

BREAKING OF COUPLING OF TRAINS ON THE SERBIAN RAILWAYS

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Abstract – This paper proposes an analysis of breaking of train coupling which occurred on the Serbian Railways (ŽS) in the period since 2007. by 2011. The problem of longitudinal dynamic forces, especially in freight trains, is most evident in the Serbian Railways, and for the reference period breaking of coupling of freight train occurred on a total of 201 cases (an average of 40.2 cases per year). Analysis of breaking of freight train coupling will be done based on number and place of breaks relative to the length of the freight trains, driving regime of trains, speed before breaking of coupling, damaged parts, causes of train breaks, etc. This analysis will identify the main factors that affect more frequent emerge of freight trains breaking of coupling, in order to prevent accidents and improve safety in freight railway traffic.

Keywords – railway, traffic safety, accident, breaking of train, breaking of coupling, break couplers, train breaks apart.

1. INTRODUCTION

The basic indicators of railway traffic safety are the number and types of accidents [1]. According to Regulation 19 [2] registration, statistical monitoring and publishing data of the accidents and incidents occurring in rail transport and other cases relevant to the safety of railway traffic were obligatory in reference period. The provisions of Regulations [3] define concept and types of accidents on the Serbian Railways. Accidents are defined as cases in which one or more persons were killed or injured, or caused damage to property, or there has been a disruption, danger or obstruction of railway traffic.

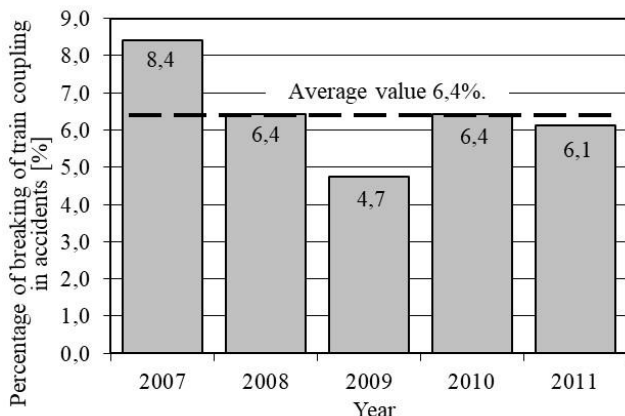


Fig.1. Percentage of breaking of train coupling in accidents on ŽS in period 2007-2011.

The number and types of accidents, reported in nominal and relative terms, are the primary indicator of railway traffic safety. The number of accidents per millions of tonne-kilometres (million tkm) is relative number of accidents.

The average number of accidents on the Serbian Railways in the period 2007. - 2011. is 558,2 accidents. During this five year period, there were a total of 210 cases of breaking of train coupling which amounts to an average of 42 cases per year (Fig.1). Breaking of coupling of trains in total number of accidents of reference period is approximately 6,4%.

2. BREAKING OF COUPLING OF FREIGHT TRAINS

Average 95,8% of breaking of coupling occurred on freight trains in the last five years, which amounts to a total of 201 cases or 40,2 cases per year (Fig. 2). Less than 2 cases per year 4,2%, occur on passenger trains. Therefore, further analysis will be performed in cases of breaking of freight trains coupling.

There are two types of trains breaks apart according to cause and consequences:

- when freight trains have only one traction (pulling) locomotive,
- when freight trains have two locomotives, one pulling and other pushing.

Breaking of freight train coupling with only one locomotive occurs in 80,6% and with two

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locomotives, (one pulling and other pushing) in 19,4% of relevant cases in reference period (Fig. 3). In the analysis were taken into consideration only the relevant cases e.g. breaking of freight trains coupling with only one locomotive, and disregard breaking of semi-automatic coupling as well as other special cases.

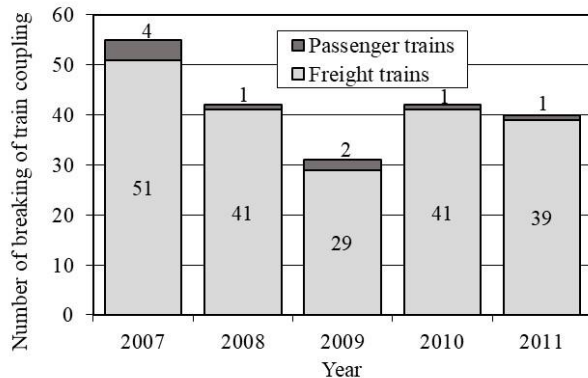


Fig.2. Breaking of train coupling for passenger and freight train

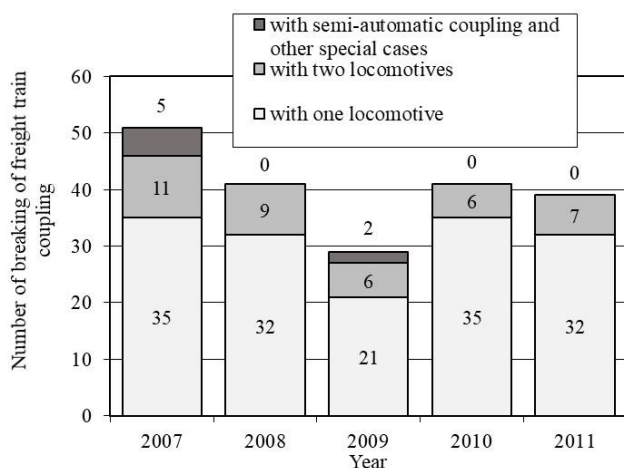


Fig.3. Number of breaking of freight train coupling

Breaking of freight train coupling with pulling and pushing locomotives occur, in most cases, when it comes to forced braking on the pushing locomotive, whether the cause is human or technical error. Trains breaks apart in two or more places, more frequently (approximately 30% of cases) with this type of traction. Primarily cause of the breaks in this cases, were poor synchronization of pulling and pushing locomotives.

Breaking of trains coupling is result of a large longitudinal dynamic forces in trains, due to traction or braking forces. Large longitudinal dynamic forces in a composition that lead to breaking of trains coupling depend of circumstances, such as state and type of traction and braking devices, the conditions of exploitation etc.

Factors that increase the longitudinal dynamic forces in the train, and thus the occurrence of potentially breaking of coupling of trains, among others are [4]:

- Braking regime (G/P) - P braking have a shorter braking time, i.e. braking force is rapidly evolving and increase longitudinal dynamic forces;
- Length of train - with increasing length of trains (at the same train weight) the longitudinal dynamic forces were increased;
- Composition of the train - empty or two-axle car at the front of the train increasing longitudinal dynamic forces;
- State of coupling - the loose coupling in train increase longitudinal forces approximately 25% relative to tight coupling;
- Mass of the train - with increasing mass of the train longitudinal dynamic forces are increasing;
- Draw gear etc.

3. ANALYSIS OF BREAKING OF FREIGHT TRAINS

Breaking of trains coupling analysis should point out when and where to expect the occurrence, in order to apply preventive measures to reduce the number of breaks.

Analysis of train breaks apart can be done in respects of:

- Number and position of breaks relative to the length of the trains (compositions),
- Driving regime of the train,
- Speed of the trains,
- Composition of the trains, (number of wagons, the length and weight of the trains, etc.),
- Causes of breaks,
- Result of a breaks (economical and logistic),
- Damaged parts etc.

3.1. Number and position of breaks

Freight trains with only one locomotive, have train breaks mostly at one place (i.e. train breaks apart in two parts) in 91% of relevant cases in reference period. Only in 7,1% of cases there are breaks at two places on the train (i.e. train breaks apart in three parts), or in 1,9% of cases train breaks at three places (Fig. 4).

Breaking of freight trains coupling operating with only one locomotive relative to the length of the train (composition) show that 59,1% of breaks occur in the first third of the train length, with 32,9% between locomotives and first wagon (Fig. 5); 17,7% of trains breaks usually occur between first third and second third of the train length.

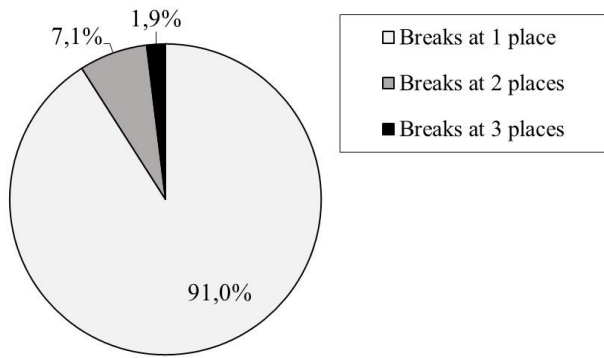


Fig.4. Percentage of places of freight train breaks

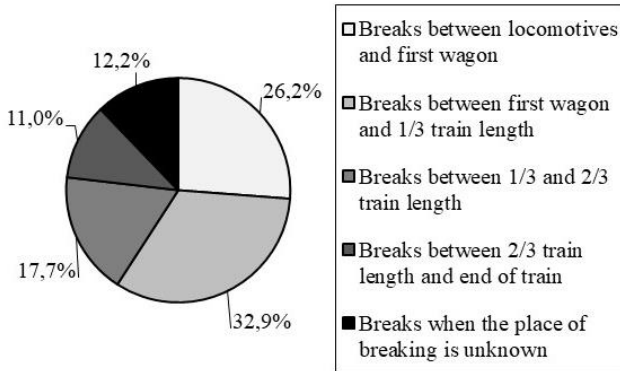


Fig.5. Position of breaks relative to the train length

3.2. Driving regime before breaking

Breaking of freight trains coupling operating with one locomotive mainly occur during braking - 53% and pulling – 22% (Fig. 6), while only 9% of breaks occur during driving. In 11% of break cases driving regime wasn't determined. In several cases there was a breaking during train pushing with one locomotive (5%).

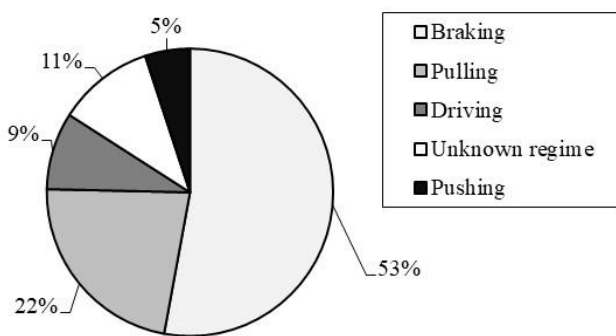


Fig.6. Driving regime before breaks

Correlation between driving regime and position of breaking relative to the train length show that dominant driving regime before breaks, between locomotives and first wagon, are pulling and braking (Fig. 7), and in the rest of the train length most dominant is braking.

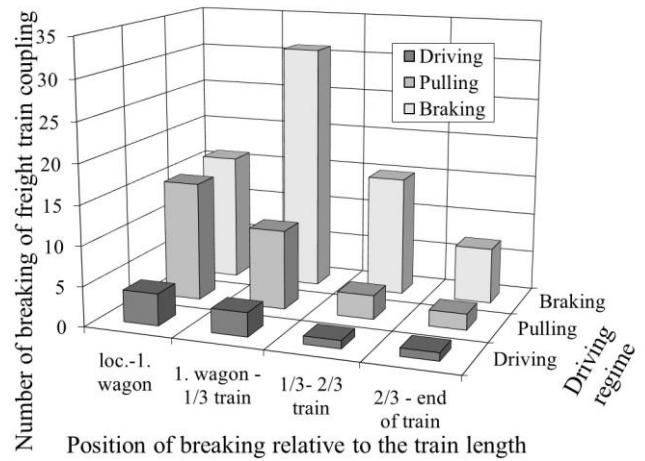


Fig.7. Correlation between driving regime and position of breaking relative to the train length

3.3. Train speed before breaking

In most cases, train speed before breaking was below 30 km/h (70,4%, Fig. 8). As the low speed and number of starts and stops (traction and braking) more frequent in the railway station and railway yard, approximately 45% of trains breaks occurred in this area.

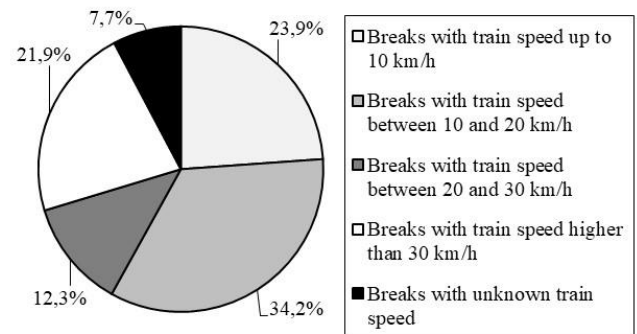


Fig.8. Train speed before breaks

Correlation between driving regime and train speed demonstrate that most dominant driving regime before train breaks is braking (Fig. 9) in all train speeds, except speed up to 10 km/h.

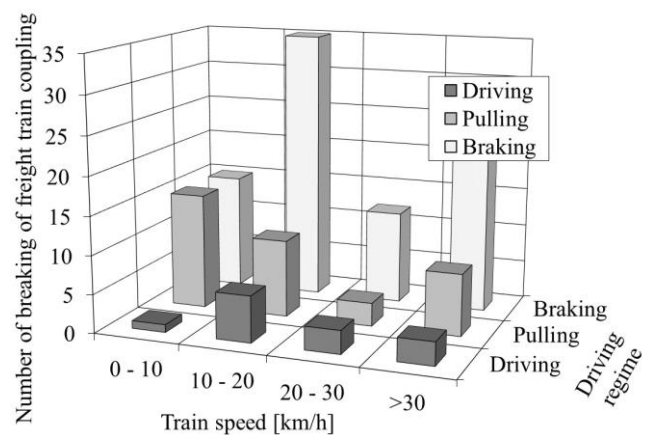


Fig.9. Correlation between driving regime and train speed

3.4. Damaged parts

Most damaged parts in train breaks are (Fig. 9):

- Coupler in 30,8% of cases and
- Draw gear in 46,2% of cases.

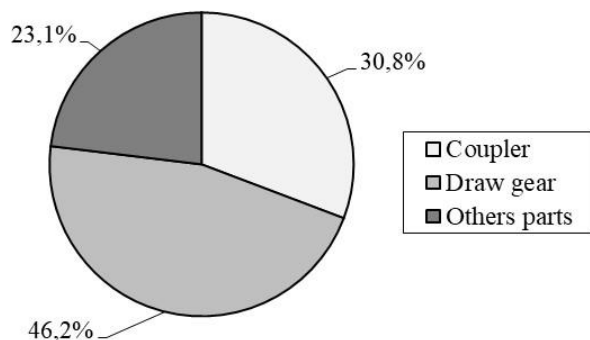


Fig.10. Damaged parts in train breaks

Damage to other parts were occurred in 23,1% cases. Mainly was damaged either coupler or draw gear, and rarely, in approximately 12% they were damaged at the same time.

3.5. Causes of train breaks

Most mentioned cause, of trains breaks apart was state of the material of damaged part, in 50,8% of cases (Fig. 10). Very present were uncorect driving of train with 15,5% and inadequate composition of train and uncorect coupling (according to regulations [5]) with 19,9% of cases. Other and unknown causes makes 13, 8% of cases.

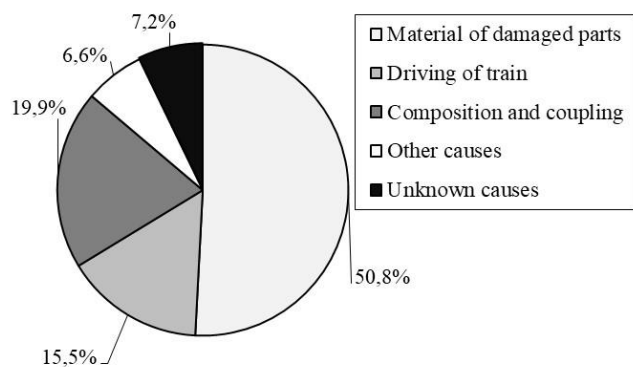


Fig.10. Causes of breaks

3.6. Other factors of train breaks

Other factors of train breaks, such as composition of the trains or product of a breaks are not clearly distinguished.

Analysis could not confirm dependence of train composition on the train breaks, because the breaks occurred on composition either it was in accordance with the Serbian Railways regulations [5] or not nearly in the same number.

Correlation between length and mass of the train is not distinguished, because the length of the trains

breaks ranged from 152 m to 720 m, with average length of 394,6 m. The minimum number of wagons in freight trains who broke apart is 10, and the largest number of wagons is 51. It should be noted that the average freight train in reference period have 26,7 wagons. Correlation between mass of the train wasn't defined, mass of trains that broke apart was from 527 t to 2333 t. The average mass of a train in reference period was 1347,6 t [1].

Direct material damage of train breaks was approximately 100,000 dinars, and traffic delay was approximately 3 to 4 hours by train breaks.

4. CONCLUSION

In order to deliver appropriate conclusions and propose concrete measures to reduce the number of train breaks on Serbian Railways we perform analysis of break cases in a five-year period from 2007. to 2011. Actual value of the longitudinal dynamic forces in the freight trains corresponds to the current state of trains, therefore they can deviate from values obtained in some tests, e.g. ERRI [4] from 90's.

In cases of freight train with one locomotive primary cause of the train breaks apart was state of the material of damaged part, as data collected according to Regulation 19 [2] show (Fig. 10). Secondary cause of the train breaks was uncorect driving of train and third inadequate composition of train and uncorect coupling.

In 58,1% of cases, train speed before breaking was below 20 km/h, and approximately 45% of trains breaks occurred in railway station and railway yard as result of frequent number of starts and stops (traction and braking). That conforms manner of train driving as one of significant causes of train brakes.

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