KÖZLEKEDÉSBIZTONSÁGI SZERVEZET

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

2006- 0027-5
RAILWAY ACCIDENT

Between Rákospalota-Újpest and Fót stations
5 July 2006

The sole objective of the technical investigation is to reveal the causes and circumstances of serious railway accidents, accidents and incidents and to initiate the necessary technical measures and make recommendations in order to prevent similar cases in the future. It is not the purpose of this activity to apportion blame or liability.

This present investigation was conducted on the basis of

- Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as Kbvt.),
- MET Decree 7/2006. (II. 27.) on the regulations of the technical investigation of serious railway accidents, railway accidents and incidents.
- In absence of other related regulation of the Kbvt., the Transportation Safety Bureau of Hungary conducted the investigation in accordance with Act CXL of 2004 on the general rules of administrative authority procedure and service,
- Kbvt. and MET Decree 7/2006. (II. 27.) jointly serve the compliance with the following EU acts:
  Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification (Railway Safety Directive)
- The competence of the Transportation Safety Bureau of Hungary is based on the Kbvt. until 31st December 2006 and on Government Decree 278/2006 (XII. 23.) from 1st January 2007 respectively.

Under the aforementioned regulations

- The Transportation Safety Bureau of Hungary shall investigate serious railway accidents.
- The Transportation Safety Bureau of Hungary may investigate railway accidents and incidents which - in its judgement - would have resulted in serious accidents in other circumstances.
- The technical investigation is independent of any administrative, infringement or criminal procedures.
- This present final report shall not be binding, nor shall an appeal be lodged against it.

Incompatibility did not stand against the members of the IC. Persons participating in the technical investigation did not act as experts in other procedures concerning the same case and shall not do so in the future.

The IC shall safe keep the data having come to their knowledge in the course of the technical investigation. Furthermore, the IC shall not be obliged to make the data – regarding which the owner of the data could have refused the disclosure of the data pursuant to the relevant act – available to other authorities.

This present final report

was based on the Draft Report prepared by the IC and accepted by the Director-General of TSB. The Draft Report was sent to the relevant parties - defined by law - for reflections. At the same time, the relevant parties and organisations were also informed and invited to the closing discussion of the Draft Report.

The following organisations were represented at the closing discussion held on 5th August 2008:

- National Transport Authority,
- MÁV Zrt. Traffic Department of MÁV Zrt. Infrastructure Management
- MÁV Zrt. Safety Department of MÁV Zrt. Safety Directorate
- MÁV Cargo Zrt. Safety and Security Organisation,

- MÁV-Engineering Zrt.

Abbreviations

MET (GKM)	Ministry of Economy and Transport (Gazdasági és Közlekedési Minisztérium)
TSB	Transportation Safety Bureau
Kbvt.	Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents
MÁV Zrt.	Hungarian State Railways Plc. (Magyar Államvasutak Zártkörűen Működő Részvénytársaság)
IC	Investigating Committee
VBO	The competent Regional Railway Safety Department of MÁV Zrt. Safety Directorate

Summary

Data of the investigation

The head of traffic operations control of MÁV Zrt. reported the occurrence to the TSB duty services at 14 hours 14 minutes on 5th July 2006.

The on duty personnel of TSB reported the occurrence to TSB's head of department on duty at 14 hours 15 minutes on 5th July 2006.

The appointment of the Investigating Committee

The Director-General of TSB appointed the following Investigating Committee (hereinafter referred to as IC) on5th July 2006 to investigate the railway accident:

Investigator-in-Charge	Gábor Szeremeta	accident investigator
Member of IC	András Kovács	field investigator technician
Member of IC	Sándor Orczy	accident investigator

The IC membership of Sándor Orczy terminated on 1st May 2007, since then he is no longer the civil servant of TSB. To substitute him, the Director-General of TSB appointed Zita Béleczki as a member of the IC.

Classification of the occurrence

Legal basis of the investigation: 19. § (2) b) of Directive 2004/49/EC
7. § (1) b) of Act CLXXXIV of 2005 (Kbvt.)

Type of railway system: National

Type of main occurrence: Railway accident

Character: Derailment

Consequence:
☐ Fatal
☐ At least 5 seriously injured persons
☐ At least 500 million HUF material damage

Type of movement: Regional passenger train

Location: Open track

Injuries:

	Fatal	*Serious*	*Minor*	*None*
Passengers				☒
Railway staff				☒
LC users				☒
Trespassers				☒
Others				☒

Infrastructure manager: MÁV Zrt.

Operator: MÁV Zrt.

Time of the accident

13 hours 42 minutes on 5th July 2006.

Location of the accident

On single-track, electrified line no. 71, between Rákospalota-Újpest and Fót stations, in sections no. 12+32.

Competent investigating authority (according to the location of the accident)
Transportation Safety Bureau

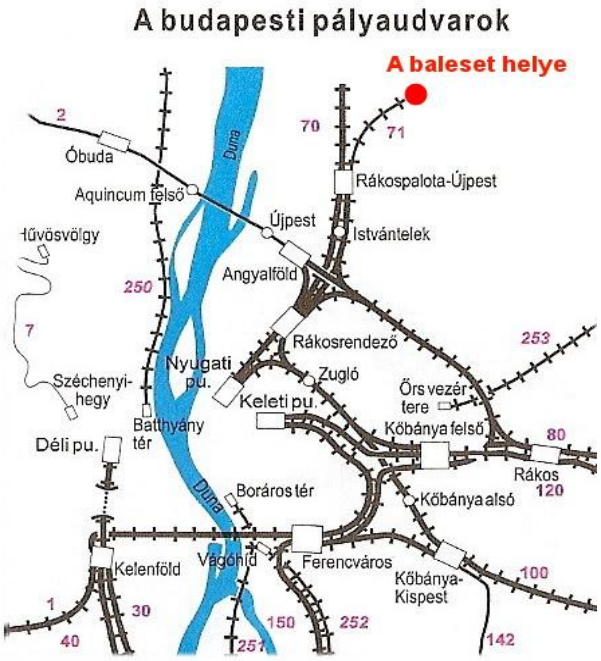

Figure 1: The location of the accident on the railway map of Budapest

Figure 2: The location of the accident (satellite photo)

1. Factual information

1.1. Course of the occurrence

The control car of passenger train No. 2424 (registration number Bmxt-002) which was at the rear of the train derailed with all four axles at a level crossing under construction between Rákospalota-Újpest and Fót stations (track section 12+32), at 13:42 on 5th July 2006. The train was running with a speed of 20 km per hour. There was no injury. As a result of the accident, a 6-metre-long section of the track was damaged. Railway traffic was blocked between Rákospalota-Újpest and Fót stations until 18:20, and replacement buses were used for transporting the railway passengers.

The track inspectorate division based in Aszód which was competent for the given track section conducted rebuilding works at the level crossing the previous day. The level crossing is in track section No. 12+35, with asphalt road surface and easer-rails. As the work had not been finished the previous day, the crossing was temporarily opened for the traffic with a 20 km per hour speed limit.

Figure 3: The rail track at the accident site

1.2. Injuries to persons

There was no injury.

1.3. Damage to railway vehicles

The Bmxt type control car (registration number 50 55 2105 002-9) derailed with all four axles. According to the loss bill, the damage was **101.450 HUF.**

1.4. Damage to infrastructure

The rail track was damaged in a 6-metre-long segment. According to the loss bill, the damage was **197.610 HUF.**

1.5 Reparation costs, cost of replacement buses

The operator did not provide data.

1.6. Personnel information

- MÁV Zrt. track department, operating engineer
  48-year-old man, in current job since 2005
- MÁV Zrt. track department, chief track inspector
  39-year-old man, in current job since 2004

1.7. Train information

Train number	2424
Train type	regional passenger train
Engine ID	BDV-010
Owner of the engine	MÁV Zrt.
Owner of the wagons	MÁV Zrt.
Number of wagons	4
Train length	104 m
Train mass	207 metric tons

1.8. Meteorological information

Weather conditions on the day of the accident: clear and sunny sky with +28^{O}C outside temperature and unrestricted visibility.

There was an 11-degree difference between the daily maximum and minimum temperatures.

1.9. Description of the rail track

The location of the accident is a track section between Rákospalota-Újpest and Fót stations, on a single-track line which is a part of the national major grid and is electrified between Rákospalota-Újpest and Vácrátót stations. Between the 11+16 and 13+71 sections the track curves to the left with a 300-metre radius and has a downward gradient of 2.5 thousandth.

The structure of the rail track is of Type 48 rail fitted without gaps on reinforced-concrete sleepers, in ballast chips (bedding depth 50 cm).

The design speed for the track is 60 km per hour, however, there was a (temporary) 20 km per hour speed limit in force between sections 12+00 and 12+50 due to a level crossing construction. The rails of the level crossing section were connected to the main track with clips and C fasteners, and their embedding had not been done yet.

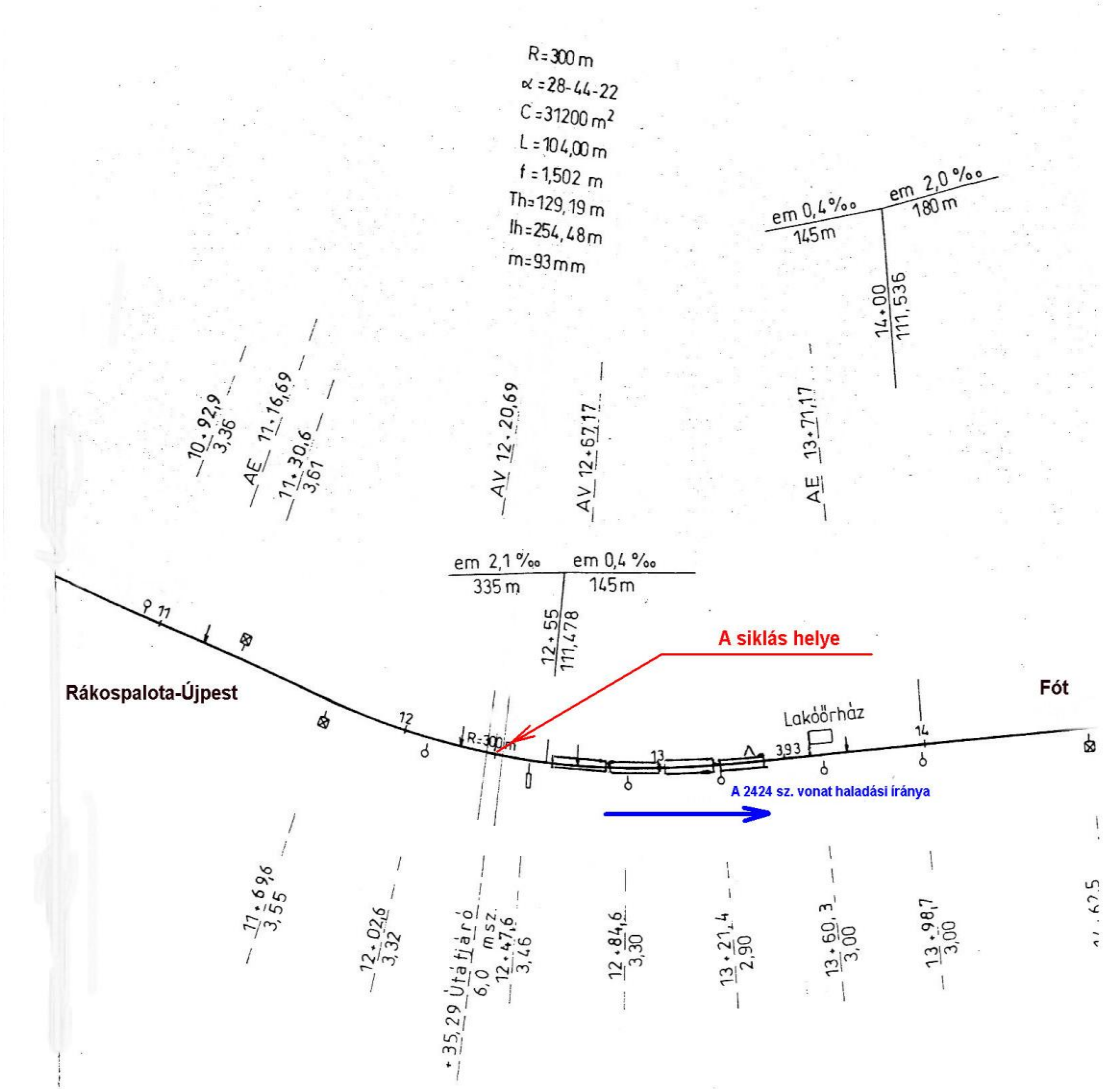

Figure 4: The schematics of the track

1.10. Communications

The communications equipment had no effect on the accident, therefore their analysis is not required.

1.11. Station information

The parameters of the stations between which the accident occurred had no effect on the accident, therefore their analysis is not required.

1.12. Data recorders of railway vehicles

The electric locomotive (ID no. BDV-010) was equipped with a TELOC system, RT 12 type strip chart recorder (serial number N L11248), the measuring limit of which is 150 km per hour. At the time of the accident, a strip able to register speeds up to 150 km per hour was used. The strip chart was clearly readable therefore the IC could use it for analysis.

2. Analysis

The Budapest 14th district Mayor's Office, Department of Construction issued a permit for closing of the level crossing (permit No. 33-71/2006). The construction work began at 16:00 on 4 July 2006 when the workers started to remove the asphalt surface of the road. The work on the rails started at 19:40 based on a MÁV Zrt. order on track closure (order No. Gy.1666-9814/2006. Forg. O.). The competent track inspectorate division based in Aszód was responsible for the coordination of the construction work. The workers removed the rails and the bedding in its entirety. During the night the workers were able to complete the new understructure crown, the lower bedding, and the upperstructure. The upperstructure included new Type 48 rails, fitted on LM reinforced concrete sleepers in ballast chips, with flexible fixing.

The upper bedding of the rails was not finished due to time constraints, therefore the rails were supported only by a limited amount of ballast chips. The rails of the crossing section were connected to the main track with clips and C fasteners. The 20 km per hour speed limit signs were posted between track sections 12+00 and 12+50 as required by regulations.

Having arrived at the accident site, the IC noticed that the new track was substantially deformed, pushed outwards, and the inner rail was lifted. The sleepers in the crossing were found moved sideways, and the cant which was clearly visible at the edge of the crossing became practically nonexistent by the middle.

The IC - with assistance from VBO - conducted measurements of the gauge, cant and chord height of the track. The measurements started from section 12+00, the gauge and cant were checked at each sleeper.

The gauge readings were within the permitted limits in accordance with the current regulations.

The cant readings started from 73 mm. All subsequent readings were consistently higher than the previous ones and at sleeper No. 40 – which was already in the newly built section - they reached the optimal value. According to the alignment plan, the clear arc starts at section 12+20,69 at sleeper No. 35. The cant readings become lower towards the middle of the crossing. The IC measured 25 mm at the point where the wheel flange of the derailed car climbed over the rail and left a mark.

The cant change was too intense, the runoff slope was less than required. The level deformation readings at sleepers 50-59 for a 2.5 m baselength are shown below:

50.	16 mm	
51.	21 mm	
52.	25 mm	
53.	28 mm	
54.	29 mm	
55.	30 mm	
56.	29 mm	updrift starts
57.	27 mm	
58.	23 mm	
59.	16 mm	wheel climb location

Nyomtávolság és túlemelés adatok

Sorszám	Nyomtávolság mm	Túlemelés mm	Megjegyzés	Sorszám	Nyomtávolság mm	Túlemelés mm	Síktorzulás mm	Megjegyzés
1	1442	73	12. szelvény	31	1444	83		
2	1442	75		32	1443	82		
3	1442	76		33	1443	82		
4	1443	76		34	1442	81		régi mező vége
5	1442	75		35	1439	78		új mező eleje
6	1442	74		36	1437	79		
7	1444	71		37	1437	80		
8	1445	73		38	1437	81		
9	1447	75		39	1437	84		
10	1448	77		40	1436	86		
11	1448	77		41	1436	87		
12	1449	77		42	1436	88		
13	1448	78		43	1436	91		
14	1447	75		44	1437	92		
15	1445	76		45	1438	93		
16	1443	77		46	1437	94		
17	1442	78		47	1436	92		
18	1441	80		48	1435	89		
19	1441	80		49	1434	85	8	
20	1439	82		50	1434	78	16	
21	14440	83		51	1435	71	21	
22	1442	83		52	1435	64	25	
23	1444	81		53	1433	57	28	
24	1446	80		54	1432	49	29	
25	1445	82		55	1432	41	30	
26	1446	82		56	1434	35	29	felsodródás kezdete
27	1447	85		57	1435	30	27	
28	1448	86		58	1435	26	23	
29	1449	85		59	1434	25	16	felkapás helye
30	1447	84		60	1433	26	9	
				61	1432	29	1	leesés helye

Húrmérés adatai

Sorszám	Mért érték mm	Számított ívsugár		Sorszám	Mért érték mm	Számított ívsugár		
1	25	500	12. szelvény	28	25	500		
2	25	500		29	18	694		
3	29	431		30	11	1140		
4	29	431		31	3	4200		
5	31	403		32	10	1250		
6	30	416		33	30	416		
7	30	416		34	62	201		
8	33	379		35	93	134		
9	34	367		36	119	105		
10	35	357		37	123	102		
11	36	347		38	109	115		felkapás helye
12	32	390		39	78	160		leesés helye
13	30	416		40	48	260		
14	31	403		41	25	500		
15	30	416		42	10	1250		
16	30	416		43	10	1250		
17	31	403		44	19	660		új mező vége
18	38	329		45	24	520		
19	45	277		46	29	431		
20	42	298		47	38	329		
21	43	290		48	40	312		
22	48	260	új mező elejénél	49	45	277		
23	42	298						
24	38	329						
25	39	310						
26	38	329						
27	30	310						

A húrmérés 10 m-es húrhosszon történt, méterenként. Az első mérési pont a 12. szelvénynél volt.
Az ívkimutatás szerint az ív sugara R=300 m., AE=11+16,69, AV=IE= 12+20,69

2006. július 05.

Figure 5: Results of track measurement made after the accident

According to the level deformation limits table (D.54. Track Construction and maintenance Technical Data, Requirements, Vol I. chapter 51, table 11), the maximum allowed category D error is 25 mm. A category D error means that the track is not safe for train traffic, the track shall be closed. The level deformation reading was 30 mm at sleeper 55!

The analysis of arc measurement results revealed that the track curve radius is decreasing until measuring point 20 where it reaches and holds the value corresponding to R=300 m. The clear arc starts between measuring points 20 and 21. Taking the inaccuracy of the measurement (1-2 mm in average) into account, the IC determined that the chord readings between measuring points 1-26 were in accordance with the radius set in the construction plan. The chord readings start to decrease from measuring point 27 which means an increasing radius. The arc measurements start to decrease from measuring point 27, which shows the increase of the curve radius. After 4 m, the curve radius reaches R=4200m which practically means the straightening of the rail track. Following the curve value of 3 mm measured at point 31, the measured data significantly rose, and the value measured at sleeper 37 indicates curve radius R=102 m. After this, the curve radius increases again and from measuring point 47 it returns to R=300 m.

Having examined the measuring points, it can be stated that the wheels climbed over the rail and the train derailed at the smallest measured curve radius (approximately 110 m) and when the level deformation reached 30 mm. Considering the measurement results, the derailment was an obvious consequence.

Having examined the traffic conditions, it can also be stated that this major deformation of the track developed gradually during the day of the accident as a result of heavy traffic on the track, (the train involved in the accident had previously run on this track several times that day) and reached the critical value when train no. 2424 was running on the track.

3. Conclusions

3.1. Direct cause

The occurrence of the accident could directly be related to human factors, namely that the technological regulations were not complied with during the reconstruction of the level crossing. Furthermore, the track section was opened to traffic after the construction work had been stopped temporarily that the stability and transversal rigidity of the track was not ensured.

3.2. Wrong procedures and measures

For the repair and replacement of the surface of the level crossing, the local track inspector division replaced the rail track structure as well. The rail track structure and the whole bedding were replaced on a 22.5 metre length. According to the local chief inspector who lead the replacement work, the temperature of the rails at the opening of the track panel was +25^{O}C and +20^{O}C when fixing the clips at dawn respectively. For the rail temperatures - measured approximately at 7 a.m. - see the below table. These temperatures are the same as the ones measured when finishing the work.

	7:00	13:00-14:00
Vác	+22^{O}C	+40^{O}C
Bp. Nyugati	+17^{O}C	+44^{O}C
Aszód	+15^{O}C	+41^{O}C

The table also contains the rail temperatures measured between 13:00 and 14:00. The difference between the temperatures at dawn (when fixing the clips) and in the afternoon at the time of the accident was at least +20^{O}C.

When examining the geo-screws of the connecting sections, the IC established that only those screws were loosened which were needed for the replacement of the track section, while the other screws were not. Therefore the so called ‘breathing’ of the track was not ensured. The neutral temperature of the track at the time of its construction was +20^{O}C.

According to the interviews, some gaps were left between the connecting rail ends. Nevertheless, this was not sufficient to offer resistance to the significant temperature increase. There was no lateral support which could have resisted the pressure arising from the change of temperature in the rails. The stability of the track was not ensured. The sleeper ends were loose and free and there were not enough ballast chips between the rails. No measures were taken in order to prevent the deformation or shifting of the rails at the connecting points, therefore the rails were shifting from the untouched section towards the opened section. Due to the above reasons, the track shifted sideways and vertically. The extent of the shifting was as high as it lead to the derailment of the train. The final thrust to the shifting of the track panel was the centripetal force arising when the train was running in a bend.

3.3. Regulations

The conditions of dismantling of rail tracks without gaps are defined in D.12/H. Technical Guidelines. (*note: the Technical Guidelines is not yet available in English language.)*

The IC considers the current regulations adequate, however, in this present case the parties/persons involved did not comply with the regulations when executing the construction work, which lead to the occurrence of the accident.

4. Safety recommendations

4.1. Immediate preventive actions

The IC issued the following safety recommendation - suggesting immediate preventive action - to MÁV Zrt. on 5th July 2006.

BA 27.1: In order to maintain transport safety, the IC recommends MÁV Zrt. to take measures during construction work requiring dismantling of track panels without gaps - when weather conditions may affect the work - so that railway traffic shall not be started before ensuring the stability and sufficient transversal and longitudinal resistance of the reconstructed track section and before the bedding has temporarily or permanently been resettled.

4.1.1. Observations and opinions

According to the reply of MÁV Zrt., the current regulations and technical guidelines with regard to tracks without gaps adequately regulate - both from safety and technical points of view - the procedures to be followed during construction work.

Following the accident, MÁV Zrt. has taken measures to ensure that regulations are complied with.

At the closing discussion held on 5th August 2008, the participants did not make any additional reflections or comments regarding the draft report and the safety recommendation.

Budapest, 8th August 2008.

András Kovács
Member of IC

Zita Béleczki
Member of IC

Gábor Szeremeta
Investigator-in-Charge