

Visibility at intersections in the city of banja luka

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Abstract: Visibility at intersections in road traffic plays a key role in ensuring the safety and efficiency of the traffic flow. Insufficient visibility at intersections can significantly increase the risk of traffic accidents. This paper investigates the importance of visibility at intersections and its impact on the safe merging of vehicles into traffic. The state of visibility at intersections in the city of Banja Luka is analyzed in order to identify factors that lead to a lack of visibility. Research results are presented that indicate insufficient visibility at certain intersections, which can lead to an increased risk of traffic accidents. Recommendations and opportunities for improving visibility at intersections are also discussed, including proper placement of traffic signs, signage and removal of obstructions that impede visibility. The importance of driver awareness of the importance of visibility and timely reaction at intersections is emphasized. This paper provides insight into the problem of lack of visibility at intersections and highlights the need to take measures to improve road traffic safety.

Keywords: visibility, traffic safety, intersection, traffic accidents

INTRODUCTION

Traffic accidents and their consequences are one of the main indicators of traffic safety. A large number of traffic accidents occur at intersections, and insufficient road visibility is a very common cause.

Intersections with insufficient visibility, especially in urban areas, must be timely marked with traffic signage and road equipment in order to enable the safe flow of traffic. A major problem presents the fact that a large number of intersections are not marked with traffic signage, and that the signage is being installed without the main traffic design.

The driver receives more than 95% of the information by the sense of sight. At intersections, sufficient visibility needs to be ensured so as to enable the driver of the vehicle without the right of way, to safely perform the action of merging onto a road with the right of way. Drivers should have a clear view of the intersection and be able to see other vehicles, pedestrians and cyclists prior to deciding to perform any action by their vehicle.

Maintaining visibility at intersections encompasses regular cleaning and maintenance of greenery, horizon-

tal and vertical signage (road markings and signs), as well as proper parking of vehicles in the vicinity of the intersection in order to ensure sufficient visibility.

The paper describes the methodology of determining the necessary visibility at intersections and connection points in accordance with the rulebooks and guidelines that are being applied in Bosnia and Herzegovina.

LEGAL REGULATIONS IN THE AREA OF ROADS AND TRAFFIC SAFETY ON ROADS IN BIH

The Law on Public Roads regulates the legal status of road manager, the manner of utilization of public and uncategorized roads; management, financing, planning, construction, reconstruction, maintenance and protection of roads; concessions on public roads; implementing public-private partnership and supervising implementation of this law (Official Gazettes of the Republic of Srpska No. 89/13 and 83/19). This law stipulates, among other things, that the management of the main (arterial)

and regional roads is performed by the PE "Roads of the RS", while the management of local roads, streets in settlements and road facilities on them is performed by the competent authority of the local self-government unit, which in this case is the City of Banja Luka.

The Law on the Basis of Traffic Safety on Roads in BiH (Official Gazettes of BiH No. 6/06, 75/06, 44/07, 84/09, 48/10, 18/13 and 8/17) the competent authorities that are managing roads shall, in accordance with the applicable regulations, analyze and undertake measures to remedy certain deficiencies on roads at locations where traffic accidents occur frequently. This law defines an intersection as follows: "an intersection is an area on which two or more roads intersect or merge, as well as a wider traffic area created as a result of intersecting or merging of roads".

Rulebook on the Method of Connecting to Public Road (Official Gazette of the Republic of Srpska No. 98/15) defines the minimum conditions for designing and construction of connections to a public road, conditions regarding the location for constructing connections, necessary technical documentation, engineering conditions and conditions for construction work as well as the manner of maintaining the built connections. This Rulebook defines a connection as follows: "a connection is the part of a road by which a public road, an uncategory road or access to a building, is connected to that road". A connection can be constructed in the locations where sufficient visibility is provided.

Rulebook on Audit and Inspection, Conditions and Manner of Licensing (Official Gazette of the Republic of Srpska No. 72/12 and 94/18), road manager is obliged to periodically inspect the conditions of the road under operation, from the aspect of the safe flow of traffic, in the aim of reducing the risk of traffic accidents.

Rulebook on the Basic Conditions That Public Roads, Elements Thereof and Facilities on Them Must Meet from the Aspect of Traffic Safety ("Official Gazette of BiH" No. 12/07) defines the visibility at the intersection as follows: "Visibility when entering into an intersection is the length that allows the driver on the road with the right of way to stop the vehicle before the intersection if the vehicle from the side direction is merging into the same traffic lane or if it crosses the intersection.

Guidelines for Designing, Construction, Maintenance and Supervision of Roads, defines stopping visibility (sight distance) - P_z for the roads that belong to the technical group C (local roads and streets in settlements) as the minimum distance at which the driver perceives an obstacle in order to completely stop the vehicle prior to reaching the obstacle under the conditions of the permitted value of the friction coefficient:

$$P_z = L_z + 7m$$

Where:

- L_z - stopping distance
- 7 m is a safety distance

For example, for the speed of 50 km/h on local roads and streets, stopping visibility P_z equals a minimum of 49 m (Figure 1).

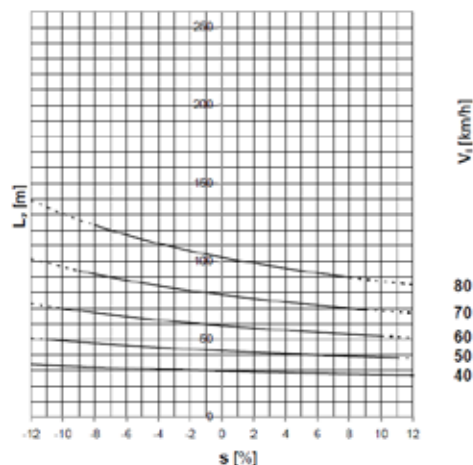


Figure 1. Stopping visibility for the roads of the technical group C

(Source: Rulebook on the Basic Conditions That Public Roads, Elements Thereof and Facilities on Them Must Meet from the Aspect of Traffic Safety)

ANALYSIS OF VISIBILITY AT INTERSECTIONS IN THE CITY OF BANJA LUKA

The following data was acquired by measuring the visibility at intersections with increased intensity of traffic in the city of Banja Luka. By the decision on the classification of public roads, the intersections taken into consideration had been classified as streets in a settlement and managed by the competent authority of the local self-government unit, in this case it is the City of Banja Luka, namely: Filipa Macure Street - Kozarska Street; Srpskih Vitezova Street - Kozarska Street; Miće Radakovića Street-Kozarska Street. These intersections are taken into account because based on the visual inspection from a vehicle, there is no necessary visibility on these intersections. The following tables and figures show the data of the intersections that were taken into consideration.

Table 1. Intersection Filipa Macure Street-Kozarska Street

Intersection	Filipa Macure Street-Kozarska Street
GPS coordinates	44.760653, 17.180304
Type of intersection	Minor road with mandatory stop - "STOP"
Intersection geometry	Three-way intersection at right angles
Stopping visibility (Guidelines)	49 m
Visibility length (Actual)	Right ~ 10 m, Left ~ 10 m
Intersection is marked by traffic signage	YES
Missing signs	NO
Speed limit on the main road	50 km/h
Note:	The tree-line and container on the left side reduce visibility while on the right side there is a concrete wall



Figure 2. Intersection Filip Macura Street-Kozarska Street (view to the right)



Figure 3. Intersection Filip Macura Street-Kozarska Street (view to the left)

Table 2. Intersection Srpskih vitezova Street-Kozarska Street

Intersection	Srpskih vitezova Street-Kozarska Street
GPS coordinates	44.759602, 17.179576
Type of intersection	Minor road with mandatory stop - "STOP"
Intersection geometry	Three-way intersection at right angles
Stopping visibility (Guidelines)	49 m
Visibility length (Actual)	Left ~ 15.0 m, Right ~ 25.0 m
Intersection is marked by traffic signage	YES
Missing signs	NO
Speed limit on the main road	50 km/h
Note:	Presence of large number of parked vehicles on the sidewalk



Figure 4. Intersection Srpskih vitezova Street-Kozarska Street (view to the left)



Figure 5. Intersection Srpskih vitezova Street-Kozarska Street (view to the right)

Table 3. Intersection Miće Radakovića Street-Kozarska Street

Intersection	Miće Radakovića Street-Kozarska Street
GPS coordinates	44.758384, 17.178845
Type of intersection	Minor road with mandatory stop - "STOP"
Intersection geometry	Three-way intersection at right angles
Stopping visibility (Guidelines)	49 m
Visibility length (Actual)	Left ~ 10.0 m, Right ~ 15.0 m
Intersection is marked by traffic signage	YES
Missing signs	NO
Speed limit on the main road	50 km/h
Note:	On the right side there is a large number of parked vehicles on the sidewalk while on the left side there is a fence that reduces visibility



Figure 6. Intersection Miće Radakovića Street-Kozarska Street (view to the right)



Figure 7. Intersection Miće Radakovića Street-Kozarska Street (view to the left)

Research results and recommendations for improving traffic safety

At all intersections subject to the research, it has been established that there was no visibility as prescribed on the basis of the Guidelines for Designing, Construction, Maintenance and Supervision of Roads, while in other aspects, each location was marked by the traffic signage as prescribed.

It was established by the analysis of the visibility of the observed intersections and connection points that the two most frequent reasons for reduced visibility were the following:

A) movable obstacles

At all controlled intersections, it was found that visibility was reduced due to the presence of movable obstacles (parked vehicles and containers on the sidewalk).

As a solution on these locations, we recommend the following:

1. Anti-parking bollards, planter-boxes, concrete cubes, etc.;
2. Moving containers to another location if possible or burying them in the ground (underground containers).

B) Immovable obstacles

At two intersections observed, namely Filipa Macure-Street - Kozarska Street and Miće Radakovića Street - Kozarska Street, visibility has been reduced by the installation of concrete and metal railings about 1.70 m high, which significantly reduce visibility when merging onto the main road.

As a solution on this location, we recommend the following:

1. Installing a traffic mirror;
2. It is necessary to limit the speed to 30 km/h on the priority road, at the approach to intersections.

In the previous period, the Republic of Srpska has adopted the Rulebook on Audit and Inspection, Conditions and Manner of Licensing (Official Gazette of the Republic of Srpska No. 72/12 and 94/18), and in this case, the road manager - City of Banja Luka, is obliged to periodically inspect the conditions of the road under operation, from the aspect of the safe flow of traffic, in the aim of reducing the risk of traffic accidents.

CONCLUSION

Visibility is key to safety at intersections, because it enables drivers to make the right decisions in critical situations. Due to improper parking of vehicles in the vicinity of intersections, visibility can be significantly reduced, which increases the risk of occurrence of accidents. Trees, shrubs, or other greenery may also restrict visibility which is why it must be regularly maintained. Installing traffic mirrors can help drivers to see vehicles or pedestrians. Also, traffic signage and lighting are key

factors that affect visibility at intersections and therefore these must be regularly maintained. It is important to pay attention to the proper placement of traffic signs in intersections, so that drivers are able to see the warnings clearly and on time. In intersections with high-intensity traffic, the placement of roundabouts or traffic lights can help reduce occurrence of traffic accidents and improve visibility.

The deficiencies found at the observed intersections are not characteristic exclusively for these locations, yet to a lesser or greater extent, these deficiencies are present in the entire road network in the Republic of Srpska. Therefore, the approach to solving this problem must be systemic and must consist of amendments to legal solutions that treat this field. This would, principally, imply the following:

- In locations where the measures undertaken (currently existing) failed to yield results, it is necessary to limit the speed to 30 km/h and install traffic mirrors.
- Considering that these are the streets in the settlement, and that the road manager is the City of Banja Luka, it is necessary to perform a targeted traffic safety inspection (TSI) with an accent on visibility in the zone of intersections and connection points.
- Review the provisions of the Rulebook on the Basic Conditions That Public Roads, Elements Thereof and Facilities on Them Must Meet from the Aspect of Traffic Safety - in the part related to determining the necessary visibility at intersections.

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