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JUSTIFICATION OF CONSTRUCTING RIJEKA-ZAGREB MOTORWAY SECTION FOR THE DEVELOPMENT OF THE PORT OF RIJEKA

ABSTRACT

The article describes the significance of the Rijeka-Zagreb motorway for the development of the Port of Rijeka, as well as its significance in the European road network and the network of state motorways. It gives a short historic overview of the phase construction of the Rijeka-Zagreb motorway per sections and years of completion, and the most important parameters are mentioned that influence the justification of the upgrading of the motorway section to full transversal profile.

Since "traffic" is one of the key components of development and necessary for all the aspects of human activities, the completion of a safe, reliable and fast traffic connection of the Croatian capital with the biggest Croatian port represents the key factor of the Strategy of traffic development of the Republic of Croatia.

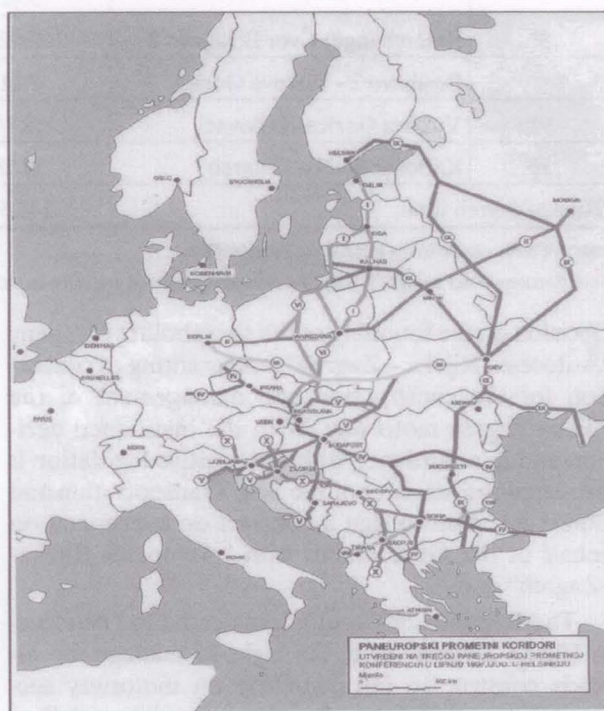
Besides, the Rijeka-Zagreb motorway represents the backbone of the Croatian motorway network, since it integrates the Croatian space connecting it with the European traffic corridors. Thus, new possibilities are opened to the national economy, mainly tourism and port traffic, and bringing direct benefits. Therefore, the greatest significance of the construction i. e. upgrading of this motorway lies precisely in raising the quality of traffic service regarding road connection, but also in a wider traffic sense.

KEY WORDS

traffic, motorway, semi-motorway, justification of construction, port of Rijeka, traffic development strategy, safety, rates of accidents and injuries, AADT, ASDT

1. INTRODUCTION

Rijeka-Zagreb motorway is part of the Pan-European traffic corridor V (Branch b). It is a component of the European route E-65 and E-71, connects Rijeka with Zagreb and further to the network of motorways of Central and Western Europe. The planned route of the Adriatic-Ionian motorway passes through Rijeka and further to Split, Dubrovnik and Greece, therefore, the Rijeka-Zagreb motorway represents the stra-



tegic corridor in terms of international passenger and cargo transport.

Completion of the safe, reliable and fast traffic connection of the Croatian capital with the biggest Croatian port, is the key factor of the Traffic development strategy of the Republic of Croatia, since the motorway from Zagreb to Rijeka: A6 and part A1, form the base of the Croatian motorway network, and Rijeka is the biggest Croatian port with the economic strategic significance for the Republic of Croatia, and for the neighbouring countries and the region on the whole.

2. IN GENERAL ABOUT "AUTOCESTA RIJEKA-ZAGREB" d. d.

At the meeting held on 11 December 1997 the Government of the Republic of Croatia brought the

Table 1 - Presentation of phase performance of the project (semi-motorway - motorway) per sections and years of completion (sequence of sections is from Rijeka to Zagreb)

Section No.	Section	Length [km]	Construction level profile	in traffic [year]
1	(Rijeka) Orehovica-Kikovica	10.5	motorway	1971
2	Kikovica-Oštrovica	7.25	semi-motorway	1982
3	Oštrovica-Vrata	12.44	semi-motorway	1996
4	Vrata-Delnice	8.93	semi-motorway	1996
5	Delnice-Kupjak	7.92	semi-motorway	1997
6*	Kupjak-Vrbovsko	10.59	semi-motorway	2003
		6.84	motorway	
7*	Vrbovsko-Bosiljevo 2	8.44	semi-motorway	June 2004
		5.42	motorway	
8*	(interchange) Čvor Bosiljevo 2	2.92	motorway	2003
	Bosiljevo 2 - Vukova Gorica	7.81	motorway	2003
9*	Vukova Gorica-Karlovac	18.16	motorway	2001
10	Karlovac-Lučko (Zagreb)	39.28	motorway	1972
Rijeka-Zagreb total:		146.50		

Source: Služba projektiranja ARZ d. d., Zagreb, 2005.

Note: Sections under items 6, 7, 8 and 9 were fully completed and open to traffic by the company "Autocesta Rijeka-Zagreb"

Decision on the founding of the shareholder company "Autocesta Rijeka – Zagreb", and granting of concession for the construction and management of the Rijeka-Zagreb motorway. With the mentioned decision and in accordance with the positive legislation it entrusted the Minister of the Sea, Transportation and Communication to sign a contract on concession on behalf of the Government with "Autocesta Rijeka-Zagreb" d. d.

The Republic of Croatia transferred to "Autocesta Rijeka-Zagreb" d. d. the right to manage the already constructed infrastructure on motorway sections Rijeka – Delnice, Delnice – Kupjak and Karlovac – Zagreb. The concession was granted for the time of 28 years, starting from the date of the beginning of concession (up to 2025). This was the first time that the preparation and finalisation of the design of a road route in the traffic, construction, economic and financial sense were started in our country in this way.

The project is conceived so as to insure the financing through long-term loans of the international development banks (EIB – European Investment Bank, EBRD – European Bank for Reconstruction and Development, KfW – German Credit bank for reconstruction). The loan is being returned and liabilities covered, both present and future, from the revenues obtained through tolls.

In accordance with the brought strategy of development, the financial structure of the Project has been completely closed.

3. BACKGROUND OF MOTORWAY CONSTRUCTION

The Rijeka-Zagreb motorway in the total length of 146.50 km¹, was planned to be completed more than 40 years ago. Certain sections were open to traffic in the 70s (Rijeka – Kikovica, Zagreb – Karlovac) in the motorway profile. From then, up to the 90s there follows a longer period without investments into the respective route. With the foundation of the company "Autocesta Rijeka-Zagreb" d. d. the project of the 1st phase of construction started, and it was completed in June 2004, when Rijeka and Zagreb were completely connected by fast and modern traffic route.

The fact is, however, that such respective route represents a mixture of sections of full transversal cross section of the motorway and semi-motorway, which increases the length of journey in traffic and safety standard and reduces safety and increases risk of accidents.

Such condition affects directly the increase in travelling costs, both of passengers and goods regarding the spent time, number of accidents and fuel costs of vehicles.

Therefore, the Company (by the Decision of the Croatian Government) started with the Project phase II of the construction of the motorway, which represents the upgrading of the 55.57 km of semi-motorway into full profile of a motorway, including also the structures that are located at the semi-motorway - 13 viaducts, 1 bridge and 11 tunnels, which form 27.97% of

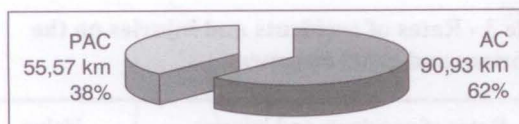


Figure 1 - Graphical presentation of shares of motorways and semi-motorways on the route Rijeka-Zagreb (condition VI/2005.)

the total length of motorways. Project phase II started in March 2005 and the completion is expected in 2008 when the entire motorway track will be of full profile.

4. INFLUENCE OF MOTORWAY ON THE PORT OF RIJEKA

Transport is one of the crucial components of the development and it is necessary for all types of human activities. With no access to work, medical care, education and other essential components of life, the quality of life would be insufficient; with no access to resources and markets, the growth stagnates, and the tendency to increase the welfare of the society cannot be sustained.

Inadequate strategy and programs of traffic development can have adverse effect on the poor economic resources, environment, user requirements, and exceed the capacities of public financing.

Well oriented i. e. guided traffic generates growth, stimulating both national and international commerce, increasing the approach to the services of medical protection and education as well as local and national tourist facilities. At microeconomic level, the improvement of traffic directly reduces the agricultural input prices including production costs, increasing the access to markets and thus indirectly stimulating the development of non-agricultural rural economy. In urban areas, the quality of traffic infrastructure and public transport influence the selection of the location of companies, size and form of urbanisation, efficiency of labour market and costs contained by this work.

The completion of a safe, reliable, and fast traffic connection of the Croatian capital and the biggest Croatian port, is the key factor in the Traffic development strategy in the Republic of Croatia².

Rijeka-Zagreb motorway is the backbone of the Croatian road network since it integrates the Croatian space and connects it with the European traffic corridors. This opens up to national economy, and especially tourism and port traffic new possibilities and brings direct benefit. The greatest significance of the construction of a full transversal profile of this motorway is precisely in upgrading the traffic services.

According to the strategic program of motorway network development in the Republic of Croatia, works are being carried out on the motorway Zagreb –

Split – Dubrovnik. The track for both motorways is unique all the way to the inter-regional interchange Bosiljevo 2, where the tracks diverge towards Rijeka and towards Split.

The Rijeka-Zagreb motorway with extensions towards Slovenia, Hungary, and towards the countries of South-eastern Europe will have the decisive significance for the development of attractive export programs, and these are tourism and transit traffic. The construction of the routes towards Central and Eastern Europe open up the tourist markets for the traffic across the wider zone of the Port of Rijeka. For instance, about 70% of tourist traffic of Croatia is realised in the tourist resorts of Istria and North Adriatic, i. e. across the region gravitating to the Rijeka-Zagreb motorway. The tourists from Hungary, the Czech Republic, Slovakia, as well as Ukraine are significant new acquisitions of out tourism, and good motorway infrastructure significantly stresses the vicinity of Croatia to these markets.

For the development of the Port of Rijeka, the Rijeka-Zagreb motorway is of utmost importance, which extends along routes towards Graz, Budapest and Belgrade. Before the war, about 90% of cargo was transported by railway, since the bulk cargo was dominant. The current condition is substantially changed by the construction of most modern container terminals on the Malta and Sardinia, thus redirecting such transport from the northern ports to the Mediterranean. The European experiences show that due to speed a great share of container transport is carried by road. It is estimated that the Rijeka-Zagreb motorway will be a decisive factor in the decisions of big operators to use the container terminal in Rijeka.

5. SAFETY-TRAFFIC PARAMETERS INFLUENCING THE JUSTIFICATION OF MOTORWAY SECTION UPGRADING

Most of the advantages that result from the upgrading of a motorway section to full transversal profile refer to the saving in time and reduction of costs for the usage of vehicles and the transport of passengers and goods. Here, it is important to stress that every possible reduction in the number of accidents represents an essential factor in making the decision on the continuation of the motorway upgrade.

The classification and comparison of the traffic accidents may confirm the fact that the motorway is safer for the traffic of motor vehicles than the semi-motorway.

Analysing the data from 1997 to 2004³, and respecting the fact that within the given period the length of motorway and semi-motorway changed according to

the completion of the 1st phase of construction, there was a total of 1915 accidents on the motorway during that period with the following consequences:

- 29 fatalities,
- 119 severely injured persons,
- 335 lightly injured persons,

The semi-motorway saw 900 traffic accidents with the following consequences:

- 36 fatalities,
- 74 severely injured persons,
- 229 lightly injured persons.

The proper ratio of fatalities and injured persons may be expressed through the coefficient expressed per 100,000,000 vehicles x kilometres [vehkm].

The coefficients are obtained by multiplying the number of fatalities/severely/lightly injured by 100 ml. and divides it then by the product of route length and the number of vehicles, i. e.:

$$K = \frac{N_{oz} \cdot 100,000,000}{L \cdot N_{voz}}$$

where :

N_{oz} – number of fatalities/severely/lightly injured,

L – route length,

N_{voz} – number of vehicles.

Based on the coefficients in Table 2, the rates of accidents and injuries in the period from 1997 – 2004 on the semi-motorway and motorway can be calculated.

Table 2 - Coefficient of accidents, fatalities, severely and lightly injured persons

motorway	traffic	vehicle x km	accidents	fatalities	severely injured	lightly injured	L1 [km]
1997	5,962,437	252,391,433	70.68	1.20	5.99	11.18	42
1998	6,292,500	266,648,630	71.89	1.51	7.19	20.43	42
1999	6,639,091	281,477,109	67.06	1.08	6.81	12.19	42
2000	7,011,227	297,541,173	63.16	1.36	3.40	12.23	42
2001	7,433,473	408,841,015	65.31	0.73	4.16	7.58	55
2002	8,080,294	444,416,170	66.15	0.68	3.15	10.13	55
2003	8,892,093	764,719,998	43.41	1.05	1.05	6.41	86
2004	9,425,154	857,689,014	32.88	0.12	1.98	6.76	91
semi-motorway	traffic	vehicle x km	accidents	fatalities	severely injured	lightly injured	L2 [km]
1997	1,985,639	69,497,365	47.48	1.44	2.88	10.07	35
1998	2,124,116	74,344,060	41.70	1.35	4.04	17.49	35
1999	2,255,256	78,933,960	89.95	7.60	13.94	20.27	35
2000	2,410,332	84,361,620	88.90	2.37	21.34	30.82	35
2001	2,527,144	116,248,624	107.53	7.74	10.32	48.17	46
2002	2,622,249	120,623,454	97.83	2.49	5.80	22.38	46
2003	3,250,462	149,521,252	111.02	4.68	9.36	30.10	46
2004	3,888,623	213,874,265	131.39	3.27	3.27	18.24	55

Source: Služba projektiranja ARZ d. d., Zagreb, 2005

Table 3 - Rates of accidents and injuries on the motorway and semi-motorway

Rates of accidents and injuries	Value
<i>Motorway</i>	
Accidents per million veh/km	0.598
Fatalities per 100 accidents	1.60
Severe injuries per 100 accidents	7.01
Light injuries per 100 accidents	18.07
<i>Semi-motorway</i>	
Accidents per million veh/km	0.895
Fatalities per 100 injuries	4.32
Severe injuries per 100 injuries	9.91
Light injuries per 100 injuries	27.60

Source: Služba projektiranja ARZ d. d., Zagreb, 2005.

Analyzing the data mentioned in Table 3, the following conclusions can be made:

- Accidents per million vehkm on the motorway 0.598, and on the semi-motorway 0.895 i. e. 1.5 times is the motorway safer than semi-motorway.
- The number of fatal injuries per 100 accidents on the motorway is 1.60, and on the semi-motorway 4.32 i. e. 2.7 times is the motorway safer than semi-motorway.

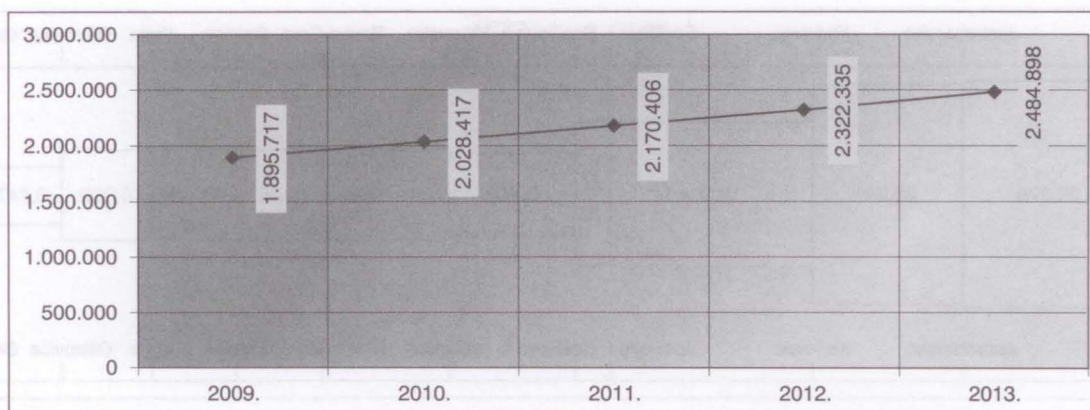


Figure 2 - Total saving in costs from injuries in the period from 2009-2013 on the motorway compared to the semi-motorway

Source: Služba projektiranja ARZ d. d., Zagreb, 2005

- The number of severely injured per 100 accidents on the motorway is 7.01, and on the semi-motorway 9.91 i. e. 1.4 times is the motorway safer than semi-motorway.
- The number of lightly injured per 100 accidents is 18.07, and on the semi-motorway it is 27.60 i. e. 1.5 times is the motorway safer than semi-motorway.

In accordance with the model which is based on the analysis of accidents and injuries in the period from 1997 to 2004, the saving in costs of traffic accidents has been calculated in the period from 2009 to 2013.

The model consists of the costs of accidents and injuries in case there was no upgrading of the semi-motorway to the full motorway profile, and the costs of accidents and injuries if there was the upgrading of the semi-motorway to the full motorway profile.

Table 4 - Saving between "without upgrading" and "with upgrading" in €

	Fatalities	Severe injuries	Light injuries	Total
2009	1,474,899	346,330	74,488	1,895,717
2010	1,578,142	370,573	79,702	2,028,417
2011	1,688,612	396,514	85,281	2,170,406
2012	1,806,815	424,269	91,251	2,322,335
2013	1,933,292	453,968	97,638	2,484,898
Total	8,481,758	1,991,655	428,359	10,901,773

Source: Služba projektiranja ARZ d. d., Zagreb, 2005

Thus, the best argument in favour of upgrading the semi-motorway to full motorway profile is that the upgrading would reduce the number of fatalities, the number of severely injured and the number of lightly injured. Converting the difference between the number of accidents and injuries on the

semi-motorway and motorway yields the annual, and then also the total saving due to the transition of the semi-motorway into full motorway profile. Thus, only in the five-year period of using the full motorway profile, ca. € 10,000,000 would be saved. Since the life-cycle of a traffic route is not 5 years but many more, one may conclude that the savings are much greater.

The traffic on the Rijeka-Zagreb motorway is constantly increasing, according to the latest information of traffic counts obtained from the Toll collecting sector of Autoceste Rijeka-Zagreb d. d., the traffic on the Rijeka - Zagreb motorway increases annually by 5-7%. This is particularly so in the summer months when the section from Zagreb to Karlovac is especially loaded (since summer 2005 Bosiljevo as well), where the average annual daily traffic reaches the number of about 25,000 vehicles, and on peak days it exceeds 50,000 vehicles.

Although in designing all the roads and motorways, the starting data of the average annual daily traffic is used, here the data on the summer traffic are also very important, since the traffic increases on the motorway from Zagreb to Karlovac (from June 2004 to Bosiljevo as well) and on the semi-motorway from Kupjak to Oštrovica by more than 75%.

Based on the measured/actual traffic from July to December 2004, the average traffic was calculated at the annual level for 2004 (AADT).

The average summer daily traffic (ASDT) for 2004:

Recently there has been an increase in the volume of traffic on this corridor, so that a marked increase may be expected in the future as well.

In accordance with the implemented forecasting of traffic, which was based on the analysis of data in the period from 1999 to 2004, it is estimated that on the full profile of the Rijeka-Zagreb motorway the AADT will amount to 30,000 vehicles.

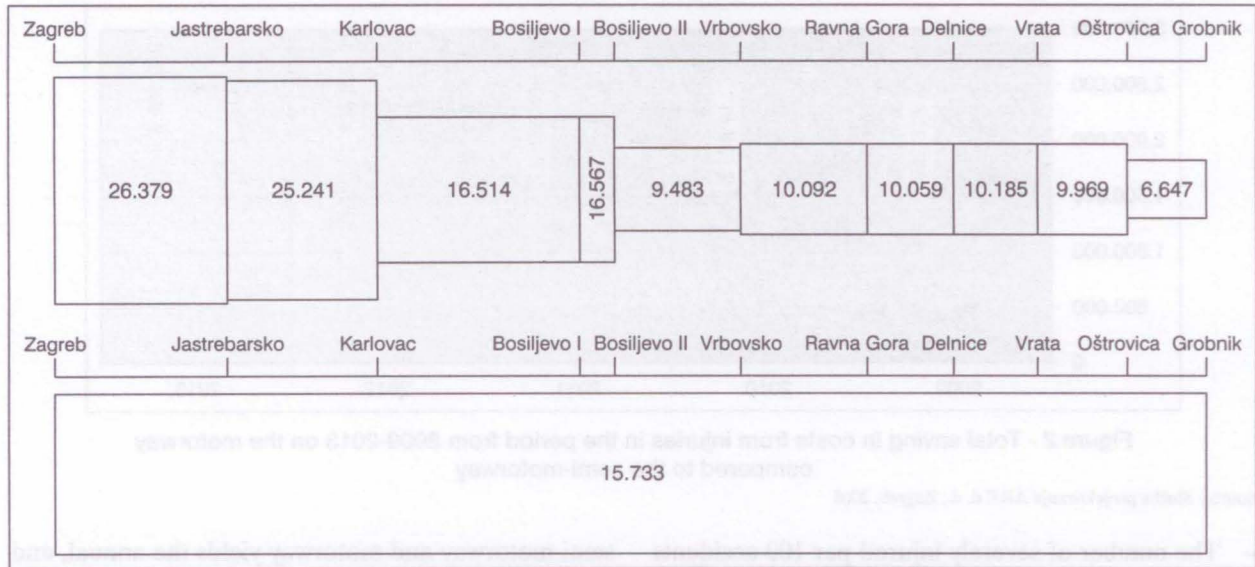


Figure 3 - AADT for 2004 (note: direction from Zagreb to Rijeka)

Source: Služba projektiranja ARZ d. d., Zagreb, 2005

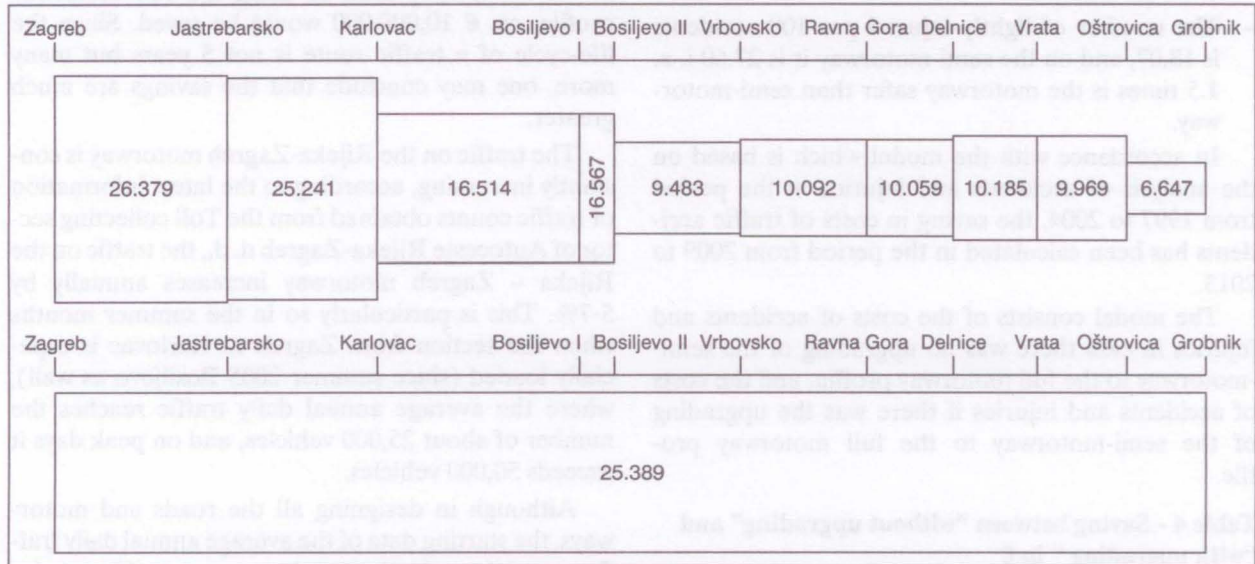


Figure 4 - ASDT for 2004 (note: direction from Zagreb to Rijeka)

Source: Služba projektiranja ARZ d. d., Zagreb, 2005.

6. IMPLICATIONS FOR THE DEVELOPMENT OF ECONOMY IN THE ZONE OF CORRIDORS AND THE PORT OF RIJEKA

Out of multiple influences of the new motorway on the surrounding area, the major implications with the shortest explanation can be given.

- Rijeka-Zagreb motorway is the backbone of the Croatian motorway network, since it integrates the Croatian space and connects it with the European transport corridors. This opens up to the national economy, especially tourism and port traffic new possibilities and brings direct benefits. The major

significance of the construction, i. e. upgrading of this motorway lies precisely in the raising of quality of the traffic service regarding road connections, but also in a wider sense.

- The construction of the motorway is a significant contribution to the employment, confirmed by about 1400 directly employed on the work per sections. This number is several times bigger if the employed in preparation and production of cement, aggregates, steel and others are include and their services as well.
- The state in construction i. e. upgrading of the motorway participates by a share from the budget (for projects, land purchase, and relocation of installations). The budget share of the state are re-

turned through V. A. T. – from road tolls, medical and retirement taxes and the accompanying taxes and surtaxes on income as expenditure taxes.

- On a longer term the motorway returns the loans through its revenues, since the project is conceived in such a way as to be financed by international capital with the state return guarantee which is returned by means of road toll revenues.
- The construction i. e. upgrading of the Rijeka-Zagreb motorway is a project of significance for the national economy, which has been achieved by the way of leading the project, since financing of the whole has been insured mainly from foreign sources. The basic principle in all the elements of leading the project was the insurance of international funding, and from the start the strict requirements of international financing institutions were respected. These are first of all the transparency of the project, inclusion of internationally known consultancy houses, international tenders for the construction, and long-term financing projections which show the competence of the company to return the loan from the revenues obtained by toll collection.
- The basic objective of the construction of the full profile of the Rijeka-Zagreb motorway is to upgrade the level of transport service. A more rational traffic service provides significant incentive to national economy by employing people and providing production capacities, which further means an increase in the social gross product.
- Rijeka Gateway Project – a project of modernizing the port of Rijeka and the access roads. Apart from modernization and restructuring of the port, this project is planned to encompass also the construction of the eastern part of the Rijeka bypass from Orehovica to Križišće, the connecting road Draga – Brajdica, the connecting road Čavle – Križišće and the rehabilitation of the bridge mainland – the island of Krk. This would provide Rijeka, and its wider surroundings with a good connection to the Rijeka – Zagreb – Budapest motorway, which is a part of the European traffic corridors. The project designed in this way should solve the biggest problems of the Rijeka traffic node.

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SAŽETAK

OPRAVDANOST IZGRADNJE DIJELA AUTOCESTE RIJEKA-ZAGREB ZA RAZVOJ LUKE RIJEKA

U članku je opisano značenje autoceste Rijeka-Zagreb na razvoj luke Rijeka, kao i značenje iste u europskoj cestovnoj mreži i mreži državnih autocesta. Dan je kratak povijesni prikaz fazne izgradnje autoceste Rijeka-Zagreb po dionicama i godinama završetka, te su navedeni najznačajniji parametri koji utječu na opravdanost dogradnje dijela autoceste na puni poprečni presjek.

Kako je „promet“ jedna od ključnih komponenti razvitka i neophodan je za sve vidove ljudskih djelatnosti, dovršetak sigurne, pouzdane i brze prometne veze glavnog grada Hrvatske s najvećom hrvatskom lukom, predstavlja ključni čimbenik Strategije prometnog razvitka Republike Hrvatske.

Osim toga, autocesta Rijeka – Zagreb predstavlja okosnicu hrvatske autocestovne mreže, budući da integrira hrvatski prostor i povezuje ga s europskim prometnim koridorima. Time nacionalnom gospodarstvu, a poglavito turizmu i lučkom prometu otvara nove mogućnosti te donosi direktnu korist. Stoga je najveći značaj izgradnje odnosno dogradnje ove autoceste upravo u podizanju kvalitete prometne usluge u pogledu na cestovno povezivanje, ali i u širem prometnom smislu.

KLJUČNE RIJEČI

promet, autocesta, poluautocesta, opravdanost izgradnje, luka Rijeka, strategija prometnog razvitka, sigurnost, stope nezgoda i ozljeda, PGDP, PLDP

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