RECONSTRUCTION OF ROADS – ROAD TO SAFETY

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Abstract
The analysis of the existing condition of Serbian road network from the safety aspect, aiming at proving necessity for road network reconstruction as the basic precondition for reducing great number of traffic accidents is prepared in this paper.

Key words
Traffic accidents, road network, road reconstruction, road rehabilitation, traffic accident cost.

1. INTRODUCTION

Modern road design means the design of safe and user-friendly roads. It has been singled out that road is not just geometry, but that it has to be perceived from all aspects and completely satisfy the system driver-vehicle-environment. Serbian road network without Kosovo (hereafter: Serbian) which belongs to the category of road networks of developing countries, recorded great number of traffic accidents. Although in the registration of traffic accidents very often human factor is mentioned as a cause, this does not ‘prove’ that other factors are not relevant. There are not recorded data on traffic accidents caused by badly designed and insufficiently maintained roads. If we take deeper analysis of road network, with accent to road design, we could find correlation between poor traffic accident data and condition of roads. The purpose of this paper is to present current condition, use some previous national fatality statistics and try not to look just single black spot, then to consider some causes of accidents on the extended route length. Based on that some measures are recommended.

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2. ANALYSIS OF SERBIAN ROAD NETWORK SAFETY

Serbian road network is comprised of:

1. Main roads in the total length of ........................................5525km
   where Motorways in the total length of ...........................604 km
2. Regional roads in the total length .................................11540km
3. Local roads in the total length of ...............................23780 km

Total:.....40845 km

The average 60000 traffic accidents take place annually on Serbian roads, in which 1000 people die, and 15000 are seriously and lightly injured. In the period 1990-2005 about 16 000 fatalities, 250 000 injuries and huge material damage were recorded.

Figure 1. Number of fatalities in traffic accidents in the period 1991 -2004.

Figure one shows that in last three years in this research period number of fatalities do not exceed 1000 persons. The biggest falls are from 1992 to 1993 and from 2001 to 2002, but the causes are completely different. The first one is related to period when international sanctions begun and in that time there were limited petrol supply, which implies reducing number of vehicles on road. The second one can be linked with big political changes in that time, which affected stronger controls taken by traffic police.

Source: MI-Republic of Serbia; CARE; IRTAD

Figure 1. Number of fatalities in traffic accidents in the period 1991 -2004
On figure two it can be spotted that in comparison to other European countries, unfortunately, Serbia is at the first place\(^1\).

**Selected Risk values for the Year 2002**

![Selected Risk values for the Year 2002](image_url)

Source: MI Republic of Serbia; CARE; IRT AD

\* Data year 2000  
\** Data year 2001

Figure 2: Risk values on road networks in Europe in 2002

Motorways are the safest transport facilities; however, the fatal traffic accidents are the commonest on them due to high speeds. The greatest number of road accidents is recorded on national roads, which are the base of traffic network, while 32\% of total number of traffic accidents takes place on regional roads; the rest goes to local roads, which comprise 60\% of road network. Concerning density, Serbian road network is at the level of European countries, but the quality of that network is very low and according to the analysis of Serbian Road Directorate, more than 50\% of main and 60\% of regional roads is in bad condition.

The causes of such road network condition are, first of all, insufficient road maintenance in the 1990-ies and complete cessation of maintenance in the following 10 years during civil war and bombing in former Yugoslavia.

Most roads in Serbia were designed before 1980. That includes designs of national, regional roads and even motorways. If it is known that at that period there was no“ The Code on basic preconditions which public roads out of settlements and their elements must fulfill concerning traffic safety “ then the cause of the necessity for alignment alteration , i.e. reconstruction could be easily identified , as well as the cause of such “black” account on the roads.

\(^1\) Without data for Albania
In that period routing was mainly the following of the field contours due to the reduction of earth works, which were costly and often heavy for carrying out for the lack of mechanization. Also long straight lines were also often used, after which the curves of small radius were designed. The application of long routes enabled the fastest connection between urban settlements. It was considered that traveling on inter-urban network must be directed to the passage through populated places, so that today most of inter-urban roads with long lengths became urban communications.

Concerning this state, urgent rehabilitations are necessary for providing acceptable condition to users. Rehabilitation (3R projects) includes resurfacing (strengthening) of pavement, renewal of pavement structure and renewal of road in the limits of Right-Of-Way (ROW). Therefore, rehabilitations (passive safety) are the main construction activity on road network.

The analyses that have been made by Serbian Road Directorate, lead to the conclusion that measures of active safety are necessary on over 30% of main and regional roads, i.e. road reconstruction. Reconstruction (4R projects) includes all activities relating to rehabilitation plus geometry alternation, i.e. going beyond the limits of ROW. That percentage is not equally distributed on roads. There is usually good coordination between design elements on majority of road lengths, but there are places that are not settled in a proper way. Those dangerous places – black spots need to be reconstructed.

According to Serbian road standards, the combination of 3R and 4R projects is not defined. However, it is defined in the developed countries, e.g. rehabilitation project is every project that includes the reconstruction of less than 30% of complete route length. With definition like this, one can reinforce complete road section with good coordination with different activities, with solving the problems on weak spots.

**3. HOMOGENEOUS INSECURITY**

Nowadays, when the vehicles with significantly improved characteristics operate on those roads, long routes followed by small curves represent the sections where users have to change driving speed instantly. With elements coordinated in such a way, we have the situation which violates the basic postulate of safe road design, **homogeneous insecurity**.

One of the phenomenons of dangerous spot rehabilitation is the migration of black spots. During the examination of black spot methodology, the relation between black spot arising and developing of the new ones near the previous is noted. During the analysis of black spots, the length of the section with elements similar to those, which exist on the length of black spot examination, must be identified (figure 3). That length represents investing area, where current condition must be identified – condition as it is.
The analysis of road network safety as the initial step has condition as it is on existing road network condition is drawn from, based on numerical and descriptive data. One of the ways is to make the diagrams of quality for each section separately. One example of diagram of road quality is presented on figure 4. Most of the parameters that are important to estimate current road condition are given separately. Each of them has to be leveled in condition as it is and they have to be improved until the acceptable level of road safety is reached. That value has to be defined by Road Directorate and it depends on budget. Based on diagram, one can begin the estimation of the necessity for certain construction intervention on roads.

Figure 4. Diagram of road section quality
As it is mentioned above, with coordination of these two approaches the combination of 3R and 4R projects can be applicable. In that way we can reconstruct the length of adaptation around black spot and rehabilitate the remaining part of the route.

By observation of wider area and making decision on the application of passive and active safety measures, the appearance of black spots migration i.e. migration of traffic accidents is avoided. After these improvements one can obtain geometry well defined with good coordinated values of route length, curve radii, transition curve length. That makes that driver equally secure/insecure on entire road section. Thus homogenous insecure road section is obtained, which induces the road user to drive in a way which is anticipated in design process.

4. COSTS OF ROAD NETWORK RECONSTRUCTION

According to the data from MI-Serbia, condition of current roads shows the obvious necessity of permanent road section reconstruction, because the invested assets return multiply, especially concerning users’ cost reduction and increased level of traffic safety.

Previous and planned future investments in road network are based on the construction of modern, express links, especially motorways. The reasons are following:

- Direct return of invested assets
- Connection to European corridors (TEN-network)
- Area development

Having in consideration that the reconstruction costs are in a group of High Cost Measures (HCM), and they are similar to those of the new construction, the investment in such measures does not seem to be rational at the first glance. In road safety studies that have been made in EU is stated that 20% reduction in road accidents can generally be expected from road improvements. Big advantage of measures taken at infrastructure level is their long-lasting effectiveness.

The term traffic accident cost exists for a long period in the developed countries. It is economic indicator of the society’s loss in the case of traffic accident. The evaluation relating to the traffic accident severity is made, and for example the costs of traffic accidents in Sweden are:

- Traffic accident with fatalities 1.5 million €
- Traffic accident with severely injured 0.3 million €
- Traffic accident with light injured 2000 €
- Traffic accident with material damage 150 €

If we take that Gross Domestic Product (GDP) in Sweden amounts to 29 898 $ / per capita, and in Serbia 5 348 $ / citizen, than by comparative analysis we can say that the traffic accident costs in Serbia are:
- Traffic accident with fatalities           0.3 million €
- Traffic accident with severely injured   60 000 €
- Traffic accident with light injured      500 €
- Traffic accident with material damage    150 €

If we multiply annual number of accidents and above stated accident costs, following data can be obtained. Serbia loses annually 700 million €, which converted in to the current costs of road construction (assuming that reconstruction costs are similar to the costs of new construction) means reconstruction of 500 km of national roads or 700 km of regional roads annually.

By not taking of this funds from the state budget the assumed funds for the renewal of road network can be significantly increased, and it will have great benefit to the whole society, with costs that are implicated from themselves.

5. CONCLUSION

The basic objective of this paper was the indication to the significance of road reconstruction, as long term investment of bringing up the road network to the level which represents starting conditions for the safety management on the road network. There is also a big appeal for renewal of road legislations, which can help accelerating the procedures of solving the black spot issues. By objective observing of Serbian road network, one can draw the conclusion that the current solutions are HCM, because only they can bring high and satisfying Benefit-Cost Ratio. A significant proportion of a national road safety budget should therefore be allocated to engineering improving projects of specific sites, along corridors or within specific areas. Such an investment is likely to pay for itself many times over within the life of the project. The stated views rely mainly on the comparison of positive experiences of developed EU countries, especially Sweden, which is world leader in traffic safety area and the experiences acquired in Serbian road industry.
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