ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

GUIDELINES FOR ROAD SAFETY INSPECTION (RSI)

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Contents

EXPLANATION

The modern concept of improving the safety of road infrastructure requires explicit concern for road safety, ie the application of modern tools (procedures) for improving road safety, in all life cycles of road infrastructure:

- at the road planning stage is being implemented the Road Safety Impact Assessment (RSIA),
- at all stages of the road designs, as well as immediately before the starting of exploitation and immediately after the release of the road into use, is being implemented the Road Safety Audit (RSA),
- at the time of exploitation of the road - for existing roads:
    - periodic and targeted Road Safety Inspection (RSI),
    - Black Spot Management (BSM),
    - An independent evaluation of the road's contribution on traffic crashes with the fatalities, or In Depth Study (IDS) and,
    - Risk Mapping (RM).

A detailed analysis of the aforementioned modern tools and the effects of their application, the first time is systematically presented in the European project RiPCORD-iSEREST (https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/projects/ripcord-iserest.pdf), whose summary (https://trimis.ec.europa.eu/sites/default/files/project/documents/20101007_170651_37168_RIPCORD%20ISEREST%20-%20Final%20Report.pdf, downloaded at 11.12.2018.) separated the tools included in the EU Directive 2008/96.

Therefore, the European Commission has made a clear decision that the Road Safety Audit and the Road Safety Inspection will be mandatory for the European main road network, as well as for other roads that are partly or fully funded from EU sources.

Based on Directive 2008/96/EC of the European Parliament and of the Council of Europe of 19 November 2008 on Road Infrastructure Safety, the National Assembly of the Republic of Serbia, in the Law on Traffic Safety of 2009 and then in the Law on Roads of 2018 (Official Gazette 41/18), prescribed the obligatory performance of the Road Safety Inspections for existing state roads, as follows: periodic RSI for a period of 5 years and targeted RSI for unsafe road sections of state roads. In accordance with the Law on Roads, the Minister in charge of transport brought the Rulebook on performing RSI and RSA.

Mentioned Laws and Rulebooks have been created conditions to start the regular application of RSI in the Republic of Serbia.

Road Safety Inspection (RSI) is a tool used for detailed and systematic analysis of elements of existing roads in order to identify possible road safety problems and to define possible improvements to existing roads in order to improve road safety.

This document presents Guidelines for the Road Safety Inspection (RSI) in the Republic of Serbia. The Guidelines determine the procedures for Road Safety Inspection of existing roads in the Republic of Serbia, in accordance with the Law on Roads, bearing in mind Decision No. 1692/96/EC of the European Parliament and of the Council of 23.7.1996. on the Union Guidelines for the development of the Trans-European Road Network and Decision no. 1346/2001/EC of the European Parliament and of the Council of 22.5.2001.

Guidelines apply to all other public roads in the Republic of Serbia, if such decision is made by the Government of the Republic of Serbia, local authority units or other public and private contractors of projects (investors).

The Guidelines also apply to the area of maintenance of roads and temporary roads, if a special request for performing RSI is included in the project or contract.

Guidelines are not a Law, nor a Rulebook. Therefore, they do not prescribe or oblige anything. The Guidelines represent only the direction to the Road Safety Inspector when performing the inspection, referring to the procedures that, when performing Road Safety Inspection, must perform, the manner of performing these procedures, and the expected results of the performed inspection.

1. THE PROVISIONS OF THE DIRECTIVE 2008/96/EC WHICH REGULATE RSI

In this chapter, are listed the provisions of the Directive of Road Safety Infrastructure 2008/96/EC relating to RSI. When specifying the content of individual articles of the Directive, the translation version was used, professional editorial board, 2014.

Article 1.

Subject matter and scope

2. This Directive shall apply to roads which are part of the trans-European road network, whether they are at the design stage, under construction or in operation.

Article 2.

Definitions

For the purposes of this Directive, the following definitions shall apply:

1. „trans-European road network" means the road network identified in Section 2 of Annex I to Decision No 1692/96/EC;

2. „competent entity" means any public or private organization set up at national, regional or local level, involved in the implementation of this Directive by reason of its competences, including bodies designated as competent entities which existed before the entry into force of this Directive, in so far as they meet the requirements of this Directive;

7. „road safety inspection" means an ordinary periodical verification of the characteristics and defects that require maintenance work for reasons of safety;

8. „guidelines" means measures adopted by Member States, which lay down the steps to be followed and the elements to be considered in applying the safety procedures set out in this Directive;

Article 6.

Road Safety Inspection

1. Member States shall ensure that safety inspections are undertaken in respect of the roads in operation in order to identify the road safety related features and prevent accidents.

2. Safety inspections shall comprise periodic inspections of the road network and surveys on the possible impact of roadworks on the safety of the traffic flow.

3. Member States shall ensure that periodic inspections are undertaken by the competent entity. Such inspections shall be sufficiently frequent to safeguard adequate safety levels for the road infrastructure in question.

4. Without prejudice to the guidelines adopted pursuant to Article 8, Member States shall adopt guidelines on temporary safety measures applying to roadworks. They shall also implement an appropriate inspection scheme to ensure that those guidelines are properly applied.

2. BASIS OF INSPECTION

2.1 What is Inspection?

Road Safety Inspection is systematic, professional, multidisciplinary, independent, formal, periodic or targeted, comprehensive, detailed, field analysis of all elements of the existing road in order to identify possible deficiencies and those elements that could increase the risk of accidents or could increase the severity of accident consequences on that road. The Inspection also includes making recommendations in order to improve certain road elements.

Therefore, Inspection refers to existing roads that are in use for a longer period (longer than 6 months). Road Safety Inspection is based on field visit and review of the existing road or road section, taking into account the environment of that road. In order that - RSI to meet expectations, it is necessary that it is carried out by a team of trained road safety inspectors.

It is important to clarify the characteristics of Inspection:

1. Inspection is a systematic inspection, which means it must include data collection about road section, traffic load, traffic accidents, real speeds and other traffic safety indicators on the road, analysis of collected data, fieldwork, driving on the inspected road, driving at reduced speed, passing through the field area or parts of the field area as pedestrian, field recording and measuring, analyzing videos, matching the attitude of the inspectors, writing reports, meeting with the Client, etc.;
2. Inspection is independent, which means that the inspectors should be independent of the road designer, independent of the road maintenance and independent of the road authority. The inspectors can't be experts who have been involved in the design, construction or maintenance of the road. It would be optimum for the inspectors to hire another independent institution (for example Road Traffic Safety Agency), rather than the road authority. However, even when inspectors are engaged by a road authority (as is the case in Serbia), it is necessary to ensure the inspector's independence. If the inspector's independence is jeopardized, then the value of the RSI process may be diminished or the entire process has been ignored. Inspectors should only run one criterion, that is, road safety. They are in the function of improving road safety, constantly and again posing the question: *"Can and in what way can the risks of accidents and severity of accidents be reduced, which, however, occur on the observed section of the road?''*
3. Inspection is a professional and multidisciplinary inspection that is provided in a team of inspectors involved experts of various profiles and experiences: traffic safety experts (traffic engineers), experts with road design experience (civil engineers and traffic engineers), and sometimes and some other experts (eg psychologists, railway traffic experts, lighting experts, drainage, etc.);

4. Inspection is a formal tool, which means that they are a formally defined way of proceedings, process participants, reporting method, the content of the RSI report, as well as the process of declaring recommendations and implementing the accepted recommendations;
5. Inspection is a periodical or targeted inspection, which means it can be implemented as a regular, periodic inspection for all sections of the roads of a particular category (eg every 5 years for all sections of state roads) or targeted for selected sections of the road - usually for the riskiest road sections;
6. Inspection is a comprehensive inspection, i.e. the inspectors are obliged to examine various problems that can affect the road safety, under different conditions (day, night, rain, dry weather, etc.) and from the point of view of all participants in traffic. It is particularly important to pay due attention to the problems of vulnerable road users. That's why the inspectors will *"change the dioptre through which they look at the road"*: first it will be put into the role of the driver, then the pedestrians, cyclists, etc. Comprehensiveness also means that all elements of the road and the environment will be covered: road function, cross-section, alignment, traffic signing, marking and equipment, etc.
7. Inspection is a detailed check, i.e. in the inspection process, all the important elements of the road are analyzed thoroughly: first in the office, then on the field, and then again in the office. In doing so, video cameras which provide the recording with GPS data (allowing for coordinated tracking of the record, paths and selected vehicle motion parameters) and cameras that capture the location coordinates and other parameters along with the photo. This way of collecting data from the field allows, after the fieldwork, to analyze in detail the individual sites (locations) and certain elements of the road.
8. Inspection refers only to existing roads, i.e. roads that have been in use for a long time, and not on the road that is in the phase of design or construction;
9. Inspection is a proactive tool for improving traffic safety on the road and relies on a detailed field survey of all road elements and an assessment of the inspector, who do not need to know traffic accident data. Some experts even believe that accident data can distract the RSI procedure because they direct the inspectors only to certain points on the road and contribute to distracting of other important parts of the road where there were no (still) traffic accidents. If the inspectors have accident data, it is recommended that they analyze this data only after they have completed field recording. However, even when the accident data is used in the implementation of Inspection, RSI is a proactive tool that is being implemented to prevent the occurring of new traffic accidents, therefore, before accidents occur.

Inspection should direct activities to improve road safety and reduce the risk of accidents, and if accidents occur, then Inspection should reduce the consequences of these accidents. This is achieved by quality Inspection and the implementation of recommendations from the Inspection report.

2.2 The objectives of Inspection

Inspection should direct and improve the road safety management process on the road network, ie on selected road sections.

Regular use of Inspection should achieve the following goals:

- to identify deficiencies on the road, road facilities, the road environment and road equipment that increases the risk of accidents, and in particular accidents with the most severe consequences (accidents with dead and seriously injured persons);
- to identify road deficiencies, road objects and road environments that may increase the severity of incidents that may occur;
- on the basis of an analysis of the road and road conditions and analysis of road safety issues on the section, propose the necessary type of interventions on the section (maintenance, intensified maintenance, rehabilitation, reconstruction or design and construction of a new road or individual objects or parts of the road);
- Whenever possible, on the basis of the professional experience of the inspector and the analysis of the particular road section, shall recommend to the road authority optimal measures for improvement or alternative measures to ensure that the risk of accidents and the consequences of the accidents on the observed section of the road be at the lowest possible level;
- on the basis of the constant agreement of attitudes with the road authority, improves the process of public procurement, maintenance of existing roads, but also the process of designing new roads;
- based on experiences from the Inspection, contribute to the improvement of regulations, standards and expert guidelines for planning, designing, building, and maintenance of roads and,
- in the longer term, contribute to the improvement of knowledge, i.e. the theories and practices of traffic safety and road design, etc.

2.3 The Cost and Benefits of the Inspection

The cost of the Inspection includes:

1. administrative costs and the cost of starting the Inspection procedure,
2. the cost of RSI and the writing the Inspection report and,
3. the cost of applying the recommended, ie other measures in order to improve the traffic safety on the road.

Administrative costs are the smallest, but it is necessary to bear in mind the time needed to start and implement public procurement, ie slow down the process of road improvement, due to the implementation of Inspection.

The cost of the recommended and/or other measures aimed to improving road safety is the largest item in the cost of Inspection and depends on the recommended or accepted measures. As part of the Inspection report, the inspector should also declare at least the approximate prices of individual measures. In this way, the road authority will be able to take into account the estimated cost of the application of individual recommendations and the available budget when making a comment on Inspection recommendations. It is therefore important that the road authority in his budget envisages funds for the implementation of Inspection recommendations, and it would be best if the preparation of the Inspection report was preceded by budget preparation. It should be having in mind that, as a rule, some more expensive measures give significantly higher effects, so the road authority will take into account the cost/benefit ratio, ie the cost/effective ratio.

Society, especially road users have a great benefit from Road Safety Inspection, especially:

- Inspection determines the directions of activities to improve traffic safety on the road. Some traffic safety issues can be solved by directing and intensifying road maintenance (eg, clearing culvert and channels along the road, replacing the damaged guardrail), other problems can be solved by rehabilitation (eg repair of the carriageway, adding a missing guardrails), and some problems solve reconstruction, design, and construction (eg the construction of a roundabout in order to calm down the traffic, the construction of pedestrian islands, the reconstruction of the sharp curve, etc.). Choosing the optimal direction of operation reduces the price of improving traffic safety, because avoiding rehabilitation that does not solve the problem, or there is no unnecessary reconstruction in cases when rehabilitation can solve the problem of traffic safety. In this way, Inspection makes it easier the planning of works to improve road safety.
- The Inspection identifies certain road hazards and makes recommendations on how these hazards can be reduced or eliminated. Thus, the number of traffic accidents decreases, ie the consequences of incidents which still happen.
- It should be noted that problem identification and the application of rapidly feasible, inexpensive measures to alert participants to the problem of traffic safety, reduce the risk of an accident. Namely, when participants are well informed about the problem of traffic safety, they generally undertake activities to positively compensate risks and adjust their behavior (for example, reduce speed). Thus, even before implementing the recommendations from RSI, cheap information measures, reduce the risks and severity of the accident at these sites;
- By implementing the accepted recommendations from the Inspection report, the greatest benefits are realized from Inspection. Depending on the type of recommendations implemented, the number of accidents, and especially the number of accidents with the most severe consequences, is significantly reduced. The ratio of investments into these measures and benefits achieved through the reduction of the cost/benefits ratio ranges from 1:1, and goes beyond 1:30. It should be having in mind that Serbia still has not agreed on the overall socio-economic consequences of traffic accidents, so standard estimates from the EU can be used. According to these estimates,

traffic accidents with dead persons cost about 2.58 million euros, accidents with severely injured costs about 350 thousand euros, and accidents with lightly injured about 37 thousand euros and accidents with material damage only cost about 4 thousand euros (Table 2.1).

Table 2.1. Total socio-economic consequences (costs, damages, and losses) of traffic accidents in the EU, according to the severity of the accident [1]

	Medical costs	Production loss	Human costs	Property damage	Administrative costs	Other costs	Total (unit) costs
Fatalities	€ 5,430	€ 655,376	€ 1,587,001	€ 11,555	€ 6,346	€ 3,638	€ 2,269,346
Serious injuries	€ 16,719	€ 43,627	€ 230,385	€ 7,622	€ 4,364	€ 413	€ 303,130
Slight injuries	€ 1,439	€ 2,669	€ 15,597	€ 5,317	€ 1,876	€ 519	€ 27,418
Fatal crashes	€ 11,757	€ 727,616	€ 1,809,467	€ 17,542	€ 8,891	€ 3,817	€ 2,579,089
Serious injury crashes	€ 19,158	€ 50,285	€ 263,945	€ 11,143	€ 5,557	€ 709	€ 350,796
Slight injury crashes	€ 1,957	€ 3,629	€ 21,212	€ 7,231	€ 2,677	€ 634	€ 37,340
PDO crashes	€ 0	€ 0	€ 0	€ 2,795	€ 764	€ 400	€ 3,960

On the other hand, in the document on the Road Traffic Safety Strategy of the Republic of Serbia for the period from 2015 to 2020[2], values were used based on the calculation of the damage level according to research in the Republic of Srpska (Ross et al., 2012[3]), which took into account only minimal material costs and damage from traffic accidents (human capital model). According to this model, it is estimated that the cost of an accident with casualties amounts to 317,317 €, one traffic accident with seriously injured 34,094 €, and one traffic accident with light injured € 3,181. It should be kept in mind that these values are underestimated, the data used are outdated, that the gross national income in Serbia is significantly higher than that of the Republic of Srpska in 2012, and that it was the first attempt to define the minimum and undoubted the consequence of traffic accidents in the

[1] WIJNEN, W. ... et al., 2017. Crash cost estimates for European countries, deliverable 3.2 of the H2020 project SafetyCube. Loughborough: Loughborough University, SafetyCube.
[2] Road Traffic Safety Strategy of the Republic of Serbia for the period from 2015 to 2020, Official gazette RS, 05 No 344-1721/2015-1, Belgrade, 2015.
[3] Ross, A. i Lipovac, K. (2012). Traffic crash costs in republic of Srpska, Economics Institute, Banja Luka.

Republic of Srpska. Given the acceptance of European models and the Value System, and taking into account the progress in traffic safety in Serbia, it would be more appropriate to use the European standard from 2017.

Many foreign experiences support the claim that it is possible, with cheap and simple measures, to achieve a significant reduction in the number of traffic accidents. Research by a well-known Norwegian scientist, Rune Elvik (The handbook of Road safety measures, Elsevier, 2006), speaks of the high expected decrease in the number of traffic accidents and the consequences of these accidents due to carried out Road Safety Inspections. Examples include:

- removing irregular traffic signs: reduction 5 - 10%
- adding guardrails on embankments: reduction 40 - 50%
- ensuring sufficient sight distance: reducing 10 - 40%
- removal of side obstacles: reduction 0 - 5%

The previously mentioned "*financially acceptable measures*", which are, as a rule, proposed in the Inspection report, are the short-term and medium-term measures for improving road safety. Although it is not always possible to accurately measure the overall socio-economic benefits of the Inspection, there is strong evidence that, from the point of view of costs, it is an efficient and highly profitable.

The effect of the implemented measures varies from country to country and depends on several factors.

2.4 Inspection and data on traffic accidents

When performing Inspection, data on traffic accidents are not necessary! If the inspector has information about traffic accidents, then he must be careful, as this data would not divert him from the essence of Inspection. Namely, the inspectors should review all parts and all elements of the road and the environment of the road, and not only those contributing to the occurrence of traffic accidents. In doing so, the inspectors rely on his expertise and experience, and not on data on traffic accidents.

Inspection is different from the analysis and remediation of black spots. Black Spot Management (BSM) is a special tool based on data on traffic accidents on the road network. Based on data on locations of traffic accidents, there are points of accumulation of traffic accidents, the ranking of hazardous places, identification of black spots, and then a detailed analysis of places identified as black spots and recommendations for improvement of a particular place. When the "black spot" is identified, within the "black spot" analysis, Inspection can be performed, i.e. Inspection can be an element of the "black spot" management tool.

Inspection is also different from the in-depth analysis of traffic accidents, which thoroughly analyzes the circumstances the occurrence of an accident with the most severe consequences (most often accidents with the dead persons) and checks whether the road

contributed to the occurrence of an accident or the consequences of an accident. If it is determined that some elements of the road contributed to the occurrence of the most severe consequences, recommendations for improvement are given. These in-depth analyses of traffic accidents can include a wider analysis of the place where the accident with the most severe consequences occurred and the recommendations that can eliminate or reduce hazardous at the place or on the roads in general.

Regardless of the above, data on traffic accidents are used when determining the order of performing the Inspection. Namely, in addition to regular, periodic Inspection, targeted Inspection is performed on the road section with increased concentration of traffic accidents. Roads with a large number of serious traffic accidents have priority in the performance of Inspection. Likewise, in Inspection on the road section with a high number of traffic accidents, the inspection can only be directed to those road characteristics that caused a greater number of accidents or contributed to the greater consequences of accidents. For example, Inspection can be focused only on guardrails or obstacles along the road, only on pedestrian infrastructure, bicycle infrastructure, etc.

2.5 Road and Road Maintenance

Road maintenance is performed by the contractor of the regular maintenance, which was hired by the road authority. Inspection is performed by the Road Safety Inspectors. Although these are two independent legal entities, the inspectors contribute to the quality and well-directed maintenance of the road, especially in the part dealing with the elimination of defects that can contribute to the occurrence of a traffic accident with serious consequences. Namely, once the RSI program is established, the road authority should establish a procedure for analyzing the RSI report, in particular analyzing and agreement of the attitudes on Inspection recommendations and implementing the recommendations. In this process, the continuous cooperation between the traffic safety sector and the road maintenance sector is important in the process, as part of the recommendations refers to road maintenance and can be implemented quickly. The maintenance sector receives reports on Inspection and should participate in the analysis of these recommendations, acceptance of measures related to maintenance and explanation why some measures cannot or will not be accepted. When the road authority pleaded at recommendations, then part of the recommendations to be implemented during road maintenance are included in maintenance plans as a priority measure. The maintenance sector takes care of the implementation of these measures and reporting to the traffic safety sector and other interested parties.

The traffic safety sector run the program of Road Safety Inspection that includes establishing and continuously updating a database of:

- planned regular Inspection,
- ongoing Inspection,
- reports on completed Inspection,
- recommendations that are accepted and those that are not accepted,

- the estimated value of works on the implementation of individual recommendations,
- entities and organizational sector within the road authority to whom the accepted recommendations have been forwarded,
- sectors and individuals responsible for the implementation of recommendations,
- the phase in which the implementation of certain recommendations is made,
- the effects of implemented recommendations, etc.

Based on this database, the road authority plans and directs road maintenance activities, plans for design, rehabilitation, intensify road maintenance, road reconstruction, etc.

2.6 Inspection and the human factor

The driver's driving is based on information that the driver receives while the driving from the road environment in which the vehicle is moving while driving. The driver's reaction depends, above all, on the road alignment, the immediate environment and the resulting traffic situations.

Enabling safe traffic conditions on the road is a very complex work that depends on the behavior of the driver, the characteristics of the vehicle and the road, traffic conditions, etc. When it comes to safe driving, it is necessary to combine two approaches: to adopt the road and road environment to drivers and to adopt the driver's to the road, the road environment and traffic conditions (driver's skills, driver training, regulations, compliance, predicting, and risk management, etc.).

In doing so, it is necessary to have in mind and respect the driver's capabilities and limitations, and in particular:

- functions and possibilities of sensory organs,
- psychomotor abilities,
- mental abilities.

By sensory organs, which stimulate the nervous system, and there is eyesight, hearing, sense of smell, etc. The basic psychic process is the stimulus that leads to decision making and is continuously repeating in the process of driving. Observation and understanding of the environment are made possible by sensory organs, which, through physical and chemical processes, inform about the outside world and changes within the body. Eyesight is the most important sense for safe traffic participation. Over 95% of all information that is significant for traffic is received by the human through the eyesight. According to some studies, more than 95% of all decisions the driver makes depends on the eyesight. In doing so, they are very important: adjusting the eye to light and darkness, the width of the field of view, color differentiation, visual acuity and the possibility of stereoscopy (stereoscopic), etc.

Psychomotor abilities are abilities that enable the successful performance of movements that require speed, precision, and consistency of the perception and operation of the muscles. The most important are the following psychomotor abilities when driving a vehicle:

- reaction speed,
- speed of performing movement,
- compatibility (coordination) of the movement and the perception process.

The time period from the moment of occurrence of a signal or some particular situation to the moment of reacting a man to a vehicle command is called the response time and it is inversely proportional to the speed of reaction. The response time is between 0.5 and 1.5 seconds and can be divided into perception time, times of recognition and understanding, time of assessment and decision-making and time of action. The speed of reaction, or the response time, depends on the individual characteristics of a person, from his age, from the strength of the stimulus, from the complexity of the traffic situation, from the physical and mental condition and stability of the driver, from the concentration and fatigue of a man, whether a person reacts by hand or foot, whether it is reacted with a left or right hand or foot, whether the stimulus is sound or visible, from climatic conditions, from the speed of movement, from the sight distance of the road, from the style of participation in traffic, from fatigue, etc.

Mental abilities are thinking, memory, intelligence, learning ability, and so on. The person with developed mental abilities, better and easier to understand and understand the environment and successfully adapts to the conditions. The personality that is mentally insufficiently developed has slower all psychic processes, it is harder and slower to adapt to traffic conditions. For mentally insufficiently developed personalities, vehicle steering can be a very hard activity and such a person cannot be good drivers.

The task of the inspectors in relation to the psychophysical characteristics of the driver is to establish:

Will the driver timely see XXX (eg a traffic sign, pedestrian or some traffic situation)?

Will the driver correctly understand XXX?

Will the driver have enough time to react correctly to XXX?

Will the driver's reaction to XXX will be safe, i.e. enough to avoid the danger?

All the aforementioned questions apply to the analysis of the possible behavior of all other traffic participants. Therefore, when performing RSI, it is necessary to put into the role of "a man in a traffic situation", that is, in the role of all expected participants in traffic.

3. THE SUBJECT OF THE INSPECTION

3.1 Field of application and type of Inspection

Directive 2008/96 primarily relates to the trans-European road network (TEN) and to EU-funded roads. However, the Directive is not limited to these roads alone, but can also be used for other roads.

According to the Law on Roads (Article 89), in Serbia, it is foreseen that:

'' ... *The public road authority must ensure the Inspection, and that:*
1) periodic Inspection of state roads of the first order at least once in a period of five years;
2) targeted Inspection for public road sections of the highest risk, according to the risk map of roads and streets...

The Audit and the Assessment referred to in Article 88 of this Law may also be implemented with other public roads designated by the Government.''

As a rule, all roads, regardless of category, traffic load and other characteristics, should be regularly periodically reviewed from the point of view of safety features. However, due to the volume of work and limited capacity, usually the establishment of periodic Inspection programs starts from the most important, state roads, and then this program extends to other roads. In doing so, priority lists can be made, that is, the order of carrying out Inspection, given the importance of the road, the scope of traffic safety problems, traffic load, etc.

On the other hand, targeted Inspection is most often planned on the basis of collective risk on road sections. All sections of roads are ranked according to the number of consequences of accidents (number of dead, number of dead or severely injured or weighted number of dead and injured) per kilometer. Then, depending on the size of the collective risk and the available funds, the number of the most vulnerable sections will be determined which will, as the most vulnerable, be prioritized to Inspection. Implementation of targeted Inspection can affect the order of planned, periodic Inspection. If some of the sections are covered by targeted inspections, they will be omitted (changed) from the plan of regular, periodic Inspection in the upcoming period.

3.2 The basic elements of the road being inspected

Table 3.1 shows the basic elements of the road that are analyzed in detail when performing Inspection.

Table 3.1. The basic elements of the road covered by Inspection

Element	Explanation
ROAD FUNCTION	Is the clear function of the road? Does the function of the road match the role of the environment and the role in traffic? Are there different types of travel in the traffic (different road functions)? Are the speed limits appropriate to the road category, traffic and traffic participants?
ALIGNMENT OF THE ROAD	Do the elements of horizontal and vertical alignment have a negative impact on the risks and consequences of accidents? Are there sharp or sudden horizontal curves on the road? What is the ratio of the radius of adjacent curves? Are the transversal curves between the directions and the sharp circular curves of the road carried out appropriately? Does it have a compound curve, with a variable radius in the circular part of the curve? Does it have vertical curves (especially convex curves with the small radius that would limit sight distance)?
CROSS SECTION	Is the wide of the road enough? Is the number and width of traffic lanes sufficient for existing traffic? In what condition is the carriageway? Are shoulders adequate, but not too wide? Is the cross drainage of water from the carriage provided? Are vulnerable road users adequately separated from motor traffic?
CONNECTONS, INTERSECTION, AND INTERCHANGES	Is there an intersection, access, road connections, and interchanges in the analyzed road section and do they correspond to the functions of the road, traffic load, and the traffic flow structure? Are there problems with connections from the environmental object and private access? What is the surface course on the connection roads? Are there illegal or unregulated accesses? Are gravel road constructed from agricultural accesses? Are the angles of intersecting unfavorable (sharp)? Are the road connections steep?
PUBLIC AND PRIVATE SERVICES, REST AREAS AND PUBLIC TRANSPORTATION	Are there gas stations, restaurants, parking lots and other necessary facilities along the road? How is the exiting/entering of vehicles on/off from these objects regulated? Are there public transport stops or rest areas on the road section and how are they arranged? How is traffic organized in the zone of these services? How is the arrival of public transport users regulated?
VULNERABLE ROAD USERS	Is there a pedestrian, cyclist or motorcycle rider on the road? Is there a necessary infrastructure for these participants? Are the pedestrian/biking paths uninterrupted and in good condition? How is the crossover with motor vehicles resolved?
TRAFFIC SIGNING AND ROAD	Is there a traffic signage and in what condition they are (traffic

MARKING	signs and markings on a carriageway)? Is there adequate equipment on the road, including signposts, public lighting, etc.? Is there appropriate signaling in the intersection areas that clearly determines the priority of the pass? Are traffic signs repeated after the intersection, if it is necessary? Are road signs prohibited or permitted overtaking post at appropriate places? Are the signs that determine the beginning and the end of the settlement set in the appropriate places?
LIGHTING	Is there adequate lighting? Is the lighting away from the carriageway? Was it only on one side or on both sides of the carriageway? Is the carriageway well illuminated? Are there well lighting of sidewalks and pedestrian paths? Are the illuminated pedestrian passages under the road? How far is the distance between the light? Do the lights on the road blaze traffic participants?
ENVIRONMENT AND EQUIPMENT OF THE ROAD (OBJECTS, SAFETY ZONES ON THE ROAD AND VEHICLE RESTRAINT SYSTEMS)	Are there facilities on the road, and along the road, in what condition, do they interfere with sight distance and represent a risk in the case of landing a vehicle from the road and hitting these facilities? Are the slopes of cut/embankments steep and dangerous in the case of the landing from the road? Are there guardrails of the appropriate level of protection? What is the state of the guardrails, are there damages of guardrail - "windows" in the guardrails? Are there passively safe beginnings/ends of guardrails?
OTHER ELEMENTS (PARKING, PARTICIPATION OF HEAVY VEHICLES, BLINDNESS, ACTIVITIES AT THE ROAD, ITS EQUIPMENT, FLORA AND FAUNA IN THE ROAD ZONE, SCHOOL ZONE, ETC)	Does it and how is regulated parking next to the carriageway or on the carriageway? Do vehicles parked or exited from parking distract the other vehicles movement? Do parked vehicles distract the sight distance at the intersection or near the pedestrian crossing? Are parking spaces of sufficient width and length? Do the lights around the road blind the drivers? Do besides the road have activities that would distract or threaten the traffic (sales, promotions, gatherings, etc.)? Are there some elements of the ITS on the road and how they work? Does vegetation distract the sight distance? Does the road intersect with the everyday paths of animals? Is there a school near the road and how is it possible to move children along the road and across the carriageway?
WORK ZONES (TEMPORARY SIGNAGEIN WORK ZONE ON THE ROAD)	Is the works zone timely announced and well-marked? Are special traffic signs for temporary signaling (with a yellow background)? Are there sufficient protection latitudes in the work area? Is the maximum permitted speed in the work area envisaged to correspond to the available width of the lanes and geometry of

	the road? Is the maximum allowed speed gradually reduced from a regular speed limit to a limit in the work area? Was the safe re-routing of the vehicle on the part of the carriageway that was intended for vehicles from the opposite direction and did all the drivers have been notified timely and unequivocally?
BRIDGES AND TUNNELS	Is the speed limit on the bridge/tunnel according to the speed limit in front of and behind the bridge/tunnel? Are the elements of the cross-sectional profile of the bridge/tunnel of the corresponding dimensions with regard to the road elements in front of the bridge/tunnel? Are there adequate widths on the bridge/tunnel of the pedestrian area (maintenance service)? Did the corresponding traffic signagetake place on the road section in front of the bridge/tunnel? Is good sight distance ahead of entering the bridge/tunnel? Are there adequate guardrails on the bridge? Is there adequate lighting in the tunnel? Did the bridge/tunnel have the correct warping of the carriageway? Is drainage of the bridge/tunnel properly resolved? Is the lane for slow vehicle removed before the tunnel is properly engaged?

Table 3.2 shows the elements that must be considered in Inspection.

Table 3.2. Road elements which need to be considered when performing Inspection

Impact factor	**Explanation**
Weather conditions and time of day	Inspectors should perform field work in day and night conditions. It would be optimal if the day field inspection would be conducted in different hours during the day, and especially at the time when the sun could cause blindness. Whenever possible, field inspection should also be conducted in different weather conditions (eg without precipitation, rain, snow). Night field inspection of the road is important for checking the visibility of traffic signs, the illumination of certain places on the road, blinding, etc. A night inspection is especially important if you check the part of the road where a large number of traffic accidents happen at night.
Season	If possible, it is advisable to carry out the inspection at different seasons, in winter during freezing and snowfall, during the resting of vegetation and during full vegetation. This should be taken into account when preparing the inspection plan, so that successive inspection on the same section of the road are carried out at different times of the year!
Special problems	In some cases, it is necessary to carry out inspection at the time of morning and afternoon peak hours, when children come to school, at the time of agricultural work, etc. This means that, the Inspection implementation time must be adapted to the subject of the inspection. On some types of roads and in different traffic conditions, Inspection can be very specific. In that sense, Inspection check lists can also be used on motorway sections, street sections in the settlement, in the school zone, at intersections, etc.

4. WHEN INSPECTION NEED TO BE CARRIED OUT?

As already mentioned in chapter 3.1, Inspection are, as a rule, periodic or targeted.
Periodic Inspection for state roads of the first order shall be carried out at least once every 5 years, as defined in Article 89 of the Law on Roads. The road authority should adopt a periodic inspection plan, so that within 5 years, Inspection will provide all sections of the first order roads.
Targeted Inspection, as a rule, is planned based on maps of collective risk on road sections. First, all sections of roads are ranked according to the number of accidents (number of dead, number of dead or severely injured or weighted number of victims) per kilometer. Then, depending on the size of the collective risk and the available funds, the number of the most vulnerable sections will be determined which will, as the most vulnerable, be prioritized to Inspection. In the end, a number of the most vulnerable sections are included in the Inspection implementation plan for the next period.

4.1 Key reasons for initiating Inspection procedure

Key reasons for initiating Inspection procedure are:

- that this is predicted by the plan of periodic Inspection,
- that, on the basis of collective risk, for the section of the road or intersection is established to represent a place with a high degree of risk.

4.2 Other reasons for initiating Inspection procedure

Other, extraordinary reasons for initiating Inspection procedure may occur if:

- there are information about serious traffic safety issues and justified requests from the police, institutions, local government units, schools, associations of citizens (eg cycling association), etc. or
- the road authority is planning to reconstruct or rehabilitate the road in the near future, and the Inspection could identify specific needs related to traffic safety.

The concept of a targeted Inspection must not be confused with the concept of an in-depth analysis of traffic accidents!

5. PERFORMING INSPECTION

5.1 Participants in the process of Inspection and their role

The implementation algorithm of the Inspection procedure is shown in Figure 5.1, and in Table 5.1 detailed processes and operations are performed, which are carried out within the Inspection procedure.

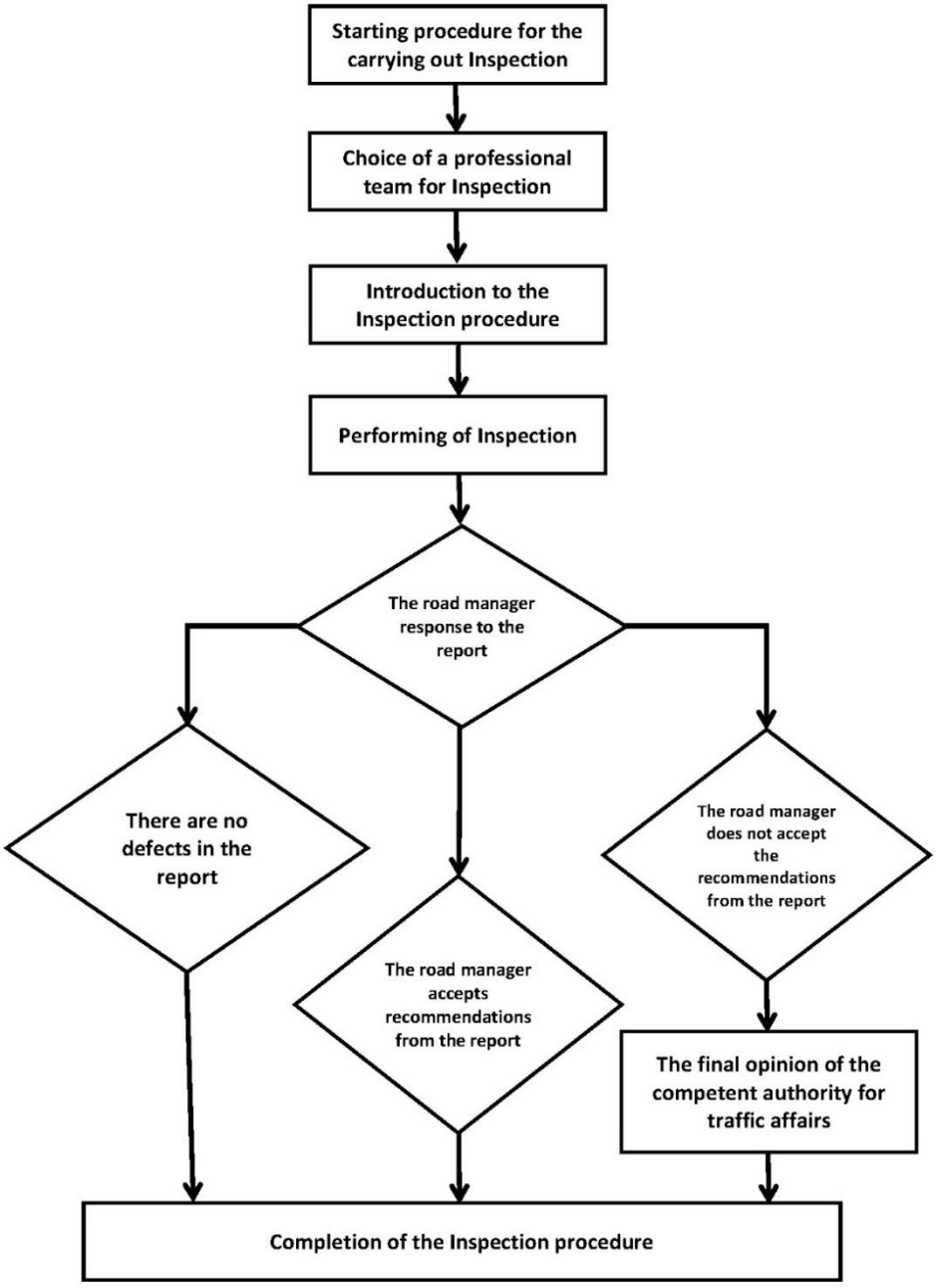

Figure 5.1 Algorithm for implementing the Inspection procedure

Table 5.1 Processes and works implemented within the Inspection process

Process	**Works that are carried out within the process**
Starting a procedure for the implementation of Inspection	The Public Road Authority prepares a "ToR for the Performance of Inspection" and Inspection Public Procurement Documents, for a specific project.
	Interested legal entities submit offers with the list and references of the team leader and team members of the expert team for Inspection. The team leader and team members of the expert team for Inspection also submit statements of independence declaring that they have not been involved in previous project development or road construction processes or in the maintenance process of the road that is the subject of the report.
	The public road authority selects a legal entity that will carry out the work of Inspection and an expert team for Inspection.
	After the public procurement procedure, the public road authority signs a contract with a legal entity that entrusts Inspection work in which the Inspectors - team members for the Inspection.
Introduction to the Inspection procedure	The road authority organizes an initial meeting with a selected Inspection expert team, which explains the subject of Inspection, the Inspection phase, the expected content of the report, and the dynamics of the implementation. The road authority hand over all technical documentation to the Inspection team leader (eg a project of a derived object), including reports on RSI in earlier periods (if any) and other documents relevant to Inspection.
Inspection	The expert team conducts Inspection and compiles the Report, which it delivers to the road authority.
The response of the Road Authority to	The Traffic Safety Sector (within the road authority) reviews the Inspection Report and submits it to the road maintenance sector and other sectors that are supposed to implement the recommendations.

the Report	The Traffic Safety Sector, based on the comments of the road maintenance sector and other sectors, writes an explanation and delivers it to the legal entity to whom it entrusted the works of Inspection.
Inspection team statement	The Inspection team analyzes the explanation of the road authority and writes own attitudes about accepting or not accepting the explanation of the road authority.
Implementation of the recommendations of the Inspection team	The road authority shall implement the recommendations he has accepted, that is, submit to the competent authority for traffic a report with recommendations he has not accepted and statements, for the final decision making. The road authority must initiate the procedure for remedying the deficiencies according to the accepted recommendations within 90 days from the date of receipt of the report (according to Article 89 of the Law on Roads).
The final opinion of the competent authority for traffic affairs	In case of unaccepting the recommendations of the Inspection team or the inability to follow the recommendations from the Report, the road authority is obliged to explain the eventual reason for not following the recommendation to the competent traffic authority (according to Article 89 of the Law on Roads) within 30 days of receiving the report. The competent authority for traffic affairs gives a final opinion on the explanation of the public road authority. The public road authority is obliged to act upon the final opinion of the competent traffic authority (according to Article 89 of the Law on Roads).

5.2 Phases of Road Safety Inspection

Road Safety Inspection includes the following steps:

1. Preparation work
2. Fieldwork inspection
3. Preparation of the RSI Report and announcement of the road authority
4. Conclusions - Implementation of accepted recommendations

5.2.1. Preparatory works

Before any Inspection, it is necessary to precisely specify the subject of the Inspection (start and end of the inspected section) and define the start time and end time of the inspection.

In the first step, you need to collect basic road information, road sections or intersection that are subject of the Inspection. As a rule, data on the start point and end point of the road section that is subject to Inspection is required, data on the road function and the importance of the road in the road network, data on the volume and structure of traffic on the road, on the project-technical elements of the road, on the previous road safety audits and the road safety inspection, about traffic accidents, etc.

In this phase, it should, if possible, answer the following questions:

a) in relation to the road function:
- What is the function of the road?
- Is the road going through the settlement?
- Are distance and local traffic mixing?

b) in relation to traffic on the road:
- What was the average annual daily traffic (AADT) on the road in the last 5 years?
- What is the forecasted of the traffic in the future?
- What is the structure of traffic on the road, and especially how much is the proportion of commercial vehicles?
- What is the proportion of transit and local traffic on the road?
- Is the transport of dangerous goods carried through the analyzed road?
- Is the school bus transported analyzed?
- Is there a vulnerable road user on the road (pedestrians, bicyclist, motorcyclists) and how much?
- Is there any movement of the vehicles of agricultural mechanization and other slow or special vehicles?
- With which roads intersecting the analyzed road and what are the intensity and structure of traffic on these roads?

c) in relation to the project-technical elements of the road:
- Are the existing project-technical elements of the road (width of the carriageway, cross slopes, the radius of the curves, guardrails, etc.) harmonized with the road function, traffic load, intersection types at one or more levels, speed limits, etc.
- Whether existing speed limits are appropriate to the road rang, cross-sectional road elements, the presence of vulnerable road users (especially children, old people, and disabled people), etc.

In the first stage of Inspection, it is necessary to dispose of appropriate technical documentation, maps, drafts, satellite or orthophotos. Method for determining location on the road should be defined already in this (first) phase of Inspection: based on the coordinates, according to the chainage or combined.

In this phase, data should also be collected and analyzed about:

- the most significant traffic violation in the analyzed section of the road,
- development plans and anticipated changes in the environment (eg foreseen changes along the road section such as new shopping centers, parking lots, gas stations ...) in the future,
- attitudes of participants in traffic on the risks of participation in traffic.

In this phase, data on traffic accidents on the observed section of the road are not collecting and analyzing!

In this (preparatory) phase, one or more team meetings are organized to determine the responsibilities and specific tasks of the individual team members. During the meeting, the inspectors harmonize the method of work, responsibilities, which equipment and means will be used, and check that the equipment and resources are ready for fieldwork. Also, a meeting should be organized with a client (road authority) in order to harmonize all open issues of RSI implementation. The road authority provides the necessary documentation, appropriate contacts and written certificates and authorizations necessary for the successful implementation of RSI.

5.2.2. Fieldwork inspection

In order to be effective and successful in the fieldwork, it is necessary, in the first phase of the Inspection, to collect plans, projects and appropriate graphical backgrounds, in order to, during the field inspection, also establish differences between the projected state and the actual situation on the field.

If there are quality preparation and data collection on the analyzed section, there will be a faster and more quality field inspection, processing of the results of the inspection, and preparation of the report.

During the field inspection, it is necessary, with a high degree of security of the inspector, to provide as soon as possible (as effectively as possible) and as less as possible to interrupting traffic flow:

- quality, videos with GPS data of the observed road section,
- quality, photographs with GPS data of the observed deficiencies on the road section,
- quality notes (audio or written record) with all the observations that the inspectors had at the field,

The first inspection is carried out from vehicles moving at the speed of the traffic flow, in daily conditions. In doing so, video recording is taken from the vehicle and getting video (movie) with GPS data. It is necessary to record in both directions and analyze both sides of the road and its environment.

The second inspection is carried out in such a way that the vehicle stops in all places where deficiencies are detected or the inspectors move on foot (if the stops are frequent and at a

short distance, for example in the settlement). In doing so, the inspectors analyze the observed deficiencies (eg sight distance on the approaches, the quality of the traffic signage and road marks, the environment of the road, etc.), discuss the deficiencies of the road and possible recommendations, write notes with observations and photograph the most important details.

The third inspection is carrying out at night. In some, special cases, additional fieldwork must be made (in the morning, in the evening, in the rain, etc.).

If the vehicle of the inspectors moves slower or often stops, all direction indicators and a well-detected yellow rotary light must be included on the vehicle. If the aforementioned measures for marking the vehicle of the inspectors are insufficient, the appropriate protection of the inspectors are provided by the official vehicles of the road maintenance service and/or the traffic police (for example, to inspection the sections of motorways, highways and other roads with high-speed traffic).

Inspector must take care of their safety: use clothes with well visible (fluorescent) surfaces, move next to the carriageway wherever possible, as short as possible be at the carriageway, etc.

Additional safety measures during the field inspection are usually required on highways, motorways and other high-speed roads. In some cases, temporary suspension of traffic may also be necessary, which is carried out in accordance with legal provisions. Warning signs may also be placed on the road that is the subject of the inspection and on the roads which intersect the analyzed road.

If there are intersections on the section of the road, it is necessary to examine the parts of the access roads, especially the mode of the give way regulating.

During the field inspection, the inspector must assign to the role of different types of participants in the traffic (passenger vehicle driver, truck driver, motorcycle, cyclist, pedestrian ...) so that he can understand traffic safety issues from the viewpoint of all participants in the traffic.

During the field inspection, the analysis should start with an overview of the environment. Local conditions and characteristics (rural environment, settlement or suburban area) need to be considered, to indicate what surrounds the road (forest, agriculture land, residential areas, etc., sunny side of the hill or shadow, proximity to the river, lake, brook, etc.).

Inspection must observe traffic conduction, identify and document (if any) all elements of the road and environment that can cause traffic accidents or may increase the consequences of an accident, in certain traffic conditions. For example, if the problem of speed is obvious on the road, it is desirable to measure the speed (eg, the hidden radar). If there are obvious improper behavior of traffic participants, it is necessary to determine why does it coming to that and if it is possible to record them (for example, frequently prohibited maneuvers).

At the beginning of the implementation of Directive 2008/96, Guidelines were drawn up in some countries that contained the checklists. The checklists were supposed to be just a reminder for the inspectors, in order to make it easier on the field, or not to forget some things to check. But over time, the Inspection in these countries has been reduced to

completing checklists without an innovative, exploratory and active approach to Inspection. Subsequently, in most countries, the checklists are removed from use (and from the Guidelines), and the Guidelines determine only the most important content of the Inspection report, as shown in Table 3.1.

Field inspections carried out by foot must be directed to identifying and documenting elements of the road and its environment that may negatively affect the occurrence and severity of traffic accidents, which could not be included in video recordings. It's specifically meant here on:

- depth and shape of the canal along the road, culverts and other elements of the drainage system,
- the slopes and height cut and fill slopes,
- condition and width of shoulders,
- the type and condition of guardrails,
- the sight distance at intersections,
- solid objects close to the road,
- traffic signs (visibility and retroreflection in the day and night conditions),
- road markings (visibility and retroreflection in day and night conditions, slipperiness),
- the existence of braking marks in front of sharp curves and in other similar places,
- traffic lights and other light-signaling devices on the road,
- illumination of the road, especially in the areas of intersections, pedestrian crossings, etc.
- road condition and road surfaces during rain, snow, fog, etc.

When inspecting the road, it is necessary to take into account the principles and rules of safety at work and to use appropriate safety, technical and measuring equipment.

Field inspection means and equipment

It is desirable that the inspectors use the following equipment during the field inspection:

- a protective suit that includes a protective (fluorescent) vest (summer), ie a jacket (winter) and a cap that, during the field inspection, must be worn in a way that the participants in the traffic can spot the inspector in a timely manner,
- measuring wheel, meter (it is optimal to be a carpet meter of length of 5 meters), a tape (from 25 to 50 m) and a cyclometer or a laser length device or some similar device for measuring the length,
- GPS device for fast positioning,
- 'Smartphone' or tablet,
- the level for measuring the cross slope and longitudinal slope of the carriageway,
- depth meter or other devices for measuring the depth of the track or impact holes on the carriageway,
- a gauge for measuring the diameter of the grain and the crack width at the carriageway,
- sprayer (spray) with white or yellow color, white chalk, and chalk-colored,

- maps, plans, orthophotos, analyzed sections of the road,
- digital camera with GPS coordinates,
- a video camera in a vehicle with georeferenced recordings (GPS),
- a well-detectable light that is mounted on a vehicle, with a rotating yellow light,
- dictation machine,
- stopwatch,
- drawing board or a similar background for drawing sketches and proceeding,
- videos from the road database
- longitudinal and cross-section profiles of the road from the database, etc.

The fact is that road safety inspectors with their well-visible, (fluorescent) clothes and field activities (recording, taking pictures, measurements, rotating lights...) are causing the attention of other traffic participants, local residents, maintenance services, traffic police, other passers-by, etc... For this reason, it is desirable that inspectors have a printed decision on the field, from authority or other documents of road authority that they have been selected and authorized to perform RSI in order to be able to present themselves.

Safety of the inspector during the conduct of the field inspection

In the case of a road with a low traffic load and low speeds on the road, for security is used:

- Measures for the personal safety of the inspectors (a retro-reflective vest or jacket, a cap, a hand-held battery, etc., which allows timely inspection of the inspectors on the road), and
- Measures for marking and securing the vehicle of the inspector (all direction indicators included, a well visible rotary light on the vehicle, safety triangle, etc.).

If it's about inspection of a high traffic intensity road or a road in which vehicles are moving at high speeds, additional safety measures should be made:

- Prepare a safety plan and coordinate it with the road authority and/or the traffic police,
- Inspectors must walk on the outside of the carriageway (where no traffic is taking place) or by car, along the edge of the carriageway, and the crossing over must be reduced to a minimum and very cautious,
- reduce the number of stops on the road, and remove the stopped vehicles from the carriageway, wherever possible,
- the detailed field inspection of the road (with stopping on the road) should be performed at the time of the least traffic load.

Traffic conditions

When determining and describing traffic conditions it is necessary to pay attention:

- general traffic conditions, and
- traffic conditions "from the user's perspective".

As part of determining general traffic conditions, it is necessary to carry out certain observations, sometimes counting traffic, and to record possible hazardous situations that can lead to traffic accidents.

Inspection by vehicle and the recording of a section by a video camera is done in both directions, and by foot are examined by some critical sites. At the intersection and interchange, inspection of all approach crossings and interchanges at connection should be performed.

As part of determining the traffic conditions from the user's point of view, the inspector is "put into the role" of one per one participant in traffic and analyzes the safety of traffic maneuvers performed by different road users (road crossing - like pedestrian, connecting from a secondary road - as a motor vehicle driver , cycling through the intersection - as a cyclist, sight distance - as a motorcycle, turning on and off from the gas station - as a driver, coming to/from the bus stop - as a bus traveler, etc.). All established facts inspector’s records (writes in notes and/or records on the dictaphone) and documents (videos and photos).

Among the most important parts of the field inspection, is the early detection of possible problematic spots on the roads and their exact positioning by different methods.

Determination of the location of critical spots on the road is carried out:

- from a video with GPS data,
- from photos with GPS data,
- by means of a kilometer mark and a measuring wheel or a laser gauge of length or
- using a special GPS device, etc.

Precise positioning of problematic spots is very important primarily due to the determination of appropriate measures for improving the state. The inspectors should specify as precisely as possible the places where some recommended measures from the Inspection report need to be implemented.

Deficiencies on the road

The task of the expert team for the road safety inspection is to identify all possible deficiencies along the road, which can directly or indirectly contribute to the occurrence of traffic accidents or affect the severity of the consequences of traffic accidents.

When looking for deficiencies, the expert team of the inspectors can use the directions listed in Table 3.1.

If there is a dilemma in deciding what is less, and more dangerous, it is possible (only after a field inspection!) to use data on traffic accidents in the analyzed section or location.

Inspectors should focus on detecting and explaining road safety problems on the observed section of the road. However, they will, as far as possible, on the basis of their analysis, provide recommendations for measures that could remove traffic safety problems on the observed section or reduce them. These recommendations are a component of the Inspection report that is delivered to the Client, or to the road authority. In some cases, the inspectors may provide more alternative recommendations and leave the possibility of

choice. Finally, in some cases, the inspectors cannot make recommendations, because generating and selecting promotion measures require more detailed analysis that is not covered by Inspection. In this case, the problems of traffic safety should be described in more detail, and the road authority should, in the following period, undertake further research and determine the optimal measures and manner of solving traffic safety problems.

5.2.3. Preparation of the Inspection Report and declaration of the road authority

The Inspection team prepares a report listing all identified defects and road errors and recommendations on measures to improve the situation. It is desirable that the measures are classified according to deadlines and importance (urgent, mid-term and long-term measures), relevance and types.

Inspectors separately write detailed notes with all observations from the field inspection. They update and complete these notes on the basis of an additional review of video and photographs from the field.

After a detailed discussion and matching of attitudes, one inspector (reporter) appointed by the team leader writes the Inspection working report. The Inspection working report includes textual explanations, photographs, and drawings that document the identified traffic safety issues, with clearer, brief explanations. It is very important for the inspectors to write all his findings in this working document (concept or draft report) and argue them with photographs and sketches. It is useful to keep this working report safe. It is not wrong if among the remarks there are those irregularities found later that they are not important and, ultimately, they do not enter the final report.

Inspector rapporteur sends a working report to the Inspection team leader, who reviews, updates, and sends it to other team members. All members of the RSI team write their comments and suggestions for improving the Inspection report. The team leader analyzes all the comments and writes an Inspection report to the client, or the road authority.

Working documents (notes, sketches, photographs, videos ...) are not an integral part of the report and remain in the inspectors archive, preferably in electronic form.

The Inspection Report must contain at least the parts defined in Article 17 of the Rulebook on the Implementation of Audit and Inspection and Establishing the Team of Experts for Audit and Inspection, and the following structure is proposed:

Cover page contains information on the road, road authority, the RSI team data (team leader and team members), unique document number, and status of the report (draft version/final version) as well.

Introductory part contains short data of procurement for road safety inspection (road authority, a method of service procurement, selected expert team, dates of procurement initiation, date of report submission), a detailed information of inspected road, road section or intersection, description of all changes and additions on road (“the road history”), information on time, weather and traffic conditions at the time of the field inspection and possible other specifics of inspection (participation of external associates, traffic police, representatives of local community, working zone during site visit, etc.).

Part A refers to preparatory actions and contains general data collected during preparatory actions in the office and a description of the activities carried out in the preparatory actions, as well as a list of all collected documents, on the basis of which preparatory actions were carried out. In this section are written the most important road data: road function, traffic conditions, design-technical elements, the environment around the road, etc.

Part B refers to the field inspection and describes the specific traffic safety deficiencies and specific potential traffic safety, and especially issues related to road maintenance (description and explanation of the problems) founded during the field inspection and assessment of the impact of these deficiencies on the road safety (risk assessment). This part also contains a completed examination or analysis form (tables) and documentation with drawings, or photographs. As a rule, Part B ends with a conclusion on findings ("Assessment of Deficiency ").

Specific traffic safety issues need to cover at least the problems which referring on road elements defined in Article 17 of Rulebook on Implementing Audit and Inspection and Establishing the Team of Experts for Audit and Inspection.

Part C contains recommendations - proposals for improvement measures, ie proposals for eliminating or reducing negative impact of identified problems (proposal description, photography or sketch of a solution example) with (at least an indicative) estimate of the cost of implementing the recommended measures. It is useful to systematize all measures for improving the situation:

- short-term measures (eg, cheap short-term measures that can be taken within the road maintenance),
- medium-term measures (eg, smaller investments such as setting up guardrails), and
- long-term measures that involve design, planning, and investment.

Estimating the costs for the execution of proposed variant measures is useful because in that case can be made the order for improving the existing situation, based on costs/benefits ratio. When proposing more complex (but still realistic) measures, the required time for implement of the proposed measures should be taken into account. In doing so, the inspector need to use his or her personal experience and expertise on good practice examples with consideration of local conditions. Estimating the cost of the proposed measures helps the road authority to prepare an investment plan for measures that will progressively improve the existing condition.

In this part of the RSI report, can be added an assessment of possible negative consequences of the proposed measures to some other type of traffic participant!

Summary and classification of recommendations The summary is a brief overview of the most important parts of the report, especially the deficiencies and recommendations noted. The summary should not be a repeat of the text already written in the preceding chapter of the Inspection report

Statement members of the expert team for performing the independent, expert and systematic Inspection

The statement should list all other external associates who participated in some parts of the audit (police, maintenance representative, local community representative, etc.), although they do not sign the statement.

Filled feedback form with identified potential problems and recommendations.

Appendix contains calculations (for example, sight distance, stopping distance, need for the introduction of a slow vehicle lane), maps, drawings and descriptions of the proposed measures and locations to be processed, photographs and other requested attachments, the purpose of which is to clarify some Inspection results and recommendations.

The appendix may also contain possible written opinions about some part of the road, intersections, pedestrian crossings ... from the police, local community, schools, owners of neighboring facilities, etc.

There are three ways to systematize the contents of the Inspection report:

- findings and recommendations can be systematized according to the type of problem by first analyzing the general problems pertaining to the entire section of the road, then analyzing individual problems related to the function of the road, alignment, intersection, vulnerable traffic participants, traffic signage (signs and markings on the carriageway), public lighting, the environment of the road, etc., or
- the report analyzes problems along the road (for example, according to the increase in chainage), by analyzing all problems at the beginning of the road, and then proceeding along the road by analyzing each location with all its deficiencies and recommendations for their elimination, and finally, the analysis ends at the end of the inspected road or
- Road authority may also require a combined procedure that would involve the use of both reporting method.

Although both methods are acceptable, the second method has proved more practical, and especially from the point of view of the road authority. The RSI procedure according to the second method describes the possible problems of the traffic participants in the order - by chainage and does not "jump" between certain locations with certain common characteristics. As a result, a larger number of EU countries envisage another the second method of reporting.

In the Inspection report, any defect (and related recommendations) are described separately, or specially. The inspectors must avoid connecting or compiling different defects (and related recommendations), because that may be unclear for the Client and the maintenance service (because some of them consider only one recommendation and the other neglecting).

The inspectors shall make an effort to eliminate any identified deficiencies on the road that affect the traffic safety. Even in rare cases, when the elimination of some defects is not feasible or the RSI team cannot give recommendations for improvement, such deficiencies should be specified in the report, but without recommendations for their removal.

The statements specified in the report must reflect the attitudes of the road safety inspectors as an experienced expert advisor. When preparing recommendations, it is necessary to propose solutions that are feasible and acceptable from the point of view of costs. In situations where there are several ways to overcome or reduce traffic safety issues, the RSI team should recommend more alternative measures and, if necessary, explain the advantages and disadvantages of each of the alternative recommendations. This can make it easier for the road authority to identify one of the recommendations and apply the selected measure.

Exceptionally, in cases where the Inspection team does not have enough information and cannot propose an improvement measure, it will use terms such as "need to be re-examined", "should be further investigated" and the like in its report.

However, the road authority should treat such terms as recommendations or part of the recommendations, in such cases. It is not desirable that the Inspection team often uses such terms, as this would indicate the professional inexperience or uncertainty of the inspectors, and such remarks, the road authority would not even take into account.

Declaration to Inspection report

The Inspection report is officially sent by Inspection team leader (to road authority) unless otherwise agreed.

The obligations of the road authority after receiving the official report are defined in Article 89 of Law the Roads.

The road authority analyzes the report, and in particular the recommendations from the report. In accordance with the possibilities, policies, and plans for the development of the road network, the road authority is advising on each recommendation individually. It is optimal if the Inspection report follows a separate table with a list of recommendations, to which the road authority entries his attitudes of accepting the recommendation.

The road authority could:

- Accept that there is a deficiency on the road, accept the recommendation and appoint the responsible persons for the implementation (individual or organizational sector) and deadlines,
- do not accept that there is a deficiency on the road and reject the recommendation and explain its attitudes,
- Accept that there is a problem, but reject the recommendation and explain its attitudes,
- Accept that there is a deficiency on the road, but reject the recommendation and suggest another, alternative measure (not given by the Inspection team),
- Accept that there is a deficiency on the road and accept one of the proposed alternative measures, explain its attitudes and determine the responsible persons for the implementation and deadlines.

A written response (clarification) of the road authority forms makes the component of the Inspection Report and is archived.

Final meeting

The final meeting between the road authority and the Inspection team is very important because the results of the inspection are discussed at that meeting. As a rule, the meeting is realized in the office of the Client, ie the road authority. It is useful if the representatives of the road maintenance sector are invited to the meeting (since most recommendations refer to the road maintenance), representatives of the road monitoring and traffic police, in whose jurisdiction belongs the analyzed road or road section.

At the final meeting, the Inspection team presents their report, and in particular clarifies the identified deficiencies and recommendations. The rest of the participants agree on how to implement the accepted recommendations.

5.2.4 Measures to improve road safety and monitoring the effects

After the implementation of the measures for improvement of the situation, it is desirable to perform assessments of the effects of the implemented measures. Such analyzes, as a rule, take place after a certain period of time after the application of the measures, when participants already get used to a new solution (eg after one year, and then again after three years from the implemented measure).

Such studies, as a rule, are ordered by the road authority, and they are entrusted to universities, that is, scientific-research institutions. These studies are performed independently, according to accepted scientific methods that give reliable conclusions about the overall effects of implemented measures.

Within these analyses, it is desirable to analyze the behavior of participants in traffic, traffic load, real speeds, and the environment, in view of the new conditions and circumstances.

These analyses are important because, based on them, the effects of individual measures can be assessed in some environment, and this is useful for us when performing other measures of this kind, in other locations.

Quality analyses of the effects of the implemented measures rely on appropriate databases (on traffic, on roads, on road objects, on accidents, on traffic safety performance indicators, etc.), or specifically ordered, targeted research.

6. TYPICAL TRAFFIC SAFETY DEFICIENCIES

6.1 General

This chapter does not have and could not describe all the factors of traffic accidents that may be related to the project-technical elements of the road, but focuses only on the basic characteristics of accidents that are characteristic for certain road and road section categories with an increased level of risk ("hazardous places "). Only the most significant deficiencies of the road and the environment of the road, which can decisively influence the number and consequences of traffic accidents.

A large amount of useful information, both for designers and for road safety inspectors, can be obtained from crash patterns analysis on different types of roads. A large number of different scientific research has been conducted in the past decades in the world, and their results have been published and used as a basis for Manuals and Guidelines for designing safer roads and improving the road safety. In addition, ongoing research also offers a good source of information about possible safety deficiencies and ways of improvement, even if those studies are not yet included in the relevant technical standards and specifications. The results of road safety inspection are used to propose effective measures to eliminate or reduce identified traffic safety problems.

Infrastructure solutions must provide all road users clear information on project-technical road elements, traffic signs, roadway markings, etc., and help them make the right decisions at any time. This means that during the design process and the road safety inspection process, the so-called "human factor" must always be considered in order to reduce the demands of the driver and thus eliminate the possibility of a driver "overloading" or a "dilemma" and ambiguity when using the road.
For example, the following situations must be avoided:

- sudden changes in speed limits on the road, i.e. excessive speed differences on adjacent road sections,
- longer sections that allow high-speed vehicles,
- large differences in the radius of adjacent curves,
- changes of the radius in the circular curves (compound curve),
- unnecessarily wide of the carriageway on road sections with low limited speeds (eg in the school zone or in the zone of settlements, etc.)
- huge differences in design characteristics and limitations for the different direction of movement
- other unpredictable situations.

It always should try to prevent the possibility of surprise and confusion, which means that the road must take into account the expectations and experience of the average driver. This requires a harmonized way of signaling on the road network and the use of similar solutions for similar situations (the concept of "self-explaining roads"). It is often very difficult to improve the state of the roads that were built long ago in the past and which cannot be compared with modern highways, or in whose environment a large number of objects of

attraction have been built, without adequate infrastructure (no parking, there are no acceleration/deceleration lanes, space for pedestrians and other vulnerable traffic participants, etc.). In such cases, a comprehensive improvement in the traffic safety situation would require new solutions with a completely new road, linked to high costs, and a long time for making changes. Since there are no realistic opportunities for this, it is necessary to implement some acceptable measures to improve existing solutions. However, in such cases, the Inspection team should clearly describe the problems of traffic safety and propose long-term, medium-term and short-term improvement measures. In this case, the road authority will take more care of the limitations and give acceptable declaration, explaining why a measure cannot be currently accepted.

6.2 Typical deficiencies

This chapter has no goal to replace comprehensive traffic safety analysis within Inspection, nor does it provide concrete solutions that are template-based. On the contrary, the following provides only a general approach to road safety inspection with all the necessary issues for Inspection and presenting only some typical examples of traffic safety issues related to typical risk situations.

Road function

One of the most important deficiencies described in the Inspection report relates to the road function, i.e. on the unclear undefined road function, the mixed road function or the non-compliance of the road function with the project-technical road elements.
For example, one of the first questions is: Is the road section part of the road out of the settlement or it is a city street. The biggest problems of traffic safety occur on the passage of state roads through settlements. In such cases, there are numerous traffic safety problems that are directly related to the road function.
If the road section is treated as a road outside the settlement, the requirements of long-distance traffic predominate, extreme speed limits (which would be suitable for the settlement) should be avoided, avoiding at-grade pedestrian crossing, avoiding traffic lights at the intersection, etc. On the other hand, due to the large, expected, exploitation speeds (especially in the long direction), special attention must be paid to the environment of the road, the guardrails next to the road, the treatment or protection of solid objects along the road, the slope of the embankment/cut, and other problems and measures of passive road safety.
If the road section is treated as a street in the settlement, then the viewpoint from which the road is analyzed is different. In this case, special attention is paid to vulnerable traffic participants, traffic calming, speed limitation, school zones, "zones 30", sidewalks or pedestrian paths, pedestrian crossings, bicycle infrastructure, etc. The boundaries of these two approaches should be clearly defined and supported by special traffic and construction-technical solutions ("gate" at the entrance to settlements and similar solutions).

The second common problem of the road function is the high traffic load and the mixed traffic flow structure in terms of vehicles (commercial vehicles, passenger vehicles, cyclists, etc.) and user requests (local traffic accepts low speeds, but long-distance traffic hardly accepts speed limits, difficult to accept restrictions on longer sections of the road). Such situations can be found on sections of roads through settlements, on the main urban roads, but also on some sections outside the settlement. On these sections, there are frequent conflicts with vulnerable road users, conflicts of slow and fast vehicles, etc. The reason is that the desire of transit traffic is to pass such a section as soon as possible, and on the other side there is a large number of pedestrians and/or bicyclists for which there is not enough crossings and enough longitudinal surfaces for pedestrian and cycling movement. Such deficiencies cause traffic accidents involving pedestrians and/or bicyclist.
Sometimes, general speed restrictions in settlements (50 km/h) do not provide enough level of traffic safety, at least not on the road section with a large number of pedestrians or cyclists on the road. Higher speed in populated places also poses a higher risk for the occurrence of traffic accidents. Crash energy to which the human body is exposed during a collision is proportional to the square of the velocity. Even small exceeding of the allowed speed (for example, for only 5 km/h), in some places, could significantly increase the risk of death of a pedestrian or cyclist. For example, at a collision speed of 30 km/h, the risk of fatal road deaths is about 10%, at a collision speed of 50 km/h, this risk is about 40%, and at a crash speed of 60 km/h the risk of death of pedestrians or cyclists grows to as much as 80%. Therefore, in these places, in some cases, it is necessary to apply construction-technical measures of traffic calming, which will ensure that all drivers (and not most drivers) reduce the speed of movement.
In some cases, there are no sidewalks, no pedestrian paths, and sometimes only partially (not in continuity) or are occupied by open stores, parked vehicles, restaurants, building materials, etc. In such cases, pedestrians are forced to move on the carriageway, which is very dangerous, especially if there are a lot of heavy vehicles in the traffic flow, in conditions of reduced visibility etc.

The risk of death or injuring of pedestrians and cyclists is particularly pronounced in areas where linear settlements along the state road are being used because of the exposure of pedestrians due to daily movements.

Alignment of the road

As a result of inspection, problems with the alignment of the existing road are often identified. In particular, it is necessary to check whether all sections of the inspected sections provide the necessary orientation, stop and overtaking distance, whether the radius of the curves are consistent with the speed limits and the real - expected speeds, whether the radius of the adjacent curves are significantly different, and whether in the circular curve of the road changes the radius of the curve.

In order to ensure road safety, the driver should, in due time, provide sufficient information on the road and what he expects in the continuation of his driving. This parameter is called *"Orientation Sight Distance"*. The required sight distance depends on the allowed, but also on the actual, exploitation speeds on the road.

Sight distance can be limited by horizontal curves, vertical curves, or surrounding vegetation or object by roads. Some typical horizontal road problems include: mismatch between the radius of successive curves that cause large differences in the limited speed, the use of small curves of radius on the high speed radius and the sudden change of the used elements of the road without a "gradual transition" and without compliance with the vertical alignment, the absence of the transverse curve after the direction, etc. Often we face with too many radius of vertical curves, the absence of a lane for overtaking on large longitudinal slopes, as well as with optical illusions (for example, "hidden-dips" or "hidden parts" of the road).

The consequences of these deficiencies could be frontal collisions or landing the vehicle from the curve.

Cross section

Frontal collisions can occur for various reasons, and in some cases, they can also contribute to the inadequate cross-section of the road. Frontal collisions outside the urban environment often end up with serious consequences, as vehicles move at high speeds.

Too wide two-way roads are disputable from the aspect of traffic safety, with both paved shoulders or edge lane, four-lane roads without a divided island, etc. In the first case, there are the abuse of asphalted shoulders and edge lane (vehicles are moving with high quality, asphalt shoulders or edge lane, leaving huge width of the carriageway that encourages high speeds and overtaking, as if it were a "three-lane" or "four-lane" road). In the second case, there may be an intentional or unintentional passage on the side of the road intended to drive from the opposite direction at high speeds. In both cases, there is a great danger of the occurrence of frontal collisions with severe consequences.

It is also dangerous if the cross section is too narrow, in short length, after long sections with the appropriate width of the roadway. In this case, it is difficult to pass by and overtakes pedestrians, bicycles or motorcycles. This is particularly dangerous if a large number of commercial vehicles are present.

When performing the road safety inspection, it is necessary to analyze the cross slopes of the carriageway, slope bench, and shoulders. The correct cross slopes of the carriageway should provide drainage of water from the carriageway to the edge of the carriageway, and the cross slopes of the shoulder further drain the water towards the slopes of the embankment. If the slopes of the carriageway are insufficient or the slope of the shoulder is opposite (according to the carriageway), water may be accumulated on the carriageway, which may cause to occur *aquaplaning,* and cause uncontrolled movement of the vehicle. The correct cross slopes of the carriageway in the curves (towards the center of the curve) should ensure that the vehicle passes through the curve, at higher speeds, without the risk of slipping. If these cross slopes are wrong or insufficient, and especially with sharp curves, it can surprise drivers and contribute to the slipping of the vehicle and get off the vehicle from the road.

Connections, intersections and interchanges

Some existing intersections were formed at a time when it was moving at low speeds and when there was a small intensity of traffic. With increasing speed and intensity of traffic, there was a need for better solutions in such locations. Intersections must, in due time, provide appropriate information for each road user in order to select and accept optimal decisions and safety traffic participation.

Some types of intersections can cause major problems. For example, the "Y" intersection can make it difficult to see traffic at intersections approaches, cause unclear situation about the priority of the passage, or cause wrong decisions and cause the occurrence of traffic accidents. Some intersections may be poorly shaped or poorly noticeable (due to vegetation or obstacles in the environment). In such cases, the Inspection team may recommend removal of vegetation, improvement of traffic signalization, reshaping the intersection in a circular or "T" intersection, changing the angle of intersecting (aiming at the right angle, i.e. angles of about 90 degrees), etc.

Another, very common, deficiency of intersections is the lack of a lane to turn left or inadequate width of the lane to turn left (for example, it does not correspond to the dimensions of heavy vehicles in the traffic flow), in situations where are intense left turns and/or where vehicles move at large speeds. The lack of the turning lane to the left increases the risk of rear-end crashes with vehicles that stand and are waiting to turn left or the risk of crashes a vehicle that turns left to the vehicle coming from the opposite direction and keeps the direction of movement.

In some cases, intersection as such are not timely visible to drivers, or sight distance is insufficient due to road equipment or vegetation in the surrounding area. In such cases, it is necessary to inspect whether there is a need for transformation or need for some other change.

A particular problem is the too large radius of the input/output curves (which allow for high turning speeds), objects in the triangle of sight distance, sharp angle of the road crossing (difficulty in examining the traffic situation, especially for older drivers), inadequate traffic timing plans (too long cycles exceed the patience of the participants in traffic and increase the number of offenders, in particular, pedestrians who do not respect the traffic light), traffic signaling at an intersection that cover by one to another or is sheltered by objects, a larger number of the traffic signs that increase workload at approach of intersection crossings, etc.

At pedestrian crossing points, the elements for securing a safe crossing of pedestrians must be a component of the technical solution. In the case of individual pedestrian crossings, and especially if pedestrian crossings are planned outside the settlement, it is not enough to announce the pedestrian crossing only with traffic signs, but additional technical and construction measures are needed (additional lighting of the carriageway, lighting of the pedestrian crossing, so-called "cat eyes" 'at the beginning of a pedestrian crossing, a vibrating lane, an elevation - ''lying policeman'' or dip of the carriageway, a platform, cross line on the carriageway, deflection, a narrowing of a carriageway, etc.). In the settlements, sometimes, in the zone of pedestrian crossings, the pedestrian fences should be set up so

that pedestrians would channelize themselves to cross the carriageway at that place and in the proper way.

On the existing road network, serious safety problems can often be identified due to frequent legal or illegal approaches. If this is established during the road safety inspection, the Report must include suggestions for improving the situation: closing or legalizing illegal approaches, connecting multiple approaches to one, driving traffic from multiple connections to a regular intersection, the traffic-technical arrangement of connections, etc. In the case of illegal approaches, a method should be checked to prevent vehicles from coming out of these approaches. In the case of approaches from agricultural land, it is necessary to construct appropriate gravel road, etc.

Particular attention should be paid to the intersection of the road and railroad in level. Some existing railroad crossing were formed at a time when vehicles and trains were moving at low speeds and when there was a small intensity of traffic. With increasing speed and intensity of traffic, there was a need for better solutions in such locations.

Some railroad crossing at the level cause major problems, primarily due to the irregular angle of crossing, poor sight distance (due to vegetation or other obstacles in the environment), inadequate safety of the crossing, malfunction of the security device, etc.

Recommendation for the solution can include removing vegetation, improving traffic signage and road equipment, changing the angle of crossing, etc. Under the "Improvement of Traffic Signage and Road Equipment", it is primarily intended for the placement of two blinking red lights (VI-9) to mark the railroad crossing at the level and the placement of bumper or semi-bumper at railroad crossing.

Public and private services, rest areas and public transport

In order to provide drivers with a break while driving (primarily professional drivers), the sufficient number of the rest area needs to be provided. Very often the number and size of these rest area do not correspond to real needs on the road. If the rest areas are located on open road sections, outside the settlement (or in the urban area with high-speed limit), it is necessary to carefully design the exits/entry (if required, request the construction of an acceleration/deceleration lane), in order to reduce the possibility of conflict between traffic on the road and users of the rest area. Otherwise, there may be the rear-end crashes like or side crashes.

Bus-stops should be carefully performed (on the carriageway, along the carriageway, along the carriageway with a divided island, outside the carriageway), and pay due attention to the pedestrian guidance along the road (sidewalks, pedestrian paths or on the edge of the carriageway) and pedestrian crossings in the bus-stop zone. If there are no implemented measures for safe pedestrian guidance, it could cause traffic accidents with pedestrians.

Vulnerable road users (pedestrians, cyclists and motorcyclists)

One of the tasks of an inspection is to identify safety issues related to vulnerable road users. These problems are especially frequent on the passage of the state roads through the settlements, but also outside the settlement, if there is an expressed need for pedestrian movement along the road or for crossing the road.

Common deficiencies in relation to vulnerable road users are the lack of surfaces for pedestrians and/or cyclists or insufficiently safe pedestrian/bicycle crossings. Although the appropriate speed limits signs are set at these places, the actual speeds are much higher, because the project-technical elements of the road (for example, the too wide the carriageway) "*invite*" drivers to drive at higher speeds *("the road provoking high speeds")*.

Motorcyclists, moped and scooter drivers ("powered two-wheelers - PTW") belong to a group of vulnerable road users. This is proved primarily by "black statistics" in many countries, both in Europe and elsewhere in the world. This was also established by the European Commission, so in the revised version of the Directive among vulnerable road users, motorcyclists.

The Inspection team needs to be aware of the fact that certain design and technical elements that are not dangerous for the driver of a passenger vehicle can be a major safety problem for motorcyclists, and the same applies to road equipment and the environment. Some locations, environments and road equipment can be highlighted that could be dangerous for power two-wheelers.

Most dangerous places for motorcyclists and mopedists are:

- compound curve (when the curve of a relatively large radius turns into a curve with a smaller radius)
- the long curves of relatively large radius,
- the horizontal curves of a relatively small radius that coincides with the middle of the convex rounding of the vertical curve, and
- the situation when after the long straight direction follow the curve with a small radius.

The most dangerous environment and road equipment are:

- pillar of the traffic signs (eg III-63 and III-64) without a guardrail,
- unprotected sharp, cut slopes,
- trees, and other solid objects at a short distance from the edge of the road,
- Inadequately determined - raised or lowered shoulder ("tooth") or insufficiently wide of shoulder,
- a combination of the horizontal curve and vertical convex curve (which causes that the road "disappear"),
- inadequate elements of longitudinal drainage (which can be dangerous for all other traffic participants), and especially unprotected concrete culvert on the access roads,
- openings in guardrails (or walls) (so-called "windows"), and

- short guardrails without the adequate start-end element.

It is desirable that the road safety inspection of the road section, where at the summer months (June-September) in the structure of the traffic flow, a greater percentage of motorcyclists is carried out by the inspectors who is also a motorcyclist.

Traffic signage

Typical deficiencies are the lack of or incomplete traffic signs, too many traffic signs in some place with too much information, and therefore they overloaded drivers and because do not perform the right role.

Traffic signs must provide to the driver all necessary information about the intersection, location, hazards, road, number of kilometers to the desired destination, street names, etc. Traffic signs must be clear, understandable and well visible, and both at daytime and at night. The signs must have a prescribed level of retroreflection.

Another common problem is the lack of signs for traffic guidance or that these signs are not clear or unreadable.

Marks on the carriageway must be clear, understandable and visible, at both day and night. They must have a prescribed level of retroreflection. The carriageway marks must have the prescribed roughness. Traffic signs and road mark must not be in mutual contradiction.

Lighting

Public lighting is an important element to be inspected, especially in urban areas, in the intersection zone, pedestrian crossings and other similar places of increased risk. In order to ensure the safety traffic in night conditions of great significance is the appropriate lighting, especially on independent (isolated) pedestrian crossings and at intersections. Typical disadvantages are: there is no illumination at critical points (pedestrian crossings, risk intersections, car exits from large attractions object, etc.), illumination is poor (a great distance between lighting poles, high-mounted bulbs, light-covering of vegetation, low light bulbs, etc.), some light bulbs do not work, poles of illumination far away from the carriageway, bulbs are wrongly oriented, bulbs in the tunnel just on one side of the carriageway, well illuminated the carriageway on the pedestrian crossing, but not approaching the pedestrian crossing, underground pedestrian pass and are not exposed or lights do not work and so on.

Road environment and object on the road

Roadside barriers could cause incomparably greater consequences of accidents than if there are no such obstacles, especially on roads outside the settlement, and on the road sections with high real speeds of the vehicle. Dangers such as poles, solid objects, walls and trees that "do not forgive driver errors" can significantly increase the consequences of landing the vehicle from the road. By landing the vehicle from the carriageway could come for several reasons: drivers can fall asleep while driving, can react wrongly when avoiding a frontal

collision or accident with animals on the road, etc. Roadside barriers can suddenly change a dangerous situation to a traffic accident with severe consequences.

On roads out of the settlement or on highway sections at high real speeds, solid objects which are too close to the road represent a serious safety problem. Therefore, solid objects that are too close to the road should: remove, move away from the road, protect by the guardrails, etc. or replace them with passive safe elements that have the same purpose. In most cases, such objects could not be removed for legal and other reasons (cultural or natural wealth, greenery, costly demolition or relocation, etc.), despite the fact that they are an obvious danger. In these cases, these objects must be protected by the guardrails, and etc.

Although in the past, such objects were often the cause of traffic accidents with dead or seriously injured persons, there is still little work on their removal, relocation or protection.

The most common defects on the roads are: in the immediate vicinity of the road there are unprotected, solid objects, there are no protective fences on the parts of the road where their installation is necessary (high and steep embankments, solid objects near the road where high exploitation speeds, etc.), '' windows '' in fences, there are fences, but they are of inadequate degree of protection, the ends of the fences are unsafe - without adequate safe endings or initial-finishing structures, the fences do not have an additional lamella to protect motorcyclists in places where there are many motorcycles what, there are no pedestrian fences (especially on bridges and overpasses) etc.

Work Zone (temporary signage in the area of works)

The biggest traffic flow disturbances occur in work areas, especially if it is necessary that vehicles from opposite directions alternately use the same traffic surface. Therefore, it is necessary to inspect the traffic signage in the work area in detail

The most common mistakes that occur in work zones are:

- the works zone is not announced in a timely manner, so requires rapid deceleration and other maneuvers,

- the distance from the first traffic sign "work on the road" (I-19) to the narrowing area is less than the minimum prescribed for the concrete road rang (1200 m for motorways, 800 m for other roads and 50 m for streets in the settlement) ie less than the minimum that allows safe adjustment of driving modes, in given road conditions and environment,

- it is envisaged that vehicles from the driving lane on the highway are directed to the overtaking lane, instead of first directing the vehicles from the fast lane to the slower lane, and then they lead together in the work area.

- temporary traffic signage does not have adequate retroreflection, so it is not well visible in conditions of reduced visibility,

- there are '' regular '' traffic signs and marks that confuse drivers,

- traffic management is unclear, and the risk of some drivers misinterpreting the correct paths, causing conflicts and traffic accidents,

- in the work area, speed limits are provided which do not ensure safe traffic flow in the work area, because the available widths of the driving lanes are insufficient or the protective belt is narrow,

- the width of the traffic lane in the area of narrowing is lower than the minimum (2,5 m), or less than the necessary width for the expected traffic structure,

- no minimum protection width between traffic and work area is foreseen,

- A one-off suddenly (high) speed reduction (eg from 80 km/h to 40 km/h) is envisaged, instead of a gradual reduction in two or three steps (eg from 80 km/h to 60 km/h, and then at 40 km/h).

Bridges and tunnels

The most common mistakes in bridges and tunnels are: the change in the dimensions of the cross-section profile (narrowing), the elimination or narrowing of the pedestrian infrastructure on bridges and tunnels (interruption of the sidewalk or pedestrian paths, narrowing of the sidewalk, etc.), unprotected solid elements of the road at the entrance to tunnel or bridge access, lack of lighting or poor lighting in the tunnel, equal intensity of daylight and night in the tunnel ("overlighting" at night), lack of guardrails of the appropriate level of protection on the bridge, dangerous and unprotected tunnel stop areas (niches with sharp walls at right angles to the carriageway), etc.

Other elements (parking, participation of heavy vehicles, blindness, activities at the road, its equipment, flora and fauna in the road zone, school zone, etc)

The most common disadvantages are (un)regulated stops and parking on the carriageway and by the side of the road, the areas for stopping/parking are below the level of the carriageway, the width of the stopping surfaces is insufficient, and the vehicles are part of the width on the carriageway, heavy vehicles pass through the core of the settlement, there are lights that blaze traffic participants, besides the road there is (un)legal sale of agricultural and other products, ITS equipment is not installed or functioning, no areas are maintained along the road, vegetation restricts sight distance, there are daily movements of animals across the road, and if this is not regulated or the drivers are not informed about it, there are schools and other objects of attraction, and that the zones of these objects are not properly arranged, etc.

6.3 Reducing the risk of traffic accidents after the implementation of certain measures

For each type of measure to improve traffic safety, it is necessary to know the effect of its operation (the potential for reducing the number of traffic accidents and the death or injured persons).

Therefore, the following (table 6.1) presents possible measures for elimination of typical road deficiencies, as well as an assessment of the potential decrease in the number of traffic accidents due to implemented measures.

The last column in the table is derived from the results of various international research (primarily Rune Elvik) and could be used to better understand the effects of different measures.

Table 6.1 Efficiency (reducing the number of accidents) of various measures to improve traffic safety (Source: Rune Elvik & Truls Vaa, The handbook of Road safety measures, Elsevier, 2006)

Typical deficiency	Possible measure	Possible reduction of number of traffic accidents [%]
Project - technical elements		
Use of dangerous elements	Improve elements	19-33
Insufficient number of traffic lanes	Increase the number of traffic lanes	22-32
Traffic lanes of insufficient width	Extend the lane by 0.3 - 0.6 m	5-12
There is no edge lane or edge lane is insufficient width	Extend edge lane to 0.3 - 1.0 m	4-12
There are no central dividing island	Construct the central dividing island	40
The road on the bridge is insufficient width	Expand or re-design the bridge	25
Shoulders are insufficient width	Expand the shoulders	10
Missing the lane for overtaking	Construct the lane for overtaking	20
There is no special lane for the right turning at the intersection	Add a special lane for the right turning	40
There is a special lane for the left turning at the intersection	Add a special lane for the left turning	15
Missing pedestrian overpass	Construct the overpass for pedestrians	10
Steep slope of the embankment	Alleviate slope of the embankment from 2:1 to 4:1...7:1 or more	6 ... 15
	Alleviate slope of the embankment from 4:1 to 5:1...7:1 or more	3 ... 11
There is no service road that would reduce the number of connections to the main road	Construct the service road	20 - 40
Excessive driving speeds	Perform measures for traffic calming	12 - 60
	Reduce the speed limits from 70 km/h to 50 km/h	10 - 30
	Reduce the speed limits from 90 km/h to 60 km/h	17 - 40
Horizontal alignment		

Dangerous road elements	Improve horizontal elements	20 - 80
Sharp curves with small radius	The larger radius of curve	33 - 50
Vertical alignment		
Too low radius of convex vertical curves	Change the longitudinal slope / eliminate the small radius of the convex vertical curve	12 - 56
There is no cross slope in the curve	Perform an adequate cross slope in the curve	50
There is no lane for overtaking	Construct lane for overtaking	11 - 43
There is no lane for slow vehicles	Perform lane for slow vehicle	10 - 40
Cross section		
Too narrow traffic lane	Expand the lane	12 - 47
Insufficient adhesion of the carriageway	Improve adhesion of the carriageway	18 - 74
To narrow shoulder	Expand the shoulder	10 - 40
Undetermined shoulders	Determine shoulder	22 - 50
To narrow edge lane	Expand edge lane	13 - 44
Intersections		
Irregular angle of intersection	Ensure the right angle of intersecting	40 - 95
Dangerous "Y" intersection	Transform to "T" intersection (or roundabout)	15 - 50
Dangerous left turn at the traffic light intersection	Perform special traffic light phases for left turns	45
A dangerous intersection, in which traffic is guidance only by traffic signs	Transform into the roundabout	25 - 81
A dangerous intersection, in which traffic is guidance by traffic lights	Transform into the roundabout	25 - 50
A dangerous small intersection	Transform into the mini roundabout	40 - 47
No special lanes for turning	Perform special lanes for turning	10 - 60
Lack of the grade islands	Perform the grade islands	39
No protection element (grade islands) for turning	Perform the protective element (grade island) for left turns in the urban environment	30
	Perform the protective element (grade island) for turning in the urban environment	45
Too narrow approach road at the intersection	Additional lane at the intersection	20
Insufficient adhesion of the carriageway at the intersection	Improve adhesion of the carriageway	20
Driving through the red light at the traffic lights	Set up cameras to record driving through the red light	10
Poor police control of respecting the traffic regulations	Improve police controls	7 - 25
Traffic management scheme		
Lack of traffic signs at the intersection	Post appropriate traffic signs	22-48
Lack of information traffic signs in front of the intersection	Post information traffic signs in front of the intersection	14 - 58
Lack of traffic signs on the portals above the carriageway	Post the traffic signs on the portals above the carriageway	15
Lack of traffic signs along the edge of the carriageway	Post the traffic signs along the edge of the carriageway	19 - 24
Low visible traffic signs, longitudinal and cross marks on the road	Make traffic signs, longitudinal and cross marks on the road more visible	24 - 92

Lack of traffic signs and equipment for direction (guidance) the traffic flow	Post the traffic signs and equipment for direction (guidance) the traffic flow	29 - 37
Lack of traffic signs for dangerous curves and/or double curves	Post the traffic signs for dangerous curves and/or double curves	20 - 57
Lack of traffic sign for mandatory stop (II-2)	Post the traffic sign for mandatory stop	47
Lack of traffic sign for speed limit	Post the traffic sign for speed limit	23 - 36
Lack of traffic warning signs, explicit orders, and information sign	Post the traffic warning signs, explicit orders, and information sign	20
Exceeding speed	Change speed limits, and post appropriate traffic sign for speed limit	16 - 19
Lack of a traffic sign for the give way	Post the traffic sign for the give way	59 - 80
Lack of traffic sign for mandatory stop	Post the traffic sign for mandatory stop	33 - 90
Uncontrolled/dangerous traffic situations	Post traffic light at the intersection	15 - 32
Inadequate traffic light program	Do the appropriate traffic light program	13 - 85
Intersection without measures for channelizing the traffic flows	Implement measures for channeling traffic flows	10 - 51
Parking next to the carriageway	Remove parked vehicle next to the carriageway	10 - 25
Visibility and sight distance		
Low visible longitudinal and transverse marks on the road or missing	Renew longitudinal and transverse marks on the road	14 - 19
Low visible edge line or missing	Renew edge lines	8 - 35
Low visible transverse markings for marking places where a lower limited speed is prescribed or they are missing	Renew transverse markings to indicate places where a lower speed limit is prescribed	24 - 52
Lack of platforms (grade) retroreflecting markings of the carriageway	Apply platforms (grade) retroreflecting markings of the carriageway	6 - 18
Lack of "barriers" (IX-7)	Post "barriers" (IX-7)	2 - 47
Lack of yellow warning flashing lights on the edge of the carriageway to mark dangerous locations	Post yellow warning flashing lights on the edge of the carriageway to mark dangerous locations	5 - 75
Lack of road lighting	Post road lighting	6 - 75
Insufficient sight distance	Ensure sight distance	28
Lack of measures for channelizing traffic flows straight, left, and right	Implement measures for channeling traffic flows	22 - 50
Reducing the consequences of crashes		
Lack of dividing guardrails	Post the guardrails	14 - 27
Lack of edge guardrails	Post the edge guardrails	15 - 60
The existence of stiff construction (pillars)	Change stiff construction with deformable elements	30
Solid object by the road (trees)	Remove the trees from the road	10
Stiff objects (pillars) by the road	Move away the pillars in the settlement	20
No crash absorber	Post the crash absorber	20
Pedestrian infrastructure		
Lack of pedestrian infrastructure	Perform pedestrian infrastructure	33 - 44
Lack of marked pedestrian crossings	Perform marked pedestrian crossings	5 - 50
Lack of grade pedestrian crossings on a trapezoidal platform	Perform grade pedestrian crossings on a trapezoidal platform	5 - 50
Lack of traffic light pedestrian crossings	Perform traffic light pedestrian crossings	21 - 83
Lack of pedestrian protection fences	Perform pedestrian protection fences	10 - 35
Bicycle infrastructure		
Lack of bicycle infrastructure	Construct the bicycle infrastructure	35 - 56

Lack of the bicycle crossing over the carriageway	Set a traffic light for bicycle crossing across the carriageway	10 - 15
Lack of additional continue stopping line for cyclists ("bike-box")	Mark additional continue stopping line for cyclists ("bike-box")	35
Railroad crossing at grade		
Lack of two blinking red lights (VI-9) to mark the railroad crossing at grade	Post the blinking red lights	73 - 91
Lack of bumpers or semi-bumpers	Post the bumpers or semi-bumpers	81 - 93
Traffic calming		
Lack of traffic calming zone (30 km/h)	Perform measures for traffic calming (artificial barriers, platforms, deflection, etc.)	10 - 80
Lack of vibration marks or depressions	Perform the vibration marks or depressions	27 - 50

Notes:

- Table 6.1 DO NOT CONTAIN all possible road deficiencies, nor any possible measures to improve traffic safety.
- Reducing the number of accidents DEPENDS ON COUNTRIES TO COUNTRY. Table 6.1 lists only general values that cannot be guaranteed.
- Reduction of accidents is LOWER IN COUNTRIES WITH HIGHER LEVEL OF TRAFFIC SAFETY and vice versa.
- Reduction of the number of accidents does NOT ADD UP if several measures are proposed for a specific location but should be counted on reduction after taking the most effective measure (maximum reduction) or more measures to treat as dependent variables.
- Reduction in the number of accidents at intersections refers to ALL REDUCTIONS IN A SOME INTERSECTION, where measures have been taken.

7. APPROXIMATE VALUES OF FEES FOR INSPECTION CONDUCTING[4]

The costs of an inspection include the review of previous audit and inspection reports, review of other relevant documents for subject road or section, field review in daytime and night time conditions, writing an inspection report, writing the minutes from the meetings held during the inspection, submitting all materials generated during the inspection, and realization of the other tasks related to inspection work.

The price from the above paragraph includes the all necessary elements for carrying out of inspection and cannot be subsequently increased unless otherwise agreed with the road authority (eg travel expenses, participation in meetings during the inspection, participation in the final meeting, etc.)

The cost of inspection is expressed in the form of points.

The cost, as a rule, is calculated per kilometer of the road for which the inspection is carried out.

Basic price of inspection is 250 points/km.

The base price may be affected by the category of the road, the length of the road, the number and type of intersections, the complexity of conditions on and around the road, etc. The price is determined by the formula:

$C = N \times O_c \times F_{kp} \times F_{dp} \times F_{br} \times F_{tr} \times F_{ds} \times \ldots$

Where are:

- N – road length in kilometers,
- O_c – basic cost per linear road kilometer,
- F_{kp} – road category factor (from 1,0 to 1,2),
- F_{dp} – road (road section) length factor (from 0,8 to 1,0),
- F_{br} – intersection density factor (the price increases with the increase of number of intersections or the prices are added for individual inspections for intersections),
- F_{tr} – intersection type factor (depending on the type or complexity of the intersection),
- F_{ds} – additional roadside facilities factor.

At this price can be added the prices of individual inspection of intersections and facilities along the road, or multiply the base price with the appropriate factor.

Road category	class IA	class IB	class IIA	class IIB
$\mathbf{F_{kp}}$	1,2	1,0	1,1	1,1

Note: IA column – calculation is made for both carriageways.

[4] The authors of the proposal believe that the prices of the implementation of the inspection should not be an integral part of these guidelines, but can be adopted as a separate document, in the form of recommendation, and each specific case requires a professional analysis of the scope, type and inspection tasks specificities.

Length of the road (km)	0-5	5-10	10-20	20-50	>50
F_{dp}	1,00	0,95	0,9	0,85	0,8

The density of the intersection (intersections/km)	0-5	6-10	11-30	31-50	>50
F_{br}	1,00	1,2	1,3	1,4	1,5 – 2,0

The intersection type factor varies from 1.0 to 1.2, depending on the complexity of the intersection, the number of the accesses, the presence of bicycle and pedestrian infrastructure, etc.

The factor of additional content alongside the road ranges from 1.0 to 1.2, and depending on the frequency and complexity of the content by the road (parking lots, public transport stops, schools, restaurants, and other objects attractions, etc.)

The cost of inspection is different for individual objects and individual connections on the road when the audit is performed individually for them. The cost of the inspection of the individual connection is calculated as the triple basic price per kilometer.

The cost of the inspection of a road object, depending on the type of facility and the complexity of the work, is:

- 3-5 times higher than the basic price for object whose length is the between 15m and 49m,
- 5-7 times higher than the basic price for facilities between 50m and 149m, and
- 7-15 times higher than the basic price for facilities between 150 and 499m.

The price for inspection of at-grade intersection, when it is done as a single object, is 2-5 times higher than the base price for the kilometer of the road in case that the number of approaching legs is less than or equal to 4, and if the number of approaching legs is greater than 4 than the price is higher for 3-10 times from basic price per kilometer.

The price of the inspection of the roundabout is 5-10 times higher than the basic price per kilometer.
The price of the intersection in grade is 10-20 times higher than the basic price per kilometer.

If the Client of the inspection has requested that external associates specializing in specific areas participate in the expert team, the inspection price is additionally increased.

The Client of inspection, in each individual case, depending on the complexity of the work, define the cost of the audit that may deviate from the above recommendations.

Literature

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