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THE TRAFFIC DEVELOPMENT OF THE REPUBLIC OF CROATIA WITHIN EUROPE IN THE 21ST CENTURY

ABSTRACT

The paper deals with the prospective development of modern transport technologies for 21st century as a precondition for integration of Croatia with Europe. By its geographical position, Croatia is an eminently European country. Her transport infrastructure and technological transport solutions present today significant hindrance to its integration with Europe.

The Transrapid railway system is a novel technological transport form that could be developed in Croatia, within the European Transrapid network. Furthermore, Croatia has great expectations in the development of air transport even by air buses for transporting cargo and passengers. Special attention will be paid to organising high-speed suburban traffic in Zagreb, based on the railway.

KEY WORDS

Croatian traffic system development, Transrapid railway system, European Transrapid network, high-speed suburban traffic, Zagreb airport development

1. INTRODUCTION

The Republic of Croatia is going through great changes, and within her political and economic transformation the traffic factors have a special significance. Planning of traffic development is complex in itself since it results from the totality and individuality of life and development, and has to rely on the real geographical basis, human potentials and the created goods - understanding here the importance of their distribution, traffic and geographic location of Croatia and her inner organisation.

Every single thought and idea about the traffic development in Croatia and about the adequate development strategy, and also the traffic strategy, need to realistically, and not only declaratively, rely on the undoubtedly extraordinary characteristics of the Croatian region, both regarding her location and regarding her inner organisation.

The Republic of Croatia is a Central-European and Adriatic country, located almost in the heart of

Europe, on the meeting point of the Mediterranean, Pannonian, Dinaric and pre-Alpian regions. Covering an area of 56,538 km², she is approximately as big as Denmark or Switzerland, and with almost 5 million inhabitants she equals approximately Denmark or Norway. The geographic location of Croatia at the intersection of the routes leading from the West to the East and from the North to the South, and the shortest link of Central Europe with the Adriatic and further with the Mediterranean, make it an imperative for Croatia to offer her traffic infrastructure to the European and world market of goods and passengers.

Croatia is at the same time a continental country - leaning to the Danube traffic backbone and coastal - maritime oriented country. Logically resulting from her geo-traffic position, Croatia has a more complex and compared to other countries wider spread traffic network. It should be noted that Croatia is covering a relatively small territory regarding the size of her continental part, but not small regarding the distances between the end points of her national territory. For numerous countries Croatia presents a transit area in inner continental or overseas destinations, and efforts should be made within the limits of national interests to keep this transit on the Croatian roads and through her maritime centres.

Considering the objectives as the starting point for planning and traffic development strategy in Croatia, one should be aware that it is not just simple catching up with the conditions in the developed European countries, but at the same time a follow-up of the technological development, and also confirmation of the new criteria, i.e. of smaller and wider communities of people towards the upgrading of the traffic infrastructure, its load and conditions of its exploitation.

The approach to the planning of traffic development in general, and especially the defining of objectives and development strategy, necessarily meets numerous questions and dilemmas which are specially emphasised by the fact that the Croatian traffic network has been developing in various political and economic constellations, and that it is underdeveloped,

that the traffic modes are to a great extent obsolete, and that the accumulation and reproduction capacities of transportation companies are generally unsatisfactory.

The overall content of the traffic system development objectives has to reflect the current and future interests for the considered period of time, as well as tendencies regarding traffic development - but also to a much wider extent.

Regarding her territory, the Republic of Croatia belongs to the smaller European countries, but because of her location, physical indentation and the sea aquatorium, she has to develop a relatively complex, widespread and among single transport branches co-ordinated system. It is important to comprehensively consider the transportation aspects of the Croatian economy and the Croatian country as a whole, as well as her role and necessary participation within the European and world traffic flows. In the Croatian traffic development strategy one has to be aware of the fact that Croatia is an integral part of Europe, partly also with certain given functions in this respect.

According to her geographical complexity, which is directly reflected on her territorial and geographic features, the Republic of Croatia is a uniquely specific part of the European region. Croatia is the only Central-European and Pannonian, Danube and Adriatic Mediterranean country, located in the part of Central Europe where it is in direct contact with the South-eastern European region. Regarding her traffic and geographic location, Croatia is a country of multidirectional contacts, and during the 20th century the following routes were specially emphasised with a variable degree of importance: the route from Western and Central Europe towards the Black Sea region and the European South-east, and the route from the parts of Central Europe, Pannonian and Baltic regions and the parts of Eastern Europe towards the Adriatic coast, i.e. Mediterranean region in the wider sense.

Regarding her traffic and geographic location, not only does Croatia have a real interest in, but as a part of the European region she also participates in its development and her obligation is, in accordance with her possibilities and also along with the participation of other European institutions, to insure optimal conditions for international communication through her national territory. This has to be clearly included in the basic objectives of the Croatian traffic system development, and combined with national needs and interests of the whole national traffic development. The need for international communication in the Croatian regions is advocated by the relatively great length of declarative European communications via Croatia, i.e. towards single traffic-centred regions at the Croatian Adriatic coast and towards the Eastern state border.

Speaking of objectives of traffic development within the international communication, the linking of Croatia with her European environment is singled out as the primary interest, with a special emphasis on those traffic connections that correspond to the political and economic orientation of Croatia. The emphasis is on the continental traffic routes leading towards the Central Europe and further towards Western Europe, and towards the Pannonian part of the Central European region and further towards Northern and Eastern Europe.

The international traffic links of Croatia with her European environment are at the same time, considered in a wider sense, the transit connections with the continental communication routes West - East, i.e. North-east - South-west, with the former link being explicitly continental, and the latter directed to links of maritime transport with possibilities and opportunities of integrating Croatian river waterways into the international traffic flows. Speaking of international traffic flows on the Croatian territory, the significance of tourist traffic needs to be specially emphasised, as well as the orientation towards insuring the maximally convenient traffic conditions for this branch of Croatian industry.

As the main target objective it needs to be confirmed that the Croatian government and the Croatian industry are interested in transit traffic, and therefore also in attracting the transit traffic routes onto the Croatian territory.

As an additional important consideration, the traffic linking is emphasised, i.e. the transit through the Republic of Bosnia and Herzegovina, which in certain parts and with certain routes presents the traffic and geographic whole with the Republic of Croatia. This is confirmed by the realisation that certain bordering regions of Croatia, such as the Croatian Danube region, and the Neretva-Dubrovnik coastal region mutually, but also with some other continental parts, can economically communicate primarily over the roads of Bosnia and Herzegovina. These are in fact integral traffic routes whose sections are located in two countries. It should be specially emphasised here that the development of certain maritime centres in South Croatia most directly depend on the hinterland of Bosnia and Herzegovina, as their obvious gravitational region. This traffic connectivity needs to be accompanied by certain inter-state political institutionalising.

Regarding the traffic system development, and especially when speaking of international routes, a wider international co-ordination, especially with the neighbouring countries is important.

The international co-ordination of the traffic development in Croatia and determining of adequate target interests, need not only be directly and actually

planned in more detail, but also politically considered and acted upon. Although the traffic and geographical advantages of the Croatian territory are something quite real, they have to be confirmed through adequate activities, development, and construction. One should count on certain acceleration in the political and planning orientation with regard to the development in the recent past, taking into consideration that tendencies are present within Croatia to partly re-direct the international traffic routes in this part of Europe. Such tendencies are clearly defined in the traffic policies of some neighbouring countries. Activities are directed partly towards re-directing of transit routes outside Croatia, and here also the construction of major new roads towards the Italian and Slovenian Adriatic coast needs to be mentioned. Such increase in importance of the Northern Adriatic region needs to be accepted in the long run as the interest of Croatia as well, since the development possibilities of her maritime industry are extremely important.

2. THE DEVELOPMENT STRATEGY OF THE CROATIAN TRAFFIC SYSTEM IN THE 21ST CENTURY

However inappropriate they might seem at the moment, new ideas in traffic linking still have to be considered, suggested and put to paper. The previous experience precisely in the traffic development provide the best guarantee, as there is no major prosperity in transport without new ideas.

The congested Western market needs new space. In order to break through, it needs traffic infrastructure with a special role played also by the railway which will be modern and ready to meet immediately any challenge. The position of the Croatian railways within the network of Pan-European corridors offers them a safe future in these regions. By passing of traffic corridors through her territory, Croatia proves that this is the shortest way between the European East and West, and the Baltic and the Adriatic, and the only natural way for transporting passengers and goods. In this sense Croatia at the same time accepts the obligation to insure the transportation by modernising the traffic routes, especially the railways according to the modern standards and changes in their organisation.

The previous concepts of Croatia within Europe and her main geo-traffic features indicate that the strategic selection of introducing new transport technologies in Croatia should rely primarily on the Trans-European traffic network.

The development plans of the Croatian railways are directed towards improvement of the following routes:

- West - East, connection of Central Europe with the Black Sea and the countries of the Near East,
- North - South, connections between Central and South-eastern Europe, i.e. the Baltic and the Adriatic.

The central section of the East - West connection is the railway line Savski Marof-Zagreb-Vinkovci-Tovarnik supporting speeds of 140-160 km/h.

The linking of the Adriatic with the Danube countries, Poland and Ukraine, in the direction South-west - North-east is planned by the construction and modernisation of the following railway lines:

- the construction of the new level, double track, electrified railway line Rijeka-Zagreb in the length of 126.6 km which would shorten the current distance between Rijeka and Zagreb by 80 km. The qualitative shift is in reducing the levelling point from 836.4 m to 261 m, the maximum rail inclination of 7 per mil, and the possible train speed of 200 km/h. The 2.709 mld. USD worth project would be realised in phases.
- the construction of the second track of the railway line Dugo Selo-Koprivnica-Croatian-Hungarian state border for speeds of 150 km/h. The project is 300 mld. USD worth, and the construction would take 3 years.
- the construction of the railway line Lupoglav-Jurdani in the length of 22.7 km with the main tunnel through Učka. The project is worth 180 mld. USD.

The Adriatic is connected with the Central European countries in the direction South - North by railway lines Split-Zagreb-Maribor-Vienna-Prague and Ploče-Osijek-Budapest. The qualitative shifts on these routes have been achieved by:

- the construction of the new double track, electrified railway line Zaprešić-Krapina-Croatian-Slovenian border,
- modernisation of a section of the railway line Oštarije-Gospić and the construction of the sections of the railway line Zadar-Šibenik-Split
- modernisation of the railway line Vrpolje-Osijek-Beli Manastir-Croatian-Hungarian border.

Taking into consideration the development of the European railways and the development plans of the Croatian railways, according to her geo-traffic functional location Croatia can be integrated into the network of fast levitation trains "Transrapid" on three basic routes:

1. Central Europe - Adriatic, a and b versions,
2. the Mediterranean route,
3. Western Europe - Near East.

The Central Europe - Adriatic route has its basis in the tradition of passenger flows towards tourist destinations of one of the most promising top-quality natural resources for holidays and recreation in Europe,

the Croatian Adriatic coast. The only problem is how to reduce the negative characteristic of extremely variable number of visiting passengers over the year. The emphasis of this route in Croatia is the relation Zagreb-Rijeka with the annual traffic of about 4 mill. passengers. The logical origin of this route is in Budapest, where the today existing railway line started to be built around the middle of the last century. The opening of the East European region to market economy speaks in favour of the possible more appropriate prognoses of increasing the passenger traffic on the route Budapest-Zagreb-Rijeka (Pula-Trieste) by the year 2020, to 7 mil. passengers. If a level railway line were built along the Kupa river very fast transportation of passengers from Budapest to Rijeka (about 500 km) would be possible and the journey would take about 2 hours.

The other version of the "Transrapid" levitation trains from Central Europe towards the Central Adriatic, from Vienna to Split in the length of about 800

km has less advantageous characteristics. Today's railway line is a detour and leads via Graz-Maribor-Zidani Most-Zagreb through Lika in the length of 895 km. The journey takes about 15 hours and the traffic is very, very poor. For the requirements of fast speed train travelling on this route, a new railway track would have to be planned over a significant section, especially through Croatia, the section through Hrvatsko zagorje (Maribor-Krapina-Zagreb) and through Lika. The prognoses of the possible future transportation do not justify the construction of the "Transrapid" system. The predictable passenger transportation, namely, between Zagreb and Split, is estimated in the year 2020, to ca. 2.3 mil. passengers.

The Mediterranean "Transrapid" route relies primarily on the tourist potentials of our Adriatic coast. We believe that the preconditions for the start of its operation should be related to Trieste as the origin of the concentrated tourist flows from the Central Europe. A step-by-step construction would pass along

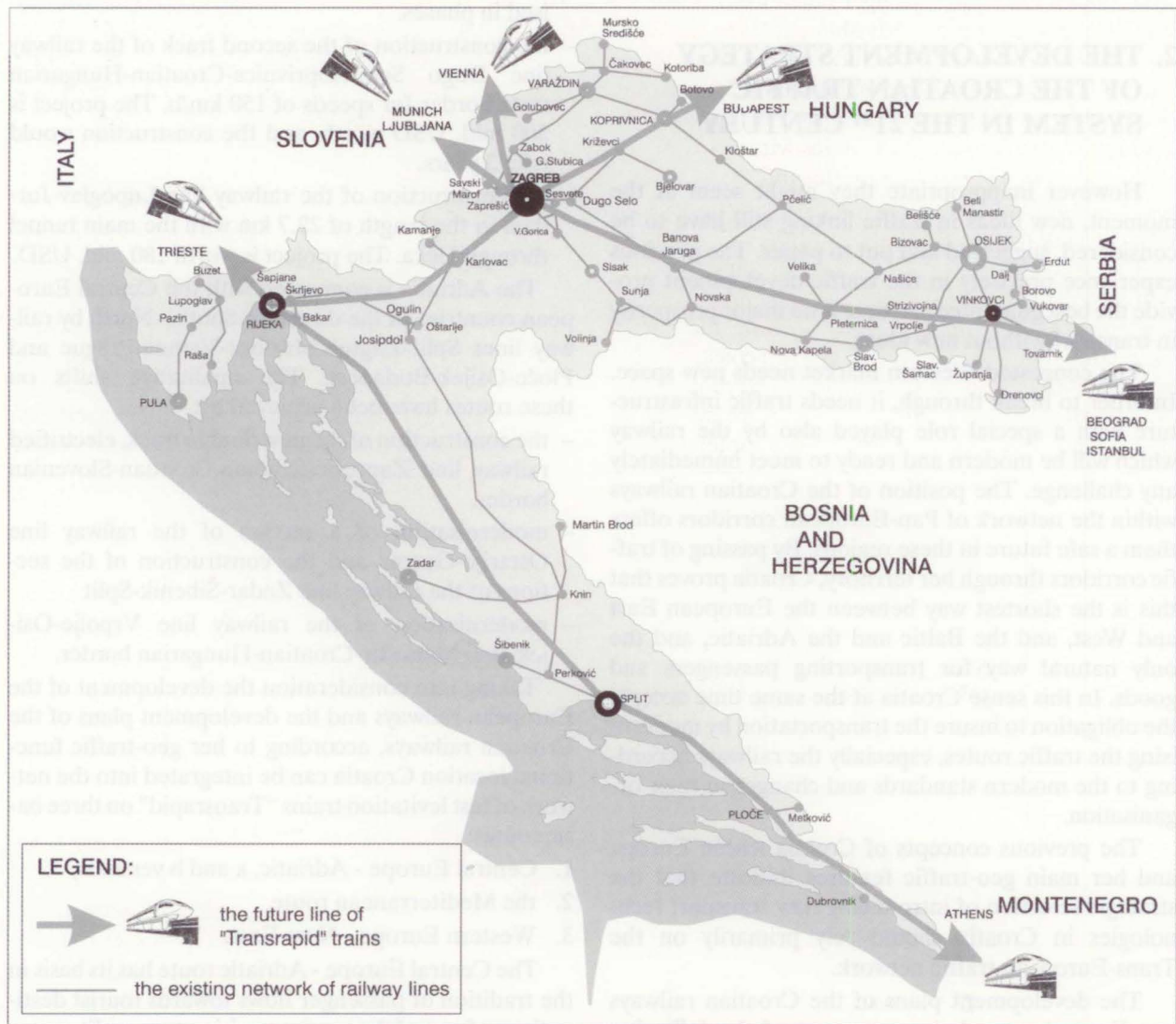


Figure 1 - Future routes of "Transrapid" trains in Croatia

the Adriatic coast, following the dynamics of tourist revival. Subsequently this route could be further constructed via Montenegro and Albania all the way to the Western tourist destinations in Greece. The predictable length of the "Transrapid" railway line from Trieste to Dubrovnik is about 500 km, and to the Western coast of Greece about 900 km. The estimated annual passenger traffic in 2020 between Trieste and Dubrovnik amounts to about 5 mil. passengers.

Undoubtedly, the route from Western Europe to the Near East is of special significance for Europe. This railway, as well as the road have a centennial tradition. The "Transrapid" railway line could start in Munich and via Salzburg, Ljubljana, Zagreb, Belgrade and Sophia finish in Istanbul. The foreseen total length of this line is about 2,000 km, out of which about 270 km would pass through the Croatian territory (Dobova-Tovarnik). The estimated passenger traffic on this line in 2020 would amount to about 6 mil. passengers. The line might function because it should be the central passenger objective of seven to ten European countries with about 100 mil. inhabitants. Its end destinations include two of ten leading European cities with several million inhabitants, Munich and Istanbul. Moreover, this "Transrapid" line would pass also through three cities with a million inhabitants each, Zagreb, Belgrade and Sophia, at 1 hour journey distances, thus connecting these capitals at the level of everyday communication.

The fast and mass "Transrapid" transportation along the Croatian coast requires a revision of the current condition and policy of establishing the traffic connections between the islands and the coast. The today's system relying on low-capacity ferryboats, and few hydrofoil boats, as well as the future system of small island airports for planes and helicopters, which

are being constructed fast (Brač, Cres, Hvar, Korčula, Šolta, etc.) will not be able to satisfy the multiple expected influx of tourists to our islands in particular and to our Adriatic coast in general. It should be strategically considered which are the new more successful systems that could more adequately meet the new predictable needs of tourist customers.

By all means, the 21st century will require transportation systems that will be cheaper both regarding capacities and speed and more adequate to the tourist requirements, such as lighter-than-air aircraft (such as "Zeppelin" once). Their starting locations, when speaking of big aircraft flying on very tourist-attractive routes, may be in Zagreb, Ljubljana, Trieste, but also deeper in the Central European continent, such as Munich, Salzburg, Innsbruck, Vienna, Budapest, Prague or Bratislava. The other group of starting locations for the lower-capacity aircraft may be the Adriatic coastal centres Rijeka, Zadar, Split and Dubrovnik.

Fast transversal transportation of passengers towards the islands from the mainland and vice versa, especially in combination with the "Transrapid" railway line in the 21st century, should rely on hovercraft. These boats could and should include many more destinations along the Adriatic coast and islands.

3. THE DEVELOPMENT OF THE 21ST CENTURY TRAFFIC SYSTEM IN THE ZAGREB METROPOLIS

The railway and the cities first developed in a cause-effect manner. The development of cities gave incentive to the development of railways, and the railway at the same time affected significantly the city development as an important segment of the urban and

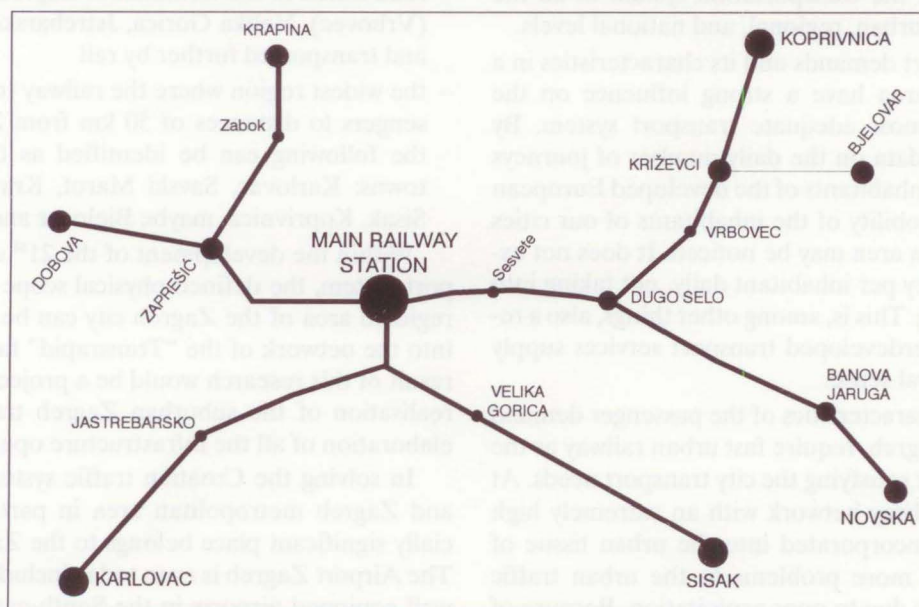


Figure 2 - Railway network of the Zagreb region Within the "Transrapid" routes

suburban passenger transportation. The physical expansion of cities resulted in the development of networks of various forms of public transportation. Since these forms had limited scope regarding capacity of speed and quality, there was the need to adapt the railway network within a wider city area or city regions. Daily travelling within the city and region is one of the main activities of all the city inhabitants. The quality of living in the city is significantly affected by the quality of the urban and suburban transportation system.

Zagreb, the Croatian metropolis, as the cultural and spiritual centre and the capital of Croatia is an important economic, cultural but also transport centre of this part of Europe. Today, Zagreb is already an agglomeration of more than 1,500,000 inhabitants, out of which more than 1,000,000 live in the city itself.

The Zagreb region in the functional and gravitational sense encompasses the area between the borders to Slovenia and Hungary, as well as Karlovac, Sisak, Kutina, Bjelovar, Križevci and Čakovec. Its integrity cannot be envisaged without the development of a modern railway suburban transport system. The urban mass transport that exists today cannot satisfy the development requirements of Zagreb. Therefore, the development of the urban passenger transport needs to be incorporated into the development of the railway centre. In this sense the geo-traffic position and the previous urban development of the wider area of the city of Zagreb present an important basis for the implementation of the public urban passenger transport system by railway.

The integral approach to traffic - urban planning of passenger travelling with the unique technical organisation and tariff policy can offer good results. Therefore, a common development strategy is necessary, a development of the transportation system of all the traffic forms at urban, regional, and national levels.

The transport demands and its characteristics in a certain urban area have a strong influence on the choice of the most adequate transport system. By comparing the data on the daily number of journeys realised by the inhabitants of the developed European cities, a poor mobility of the inhabitants of our cities within the urban area may be noticed. It does not exceed one journey per inhabitant daily, not taking into account walking. This is, among other things, also a result of the underdeveloped transport services supply in a more general sense.

The main characteristics of the passenger demand in the city of Zagreb, require fast urban railway as the best solution for satisfying the city transport needs. At present, the railway network with an extremely high level of being incorporated into the urban tissue of Zagreb, causes more problems to the urban traffic than advantages due to poor exploitation. Because of its plants and the star-like spreading of the railway

lines, it has caused more traffic congestion in the city, especially regarding the connection of the Northern and the Southern parts. Apart from different methods in the public transport tariff system, another important factor is the existing organisation of the suburban transportation which has an adverse effect on the railway exploitation.

The concrete organisation of the suburban transport in Zagreb can be suggested regarding the intensity of the passenger flows and the zones in the function of the city as the centre of attraction. Other optimisation criteria include: reduced fuel and space consumption, preservation of the ecological balance, faster speeds and minimisation of the negative effects on the passengers such as noise, vibration, etc.

According to the development up to now and the possibility of applying new achievements, the mentioned criteria may be met by the electromotive trains that could be adapted according to the number of passengers. The light design of the vehicles and the aerodynamic shape reduce the mass per capacity of the vehicle and allow high speeds by reduced drag and reduced longitudinal and lateral vibrations.

The considered problems regarding the organisation of the suburban Zagreb transport require a conceptualisation of the research task in order to establish i.e. define the project in time and space. The physical, demographic and other influences on the economic development of the Croatian metropolis need to be analysed by defining the physical scope of the Zagreb urban and suburban transport, as follows:

- the central city area dominated by the tram transport;
- greater city area where the railway has a dominant role in transport; passengers would be collected by road traffic to the terminals in Zaprešić, Dugo Selo (Vrbovec), Velika Gorica, Jastrebarsko, and Zabok and transported further by rail
- the widest region where the railway transports passengers to distances of 50 km from Zagreb; here, the following can be identified as the bordering towns: Karlovac, Savski Marof, Krapina, Kutina, Sisak, Koprivnica, maybe Bjelovar and Varaždin.

Within the development of the 21st century transport system, the defined physical scope of the widest regional area of the Zagreb city can be incorporated into the network of the "Transrapid" fast trains. The result of this research would be a project of complete realisation of the suburban Zagreb traffic with the elaboration of all the infrastructure operations.

In solving the Croatian traffic system as a whole and Zagreb metropolitan area in particular, a specially significant place belongs to the Zagreb airport. The Airport Zagreb is even today included among the well equipped airports in the South-eastern Europe. In former Yugoslavia, in the 70s and 80s, it was a lead-

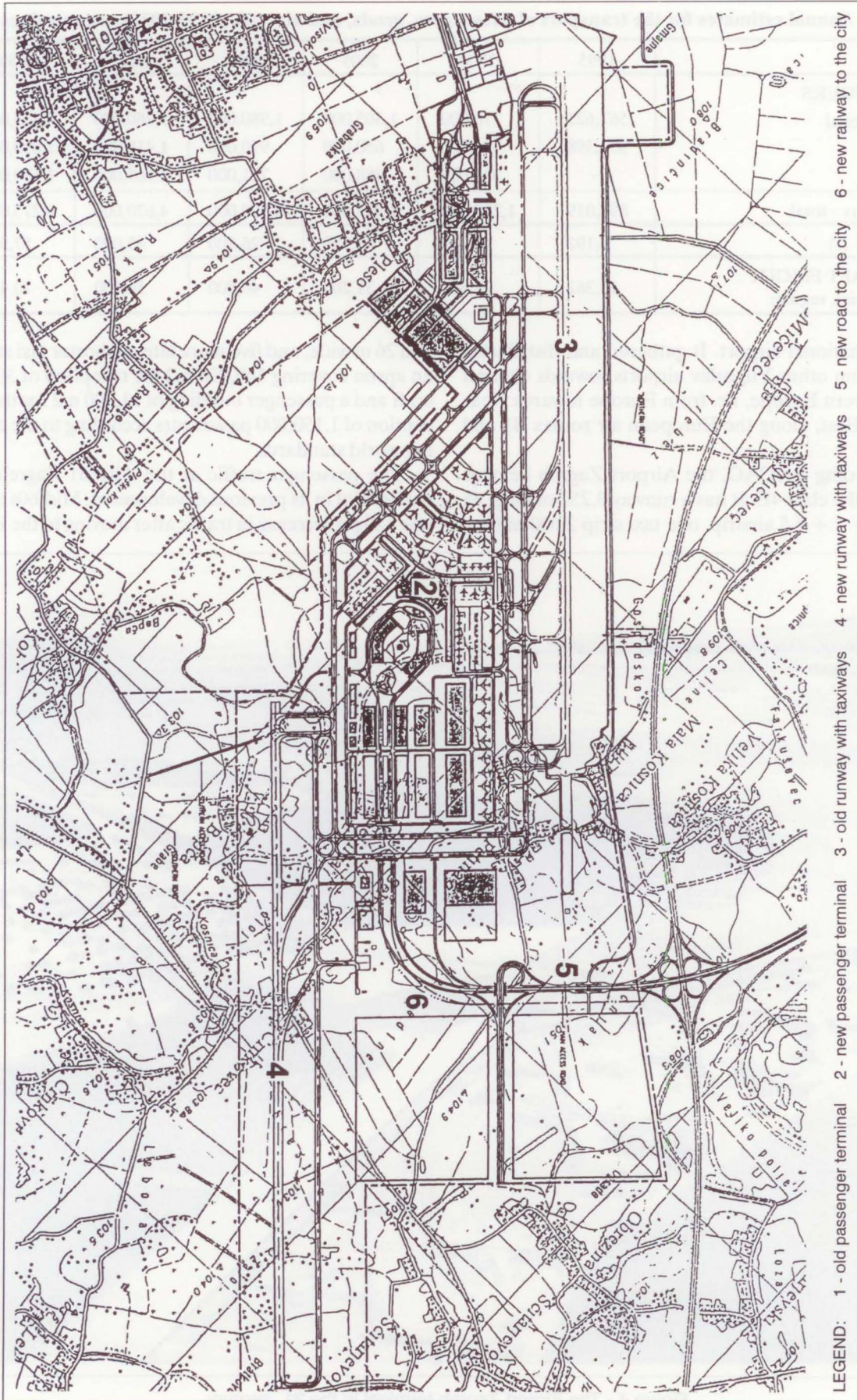


Figure 3 - Masterplan of the development of Airport Zagreb

Table 1 - Annual estimates for the transport of passengers, goods, and aircraft (1195-2030), mean values

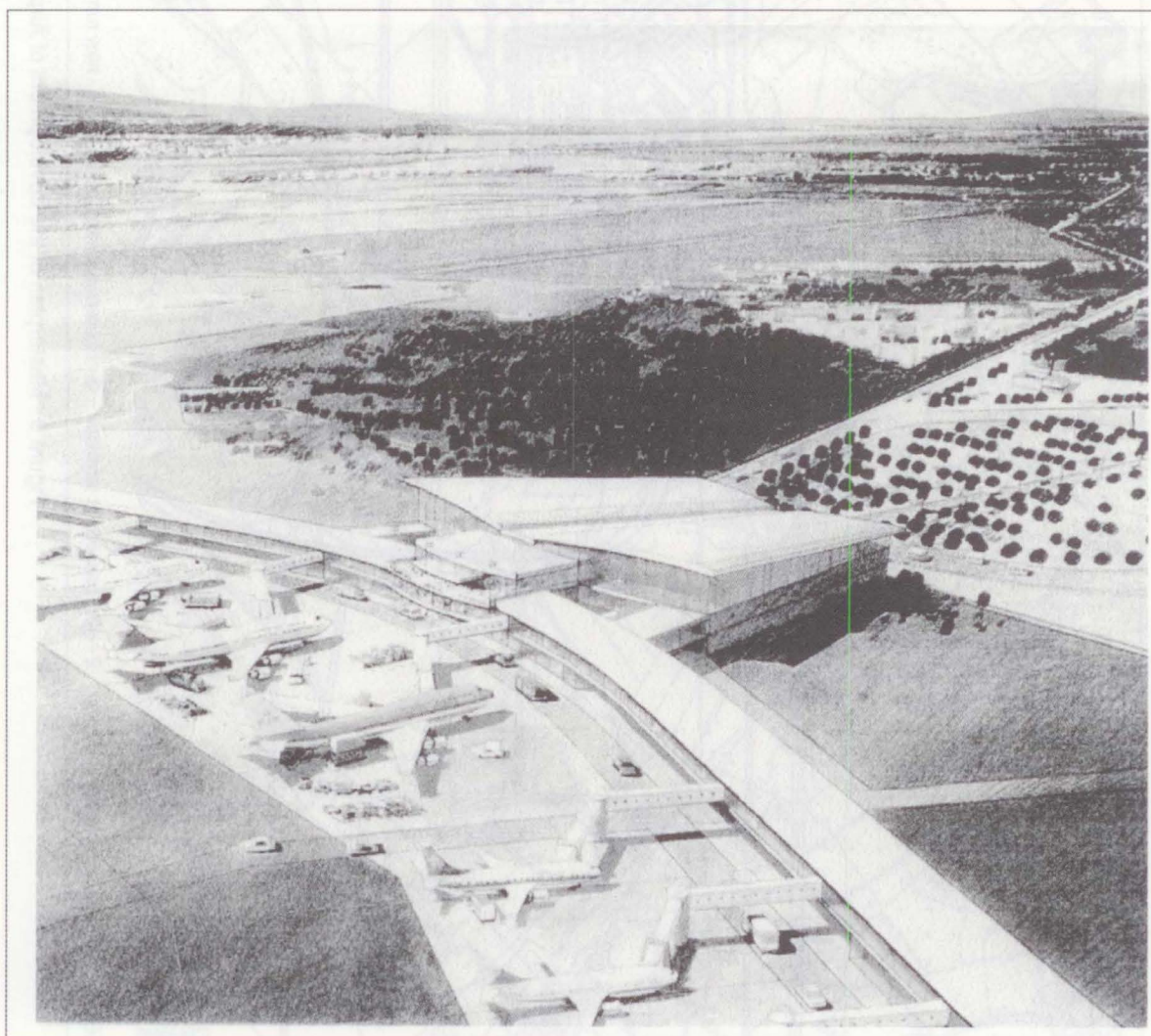
	1995	2000	2005	2010	2020	2030
PASSENGERS						
international	567,621	770,000	1,305,000	1,980,000	3,260,000	4,485,000
national	330,398	435,000	650,000	910,000	1,410,000	1,890,000
transfer	–	301,000	488,000	721,000	1,165,000	1,570,000
passengers - total	898,019	1,205,000	1,955,000	2,890,000	4,670,000	6,275,000
GOODS (t)	8,192	10,700	17,500	26,300	43,000	57,500
AIRCRAFT FLIGHT commercial, regular	15,362	22,400	31,200	40,800	56,900	70,400

ing international airport. It gathered and distributed traffic from other Yugoslav airports towards Central and Western Europe, i.e. from Europe towards Near and Far East, along the European air routes B1 and B5.

According to ICAO, the Airport Zagreb belongs today to the class 4E. It has a runway 3,252 m long, 45 m wide + 2 + 7.5 airstrip, one taxi strip 2,600 m long

and 26 m wide, and five more lateral shorter taxi strips, an apron covering 140,000 m² for reception of 39 aircraft and a passenger building of 11,500 m² for the reception of 1,150,000 passengers according to the existing world standards.

The passenger traffic at the Airport Zagreb has varied a lot in its previous development. Mid-60s there was a slight increase in traffic after moving to the Pleso

Figure 4 - The Airport Zagreb terminal in the 21st century

location, 10.5 km air line from the centre of Zagreb, i.e. 16 km by road. Maximal number of passengers at the Airport Zagreb was recorded end-70s (1979 - 1,917,000 passengers). The world oil crisis was reflected in the significant reduction of the Zagreb airport traffic in the 80s. Slow revival of the passenger traffic at Pleso was helped by the development of tourism in Croatia of the 80s, but far from the extent of the 70s (in 1987 passenger traffic amounted to 1,866,000). The years of war at the beginning of the 90s reduced substantially the air passenger traffic in Croatia including the Airport Zagreb. Today, the number of passengers is about 1 million, and by the year 2000, a number of 1,200,000 to 1,500,000 passengers is planned.

The stabilisation of political, and also economic conditions gives hope to further increase in air traffic both in Croatia and at the Zagreb airport. The Airport Zagreb has therefore initiated the elaboration of its long-term planned development. Along with a national expert team, a Dutch expert group NACO was engaged, resulting in the prognostics development MASTER PLAN for 6,000,000 passengers annual traffic by the year 2030.

The Airport Zagreb remains at the present location with one existing runway, but with the necessary expansion of the building (premises) capacity for the reception of passengers and taxi strips for the increased number of handled aircraft. The surface expansion of the Airport Zagreb is predicted from the existing 300 ha to 1,000 ha. A new special road connection from Zagreb is planned, on the East side of the airport via a new bridge over the river Sava, and a big interchange on the existing Zagreb ring-road. There is also the possibility left for a track reserved for a fast railway line from the city centre to the airport with an underground station next to the airport terminal building itself.

4. CONCLUSION

Croatia is a new and young Central European country. Her social and economic life relies on the European development flows. The traffic system of the Republic of Croatia necessarily adjusts itself to the European traffic routes.

The Croatian region corresponds to a great extent to the European traffic flows, and therefore it proves logical that our future traffic connections need to be

all the more integrated into the modern European traffic system.

In the 21st century the traffic of Croatia can be better connected to Europe by the "Transrapid" levitation railway lines. We suggest three basic directions of the "Transrapid" system:

1. Budapest-Zagreb-Rijeka
2. Munich-Ljubljana-Zagreb-Belgrade-Sophia-Istanbul
3. Trieste-Rijeka-Split-Dubrovnik

Today, Croatia is already building motorways (Goričan-Zagreb-Karlovac-Rijeka and Zagreb-Slavonski Brod-Lipovac) in the region of the future "Transrapid" railway corridors.

Fast railway connections can be especially well used in the traffic linking of the Metropolitan Zagreb, all the way to Sisak, Karlovac, Krapina, Varaždin, Križevci, Bjelovar and Kutina.

The Airport Zagreb is one of the key transport centres of the future Croatian traffic. Zagreb already has a very qualitative runway for air traffic, providing thus fundamentals for a better integration into the European transport system. According to the Master Plan of the Zagreb airport development the reception facilities will be expanded, as well as the terminal building, taxi- and other manoeuvring strips, and the construction of a new runway is also planned. The airport will be connected with the city centre by a new motorway and a fast railway line. The Zagreb airport will also present one of the major destinations of our hovercrafts related to the possible development of the Croatian and European tourism.

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