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Professional paper

Night Road Safety Inspection

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Abstract – **Europe has committed to reduce the number of serious road traffic accidents. This requires building a safe infrastructure. Safety inspections are used to measure and increase the road safety. To fulfil the stated goals, the safety inspection must also be carried out at night, when specific road defects are encountered.**

Keywords – **Night Safety Inspection, Safety Defects, Road lighting, Traffic accidents.**

I. Introduction

Nowadays, not only in the European Union countries, a policy of gradual reduction of the serious traffic accidents (with fatal and serious injury) is applied. In some countries, the efforts are being made not only to reduce the occurrence of these accidents but also to eliminate them altogether (Vision Zero, etc.) [1]. To achieve this goal, the development in the area of all the basic pillars influencing the incidence of traffic accidents (human, vehicle, infrastructure) is necessary. The biggest shift today can be seen in the development of active and passive safety of vehicles. There are significant gaps in the driver education, where the situation in the Czech Republic cannot be considered ideal. However, there has been a positive trend in introduction of new teaching practices of novice drivers, and at the same time, introduction and development of new awareness campaigns.

However, it is also necessary to focus also on the road itself, which has a significant impact on the occurrence of traffic accidents and the behavior of road users. In order achieve safe roads, we must ensure that the road fulfil two basic rules – it must be self-explanatory and forgiving. One of the tools for assessing the level of safety of the road network is the Road Safety Inspection (RSI). This is the most commonly used tool for the assessing of safety on the existing road network. It is nowadays also integrated into practice through legislation in many European countries and most road managers already use this tool routinely.

Until now, the RSI was carried out during the day in normal visibility. However, in order to cover and identify all the potential risks, it is necessary to broaden the RSI even to the times of reduced visibility, when new defects and risks, that do not affect the road users in normal traffic, or do not appear at all in daytime, may appear.

Currently, a pilot project of inspection in times of reduced visibility, the so-called Night Road Safety Inspection (NRSI) [3], is already being implemented on selected primary roads in the Pilsen Region. It is also assumed that by 2025 the legislation will mandate night-time inspections on the entire TEN-T (Trans-European Transport Network) together with the classical safety inspection.

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II. Current Status

In the Czech Republic, there is a legal obligation to carry out the RSI on the TEN-T road network (Fig. 1) every 5 years [4]. Outside the TEN-T network, safety inspection is not mandatory but strongly recommended. Within the Czech Republic, the RSI is also carried out outside this network, specifically on a large part of the primary roads.

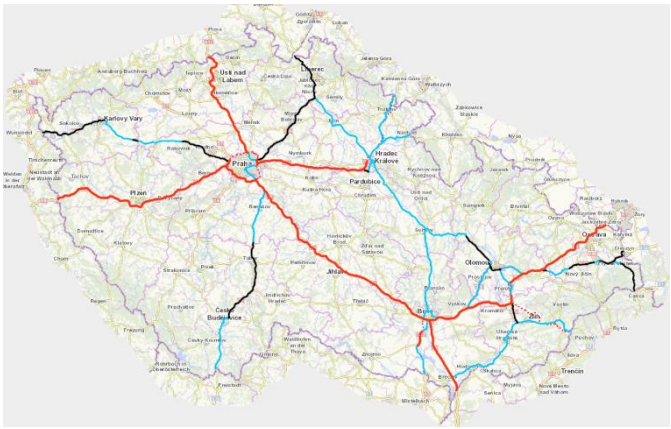

Fig. 1. Road network included in the TEN-T network [5]

The RSI is a proactive tool (aims to prevent accidents) that tries to identify the road safety defects. These defects may play a role in the incidence of a traffic accident or worsen its consequences. These defects are risk-rated in the inspection, where a three-scale scale is used in the Czech Republic. Together with the identification and assignment of risk, appropriate remedial action is recommended to the road manager or administrator for each defect.

Currently, the identified safety defects are being removed in two ways. Most common is implementation of remedial measures during the regular reconstructions of the section of road. The second is independently by teams appointed by the road manager to eliminate these safety defects. In order to effectively improve the level of road safety, the identified safety defects are usually prioritized by the corresponding risks. Therefore, the most usual approach by most road managers in the Czech Republic is focus on defects from the riskiest to the least risky ones. From this point of view, the current development can be considered positive.

Still, it is important to note that regardless of the type of the road to which the inspection is applied, it is always a safety inspection carried out during the day under standard visibility conditions. An average day of the whole year contains half of the time in reduced visibility conditions (night, fog, dusk, etc.) which significantly change not only the behavior of the road users but also their ability to perceive and distinguish

elements on the road. Carrying out an inspection only during daylight hours will not ensure that all defects and risks on the road are identified, as they may only occur in reduced visibility.

The current methodology for carrying out RSI does state that they should be carried out outside good visibility, but it does not describe in detail what exactly should be monitored and how this should be done. However, this changed in 2020 when a new methodology came into place describing how NRSI should be carried out.

III. Night Safety Inspection

Driving in the traffic area in low visibility, especially at night, is different primary due to the reduced sight distance. In general, the ability to distinguish objects, but also the speed of their perception, depends on the level of illumination and on the contrast of the perceived elements. In order to create a safe road, it is therefore necessary to focus primarily on controlling the sufficient perceptibility of the objects forming the road (fixed obstacles, junctions, crossings, etc.), the light technical characteristics of traffic signs and the correct illumination of the traffic space in the built-up area [3][7].

Before a NRSI can be carried out, it is necessary to carry out a conventional safety inspection during the day. This is for the auditor to ascertain the particular characteristics of the area and the behavior of drivers on the road. At present, the inspection team from the Department of Forensic Experts in Transportation, Faculty of Transport of the Czech Technical University has been working on a pilot project of NRSIs. It took place in the Pilsen Region on selected primary roads. These are roads where regular RSI was already implemented by the same team in 2019 [9].

In this project, a total of four primary roads (I/19, I/20, I/26, I/27) with a total length of 213 km in the Pilsen Region were inspected [2][5][9]. The selected road sections had a different traffic characteristic which included not only the built-up areas but also the rural area. A total of 205 safety defects were identified on the road under the reduced visibility (Fig. 2). The low-risk defects were the most common (71.2%), followed by the medium-risk defects occurring in 28.8% of cases. The high-risk defects were not observed. The night-time defects were divided into 6 categories and a total of 14 types.

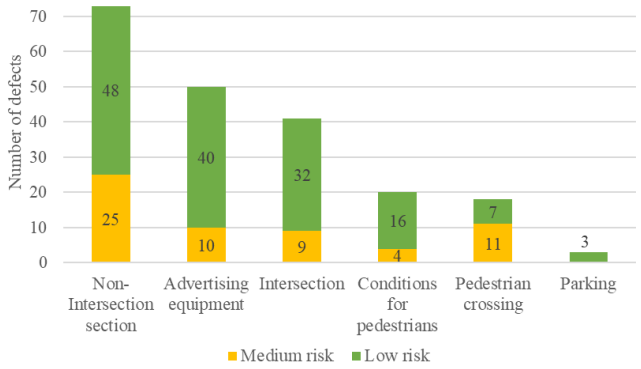

Fig. 2. Chart of recorded defects [9]

The most frequent group was the non-intersection category with 73 registered safety defects. The most common issues were inadequate lighting of the traffic area or an insufficiently perceptible curve of the road.

The first type of the mentioned defect was mostly found in the built-up areas, as these parts are usually illuminated (Fig 2 and 3). In this case, the areas are not illuminated by the public lighting and there is a so-called contrast shadow (unlit area in an otherwise illuminated section). This poses a major problem for the drivers whose eyes cannot adjust quickly enough to changes in light intensity. This is especially problematic in case, when a pedestrian who is moving in the unlit area may be overlooked and a serious accident can happen. The severity of these defects is increased by the fact that often no sidewalk is implemented at these locations.

In many cases, this defect can be effectively and inexpensively eliminated. In general, this problem is created by switching off a certain part of the public lighting (for example, every second lamp) to lower the costs for the operation of the lighting by the municipalities. Unfortunately, they often are not aware that it creates a potentially dangerous configuration for the road users.

If lamps are missing at a given location, then the solution is more difficult and expensive. It is necessary to carry out a detailed luminance analysis, according to which the following course of action can be decided. The most common practise is to replace the lighting bulbs or to increase the light intensity.

Fig. 3. Example of contrast shadow in a build-up area [9]

Fig. 4. Contrast shadow near the intersection [9]

The second most frequent defects type was the hardly perceptible curve of the road (Fig 5 and 6). This type of defect was mostly identified in the rural area, where the traffic flow is outside the illuminated area, but also at higher speeds. In these places, traffic signs indicating the directional curve are most

often missing. Additionally, the directional posts on the sides of the road are missing as well and the horizontal markings are often in poor condition.

Fig. 5. View of a road curve during the day [9]

Fig. 6. View of a road curve at night [9]

The picture above shows a curve that is hard to see or predict at night. In this particular case, the risk of identified safety defect is further increased by several factors. The fact that the directional change is after a long straight stretch of the road and a power line pole in the near proximity of the road. Based on the statistics [6], if a curve is missed, the vehicle usually run off the road. A rigid obstacle in the form of a power line pole placed in the possible trajectory of the vehicle thus presents a fixed obstacle which may worsen the consequences of the accident. [8]

To ensure sufficient visibility of the road curve, it is possible to implement traffic signs that warn the driver. It is also possible to install additional directional signs on the outside of the curve to indicate the direction of the road to the driver. A properly marked road curve can be seen in the Fig. 7.

Fig. 7. An example of a well-marked curve with traffic signs [9]

Both defect types above cannot be identified during the daytime RSI in most cases. The visibility of the change of direction of the road as well as other critical parts of the road must be verified for all possible situations. Thus, not only during the daylight hours, but also at night when visibility significantly differ. This applies to all elements on the road that affect the traffic flow and safety.

To provide an idea, other frequently noted safety defects can be mentioned. A very large group is made up of the advertising devices (50 defects). These elements present a risk throughout the day when they distract the driver's attention. If placed close to the road, they can also form a solid obstacle. However, some of these devices have additional night lighting that illuminates the advertising area. This is even more distracting and can cause dazzle to the passing drivers if the advertising device is in a rural area or unlit part of the road.

Pedestrian crossings were another category of safety defect where medium-risk defects were frequently recorded. These locations are primarily located in the built-up area, i.e. in a place where there is already public lighting. To make the pedestrian crossing easily perceptible for the drivers even in the times of reduced visibility, it is required to change the intensity of the lighting at this location. In most cases, this is done with special lighting, i.e. a lamp with a higher light intensity above the crossing. Nevertheless, it is necessary to ensure that contrast shadows are not created. These could cause pedestrians being overlooked.

More often, the additional lighting was missing completely (15 cases, 8 of them with medium-risk). This type of defect described above is a common cause of accidents between drivers and pedestrians at night in built-up areas, where serious consequences are registered [6].

The list below shows all 14 types that were monitored during the night safety inspection. [9]

Intersection

- Insufficient visibility of the intersection in times of reduced visibility
- Insufficient light-technical characteristics of the road signs
- Insufficient visibility of the road equipment

Non-Intersection section

- Missing public lighting in the traffic area
- Insufficient lighting of the traffic area
- Insufficient visibility of the road equipment
- Insufficient light-technical characteristics of the road signs
- Insufficient light-technical characteristics of the horizontal markings.
- Insufficient perceptibility of the curve of the road

Parking

- Insufficient visibility of the road equipment

Pedestrian crossing

- Missing additional lighting
- Surrounding light source creates significant contrast shadows

Conditions for pedestrians

- Missing public lighting

Advertising equipment

- All-day disturbance effect on the road users

IV. JUSTIFICATION OF NRSI

Even though significantly fewer safety defects are found during the NRSI compared to the daytime inspection, the importance of its implementation is proven by the accident rate [6].

Individual examples are presented based on publicly available data from the Police of the Czech Republic [6]. The graph below (Fig. 8) shows that there is an overall increase in the number of recorded traffic accidents during the night hours. In contrary, there is a decrease in their severity, but this decrease has almost stopped in the last 4 years. It is justified to assume that there may have been an increase in severity in the last year. However, its final outcome has been highly influenced by the ongoing global pandemic of the Covid-19. More specifically, the casualty rate has been affected by various governmental measures (restricted movement, trade slowdown, etc.) aimed at limiting the spread of the virus.

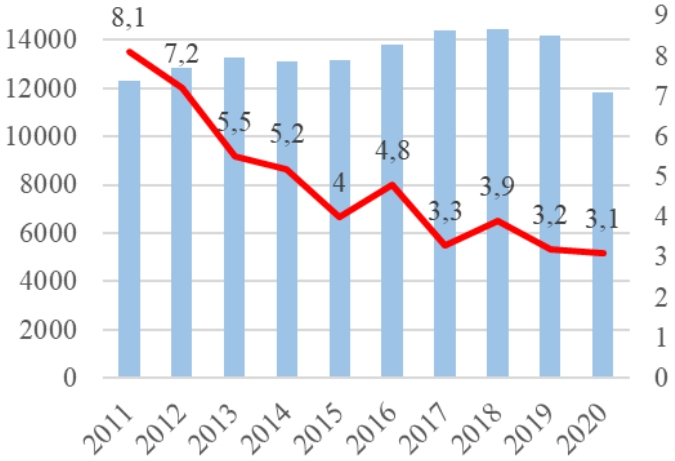

Fig. 8. Accident trends and severity (blue - number of accidents, red - number of deaths per 1000 accidents) [6]

It can be concluded that the number of recorded traffic accidents at night corresponds to the lower traffic volumes. In 2019, 547 people were killed in traffic accidents. Approximately 70% of the deaths happened during the day and the remaining 163 deaths were reported during the night hours. However, in terms of relative fatality per number of accidents, night-time accidents come out worse (by about 15%).

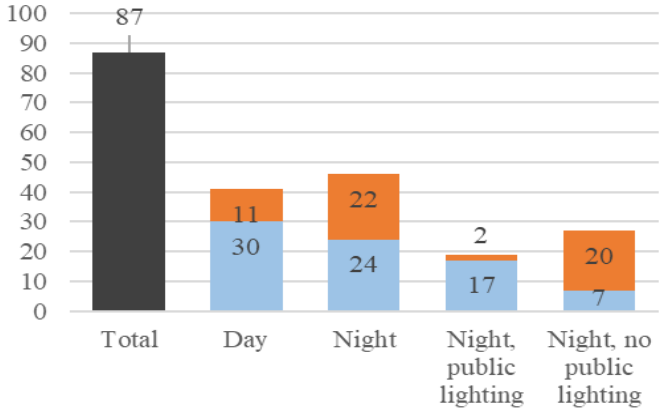

Fig. 9. Vehicle-pedestrian fatal accidents in the Czech Republic in 2019 (blue – Built-up area, orange – Rural area) [6]

The accident statistics show increased severity of the consequences in times of reduced visibility. As an example, the road traffic accidents involving the most vulnerable participants, pedestrians, can be shown. In 2019 alone, a total of 87 vehicle-pedestrian collisions with fatal injury were recorded. More than half of these cases (46 accidents) took place in the times of reduced visibility (at night). A total of 24 accidents were recorded in the built-up areas. Of these, 7 accidents occurred at a pedestrian crossing. The detailed distribution of these accidents is shown below (Fig. 9).

V. CONCLUSION

If Europe wants to achieve its goals of reducing the serious road traffic accidents, or achieving Vision Zero, the focus must be not only on developing of new safety technologies in cars or driver's education. It is also necessary to focus on the road safety itself, which must ensure the above-mentioned self-explanation and forgiveness. The night road safety inspection has the potential to fill one of the gaps in the road safety assessment and thus prevent road traffic accidents from occurring or mitigate their consequences. Its obligatory application at least on major roads and highways (e.g. TEN-T network) will help to create the necessary conditions that, together with other safety assessment tools, will help to fulfil the vision.

ACKNOWLEDGEMENT

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