CONSIDERATIONS CONCERNING THE REHABILITATION OF THE RAILWAY LINE FROM THE HUNGARIAN BORDER TO SIMERIA

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Abstract: *The railway line from Hungarian border to Simeria is the busiest railway route of the CFR national Company network because the most important freight and passenger traffic both national and international runs on it. But to make this railway line to comply with the international demands as required by the norms and by the parameters of the railway traffic along the Pan – European Corridor IV, it is necessary to rehabilitate the line. The studied railway section, being part of Corridor IV (from Germany to the Black sea), could also constitute an important link towards Caucasian and Central Asia countries. The scope of the study is to improve the existing technical conditions of the railway line, the quality of the railway construction and installations that make possible the trains to run with a speed equal to 160 km/h (passenger trains) and 120 km/h (freight trains). To this aim, all the natural and current geometrical constraints were analyzed, in order to propose the best mix of upgrading works to be evaluated under the points of view of the financial and economic analyses. Particular attention was given to the horizontal curve radius in order to propose their increasing were possible, limiting as much as possible impacts on the existing urban settlements and roads or installation, and limiting stations removals or adaptation. Currently, line minimum curve shows radius of 350/400 m, while, line speed of 160 km/h requires a minimum radius of 1500 m. Four alternative rehabilitation investments have been identified, through the adequate combination of different compliance with AGC/AGTC standards. Studied solutions both envisage high changes compliant with minimum radius of 1500 m and low changes compliant with radius of 800 m (corresponding to 120 km/h speed).*

Key words**:** *railway line, geometrical constraints, curve radius*

INTRODUCTION

The present railway line Border–Curtici-Arad-Deva-Simeria has a length of 185 km, out of which 176 km are double line. The line is operated with passenger and freight traffic and presently it has 23 sectioning points (19 railway stations and 4 crossing halts). This line ensures, through Arad, Radna, Ilia, Păuliş and Deva stations, the railway connection to Timişoara-Stamora Moravița, Salonta, Oradea, Cluj, Braşov, Sibiu and Filiaşi. The railway line is sinuous because of the topographical situation, running along the Mures River for its longest part. Gradient of the line is good, being not a constraint to the transportation of long heavy trains, but horizontal curves often have very small radius going from 425 to thousands metres.

The scope of the study is to rehabilitate and improve this railway line in order to comply with the standards set forth by the European Corridors and TEN Corridors. In fact, the line belongs to the IV TEN Corridor, linking the Western part of South Europe to the Black Sea (COSTANŢA HARBOR). This study was performed in cooperation with Italferr S.p.A., Italy. The purpose was to carry out the technical, economical and financial documentation concerning the revision of previous feasibility study for the rehabilitation of the railway line from the Hungarian border to Simeria, thus enabling CFR to present funding requests to international donors, including the European Commission

MATERIALS AND METHOD

The present practical capacity of the line is between 60 (first single track section) and 210 trains/day (double track sections). The maximum speed of circulation is 65-120 km/h for passenger trains and 65 – 95 km/h for freight trains. The effective travel time for fast trains (without stopping time) is around 11 hours and 16 hours for container trains between Curtici and Constanta. One hour is the average delay due to improper infrastructure conditions. Currently, direct passenger trains (Intercity) link Curtici to Simeria in about 2 hours and 30 minutes. The first section of the line is running in a mostly flat environment, being characterised by good plan-altimetry conditions, while the second part (in Simeria direction), running in the Mureş River valley, is characterised by difficult and restrictive geometrical conditions. In the second section, because of the presence of villages and the main national road running parallel to the River course, the line is currently "closed" in an obliged and narrow corridor and many level crossings are limiting line operation and safety both for railway operation and for crossing traffic. The railway under study should comply with the AGC and AGCT Agreements and reaching a maximum speed of 160 (passenger trains) and 120 km/h (freight trains).

In order to study homogeneous line sections, the entire line was divided in 5 parts. Figure 1 shows the railway line, divided in five sections, according to the study necessities. To this aim, all the natural and current geometrical constraints were analyzed, in order to propose the best mix of upgrading works to be evaluated under the points of view of the Financial and Economic analyses. Particular attention was given to the horizontal curve radius in order to propose their increasing were possible, limiting as much as possible impacts on the existing urban settlements and roads or installation, and limiting stations removals or adaptation. Currently, line minimum curve shows radius of 350/400 m. The studied solutions, both envisage high changes compliant with minimum radius of 1500m (for 160 km/h speed) and low changes compliant with radius of 800m (for 120 km/h speed).

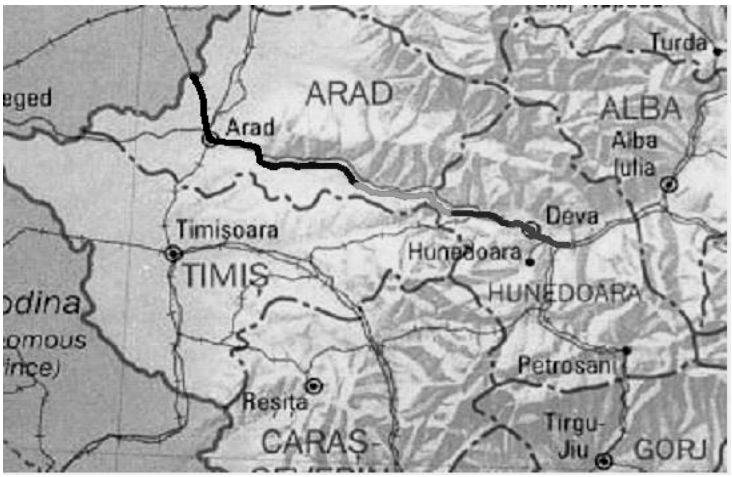

Figure 1: Curtici – Simeria railway line divided in five sections

The considered five railway sections are: from Hungarian Border to Radna (58 km), from Radna to Valea Mureşului (38 km), from Valea Mureşului to Gurasada (47 km), from Gurasada to Mintia (22 km) and from Mintia to Simeria (20 km). In fact, the line has been analysed by decomposing it in the mentioned five sections (I, II, III, IV and V), and for each

one of them two alternatives have been produced, one envisaging small upgrading works (Alternative 1) and one (Alternative 2) envisaging high impacting upgrading works (mainly based on new sections in tunnels). By composing in two groups Alternative 1 and Alternative 2 for each one of the five sections, Alternative 3 and Alternative 4 have also been produced.

RESULTS AND DISCUSSION

The largest part of the section is placed in the Mureş major riverbed that may be one of the causes of some track infrastructure faults: embankment softening, track settlement, slopes sliding etc. On the longitudinal profile, the line level ensures the connection between many points having compulsory levels, namely: Border Crossing - SUL level = 100,00 m, the crossing level for Mures River at km 493+740 - SUL level = 186,75 m, and Simeria - SUL level = 201,11 m. Apart these compulsory points, the railway line route generally followed as strictly as possible the land configuration.

Alternative 1 assures 160 km/h till approximately the station of Ghioroc (with the exception of Arad area) and between Deva and Simeria; it permits 120 km/h in all the Ghioroc-Deva section, with the exceptions of Radna area, the section between Barzava and Batuţa and in Deva station, where the line speed decreases to 90 or 100 km/h. Other three Alternatives have been examined in the study. Alternative 2 shall be fully compliant with AGC standards except in correspondence of the main stations as stated in the following paragraph. In fact, Alternative 2 envisages the continue speed of 160 km/h except for the critical areas of Arad and between Mintia and Deva where train speed will be limited at 100/120 km/h. Alternative 3 and 4 will be a mix of the preceding speed limits, according to the fact that they are formed by different mix of Alternative 1 and 2, as shown in the scheme reported in Figure 2.

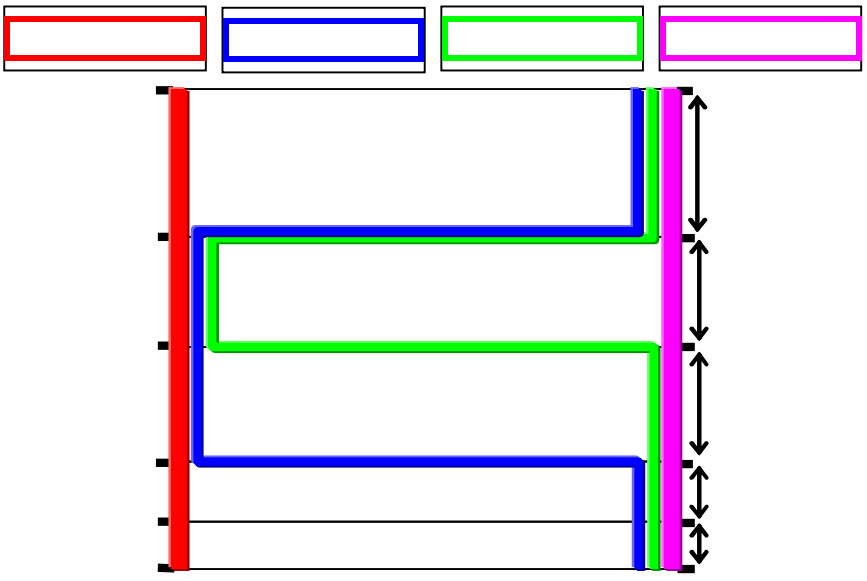

Figure 2: Scheme of the fourth alternatives studied on the railway line

Table 1 shows the most important technical parameters to be adopted under AGTC and AGC rules.

Table 1

AGTC and AGC technical parameters

Parameter	AGTC (Law 8/93)			AGC (Law 100/96)		
	Existing lines		New lines	Existing lines	New lines	
	Present	Aiming			Passeng.	mixed
1.lines	Unspecified		2		2	2
3. Min. distance b. axes		4.00	4.20	4.00	4.20	4.20
4. Min. line speed (km/h)	100	120	120	160	300	250
5. Axle load (t)						
locomotives < 200 km/h				22.5		22.5
EMU < 200 km/h				17	17	17
passenger coaches				16	16	16
freight wagons						
➢ 100 km/h	20	22.5	22.5	22.5		22.5
➢ 120 km/h	20	20	20	20		20
➢ 140 km/h				18		18
6. Adm. load linear m.				8		8
7. Bridge train type				UIC 71		UIC 71
8. Max gradient (‰)	Unspecified		12.5		35	12.5
9. Main station platforms (m)				400	400	400
10. First deviation lines (m)	600	750	750	750		750
11. Level crossings				No	No	No

Maximum adopted declivity on line shall be equal to 12 ‰; the maximum declivity recommended in the station shall be equal to 2 ‰ and the maximum declivity in halts shall be equal to 2 ‰. Minimum horizontal radius considered was Rmin= 1,500 m for 160 km/h (Vmin 80 km/h) and Rmin= 800 m for 120 km/h (Vmin 60 km/h).

Table 2

The schematic lay-out of the proposed solution

	Original Solution		Alternative 1- the proposed solution	
STRETCH	LENGTH (m)		LENGTH (m)	
• Hungarian Border – Radna	58,185		58,445	
• Radna – Valea Muresului	38,000		37,982	
• Valea Muresului – Gurasada	46,870		46,984	
• Gurasada – Mintia	22,130		21,875	
• Mintia – Simeria	19,880		19,880	
• TOTAL	185,065		185,166	
Length difference on Original Solution	0		+101 m (+0.06%)	
	Length of Max design speed (m)	(%)	Length of Max design speed (m)	(%)
160 km/h	36,779	19.87%	42,701	26.84%
120-130 km/h	68,993	37.28%	116,466	62.90%
90-100 km/h	71,834	38.82%	14,705	7.94%
< 80 km/h	7,459	4.04%	4,294	2.32%
TOTAL	185,065	100.00%	185,166	100.00%
Commercial Speed (km/h)	91.77		100.12	
Running time (min)	121’		111’	
Reduction of running time in comparison with present situation	51’		61’	

Table 2 shows the comparison between the approved solution (also named Alternative 1) and the original solution of the previously approved ISPCF Feasibility Study. As it is possible to note, this solution quite maintains the same line length, with few increasing related to the adjustment of the curve radii.

The proposed solution of the study is composed by the following variants:

1. From Hungarian Border to Radna: From Hungarian Border to Radna (58 km long) the line crosses the present Banat flat plan, serving the main city of Arad.

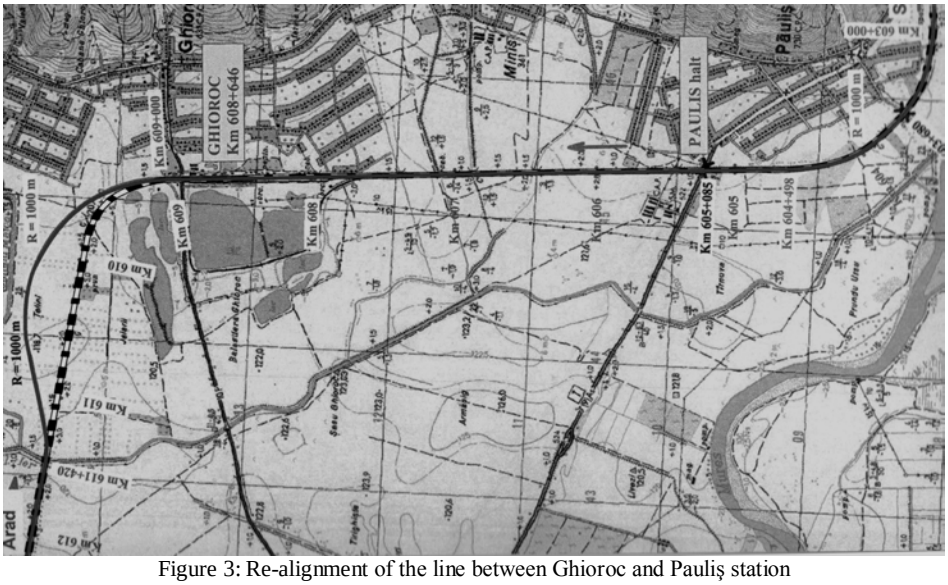

Figure 3: Re-alignment of the line between Ghioroc and Pauliş station

Along the initial stretch of the line, the alignment shall be maintained with few improvements of curve radii in order to take the line at 160 km/h. The Hungarian Border-Curtici shall be doubled on the eastern side of the existing track. Only marginal land appropriation has been considered as necessary in correspondence of this part of the alignment. From Arad to km 612 the project shall maintain the existing alignment that permits a 160 km/h speed. Then the line shall be re-aligned in correspondence of the northern entrance of Ghioroc station and the western entrance of Păuliş station in order to permit a line speed limit of 120 km/h. The alignment from Ghioroc station and Păuliş halt shall be maintained. This alignment corrections, specifically that one north of Ghioroc, need some land appropriation but interesting agricultural area only without taking close the line to the urbanized areas of the villages. No relevant civil works shall be needed on these re-aligned stretches.

2. From Radna to Valea Mureşului: The second part of the line interests the narrow gorges of the Mureş River and it is characterized by the physical constraint of Radna-Lipova. The proposed solution foresees to maintain the existing alignment considering the improvement suggested by the ISPCF Feasibility Study and other minor improvements that permits to take the line speed from the eastern entrance of Radna station to Bârzava station to 120 km/h. The line speed in Radna station shall be maintained at 90 km/h. The stretch from Bârzava to Bătuţa and km 559, just before Valea Mureşului, shall keep the 100 km/h speed but eliminating the alignment constraint south of Bătuţa. These alignment corrections need some

land appropriation, but interesting agricultural area only without taking close the line to the urbanized areas of the villages. In this way no relevant civil works shall be needed on this part of the alignment. The present passenger service points shall be kept as the present position but with upgrading of the infrastructures.

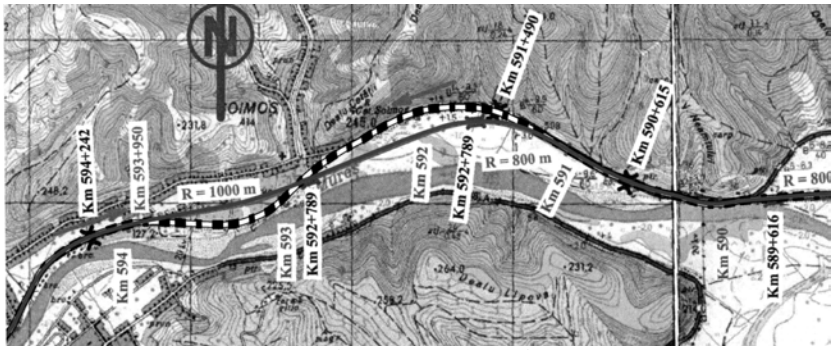

Figure 4: The elimination of physical constraint from Radna - Lipova area

3. From Valea Muresului to Gurasada: The third intermediate stretch is foreseen to be upgraded at 120 km/h so maintaining the ISPCF Feasibility Study solution with some improvement of the alignment in the areas of Cuieş and south of Zam in order to eliminate any speed constraint. Some marginal land appropriations are required nearby but in any case they interest areas comprised between the present railway line and the Mureş River. The present passenger service points shall be kept as the present position but with upgrading of the infrastructures.

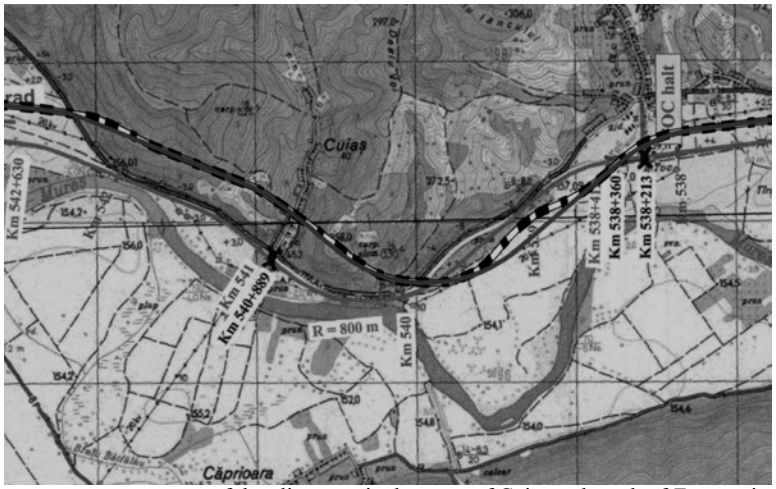

Figure 5: Improvement of the alignment in the areas of Cuieş and south of Zam station

4. From Gurasada (included) to Mintia: The stretch between Gurasada to Mintia is characterized by the straight part of the line that takes to Ilia station and by the existing constraint of Brănişca and the related crossing of the Mureş River. Under the technical point of view it is necessary to reduce this constraint because it affects the train operation of the whole

line. In order to limit the influence of this constraint, some improvements of the alignment shall be foreseen on this part of the line, to obtain a speed limit of 120 km/h. The radii of the curves located north to Brănişca station shall be improved in order to permit the above said speed. More relevant shall be the re-alignment south to this station, practically up to Veţel Halt; a new bridge shall be realized on the Mureş River, 200 m eastward of the existing one. The new bridge shall perpendicularly cross the river in a narrow point, without interfere with any urbanized area. At the same time the railway level inside Brănişca station shall be lightly modified to solve the existing problems for the railway maintenance. This re-alignment generates some land appropriation but of agricultural land only. It eliminates any physical constraints inside the urbanized area of Brănişca too. The present passenger service points shall be kept as the present position but with upgrading of the infrastructures.

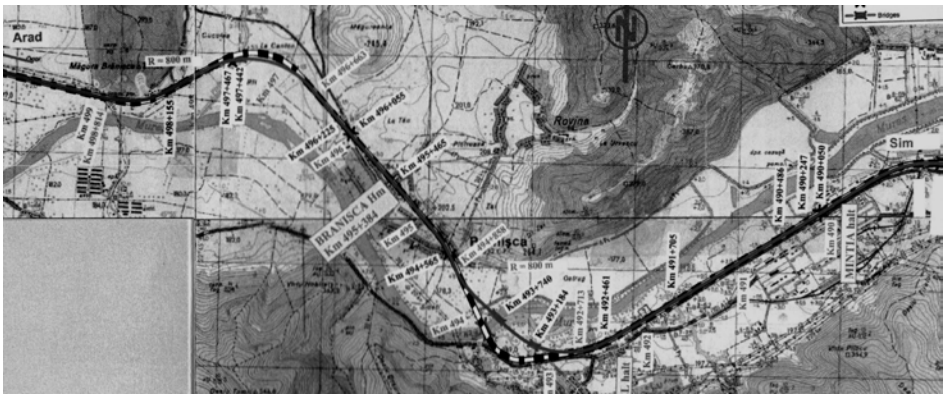

Figure 6: Improvement of the alignment in the area of Brănişca station

5. From Mintia (included) to Simeria: The last stretch from Mintia to Simeria is characterized by three important stations (Mintia, Deva and Simeria) and the alignment shall be kept as the existing one with some improvement of the curves nearby Deva station. Some marginal land appropriation should be foreseen on this part of the alignment. The present passenger service points shall be kept as the present position but with upgrading of the infrastructures.

CONCLUSIONS

The overall objective of the study was accomplished: to promote sustainable mobility along the Pan-European Corridor IV, through the rehabilitation of the railway line from the Hungarian border to Simeria (185 km) in terms of increased travel speeds, reduced travel time for passengers and goods, increased transport safety and protection of the environment and increased interoperability with EU standards.

The foreseen works shall regards: re-arrangement of existing line infrastructures (main line and station lines) in order to achieve the necessary upgraded parameters along the whole line, including: earthworks and drainages, structures (walls, 1 long bridge on Mureş River (to replace the existing one), 54 standard bridges having 25m and 15m spans, 178 culverts (pipe and box type) and 27 roadway fly-overs) and the replacement of permanent way.

Also, there are proposed the followings: the realization of 27 sections interesting alignment variants for a total estimated length of 32,9 km, in order to improve the existing geometric parameters (curve radius), re-leveling of the whole line (185 km), line doubling and

electrification for the first section (about 9 km from Hungarian border to Curtici), replacement of the power supply system (contact line and traction sub-stations) for the main line and stations, replacement of line safety and traffic management system and station's interlocking for all the stations of the line that shall be maintained; the principles of Automatic Block Line (ABL) shall be installed, replacement of the whole telecommunication system, providing adequate platforms with access at separated level through the realization of overpass (minor stations) and underpass (main stations); realization of platform covers; transforming some existing stations in halts in order to simplify the line lay-out.

Among the civil works, this study proposes the upgrading of passenger and technological buildings for all the stations of the line (17 stations, 19 halts), construction of 6 new workshops for railway maintenance, upgrading of Curtici border station (yards and buildings), in order to be compliant with the future border crossing procedures and elimination of 24 level crossings, maintaining other 50 existing level crossings to be equipped with automatic controlled systems having half barriers or lights.

The adoption of Alternative 1 will increase the compliance with the AGC/AGTC standards, ensuring 50 km at 160 km/h and 117 km at 120 km/h,. The average speed of trains passing from the present 73 km/h to 129 km/h for passengers and to 96 km/h for freight train on the whole project railway section; produce savings (25-35%) on the present operating costs of the railway company and enhance the capacity to ask in the future increased tariffs because of the better service offered, produce a 20% time savings for passengers and goods transported and offer a better interoperability with EU railway system.

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