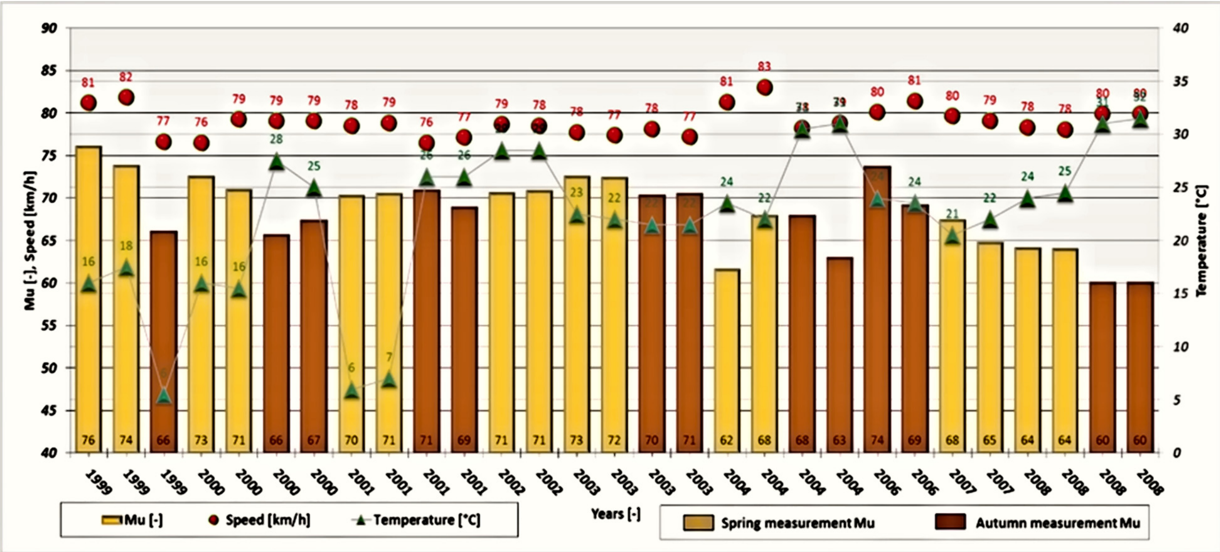

Fig. 4. Mu values in the section Chocholná D1 with the surface SMA 11 1999-2008 together with speed and temperature.

When comparing the values of longitudinal friction in the sections it was not proved any dependency between the values of single surfaces and temperature. Approximately same Mu values were reached at different temperature levels. The situation could be caused by circa the same temperature levels of the water in the Skiddometer tank.

When comparing Mu values in relation to different speed levels there was proved no clear dependency too. The comparison is not definite because the speed of Skiddometer was circa constant but the measurements were performed in long-time distances. The dependencies are also affected by not keeping to the many minor terms.

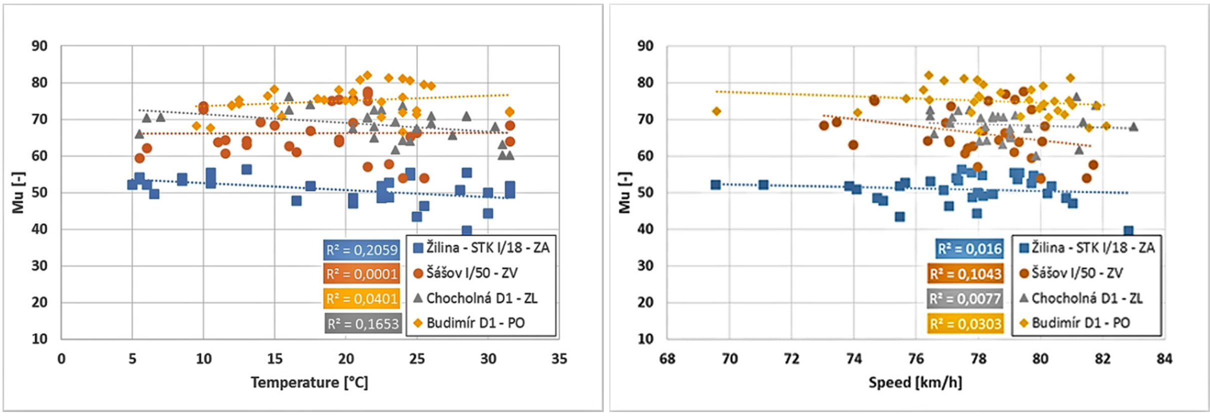

Fig. 5. The dependencies of longitudinal friction from temperature and speedin the sections.

The values of longitudinal friction in the sections during the selected time were changing after filtering off wrong measurements using statistical methods and after dividing them according to the mixture type:

a) Variability of Mu values for SMA11 in the section Chocholná from 1999 to 2008 ranged between 60-76 points which creates variation interval of 16 points.
b) Variability of Mu values for the mixture AC II in the section Šášov from 1998 to 2008 ranged between 54-78 points which creates variation interval of 24 points.
c) Variability of Mu values for the mixture AC in the section Žilina STK v from 1998 to 2008 ranged between 40-56 points which creates variation interval of 17 points.
d) Variability of Mu values for the mixture AC 16 in the section Budimír from 1998 to 2008 ranged between 67-82 points which creates variation interval of 15 points.

There was not proved distinct dependency about decreasing values over time in all sections. The dependency between friction and time of putting pavement surface into practice was not showed and also no dependency was found between friction and type of mixture. The analysis only resulted in slight influence of temperature on the measured values. It is noteworthy that there is allowed speed over 80 km/h in the sections while the proper value of longitude friction is between 53-68 points and the required friction was not always reached in some sections.

3. Conclusion

To ensure safety on roads it is necessary to pay more attention on skid resistance monitoring as one of variable parameters. The article highlights the fact that skid resistance measurement demands great accuracy because of many minor conditions, which cannot always be eliminated. Direct characteristics affecting the coefficient of friction are age of wearing course, traffic intensity, and climatic conditions of section. Other characteristics influencing measured values of the coefficient of friction include speed, temperature, tyre, tyre pressure, season, state and type of road surface, the same measurement track. The analysed results show the fact that the value of the coefficient varies over time and it is not possible to describe definite dependency of the coefficient on traffic intensity. To know current state, it is necessary to measure and evaluate skid resistance according to valid technical regulations. Then the adequate conclusions can be made and road managers can effectively use financial funds.

Acknowledgement

The paper is a result of the research supported by the research project VEGA 1/0804/12 Influence of material composition of asphalt on characteristics of pavement surface texture, noise emission and air pollution

References

[1] J. Čelko et al.: The surface properties of pavements, in Slovak: Povrchové vlastnosti vozoviek (Prevádzková spôsobilosť vozoviek), EDIS Žilina, 2000. ISBN 80-7100-774-9.

[2] M. Kováč et al.: Diagnostics of serviceability parameters of pavements, in Slovak: Diagnostika parametrov prevádzkovej spôsobilosti vozoviek, EDIS Žilina 2012. ISBN 978-80-554-0568-1

[3] STN EN ISO 13473-5, Characterization of pavement texture by use of surface profiles. Part 5: Determination of megatexture, in Slovak Charakterizovanie textúry vozovky s použitím profilov povrchu. Časť 5: Stanovenie megatextúry (ISO 13474-5:2009)

[4] M. Slabej, P. Kotek: Pavement surface characteristics influencing a pavement serviceability, in Slovak: Charakteristiky ovplyvňujúce prevádzkovú spôsobilosť cestných komunikácii, TRANSCOM 2013, Žilina 2013, ISBN 978-80-554-0696-1

[5] TP14/2006, Measurement and evaluation of skid resistance using the device SKIDDOMETER BV11 and PROFILOGRAPH GE, in Slovak: Meranie a hodnotenie drsnosti vozoviek pomocou zariadení SKIDDOMETER BV11 a PROFILOGRAPH GE