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DEVELOPMENT STRATEGY OF RAILWAY TRAFFIC INFRASTRUCTURE OF THE REPUBLIC OF CROATIA

ABSTRACT

Considering the strategy of the railway traffic infrastructure development of the Republic of Croatia, the authors have also considered the restructuring of the railways in EU and Croatia with the aim of insuring the very complex process being carried out in everyday lives, full of interdependencies. First, the parallel development of the three networks that form the EU railways system is given, together with their characteristics and future roles. These are: the network of the Trans-European conventional railway line system, the high-speed railway line network (HS Net) and the network of railway lines intended prevalingly for the cargo transport (RTEFF, TEFFN). This is followed by a presentation of the basic aims of the strategic development of railways in Croatia and the overview of the conditions and the necessary activities on the Corridor railway lines so as to prepare them for the integration into the EU traffic system. In elaborating the development strategy of the railway traffic infrastructure in Croatia, a summarised overview of the objectives and the necessary activities is given, in order to renew the railway network, and to reconstruct it so that it could meet the requirements set by the AGC and AGTC standards which are the condition for the Pan-European railway lines.

KEY WORDS

railway traffic infrastructure, development strategy, Croatia

1. INTRODUCTION

The railway traffic system in Europe is undergoing great changes. The changes are happening in all parts of the traffic system, and the biggest are happening in the railway sector in the field of organisation of companies, position of railways in the traffic system of the countries and the community, infrastructure and the transport means. The European Union (EU) wants an efficient railway which is not restricted by the state borders which are becoming in the EU partly

administrative, and competitive on the transport market. One of the strategic goals of EU is to create a market of transport services which will provide equal treatment to all traffic branches as well as equal business conditions. As a logical consequence the investments into the traffic system need to be more uniform.

The additional incentives will be allocated to the systems which are environmentally more friendly, systems which can be included in the chain of traffic services where several can be included in the multimodal and combined traffic, so that each of the systems on the transport route gives its maximum contribution in that particular segment in which it, as a system, can provide the comparative advantages over the others. In transport of mass cargo at greater distances the emphasis is on the combined transport: sea traffic, railways, inland waterways, and road. In this transport chain road transport should be losing the role of the carrier of greater volumes of transport at greater distances.

Changes are happening at the railways and they should result in the separation of the infrastructure from the carrier. The infrastructure should be entrusted to the government that should take care of its maintenance and development. The state would gain revenues by leasing the routes on the traffic service market, which would ensure equal and non-discriminating treatment among the carriers that would participate in the bidding for these routes. For greater investments and new constructions the financial sources should be allocated from the bank loans, funds, private capital, etc. The railway carriers should operate independently on the market, and subventions would be provided for the services of wider importance for the society, which are necessary but cannot be covered in full from the transport service prices.

In this environment the development strategy of the railway traffic infrastructure in Croatia cannot

be considered separately from the development strategy of the EU traffic network. In EU three basic railway networks are being established. This is the network of the Trans-European system of conventional railway lines, network of high-speed traffic lines, and a railway line network for cargo transport. The Croatian Railways have the greatest interest to join the network of Trans-European systems of conventional lines (it consists of the TEN network in the EU region and the network of Pan-European railway lines in the countries that belong to the circle of EU accession candidates and their environment) and the railway lines for cargo transport. The cargo transport network is formed by exploitation of the existing lines that can provide the necessary service quality. The integration into the high-speed lines network is likely to occur in the later phases of the considered period.

The entire overview of the railway network development in the EU should be considered with a certain reserve because of the EU enlargement, so that a shift in priorities is likely to occur regarding the construction of certain traffic routes after the integration of some countries, i. e. that there will be additions to the network at some of its segments. The networks themselves are not expected to experience any major changes.

2. CHARACTERISTIC OF THE EU TRAFFIC INFRASTRUCTURE

The railway traffic infrastructure of the EU consists of three basic networks. These are:

- *Infrastructure of the Trans-European system of conventional railway lines*, the backbone of which is the TEN network (Trans European Network). The

TEN network is presented in Figure 2.1. It is the extension of the Pan-European line network which runs through the countries that plan to join the EU (network of Pan-European railway lines is presented in Figure 2.2). This network is characterised by the parameters that have been determined by the AGC and AGTC agreements. This network includes the greater part of the TER network, which had been created earlier than the other networks (under the auspices of UN) and has the objective of harmonising the railway network at a slightly lower level. The TER parameters today are considered as a transition solution from the existing condition of the railway lines on the international routes towards their future condition. Somewhat less demanding TER parameters in the modernisation of the existing network are implemented on the lines in very unfavourable terrain conditions (hills, mountains, populated areas, etc.).

- *Infrastructure of high-speed railway lines (HS Net)* is presented in Figures 2.3 and 2.4. The high-speed network is being established. Up to now about 10,000 km of railway lines in EU are in service. In the next 20 years the railway lines are planned to expand in the EU countries (the existing and the newly joined) and the surrounding countries.
- *Infrastructure of railway lines for cargo transport mainly (RTEFF, TEFFN)* is presented in Figure 2.5. This network is in the initial phase of creation. The usage is planned of the existing railway lines that would be modernised with the aim of providing better service to the cargo transport (capacity, structure gauge, traffic priority to cargo trains, etc.). The later phase plans gradual forming of the network which will be used mainly for cargo traffic (taking as model similar networks in some parts of the world, e. g. the USA).

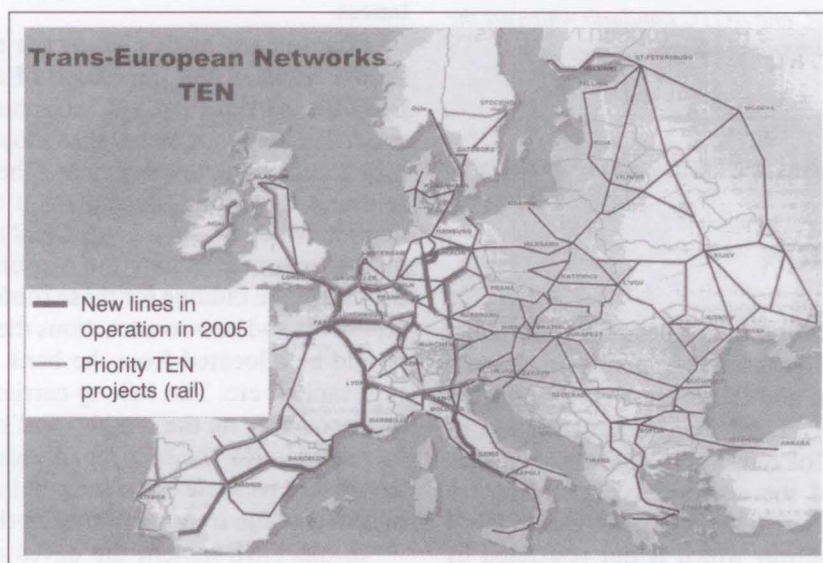


Figure 2.1. TEN network

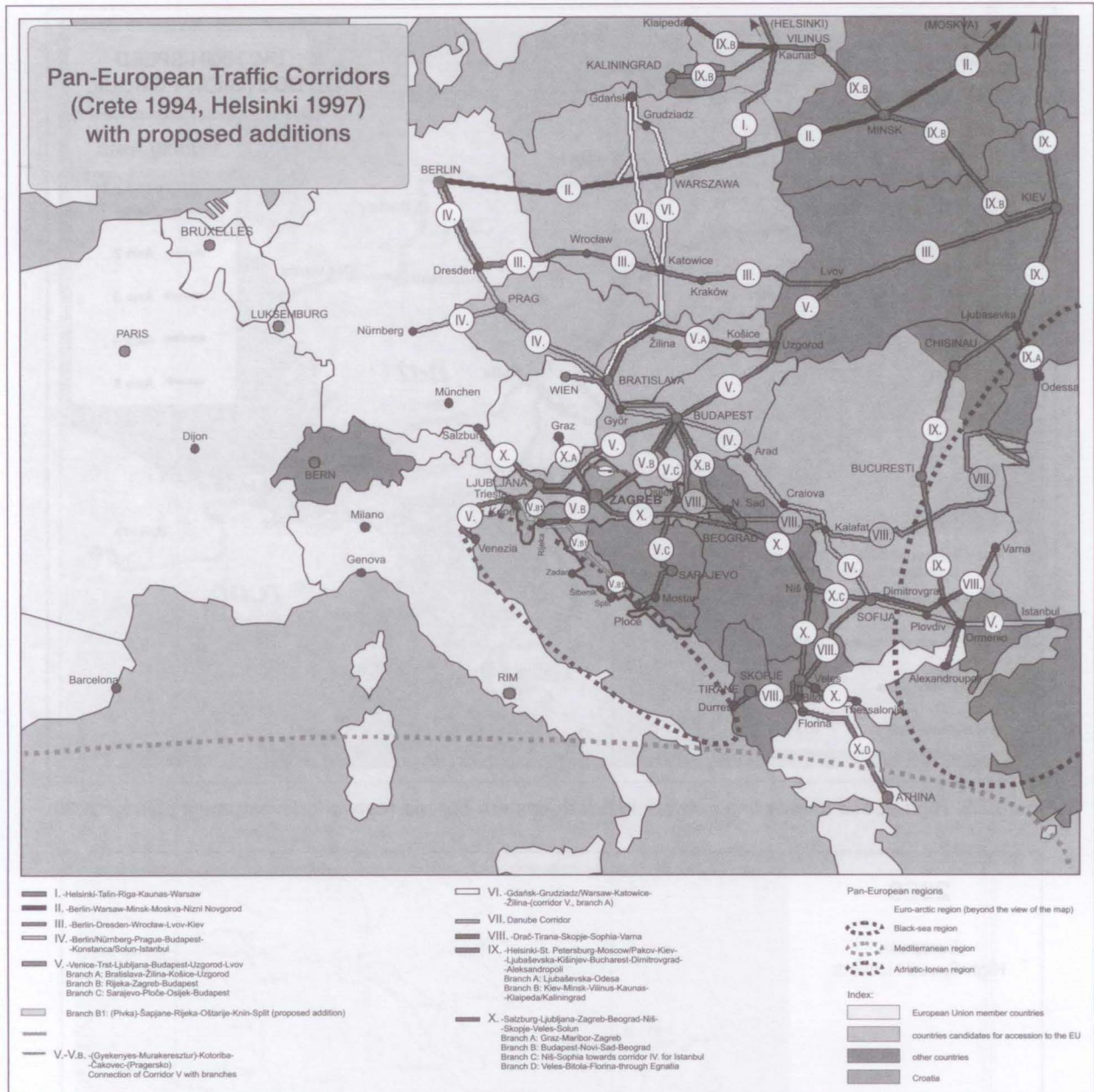


Figure 2.2. Pan-European railway lines network

The high-speed railway line network in South-eastern Europe, which is where Croatia is located, includes the high-speed railway line in the Pan-European corridor X. The section of Corridor X in Croatia plans

The first projections of the development of railway network for cargo transport have reached the EU borders of 2003. The expansion of the network is expected to the newly accepted countries and the candidate countries.

Figure 2.6. presents the traffic of Trans-European cargo trains in EU. It shows that the majority of transit traffic from North-west towards South-east of Europe is concentrated to Sopron in Hungary. At that section the network of Trans-European cargo trains enters

the region of South-eastern Europe. Sopron has taken over the role of a large cargo-distributive hub (which includes part of the private railway company – GySEV – which owns the railway line from Sopron to the Austrian border, container terminal, shunting yard, and other necessary facilities). Sopron has attracted big companies (especially forwarders - Prodos and Shenker) which invested their capital into the development of the traffic infrastructure and equipment. Therefore, about 10 million tonnes of cargo were delivered to that point from North-western Europe.

From the Sopron scope we can see that the development and the throughput of traffic flows from the North-west to the South-east of Europe and vice versa, and on some other routes, can be achieved even

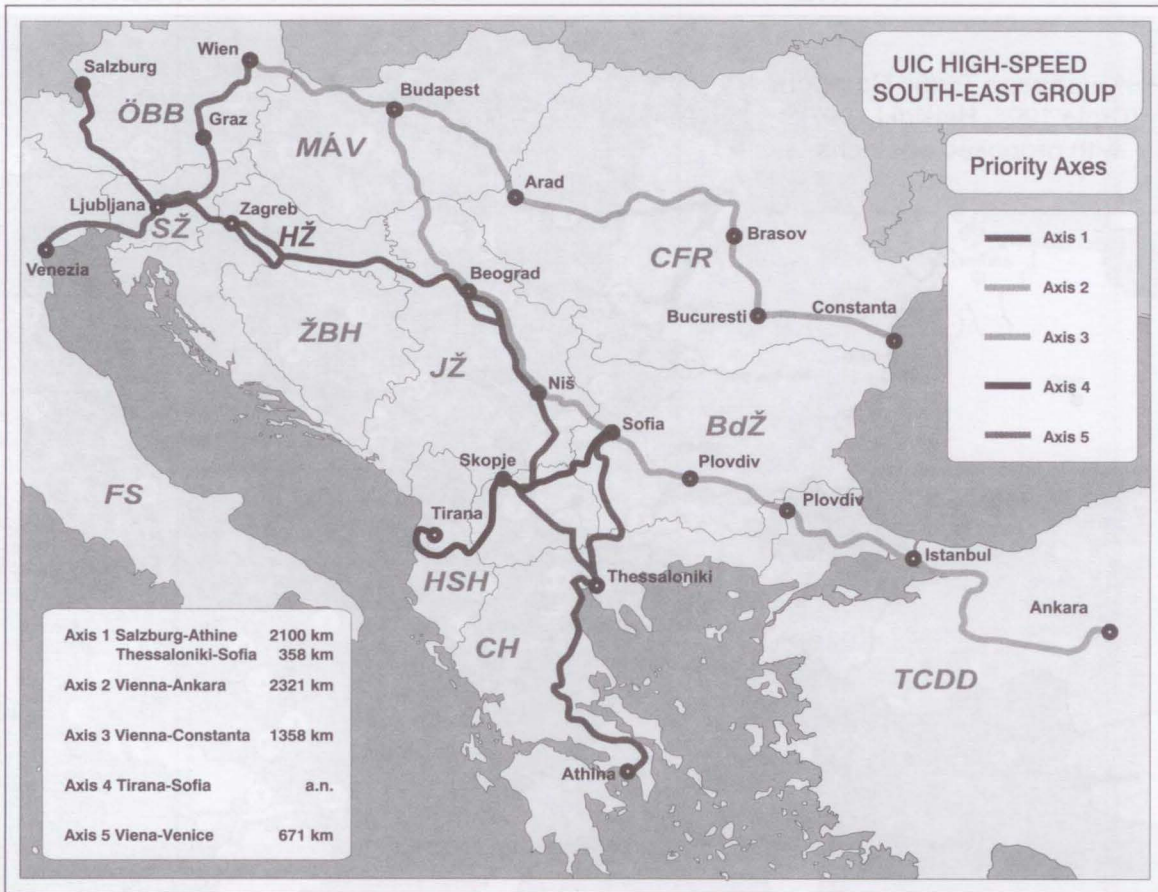


Figure 2.3. High-speed railway line network in South-eastern Europe (network development plan by 2020)

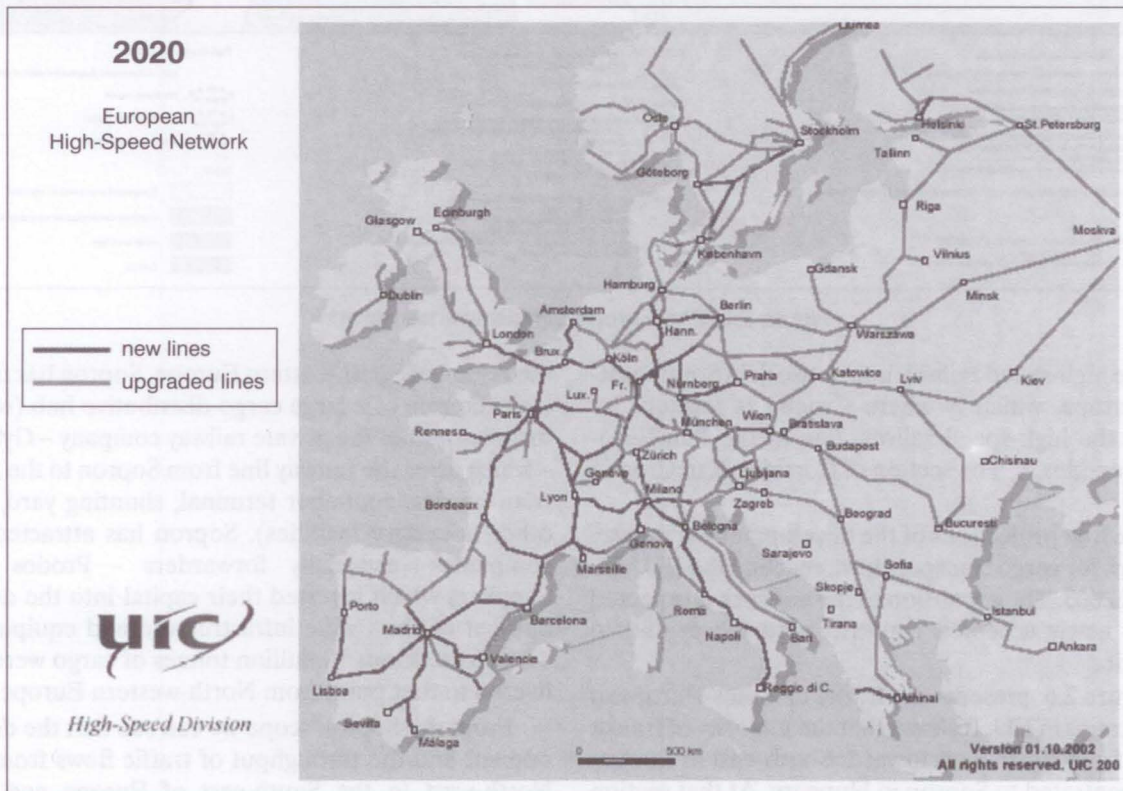


Figure 2.4. High-speed railway line network in Europe

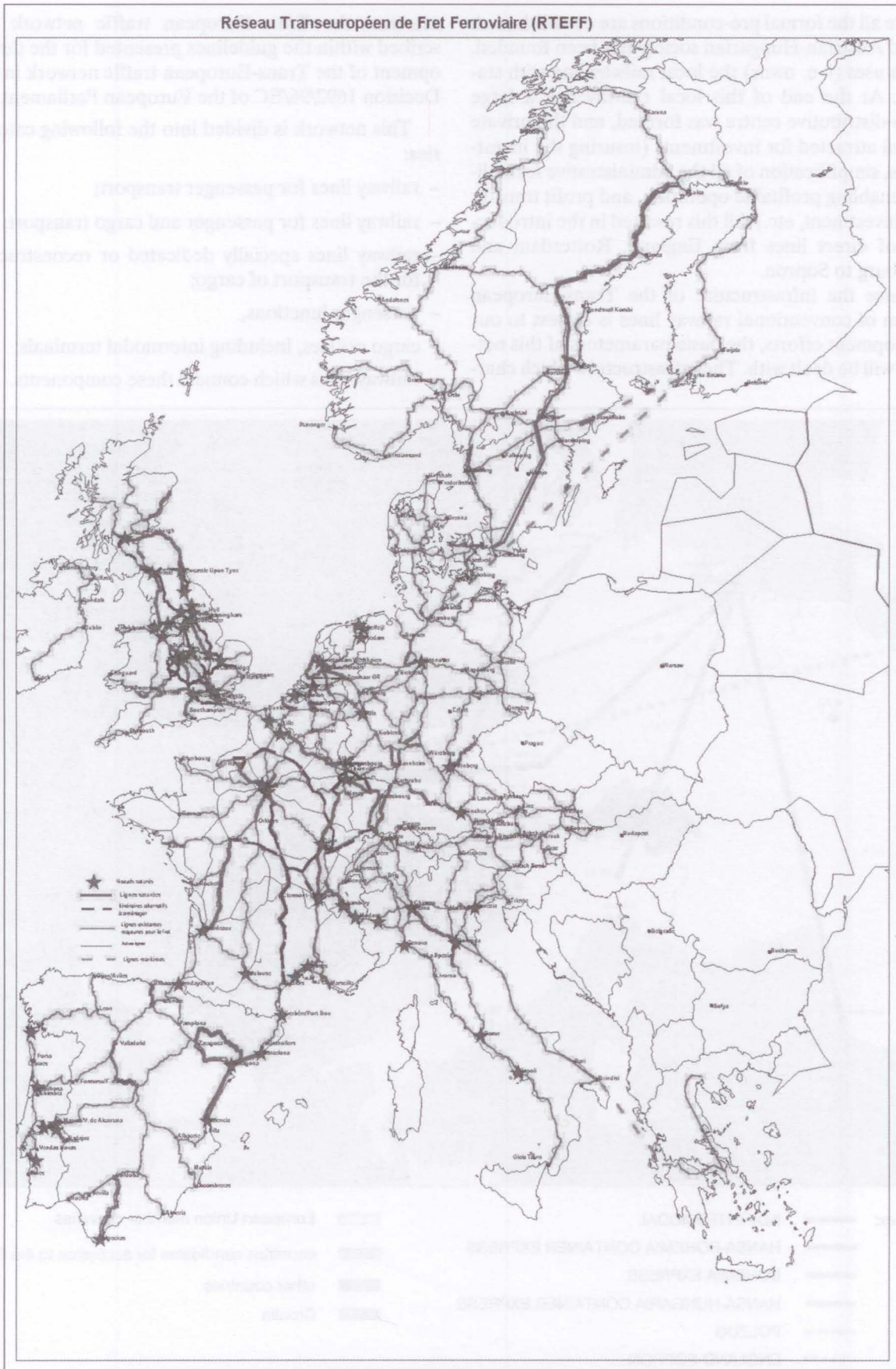


Figure 2.5. Network of railway lines for cargo traffic

before all the formal pre-conditions are established. A mixed Austrian-Hungarian society has been founded, which uses (i. e. owns) the local railway line with stations. At the end of this local railway line a large cargo-distributive centre was formed, and the private capital attracted for investments (insuring the investments, simplification of all the administrative formalities, enabling profitable operation, and profit transfer or reinvestment, etc.) All this resulted in the introduction of direct lines from England, Rotterdam and Hamburg to Sopron.

Since the infrastructure of the Trans-European system of conventional railway lines is closest to our development efforts, the basic parameters of this network will be dealt with. The infrastructure which char-

acterises the Trans-European traffic network described within the guidelines presented for the development of the Trans-European traffic network in the Decision 1692/96/EC of the European Parliament.

This network is divided into the following categories:

- railway lines for passenger transport;
- railway lines for passenger and cargo transport;
- railway lines specially dedicated or reconstructed for the transport of cargo;
- passenger junctions,
- cargo centres, including intermodal terminals;
- railway lines which connect these components.

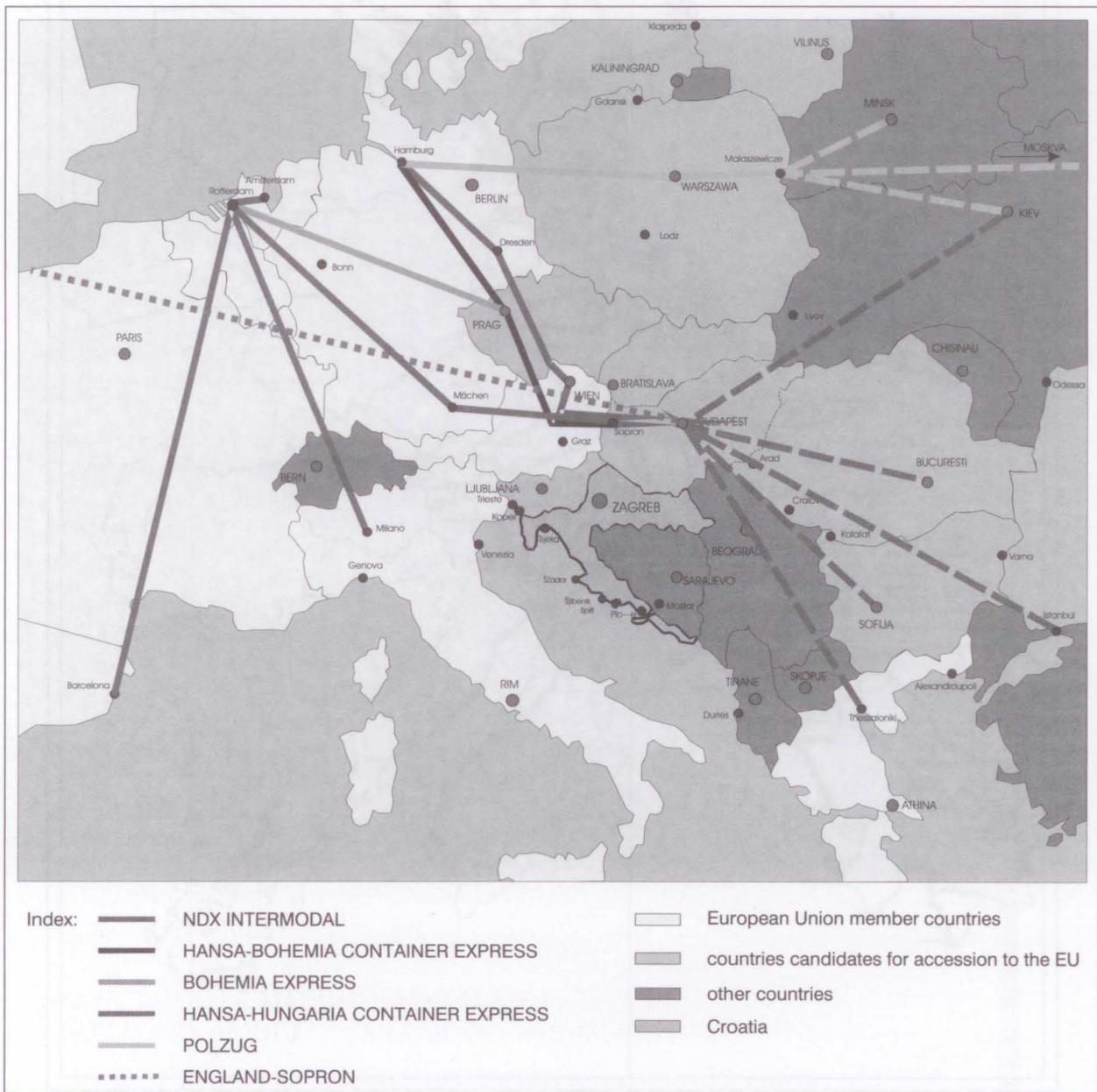


Figure 2.6. Direct cargo corridors in Europe (state-of-the-art – 2003)

Such infrastructure includes traffic management, determining of the travelling route, and navigation system, technical facilities for data processing and telecommunications for services of remote traffic on the network, in order to enable normal operation of the network and efficient traffic control.

Transport means include all those means that will operate along the Trans-European system of conventional lines, and these include:

- diesel or electric self-propelled trains;
- traction units using thermal or electric power;
- passenger wagons;
- cargo wagons including wagons for the carriage of trucks.

Each of the above-mentioned categories must be divided into:

- transport means for international exploitation;
- transport means for national exploitation;
- taking into consideration the local, regional, or international exploitation of these means.

The quality of transport in EU depends, among other things, also on the quality of compatibility between the characteristics of infrastructure (in the widest sense, i. e. among the stable parts of the given subsystems) and the characteristics of the transport means (including the components of the respective subsystems which are onboard trains). This compatibility affects the level of performance, safety, quality of transport and cost of transport.

The Trans-European system of conventional railway lines is divided into two subsystems:

(a) structural areas:

- infrastructure;
- energy;
- control, command and signalling;
- functioning and control of traffic;
- transport means;

(b) operative areas:

- maintenance;
- telematic application for the transport of passengers and cargo.

3. BASIC OBJECTIVES OF RAILWAY TRAFFIC DEVELOPMENT STRATEGY IN CROATIA

The basic objectives of the railway traffic development strategy in Croatia include the following:

- integration into the normative system of the EU Railways Union;
- increase in the level of integration into the European railways network,

- improvement of connections among cities and regions within the Republic of Croatia with a pronounced Adriatic orientation;
- reconstruction and modernisation of railways with the aim of increasing the quality of transport, reduction of operation costs, and maximal preparation of railways for the market conditions of operation;
- restructuring of Croatian Railways, implementing of social program, preparation of railway carriers for independent market operation and increase of their competitiveness;
- promoting of the development of ports and free zones;
- promoting and development of combined traffic from the Adriatic towards the interior by using the railways and inland waterways (navigable sections of the rivers Sava and Drava, as well as the Danube);
- increase of safety in railway traffic;
- environmental protection.

In order to realise this, it is necessary to achieve the following:

- harmonisation with the European railway network in compliance with the European standards of services, technical standards, and traffic parameters of infrastructure on the major European main routes (corridors). The tendency is towards realising the average travelling speed on the main routes, in passenger traffic of over 100km/h and transit cargo traffic of about 50km/h,
- increase of quality and service price, and productivity and approaching the European standards,
- development of the network in accordance with the needs and possibilities (with the implementation of market criteria of development of services, infrastructure, and transport means), and the marked Adriatic orientation (strategic breakthrough of the new lines with level characteristics from the interior towards the Adriatic),
- harmonisation with the legal regulations of the EU regarding railways and adoption of provisions of the EU guidelines in the domicile legislation, and their implementation in practice,
- provision of general conditions in the country to give incentive to the foreign investments, and especially those from the private sector for construction and usage of railways and other traffic infrastructure.

4. CHARACTERISTICS OF RAILWAY INFRASTRUCTURE IN CROATIA

The Croatian Railways today have railway lines in exploitation length of 2,774 km, out of which about 35

per cent have been electrified. The length of the railway lines of the Pan-European corridors in Croatia is 770km, which is less than 30% of all the railway lines. Although this is less than a third of railway network, the Pan-European corridors require more consideration, since almost half of all the funds allocated for the modernisation of railway lines in Croatia are planned for their modernisation.

4.1. GENERAL OVERVIEW OF THE PAN-EUROPEAN CORRIDORS IN CROATIA

After the Pan-European Conference (Helsinki 1997), the network of Pan-European corridors was defined, which runs through the non-EU countries, but that have been strategically oriented to the accession to the EU. The network of Pan-European corridors in Croatia consists of three (3) land corridors (Vb, Vc and X with the branch X. a) and the river Danube as a special corridor (VII.). The Danube corridor encompasses also the tributaries which are navigable and the new multi-purpose canal Vukovar – Šamac.

The total length of the land corridors is 770.3 km, that is, 838.0 km (including Corridor X. a which is still in the form of documentation, and the Danube Corridor in the length of 137.5 km. In its basic form, the total length of all the corridors would amount to 975.5

km. If the land corridor included also the existing connections between Corridor V. b and the main branch of corridors in Slovenia, and the proposal of a new Branch (V. b1), then the land corridors would be of a length of 1400.7 km. The Danube corridor together with the navigable sections of the Drava and the Sava amounts to 596.9 km. The corridor length is given in Table 4.1.1.

4.2. STATUS AND ACTIVITIES ON THE RAILWAY LINES IN PAN-EUROPEAN CORRIDORS IN CROATIA

4.2.1. Corridor X.

(main route), railway line:
(Ljubljana/Maribor, Zidani Most) - state border - Zagreb - Vinkovci - state border - (Belgrade, Sofia, Istanbul, Athens),

Branch A:

Zagreb-Krapina-state border-(Maribor-Graz), the length of the new line from Zaprešić to Pragersko is 71.3 km.

- r/w. line length - 302.5 /km via Sisak/290.0 km via Dugo Selo;
- track gradient - 7.0‰;
- maximum speed - 160kmh on double-track section of the line (from Zag-

Table 4.1.1. Lengths of Pan-European corridors in Croatia

Pan-European Corridors in Croatia		
Pan-European Corridor	Corridors Border Points in Croatia	Length (km)
Corridor No. X. - Main Direction	S.B. Savski marof - Tovarnik S.B..	316,4
Corridor No. X. - Branch A	Zagreb - Krapina - S.B.	67,7
Corridor No. V. - Branch B	S.B. Kotoriba - Zagreb - Rijeka	328,7
Corridor No. V - Branch C	S.B. Osijek-S. Žamac S.B-(B and H)-S.B. Metković-Ploče	125,2
Total Land Corridors		838,0
Proposal: Branch V. B1	(Pivka) S.B. - Rijeka - Ogulin - Knin - Split	522,0
Total Land Corridors (Incl. Proposal - Branch V.B1)		1,360,0
Interconnection of Corridor and Branches (Corr. No. V.)	S.B. Kotoriba - Čakovec - S.B.	40,7
Corridor No. VII. - River Danube	E-80 Batina - Ilok	137,5
European Inland Waterway in Croatia	E-80-08 Mouth of River Drava into River Danube - Osijek (River Drava)	22,0
	E-80-10 Sisak - Jamana - S.B. (River Sava)	376,0
	E-80-12 New Multipurpose Canal: Vukovar - Šamac	61,4
Total European Inland Waterway in Croatia (without River Danube)		459,4
Total (Dunav, Sava, Drava, New Canal Vukovar-Šamac)		596,9
Total All Corridors V.B, V.C, X., X.A and VII		975,5

Note: S.B. - State Border

Table 4.1.2. Investments into railway in Pan-European Corridors in Croatia

(In Mln. Kn / Eur)

Investment Field	Total	
	kn	EUR
CORRIDOR No. X. (Dobova)-S.B.-Savski Marof-Zagreb-Dugo Selo/Sisak-Novska-Tovarnik-S.B.-(Šid)	2,797.8	373
Corridor Branch V.B (Gyekeyes)-S.B.-Botovo-Koprivnica-Zagreb-Oštarije-Rijeka	2,199.1	293.2
Corridor Branch V.C (Magyrboly)-S.B.-Beli Manastir-Osijek-Slavonski Šamac-S.B.-(Bosanski Šamac-Sarajevo- -Čapljina)-S.B.-Metković-Ploče	713.2	95.09
Corridor Branch V.B1 (Pivka)-S.B.-Šapjane-Rijeka ** Rijeka-Ogulin * Ogulin-Josipdol * (Oštarije)-Josipdol-Knin-Split	1,509.9	201.3
Total - All Corridor Lines in Croatia	7,220.0	962.7

reb to state border with Slovenia, in the length of 32km will be realised after the reconstruction of the rlw. line, and also on the section Vin-kovci-Tovarnik-state border with SRJ in the length of 34 km, 130 km/h on a single-track sections of the corridor;	
- axle mass	- 22.5 t/axle, 8.0 t/m ¹ (on non-reconstructed sections of the rlw. line 22.0 t/axle i 8.0 t/m ¹);
- number of tracks	- two (on 185.1km of route between Novska and state border with SRJ), two single-track rlw. lines between (Zagreb) Dugo Selo and Novska, and Zagreb via Sisak to Novska. The plans are to realise double-tracks on the entire length of the corridor which passes through Croatia;
- rlw. line equipment	- electrified (25kV, 50Hz), automatic block (AB), ground-train radio link, safety of rlw. stations and lines by means of relays;
- line capacity	- 25 mil. t/year
- transport	- 12 mil t/year and 7 million pax/year in the period until 1990, now about 1.5 mil t/year and 2 mil pax/year.

The existing railway lines in Corridor X in Croatia satisfy the current traffic needs. In order to level the capacities and increase the quality of transport supply

in the future, it is necessary to upgrade the current condition of the railway lines. The current single-track railway lines from Zagreb (via Sisak and Dugo Selo) to Novska represent a discontinuity regarding the capacity and speed. Therefore, along the existing line the construction of the second track is planned from Zagreb to Sisak (for speeds of up to 160km/h in the first phase, with the possibility of increasing the speed to 250km/h), and from Sisak to Kutina the construction of a new double-track line is planned with such elements that would allow speeds of up to 250 km/h. From Kutina to Novska, along the existing line, a second track will be constructed for the speeds of up to 160km/h. This would result in a double-track railway line along the entire length of this corridor, which needs to be reconstructed partly and modernised on some sections (smaller radii curves) in order to allow travelling speeds of 160 km/h (with the possibility of increasing the speed to 250km/h). With this additions along the entire length of the corridor the railway lines would fully satisfy the AGTC standards. The railway line organised in this way would accommodate tilting trains that could realise speeds of 200 km/h, and with further modernisation even up to 250km/h.

In the area of the city of Zagreb, the railway line passes practically through the very city centre. In that part, the traffic flows are extremely heavy and therefore the construction of a bypass line from the railway station Klara (access station to the shunting yard Zagreb) to the railway station Zaprešić has been planned.

Apart from this railway line, in the Sava Corridor, the construction of the high-speed Trans-European railway line East – West has also been planned, and it would mainly operate passenger traffic. It will be con-

structed and equipped for the speeds of up to 300 km/h. Although its construction is planned in the far future, as late as after 2030, its place in the urban planning has already been reserved.

The construction of RO-LA terminal is planned at the railway station Spačva (10 km from the SRJ state border). Preparation works are underway now (getting agreement and developing technical documentation). After it has been constructed it will be possible to transport trucks on the trains (RO-LA system, Piggyback) on relations Munich-Villach-SRJ state border (Spačva), Trieste-SRJ state border (Spačva), Vienna-Graz-SRJ state border (Spačva), Sopron-Koprivnica-SRJ state border (Spačva). It should also be noted that in Corridor X in Croatia, there is also the navigable waterway along the river Sava (navigability categories IV and V), allowing also combined transport (Adriatic ports – railway line – Sava – Danube – waterway system Rein – Main – Danube). Corridor X includes also the international airport Zagreb and two airports in Osijek (one of which satisfies the conditions of international traffic). The travelling time of the high-speed cargo train from the Slovenian state border across the Croatian part of Corridor X to the SRJ state border today takes 8 hours, and can be reduced to 6 hours by changing and speeding up the customs clearance regime with Slovenia.

Branch A of Pan-European Corridor X connects directly Graz and Zagreb. The existing railway network allows connection of Zagreb with Graz by the railway line Zagreb-Zidani Most-Maribor-Graz. This is a double-track railway line from Maribor to Zagreb. In order to realise the shortest connection on the relation Zagreb-Graz it would be necessary to perform partial reconstruction of the existing line (between Zaprešić and Krapina), its electrification and construction of the second track, and a new railway line from the railway station Krapina towards Pragersko. The new line from the railway station Krapina towards North-west would pass through the tunnel through the Macelj Mountain where it would cross the state border of the Republic of Croatia and Republic of Slovenia, and in Pragersko it would connect to the railway line Zidani most - Celje - Maribor. The railway line (between Krapina and Pragersko) would be 31.7 km long, and the route between Vienna and Zagreb would be shortened by 65.3 km. The railway line was planned as a double-track electrified line with maximum speed of up to 200km/h. The gradient is planned up to 12.5‰. Through Croatia, the railway line is 13.0 km long and in the Republic of Slovenia it is 18.7 km long. The total length of Branch X. a from Zaprešić to Pragersko would be 71.3 km, and this would shorten the existing line (via Zidani Most) by 64 km.

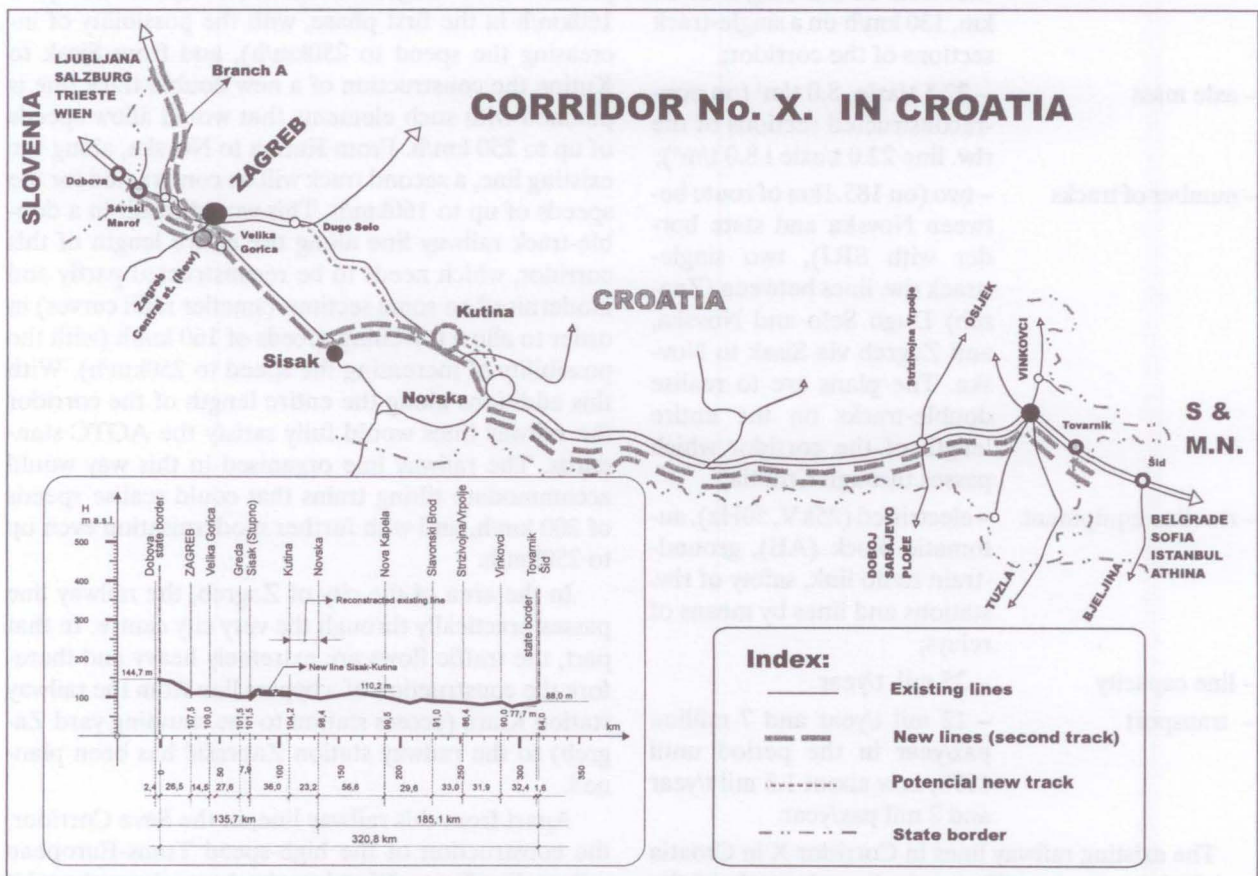


Figure 4.2.1. Tenth Pan-European Corridor in Croatia

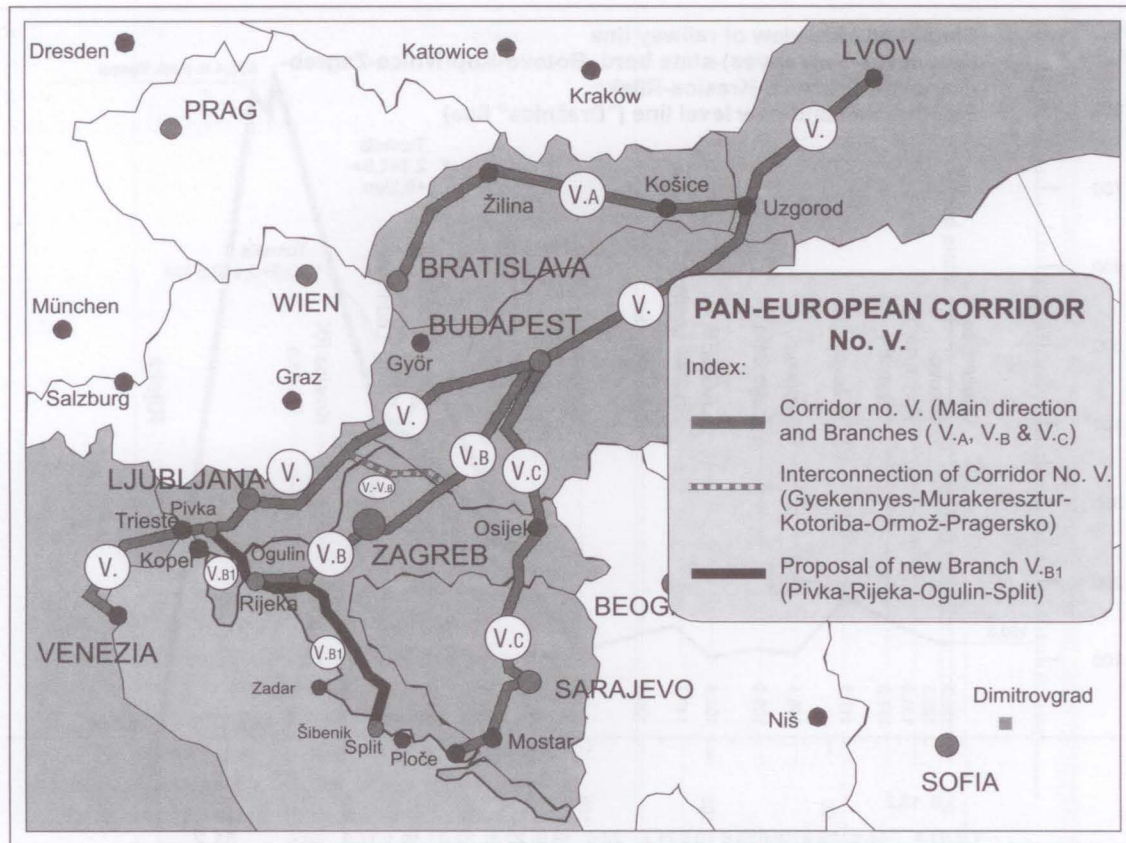


Figure 4.2.2. Fifth Pan-European Corridor with branches

4.2.2. Corridor V.

The main route of Corridor V is planned through Slovenia where the direct line with Hungary is realised on the new railway line between Murska Sobota in Slovenia and Hodoša in Hungary. There is also Branch A of Corridor V which passes through Slovakia (connects Uzgorod via Košice with Bratislava). In Croatia, Corridor V consists of Branches B and C. The initiative is underway regarding signing of a new Letter of Intent related to the activities on Corridor V. The Croatian proposal is to include also Branch V. b1 into the network of Pan-European corridors that would extend from Pivka in Slovenia to Split in Croatia.

Pan-European Corridor V is presented in Figure 4.2.2.

4.2.2.1. Corridor V. (Branch B)

railway line: (Budapest-Gyekenyes) - state border - Botovo - Koprivnica - Zagreb - Rijeka

- r/w. line length - in Croatia 328.5 km
- track gradient - 8 ‰ (from the Hungarian border to Moravice, 238.5 km) and 25 ‰ (from Moravice to Rijeka, 90 km)
- maximum speed - 120 km/h (from Hung. border to Karlovac in the length of 152.4 km, 70-100 km/h

(from Karlovac to Rijeka, 176.1 km)

- axle mass - 22.5 t/axle, 8.0 t/m¹ (on un-repaired sections of the line 22.0 t/axle and 8.0 t/m¹)
- number of tracks - single
- r/w. line equipment - electrified (25 kV, 50 Hz from Zagreb to Moravice, from Moravice to Rijeka 3 kV D. C.), automatic block (AB Zg-Mor., Mor-Ri inter-station dependence), ground-train radio link, security at stations and r/w. lines by relay devices;
- r/w. line capacity - 6.1 mil. t/year
- transport - 5.5 mil nt/year and 1 million pax/year in the period until 1990, 2.5 mil nt year now and 0.5 mil pax/year.

The dry cargo handling capacities in the port of Rijeka amount today to over 7 million tonnes, and in the future these could be increased to over 20 million tonnes. The sea depth in the ports (Bakar, Goranin, Sušak, Rijeka, Bršica) which form part of the Luka Rika Company is 18-20 m and can accommodate the biggest ocean-going ships. The travelling time by highest-speed trains from the Hungarian border to Rijeka today takes about 5.0 hours. If the new level line were

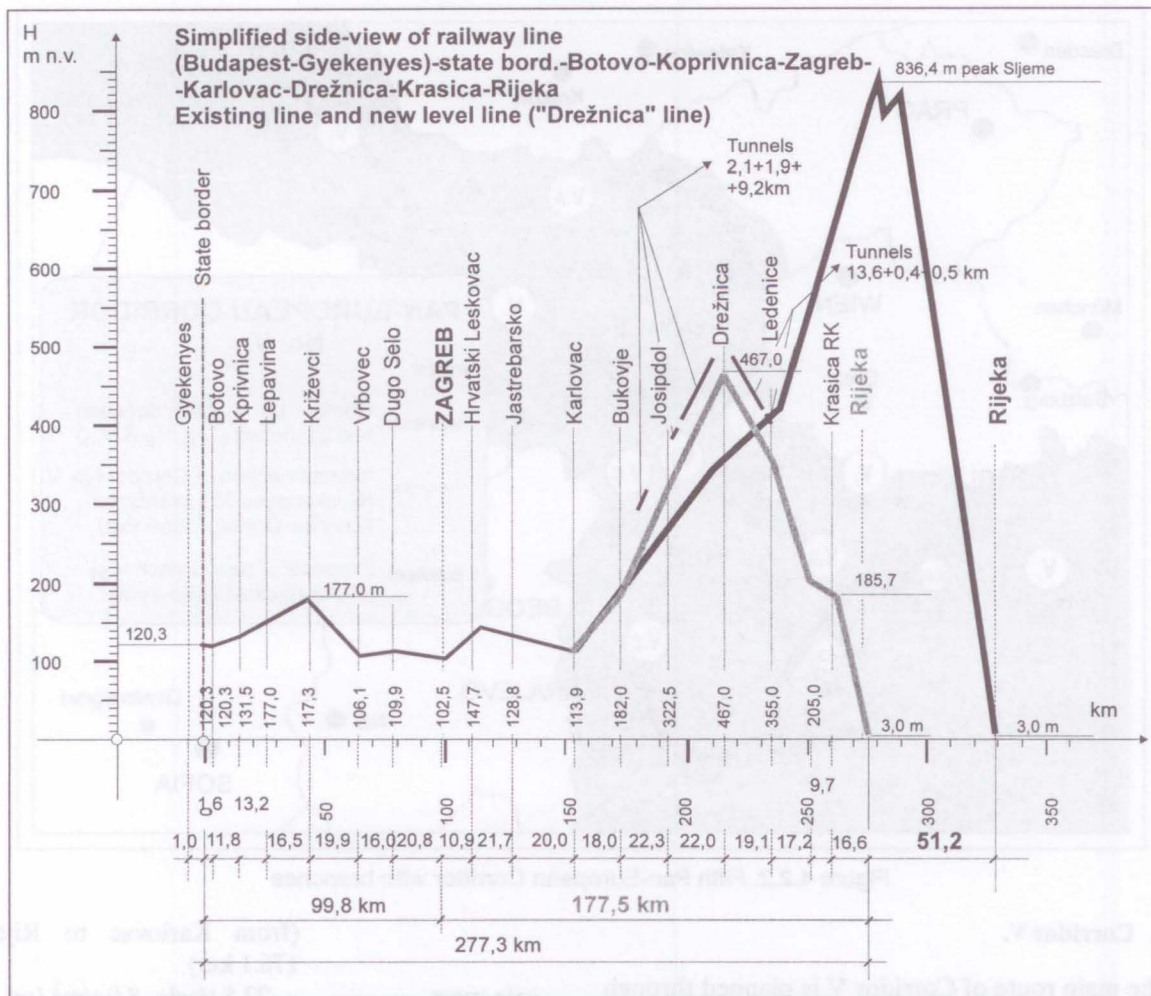


Figure 4.2.2.1. Branch B of the fifth Pan-European Corridor in Croatia

built (from Karlovac to Rijeka and with the construction of the second track along the existing railway line from the Hungarian border to Karlovac) the travelling time on this relation would be reduced to less than 3 hours. Graphical presentation of the simplified longitudinal section of the railway line in Corridor V. b in Croatia is shown in Figure 4.2.2.1.

The railway line from Budapest to the Croatian border is about 260km long (via Dombovar); so that the total distance from Budapest to Rijeka, under the conditions of the existing line amount to 588 km, and of the new line these would be 537km.

The first step in modernisation of the line is the general overhaul of the line, followed by the replacement of the electric traction system from Moravice to Šapjane (110 km), the existing 3 kV D. C. system by the new 25 kV 50 Hz system. At the same time the signalling and telecommunication systems will be upgraded. The gains will encompass increased throughput and railway line transport capacity, improved exploitation of the engines and technical and technological harmonisation of the system along the entire line and reduction of costs spent on the maintenance of

the obsolete electric traction system. Further modernisation will include installation of the remote control system using signalling devices and optic cable along the entire section from Botovo to Rijeka.

Further modernisation of the line is planned by the construction of the second track along the existing line from Dugo Selo to the border in the total length of 79.0 km and from Zagreb to Karlovac in the total length of 52.6 km. The construction of the second track improves the rlw. line capacity, increases the speed and generally raises the quality of the transport offer on this corridor. The technical elements of the line will allow speeds of 160 to 200 km/h. The line will feature the technical properties of AGTC line. The construction of a new level electrified line from Karlovac to Rijeka is planned (124.9 km). The construction of this line and the junction represent reaching of high-quality transport offer uniform on the entire section of the Corridor through Croatia from Botovo to Rijeka. This line will also feature the technical elements allowing speeds of 200 km/h. Thus, this section of the Corridor will have all the technical properties of AGTC railway line.

The construction of a railway line is also planned with the main tunnel in the length of about 12.0 km between Opatija-Matulji and Vranje in Istria. This would provide direct connection of the railway lines in Istria with the rest of the HŽ railway network. This connection would also represent part of the new railway line towards Trieste.

4.2.2. Corridor V. (Branch C), railway line:

(Budapest-Magyarboly)-state border Beli Manastir - Osijek - Strizivojna/ Vrpolje-Slavonski Šamac - Hungarian state border - (Doboj-Zenica-Sarajevo-Mostar in B&H) - state border with B&H - Metković-Ploče

- rw. line length - 509,0 km (in Croatia 102,4 km, u B&H 406.6 km)
- track gradient - in Croatia 7.0 ‰
- maximum speed - 80-100 km/h (on unrepaired section 40-60 km/h)
- axle mass - 22.5 t/axle 8.0 t/m¹ (on unrepaired section from Osijek to Viškovci in the length of 12.7 km 16.0 t. The overhaul of this section has been included in the "Quick Start" project of the European Investment Bank (EIB) and the works are expected to start in 2001);
- number of tracks - single (double in Bosnia and Herzegovina, on the section from Grapska (Doboj) to Jelina (Zenica) in the length of 92.7 km);
- rw. line equipment - electrified (25 kV, 50 Hz on the section from Vrpolje to Šamac and from Metković to Ploče. In B&H it was electrified along the entire length but the catenary was destroyed during the war), automatic block (AB), ground-train radio link, safety at stations and on lines by means of relay devices;
- rw. line capacity - about 5 mil. t/year ("bottleneck" of the whole route is the climb on the Mountain Bradina in B&H, climb 25‰);
- transport - the busiest section (Vrpolje-Šamac, 20.0 km long) 6 mil. t/year and 2 million pax/year in the period until 1990, 0.6 mil. t/year now and 0.2 mil. pax/year.

The revival of traffic along this Pan-European Corridor is expected in the near future. It has been included in the priority investments in the Pact of Stabil-

ity (which is financially supported by EIB). This traffic route is very significant for Bosnia and Herzegovina since it provides railway connection with Europe. It is also significant for the eastern parts of Croatia and south-eastern parts of Hungary since it provides favourable connection to the Adriatic Sea.

The modernisation programme of Corridor V. c on the territory of Croatia (railway lines: Beli Manastir - Osijek - Strizivojna/Vrpolje - Slavonski Šamac and Metković - Ploče) in the first stage up to 2005 comprise the activities on track overhaul; reconstruction of certain curves for speeds up to 160 km/h, required deviation of single track section; completion of track construction and reconstruction of stations. Maximal speed will be up to 120 km/h, until all adequate parameters for speed of up to 160 km/h are acquired. Further steps in the programme are safety equipment for stations and transport dispatching rooms, establishment of inter-station dependence, installation of AS equipment on track and in stations, protection of level-crossings, construction of automatic railway telephone exchange and automatic railway telephone system, laying of optical fibres along the entire line, laying of copper cable from Beli Manastir to Strizivojna/Vrpolje, installation of traffic remote control, installation of GSM-R and UHF network in bigger stations.

Apart from the mentioned, also the following activities are foreseen: upgrading of fixed installations on sections Strizivojna/Vrpolje - Slavonski Šamac and Metković - Ploče; reconstruction and upgrading of low-voltage network and station lighting. The electrification of line from Beli Manastir to Strizivojna/Vrpolje (most probably after 2005) is foreseen. It will be a single track line, but all the prior conditions had been fulfilled for the construction of the second track (when required).

Considering the accomplished traffic volume the Port of Ploče is the second port in Croatia. Located in the Central Dalmatian region, between Split and Dubrovnik the Port of Ploče is the biggest departure and destination point for transport flows in Corridor V. c. It is extremely important for the economy of Bosnia and Herzegovina, and this Port enables most convenient connection between South-eastern Croatia and Southern Hungary with the Adriatic.

At the moment, the Port of Ploče is again in the position to fulfil all the requests submitted by their business partners in Croatia, Bosnia and Herzegovina and Hungary regarding the quality of services, speed, reliability and acceptable charges. The Port of Ploče manages 230 ha of land (the existing terminals and land foreseen for future Port development) that are considered as important development potential. Together with the reloading terminals the Port has terminals for passenger transport. The Port management

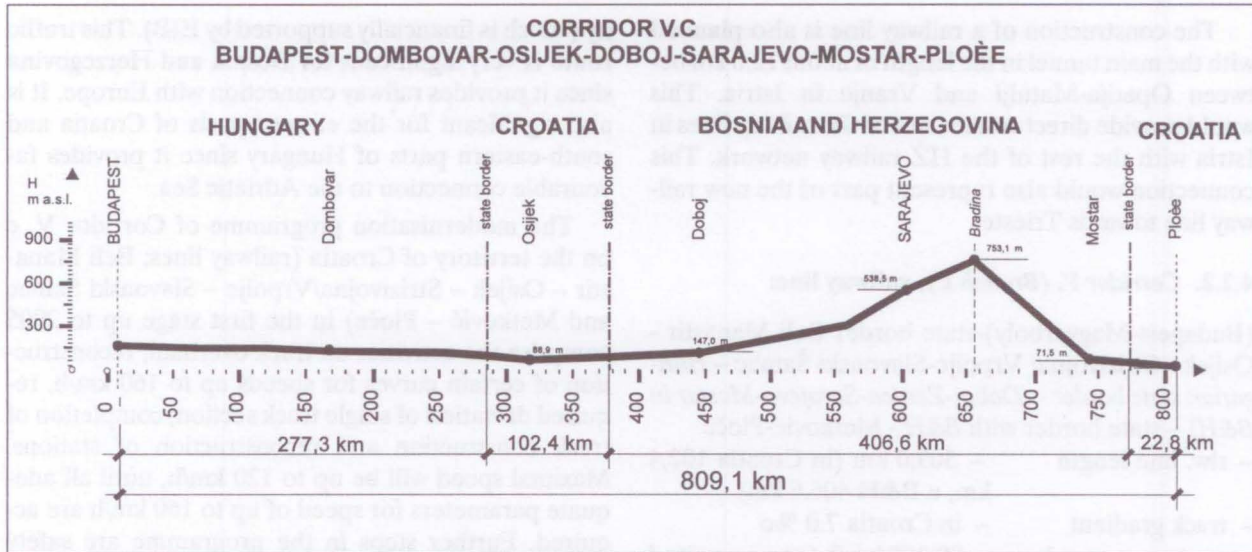


Figure 4.2.2. Simplified longitudinal railway line section in Corridor V.c

includes also a terminal in Metković (on the river Neretva). The depth of the sea in the Port piers is from 8.5 to 13.5 m, which provides accommodation of various ships, including big liners and big sea ships.

In mid-term period till 2003 the foreseen investments include: terminal for liquid gas (LPG terminal), extension of terminal for timber reloading and upgrading of the Port infrastructure. Long-term development programme foresees the investments in container terminal and new terminal for bulk freights. The entire territory of the Port of Ploče is a free-trade zone which provides special duty rates and special tax relief. Potential development capacities of the Port of Ploče are approximately 8.0 million tons.

The railway line in Corridor V. c is represented in Figure 4.2.2.2.

4.2.3. Corridor V. (Branch B1), railway line (proposal):

(Pivka, Slovenija)-state border-Rijeka-Ogulin-Knin-Split

- rlw. line length (km) - 522.0 km
- track gradient - 23.0 ‰
- maximum speed - 60-160 km/h
- axle mass - 22.5 t/axle 8.0 t/m¹
- number of tracks - single
- rlw. line equipment - electrified (3 kV, D. C., partly), safety at stations and line by relays;
- rlw. line capacity - 3.5 mil. t/year
- transport - in the period until 1990, 0.8 mil nt/year now and 0.2 mil pax/year Planned traffic in the future 3 mil nt/year and 0.5 million pax/year

The existing railway line Rijeka – Trieste in the length of 124.0 km, with the highest rlw. line Hill of 578.0 m (Pivka). It allows further connection of Rijeka with Trieste which provides direct connection of the three North Adriatic ports.

Central Dalmatia is formally not directly connected by Corridor lines with the interior. The textual part of the Helsinki Document speaks of the possibility of finding new traffic corridors in the Adriatic – Ionian basin, and explicitly mentions the railway line towards Split. On the other hand, the Croatian traffic strategy has defined modernisation of the traffic route towards Central Adriatic as its priority. The road construction program is nearing its completion, and a more intensive investment program into the railways on the mentioned route has started. These are the reasons why Croatia has proposed inclusion of the new Branch V. b1 (Pivka-Rijeka-Ogulin-Knin-Split) as supplement to the Letter of intent for Corridor V.

The planned modernisation of the Lika railway line includes repairs of track facilities, capital overhaul of the railway line on 249.6 kilometres out of which 30.4 km on the section of the Zagreb – Oštarije railway line, 113.4 km on the Oštarije – Knin section and 105.8 on the Knin – Split section. On certain parts of the Oštarije – Knin section the correction of the railway line route will be carried out, and on the Studenci – Gračac (65.8km) section, the reconstruction of curves will allow maximum train speed of up to 160 km/h, with several limitations to 120 km/h. The extension of the tracks at six railway stations on the section Oštarije – Knin will allow crossing of longer cargo trains and raise the transport capacity of the railway line.

On the part of the Oštarije – Split railway line, the signalling and safety devices at 28 railway stations will be modernised. The purchase electronic and other equipment has been planned for protection of 12 rail-

way stations by SS devices on the section of the railway line from Josipdol to Gračac, for the installation of inter-station dependence, for installation of remote control between the railway stations Oštarije - Rudopolje, for the protection of 16 level-crossings by new SS devices. Included in these devices on the section of the Oštarije - Knin railway line the purchase of 6 electronic automatic railway telephone exchanges has been planned as well as the systems for their interconnection. To allow running of the tilting trains at higher speeds than the conventional train speeds, it is necessary to adapt the signalling-safety devices at 48 CPR.

Electrification of the Oštarije - Knin - Split (and Perković-Šibenik) railway line, the provision of energy resources on the lines of that area and the construction of lighting at traffic places of work on the railway line would require the construction of seven electric traction substations 110/25 kV and addition of one feeder station, as well as the construction of 139 transmission lines of 110 kV and 6 transmission fields. The construction of 383 km catenaries and the secondary stable facilities of electric traction are planned for the period by the end of 2006.

Tilting trains provide effects on repaired lines, with curve radii of 250 m and more, such as are just to be renewed on the Zagreb - Split route, by reducing the travelling time on the average by about 20%, confirmed by the experimental runs using such types of trains on HŽ lines. The introduction of tilting trains into traffic does not compensate for the need of further infrastructure modernisation, but rather represents the improvement of the services on the existing lines with unfavourable routes in the transition phase until the construction of new or significant improvement of the new railway infrastructure. The travelling time of the tilting trains on the Zagreb - Split relation under the conditions of the undertaken modernisation which can be done by the time the tilting trains start operating (June 2004) has been estimated at less than 5 hours.

The lengths of individual sections of the proposed new Branch of Corridor V. are given in Table 4.2.3.

Table 4.2.3. Corridor Vb1 - proposal

Rail Line Section	Length (km)
S.B. - Šapjane - Rijeka	30.0
Rijeka - Ogulin	119.8
Ogulin - Josipdol	10.0
Josipdol - Knin	234.1
Knin - Split	102.7
Total (Rail Line in Croatia)	496.6
Pivka - S.B. (Rail Line in Slovenia)	25.4
Total Branch Line Length: Pivka-Rijeka-Ogulin-Split	522.0

Note: S. B. - State Border-

5. RAILWAY TRAFFIC INFRASTRUCTURE DEVELOPMENT STRATEGY IN CROATIA

The realisation of the basic goals in the field of infrastructure is planned with the emphasis on improving the infrastructure on Pan-European corridors that pass through Croatia (Corridors X., V. b and V. c). The tendency is to realise those corridor railway line parameters that were drafted in the AGC and AGTC agreements (Croatia has signed these agreements thus accepting the obligation to implement them). Basically, this means reaching the allowed capacity of 22.5 t/axle and 8.0t per metre of length, structure gauge UIC C₁, construction of double-track electrified lines equipped with advanced systems of traffic safety and regulation, realisation of minimum speed of 160 km/h on the existing lines and 250 km/h on the new lines that would accommodate mixed traffic (passenger and cargo), realisation of the useful track length at railway stations of 600 m on the existing lines and 750 m on the new lines, etc. During the transition period the current condition is tolerated on the existing lines, i. e. exceptionally parameters defined by the TER project are applied (maximum speed 120 km/h, rlw. station length of 500m, etc.). The deadlines for the realisation of the mentioned parameters have not been strictly determined, but the network of Pan-European corridors has been set so that there are competitive routes and the route that sooner provides higher quality conditions will attract greater volumes of cargo and passenger flows, and consequently higher revenues. It is essential to define a Master plan of the activities for every corridor with a framework dynamics and means necessary to realise the activities. The corridors with clearly set goals can expect faster and more substantial support from the banks and financial institutions.

The integration into the EU standard system is an imperative for the accession to the European Union. During the transition period the dynamics of implementation has not been defined and it may develop in accordance with the local conditions, but for each of the EU candidate countries the implementation of these standards represents the goal. They set conditions for the accountancy separation within the railways to infrastructure and transport (actual separation is not a condition, they allow access to the railway network of a certain country to all the interested subjects that need to satisfy the required conditions, thus increasing the market competition that needs to result in better and cheaper traffic service. Regarding the inherited conditions and the state of the infrastructure and the transport means, the Croatian Railways (HŽ) are realising the implementation of the mentioned principles. During the restructuring project (first

phase until 2003 and the second by 2006), the implementation of the standards will focus on the railway operation in the market conditions, keeping the unique (single) organisational form. During that period the railways will be transformed into a market-oriented company, with the productivity and high-quality service provision at the level of the countries that are candidates for accession to the EU. The basic quality level of the infrastructure and the transport means, organisational equipment of single parts of the companies (which will eventually be privatised or will operate in market conditions) will be raised to the level at which they will be able to enter maximally equal competition with other EU railways, and especially with our neighbouring railways. The basic pre-condition for these activities have been included in the new Law on Railways, that is to be accepted after 1 April 2004.

The improved connections between the cities and the regions within the Republic of Croatia with pronounced Adriatic orientation are meant to be realised by improving the railway line network in Pan-European corridors and other lines that connect the county centres with each other and with the capital of Croatia, Zagreb. The basic aim is to raise the level of services until realising competitiveness with the road traffic, as the main competitor on the transport market. This means average travelling speeds of about 100 km/h in passenger traffic and the travelling speed of cargo by trains of about 50 km/h.

The development of the urban and suburban traffic in the city, and regional traffic is also one of the strategic guidelines in the development of the railways. Apart from Zagreb (where urban and suburban traffic is operating) it has to be developed also in Rijeka, Split and Osijek.

The strategic orientation in strengthening intermodality in the concept of traffic network development in Croatia will result in increased investments into the traffic infrastructure of the railway and water traffic. The railways is planning to provide new services in the multimodal and combined transport along with purchasing the transport means for that purpose and developing the centres for combined transport in Zagreb, Spačva and Knin.

The strategic orientation of the port of Rijeka to reach traffic volume of about 12 million tonnes a year will require the construction of a new railway line with level characteristics from Zagreb to Rijeka. The construction dynamics will depend on the actual increase of the traffic in the port, and it needs to start when it reaches the capacity of the existing line (of about 7.0 million tonnes a year after having modified the traction system from Moravice to Rijeka and Šapjane and the introduction of tilting trains).

The increase of safety in railway traffic is also a strategic guideline of the railway development. The

railways, as a traffic system, is the leading one regarding safety, compared to other branches of traffic, but this does not mean that such a condition cannot be improved. The modernisation program and the means invested in modernisation, as well as adequate education of people working at the railways will increase the level of safety at the railways.

Environmental protection is one of the basic guidelines in the development strategy of the majority of countries in the world. The railway is a system that is more environmentally friendly than other traffic branches. Scientific research in this field has proven that over 90% of pollution and negative impacts on the environment that are generated by traffic are accounted for by road traffic. The European Union in the new traffic policy is planning to transfer external costs of traffic (including the negative impact on the environment) to the traffic branches that cause these costs. This will result in directing substantial means to the branches which are more environmentally friendly, and in practice substantial additional means will be allocated to the development of the railways.

The implementation of the social program is also a strategic orientation of the Croatian Railways (HŽ). The restructuring and modernisation of the railways result in the necessary reduction of the number of employees. This process is approached in a planned manner, with maximal tendency to reduce the negative effects in the process. Re-training and re-employment centres are being established to support the workers who are becoming redundant during the technological process of operation. The entire process is coordinated with the unions and supported by the state and the world banks as part of the project regarding company restructuring.

6. CONCLUSION

EU has defined the type of railways it needs and has set the framework for the period within which these objectives should be realised. The future EU railways should be the railway which provides high and safe level of service, which has minimum adverse impact on the environment, which operates on market principles and without additional state subventions (if not determined otherwise by contract with the aim of providing services of general interest that cannot be profitable). Substantial investments into railways are planned, and the railway is expected to operate on the market principles subjected to equal and fair competition of other transport modes. Therefore, the railways need to undertake big changes in the organisation of operation and in raising the quality of services. The Croatian Railways (HŽ) are joining these processes and since the strategic orientation of Croatia is to join the EU membership, they are

adapting their operation to the system strictly defined by EU. Such orientation conditions also substantial investments into the railways with the aim of providing equal conditions for the operation and the level of

traffic services in the entire region of the future integrated Europe. Since one of the most significant strategic guidelines for Croatia is the accession to the EU, during this process the railways and the conditions at

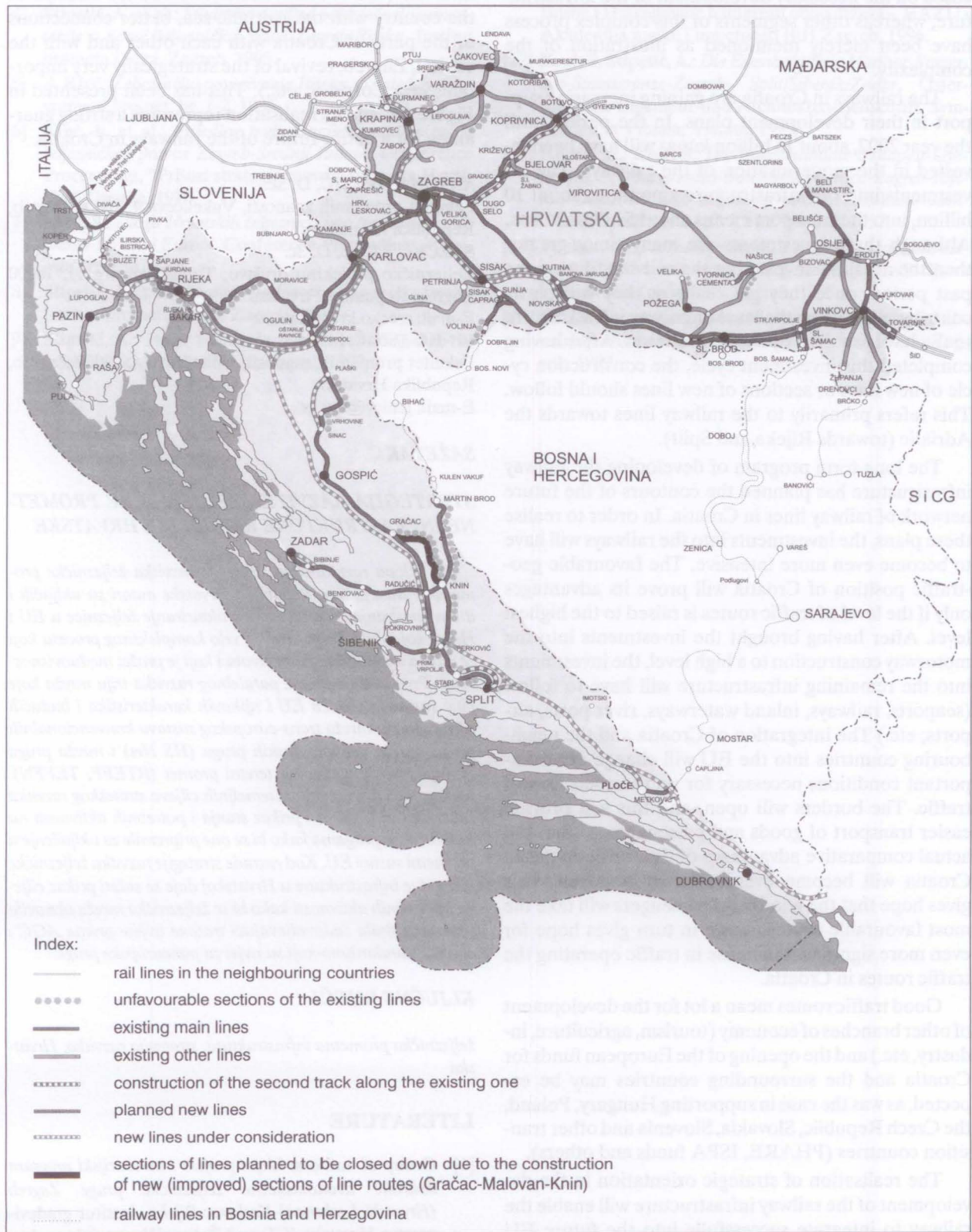


Figure 6.1. Proposal for the development of the railway line network in Croatia (2020)

the railways will have to be harmonised with the European guidelines.

The process of creating a new railway in EU is very complex. In this work, research has been primarily focused on the necessary development of the infrastructure, whereas other segments of this complex process have been merely mentioned as illustration of the complexity.

The railways in Croatia are gaining increasing support in their development plans. In the period until the year 2007, about 15 billion kunas will have been invested in the modernisation of the railways. The investments into the infrastructure amount to about 10 billion, into the transport means about 5 billion kunas. Although these investments are many times greater than the amounts invested in the railways during the past period, once they get realised, they will partly contribute to raising the level of railway infrastructure to the level required by the EU railways. After having completed this investment cycle, the construction cycle of new lines or sections of new lines should follow. This refers primarily to the railway lines towards the Adriatic (towards Rijeka and Split).

The long-term program of developing the railway infrastructure has planned the contours of the future network of railway lines in Croatia. In order to realise these plans, the investments into the railways will have to become even more intensive. The favourable geo-traffic position of Croatia will prove its advantages only if the level of traffic routes is raised to the highest level. After having brought the investments into the motorway construction to a high level, the investments into the remaining infrastructure will have to follow (seaports, railways, inland waterways, river ports, airports, etc.) The integration of Croatia and the neighbouring countries into the EU will change other important conditions necessary for undisturbed flow of traffic. The borders will open, and this will provide easier transport of goods and passengers, so that the actual comparative advantages of the traffic routes in Croatia will become even more pronounced. This gives hope that the goods and passengers will take the most favourable routes, which in turn gives hope for even more significant increase in traffic operating the traffic routes in Croatia.

Good traffic routes mean a lot for the development of other branches of economy (tourism, agriculture, industry, etc.) and the opening of the European funds for Croatia and the surrounding countries may be expected, as was the case in supporting Hungary, Poland, the Czech Republic, Slovakia, Slovenia and other transition countries (PHARE, ISPA funds and others).

The realisation of strategic orientation in the development of the railway infrastructure will enable the railway to integrate successfully into the future EU traffic system. The development proposal for the fu-

ture railway line network in Croatia contains the synthesis of the requirements that EU has set for the development of the network, and at the same time enables the realisation of the basic government strategic interests (better connections between the interior of the country with the Adriatic sea, better connections of the parts of Croatia with each other and with the capital, Zagreb, revival of the strategically very important Sava Corridor, etc.). This has been presented in Figure 6.1. and its realisation represents a strong guarantee for a better future of the railways in Croatia.

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SAŽETAK

STRATEGIJA RAZVITKA ŽELJEZNIČKE PROMETNE INFRASTRUKTURE REPUBLIKE HRVATSKE

U sklopu razmatranja strategije razvitka željezničke prometne infrastrukture Republike Hrvatske autori su uključili i dio razmatranja vezanih uz restrukturiranje željeznice u EU i Hrvatskoj u cilju osiguravanja vrlo kompleksnog procesa koji se odvija u svakodnevnom životu i koji je prožet međuovisnošću. Prvo se daje prikaz paralelnog razvitka triju mreža koje čine sustav željeznica EU i njihovih karakteristika i budućih uloga. To su: mreža trans-europskog sustava konvencionalnih pruga, mreža velikobrzinskih pruga (HS Net) i mreža pruga namijenjenih pretežno za teretni promet (RTEFF, TEFFN). Nakon toga daje se prikaz temeljnih ciljeva strateškog razvitka željeznica u Croatia i prikaz stanja i potrebnih aktivnosti na koridorskim prugama kako bi se one pripremile za uključivanje u prometni sustav EU. Kod razrade strategije razvitka željezničke prometne infrastrukture u Hrvatskoj daje se sažeti prikaz ciljeva i potrebnih aktivnosti kako bi se željeznička mreža obnovila i rekonstruirala zadovoljavajući tražene uvjete prema AGC i AGTC standardima koji su uvjet za paneuropske pruge.

KLJUČNE RIJEČI

željeznička prometna infrastruktura, strategija razvitka, Hrvatska

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