IMPLEMENTATION OF ROAD SAFETY AUDIT IN THE DESIGN PROCESS OF THE STATE ROAD A1, SECTION DRENOVO-GRADSKO

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Abstract

Road safety mostly depends on the level of equipment in both civil engineering and traffic aspect. The obsolete methods and standards of equipment and the non-application of the experience measures of the Western countries can also be cited as additional reasons for unreliable roads. Considering the fact that the roads are supposed to provide for maximal safety to the users, the equipment level has to be appropriate, without any derogations due to physical, financial or any other reasons.

This paper will present part of the remarks identified by Road Safety Audit in the design documentation related to the Drenovo-Gradsko road, and the methods and technical measures necessary to overcome them.

Keywords – Road safety audit, Traffic, Accidents, Equipment, Safety.

INTRODUCTION

The traffic design refers to a section of the A1 primary route located in the central part of Republic of Macedonia. The route envisaged is the main connection of the western part of Macedonia with corridor 10.

More precisely, this section is the shortest and the fastest connection between Prilep and Corridor 10. The section commences immediately after a delevelled intersection of Drenovo and stretches over the Rosoman ring-road to end at the delevelled intersection at Gradsko, with the whole length of L=15.5km.

Although the section is relatively short, the connection it provides is of a considerable importance for road network of the country, with a great priority of its effectuation due to the relatively high traffic volume within the designed exploitation period [1].

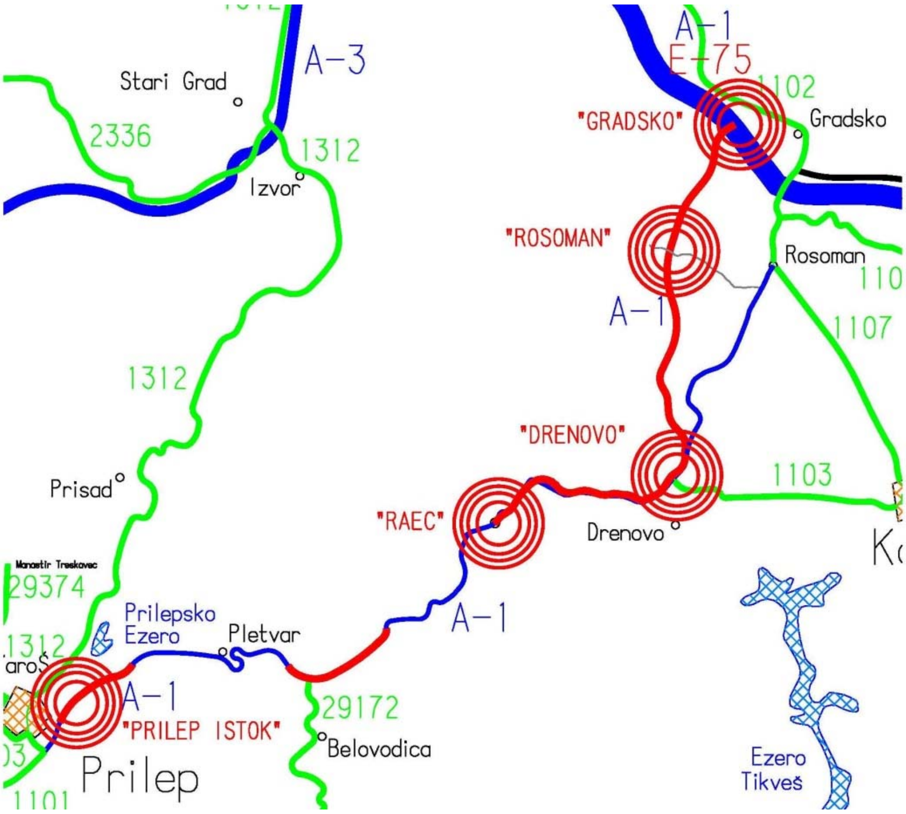

Fig.1. Section Prilep - Gradsko

BASIC DESIGN

The basic design of the section envisaged has been constructed on the ground of the Concept design, which establishes the final centre line of the express road. The design brief defines the following elements of the cross-section of the road:

Vr=110 (100) km/h

Traffic lines	2x3.50	7.00 m
Stopping lanes	2x2.50	5.00 m
Border lanes	2x0.20	0.40 m
Shoulders	2x(1.0)1.50	(2.0)3.00 m
Drain channel + berm	2x(0.75+1.00)	3.50 m

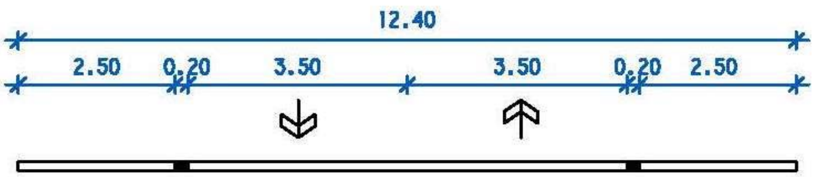

Fig.2. Geometrical cross-section of expressway

The traffic design has been elaborated depending of the newly designed construction configuration of the expressway, from the established need of the basic lane and the constructions alongside it. [2].

The designing was carried out as in compliance with the valid standards and Rulebooks of the Republic of Macedonia.

ROAD SAFETY AUDIT, GENERAL

The main purpose in this stage of the road safety audit was to familiarize the designer with the remarks and the suggestions incurred in the course of the preparation of the design documents, thereby avoiding the problems and shortcomings which would have an adverse road safety impact [4].

The performed road safety audit will create better conditions in the sense of:

- Reduction of the number of traffic accidents. The existing dangerous location would be systematically identified, analysed and appropriate measures would be envisaged in view of the reduction of traffic accidents on certain locations,
- Reduction of time and expenses by application of solutions as early as during the design elaboration,
- reduction of pollution expenses .

REMARKS IDENTIFIED BY THE ROAD SAFETY AUDIT

The effectuation of the road safety audit involved an analysis of the entire design documentation (civil engineering and traffic design), whereby the problems identified are explained in detail in separate chapters..

Road functionality - speed management

Speed management in this section is the key to the achievement of a high safety level. A false speed limitation can result in an increase of the number of traffic accidents (if the limitation is higher than the roads class) or result in lack of confidence in the driver regarding the exposed speed limit signs (if the speed limit is too low).

Upon the revision of the traffic design, a speed limit of 110 km/h was identified in a considerable part thereof, while the limitation was up to 89 km/h in the zones of delevelled loops.

The speed limit is of 110 km/h on the main road, where the profile consists of 1=1 road lanes (3.5 m), with a wide stopping lane (2.7 m) and can entail the following security problems:

- Overspeeding,
- Establishment of a 2+2 driving system.

The physical separation of the two directions by a protective fence or alimitation of the sector speed to 90 km/h [4] are possible solutions to deal with this problem.

1+1 cross-section profile with a wide stopping lane

As in compliance with the BAST research, conducted in 2001, the highest number of traffic accidents occur on a 1+1 cross-section profile with a wide stopping lane. Such roads are often used by drivers as narrow four-lane sections. Besides the use of the road as a four-lane one, overspeeding appears as a secondary problem especially in roads with a low traffic volume. The traffic accidents are often very serious [5].

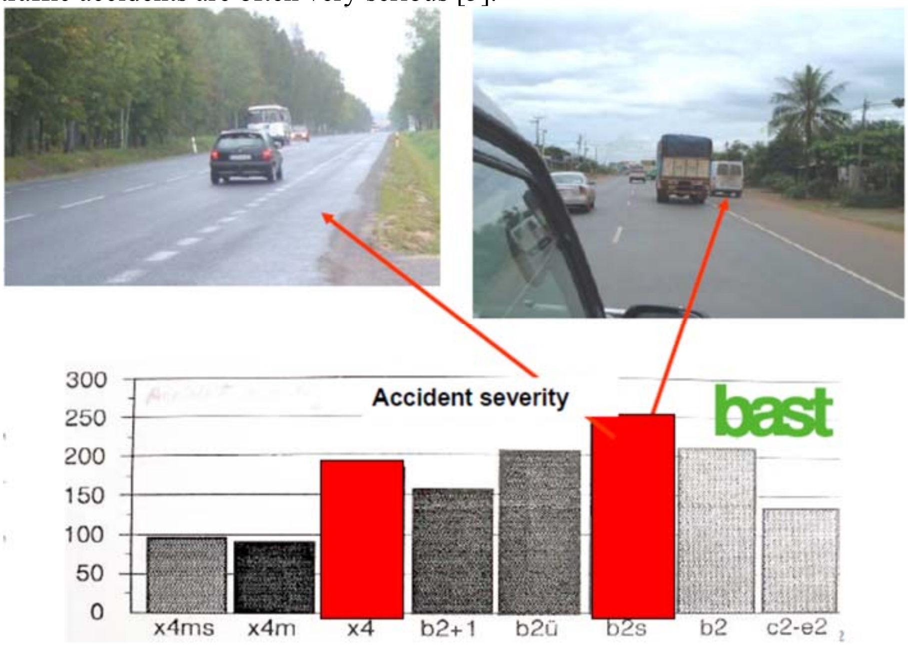

Fig.3. BAST Example of most dangerous cross section

The stopping lanes are good in case of some vehicle defect or of a traffic accident where the vehicle is to be removed from the main lane to avoid yet another accident. But if the stopping lane is wider and if vehicles can be allowed to go along it, there is a situation of a road being used as a narrow road with four lanes. There are two main types of traffic accidents that can occur on a cross-section profile of this type:

- Head-on (a direct impact),
- Run-off-road.

Both types leave serious consequences, the front collisions happen between vehicles coming from opposite directions, while off-road accidents occur when the vehicle tries to avoid a collision or a stopping lane barrier.

An improvement recommendation is the use of a medium-belt 2+1 profile between the two directions.

This profile type is beneficial both for road safety and capacity. The latter is of 20,000 vehicles/day, while a traffic flow of 14,500 vehicles/day has been envisaged for this section regarding the final year intended by the design.

In order to provide for quick traffic allowing for overtaking slower vehicles, the 2+1 profile should be changed to 1+2 each 2 – 5 km. This should be carried out by additional signaling, informing the drivers about the point secure for this change. It is recommendable to use both lanes in great ascents and one upon falls.

The necessary road width for the 2+2 profile is of 13 m to 15.5 m. The velocity at such road sections is limited to 100 or 120 km/h maximum, depending on the measures taken for the separation. This profile is considerably more secure than the 1+1 one with stopping lanes.

Two different approaches are recommendable as for the direction barrier:

- Swedish approach - the physical separation is provided for a centre cable barrier.
- German approach – the separation is provided for by the wide bolded road beacons on the pavement.

Fig.4. Typical 2+1 roadway with centre cable barrier in Sweden

Fig.5. Typical 2+1 roadway in Germany

It is recommendable to apply the Swedish approach with physical separation for this road section, as a high level of driving culture and an increase of fines is necessary for the application of the German approach.

Another possible method to deal with the problem is to use a 1+1 profile with a narrow stopping lane, maximum 1.0m wide. The overall width of the road will be 10 to 11 m.

The velocity limitation for this profile will be of 70 to 90 km/h.

The narrow stopping lane would be sufficient for urgent stoppage of the vehicles, to stabilize and return the vehicle to the main driving lane upon its incidental slipping out of the pavement.

In the case of such a slipping it is recommended to apply profiled lines or edge rumble strips warning the driver about the possibility to slip off the pavement and help him correct the driving.

Fig.6. Example of edge rumble strips

Fig.7. Example of narrow hard shoulder

Merging lanes

There are several locations on the route concerned where the lanes are interrupted, to mark the end of a slow vehicle lane, an interruption of the second lane at ramps or a complete discontinuation of a lane (upon the passage from a motorway to an express road profile). In these case of discontinuation of a lane, the slow vehicles are directed towards the left-hand side and the fast traffic is directed towards the main driving lanes. This type of a lane discontinuation prioritizes the fast vehicles and decreases the possibility of inflow of the small ones, which incites the risk of a lateral collision.

In this case it is recommendable to provide for the correct method of lane discontinuation, that is, to interrupt the left-hand lane enabling for an inflow of the traffic from the fast into the slow lane [6].

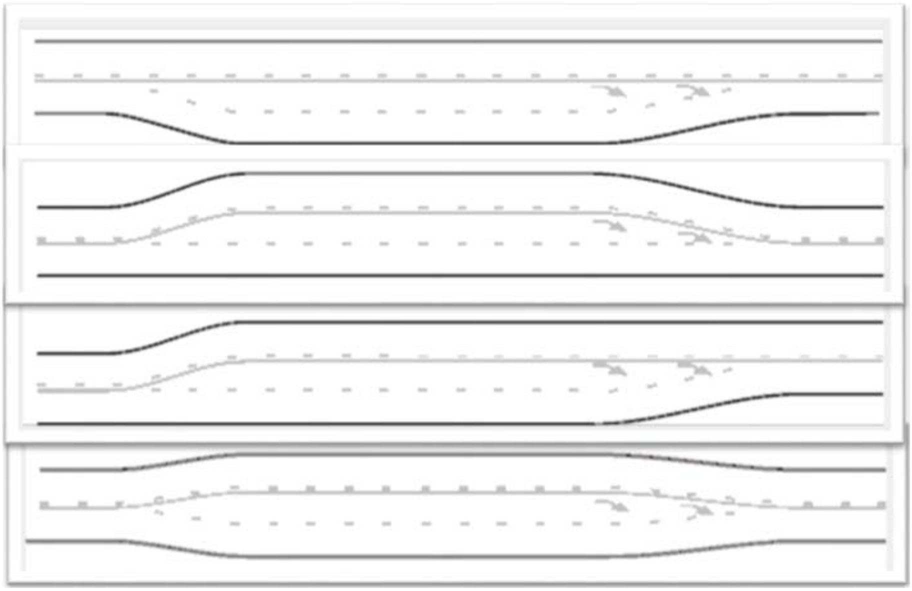

Fig.8. Examples of closing overtaking lanes on uphill section

ROAD EQUIPMENT AND PASSIVE PROTECTION ELEMENTS

General remarks on the protective fence

The fact that the design documentation does not include details on the existing and planned roadside vegetation is cited as a general remark on the road equipment and on the elements of passive protection. If there are trees within the zone closer than 10m, which is considered as secure for the vehicles to stop upon a velocity of 110 km/h, this zone should be protected by a fence.

The following remarks can be given as for the protective fence used:

- The applied level of effectuation is not appropriate for the design (the prevention level, the effective width, the transition constructions, shock absorbers. etc.),
- the chainage for the use of a distancer does not correspond with the design,
- The distance between the poles of the applied protective fence is of 0.4m without a distance,
- There are no data about the traffic composition which would make it possible to decide on the final decision on the appropriate withholding level.

An additional general remark that deserves attention is the late start of the fence, the so-called open windows which cause the vehicles to pass immediately after the beginning and hit the constructions protected by the fence.

It is recommended that the protective fence should be redesigned and, if there is no national standard regulating this field, this should be done according to the European EN 1317 standard.

Extension of the fence

The minimal length of the barrier for the envisaged velocity of 110 km/h on a carriageway upon two-direction traffic would be of 56 m.

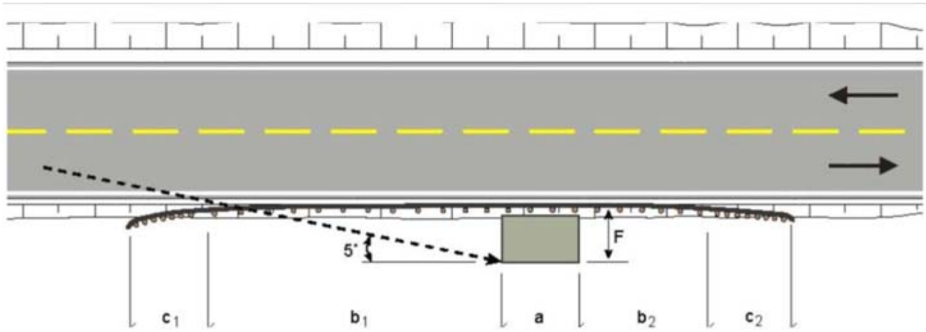

Fig.9. Illustration of parameters that are included when calculating the length of the safety barrier extensions

Where:
c1=c2= 12m – barrier end terminals,
b1= 16m for the speed over 80km/h
b2= b1 on single-lane carriageways with traffic in both directions

On certain points of the design it is necessary to connect the short section of the protective system in order to obtain an entire protective section. A fence would not function if the elements used are shorter than necessary. Each part shorter than 56m should be extended or grouped with the neighboring sections (if necessary) in order to form a complete protective system [7].

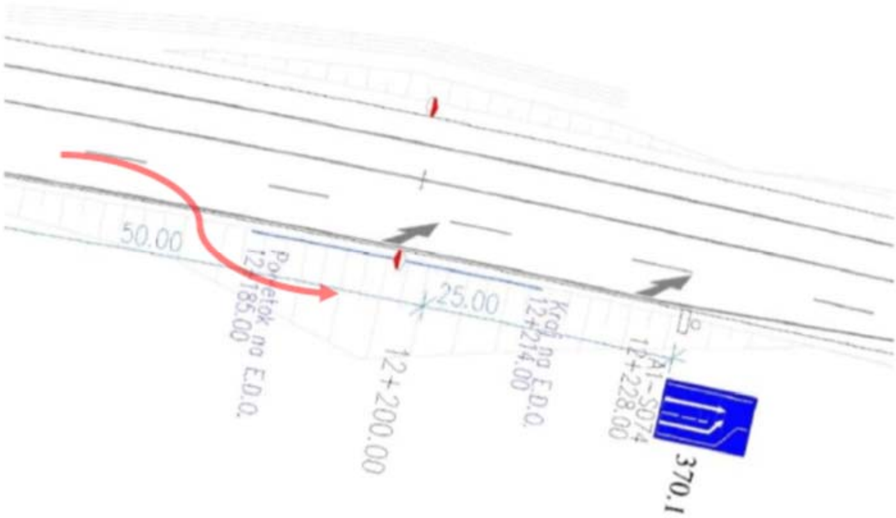

Fig.10. Excerpt from Drawings – Too short guardrail system

If the space between two sections is less than 100m, the protective fences should be connected, except when it is necessary to separate them because of an exit road, an intersection etc.

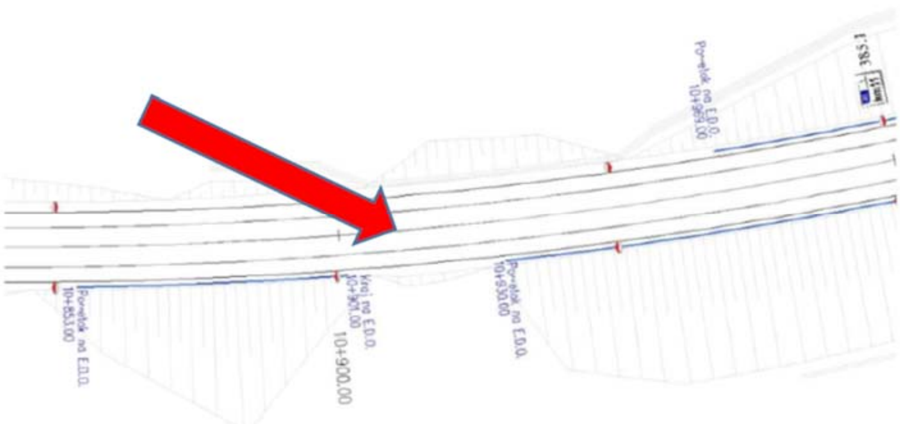

Fig.11. Excerpt from Drawings - gap between guardrail system

This would be a more secure and often a financially more plausible solution than the construction of a protection of the two end terminals.

Unprotected barriers

On locations with dangerous barriers as portal posts, overpass pillars, lighting posts etc., positioned in the vicinity of the carriageway borders it is necessary to provide for a protecting fence in order to protect the vehicles.

Fig.12. Unprotected portal posts left and right side on chainage

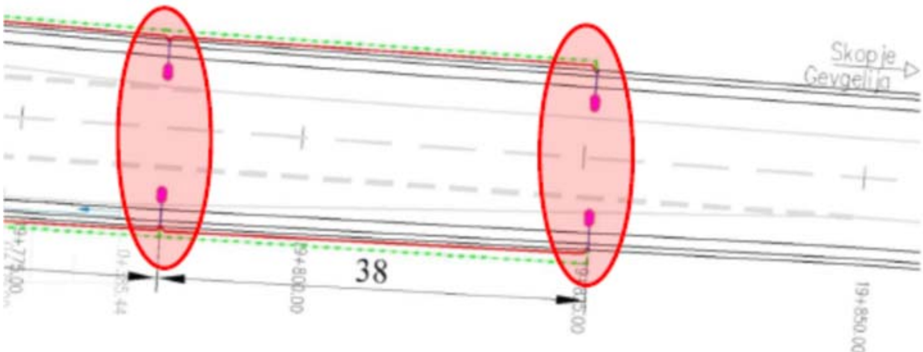

Fig.13. Excerpt from Drawings – Unprotected lighting posts

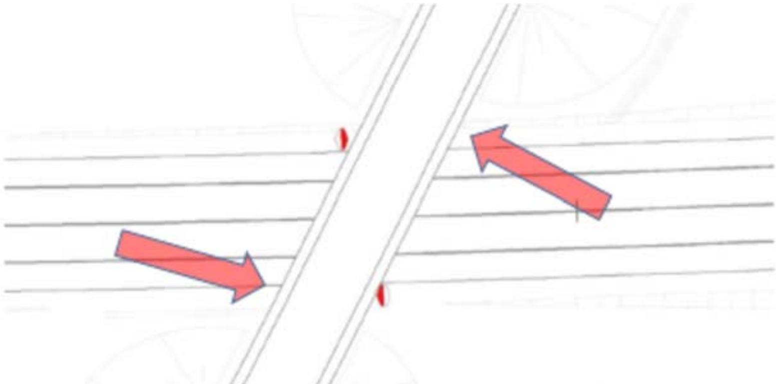

Fig.14. Excerpt from Drawings – Unprotected bridge abutment

The anchorage of the fixed roadside barriers, as are walls or similar flat-end constructions in the vehicle movement direction is carried out so as to be gradually tighter until the barrier (the transition is achieved with harder protective barriers).

Fig.15. Example of transition between concrete barrier and guardrail

Final terminals

The boards of the elastic fence end at an angle where there is no final terminal. On the basis of a large number of impact tests and road accident statistics it was concluded that such an inclined ending is insecure and creates the danger for the vehicle to overturn upon a collision with them.
It is recommendable to include a final terminal, stretching in the direction of vehicle movement, in the construction of the initial part of the protecting fence, as the final terminal has the quality of amortizing the vehicle impact.

Fig.16. Example of end terminal

Open window

The open window problem is an additional one, incurring on locations where the transitional module between the concrete and the metal barrier has been omitted. If the driver loses control and there is no protection on the location to stop the vehicle, it can fall over on the secondary road and cause a traffic accident with a fatal outcome.

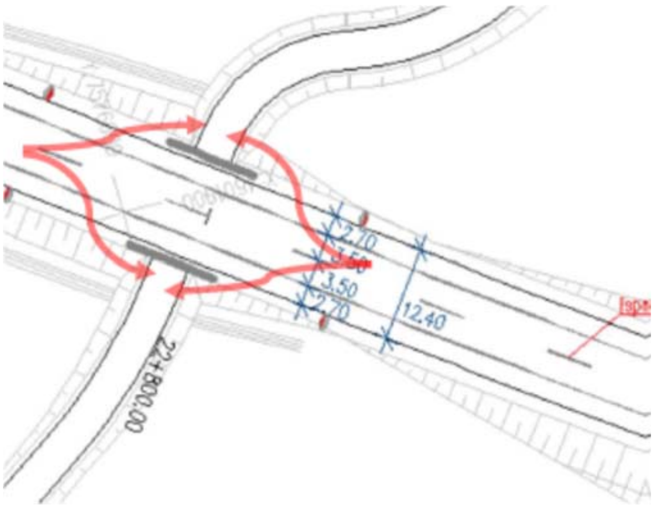

Fig.17. Excerpt from Drawings – Open window

In order to close these shortcomings and protect the mistaken vehicles before the underpass, it is recommendable to position the protective fence at the length of min b1 + c1 (28m) and connect it to the concrete fence [7].

IMPLEMENTED OF THE ASCERTAINED OBSERVATIONS

The previous chapter analyzed part of the problems and the reasons for the decrease of road safety. Specific security enhancing measures have been taken as pursuant to the problems identified. Besides the basic recommendations, the auditor suggests some additional alternative measures which would either be in compliance with our rules or present a more cost-effective solution.

The designer reviewed all the recommended solutions and envisaged improvement of design documentation on the locations where the intervention is possible and allowed. Within the general problems of this road section, the profile type and the envisaged sector velocity, the designer has no chance to intervene as they are all identified in the design brief and in conformity with the current rulebooks and standards.

CONCLUSION

The elaboration of the audit regarding road safety will increasingly improve the traffic solution. The problems identified indicate considerable shortcomings in the design of the new roads in Macedonia.

The very approach to the road safety audit also indicates the level of attention paid by European and world institutions to each individual traffic participant.

The general conclusion that could be driven from this report is that it is necessary to obligatorily and urgent change of our regulations. The changes that should be incorporated should be based on the worldwide regulations and experience. Within road regulations, it is recommendable to use the road safety audit as a base accompanying documentation. This should be the case not only with the roads benefitting from the EU funds but on all the state roads in Macedonian.

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