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## THE STATE AND THE PROSPECTS OF RAILWAY DEVELOPMENT IN CROATIA

### SUMMARY

*The authors consider the existing state of railway transport in Croatia which is characterised by insufficient development and backward technology. These make specific obstructions for the Croatian joining of the trans-European integration processes. A solution that would make Croatia an important node in linking the European East and West, i.e. South and North is proposed. In this way two leading centres would be activated: Zagreb and Rijeka. Regarding inland transversal linking priority is given to modernisation and reconstruction of an essential direction of Croatian North and South which links two leading industrial and population centres: Zagreb and Split.*

*This would enable the economic and social revival of Dalmatian influence within Croatian economy.*

### KEY WORDS

*main railway lines, high-speed trains, tilting trains*

### 1. INTRODUCTION

The present railway transport is performed in unfavourable geographical conditions. There are several reasons for that: obsolete railway network and infrastructure, insufficient number of double tracks, decrease of economic production, reduced rate of foreign trade activity. These reasons, together with railway track destruction during the 1991–1995 War caused the decrease of transport within the entire railway network.

Railway is a way of rapid economic inclusion of Croatia into the European integration processes. It is therefore necessary to adjust the Croatian railway network to the state of railway infrastructure on the territory of Europe.

It is necessary to introduce high-speed trains from 160–200 km/h in the first step and afterwards with higher speeds (250–300 km/h) on the main railway lines and secondary main lines in passenger transport,

i. e. with speeds higher than 100 km/h, in international goods transport, developing combined road – railway transport.

In keeping in line with the European integration processes emphasis should be put on the transverse link Botovo – Zagreb – Rijeka with a side-track to Dalmatia: Ogulin – Knin – Split (Zadar / Šibenik) and to the link Eastern Europe – the border Beli Manastir – Osijek – Šamac – the border of Bosnia and Herzegovina – Sarajevo – Croatian border – Metković – Ploče. In longitudinal linking, priority should be given to the link from Western Europe through Slovenia – Savski Marof – Zagreb – Vinkovci – Tovarnik – Yugoslav border – Greece – Bulgaria. In this way Croatia would be included in the part of trans-European traffic directions that link the areas of Northern and Western Europe with the Mediterranean and South – Eastern Europe. With these directions the access to the sea for the landlocked countries of Eastern and Central Europe is made possible. The primary link is, therefore, Botovo – Zagreb – Rijeka

### 2. THE STATE OF RAILWAY TRANSPORT

In total, the railway network in Croatia is 2709.727 km long, only a tenth of which are double tracks (Table 1). The majority of double tracks belong to the category of main lines whose actual length is 847.325 km. Depending on economic exchange, transition, international transport and the intensity of transport, railway tracks can be categorised in four basic groups: main railway lines, secondary main lines, first grade lines, second grade lines. Croatia has four main lines and two of them make “the backbone” of the railway system:

**Main line 1:** Botovo – Koprivnica – Dugo Selo – Zagreb (100.995 km long) – Karlovac – Rijeka (228.333 km long)

**Table 1. Railway track length on the territory of Croatia, 1997**

Class	Actual length	Usable length	Total construction length	Single tracks	Double tracks	TOTAL
MG	847,325	752,563	848,005	603,633	244,372	1092,377
MP	609,888	541,735	694,935	691,306	3,629	698,564
I	571,030	509,405	577,528	577,528	–	577,528
II	600,484	493,019	605,909	605,909	–	605,909
TOTAL	2709,727	2296,722	2726,377	2478,378	248,001	2974,378

Source: Croatian Railways, 1998

**Table 2. The number of transported passengers according to types of transport (1995 – 1997) In 000**

Transported passengers	Year		
	1995	1996	1997
TOTAL	113809	116654	118249
Rail	28624	29102	28785
Road	83652	85836	87544
Air	1533	1716	1920

Source: Croatian Railways, 1998

**Table 2a. Goods transport according to types of transport (1996 – 1997) in 000 t.**

Type of transport	Year			
	1997	%	1996	%
TOTAL	86,627	100,00	62,642	100,00
Rail	12,168	14,55	11,061	17,66
Road transport	4,986	5,96	4,918	7,85
Piping:	7,495	8,96	6,853	10,94
oil transport	5,361	6,41	4,981	7,95
gas transport	2,044	2,44	1,972	3,15
Maritime and coast transport	38,092	45,55	3,644	45,82
Inland water transport	971	1,16	1,181	1,88
Air transport	5	0,01	5	0,01

Source: Croatian Railways, 1998

**Main line 2:** Savski Marof – Zagreb – Sisak – Novska – Vinkovci – Tovarnik (328.599 km long) (Supplement 1)

The main railway lines with linking directions in the zone of central railway hubs (Zagreb, Vinkovci) are supplemented by secondary main lines which have the function of linking the continental inland and the Adriatic coast (Main line 1. 1. Oštarije – Knin – Split / Zadar /Šibenik), in other words a function of linking Eastern Europe and Dalmatia with the link Beli Manastir – Osijek – Đakovo – Strizivojna – Vrpolje –

**Table 3. Railway transport according to types of goods (1996 – 1997) in 000 t.**

Type of goods	Year			
	1997	%	1996	%
Coal and coke	143	0,91	189	1,30
Crude oil	39	0,25	47	0,32
Petrol, paraffin and gas oil	885	5,62	775	5,33
Gas	616	3,91	696	4,79
Oil and concentrates	51	0,32	129	0,89
Non-metals (rock, salt and sulphur)	1,357	8,62	1,377	9,47
Building material (asbestos, stone, glass)	39	0,25	64	0,44
Metal products (iron, iron products)	1,708	10,85	1,407	9,68
Wood and wood products	1,393	8,85	1,154	7,94
Cement	180	1,14	157	1,08
Cereals and milling products	881	5,60	280	1,97
Crop products (sugar-beet)	390	2,48	412	2,83
Fertilizers	684	4,35	780	5,37
Rest:	3,675	23,35	3,526	24,26
a) nutritional industry products	421	2,67	518	3,56
b) chemical industry	629	4,00	577	3,97
c) means of transport	188	1,19	126	0,87
d) wagons, private, empty	1,106	7,02	1,135	7,81
e) containers large loading	431	2,74	452	3,11
f) road vehicles	182	1,16	147	1,01
g) rest	718	4,56	571	3,93
Command consignment	19	0,12	13	0,09
TOTAL	15735	100	14532	100

Source: Croatian Railways, 1998

Bosnia and Herzegovina – Metković. Among the first grade lines the link of North-Western and Eastern

**Table 4. Combined transport in 1997 according to cargo units**

Type of transport	Consignment number	% of total transport	Tons	% of total cargo transport
Inland	971	0,36	12911	0,41
International:	33399	12,46	660968	7,38
a) transit	29096	19,01	599902	11,51
b) import	2545	3,71	37035	1,65
c) export	1758	3,80	24031	1,60
<b>Total a + b + c</b>	<b>34370</b>	<b>6,43</b>	<b>673879</b>	<b>5,55</b>
Type of transport units				
Containers – empty	6856	20	29710	4
Containers – loaded	17400	51	431066	64
Truck crates – empty	535	2	2191	0
Truck crates- loaded	767	2	28974	4
RO – LA truck consignment	8812	26	181938	27
<b>TOTAL</b>	<b>34370</b>	<b>100</b>	<b>673879</b>	<b>100</b>

Source: Croatian Railways, 1998

Croatia, the so-called Podravina main line Varaždin – Koprivnica – Osijek – Dalj is of great importance, together with the link of the inland of Istra with the coast: Buzet – Pula, and the direction North–South which links two leading industrial centres in Eastern Slavonia: Vinkovci – Osijek. The second grade lines are for the most part low profitable, not electrified, without essential infrastructure (Savski Marof – Kumrovec, Zabok – Đurmanec, Križevci – Bjelovar, Pleternica – Velika, Bizovac – Belišće, Borovo – Vukovar; supplement 1).

Railway is again the dominating way of goods transport by land transport vehicles, where the quantity of transported goods is 2.5 times larger than in road vehicles transport, i.e. 1.5 times larger than in pipeline-system.

However, in passenger transport, railway falls far behind the road vehicles. While the number of transported passengers by road vehicles is on the increase, railway passenger traffic shows no essential changes in this number (Tables 2 and 2a). Among the transported goods the largest share are metals (10.85 %), wood and semi-products (8.85 %), non-metals (8.62%), petrol (5.62%) and cereal products (5.60%).

The number of transported goods within two previous years shows ascending trend, particularly in ore, metal and cereal products transport. The reason for that also lies in the fact that the war has ended, and the railways of Eastern Slavonia, Lika and Dalmatian have been integrated into the Croatian traffic system.

Since 1997 railways have been included in the combined transport of goods (road – railway) where road vehicles are transported on low-floor wagons in RO – LA train system. In this kind of transport Croatia has

been included as transit area from Eastern to Western Europe and from the North to the South (Croatia – the border of Bosnia and Herzegovina – Croatia), as well as a domicile area for goods transport towards Western Europe. On the main line 3, Kotoriba – Čakovec, 8000 truck consignments were transported, together with 1300 replaceable truck crates and semi-trailers. For intensive integration of Croatia into combined transport system, it is necessary to enable railway tracks for high-speed trains, as well as to provide a larger number of specialised wagons and reloading equipment. On account of all these deficiencies, combined transport has a negligibly small share of consignments in interior transport (971 consignments or 0.36%), i.e. only 0.41 of total cargo (Table 4).

The circumstances have been improved by the goods transport in international, i.e. transit transport, with 12.46% and 19.01%. The biggest part of goods

**Table 5. Railway track Rijeka – Zagreb alternatives**

Elements	State	Alternatives		
		I	II	III
Length (km)	228,333	149,7	170,8	165,5
The highest point (in meters above sea level)	836,4	270	469	361
Bridge length (km)		57	27	43

has been transported by containers and RO – LA truck consignment which make 77%, i.e. 92% of the total annual traffic and cargo (Table 3).

For more intensive integration into European railway system fundamental changes in technological development are indispensable. It is necessary to apply those technical solutions which have been used by the developed European countries for some time now, and which are for our relief – topological – geomorphological conditions the most appropriate. It includes high-speed trains with the possibility of crate inclination (tilting) and the use of bimodal technology in goods transport. First of all it is necessary to reconstruct and modernise railway tracks on main lines in the first stage, i.e. on secondary main lines in the second stage.

### 3. DEVELOPMENT ASSUMPTIONS

High-speed tracks are the ones on which trains drive at speeds over 200 km/h. Compared with high-speed trains in France, Japan or Belgium, the 200 km/h speed can be considered as the lowest limit. While constructing these kinds of trucks priority should be given to the routes which are part of trans-European railway transport system.

The dominating directions are the ones which form the Croatian railway cross:

1. Zagreb – Vinkovci – Tovarnik – link with South – Eastern Europe (Greece/Turkey / Bulgaria)
    - 1.a. Zagreb – Savski Marof – Dobova – Ljubljana
  2. Zagreb – Rijeka
    - 2.a. Zagreb – Koprivnica – Budapest
  3. Zagreb – Zabok – Maribor – Graz – Vienna
    - 3.a. Varaždin – Krapina
- and secondary main line Zagreb – Oštarije – Knin – Split (Zadar / Šibenik)

Railways on routes Zagreb – Vinkovci – Tovarnik (130 – 160 km/h) come closest to this. However, the main problem is the insufficient number of constructed double tracks on these primary links (Dugo Selo – Botovo, Zagreb – Sisak, Rijeka – Karlovac).

### 4. PROPOSALS FOR THE ZAGREB – RIJEKA AND ZAGREB – DALMATIA RAILWAY LINE

Primary railway line Zagreb – Rijeka is 228,33 km long. It is the dominating transport direction, and was built during the Austrian–Hungarian monarchy. It is Central and Eastern European shortest way to the sea.

Under the changed political and social and economic circumstances, more intensive integration of European countries during the 1990s gave the trans-

port infrastructure the priority not only to modernise but also to construct a completely new double railway track from Rijeka to Zagreb.

In this way, within Croatia, the leading harbour and the leading urban – industrial centre are being linked; while in terms of Europe it is a link from the Baltic to the Adriatic. The existing track doesn't satisfy the development requirements.

The present single-rack has inclinations to 25 % acute angles of 230 m, and average speed of 50 – 100 km/h. It is therefore necessary to construct a new track, and there are three alternative solutions:

- 1) Option along Kupa – follows the current tracks and plans a tunnel through the Risnjak
- 2) Option via Drežnica – across Drežničko polje (Field) and Crikvenica
- 3) Option via Ogulin- a modified second option via Gorski Kotar

All three options imply route reduction by 50 – 80 km, inclination decrease by 15 – 19%, and ascension reduction by maximal 564 m above sea level. The future track should be double allowing speeds over 200 km/h, which shortens the travelling time by 75%.

The 1st option predicts the length of 149.76 km; with maximal inclination of 7%. Due to efficient relief barriers mastering the construction of 22 tunnels, bridges and viaducts on the route is predicted. The longest tunnel would pass through the mountain massif of Risnjak (24.8 km). This assumption has some negative connotations in regard to endangering the existent Eco-system within the national park.

In the second option the route is separated at Karlovac in the direction of Drežnice – Josipdol – Velika Kapela passing across Drežničko polje and through a 13.7 km long tunnel it appears at Novi Vinodolski. The total length of this route is 170.8 km with inclination to 10.9% and shortened travelling time by 70%. According to the third option, the route Zagreb – Ogulin is partly used together with the tunnel Kapela and exits at Novi Vinodolski.

Taking into consideration the possible endangering of ecological values and the disturbance of natural balance in the area of Risnjak in the first option, we think that a link via Ogulin (3) is the most acceptable solution.

Rijeka is the railway transport key point of the future track to Dubrovnik. It is the coastal option, i.e. option via Lika. The route via Lika (Rijeka – Gospić – Gračac – Benkovac) would enable the economic development of Lika (Gospić/ Gračac) and in this way the port of Zadar would be activated.

The present secondary main line Zagreb – Split does not satisfy their potentials in either passenger or goods transport. It links the two leading industrial and urban centres of Croatia. More than 2 million people live in this area, i.e. 45% of the total population.

Thus a new double high-speed track (speed over 200 km/h) with side-tracks to Zadar and Šibenik would contribute to the revitalisation of Northern and Central Dalmatia. In this way Dalmatia would be more actively included in the transit circulation with Central Europe which would enable economic growth of Dalmatian towns.

Economically, Croatia is at the level of a monocentral country system with Zagreb as the dominating centre and the "Croatian desert" remains, therefore the future development needs to be based on the dispersed system of industry and population.

The construction of this track will contribute the opening of new working places along the track, and also to daily migrations on medium distances. Considering the fact that the track Zagreb-Split forms part of traffic corridor No. X, it would be necessary to bring about a new track classification and to upgrade the secondary main lines to the level of main lines.

## 5. CONCLUSION

Croatia is characterised by undeveloped and obsolete railway network, which makes her integration into the European transport system more difficult. The basic presumption for future development is the construction of modern railway network with the introduction of high-speed passenger trains (over 200 km/h) on main lines as well as more intensive introduction of combined transport system (road-railway).

Primarily, Croatia must enable the line Zagreb - Rijeka since this route is a part of the European corridor which provides the shortest link between Central Europe and the Mediterranean, as well as the route from Savski Marof to Tovarnik as part of the transport system between Western and South - Eastern Europe. Regarding inland transport linking, priority is given to a route connecting two leading urban - industrial centres, which stimulates renting and the economical development of Lika and Dalmatia: Zagreb - Split (Zadar / Šibenik). Because of economic, social and strategic importance of this line it is essential to change the secondary main line to the level of the main line.

On account of all these facts, during the coming 10-year period, it is necessary to accomplish some inevitable actions:

1) double track construction on main directions,

- 2) introduction of high - speed "tilting trains",
- 3) developing road - railway transport system,
- 4) directing development onto main lines and secondary main line Zagreb - Split.

## SAŽETAK

### STANJE I PERSPEKTIVA RAZVOJA ŽELJEZNICE U REPUBLICI HRVATSKOJ

*Autori razmatraju sadašnje stanje željezničkog prometa u Republici Hrvatskoj koje karakterizira nedovoljna razvijenost i zastarjela tehnologija. To su svojevrsne kočnice ulasku Hrvatske u transeuropske integracijske procese. Predlaže se rješenje koje bi Hrvatsku učinilo važnim prometnim čvorištem u povezivanju europskog Zapada i Istoka, odnosno Sjevera i Juga. Na taj bi se način aktivirala dva vodeća središta: Zagreb i Rijeka. U unutrašnjem transverzalnom povezivanju daje se prioritet modernizaciji i rekonstrukciji glavnog pravca hrvatskog sjevera i juga kojim se povezuju dva vodeća industrijska i populacijska središta: Zagreb i Split.*

*Na taj bi se način omogućilo ekonomsko i socijalno obnavljanje utjecaja Dalmacije unutar hrvatskog gospodarstva.*

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## SUPPLEMENT 1

### Croatian railway lines classification

#### A-Main railway lines classification

<b>MG 1</b>	<b>Botovo – Koprivnica – Dugo Selo – Zagreb – Karlovac – Rijeka with side tracks</b>	
	M G 1.1.	Sesvete – Velika Gorica (link MG 1 and MG 2)
	M G 1.2.	Čulinec (side – track) – Zagreb – Resnik (link Mg 1 and MG 1.1.)
	M G 1.3.	Zagreb (goods station – West) – Trešnjevka side – track (link MG 2 and MG 1)
	M G 1.4.	Zagreb (Klara) – Delta side track (link MG 2 and Mg 1)
<b>MG 2</b>	<b>Savski Marof – Zagreb - Sisak – Novska – Vinkovci – Tovarnik</b>	
	MG 2.1.	Dugo Selo – Novska (link MG 1 and MG 2)
	MG 2.2.	Vinkovci – Vinkovci (cargo goods station A and B)- Jarmina side – track (link MG 2 and MG 2)
	MG 2.3.	Vinkovci –Vinkovci (cargo goods station C and D) – Jarmina side – track (link MG 2 and MG 2)
<b>MG 3</b>	<b>Kotoriba – Čakovec</b>	
<b>MG 4</b>	<b>Šapjane – Rijeka</b>	

#### B – Secondary main lines classification

M P 1.1.	Oštarije – Knin – Split
M P 1.1.1.	Knin – Zadar
M P 1.1.2.	Perković – Šibenik
M P 1.1.3.	Ogulin – Krpelj side track (link MG 1 and MG 1.1.)
M P 1.2.	Sunja – Volinje – part of track Bihać – Knin
M P 1.2.1.	Krivaja side – track – Gaj side – track (link MG 2 and MG 1.2.)
M P 1.3.	Beli Manastir – Osijek - Đakovo – Strizivojna – Vrpolje (link MG 2 Slavonski Šamac – Metković – Ploče)
M P 1.4.	Vinkovci – Erdut

#### C – First grade lines

I 100	Varaždin – Koprivnica – Osijek - Dalj
I 101	Zaprešić – Varaždin – Čakovec
I 102	Buzet – Pula
I 103	Zagreb (Borongaj – Zagreb (goods station East)
I 104	Zagreb Klara – Zagreb shunting yard - Sava side – track – goods station West Zagreb Klara Zagreb shunting yard – Sava side – track – goods station South
I 105	Zagreb Klara – Zagreb shunting yard (Karlovačka street)
I 106	Zagreb Klara – Zagreb shunting yard (Sisačka street)
I 107	Zagreb shunting yard – Mičevac side – truck
I 108	Zagreb shunting yard – Zagreb shunting yard
I 109	Vinkovci – Osijek
I 110	Vinkovci – Drenovci
I 111	Mirkovci – Vrapčana
I 112	Slavonski Brod – state border
I 113	Škriljevo – Bakar
I 114	Sušak (Brajdica) – Pećine – Rijeka
I 115	Ražine – Šibenik port

D – Second grade lines

II 200	Čakovec – Mursko Središće
II 201	Varaždin – Golubovec
II 202	Savski Marof – Kumrovec – border
II 203	Zabok – Đurmanec
II 204	Hum – Lug (side-track) – Gornja Stubica
II 205	Križevci – Bjelovar
II 206	Banova Jaruga – Pčelić side-track

II 207	Nova Kapela – Batina – Našice
II 208	Pleternica – Velika
II 209	Bizovac – Belišće
II 210	Borovo – Vukovar – Stari Vukovar
II 211	Vinkovci – Županja
II 212	Sisak – Caprag – Karlovac
II 213	Karlovac – Komonje
II 214	Lupoglav – Raša

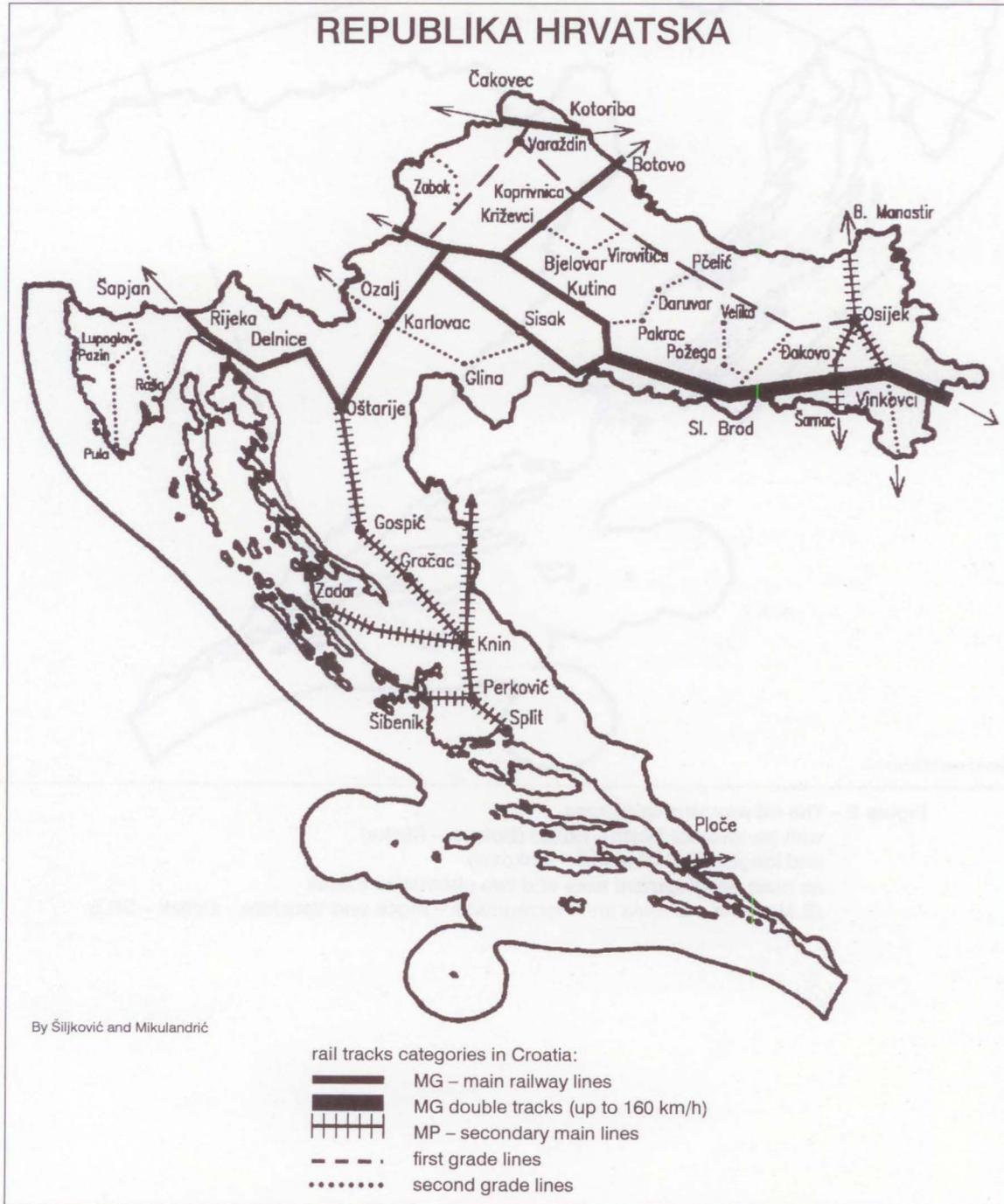


Figure 1 - Categorisation of rail tracks in Croatia, 1999



Figure 2 – The railway strategic cross with transversal North – South (Botovo – Rijeka) and longitudinal (S.Marof – Vinkovci) as main development axes and two alternative routes (B.Manastir – Bosnia and Herzegovina – Ploče and Varaždin – Osijek – SRJ)

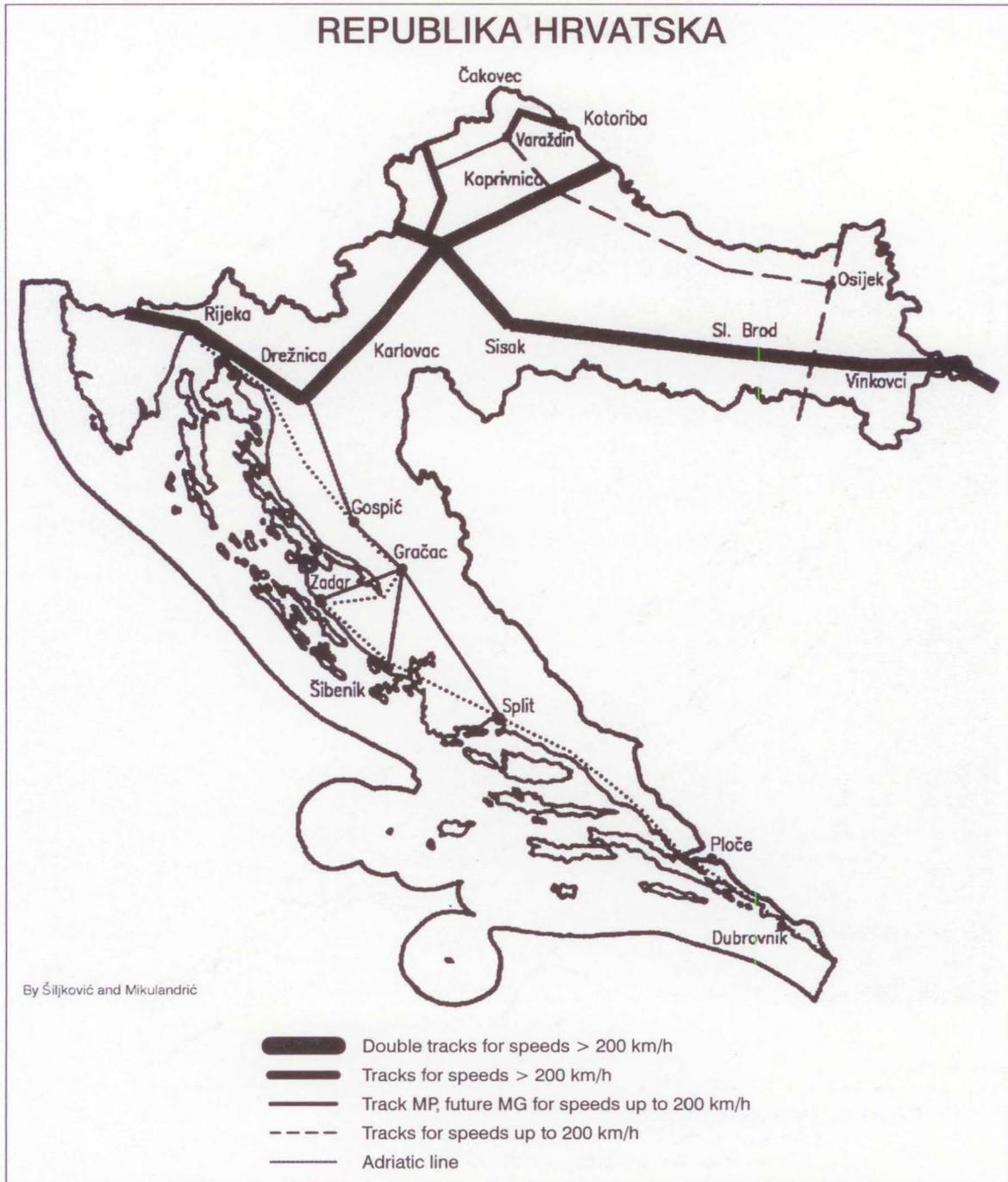


Figure 3 – Proposal for the possible development of the Croatian railway traffic