10.2478/v10160-011-0023-x

Transactions of the VŠB – Technical University of Ostrava

No. 2, 2011, Vol. XI, Civil Engineering Series

paper #23

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IMPACT OF THE TRACK CONSTRUCTION ON THE FLAT WHEEL DETECTION

VLIV KONSTRUKCE KOLEJE NA DETEKCI PLOCHÝCH KOL

Abstract

The article deals with the impact of wheel service condition and type of the running rail on vibrations in immediate surroundings of the tram track. The entire measuring was based on the presumption of higher noise and vibration values during passage of a tram vehicle with the so-called "flat wheel" and the possible difference of values of vertical vibrations in individual types of the running rails.

Keywords

Tram transport, noise and vibrations, flat wheel, flat wheel detection, types of rails.

Abstrakt

Článek se zabývá vlivem provozního stavu kola a typu pojížděné kolejnice na vibrace v přímém okolí tramvajové trati. Celé měření vycházelo z předpokladu, vyšších hodnot hluku a vibrací při průjezdu tramvajového vozidla s tzv. „plochým kolem" a možném rozdílu v hodnotách vertikálních vibrací u jednotlivých typů pojížděných kolejnic.

Klíčová slova

Tramvajová doprava, hluk a vibrace, ploché kolo, detekce plochých kol, typy kolejnic.

1 INTRODUCTION

This article focuses on occurrence of the so-called "flat wheels" in tram vehicles, due to the impact of the type of the running rail on the level of acceleration of vertical vibrations and the method of detection of the flat wheels. The so-called "flat wheel" is caused by blocking of wheels of the set of trams by jamming on the brakes and simultaneous forward motion of the tram set. This causes "sliding" of the tram set on the track, and due to friction the wheel profile gets abraded and a flat wheel develops. Such an asymmetry in shape of the wheel is a source of a big level of acceleration of the vertical vibrations, as well as of the noise. These vibrations have a big impact on the tram superstructure and the immediate surroundings of the tram track. The impact of excessive vibrations due to operation of a "flat wheel" vehicle causes faster degradation of operating condition of the tram

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superstructure, as well as an increase of costs of its maintenance. We shall also mention propagation of these vibrations and its impacts on the surrounding built-up area and its inhabitants.

In case of exceeding of the hygienic limits, it is possible and necessary to absorb the vibrations by installation of flexible materials into the tram superstructure construction. Such precautions are highly effective; nevertheless the costs of their installation limit its wider use in the entire tram track network. In case of insufficient maintenance of the tram vehicles and especially insufficient checking of the wheel roundness, there also drops effectiveness of the absorbing materials. We shall take into consideration that a tram with a flat wheel generates excessive vibrations and noise in the entire length of the track, on which it moves. With regard to financial demands of the building precautions, it seems to be convenient to implement a thorough detection of the flat wheel vehicles and to send them to be reground immediately.

Detection and the subsequent regrinding is already being carried out in Dopravní podnik Ostrava, a.s. (DPO, a.s.) for many years, however only in a limited scale. The detector is installed only in one of the two tram depots on a track with the 49E1 (S49) rails. The detector records acceleration of the vertical vibrations; and by means of a special conversion relation it records dimensionless quantity expressing the assymetry ratio of each wheel and it assigns them to vehicle type and number (Fig. 1). In case of exceeding of the limit values, the vehicle is sent to be reground (value 10 is set at the present).

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Vehicle identification:  01132
Date: 24.07.2011.
Time: 16:41:59
Average speed = 34.9 km/hour
Left side      13.48  9.51  9.40  6.50  6.04 11.57  7.85  17.53
Right side      6.44  6.46  5.57  4.61  4.39  8.05  9.07   5.91
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Fig. 1: Recording of a passage of vehicle No. 01132 through a flat wheel detector installed in the DPO, a.s. depot. Individual data express the asymmetry ratio of individual wheels.

The presumption of this experiment was a difference in the geometry of the 49E1 (S49) and NP 4 railhead types (Fig. 2) with the arising eventual different position of the eventual flat on the running wheel area. In other words, the flat formed on the NP 4 rail type might not be detected by the detector installed on the 49E1 (S49) rails track and eventually vice-versa. As there are 60% of the NP 4 rails in the DPO, a.s. tram sections network, support of such a presumption would lead to a clear recommendation to install flat wheel detector also on the NP 4 rail type track, as well as to remarkable reduction of the amount of vibrations on the entire length of the DPO, a.s. tram section network.

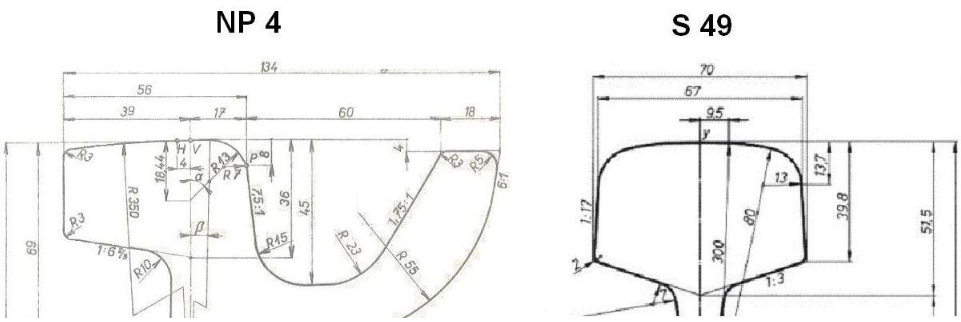

Fig. 2: Profile of the NP 4 and the 49E1 (S49) railway heads.

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2 MEASUREMENT

The measuring itself was done on July 26, 2001 in cooperation with the colleagues from the Department of Machine Parts and Mechanisms, Faculty of Mechanical Engineering, VŠB – TU Ostrava. There were selected two testing sections within the premises of Vozovna Poruba DPO, a.s. depot. Both of them have comparable conditions of vibration propagation. One of them with an open superstructure and the 49E1 (S49) rail and the other one with a superstructure covered with medium polluted crushed-run rock and the NP 4 type rail (Fig. 3).

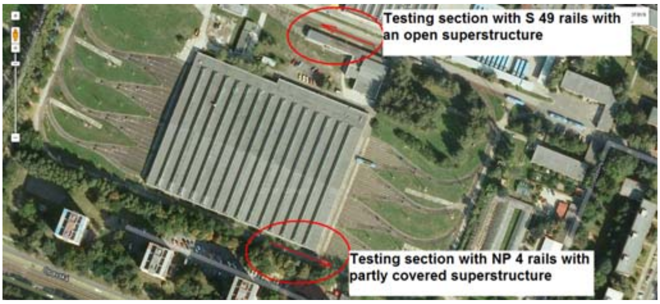

Fig. 3: Layout of placement of measured sections. The arrow points at the direction of the reference vehicle drive.

As the reference vehicle for this measurement was selected one tram of the T6 type ev. No. 1129 without any signs of damage on the running wheel surfaces, and another train T6 ev. No. 1132 with a remarkable flat on the rear bogie. The 1132 train was selected by the DPO, a.s. technicians on the basis of values from the flat wheel detector. There were measured five passages of each vehicle on both testing sections.

Wilcoxon research vibration sensor was used for sensing of values of vertical vibrations at the base of the rail, it was screwed into a steel holder clipped to the base of the rail.

3 MEASUREMENT RESULTS

Following deduction of the effective values of acceleration of vertical vibrations of the base of the rail $a_{eq,2s}$ and definition of the mean values, there is a visible drop in case of the vehicle with good wheel operating conditions. It is also worth comparing the individual sections. There is visible a big drop in the vertical vibration values at the base of the rail on the testing section equipped with the NP 4 type rails, regardless of the vehicle used.

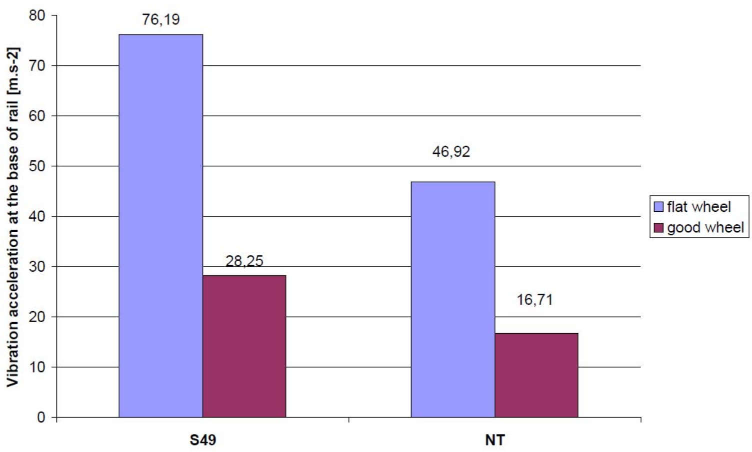

Fig. 4: Mean effective values of acceleration of vertical vibrations on the base of the rail for good and bad wheel operating conditions with regard to the type of running rail.

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The percentage drop is summarized in table Tab. 1. It also shows the percentage difference of values of vertical vibration acceleration for the reference vehicle and the flat wheel vehicle.

Tab. 1: Comparison of effective values of vertical vibrations depending on the type of rail and wheel operating conditions.

Wheel condition	**Rail type**		**49E1 (S49)/NP 4 ratio**
	49E1 (S49)	**NP 4**	
Flat wheel [$m.s^{-2}$]	76.19	46.92	**61.58%**
Good wheel [$m.s^{-2}$]	28.25	16.71	**59.15%**
Flat wheel / good wheel ratio	**37.08%**	**35.61%**	

These values show that the percentage ratio remained stable, whether comparing the flat wheel and the good wheel vehicle (drop to about 36% of the original value) or comparing values measured at various types of rails (drop to about 60% in case of the NP 4 compared to the 49E1 (S49)).

4 CONCLUSION

The measured values show that the percentage ratio between the values measured in passage of the flat wheel vehicle and the reference vehicle remained in the same proportion on both types of rails approximately at the value of 60%, see Tab. 1. Comparison of the measured values favours the NP 4 type rail testing section. This is due to the construction of the NP 4 flange rail track, where the vibration values are influenced by shape of the rail, as well as by absorption of vibrations due to padding of the rail web with gravel (in case of the measured section).

Comparison of the effective values of the vertical vibrations acceleration at the base of the rail of the flat wheel vehicle and the reference vehicle provides an approximately equal percentage ratio of values for the 49E1 (S49) rail and the NP 4 rail, namely about 36% of the original value. The above mentioned presumption that the flat wheel formed on one type of the rail would not show on the other type, or it would be less obvious on the other type, was not confirmed by this measuring. Partial conclusions from measuring of the other noise-eliminating precautions also support this conclusion. Placement of another flat wheel detector on the NP 4 rail section is therefore unnecessary at the moment. This partial conclusion, however, has to be confirmed by further measuring.

With regard to large drop of values of the vertical vibrations acceleration at the base of the rail during passage of the reference vehicle (about 60%), it is necessary to set a strict system of flat wheel detection, and then send these vehicles to be reground immediately The record of the flat wheel detector taken at the time of measurement shows that the currently set limit value at level 10 is probably too benevolent. After filtering out records with at least one value exceeding 10, the vehicle ev. No. 1132 does not appear on the list at all. Despite of the fact that the values of vertical vibrations during its passage rose up to 2.7 multiple of values of the reference vehicle on the 49E1 (S49) rail and to 2.8 multiple on the NP4 rail.

These percentage ratios show necessity of timely and regular maintenance of geometry of the running surface of wheels of tram vehicles by means of a suitably calibrated flat wheel detector (depending on conditions at the place of location), especially with regard to the favourable ratio of costs of the flat wheel detection and their grinding and costs of installation of the absorbing elements. A timely grinded wheel will lead to absorption of vibrations at the entire length of the operated tram section, with financial costs multiply lower than eventual costs of wide-spread installation of building elements absorbing vibrations in the track. The collegium of authors recommends installation of the flat wheel detector also into the second depot of DPO, a.s. To define parameters of the best suitable setting of the flat wheel detector, it is necessary to enlarge the existing data; therefore we recommend carrying out further measuring.

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