

## THE MAIN ROAD NETWORK IN SERBIA: THE CONCEPT OF TRAFFIC MANAGEMENT AND CONTROL

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### Abstract

The existing main E road network in Serbia is 2224 km long. The greatest portion of the road network belongs to Corridor X and to the branches of Corridor X. Total length of road network belongs to Corridor X (including branches) is 718 km. All motorways are located on Corridor X. The highest traffic volume is carried out on Corridor X, i.e. AADT on level of the year 2002, depending on sections, is from 4,000 to 130,000. The highest AADT of 130,000 was recorded in the urban area of the city of Belgrade. With the exception of areas of big cities such as Belgrade, Novi Sad, Nis, Kragujevac, Kraljevo at present, there is no capacity problem. The basic problem lies in the existing traffic management system, as well as in the quality of pavement. The existing system of traffic regulation and management on the main road network (mainly belongs to Corridor X) in Serbia has not been modified for years. In the last three years (from 2000) there has been a noticeable growth of traffic on the main road network ranging from 6% to 12 %. Transit through Serbia has particularly increased, mainly on Corridor X, and it ranges from 11% to 15% in last two years, depending on certain sections of the road network. All these facts, together with inadequate traffic management system, influenced level of service and level of safety on certain sections of the road network, especially in the areas of big cities and in the areas of traffic inflow/outflow ramps from highways. In order to minimize negative impacts, with the assistance of international credits, the Road Directorate has included into its ambitious program the following: Road rehabilitation, Reconstruction of certain bottlenecks, Construction and completion of bypasses in the zones of big cities. During 2002, TTEF (transport and Traffic Eng, Faculty-University of Belgrade) was done a comprehensive Study of Priority in improvements of Traffic Management and Control on the main Road Network in Serbia for the the Road Directorate of Serbia.

Keywords: Road network; Traffic management

Topic Area: G5 Regional Transport Issues in South/East Europe

### 1. Methodology applied in study

Methodology applied in Study as well as main results of the Study (in this case only for roads on corridor X) are presented in following chapters. Corridor was divided on several sections depending of significance and number of lanes per direction.

Type of section of Corridor X and axes (motorway, two lane road, semi motorway)

- 1.Border with Croatia -Belgrade (motorway)
- 2.Urban area of Belgrade (motorway)-not included in further analyses
- 3.Belgrade- Nis- Leskovac (motorway)
4. Leskovac- FYROM border (two lane road)
5. Novi Sad -Hungarian border (semi motorway)
6. Belgrade- Novi Sad (semi motorway)
7. Nis- Bulgarian border ( two lane road)



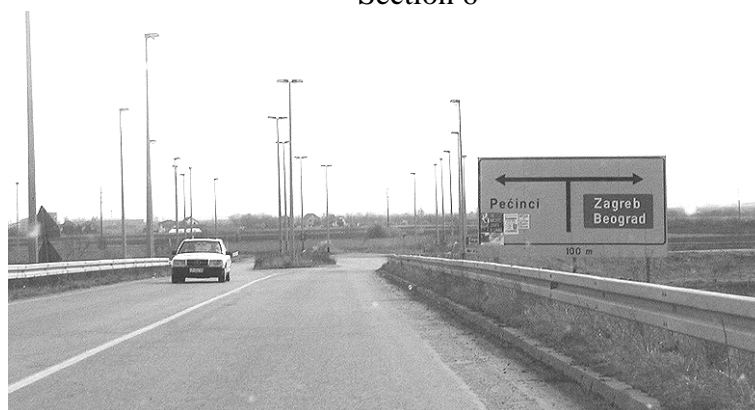
Figure 1. Corridor X



Section 3



Section 6



Section 1

In the first part of Study the basic indicators of the present state, expected traffic growth, present level of safety and level of service especially in ramp area , as well as the state of the existing traffic control and management system (quality assessment) were established.

Quality assessment according to several criteria significant for existing traffic management was made for all sections on the main road network. Scores assigned (from 1 to 5, where 5 is the highest), for depending on the section, range from 2.2 to 4.

Table 1. Results of Quality assessment

Criteria	1. Croatian Border - Belgrade	3. Belgrade – Nis - Leskovac	4. Leskovac - FYROM	5. Novi Sad – Hungarian border	6. Belgrade – Novi Sad	7. Nis – Bulgarian border
Pavement (road) markings	3	3	2	5	2	3
Road signs	3	3	2	4	2	2
Guide signs (direction signs)	3	3	3	4	1	2
Road safety barriers	4	3	3	-	-	3
Access control	2	2	3	2	2	1
Road lighting( intersections)	4	4	3	-	-	3
Toll plaza	3	3	-	4	3	-
Petrol station	2	4	3	4	3	2
Parking space	3	3	2	4	2	2
Rest area	2	2	2	5	3	2
Maintenance	3	3	2	3	2	3
Traffic management through urban area	-	-	3	-		3
<b>Average quality scores</b>	<b>2.92</b>	<b>2.92</b>	<b>2.5</b>	<b>4,0</b>	<b>2.2</b>	<b>2.54</b>

More than 100 million euro is needed only to improve traffic management and control on Corridor X without any rehabilitation of pavement or slight reconstruction.

## 2. Multicriteria evaluation

Multicriteria evaluation of importance of section from traffic management and control point of view was done. Results of multicriteria evaluation are used to define investment priority.

The basic criteria in the multicriteria evaluation were:

- Economic and traffic criteria (existing traffic level-AADT, forecasted traffic level, rate of transit flows, benefits of implementation, investment costs for traffic management and control )
- Level of traffic safety
- Environmental effects (noise, air pollution)
- Significance of a road in the scope of network ( importance of domestic and international demands in passenger and freight traffic)
- Readiness of the authorities to assist financially in realization of the program
- Level and quality of the existing documentation

For example for traffic level four categories were used: AADT>10000-very high, AADT>6000-high, AADT>3000 –medium, AADT <3000-low

For forecasted traffic levels in next five years three categories were used: >20%(15) large increase, >10% moderate increase, <10% low increase.

Some of input data are presented in next table

Table 2. Input data

Criteria	1. Croatian Border - Belgrade	3. Belgrade – Nis - Leskovac	4. Leskovac - FYROM	5. Novi Sad – Hungarian border	6. Belgrade – Novi Sad	7. Nis – Bulgarian border
Existing traffic level-AADT (2002.)	5988	11840	3487	5604	11603	5435
Forecasted traffic level 2002/2001.	14.1%	15%	21%	15.3%	7.7%	7.9%
Level of safety (No/of accidents per mill km - the average rate - 2001year)	0.63	0.51	0.45	0.42	0.87	0.72
Investment costs (mill euro)	9.4	24.450	0.4	0.475	2.2	3.850

The weighting of criteria are : Economic and traffic criteria 0.4, Safety criteria 0.2, Environmental effects 0.05, Significance of a road in the scope of network 0.15, Readiness of the authorities 0.1, Level and quality of the existing documentation 0.1. Also sub criteria was given as well as numeric scale for each criteria (for example : very high traffic =100, high traffic 75, etc) The weighting criteria are given in following table.

Table 3. Weighting factors

The main road network in Serbia -the concept of traffic control and management												
	Crit-weight	Sub-crit weight	Scale used for each criteria				Total Score used for each criteria					
<b>I Economic appraisal</b>	0.4		A. Very High	B. High	C. Medium	D. Low		A. Very High	B. High	C. Medium	D. Low	
I-a Existing Traffic level		0.30	100	75	50	0		12.00	9.00	6.00	0.00	
Increase in existing traffic			A. high	B. average	C. Slight	D. none or decrease		A. high	B. average	C. Slight	D. none or decrease	
I-b Forecasted change in existing traffic level		0.10	100	50	25	0		4.00	2.00	1.00	0.00	
Level of Benefit			A. Very high	B. High	C. Medium	D. Low	E. Not significant	A. Very high	B. High	C. Medium	D. Low	E. Not significant
I-c Benefits of implementation		0.30	100	75	50	15	0	12.12	9.09	6.06	1.82	0.00
Investment cost			A. Low	B. Average	C. Expensive	D. Very expensive		A. Low	B. Average	C. Expensive	D. Very expensive	
I-d Investment costs		0.30	100	50	25	0		12.12	6.06	3.03	0.00	
<b>II Level of safety</b>	0.2		A. High	B. Low				A. High	B. Low			
			50	100				10	20			
<b>III Environmental effects</b>	0.05		A. High	B. Moderate or slight beneficial	C. Neutral	D. Moderate or slight negative effect		High	Moderate or slight beneficial	Neutral	Moderate or slight negative effect	
			100	75	50	0		5	3.75	2.5	0	
<b>IV Functionality and coherency of the network</b>	0.15		A. High	B. Small				A. High	B. Small			
IV-a Importance of domestic demand		0.2	100	50				3	1.5			
Improvement of the network			A. Very high	B. High	C. Medium	D. Low		Very high	High	Medium	Low	
IV-a Importance of international demand (Pass)		0.15	100	75	50	0		2.25	1.6875	1.125	0	
IV-b Importance of international demand (Goods)		0.15	100	75	50	0		2.25	1.6875	1.125	0	
Improvement of the network			A. Large	B. Moderate	C. Not significant			A. Large	B. Moderate	C. Not significant		
		0.2	100	50	0			3	1.5	0		
Improvement of the network			A. Inadequate	B. Adequate				A. Inadequate	B. Adequate			
IV-c EU standards of service of existing infrastructure		0.3	100	0				4.5	0			
<b>V Readiness of the Authority and quality of documentation</b>	0.2		A. Very Ready	B. Moderately ready	C. Not Ready			A. Very Ready	B. Moderately ready	C. Not Ready		
			100	50	0			20	10	0		

### 3. Results of multicriteria evaluation

The results of multicriteria evaluation are presented in following table

Table 4. Total score – multicriteria evaluation

Road	Total score	Rank
1.Border with Croatia -Belgrade (motorway)	58	6
3.Belgrade – Nis - Leskovac (motorway)	71	3
5. Nis - Bulgarian border	67.75	5
4. Leskovac - FYROM border (two lane road)	80.75	2
6. Belgrade - Novi Sad (semi motorway)	85.25	1
5. Novi Sad - Hungarian border (semi motorway)	68	4

The road –semi motorway Belgrade –Novi Sad has the highest score according to the results of multicriteria evaluation. The second one is two lane roads on Corridor X, Leskovac –FYROM. In this moment the second part of semi motorway Belgrade- Novi Sad is under construction and road Leskovac FYROM is under tender process.

### 4. The basic concepts of strategy

The basic concept of strategy that should be applied in the field of traffic control and management on the main road network in Serbia ( in this case only roads on Corridor X) was established. This strategy is the results of Quality assessment and multicriteria evaluation. Two examples are given in tables below (Table 5 and 6).

Table 5. Motorway: Border with Croatia –BELGRADE (example)

	Requirements
Number of lanes	2 x (2+1)
Pavement markings	White color
Road signs and guide signs	Replace all signs and road guide (directional) signs according to Yu standards. (two letters, Cyrillic and Latin on guide signs)
Technology (materials)	Class II and III
Max. speed	120km/h; 80km/h urban area of Belgrade
Length of in/ out lanes	Min. 230m; min. 150m
Road safety barriers	Replace old with new on all sections
Access control	Full control
Toll plaza	Accordance to recommendation given in Study -final report
Noise protection	Area: Belgrade
Type of noise protection	Accordance to recommendation given in Study -final

### 5. Conclusions

Generally the recommended strategies to be applied are given in relation to road categories and importances, level of AADT, level of safety and dynamics and financial potentials of the country. The state of current documentation is also important. The methodology applied in this Study is simple one but very efficiency one especially in decision making process. Different scenarios with different weighting factors are able also.

Table 6. Two lane road: Nis –Bulgarian border (example)

	Requirements
Number of lanes	(2+1)
Pavement markings	White color
Road signs and guide signs	Replace all signs and road guide (directional) signs according to Yu standards. (two letters, Cyrillic and Latin on guide signs)
Technology (materials)	Class II
Max. speed	100 km/h
Road safety barriers	Replace old with new on all sections
Access control	Signalized intersection , roundabouts,
Noise protection	Area of Nis, Pirot
Type of noise protection	Accordance to recommendation given in Study

## References

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