

# Considerations on the derailment causes over the years on the Romanian railway network

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**Abstract.** This paper has analysed a series of railway accidents produced by derailment in two different time periods: 1938-1945 and 2010-2011, in attempting to compare direct causes typologies. The comparison serves as purpose to establish the way in which technological development produced several changes and the conclusions can be surprising. In spite of the technical evolutions in the railroads industry during 70 years, a lot of the causes remain the same.

## 1 Introduction

The railway accident is defined in the national legislation [1], as well as in the European legislation [2] as an “unforeseen event, unwanted and unintended or a specific chain of events which had harmful consequences”. The derailment is one of the distinct categories of the accidents according to the same legislation.

The study of the derailment and the avoid in occurring a such event had always an utmost importance due to safety but also economic reasons. The train derailments are the result of the contact loss between the wheel and the track or the rolling of the wheels outside the track (either on the exterior of the tracks either between them). The railway track sustains the wheels but it also guiding them. In consequence, any situation in which this capacity is reduced, it results in a derailment.

In the specialized papers that analyses the phenomenon [3], the mechanisms that determine a derailment are classified in the following categories: derailments as a result of wheel flange climb, derailments caused by wheel lift, derailments caused by gauge spread, derailments determined by rail failure, derailments due to incorrect switch rail position and condition, derailments caused by suspension failure.

The ways of derailment investigation can be based on a deterministic method that explains the mechanisms in order to establish the conditions that lead to their occurrence or methods based on statistics that focus on the probability analysis of the causes. Generally, in Romania, establishing the causes of the derailments was based on a deterministic method. A retrospective analysis on the derailment causes could highlight aspects that could serve as a starting point in establishing recommendations to reduce this type of accident.

In this paper it is presented a comparison of the types of causes of derailment in two different time periods: 1938-1945 and 2010-2014.

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## **2 Causes of derailments produced between 1938-1945**

In the railway history, since the beginning, on the Romanian railway network several derailments drew attention by their consequences. As not enough data is available to present an exhaustive view on these types of accidents, there were chosen only significant cases that could present elements leading to the derailment causes.

Therefore, out of different papers analysing railway accidents during time [4], the following information were extracted:

- The 11th of April 1938 – on the entering in the Cosna railway station, the first wagon of the working train L consist of 11 wagons, hauled with double traction, derailed over the switch no. 1, which was unguarded and not lightened. Following the derailment, the wagon overturned and determined the death of one of CFR staff and injuring another 4. The cause of the derailment was a malfunction of the point of the switch.
- 12th of March 1939 – on the entering in the Sarulesti railway station, the rear 2 wagons from the passenger train nr. 9003 derailed and overturned because of the switching under the train of the switch no. 1 from the station. Following the derailment 4 employees died and another 2 were injured.
- 20th of February 1940 – between the railway stations Vintu de Jos and Sibot occurred the derailment of the locomotive and 25 wagons from the train of rapid post no. 2605. The accident caused the death of 2 persons and the injuring of another 4. The cause of the accident was a missing fishplate.
- 3rd of October 1943 – On the entering in the Manasia railway station, the locomotive and the first 11 wagons from a working train derailed on passing over the switch no.4 which was half opened. The accident caused the death of one person and injured another 4.
- 20nd of October 1944 – the locomotive and the first 4 wagons from the train no.2585 (military number) derailed between the stations Manastirea Turnu and Lotru, because of breaking on a length of 600mm of the rim of the wheels from the first wagon. Following the accident one of CFR staff died and 3 other soldiers were injured.
- 17th of September 1945 – after the dispatching of the freight train no.5676 from the Roznov railway station, while passing the Caracău bridge, on a curved track section, one of the stanchion from the wagon was broken and the whole wagon load fell on the bridge. This had as a consequence wagons derailed, 4 persons died and one was injured.

## **3 Causes of train derailments occurred between 2011-2014**

During the 2011-2014 period, a number of 104 accidents occurred on the Romanian railways network that include accidents on level crossing (without considering the ones resulted of the non-closing of the barrier), collisions and derailments. Of this total, 84 are derailments, meaning 81% of them, the percentage for each of 5 years is in the Table 1.

**Table 1.** Percentage of derailments from the total accidents number occurred between 2011-2014.

	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>Total 4 years</b>
<b>Derailments</b>	21	22	19	22	104
<b>Total accidents</b>	31	24	25	24	84
<b>Percentage</b>	<b>68%</b>	<b>92%</b>	<b>76%</b>	<b>92%</b>	<b>80%</b>

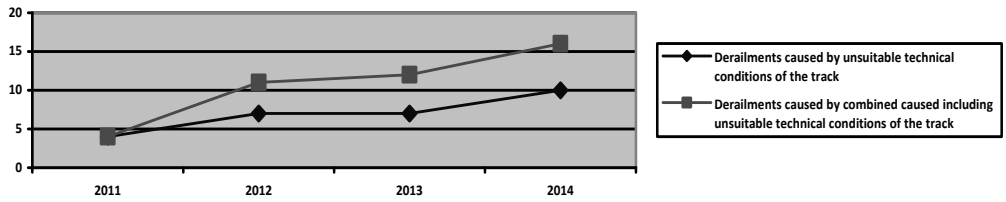
It can be clearly seen that the percentage of derailment in the total number of accidents each ear is significant at a minimum of 68% and even exceeding 90% of the total number.

Information regarding the 84 derailments between 2011-2014 can be found in the investigation reports published by the Romanian Railway Investigation Agency [5]. These were ranked for the analysis by their direct causes in several categories, as shown in the Table 2.

**Table 2.** Derailments classification occurred on the Romanian railway network between 2011-2014 according to direct causes.

<b>Type of cause/Year</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>Total</b>
<b>A. Faults and the rolling stock wear</b>	8	7	3	2	20
<b>B. Wrong handling of the switches or wrong pathing of the trains</b>	6	1	1		8
<b>C. Unsuitable state of the tracks</b>	4	7	7	10	28
<b>D. Broken axles</b>	1	-	-	1	2
<b>E. Colision with obstacles (parts from other railway vehicles)</b>	1	2	2	-	5
<b>F. Signals passed on danger</b>	1	1	-	-	2
<b>G. Combined causes determined by the poor state of the railway tracks and faults to the rolling stock or loading issues.</b>	-	3	4	6	13
<b>H. Uneven repartition of the loading</b>	-	1	2	1	4
<b>I. Meteorological causes or exterior intervention of persons</b>	-	-	-	2	2

If these accidents were to be classified by each type of cause it can be seen that starting 2012 most of the derailments happened because of a non-proper state of the track. Coming secondly, in 2013 and 2014 and the third place in 2012 are the derailments with a combined direct causes: unsuitable technical state of the tracks with failures or the wearnes to the rolling stock. For both types of causes, the increase is linear and this result can be seen in the Figure 1.



**Fig. 1.** Derailments evolution on the Romanian railway network 2011-2014.

For 28 accidents, for which direct causes identified was in connection with the unsuitable state of the railway track, the main types of issues identified was:

- In 2011: unsuitable technical condition of the track, respectively level deviations and gauge over the accepted limits, mainly because the unsuitable condition of sleepers - 3 cases and 1 case generated by the joint failure.
- In 2012: unsuitable condition of the sleepers, rail breakage, track twisting because the track bed condition;
- In 2013: the main causes that led to the appearance of derailments, were generated by the unsuitable technical condition of the track – 7 cases, the problems being due to track twisting because the track bed condition, sleeper condition, unsuitable condition of the track bed because the lack of the broken stone, rail breakage;
- In 2014: identified causes that led to derailments were gauge over the accepted limits -4 cases, level deviation of the track – 3 cases, choking of the broken stone- 1 case, 1 case generated by rail breakage and 1 case generated by the joint failure.

Analysing these situations, we can observe that the unsuitable technical conditions of the sleepers is preponderant which implies the lack of ensuring the imposed limits for the track geometry.

The next type of causes that led to producing 19 accidents are the failures and wears of the rolling stock. For these the below issues were founded:

- For 2011: 3 cases generated by the problems existing at the centre pivot liners or to the side bearer, breaking of parts from wagon (leaf spring, lower brake hanger pin)- 2 cases, problems to the running gear (grooves on the running tread, diameter differences between the wheels) -2 cases; 1 case when derailment occurred following the running of the wagon with the distorted chassis;
- For 2012: the direct cause for 2 accidents was the wearing of centre pivot socket liner or locking of centre pivot; 3 cases with problems to the running gear - grooves on the flange of the wheel, differences between the diameters of the wheels of the same wheelset beyond the limits imposed by regulations in force;
- For 2013: 1 case was generated by the removal of the wheels from the axle; 1 case when derailment occurred following the fracture of the web wheel; 1 case when loosening of the tyre, followed by its cross movement on the monobloc wheel web generated the derailment;
- For 2014: 1 case determined by the wearing of centre pivot socket liner and exceeding of the limits accepted for suspension.

On the third place, considering the identified types of causes are the accidents produced because of the overlapping of track defects and defects of the rolling stock or loading problems, which strengthens the argument that positioning the 2 other types of causes in the

first places is not random. Therefore, for this category there were identified the following types of problems:

- Year 2012 exceeding of the values accepted for the track twisting combined with exceeding limits for the differences of diameters of the wheels from the same wheelset-1 case; unsuitable condition of sleepers combined with exceeding limits for wheel gauge-1 case; the gauge value over the maximum accepted limit combined with the lack of centre pivot socket liner
- Year 2013 exceeding of the values accepted for the track twisting combined with exceeding limits for the differences of diameters of the wheels from the same wheelset-1 case ; unsuitable condition of sleepers combined with exceeding limits for the side bearers clearance -1case; unsuitable condition of sleepers combined with lack of elastic side bearer-1 case ; technical conditions of the joints and sleepers on the point of switch ; unsuitable conditions of the track combined with the lack of wagon mobility in curves-1 case ;
- Year 2014: technical condition of the track combined with exceeding of the ratio between the wheel loads of a single axle across the wagon-2 cases; technical condition of the track combined with uneven load-2 cases; technical condition of the track combined with exceeding of wheelset gauge limit-1 case; exceeding of track gauge combined with breakage of wagon spring-1 case.

On the next level there are the causes determined by a wrong operation of the switches or in a wrong route, accidents in which an important contribution has the human factor.

The other categories of accidents are less in number and without important differences between them, thereof a tendency cannot be established for the analysed period.

## 4 Conclusions

If in the inter-war period, the derailments had in majority causes as tracks defects and human errors (operating the switch under train) or breaking and falling of certain subassemblies, lately the weight of causes of derailment is consisting in the technical conditions of the tracks or technical conditions of rolling stock. A part of the human errors that were resulting in railway catastrophes are now avoided due to the increasing level of signalling safety.

On the other hand some causes as tracks breaking, wear of the switches, axle fracture produced in the past continue happening even though the railway was developed from a technological point of view in the 70 years analysed.

## References

- 1 Romanian Parliament, *Law no.55/2006 on railway safety* (2006)
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- 3 A.H. Wikens *Fundamentals of railway vehicle dynamics* (Swets & Zeitlinger Publisher)
- 4 R. Bellu *Catastrophe, attacks and sabotage on Romanian railways 1860-1980* (1980)
- 5 Romanian Railway Investigation Agency site [www.agifer.ro](http://www.agifer.ro)