

Analysis of road safety before and after road safety assessment carried out on the road section no. 16 Banja luka – Celinac, intersection “Groblje-Vrbanja”

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Abstract: The Republic of Srpska implemented three procedures provided by the Directive 2008/96/EC, namely: road safety audit for infrastructure projects (Road Safety Audit, RSA), road safety impact assessment (Road Safety Assessment RSI), as well as the procedures of identifying, ranking and remedying and black spots management (BSM).

This paper presents a concrete road safety inspection of intersection on the primary road (major road) M4 in the place Vrbanja near Banja Luka. The said intersection is where the major road and access road to newly constructed cemetery in Banjaluka intersect. After the inspection, the Public Company “Republic of Srpska Motorways“ as road administration implemented some recommendations from the final Report on road safety inspection in order to improve these procedures.

Also, an analysis was carried out to identify the conditions before and after the audit and partial implementation of recommendations.

Keywords: 2008/96/EC, Republic of Srpska, RSA, RSI, BSM.

INTRODUCTION

Regulation on audit and inspection, requirements and manner of licensing (Official Gazette of the Republic of Srpska, number 72/12) road safety audit is defined as follows: “Road safety inspection is a formal safety assessment of the current road conducted by a competent individual or a team”. Road safety inspection is carried out by an auditor having a license for road safety audit which is issued by the Road Safety Agency, pursuant to provisions laid down in the said Regulation.

During the year 2014, and given the higher number of traffic accidents at the said spot, road safety inspection was carried out [1], on the section Banja Luka (Rebrovac)-Čelinac, major road M4, for the micro-spot of the intersection of the access road to the New city cemetery in Banjaluka and previously mentioned section of the major road M4.

The said intersection, in the form it currently exists, was constructed in several different phases, based on the project documentation developed for the purpose of constructing the said intersection, which included significant construction works and violation of property relations, the existing residential buildings within the intersection

zone. It is necessary to highlight that certain elements of the intersection are constructed within the borders of available land in the manner that some elements of the intersection provided for by the project documentation were constructed in an improvised manner, in order to suit the current property situation.

In the course of the year 2013, on previously constructed area of the intersection, channelling island was constructed which was fully compliant to the project documentation, whereas other elements of the intersection were not in line with solutions from the project documentation.

Given the nonconformity, traffic accidents occurred more frequently, featured by hitting the channelling island which made the administrator to remove the island after the order of the road inspection and to require a road safety audit to be carried out (RSA, RSI).

METHODOLOGY

Through previously mentioned road safety audit procedure, an analysis of the subject spot was conducted relating to road safety, in accordance with methodolo-

ogy determined for this procedure. The report provides short-term, medium- and long-term measures to improve the traffic conditions on this spot.



Picture 1. An overview of road safety audit coverage (Google earth, 2016)

This paper provides an analysis of activities undertaken after the procedure of the road safety inspection was conducted on the section of the major road M4, in the place Vrbanja in Banjaluka, first of all from the aspect of civil-engineering and other measures on the subject section and/or concrete spot, as well as the analyses of the effect of certain measures on safer traffic at the very spot.

The analysis was conducted with the aim of bringing it as close as possible to the content of the report [1] and to make as simple as possible the comparison of the conditions before the report was made and the conditions on the day this paper was produced. In this regard, the results of the research and discussion relating to the research included the following segments which are typical for the implementation of road safety audit procedure:

1. Function and road environment;
2. Cross-section of the road;
3. Road route;
4. Intersections;
5. Public and private services, services and rest area, public transport;
6. Needs of vulnerable participants in the traffic;
7. Traffic signalisation and road equipment.

Finally, this paper provides final considerations relating to the importance of implementing this procedure to the concrete spot.

RESULTS OF RESEARCH

The subject spot presents a zone of intersection of the major road M4 and access roads to the newly constructed city cemetery "Vrbanja" in Banja Luka, which is presented in the picture 1

Function and road environment

Conditions before the road safety audit was carried out

The subject section is used for mixed traffic, whereby it should be emphasised that along the section, to the

left, looking from the direction of Banja Luka towards Čelinac, there are two individual residential buildings with connections to the road, and the connection spots of individual residential buildings and connecting roads are not marked. Further on, the road spreads in the form of a sharp curve to the left in the radius of 90 m, and then 80 m far from the curve to the left separates the connecting road to the new cemetery which spreads like a sharp right curve in the radius of 120 m.

Proposed measures

Through short-term measures, the report recommends removal of the trees and overgrowth from the right side of the road, looking from the direction of Banjaluka towards Čelinac, in the entire length between the two adjacent curves.

Implemented measures

In this moment, it can be stated that no significant interventions have been implemented in order to reduce the impact of the road environment and its effect to traffic accidents.

Road function is a parameter that is changed in the long run and by systematic measures and in the given context so that the change of the road functions was not envisaged in the short period which elapsed from the period of this report until now.

Cross-section of the road

Conditions at the time road safety audit was carried out

At the time the Road safety inspection was carried out, the road was divided in two lanes with one traffic lane, whereby the right lane was 3.40 m wide and the left one 3.30 m. On the very surface of the intersection, the right lane included one traffic lane 3.0 m wide, while the left lane included three traffic lanes at the width of 3.20; 3.30 and 3.00 m respectively (end left traffic lane). After the intersection the road was divided in two lanes with one traffic lane each, the right one 3.20 m wide and the left one 3.40 m.

Access road to the new cemetery consisted of two lanes whereby the right lane, looking from the direction of the cemetery, was divided in two traffic lanes, right- and left-turn lanes, and the left-turn lane consisted of one traffic lane.

Water drainage from the connecting road was resolved in the way that a culvert with grids was constructed over the entire width of the connecting road, whereby the grid was partially damaged. At the very crossroad, the surface of the lane was different, and particularly emphasised are colours of the asphalt on certain traffic lanes which can confuse participants in the traffic.

On the observed section, the width of traffic lanes is not widened in curves.

There are no pedestrian lanes on this section except for the 60 m long sidewalk which spreads from the right edge of the connecting road, looking from the direction

of the major road towards Čelinac.

There is a real danger of vehicles congestion on the observed intersection when drivers turn to the cemetery and back at the time of funerals, which was not properly marked. Given that there is no special left-turn lane, when looking from the direction of Banja Luka towards Čelinac, and that the length of the right traffic lane leading from the curve is relatively short (about 75 m) there is a real danger of vehicles congestion and hitting vehicles from the back due to insufficient visibility.

Proposed measures

Within medium-term measures, a reconstruction of the intersection is envisaged, with special accent on the channelling island on the direction towards Čelinac with recommended length of at least 250 m, as well as construction of a bus stop that is a lay-by.

Long-term measures predict reconstruction of the subject intersection and turning the current three-leg crossroad into roundabout.

Implemented measures

Partial reconstruction has been made in the zone of the subject intersection, whereby channelling island was constructed in the length of ~128 m, while channelling island was physically constructed at the length of ~90 m, and the remaining part is in the form of horizontal traffic signalisation.



Picture 2. Condition on the subject spot from 2011 (Google earth, 25 October 2016)



Picture 3. Condition on the subject spot from 2016 (Google earth, 25 October 2016)

Road route

Conditions in the time road traffic safety audit was carried out

The report states that the current speed limit of 50

km/h is not in compliance with elements of the road route and that visibility at the right curve is not ensured due to the overgrowth and trees on the right side of the road. Within the very zone of the intersection, it was stated that the road route is not appropriate and/or that after the direction (direction from Čelinac) at the length ~300 m the route enters the curve with a radius of 120 m.

Proposed measures

Neither short nor medium-term measures presume the change of horizontal geometry of the road in the zone of the subject intersection, while long-term measures suggest correction of the horizontal geometric elements of the road.

Implemented measures

Compared to the analysed conditions, no change in the horizontal geometry of the road occurred so that the same curves are retained in the same conditions as recorded in the course of the year 2014.



Picture 4. Condition on the subject spot from 2011 (Google earth, 25 October 2016)



Picture 5. Condition on the subject spot from 2016 (Google earth, 25 October 2016)

Due to the overgrowth and trees on the right side of the road when looking from the direction of Čelinac, horizontal visibility is still reduced at the right curve.

Intersections

Conditions in the time the road traffic safety audit was carried out

There is an intersection on the observed section where the access road to Novo groblje (New Cemetery) connects to the major road, to the left, when looking from the direction of Banja Luka towards Čelinac. The connecting road collides with the major road at an angle

of about 100°. The lane of the intersection is 12.50 meters wide and the width of the right traffic lane is 9.50 meters wide, looking from the direction of Čelinac, which can confuse drivers when they are to choose the traffic lane and encourages them to drive faster, which is very dangerous when we take into consideration the vast curve from both directions and the crossroad in the zone of two consecutive curves from opposite directions.

Traffic priority in the crossroad can be recognised, but traffic flow is not fully comprehensible because of the three traffic lanes on the left lane. The crossroad project does not meet the needs of road users, which particularly refers to the needs of users driving to the new cemetery. There is no left-turn lane, looking from the direction of Banja Luka towards Čelinac, although it is expected that funeral processions move from the direction of Banja Luka.

Proposed measures

The surface of the intersection has been considered through all the three levels of measures in this report and/or short-, medium- and long-term intervention measures on the subject locality.

Short-term measures presume installation of traffic signalisation and equipment in order to reduce the speed of driving through the surface of the intersection, and in terms of an appropriate and timely identification of horizontal elements of the road and the intersection.

Furthermore, medium-term measures propose partial reconstruction of the intersection with the aim of separating the traffic lanes for different directions, while the long-term measure proposes the reconstruction of the said intersection in a wider context and its transformation into a roundabout.

Implemented measures

At this moment, it can be concluded that short- and medium-term measures have been partially implemented. The intersection has been reconstructed in the manner that traffic lanes were separated by construction (item 3.3.3), so that appropriate vertical and partial horizontal signalisation has been installed along the road (item 3.7.3), as proposed by the short-term measures, which enables drivers to timely and properly notice certain elements in the intersection, including the elements of the road horizontal geometry.

Public and private services, services and rest areas, public transport

Conditions in the time the road traffic safety audit was carried out

Public suburban traffic is carried out along the subject intersection and/or the intersection zone, within the system of the public and suburban transport of passengers in Banja Luka. At the time the road traffic safety inspection, the cemetery was not in function so that a bus stop was not needed in the subject zone.

Proposed measures

Considering the fact that relative to the time of pre-

paring this report on traffic safety inspection commissioning of the location intended for the cemetery was expected, in this regard auditors of the road traffic safety provided concrete proposals for the construction of bus stops on the part of the road in that direction, directed towards Čelinac. Besides the above stated we need to say that auditors reported that zebra crossings and sidewalks should be planned for pedestrians in addition to bus stops.

Implemented measures

Compared to the conditions before the road traffic safety inspection, no substantial changes occurred, except that one public transport line was introduced to the city cemetery, in accordance with the timetables, while only one bus stop with turning option was formed within the complex so that buses coming from the direction of Banjaluka approach the cemetery and the bus stop via the crossroad.

Needs of vulnerable users of the road

Conditions at the time the road traffic safety audit was carried out

At the times this report is developed, needs of pedestrians are not taken into consideration because there are no zebra crossings. The subject section is not lighted so that movement of pedestrians is not safe at night. Due to reduced visibility, visual contact between a driver and a pedestrian is not ensured. The observed section does not provide biking paths or lanes.

Proposed measures

Having in mind that short-term measures envisage substantial construction works, and given that no activities are planned in this respect to improve the safety conditions and movement of pedestrians, it was planned through medium-and long-term measures instead, where construction of appropriate footpaths have been envisaged.

Implemented measures

A higher number of pedestrians are expected on the observed section once the cemetery is in function. Needs of pedestrians have not been taken into consideration since zebra crossings are not provided. The subject section is not lighted so that movement of pedestrians is not safe at night. Due to reduced visibility, visual contact between a driver and a pedestrian is not ensured. There are no biking lanes or paths on the observed section.

Traffic signalisation, marking, light

Conditions at the time road traffic safety audit was conducted

At the time this Report was developed, not all vertical traffic signalisation was installed on major or on access roads. There are traffic signs of speed limitation of 50 km/h from both directions of movement. When approaching the subject intersection, danger signs for connection roads are missing. Horizontal signalisation at the very intersection is missing as well as signs to guide traffic in the intersection – permitted directions and direc-

tions of movement.

Proposed measures

Traffic signalisation and equipment are integral part of the road so that installation of appropriate traffic signalisation and road equipment are planned to this respect in all three levels of the proposed measures.

Concrete development of traffic signalisation is given through the implementation of short-term measures, first of all because of the fact that the installed traffic signalisation and equipment make the basis for these measures.

In medium-term measures, the proposed traffic signalisation and road equipment are in the function of final solutions and the road safety auditors fail to provide any concrete traffic-technical solutions in this context, but the designer was given the task to design the appropriate traffic signalisation and equipment in accordance with positive legal regulations.

DISCUSSION

Guidelines for traffic safety assessment [3], adopted by the Republic of Srpska Government, traffic safety assessment is defined as follows: "Traffic safety assessment is a regular and routine assessment of characteristics and possible errors and/or defects on the roads that require maintenance for safety, which means that it is about assessing and/or defining possible deficiencies incurred after commissioning of the road".

Within the report on road safety assessment [1], in addition to the analysis of conditions and the proposed measures, certain problems were identified that are reflected through the following:

- Intersection for the newly constructed cemetery lies between a sharp right and a sharp left curve whereby the distance between these two curves amounts to 159 m,
- Visibility on the mentioned section leading to the newly constructed cemetery lies between a sharp right and a sharp left curve whereby the distance between the tops of these two curves amounts to 150 m,
- Visibility on the said section is insufficient due to the trees and overgrowth which do not allow participants in the traffic to spot the curve timely. Visibility problem is particularly difficult for drivers who turn left,
- Speed measurement, which is given in the attachment herewith, showed that the current speed limitations are not observed. This particularly stands for vehicles driving from the direction of Čelinac towards Banja Luka,
- Left-turn lane is missing, looking from the direction of Banja Luka towards Čelinac, where several tens of vehicles are expected to gather in the time of funerals,
- Connection road for the new cemetery is not at

the level of the major road, it is on the ascent with the longitudinal slope of 6 to 10%,

- There is a problem of traffic management in the intersection due to the three traffic lanes for vehicles driving from the direction of Čelinac towards Banja Luka, while there is one traffic lane for vehicles moving from the direction of Banja Luka towards Čelinac,
- There is a problem for vehicles connecting from the direction of the cemetery towards Banja Luka when they turn right. The time needed to make sure that the road is free, to turn right and to achieve the permitted speed of 40 km/h (traffic flow speed) amounts to about 8 seconds. There is a real danger that drivers driving from the direction of Čelinac towards Banja Luka who exceed the permitted speed of driving (which was indicated in speed measurement), will not notice a vehicle connecting the road from the direction of the cemetery on time and that this vehicle might be hit from behind.
- There is no public bus transport stop nor the pedestrian path on the observed section.[1]

Pursuant to article 10 of the actual Regulation [2], once the auditor has completed the report, provided recommendations and submitted the report, the authority shall be obliged to analyse the assessment carried out and make a written statement on recommendations given by the auditor.

In this concrete case [1], there is no track on the statement on auditor's recommendations so that it is not possible to make an analysis of attitudes the authority on recommendations of the road safety auditor in this segment.

Analysis of implemented measures brings the conclusion that the authorities (the City of Banja Luka for the access road and the public company "Republic of Srpska Motorways" Ltd. Banja Luka for the major road), have not implemented the measures and recommendations given in the report to a significant extent. [1].

Auditor's recommendations, stated in the report are defined as short-term, medium- and long-term measures. Short-term measures were in the function of fast action with the aim of reducing the number of traffic accidents and they could not have been analysed from this point of view given that realisation and implementation of these measures was not observed, so the time when the authority implemented a number of medium-term measures was not recorded. The implementation of long-term measures is not the subject of this discussion either, because they have not been implemented.

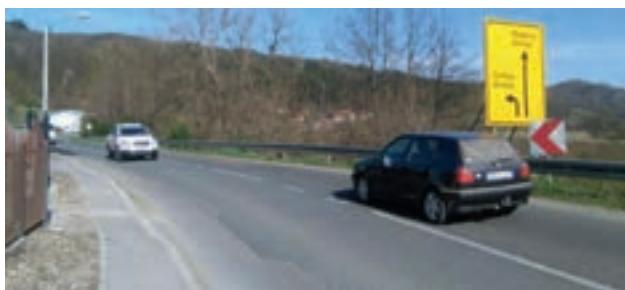
When it comes to medium-term measures, it is obvious that they have been implemented to the extent that the form of recommendations was met in the segment of channelling the road surface, additional lanes were formed for left-turn, and a part of signalisation system and equipment was installed.

In the report, auditors indicated the need for one channelling island at the length of at least 250 m, with the aim that the channelling island and the current horizontal curve that are of relatively small radius could be noticed much earlier so that drivers could adjust the driving speed to the conditions.

Within the presentation of the research results, it was stated that the speed in the intersection zone is limited to 50 km/h. However, taking into consideration the fact that disregard for speed occurs mostly on sections where the speed limit is 50 km/h or 60 km/h, 58%, and/or 68% drivers who disregard the permitted speed were recorded [4], while it was expected that most drivers disregarded the prescribed speed limit in the zone of the intersection, which prompted auditors to define the minimum length of the channelling island. In this connection, the consequences on the channelling island (direction from Čelinac), which can be seen on the picture no. 6, support the fact that the lack of visibility and inadequate speed prevent a certain number of drivers from establishing the contact with the channelling island, the traffic signalisation and the road equipment, which obviously existed in the given moment.



Picture 6. Condition on the subject spot from 2016 (4 March 2016)



Picture 7. Condition on the subject spot from 2016 (4 March 2016)

According to the above stated, it can be concluded the channelling island was not constructed in the right manner and in appropriate dimensions so as to make it visible to all motor vehicle drivers.

From the direction of Banja Luka (Picture no. 7), a separate left-turn lane was constructed ($n=2$), which prevents vehicle congestion, while the traffic signalisation that marks the spot where the sharp curve starts (sign "Direction post" (III-71) and (III-72)), was installed in an appropriate manner, which can be said for another direction as well (from the direction of Čelinac).

Compared to the conditions before the report was produced, the safety level was increased and traffic signalisation installed so that it can be concluded that this notably reduced the consequences arising from the insufficient implementation of the required construction measures.

CONCLUSION

The above text presents the research results that refer to traffic conditions in the zone of the intersection of the access road towards the new cemetery and the major road M4 in the place Vrbanja in Banjaluka.

In the course of the year 2014, a team of auditors produced a report on road traffic safety assessment, in which they stated problems in an unambiguous manner, and provided recommendations in terms of short-term, medium- and long-term measures to improve the traffic safety on the subject site.

The assessment of the expert team aimed at informing the authority about the real scope of the problem on the subject spot and recommending the authority to undertake measures following an appropriate dynamic plan, adequate and quality measures.

After the analysis was carried out, it could be concluded that the authority failed to appropriately recognise the scope of the problem which is the result of the construction of three-leg crossroad on the subject micro-location, whereby the authority failed to recognise the importance of the traffic safety assessment procedure.

Development of laws and bylaws in terms of strengthening the procedures of audits and safety assessment is one of the ways for the appropriate implementation of recommendations, as well as the appropriate and quality measures with a suitable dynamic plan.

Besides the above indicated, auditors must justify the trust through their report on implemented measures and audits and give recommendations and propose measures that can be implemented in the given moment with the best ratio between the "invested and gained".

In addition to the above stated, in further context of traffic safety improvement on the subject site, it is necessary to track the occurrences of traffic accidents and consequences thereof, and to undertake appropriate actions and implementation of the remaining recommendations that have not been implemented yet.

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