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"SHOOTING TO TARGET" FROM THE FIRST BRAKING POSITION

The research goal was to examine the functioning of various cuts of wagons in the track lead and to verify the hypothesis that there is a correlation between kinetic energy of the cut before the first position retarder and losses of energy in the track lead behind the first position retarder and to use collected measure data to produce "Shooting to target" from the first braking position so that the speed set in beforehand was achieved at the second braking position.

„STRZAŁ DO CELU" Z PIERWSZEJ POZYCJI HAMOWANIA

Celem pracy było zbadanie funkcjonowania różnych odprzęgów wagonów na torze oraz sprawdzenie hipotezy, że występuje korelacja pomiędzy energią kinetyczną odprzęgów przed pierwszą pozycją hamulca torowego i stratami energii w torze za pierwszą pozycją hamulca torowego oraz wykorzystanie zebranych danych pomiarowych do wygenerowania „Strzału do celu" z pierwszej pozycji hamowania tak, aby ustalona prędkość została osiągnięta w drugiej pozycji hamowania.

1. INTRODUCTION

In the 1980s the marshalling yard operation was automated on 15 marshalling yards at PKP. The automation covered switching points on the basis of a shunting card and track retarders control. Two braking positions were applied. The task of a retarder at first braking position was to set such an OUT-speed on the basis of measurement of running parameters of cuts so that the wagon would reach the second braking position with the speed of 5m/s. The "shoot to target" operation was executed by means of the retarder in the second braking position. Wagons standing at the marshalling track were the target and the impact speed was lower than 1,5m/s. The capacity of up to 4 000 wagons/24hours was achieved at these marshalling yards.

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The traffic volume at PKP has gone down during recent years. The above mentioned marshalling yards currently handle about 800-1000 wagons per 24hours. Due to limited resources maintenance of automation equipment at marshalling yards has posed a problem for PKP.

Therefore, the question has arisen whether it would be possible to 'shoot to target" from the first braking position for the volume of wagons that are handled at the marshalling yards? If it was possible then the retarders at the first braking position would only operate at the marshalling yards. The retarders at the second braking position would be a source of spare parts for the retarders at first braking position that would be in operation.

Institute for Traffic Control Systems(Instytut Systemów Sterowania) together with the company Bombardier Transportation (ZWUS) Polska Sp. z o.o. who has been granted a 50% financing from Polish Scientific Research Committee(Polski Komitet Badań Naukowych) undertook to find the answer to this question.

The marshalling yard in Tarnowskie Góry was selected for conducting the tests. The marshalling yard in Tarnowskie Góry is equipped with complete automation equipment described above. The said automation equipment handle the capacity of about 800 wagons/24hours.

Two test objectives were set:
- Identification of the running parameters of the cuts of wagons.
- "Shooting to target" from the first braking position so that the speed set in beforehand was achieved at the second braking position.

2. IDENTIFICATION OF RUNNING PARAMETERS OF THE CUT OF WAGONS

The research goal was to examine the functioning of various cuts of wagons (further called cut) in the track lead and to verify the hypothesis that there is a correlation between kinetic energy of the cut before the first position retarder and losses of energy in the track lead behind the first position retarder.

It has been determined on the basis of collected measure data, which parameters have well and poor running cuts.

On the basis of the measures, using statistical methods, the losses of speed in track leak have been determined for two basic groups of cuts: loaded and empty.

2.1. PLACE OF RESEARCHES

The researches have been carried out at the marshalling yard Tarnowskie Góry (TGm-31) on a chosen half fan of sidings on the tracks: 345, 346, 347 and 348, using the retarder H4.

For the examined cuts, the following data from the cut card has been collected:

- cut type abbreviations_ (V, X, /, O, VV, XX etc.);
- cut mass;
- number of siding;
- date and time of marshalling;

The cut card was sent from SMS system. Beside the data from the cut card, for each cut the following data was collected:

- time of passing between two first ELS-7 wheel detectors of the cut identifier;
- number of axis counted by cut identifier;
- time of passing between the CTI wheel detectors, placed before the first position retarder;
- time of passing between the CTI wheel sensors, placed after the first position retarder;
- time of passing between the CTI wheel detectors, placed before the second position retarder on the tracks: 345, 346, 347 and 348;
- time of passing between the CTI wheel detectors, placed after the second position retarder on the track no 348;
- time of passing between the basis after the first position retarder and before the second position retarder;

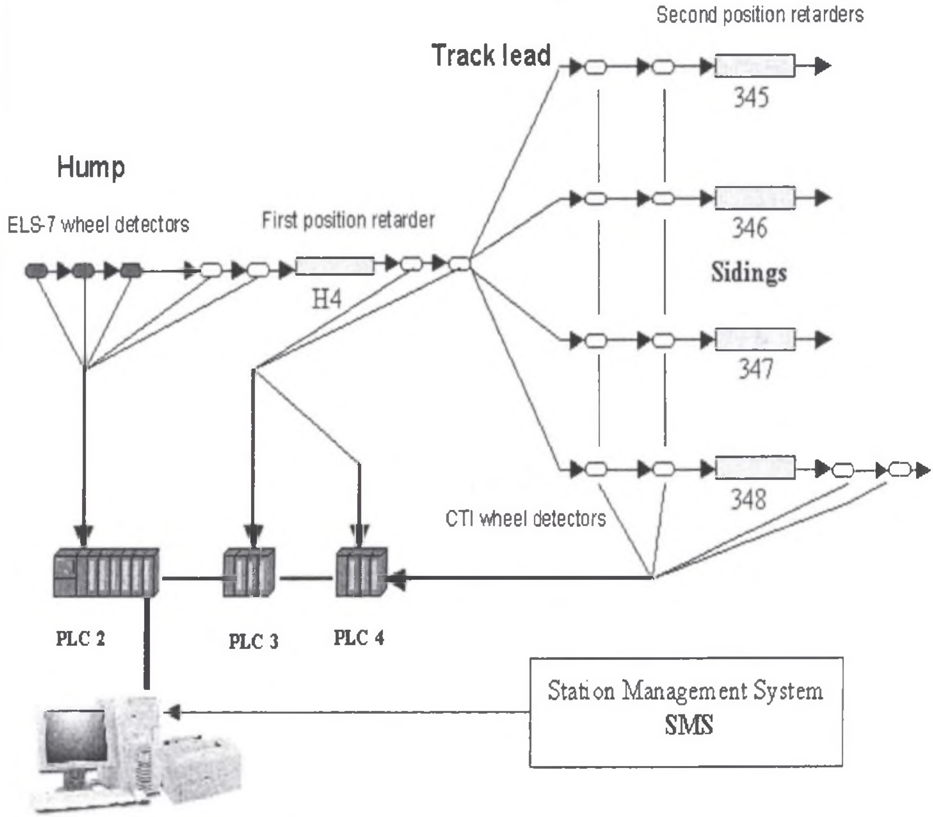

Fig.1. Place and system used in researches

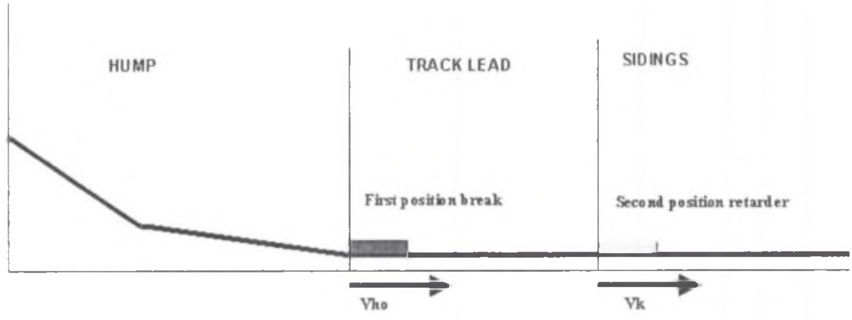

Fig.2. Situation plan with zones and speed measures

On the basis of times measurements, the following speeds have been calculated:
- pushing speed of the train;
- IN-speed into the first position retarder H4;
- OUT-speed from the first position retarder H4;
- IN-speed into the second position retarders (for the tracks: 345, 346, 347, 348);
- OUT-speed from the second position retarder at the track 348

All data have been collected automatically.

2.2. MEASURE DATA ANALYSIS

The data analyzed have been sorted by cut type and by siding track, to which the cut was going. For each cut, a Characteristic Energetic Parameter (CEP) has been determined in the zone before the first position retarder. Characteristics for groups of cuts have been determined. It is obvious that the cuts running worse lose more energy in the track lead and they should behave similarly in the zone before the primary retarder brake. The analysis of various types of cuts proved that this hypothesis was right.

2.2.1. THE ANALYSIS OF FREE RUNNERS

The cuts have been sorted by the siding tracks, and then by the value of characteristic energetic parameter CEP. For the free runner the CEP parameter was changing between 45 to 56. Cuts of small CEP calculated for the zone before the first position retarder have worse running parameters than cuts with high CEP in this zone.

An example of diagrams for good running cuts has been presented in Fig.3. The diagrams present the correlation between CEP and IN-speeds into the second position retarder and the OUT-speeds from the first position retarder.

$$V_4 = f(V_3)$$

where:
V_4 – In-speed into the second position retarder;
V_3 – Out-speed from the first position retarder;
where CEP indicated by one colour is constant

Points on the graphs marked with colours, which characterise the CEP for a particular cut. Two classes of free runner have been selected. It has been assumed that cuts with CEP from 46 to 50 are worse running cuts within the class of free runner, while those with CEP form 52 to 56 are better running cuts.

For these two sub-classes of free runner, straight lines have been determined using the method of linear regression.

Other types of cuts behave in a similar way. The more cars the cut_contains, the more stable it its behave in the track lead.

2.2.2. THE ANALYSIS OF BAD RUNNER

The cuts have been sorted by the siding tracks, and then by the value of CEP. For the bad runner the CEP was changing between 36 to 50. Cuts with small CEP calculated for the zone before the first position retarder have worse running parameters than cuts with high CEP in this zone.

Like for good runner, it was necessary to examine if there was a correlation between the CEP and the loss of speed in the track lead after the first position retarder.

Such a correlation exists, and Fig.4. presents diagram describing this correlation for the bad runners. These diagram present the same correlation $V_4 = f(V_3)$.

Points on the graphs marked with colours, characterise the CEP for a particular cut. Three classes of bad runner have been selected. It has been assumed that cuts with CEP from 36 to 40 are worse running cuts within the class of bad runner, while those with CEP form 42 to 44 are mean running cuts, and those with CEP from 46 to 50 are good running cuts within the class of bad runner.

For these three sub-classes of bad runner straight lines have been determined using the method of linear regression.

2.3. CONCLUSIONS

On the basis of researches in the track lead zone after the first position retarder and the measures of CEP of cuts in the zone before the first position retarder, it has been found that there is a correlation between the behave of the cuts in these two zones. This means that the cut, which has a small energetic CEP before the first position retarder, will behave in a similar way in the track lead zone. There is a similar situation when the cut has a high CEP. In such a case it is a free runner in the track lead.

Having analyzed the measured data, two sub-classes within the class free runner_and three classes within the class bad runner have been selected.

3. "SHOOTING TO TARGET" FROM THE FIRST BRAKING POSITION SO THAT THE SPEED SET IN BEFOREHAND WAS ACHIEVED AT THE SECOND BRAKING POSITION

The second objective of the tests was to set the OUT-speed of the cut from first braking position in such a way so that the speeds like for example 1,5m/s, 2m/s .... 5m/s could be achieved in the second braking position.

It actually is "shooting to target" from the first braking position. The retarder at the second braking position instead of wagons standing in the marshalling track constitutes the target.

In this way we wanted to prove that we can release cuts from the first braking position at such a speed so that at any location of a marshalling track any set speed can be achieved, for example 1,5m/s can be achieved at a point of wagon stand still on a marshalling track.

4. FINAL CONCLUSIONS

The following requirements must be met in order to conduct "shooting to target" from the first braking position:

- The first braking position retarder must realise the set speed with the accuracy of +/- 0.1ms
- It must be possible to regulate the pushing speed of the train into the top of marshalling yard automatically so that the free runner that leaves the first position retarder at a low speed was not caught up in the track lead with a bad runner that leaves the first position retarder at a high speed. Such situations can be foreseen through analysis of a marshalling card. One can find data in the specialised literature about the number of such cases occurring during the marshalling operation and they range from 1to 5%.
- The research should be continued at a site that is equipped with more precise retarders and with a system for automatic regulation of pushing speed of a marshalled train.

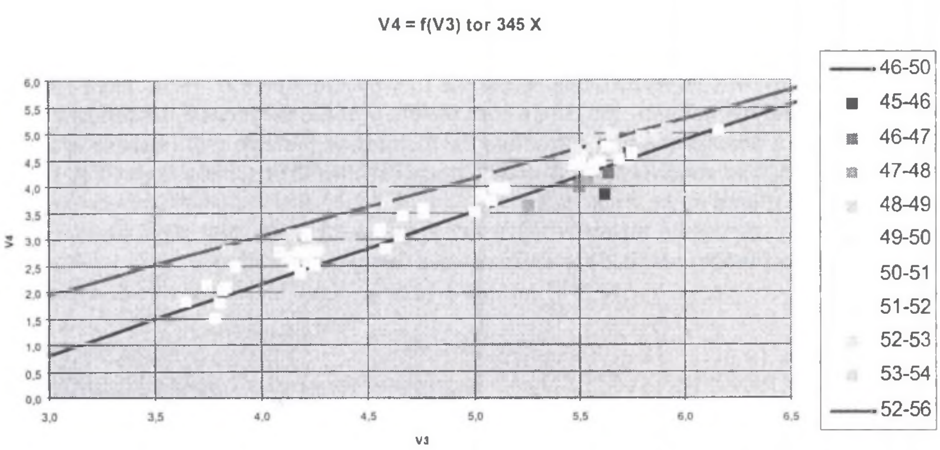

Fig.3. Characteristics for free runner

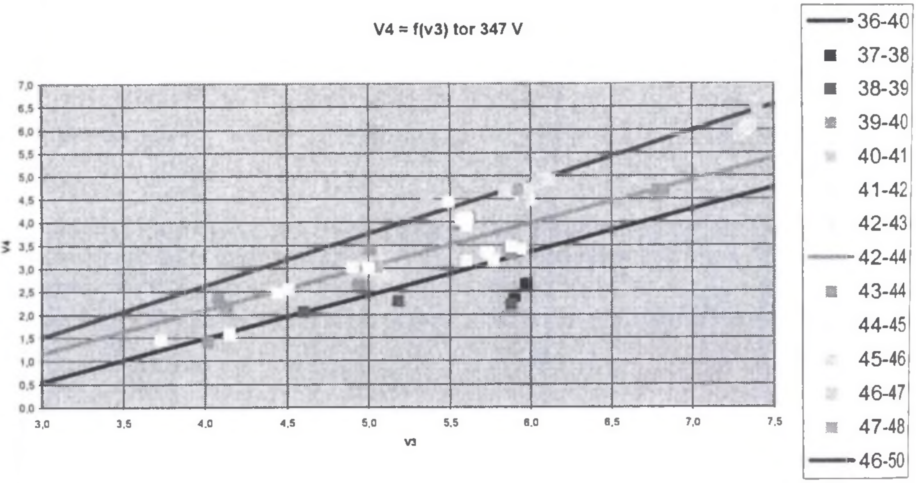

Fig.4. Characteristics for bad runner

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Reviewer: Prof. Andrzej Lewiński