CETRA2024 15-17 May 2024, Cavtat, Croatia
8th International Conferenceon Road and Rail Infrastructure

EFFECT OF CRACK SEALING TREATMENT ON SKID RESISTANCE OF PAVEMENT

Marjan Tušar, Jure Zekič, Darko Kokot, Lidija Ržek
Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia

Abstract

The goal of the study was to evaluate the effect of crack sealing treatments on the skid resistance of the pavement. Measurements were conducted using the Skid Resistance Tester (SRT or British pendulum) and the SCIMTEX equipment, which measures the side-way force acting perpendicular to the measuring wheel set a 20-degree angle to the direction of travel. The results of the SRT measurements on the surface of the bituminous sealing compound after the sealing treatment revealed a considerable loss of skid resistance compared to the non-sealed surface. The lowest measured value was 23 SRT units, significantly below the requirement for highways in Slovenia (50 SRT units). These results were observed only on a narrow area of the pavement surface within the treated crack limits. The width of the treated fissure is typically around 3 cm, which has a notable impact on the safety of cyclists and motorcyclists, given that that contact width between the pavement and the wheels of bikes and motorcycles in bends is less than 3 cm. To enhance the skid resistance of the pavements post-treatment, we utilized specially produced expanded clay with a grain size of 2/4 mm. Measurements using the SRT and SCRIMTEX equipment indicated some improvement in skid resistance.

Keywords: sealing treatment, skid resistance, skid resistance tester, SCRIMTEX, light expanded clay aggregate

1 Introduction

Skid resistance is a pavement property that directly affects road traffic safety. Surface deterioration, in forms of rutting and cracking, also compromises road traffic safety. Maintaining road pavement surfaces in good condition is in the interest of both road users and road owners. Crack sealing with bituminous sealing compound is usually the first maintenance measure carried out (see Figure 1). It cost around 1 Euro/m^2 in year 2000 [1] which is not a low price. In the literature about this topic, most authors focus on the cost-effective performance of crack sealing treatment under a variety of environmental and traffic conditions [2, 3]. In studies, authors focus on specific details that require attention [2]:

- Evaluation of pavement condition before sealant application –such as the type of crack present, the severity of the cracking, and the density of the cracking,
- Proper preparation of the crack before sealant application,
- Evaluation of sealant performance.

However, skid resistance is rarely measured in literature. Our study focused on differences in conditions before and after such treatment, based on the assumption that skid resistance of pavement could be reduced due to crack sealing treatments. The results of the study also help road owners evaluate the risks associated with changes in skid resistance due to crack sealing. In the literature, we found only one similar study [4, 5], where Locked-Wheel Skid Tester (LWST) testing was conducted on several pavement projects in North Carolina, United States, with varying amounts and patterns of crack sealant. It was established that the application of high amounts of crack sealant to the wheel path can pose safety hazards.

Figure 1 Crack sealing with bituminous sealing compound

2 Measuring methods

Skid resistance was measured using the British pendulum apparatus (SRT - Skid Resistance Tester) [6] and the SCRIMTEX device [7, 8]. The SCRIMTEX device was utilized to gauge the average effect and overall skid resistance on the pavement surface of the entire test section (see figure 2). The SCRIMTEX device is a Sideway-force Coefficient Routine Investigation Machine (SCRIM) equipped with sensors for measuring texture depth. A free-rolling measuring wheel with a tire lacking a profile is mounted on the frame of the measuring mechanism, approximately in the middle of the vehicle (viewed longitudinally). A known weight applies vertical pressure on the measuring wheel, which rolls along the right wheel track at a 20° angle to the direction of travel. Just ahead of the measuring wheel, we wet the carriageway with a controlled jet of water, simulating unfavourable conditions on the road surface. The pendulum was utilized to conduct measurements directly on sealed cracks (see figure 3) and also to compare the skid resistance of the asphalt surface near the sealed cracks with that of the sealed cracks themselves. Measurements were taken at three different locations, each with an average length of about 0.5 km. According to national regulation for measurements using the SRT, results below 50 SRT units indicate poor condition of the road pavement surface.

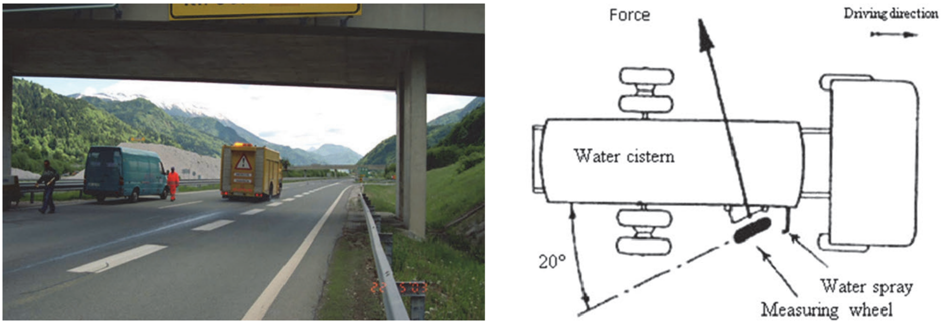

Figure 2 The SCRIMTEX device was used to measure the average effect on the overall skid resistance of the entire road surface

Figure 3 The SRT was used to measure directly on the sealed crack in both the transversal and longitudinal direction

3 Measurement results on first location

In the following tables 1 and 2, the results from the first location can be observed. From the results in Table 1, it can be observed that the skid resistance of the non-deteriorated pavement surface on the test field was found to be very good. The skid resistance of the surface with bituminous sealing compound was low, but improved with age.
Table 2 and Figure 4 show measurements taken with the SCRIMTEX device. It can be seen that the difference in skid resistance of the entire road section before and after crack sealing treatment is small yet significant. The measurement results indicate that intensive crack sealing treatments reduce the skid resistance of the entire road surface. Results are expressed in SR values, measured in the nearside wheel path.

Table 1 Location 1, measurements with the British pendulum

SRT measurement on			SRT			Average value
Non-deteriorated asphalt surface	76	76	75	75	74	75
Fresh sealed crack in longitudinal direction	29	29	28	27	26	28
Fresh sealed crack in transversal direction	56	55	54	54	53	54
Two years old crack seal in longitudinal direction	57	56	56	55	54	56
Two years old crack seal in transversal direction	62	61	61	60	59	61

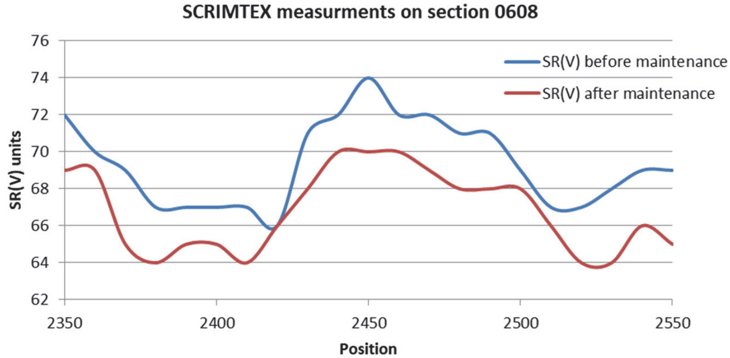

Figure 4 Measurements with the SCRIMTEX device

Table 2 Measurements with the SCRIMTEX device

SCRIMTEX measurement on	Average value SR(V)
Asphalt surface before maintenance	69,4
Asphalt surface after maintenance	66,8

4 Case study: possible solution to this problems

At two locations, a trial was conducted to enhance the skid resistance of sealed cracks. Light Expanded Clay Aggregate (LECA) [9] was spread over freshly sealed cracks where the sealing compound was still in liquid form. LECA stands for lightweight expanded clay aggregate which is produced from special plastic clay with little or no lime content. The clay is dried, heated, and burned in rotary kilns at temperatures ranging from 1100 to 1300 °C.
LECA is porous ceramic product with a uniform pore structure, typically resembling a potato or round shape due to the circular movement of the klin. Its lightweight and thermal and sound isolation properties stem from the numerous small, air-filled cavities within the material. The objective of the trial was to enhance the skid resistance of the cracks. The density of LECA granules (2/4 mm) is approximately 0.5 g/cm3, and they adhere to the surface of the liquid sealing compound. Even after the compound hardens, the granules continue to protrude from the surface, as shown in figure 5.
At locations 2 and 3, we attempted to enhance skid resistance by spreading LECA on the surface of the cracks.

Figure 5 Light Expanded Clay Aggregate (LECA) on the surface of the left part of sealed crack

Table 3 Location 2, measurements with the British pendulum

SRT measurement on	SRT					Average value
Non-deteriorated asphalt surface	47	46	46	45	44	46
Fresh sealed crack in longitudinal direction	37	36	36	35	35	36
Fresh sealed crack in transversal direction	25	24	24	23	21	23
Fresh sealed crack strewed with LECA in longitudinal direction	66	65	64	63	62	64
Fresh sealed crack strewed with LECA in transversal direction	90	89	88	87	86	88

At the second location, measurements revealed poor skid resistance, even in the case of the non-deteriorated pavement surface. However, at the location where LECA was spread on the surface of the cracks, an improvement in skid resistance was observed.

Table 4 Location 3, measurements with the British pendulum

Measurement on	SRT					Average value
Non-deteriorated asphalt surface	54	53	52	52	51	55
Fresh sealed crack strewed with LECA in longitudinal direction	79	78	77	76	76	80

At the third location, the skid resistance of the non-deteriorated pavement surface was good. According to the SRT measurements (Table 4), it was found that on crack sealing treatments where LECA was spread on the surface of the cracks, an improvement in skid resistance was observed. However, due to traffic conditions we were unable to perform SRT measurements on crack sealing treatments without LECA.
Measurements were also conducted at all three locations using SCRIMTEX equipment. At the first two locations, were cracks covered a moderate part of the pavement surface, measurements showed only a small but significant difference in skid resistance measured with the SCRIMTEX before and after the sealing treatment.

The situation was different at the third location, where a substantial portion of the pavement surface was cracked, making the sealing compound's effect on skid more pronounced. In table 5 below, SCRIMTEX results from the third location are presented. It can be observed from table 5 that after the sealing treatment, the skid resistance of the surface with a large number of cracks was approximately 10 percent lower than that of the non-deteriorated surface.

Table 5 Location 3, measurements with the SCRIMTEX device

Measurement No.	Average SR(V)
Asphalt surface before maintenance	80
Asphalt surface after maintenance	73
Asphalt surface after maintenance + LECA	77

From tables 4 and 5 it is evident that the skid resistance of the pavement surface without cracks at location 3 was initially very high. However, after the maintenance with crack sealing, the skid resistance was significantly reduced. Measurements indicated an increase in skid resistance in areas where LECA was added to the sealing compound.

5 Conclusions

The results of the pendulum measurements on the surface of the bituminous sealing compound after the sealing treatment revealed a significant loss of skid resistance compared to the non-sealed surface. Similarly, measurements with the SCRIMTEX device showed a lesser but still notable loss of skid resistance on pavement surfaces treated with sealing compounds.

In an effort to improve the skid resistance of the pavements post-treatment, we introduced a specific amount of specially prepared Light Expanded Clay Aggregate with a grain size of 2/4 mm into the hot sealing compound. Measurements using the pendulum and the SCRIMTEX device demonstrated that the skid resistance increased compared to the "standard" sealing compound.

Typically, the width of the treated cracks is about 3 cm, which means that such treatment does not significantly impact the road traffic safety of most vehicles. However, surfaces with embedded sealing compounds can pose risk for cyclists and motorcyclists, as the contact width between the road pavement surface and the wheels of bicycles and motorcycles in bends is less than 3 cm.

References

[1] Yeaman, J.: How long is "Whole of Life" for Pavements, 1st International Conference, World of Asphalt Pavements, Sydney, Australia, 10-24 February 2000.

[2] Decker, D.S.: Best Practices for Crack Treatments for Asphalt Pavements, NCHRP Report 784, National Research Council, Washington, D.C., 2014.

[3] Masson, J.F., Collins, P., Lowery, M.: Temperature control of hot-poured sealants during the sealing of pavement cracks, Construction and Building Materials, 19 (2005) 6

[4] Castorena, C., Fried, A., Malladi, H.: Quantifying the Impact of Crack Sealant on Pavement Surface Friction, Final report, NCDOT Project 2017-04, FHWA/NC/2017-04, 2019.

[5] Fried, A., Malladi, H., Castorena, C.: Impact of Crack Sealant on Pavement Skid Resistance, Transportation Research Record Journal of the Transportation Research Board, 2673 (2019) 7, DOI: 10.1177/0361198119849590

[6] EN 13036-4:2011: Road and airfield surface characteristics - Test methods - Part 4: Method for measurement of slip/skid resistance of a surface: The pendulum test

[7] CEN/TS 15901-6:2010: Road and airfield surface characteristics - Part 6: Procedure for determining the skid resistance of a pavement surface by measurement of the sideway force coefficient (SFCS)

[8] Nicholls, J.C., Carswell, I., James, D.: 300-007 Performance data on thin surfacing systems after up to 15 years in service, 4th Eurasphalt & Eurobitume Congress, Copenhagen, Denmark, 21-23 May 2008.

[9] Rashad, A.M.: Lightweight expanded clay aggregate as a building material - An overview, Construction and Building Materials, 170 (2018), pp. 757-775