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POINT MACHINES WITH HIGH SPEED SWITCH POINTS

Introduction

The increasing speed of rail vehicles requires better and more advanced vehicles to be constructed. This article presents the results of research concerning the parameters for the cooperation of point machines with high-speed switch points. The research was conducted on an Rz 60E1-760-1:14 switch point at an angle of 1:40, a multi-machine mechanism and a mechanical coupling of point locks. The research measured the switching resistance of the switch point in mechanically coupled and in multi-machine configurations, as well as the delay in actuating the point machines.

Research subject

Research was conducted on a 60 E1-760-1:14 switch point at an angle of 1:40 in a multi-machine configuration, in which the switch point is operated by three EEA-5 point machines in non-trailable version, as well as in a single-machine version with mechanical coupling of point locks. A fragment of this switch point with marked point locks, is presented in figure 1. This switch point is to be used for vehicles travelling at the velocity of V ≤ 200 km/h.

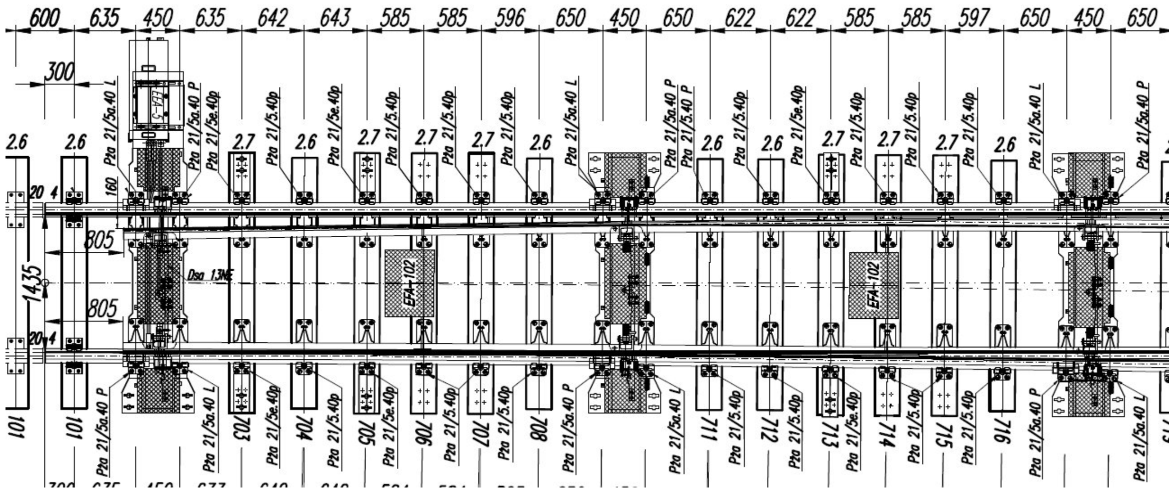


Fig. 1. A fragment of 60E1-760-2:14 switch point with marked point locks

Multi-machine configuration. Research methodology

The research consisted of independent measurements of switching resistance in each of the three point locks in both directions as well as measurements of switching resistance and delays between individual point machines.

Measurements were conducted using a double-channel apparatus for measuring forces in point machines - switch point system type HZM [1], serial number 1015, as well as gauge plungers, serial nos. 93589 and 93594 with valid calibration.

Data was processed and analysed using HZMSystem [2] (version 1.1.5) and Graph [3] (version 4.3) software.

The synchronisation of the point machines operation had to ensure minimal switching resistance due to interactions between the locks. The uniformity in point travel times should be maintained by selecting appropriate delays in point machine actuation and slider speeds.

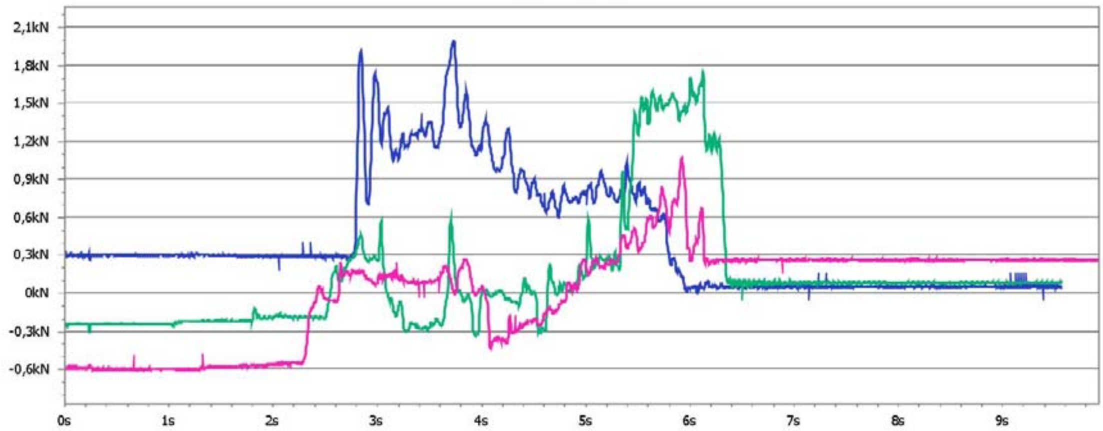
Designed (theoretical) delays in EEA-5 point machine actuation:

Switch lock no. 1 uses a 1450 rpm motor, while locks no. 2 and 3 use a 940 rpm motor. The point machines are actuated in the following sequence: II – III – I. Five different combinations of delay times were conducted (Tab. 1). Index A (in measurement results) indicates the basic delay designed by vehicle manufacturer, while indexes B to E signify different delay variants.

Table 1

A chart of time delay variants for point machine control in 60E1-760-1:14 switch point

Index	Time delay between point machines 2 and 3	Time delay between point machines 3 and 1	Time delay between point machines 2 and 1
	[ms]	[ms]	[ms]
A	150	800	950
B	150	700	850
C	250	700	950
D	150	850	1000
E	300	700	1000



	Force	STATION	OCC	P type	Point machine type	Point machine NR	F type	Date	Tester	HZM S.NR	Measuring bolt S.NR
	2,00kN	---	---	---	---	12A	Setresist <	2010-01-15	Młyńczak	1015	93594
	1,75kN	---	---	---	---	12A	Setresist <	2010-01-15	Młyńczak	1015	93589
	1,07kN	---	---	---	---	13A	Setresist <	2010-01-15	Młyńczak	1015	93594

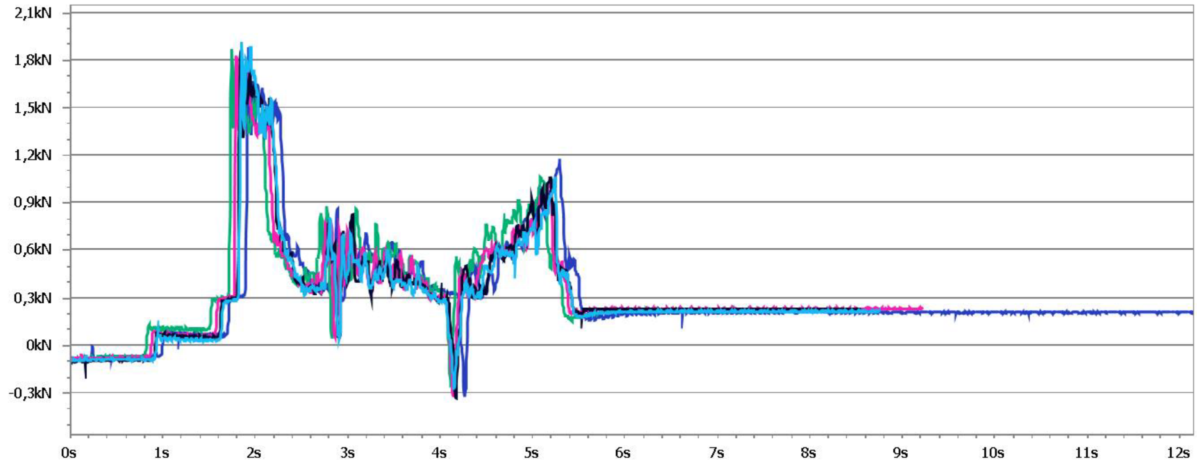
Fig. 2. Cumulative chart of switching resistance for three point machines, direction: left

Research results. Cumulative switching resistance chart for three point machines

Fig. 2 shows a cumulative chart of measured switching delays for all point machines during left-side switching.

A set of measurements for individual point locks and point machines was made to determine the base switching resistance and point elasticity. The results have proven that the switching resistance is above 4 kN for each of the point locks. The resistance was 3.1 kN only when the point switch was switched to the right. This is caused by the technical specificity of this switch point, i.e. the third point lock is located at a place, where the point is a full-size rail. It causes a huge resistance when the point is in its extreme position. It should be noted that the switching resistance measurement results show some statistical spread. This is due to the fact that a switch point is a complicated mechanical device, the characteristics of which are influenced by its component arrangement after it is switched on.

It should also be noted that the shapes of the switching resistance curves for individual point machines are similar and differ only slightly in value.



	Force	STATION	OCC	P type	Point machine type	Point machine NR	F type	Date	Tester	HZM S.NR	Measuring bolt S.NR
	1,88kN	---	---	---	---	12A	Setresist >	2010-01-15	Młyńczak	1015	93589
	1,87kN	---	---	---	---	12B	Setresist >	2010-01-15	Młyńczak	1015	93589
	1,82kN	---	---	---	---	12C	Setresist >	2010-01-15	Młyńczak	1015	93589
	1,86kN	---	---	---	---	12D	Setresist >	2010-01-15	Młyńczak	1015	93589
	1,91kN	---	---	---	---	12E	Setresist >	2010-01-15	Młyńczak	1015	93589

Comments

NAPĘD NR 1 (POMIAR NAPĘDÓW 1 I 2) KIERUNEK: PRAWO

Fig. 3. Resistance curve for the first point machine, direction: right. Source: [Own study]

	Force	STATION	OCC	P type	Point machine type	Point machine NR	F type	Date	Tester	HZM S.NR	Measuring bolt S.NR
	1,25kN	---	---	---	---	12A	Setresist >	2010-01-15	Młyńczak	1015	93594
	1,23kN	---	---	---	---	12B	Setresist >	2010-01-15	Młyńczak	1015	93594
	1,39kN	---	---	---	---	12C	Setresist >	2010-01-15	Młyńczak	1015	93594
	1,27kN	---	---	---	---	12D	Setresist >	2010-01-15	Młyńczak	1015	93594
	1,55kN	---	---	---	---	12E	Setresist >	2010-01-15	Młyńczak	1015	93594

Comments

NAPĘD NR 2 (POMIAR NAPĘDÓW 1 I 2) KIERUNEK: PRAWO

Fig. 4. Resistance curve for the second point machine, direction: right

Measuring the switching resistance at different actuation delays

The switching resistances were measured individually and in comparative pairs of machines. Double-channel measurements were made on point machines 1 and 2, 1 and 3, and 2 and 3. The curves show a comparison of measurements for the given pairs of point machines. Individual curves in the figs. 3 and 4 correspond to the measurements of delays given in tab. 1

Switching resistance measurements for different delays between machines have shown that only in the case of delay E, the switching delay diverges from other values. This may mean that additional switching resistance values appear as a result of irregularities in the locking operations. This change in delay value can be noticed most visibly for switch point no. 3 in the right direction. Considering that a significant spike in the switching resistance was also noticed for point machine no. 2, we can assume that this delay is abnormal. For other delays, we can assume that they are not directly related to the switching resistance value.

Delay measurement

The following principle was adopted for measuring the delay times between point machines: the curve name contains the numbers of point machines with measured delays, e.g. 12 means that delays between machines 1 and 2 were measured, while the letter shows the delay. The first digit means the machine on channel two (left), while the second digit means channel one (right). Delay curves were presented for delays A and E and the rest was omitted as they did not diverge from the discussed valued.

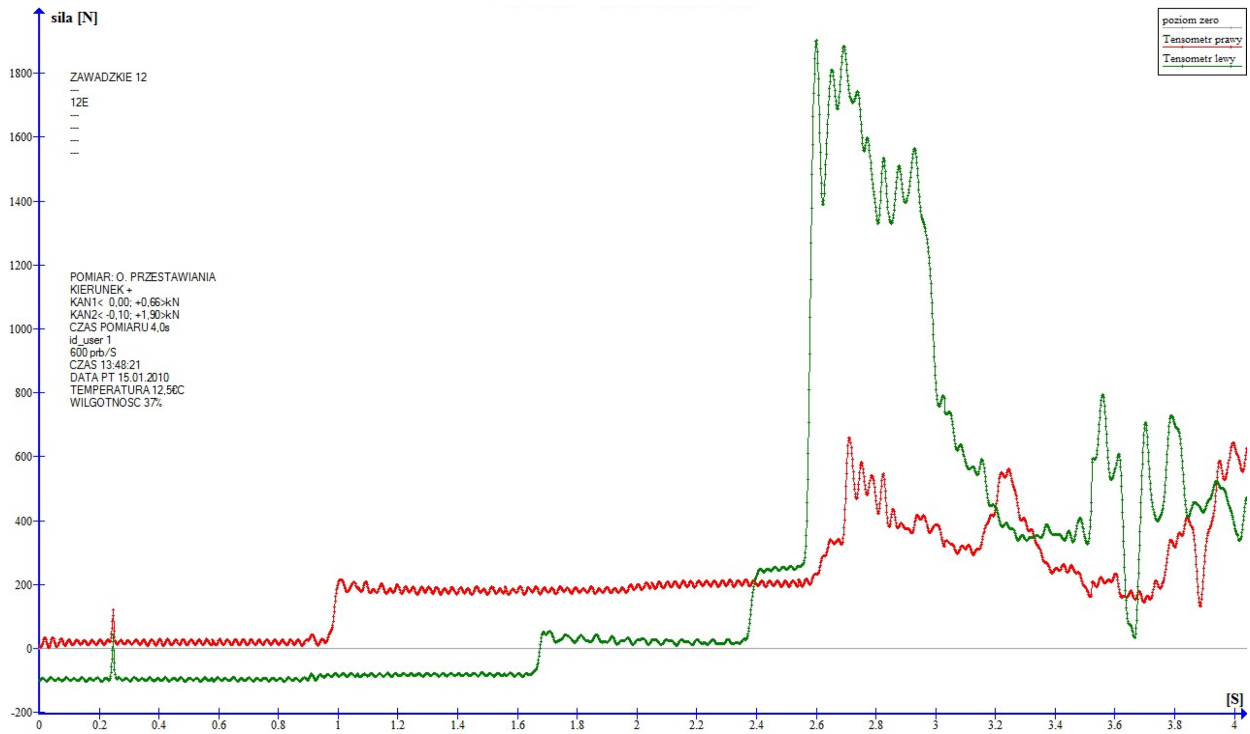
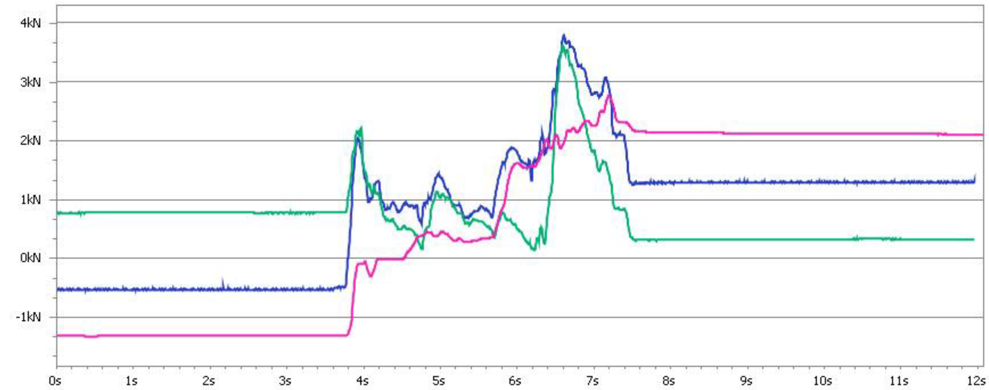


Fig. 5. Switching resistance curves for time delays between point machines 1 and 2, delay: A, direction: right

Measurements have shown that the delay in actuating individual point machines and changing the motor speeds is directly related to the measured switching delays on the mechanical side. This is due to the fact that the switching point intended for a multi-machine configuration is equipped with several (in this case, three) sets of point locks, and its points are long and somewhat elastic between locks as well as between the third point lock and the frog.

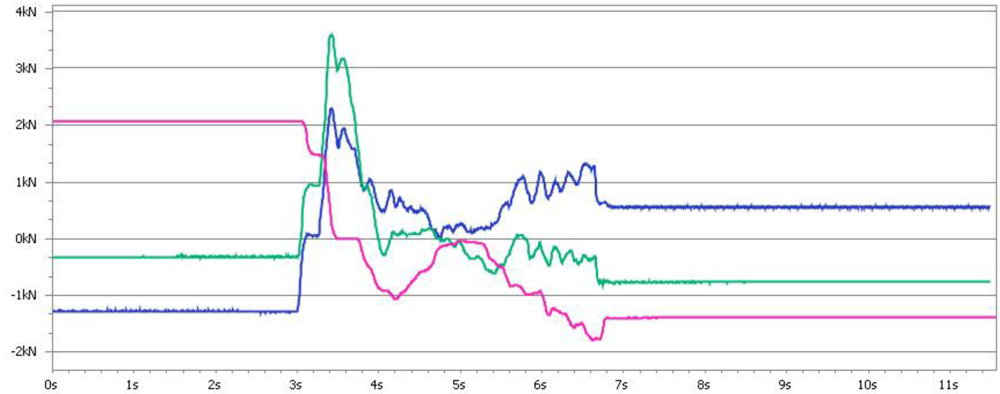
The research has proven that the delays designed by the manufacturer are appropriate. It can be assumed that the delay between the second and the third machines should not exceed 250 ms. The delay between the third and the first machines should not exceed 850 ms. The delay between the second and third point machines is significant, but only exceeding 250 ms (delay E - 300 ms) caused a visible change in the switching resistance value.



	STATION	OCC	P type	Point machine type	Point machine NR	F type	Date	Tester	HZMS.NR	Measuring bolt S.NR
	---	---	---	---	11	Setresist >	2009-12-10	Jakub Młyńczak	1015	93594
	---	---	---	---	11	Setresist >	2009-12-10	Jakub Młyńczak	1015	93589
	---	---	---	---	21	Setresist <	2009-12-10	Jakub Młyńczak	1042	93591

Comments
Niebieski - kanał 1 - 1-wsze zamknięcieZielony - kanał 2 - 2-gie zamknięcieRóżowy - kanał 3 - 3-cie zamknięcie

Fig. 6. Switching resistance measurement. Switching direction: left



	STATION	OCC	P type	Point machine type	Point machine NR	F type	Date	Tester	HZMS.NR	Measuring bolt S.NR
	---	---	---	---	11	Setresist <	2009-12-10	Jakub Młyńczak	1015	93594
	---	---	---	---	11	Setresist <	2009-12-10	Jakub Młyńczak	1015	93589
	---	---	---	---	21	Setresist >	2009-12-10	Jakub Młyńczak	1042	93591

Comments
Niebieski - kanał 1 - 1-wsze zamknięcieZielony - kanał 2 - 2-gie zamknięcieRóżowy - kanał 3 - 3-cie zamknięcie

Fig. 7. Switching resistance measurement. Switching direction: right

Mechanical lock coupling configuration

The switch was equipped with an EEA5 point machine and a mechanical coupling of point locks. Measurements were made using an HZM [1] device, which is used to measure the forces within the point machine-switch point system in the following configurations: double-channel measurement (with plungers placed between the adjustment rod of the point machine and the adjustment rod of the bar as well as between the driveshaft of the coupling and the bar of the first lock)-triple-channel measurement (with plungers placed between the adjustment rod of the point machine and the adjustment rod of the bar as well as between the driveshafts of the coupling and the bars of all locks) - Figs. 6 and 7.

Conclusions

Considering the cooperation of the switch point in question with point machines, it has to be said that this switch point can operate in a multi-machine configuration. Changes to the delays between individual point machines within the range specified by the switch point's manufacturer have no influence on the increased switching resistance, provided that the delay between the second and third point machines does not exceed 250 ms. In no case has the switching resistance exceeded 4 kN, which is the upper limit for this switch point. It can, therefore, be said that the cooperation between the point machines and the switch points was on the right level throughout the whole range of analysed delays. Exceeding the delay time of 250 ms influences the quality of cooperation between point locks, so exceeding this level should be avoided.

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Ключові слова: стрілочний привод, вістряк, що швидко переводиться, опір.

Ключевые слова: стрелочный привод, быстро переводимые остряки, сопротив-ление.

Key words: point machine, high speed switch point, resistance.

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