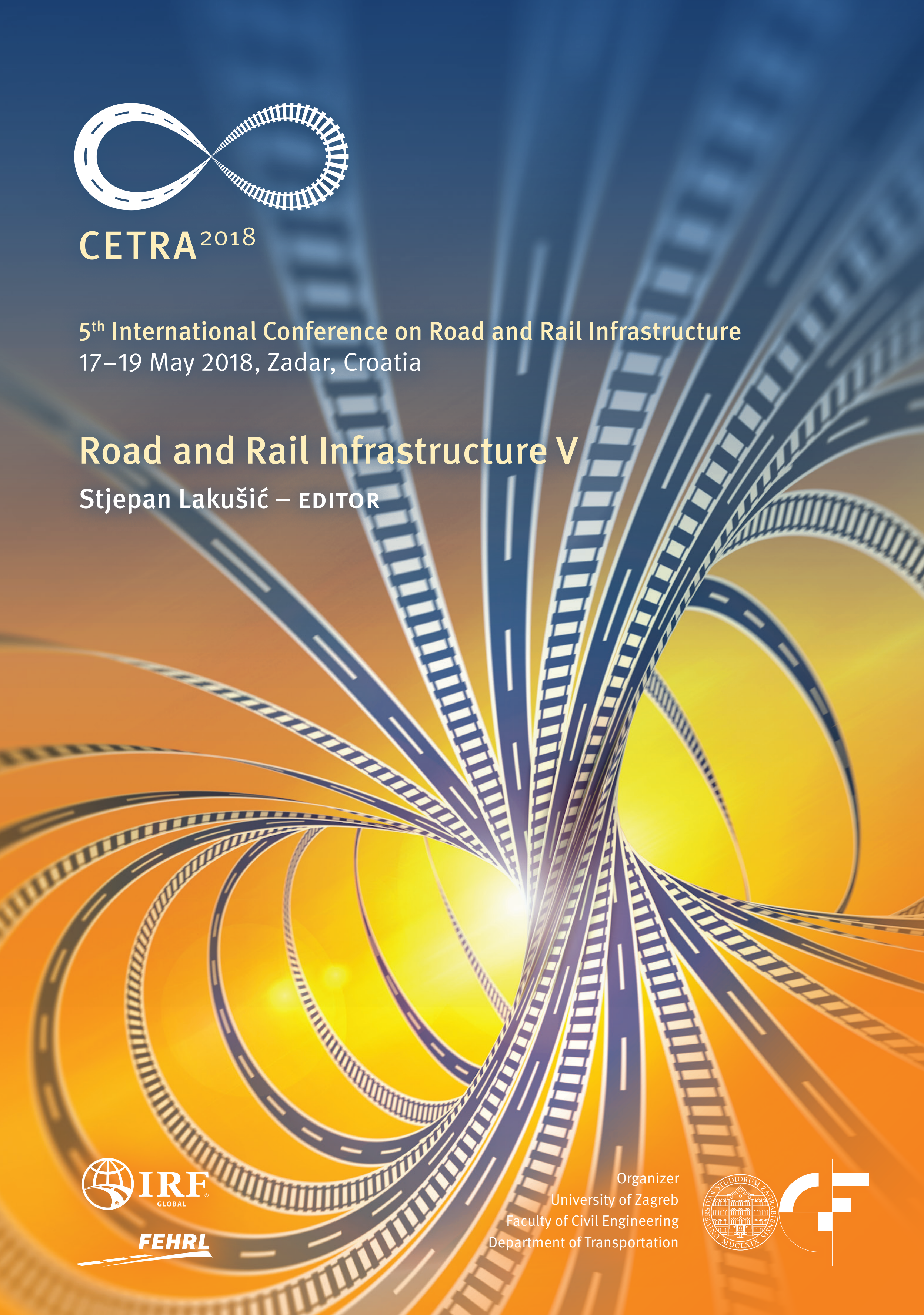

CETRA[2018]

5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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PRECISION AND ACCURACY IN DETERMINATION OF PAVEMENT SKID RESISTANCE UNIFORM SECTION LENGTH

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Abstract

Pavement skid resistance tests are usually performed to obtain the results for Pavement Management Systems (PMS), hence to assess the road pavement technical condition. In this paper the assumptions to identify the skid resistance uniform section of pavement have been checked. Two pavements, concrete and asphalt ones, were subjected to tests. On the first location the marking length has been identified from skid resistance tests and on the second one the length of stuck foil spread with organic oil. The results of accuracy and precision do not exceeded 5 % in both cases.

Keywords: skid resistance, pavement diagnosis, uniform section identification

1 Introduction

In pavement diagnosis the determined parameters should be at least: bearing capacity [1], longitudinal roughness, transverse evenness and skid resistance [2]. None of these parameters is constant in the function of time. Changes in skid resistance index during few years have been described in [3]. The changes in skid resistance arise an issue of management of this parameter in life cycle of the pavement [4, 5].
The economic justification of improving the skid resistance has been shown in [6]. That paper has proven the thesis that selected section with low skid resistance indexes and improvement of these sections have led to saving funds in large scale. The relation between skid resistance and road safety is still an open subject and increasingly sophisticated methods are used to describe this dependency [7].
The concept of improving skid resistance can be proceed in two ways. First is to pave a new layer and the second is to change the texture of existing layer. New layer is easier to manage, but it is more expensive than changing the texture of existing layer from economic and environmental point of view. Examples of that treatment based on concept of changing the texture can be: blasting [8], water blasting [9] and milling [10]. Changing the texture of existing surface course requires precise determination of the skid resistance on the section length and identification that section which needs to be improved.

2 Skid resistance test methodology

2.1 Device used to determine skid resistance

CSR (Continuous Skid Resistance) device has been used in order to determine the skid resistance index on pavement sections. The device is fixed slip ratio type and it is equal to 13 %. CSR is a device that allows to extract from the measurements of both vertical force values taking effect on measurement wheel and torque moment values (Fig. 1 and Fig. 2).

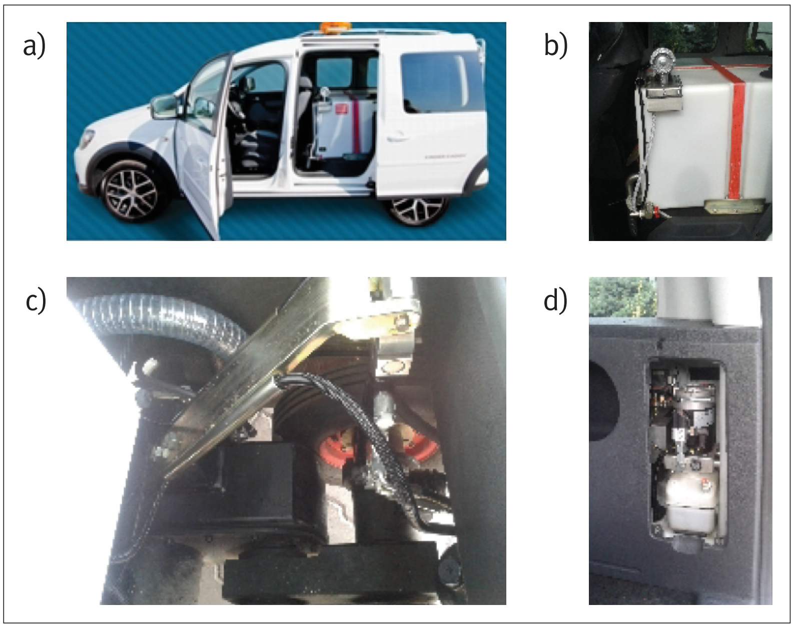

Figure 1 CSR measuring device: a) view of the entire device, b) water tank, c) hydraulic system forcing the vertical force, d) system enabling pressure control in the hydraulic actuator

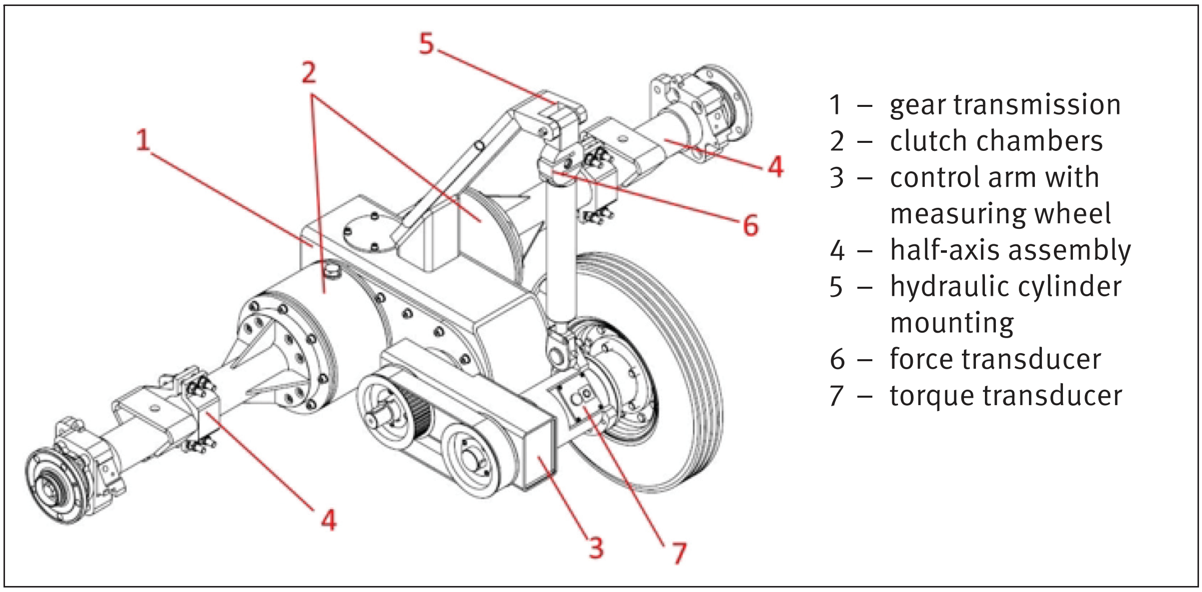

Figure 2 Scheme of the rear axle of the CSR device

The skid resistance index based on CSR device test results is calculated from Eq. (1):

$$CSRi = \frac{M}{F\,r}[-] \qquad (1)$$

Where:
M – torque moment [Nm];
F – vertical force [N];
r – distance between pavement surface and axis of the measuring wheel [m].

CSR device is capable to determine required quantities each 10 cm on a test section, that is a prime advantage of using it. That trump allows to divide section to uniform sections. During the tests Telleborg Unitester 520 tire was used. The water film thickness was 1 mm.

2.2 Determination of uniform section

In this paper, criteria for dividing the pavement measurement section into uniform ones are as follows: 1) the CSRi threshold value for pavement skid resistance is equal to 0.3, and 2) the minimum length of the section is 1 m (Fig. 3).

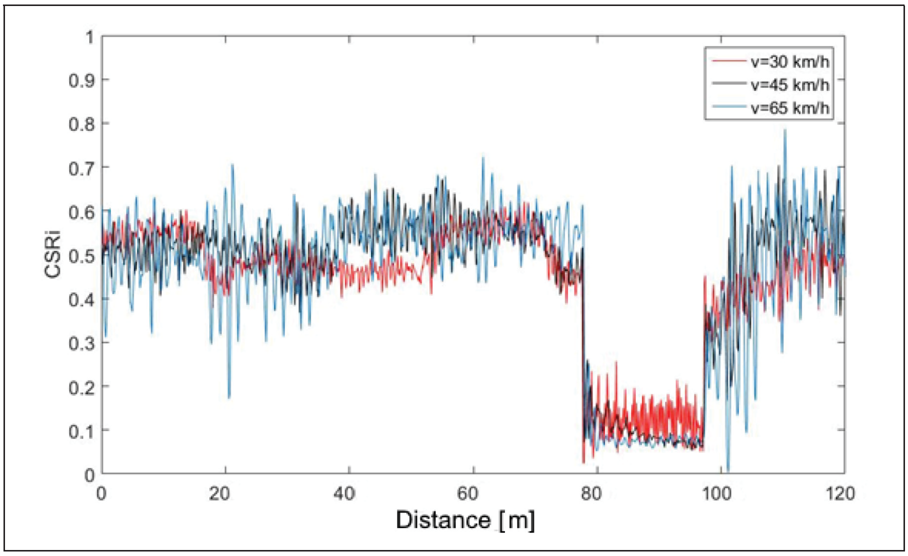

Figure 3 Illustration of determining the uniform sections on the location B

3 Experimental sections

In order to identify the length of uniform section two locations were exploited with varied skid resistance:

- Location A – section located on part of the Pyrzowice Airport runway. The concrete surface course was paved 2 years before tests. Aggregate used in concrete was granite crushed stone 0/22. Thickness of the concrete layer was 30 cm, concrete class was C35/45 and exposure class was XF4. Brushing process was used to texture the surface of the layer. The hydrophobization process was performed a few weeks before tests. On the section there were a 30 m long and 1.1 m width markings and the offsets between markings were 20 m long (Fig. 4).
- Location B – section on Rychlewski street in Poznan. Asphalt surface course was paved 2 years before performing the tests. On part of the section there was stuck the foil spread with organic oil and the length of the foil was 20 m (Fig. 5).

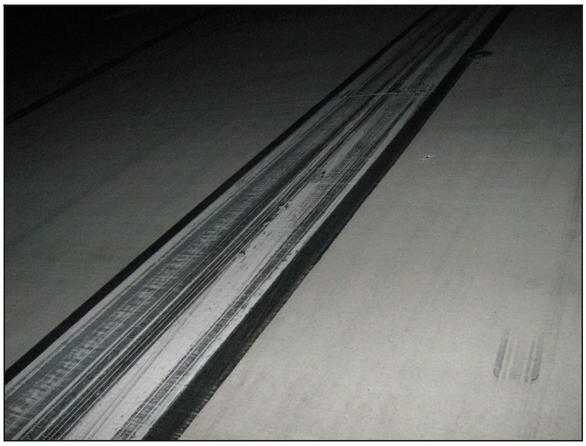

Figure 4 Pavement with marking on location A

Figure 5 Pavement with stuck foil on location B

4 Results

The length of uniform sections on location A were: $L_1 = 30$ m (length of section with marking), $L_2 = 20$ m (length of section without marking), $L_3 = 30$ m (length of section with marking) (Fig. 6).

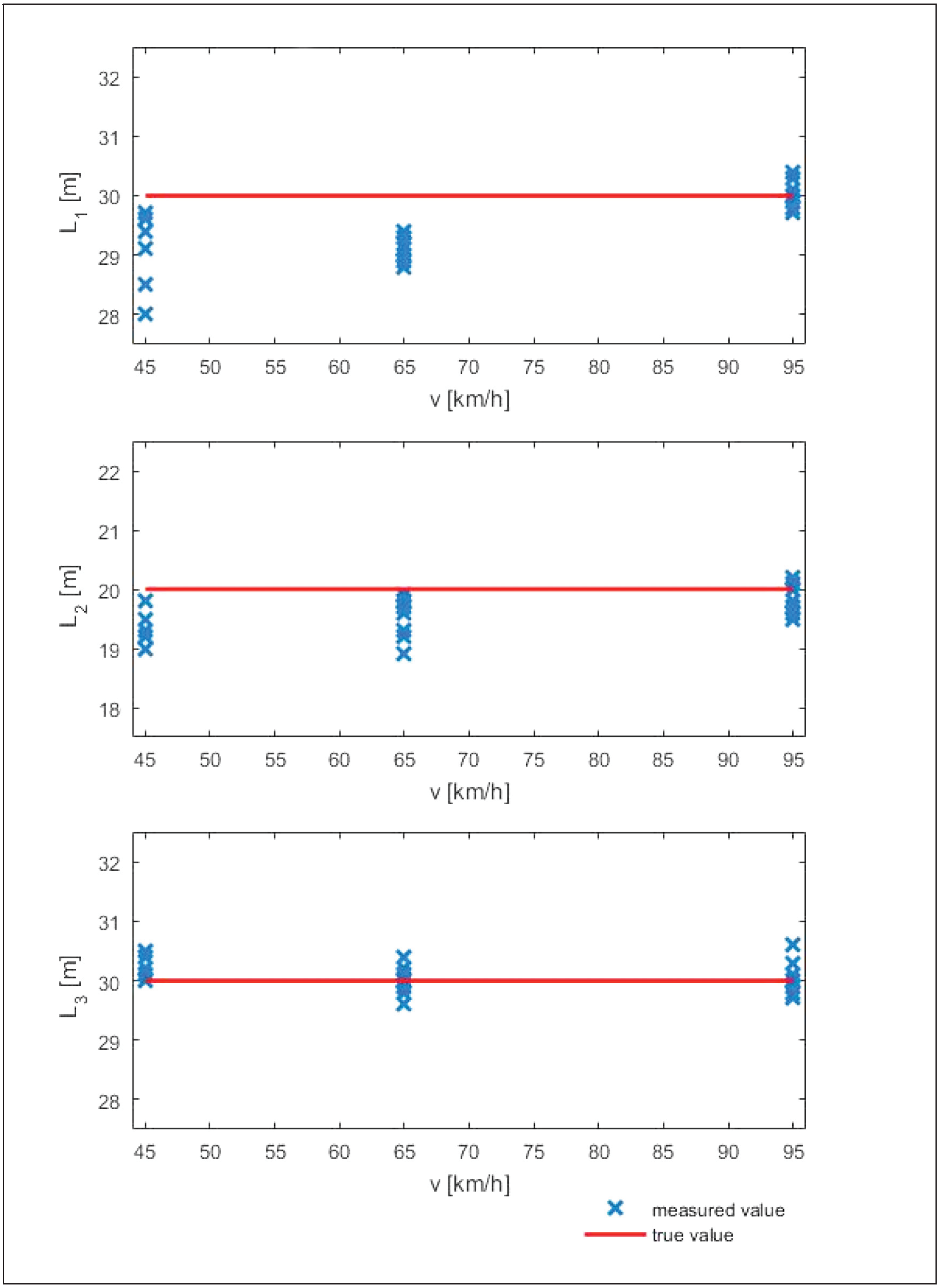

Figure 6 The identified length of uniform sections from analysis of CSR results obtained for the location A

The length of uniform section on location B was L = 20 m (length of the foil) (Fig. 7).

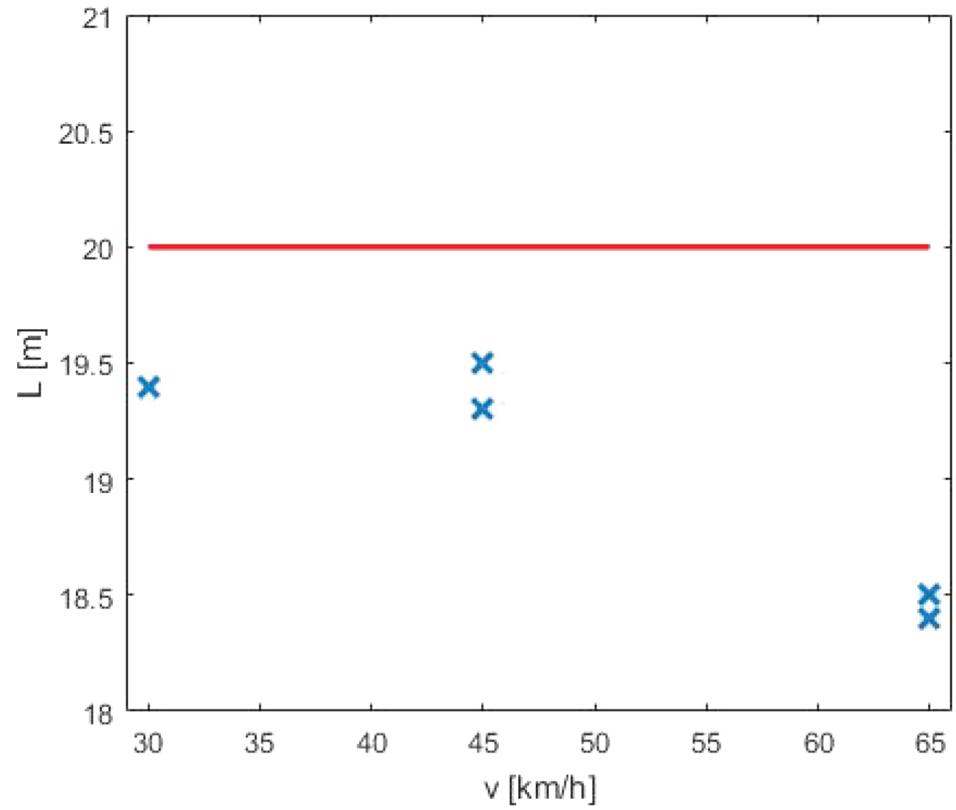

Figure 7 The identified length of uniform section from analysis of CSR results obtained for the location B

5 Analysis

5.1 Precision of determining the uniform section length

In order to assess the precision of determining the uniform section length the coefficient of variation (CV) was used. However, as the criterion of minimum population size for calculating the CV influences the results, only the measurements on the location A were considered in this statistics. CV is defined by Eq. (2):

$$CV = \frac{\sigma}{\overline{x}} \cdot 100\% \tag{2}$$

Where:

σ – standard deviation of the uniform section length;

$\overline{x}$ – mean value of the uniform section length.

The CV values determined for the location A have been shown in table 1.

Table 1 Values of CV on location A

v [km/h]	CV (L_1) [%]	CV (L_2) [%]	CV (L_3) [%]
45	2.31	1.42	0.62
65	0.78	1.67	0.77
95	0.74	1.25	0.97

5.2 Accuracy of determining the uniform section length

In order to assess the accuracy of determining the uniform section length the relative error (δ) was used. The relative error is defined by Eq. (3):

$$\delta = \frac{x - x_0}{x_0} \cdot 100\% \tag{3}$$

x – measured value of the uniform section length;
x_0 – true value of the uniform section length.

On the location A the relative error values have been shown in table 2. On the location B the relative error values have been shown in table 3. Maximal relative error for all dataset was 6.67 %.

Table 2 Relative error values achieved on the location A

v [km/h]	δ (L_1) [%]	δ (L_2) [%]	δ (L_3) [%]
45	3.17	3.25	0.78
65	3.03	2.50	0.60
95	0.57	1.20	0.77

Table 3 Relative error values achieved on location B

v [km/h]	δ [%]
30	0.75
45	1.29
65	0.89

6 Conclusions

Analisis of the technical aspects of the proposed measurment methodolgy indicates that location with markings was easier to perform the tests due to wider marking comparing to the foil width. From that piont of view the width of the section should be more than 1 m for that kind of tests.
The mean relative errors on location A and B were similar and were less than 2.2 %. That can lead to assumption that in standard cases indentification of the section with low skid resistance index can be enough accuracy from engineering point of view.
Precision of determining the uniform section length was sufficient. In none of the cases the coefficient of variation has exceeded 3 %. Both accuracy and precision were in the same range. This fact can be an evidence of correct measurement method of uniform section identification. There was no proven correlation between accuracy or precision and the test velocity.

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