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Review
U.D.C. 656.054.8:65.06:006.72
Accepted: Oct. 11, 1999
Approved: Oct. 5, 1999

STANDARDISATION PROBLEMS OF EQUIPPING THE ROADS WITH INFORMATION-COMMUNICATION INFRASTRUCTURE

ABSTRACT

The paper analyses the problem of equipping the roads with information and communication infrastructure, for which there are no national standards in Croatia yet, so that everything is left to the skills and experience of the designer. In order to solve this problem, the paper suggests standards and procedures for defining the information and communication equipment for the roads.

KEY WORDS

roads, information and communication infrastructure, standardisation of equipment, traffic control

1. INTRODUCTION

Good functioning of all the roads requires also the accompanying information and communication (IC) infrastructure. Therefore, in designing roads, the appropriate IC infrastructure needs to be taken into consideration.

There are no national standards with regard to these problems in the Republic of Croatia yet, and they need to be developed and accepted as soon as possible, insuring that they are in accordance with the appropriate European standards.

The paper gives first the basic definitions regarding roads and their elements (Chapter 2), and in the field of IC infrastructure related to roads (Chapter 3). Finally, suggestions are given for national standards regarding equipping of roads with the necessary IC infrastructure (Chapter 4), as well as a suggestion for the procedure regarding defining of the IC equipment necessary for a certain road (Chapter 5).

2. BASIC DEFINITIONS REGARDING ROADS AND THEIR ELEMENTS

2.1. Road

Road is a group of sections within a roadway physically linking sites or facilities of certain significance,

which also determines the significance of the road itself.

The roadway implies the existing road, that physically and by its constructional and technical characteristics most closely reflects the ideal line of connection between the two end points (settlements, i.e. traffic, medical, tourist, sport and recreational, historical, cultural and natural sites according to the decision on the criteria for public roads categorisation).

The Act on Public Roads of the Republic of Croatia brought in 1996, defines the Croatian public road network, and according to the decision on the criteria for categorising public roads, the roads have been categorised as national, county and local roads.

2.1.1. National Road

National road is the road that, according to the criterion of social and economic significance, has the following functions in the region:

- international roadway, connecting the Republic of Croatia with the neighbouring countries (E - roads);
- intercounty roadway, connecting the county centres among themselves and with the centres of higher rank in the Republic of Croatia, as well as with such centres in the neighbouring countries.

2.1.2. County Road

County road is the road that, according to the criterion of social and economic significance, has the following functions in the region:

- inter-district roadway, connecting centres of neighbouring local districts among themselves and with the centres of higher rank in the Republic of Croatia,
- connecting the islands to the ferry-boat lines,
- roadway in the town connecting directly the access points of regional roads into town and through the town area, or connecting the main roads in the wider town area with the county roads within the town.

2.1.3. Local Road

Local road is the road that, according to the criterion of social and economic significance, has the following functions in the region:

- district roadway connecting the neighbouring local centres among themselves and with the neighbouring centres of higher rank,
- local roadway, connecting the independent settlements (more than a hundred permanent residents according to the census from 1981), among themselves and with the neighbouring centres of higher rank,
- road in the town, directly connecting through the settlement the points of access of the local road into the settlement and of the main and regional roads, if they exist within the settlement or in the near environment.

2.2. Basic Elements of Roads

2.2.1. Section

A section represents the basic element of the road network with the related data on roads. Section is a part of the public road limited by the starting and end junctions, which also define its length.

The length of the section is the basis for determining the length of the road, as a sum of the component sections, and of the length of the public road network in total or per categories.

The type of section defines the status of the section regarding the function and location in the topological structure of the public roads network and the roadway to which it belongs.

2.2.2. Intersection

Intersection represents the reference point in the road network which defines the beginning and the end of the section i.e. the road.

Intersection as the reference point, is defined in the road network by the intersection of the public roads axes, intersection of the axis of the public road with the state border and the beginning or the end of the road at a characteristic location (settlement, traffic, tourist, medical or natural sites, etc.), according to the criteria for public road categorisation in the Republic of Croatia.

2.2.3. Tunnel

Tunnel is an underground passage through a mountain, under the river or the sea, carrying a pathway or a roadway. Tunnels as roadways are used to overcome natural obstacles and to shorten the path.

In roadways, tunnels are differentiated by their length and the equipment installed (lighting, ventilation, TV etc.).

2.2.4. Bridge

Bridge is a structure serving as a passage over natural (rivers, lakes, seas) or artificial (canals) obstacles.

2.2.5. Viaducts

Viaducts are structures carrying the roadways over artificial obstacles such as roads, railway tracks etc. and natural obstacles such as long and dry valleys, depressions, etc.

There are over- and underpasses, according to whether the primary road is above or below the secondary roadway.

2.2.6. Parking Lots (rest areas)

Parking lot (rest area) is a structure along the roadway, which is used by drivers for resting. According to the equipment, there are parking lots with the accompanying facilities, petrol stations, motels, restaurants etc. and parking lots with no accompanying facilities.

2.2.7. Toll Booths

Toll booth or toll houses are facilities along the roadway, which include the devices for manual or automatic charging of toll.

In fact, these are buildings with personnel, who require appropriate TC infrastructure.

3. BASIC DEFINITIONS IN THE FIELD OF INFORMATION AND COMMUNICATION INFRASTRUCTURE ALONG THE ROADS

The information and communication infrastructure along the roads consists of the following systems:

1. Information and communication (IC) systems for controlling and maintaining roads, and for controlling the traffic on these roads,
2. Communication systems (C) along the roads
3. Integrated information and communication (IIC) systems.

3.1. Information and Communication Systems for Controlling and Maintaining the Roads and for Controlling the Traffic on these Roads

They are used to control the condition of the carriageway and the meteorological conditions of the road environment, as well as the traffic condition upon it.

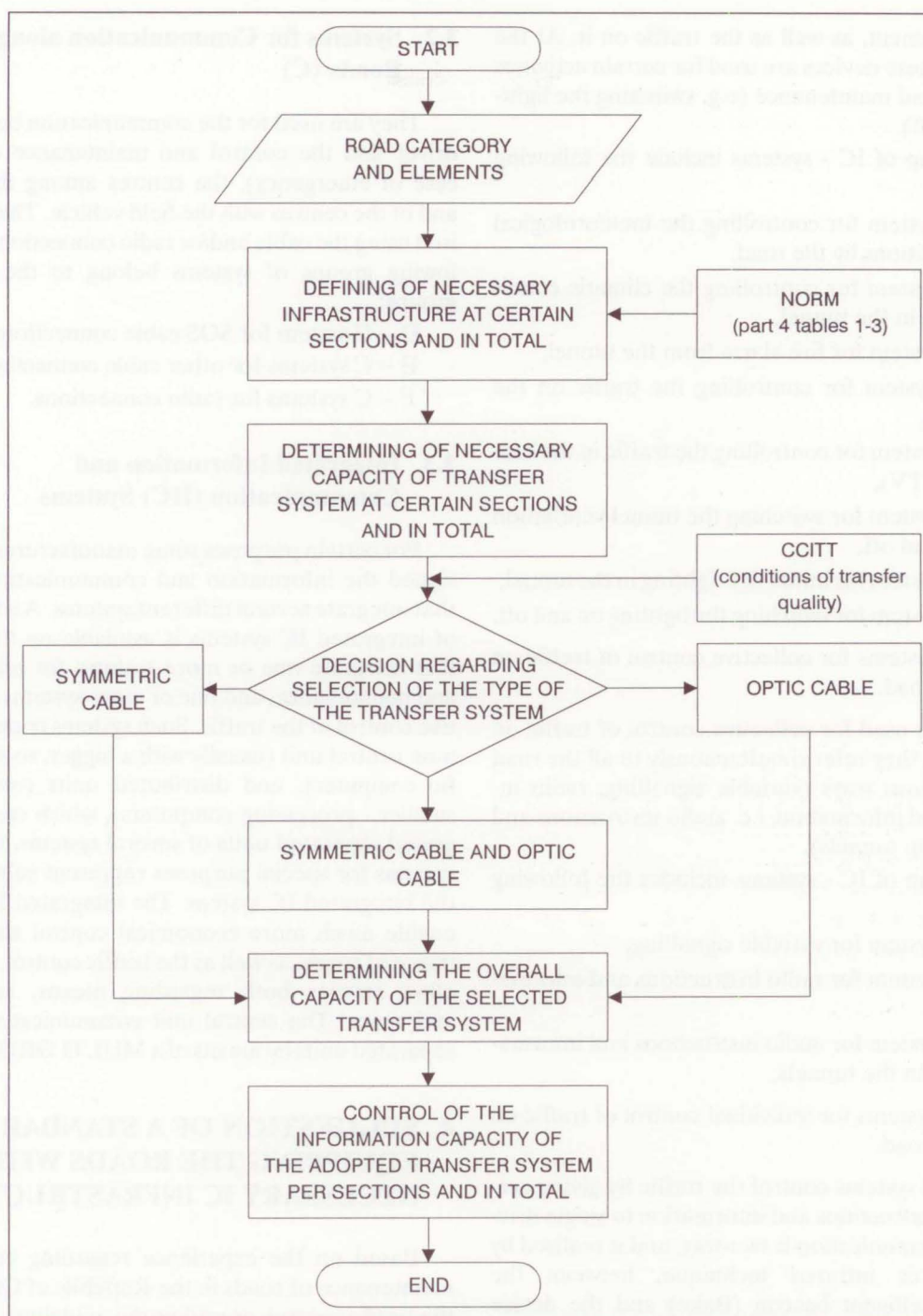


Figure 1 - Flowchart for determining the information and communication equipment for a certain road

On the basis of the collected data - the maintenance service undertakes appropriate measures to bring into order the excess situations, both by activities included in the road maintenance as well as the control of traffic upon it. These information and communication systems include the following system groups:

A – IC systems for controlling and maintaining the roads,

B – IC systems for collective control of the traffic on the road,

C – IC systems for individual control of traffic on the road.

A – IC systems for controlling and maintaining the roads.

These are used to control the condition of the carriageway and the meteorological conditions of the

road environment, as well as the traffic on it. At the same time, these devices are used for certain activities within the road maintenance (e.g. switching the lighting on and off).

This group of IC - systems include the following systems:

- A1 – IC system for controlling the meteorological conditions by the road,
 - A2 – IC system for controlling the climatic conditions in the tunnel,
 - A3 – IC system for fire alarm from the tunnel,
 - A4 – IC system for controlling the traffic on the road,
 - A5 – IC system for controlling the traffic in the tunnel (TV),
 - A6 – IC system for switching the tunnel ventilation on and off,
 - A7 – IC system for initial fire fighting in the tunnel,
 - A8 – IC system for switching the lighting on and off.
- B – IC systems for collective control of traffic on the road.

These are used for collective control of traffic on the road, i.e. they refer simultaneously to all the road users in various ways (variable signalling, radio instructions and information, i.e. audio instructions and information in tunnels).

This group of IC - systems includes the following systems:

- B1 – IC system for variable signalling,
 - B2 – IC system for radio instructions and information,
 - B3 – IC system for audio instructions and information in the tunnels;
- C – IC systems for individual control of traffic on the road.

These IC systems control the traffic by giving certain traffic instructions and information to single drivers. This communication is two-way, and is realised by microwave or infrared technique, between the so-called intelligent beacon (Bake) and the device onboard a vehicle (OBU = ON BOARD UNIT). This device is not always on, but when it nears an intelligent beacon, it switches itself on using a special signal, and they begin a two-way communication, exchanging all the necessary data. This group of IC systems includes the following systems:

- C1 – IC system for automatic toll-collecting,
- C2 – IC system for approving of the entrance into the town,
- C3 – IC system for the reservation of parking spaces at a parking lot,
- C4 – IC system for additional navigation.

3.2. Systems for Communication along the Roads (C)

They are used for the communication between the driver and the control and maintenance centre (in case of emergency), the centres among themselves, and of the centres with the field vehicle. They are realised using the cable and/or radio connections. The following groups of systems belong to the following groups:

- D – C system for SOS cable connections,
- E – C systems for other cable connections,
- F – C systems for radio connections.

3.3. Integrated Information and Communication (IIC) Systems

For certain purposes some manufacturers have designed the information and communication systems that integrate several different systems. A whole range of integrated IC systems is available on the market, that integrate one or more systems for road control and maintenance, and one or more systems for collective control of the traffic. Such systems contain a common central unit (usually with a bigger, so-called traffic computer), and distributed units (usually with smaller - processing computers), which contain integrated separated units of several systems. Certain IC systems for special purposes represent subsystems of the integrated IC system. The integrated IC systems enable much more economical control and maintenance of roads, as well as the traffic control, since they allow savings both regarding means, and labour and space. The central unit communicates with the separated units by means of a MULTI DROP system.

4. SUGGESTION OF A STANDARD FOR EQUIPPING THE ROADS WITH THE NECESSARY IC INFRASTRUCTURE

Based on the experience regarding control and maintenance of roads in the Republic of Croatia, and the traffic control, as well as the guidelines for equipping the roads with the appropriate IC infrastructure in other countries, the necessary IC infrastructure has been suggested for certain categories of roads in the Republic of Croatia.

The specification has been expressed in two categories:

- standard (type) equipment,
- recommended equipment.

The specification of the necessary IC infrastructure for roads has been presented in 4 tables:

Table 1a gives an overview of the necessary IC infrastructure for national roads, Table 1b -

for the county roads, and Table 1c for the local roads. The needs are given for all the main elements of roads, such as: section, junction, tunnel, bridge, viaduct, parking lot, and toll booths, and they are further divided, in case there is a need for that.

Table 2 gives an overview of the necessary communication infrastructure for all the three road categories,

with cable connections and radio connections presented separately.

According to the specifications of the necessary IC equipment, presented in the Tables, all the standard (type) IC equipment can be precisely defined, whereas the recommendable IC equipment for every concrete road is determined according to the wishes and possibilities of the investor.

Table 1a - Overview of the information and communication infrastructure of the national roads

		Road element												
		Section	Intersection		Tunnel		Bridge		Viaduct		Parking lot		Toll booth	
			With the road of the same rank	With the road of lower rank	Up to 300 metres	Over 300 metres	Up to 100 metres	Over 100 metres	Up to 100 metres	Over 100 metres	With the accompanying facilities	No accompanying facilities		
Control and maintenance	Meteo-conditions on the road	●	○					○	●	○	●			
	Climatic conditions in the tunnel				○	●								
	Fire alarm from tunnel					●								
	Traffic on the road	●												●
	Traffic in the tunnel (TV)					○								
	Tunnel ventilation				○	●								
	Initial fire fighting in the tunnel					●								
	Lighting		●	○					○		○	●	○	
Collective control	Variable signalisation	●	●	○	○	●	○	●	○	●				●
	Radio instructions	●				○								●
	Audio instructions					●								
	Automatic toll collection													
Individual control	Approval of entering the city	○												
	Parking space reservation	○												
	Additional navigation	○												
K	SOS telephones	●	○	○	○	●								

KEY: ● – standard
 ○ – recommendable
 pp – as necessary

5. SUGGESTION FOR THE PROCEDURE OF DETERMINING THE IC EQUIPMENT NECESSARY FOR A CERTAIN ROAD

The procedure of defining IC equipment, that is necessary for a certain road is presented in the following flowchart.

The input data are: road category, detailed data about the road itself and about all the main elements of the road.

Considering the road category and all the road elements, as well as the necessary standard IC equipment given in this paper (Chapter 4, Tables 1 and 2), the necessary IC infrastructure is determined for sections and in total.

Table 1b - Overview of the information and communication infrastructure of the county roads

		Road element											
		Section	Intersection		Tunnel		Bridge		Viaduct		Parking lot		Toll booth
			With the road of the same rank	With the road of lower rank	Up to 300 metres	Over 300 metres	Up to 100 metres	Over 100 metres	Up to 100 metres	Over 100 metres	With the accompanying facilities	No accompanying facilities	
Control and maintenance	Meteo-conditions on the road	○	○						○		○		
	Climatic conditions in the tunnel				○	●							
	Fire alarm from tunnel					●							
	Traffic on the road	○											
	Traffic in the tunnel (TV)					○							
	Tunnel ventilation				○	●							
	Initial fire fighting in the tunnel					●							
	Lighting		○	○					○		○	●	○
Collective control	Variable signalisation	○	○		○	●		○		○			
	Radio instructions	●											
	Audio instructions					○							
	Automatic toll collection												
Individual control	Approval of entering the city												
	Parking space reservation												
	Additional navigation												
K	SOS telephones					○							

KEY: ● - standard
 ○ - recommendable
 pp - as necessary

Based on the known IC infrastructure at road sections and overall, the capacities of the transfer system at certain sections and overall are determined.

After having determined the necessary capacities of the transfer system per sections and overall, the type of transfer system is selected. Three versions are possible:

1. symmetrical cable,
2. optical cable,

3. symmetrical cable and optical cable.

The selection of the possible versions depends on the concrete situation and the conditions of transfer quality (CCITT), and the current prices of various transfer systems play also a very important role in the selection.

When one of the transfer system versions is selected, the overall capacity of the transfer system is determined.

Table 1c - Overview of the information and communication infrastructure of the local roads

		Road element											
		Section	Intersection		Tunnel		Bridge		Viaduct		Parking lot		Toll booth
			With the road of the same rank	With the road of lower rank	Up to 300 metres	Over 300 metres	Up to 100 metres	Over 100 metres	Up to 100 metres	Over 100 metres	With the accompanying facilities	No accompanying facilities	
Control and maintenance	Meteo-conditions on the road	pp						○		○			
	Climatic conditions in the tunnel			○	●								
	Fire alarm from tunnel				●								
	Traffic on the road												
	Traffic in the tunnel (TV)												
	Tunnel ventilation			○	●								
	Initial fire fighting in the tunnel				●								
	Lighting		○					pp		pp	●	○	
Collective control	Variable signalisation	pp		○	●		○		○				
	Radio instructions	●											
	Audio instructions				○								
	Automatic toll collection												
Individual control	Approval of entering the city												
	Parking space reservation												
	Additional navigation												
K	SOS telephones				○								

KEY: ● – standard

○ – recommendable

pp – as necessary

Table 2 - Overview of the road communication infrastructure

		Road category											
		National				County				Local			
		TF	TG	PP	SL	TF	TG	PP	SL	TF	TG	PP	SL
Cable connections	Connecting centres	●	○	●	○	●		●		●			
	Connecting toll booths and centres	●		●									
	Connecting centres and base radio stations	●											
Radio connections	Connecting centres (fixed)	●	○	●	○	●		●		●			
	Connecting base radio stations and field vehicles	●				●				●			

KEY: TF – image transfer

TG – signaltransfer (telegraphy)

PP – data transfer (data)

SL – image transfer (video)

● – standard

○ – recommendable

Finally, the information capacities of the selected type of the transfer system per sections and overall are checked.

6. CONCLUSION

Obviously, equipping of roads with the appropriate IC infrastructure cannot and should not be solved in a chaotic manner, but in accordance with appropriate national standards.

These standards have to be in accordance with the European standards, since the same standards and regulations have to be valid in all the European countries.

We hope that our suggestion for standards will facilitate the procedure regarding developing and accepting the national standards, thus finally solving the problem of equipping the roads in Croatia with the necessary information and communication infrastructure.

SAŽETAK

PROBLEMATIKA NORMIZACIJE OPREMANJA CESTOVNIH PROMETNICA SA INFORMACIJSKO-KOMUNIKACIJSKOM INFRASTRUKTUROM

U radu se razmatra problem opremanja cestovnih prometnica s informacijsko-komunikacijskom infrastrukturom, za što još ne postoje nacionalne norme, pa je sve prepušteno umješnosti i snalaženju projektanata. U cilju rješavanja ovog problema, u radu su predloženi normativi i postupak za utvrđivanje informacijsko-komunikacijske opreme za cestovne prometnice.

LITERATURE

- [1] Bundesanstalt für Strassenwesen, "Hinweise für Aufbau und Ausstattung von Verkehrsrechnerzentralen (VRZ) und Unterzentralen", Bergisch Gladbach 1989.
- [2] Forschungsgesellschaft für Strassen- und Verkehrswesen
 - [2.1] "Merkblatt zur Übertragung von Daten, Befehlen und Meldungen bei Verkehrsrechnern und Lichtsignalanlagen", Köln 1984.
 - [2.2] "Merkblatt über Schatt- und Steuergeräte für Lichtsignalanlagen", Köln 1988.
 - [2.3] "Richtlinien für die Ausstattung und den Betrieb von Strassentunneln", Köln 1985.
- [3] Bosch Telecom
 - [3.1] "Perspektiven der Verkehrsleittechnik", Backnang 1992.
 - [3.2] "Integriertes Verkehrsleitsystem", Backnang 1992.
 - [3.3] "Ice early warning system", Backnang 1991.
 - [3.4] "Verkehrsleitsysteme", Backnang, 1992.