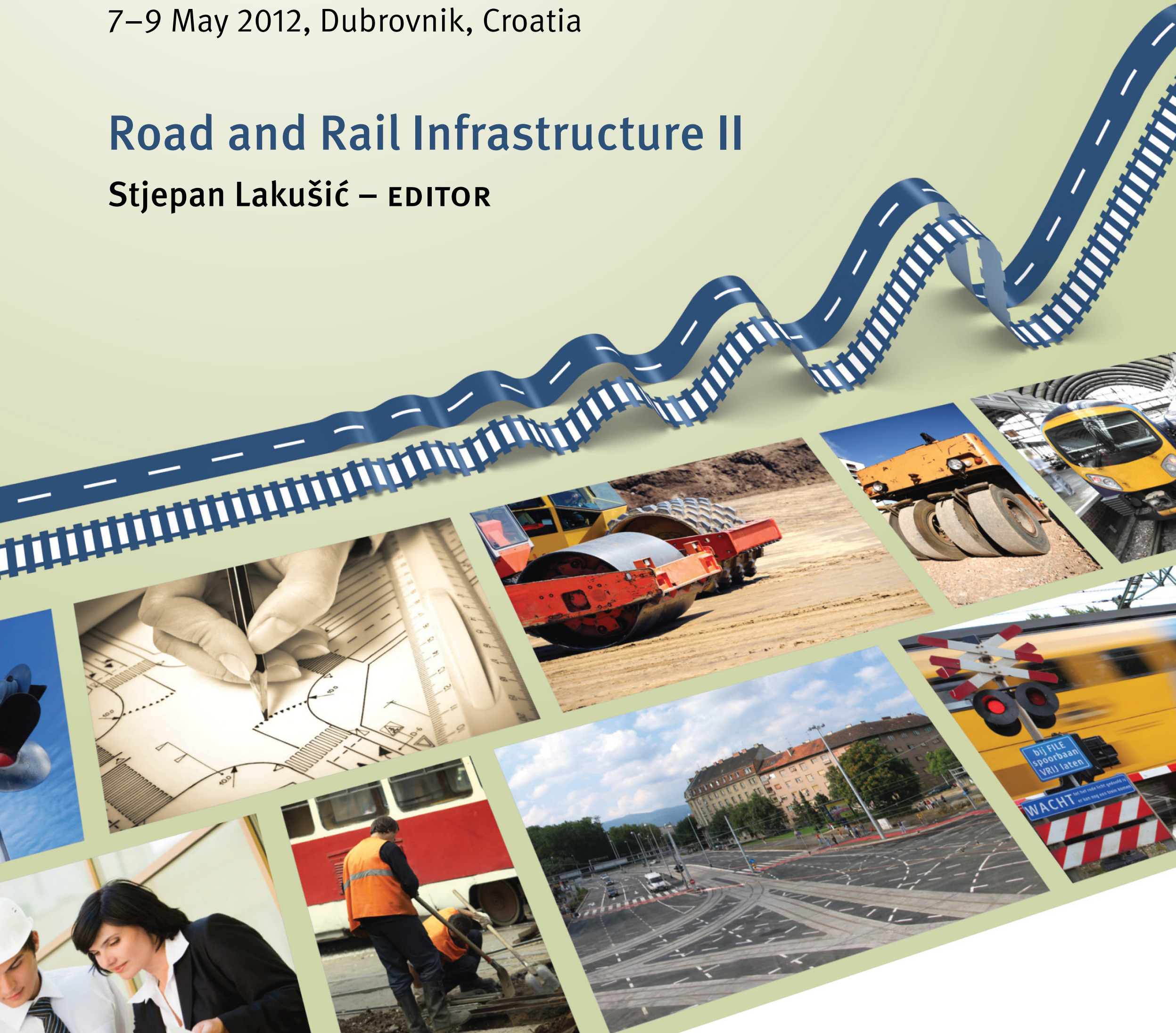
CETRA2012

2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



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INFLUENCE OF USPs ON THE QUALITY OF TRACK GEOMETRY IN TURNOUT

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Abstract

The under sleeper pads (USPs) bring elasticity into railway superstructure on the underneath surface of sleepers. Decrease of ballast and sub–ballast layers' stress, homogenization of vertical track stiffness, decrease of rail corrugation development in narrow curves and reduction of vibration transmission onto a track bed are expected contributions of this elastic layer. The trial track section with a turnout in which bearers with USP are installed were constructed in the Planá nad Lužnicí railway station (IV. railway corridor: Praha–České Budějovice–Linz) in 2007. The section comprises of the turnout and transition zones with USPs and the appropriate comparative section. The aim is to monitor the influence of USPs to the settlement of bearers in the turnout and to the quality of track geometric parameters.
The trial track section, the methodology of track geometry parameters' monitoring (precise levelling and track measuring car data) and the measurement evaluation are described in this article.

Keywords: monitoring, track geometry parameters, trial track section, turnout, under sleeper pad

1 Introduction

The dynamic effects' increase in railway track structures is connected with the train service speed increase. The dynamic effects occur due to imperfections of a railway track. Vibrations of railway superstructure elements and structure borne noise are caused by the dynamic loads. These vibrations are transferred to the track subsoil and to the track vicinity. The dynamic effects unfavourably influence development of the railway track defects and failures which usually cause changes in track geometry parameters. The ballast bed is the most stressed layer. USPs fixed on the bottom surface of a sleeper decrease the railway track stiffness. The contact area between sleeper and ballast is higher. Static and dynamic loads on sleepers and bearers decrease and vehicle–track dynamic system properties are modified. Also the transfer of vibrations to a ballast bed is interrupted and damping of vibrations is moved to upper parts of the track.

2 Description of the trial track section

The trial track section is situated in the Planá nad Lužnicí railway station. It was constructed for the turnout J60–1:12–500-I with USPs in 2007. The assembly of the USPs for the turnout was designed in the mathematical model [2].

The basic bedding modulus of USPs is 0,250 $N.mm^{-3}$. Softer USPs were used in the crossing panel and in the area of long bearers behind the crossing. The softer USPs are only used on the middle part of the bearers.
The transition zones that allow smooth transition of vertical track stiffness between the track with USPs and the track without USPs were designed. The neighbouring turnout was chosen as a comparative conventional track section. The bedding modulus of USPs in the transition zones is 0,300 $N.mm^{-3}$. The length of the transition zone is 32,4 m, i.e. 54 sleepers. The total length track with USPs is 205m. The pads were glued to the underneath surface of sleepers and bearers. The scheme of the track section is on the Figure 1.

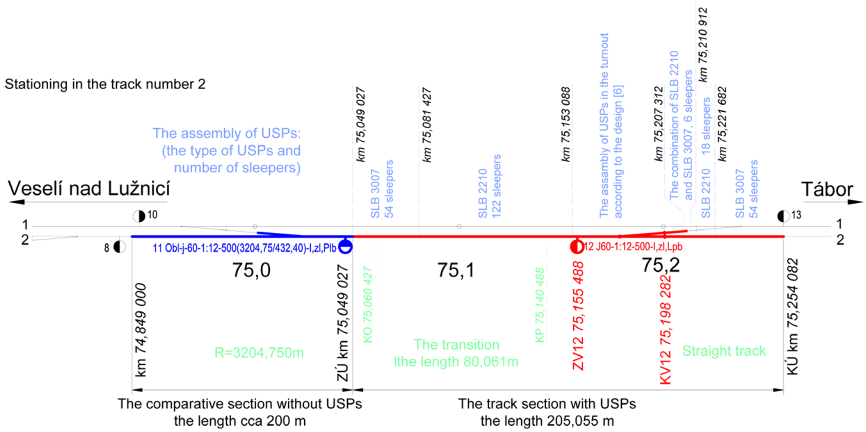

Figure 1 The scheme of the trial track section in the Planá nad Lužnicí railway station

Discrepancies between the assembly design of USPs and its execution (lacking USPs, wrong glued–on USPs) were found out after the turnout had been laid on 9th November 2007. Speed restriction was imposed. The discrepancies were repaired on 7th April 2008 and the speed restriction was removed after the tamping of the turnout and expiry of consolidation.
The tamping was carried out three times in the trial track section April 6th 2008 (only the turnout with USP), November 12th 2008 (only the turnout with USP) and July 23rd 2009.

3 Monitored parameters

All the values and events which could be influenced by the use of USPs in the trial track section are being monitored. These are the parameters being observed:
· track geometry parameters quality;
· track settlement;
· vertical deflection under a running axle;
· vibrations of railway superstructure elements;
· transfer to a track vicinity;
· noise propagation to a track vicinity.

This article deals with the track geometry parameters' monitoring by precise levelling and a track recording car. The aim is to verify the stability of the long bearers with USPs. The measured and calculated data from both the precise levelling and track recording car were compared.

3.1 Description of the precise levelling measurement

The rail top levels of the track are monitored through a precise levelling. Rail levels, bracket–type datum mark heights and others check points are monitored. Ninety three sections from 74,848 000 km to 75,282 300 km are being monitored in the Planá nad Lužnicí railway station. The sections in the track between the turnouts have the distance of 6 m; the sections in the turnouts have the distance of 3 m. The elevations are in a relative altitude system. Relative deviations from the optimized track position which was found out by regression in the initial observation were calculated. Deviations from designed position, track twists and a progress of track settlement were calculated.

3.2 Monitoring of track geometry parameters by track recording car

The track recording car measures and records the following track geometry parameters: track gauge, curvature, alignment, cant, twist and longitudinal level. Measurement deviations of track alignment, longitudinal level and cant were chosen for further processing and evaluation of the trial track section. The track twists were calculated from the cant.

4 Evaluation of monitored parameters

4.1 Precise levelling [3]

The longitudinal level of the track was measured three times every year after the trial had been put into operation. The trial track section was devided into five interest sections:
· Track without USPs (1): the track without USPs in front of the turnout no. 11 without USPs;
· Turnout no. 11 without USPs;
· Track with USPs (1): the track with USPs between the turnout no. 11 and the turnout no. 12;
· Turnout no. 12 without USPs;
· Track with USPs (2): the track with USPs behind the turnout no. 12;
· Track without USPs (1): track without USPs at the end of the trial track section.

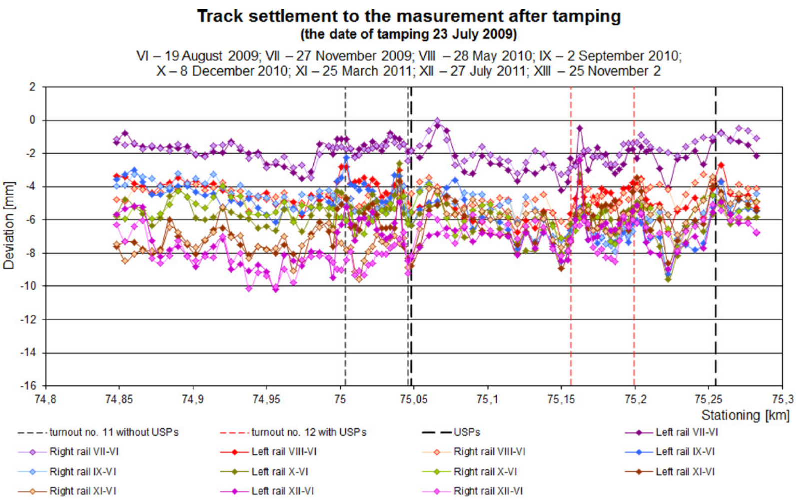

Figure 2 The track settlement after tamping (23 July 2009) to the measurement of 19 August 2009

The relative deviations of all measurements from the optimized track position are in the range of +30 mm to –27 mm. The greatest deviations are in the turnout with USPs. It is not possible to determine the track settlement over the whole monitoring time. The track has been tamped three times during the first two years. Therefore the measurements after the last tamping were further evaluated.

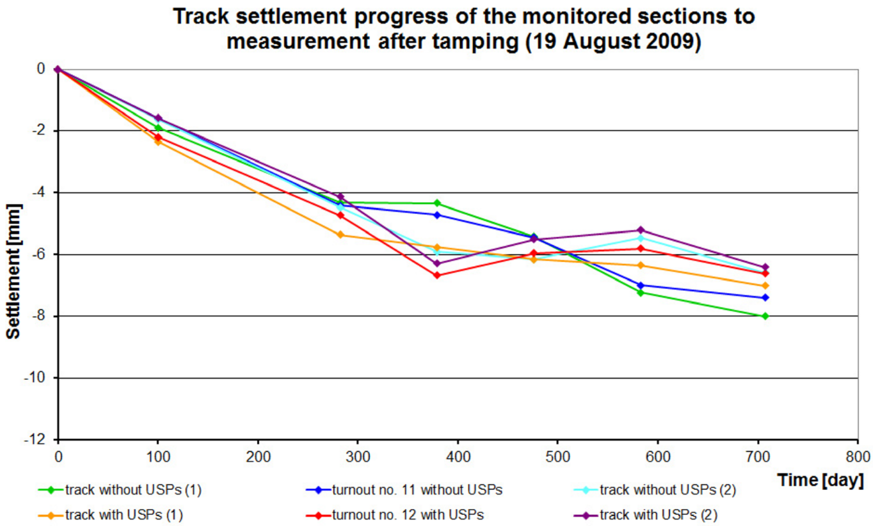

Figure 3 The track settlement progress of the monitored sections to the measurement after last tamping

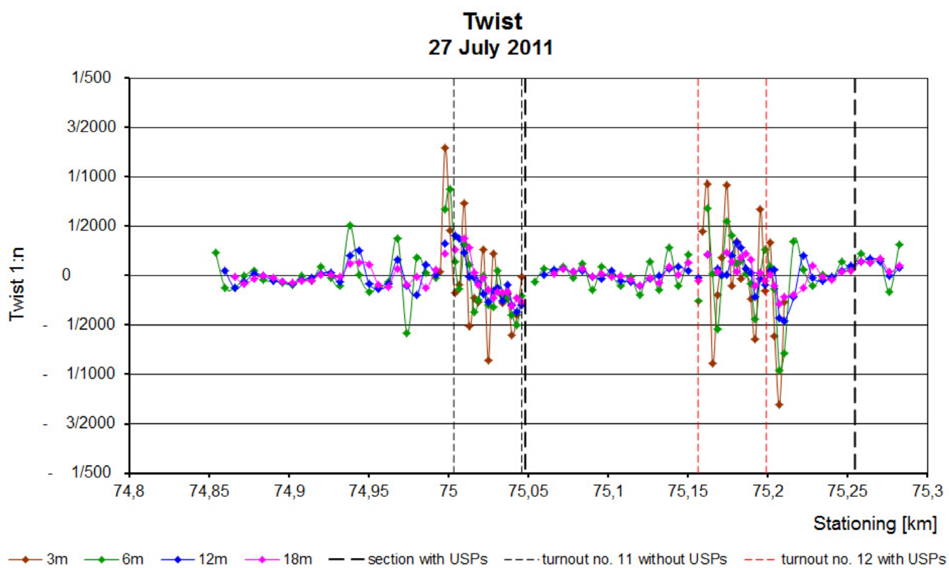

Figure 4 Track twist on the length of 3 m, 6 m, 12 m and 18 m; 27 July 2011

It is obvious that the track without USPs shows greater settlement (see Figure 2). The settlements of the section without USPs are up to 10mm (on the average 7,9 mm for the last measurement), the settlements of the section with USPs up to 9mm (on the average 6,7 mm for the last measurement). The settlement rate of the track with USPs is smaller than the settlement rate of the track without USPs in the last year (see Figure 3).

The track twist was calculated from computed cant. The distance of the measurement points is either 3m (in the turnouts) or 6m for the points out of the turnouts. Therefore, the twist was calculated for the track length of 3 m (only in turnouts), 6m, 12m and 18m. The twist for the last measurement is in Figure 4. The influence of USPs is obvious from the results, mainly for the track between turnouts.

4.2 Track recording car [3]

The track recording car runs three times a year in the section. The following measuring runs were evaluated: 28 May 2008; 12 November 2008; 1 April 2009; 11 November 2009; 24 March 2010; 14 July 2010; 3 November 2010; 2 April 2011 and 4 August 2011.
Deviation of both the track alignment and longitudinal level are unequivocally smaller in the section with USPs between turnouts (see Figure 5 and Figure 6). The deviations in the turnouts are roughly the same.

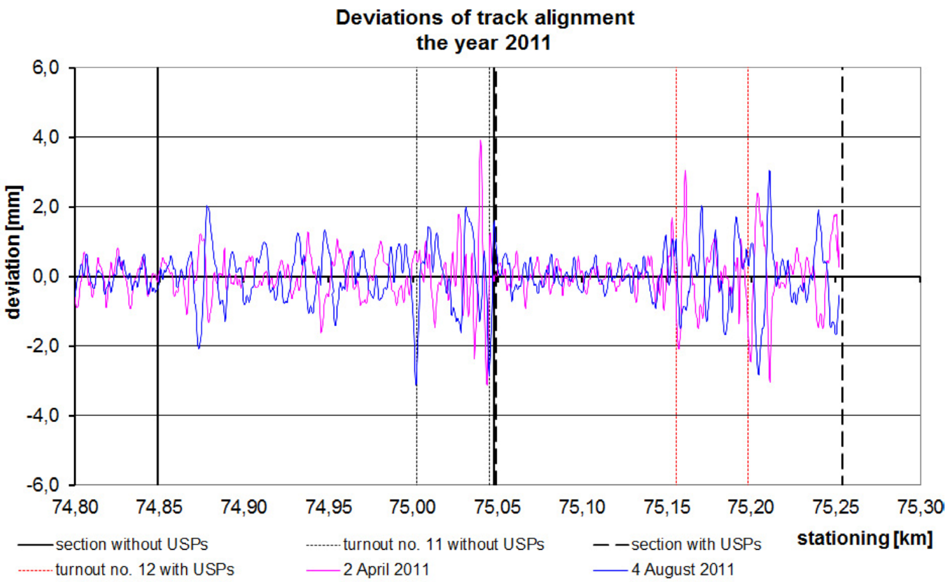

Figure 5 Deviations of track alignment in the year 2011

The track twists calculated for the track length of 3m, 6m, 12m and 18m were calculated from the measured cant. The results are the same as from precise levelling. The twists of the track with USPs are significantly smaller than the twists of the track without USPs in front of the turnout no. 11. The twists of the track in the turnout no. 12 with USPs are a little bit smaller than in the turnout no. 11 without USPs.

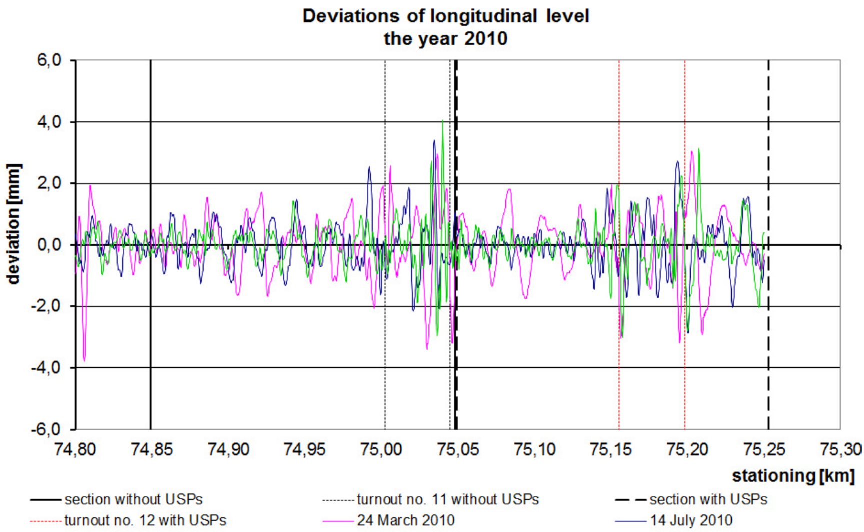

Figure 6 Deviations of longitudinal level in the year 2010

Measured data were also compared with requirements in the czech standard for maintenance limits of track parameters (ČSN 73 6360-2) – Alert Limit (AL), Intervention Limit (IL) and Immediate Action Limit (IAL).

Conclusions of the evalutations are following:

- the deviations of the parameters at the beginning of a monitoring were comparable for both sections with and without USPs, they were slightly higher in the turnout with USPs;
- the deviations in the turnouts are higher than in the other sections in general;
- the deviations of the chosen parameters don't exceed AL;
- calculated twists don't exceed AL; maximum values of twists for the both section with and without USPs are comparable;
- the deviations of track alignment, longitudinal level and twist in the section with USPs between the turnouts are lower than in the other sections from the year 2010.

5 Conclusion

The trial track section in the Planá nad Lužnicí railway station is focused on USP's influence on track geometry quality in a turnout evaluation. The stress of ballast bed under a sleeper is decreased by the use of USPs [4], [5]. The lifetime of ballast bed is extended. The track quality with USPs is better, track geometry deterioration is slower compared to the track quality without USPs. The positive influence of USPs is usually evident after longer time considering traffic density of a track. The higher track load the sooner evident of USP's influence and the more the investment in USPs pays off [1].

The Planá nad Lužnicí railway station is situated in the 4th czech railway corridor between Praha and České Budějovice. The traffic load of this track is from 20 000 to 40 000 gross tons per day. The trial section has been monitored since 2008. Track geometry parameters are monitored by precise leveling and track measuring car.

The data from these measuring show that the influence of USPs had started to be evident two years after USPs had been installed. The track settlement and deviations of track geometry parameters are lower in the section with USPs between the turnouts. It is expected that more time is required to evidence the influence of USPs. It is necessary to remind that the turnout with USPs was tamped three times compared to the turnout without USPs that was tamped once. The two more tamps undoubtedly influenced the track settlement.

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