IMPLEMENTATION OF ADVANCED TECHNOLOGIES IN VERTICAL TRAFFIC SIGNAGE IN THE CITY OF ZAGREB

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Abstract

Standard requirements for the traffic signage to be visible in all weather conditions have been intensified over the last ten years due to the ageing population who participate actively in everyday traffic. With the increasing age of the European population and the physiological processes that accompany this part of population, first of all eyesight deterioration, the quality of vertical traffic signage has to be upgraded to a higher level. Consequently, the first significant steps in Croatia have been made in the City of Zagreb, especially through the realized projects during the last five years. The paper gives an overview of these projects and comments on the results achieved on the Zagreb traffic network.

Keywords: traffic signage, ageing population, traffic accidents, urban environment, traffic safety

1 Introduction

The consequences of the increase in the level of individual motorization in the cities are usually reflected in an increase of traffic congestion and in the number of traffic accidents. There are several available measures which can alleviate these negative effects, and one of them belongs to the field of implementing high-quality traffic signalization. Owing to the advanced technologies, high-quality traffic signalization can be realized today with relatively low financial means. Each group of traffic participants has its specific requirements regarding their participation in traffic. One of the requirements that is common to all is the possibility of orientation. Correct information is valuable as help in making timely decisions about the routes of movement, either before starting the trip or during the trip. During the ride, the driver receives more than 90% of information visually, and at night and in adverse weather conditions the amount of received information is significantly reduced. In road traffic the influence of direct information is more significant than in other branches of traffic due to the large number of participants, the intensity of traffic flows and the process of decision-making being left to the individual participants in various situations, regardless of the fact whether they are managing the vehicle or being pedestrians.

2 Driver's age and visibility of traffic signs

In order to fulfil their role in night driving conditions, the traffic signs have to be of sufficient dimensions and have to have sufficient luminance to provide at least two important perception functions, and these are the conspicuousness of the traffic sign and its legibility. The traffic sign needs to be conspicuous in order to attract attention and to be noticed. Also, the

traffic signs have to be legible so that the message on the sign expressed in alpha-numeric characters or symbols would be easy to read from a distance which makes it possible for the driver to react on time. Numerous studies have researched the interdependence between the distance at which a sign can be read and the age of the drivers as well as the influence of the driver's age on the glare sensitivity. Figures 1 and 2 illustrate the loss of visual acuity and the increasing sensitivity to glare that accompany the ageing process.

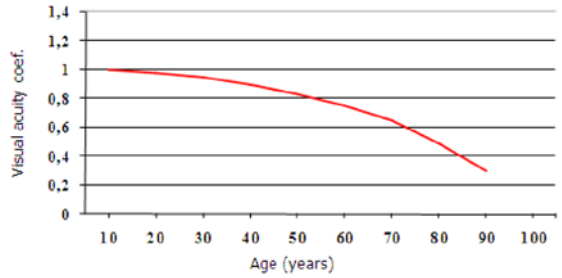

Figure 1 Visual acuity depending on the driver's age (Source: CIE, Maintained Night-time Visibility of Retro reflective Road Signs, Brussels, 1995, p. 17.)

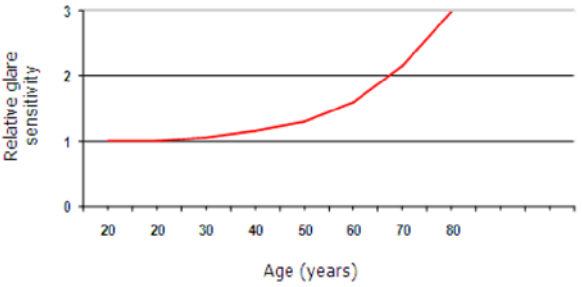

Figure 2 Influence of age on the glare sensitivity (Source: CIE, Maintained Night-time Visibility of Retro reflective Road Signs, Brussels, 1995, p. 17.)

An increasing share of older drivers in the driving population has stimulated the researchers to study their sensory abilities and those related to vision as part of the driving challenges. Some of them have only slight, difficult to notice or measure losses in visual acuity or glare sensitivity, whereas others may feature significant visual problems in the night driving conditions. These drivers may have only slightly lower visual acuity in day driving. However, older drivers see everything around them darker at night than the younger drivers. The research that compared visual performances of the older and the younger drivers during night driving suggests that an increase in the traffic sign luminance or better contrast compensates for this difference between the older and the younger drivers in noticing the traffic sign, recognising colours and the ability to read the sign. After the age of 20 years, every 13 years a person requires twice as much light in order to maintain the same visual ability. Thus, a 33 years old person needs twice as much, and a 59 years old person needs eight times as much light as a person aged 20. Apart from having poorer eyesight, older drivers have also delayed reaction and they need maximally visible traffic signs in order to notice them from as far as possible. The ageing brings along reduced visual acuity, so that persons over 80 years of age have approximately 50% of the visual acuity of a person aged 20. This is presented by a diagram in Figure 3.
These data have special significance when the forecast age structure of the European population over the next 15 years is taken into consideration (Fig. 4).

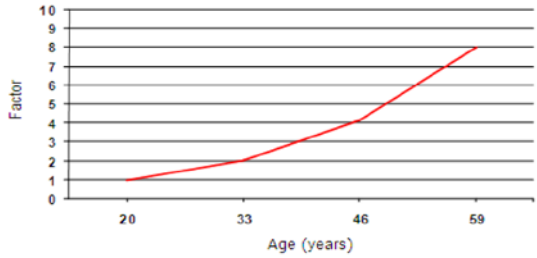

Figure 3 Required quantity of light regarding the driver's age

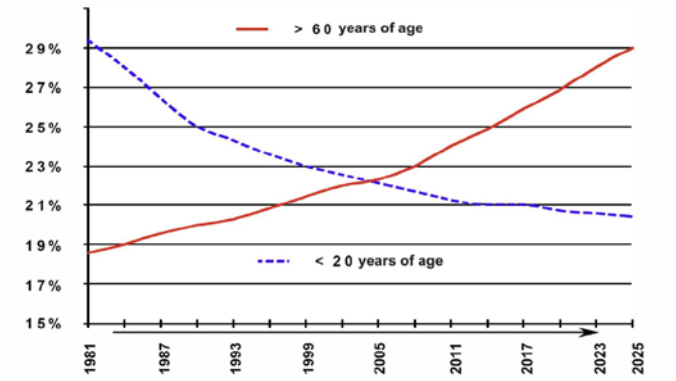

Figure 4 Forecast of the age structure of the European population (Source: EUROSTAT Statistical Office of the EC, 1995)

As can be seen from the following graph, the age structure of the population of the City of Zagreb follows the European trends, so that there are 34% of citizens living in Zagreb today who are 50 years of age or older.

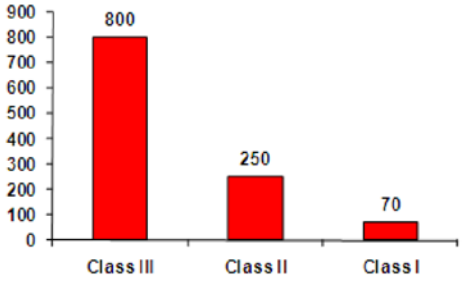

Figure 5 Age structure of the citizens of Zagreb

Day visibility of a certain object is determined by the intensity and colour of radiated light compared to the intensity of light radiated by its environment. This light may radiate from the very object or may be reflected from it. When the light leaves an object then it consumes energy. The reflection does not create its own light, but borrows the light from another source. The borrowed light ray impacts an object and is reflected from it. The reflective property of an object depends on the intensity of the incoming light ray, as well as on the material from which it is made. The method in which the object reflects the light is extremely important during night driving.

There are all kinds of reflections in traffic, but for the traffic safety the most important is the retroreflection. Retroreflection occurs when the surface reflects the incoming light ray as a beam in the direction of the light source. Therefore, to an observer standing near the source of light, such as a driver, the retroreflective materials seem extremely luminous. This is true for the drivers regarding almost all angles of looking, which renders excellent visibility to the retroreflective surfaces at night.

There are two types of retroreflection that are based on micro glass beads or micro prisms which reflect light:

- a glass bead redirects the incoming light ray while it passes through the front surface and reflects it from the mirror plane behind the bead. The ray returns again through the front surface and is reflected when it leaves the bead returning in the direction of the source of light.
- micro prisms contain retroreflective elements. Each has three equal perpendicular surfaces that refract the incoming light. The incoming light ray is refracted at each of these three surfaces and returned to its source parallel to the incoming light.

The glass bead elements or micro prisms are built into the retroreflective sheeting and coated by a thin protective layer. The first retroreflective materials were made in 1937 at the 3M Company in Minnesota, USA. There are several types of retroreflective sheetings of various designs and performances.

Three basic types of retroreflective materials are found today in use:

Class I material

Class II material

Class III material

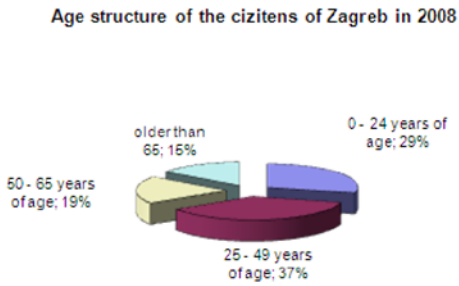

Figure 6 Relations of minimal starting luminance of the sheeting of all the three classes (silver/white)

For the traffic sign conspicuousness it is best to have dark environment free of glare from the opposing traffic. Other stimuli from the environment that compete with the sign include the sources of light generated by the street and parking lot lighting, from advertisements, lighted windows and many other factors that may cause distraction, and that are common for the urban areas.

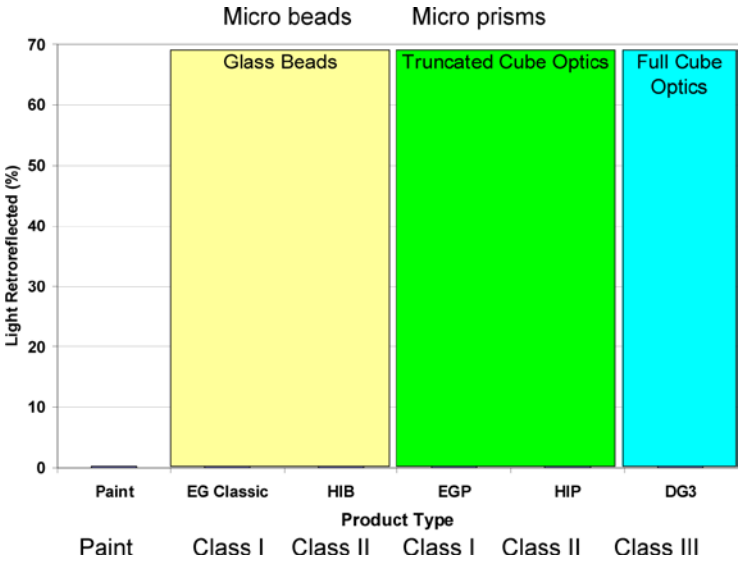

Figure 7 Retroreflection of micro bead and micro prism materials

3 Projects of direction and tourist signalisation in the cities – case study of the City of Zagreb

For remote routing and guiding of traffic the most important are the traffic signs of information for traffic guidance that inform the traffic participants about the road routes, distribution of destinations and traffic guidance towards these targets. Regarding its purpose the direction signalisation provides basic information to the driver or the traffic participant about the direction of movement towards the required destination: state, city or part of the city. In Croatia the basic rules of installing direction signalisation is defined by the Regulations on Traffic Signs, Signalisation and Road Equipment. Unlike direction signalisation, tourist signalisation provides information on the position of the tourist, cultural, and other points of interest in a certain region. If it is located within the urban area, such signalisation informs the traffic participants also about the position of the major objects in the city (e.g. hospitals, post-offices, sport facilities).

The objective of the project of direction signalisation is to establish such a traffic signalisation system which guides the traffic participant along an optimal route towards the desired destination. Based on the results of the current situation analysis, new solutions of direction signalisation are proposed attempting to include to the greatest extent also the existing signalisation.

The carrie out analysis of the existing signalisation in major Croatian cities has shown:

- poor management of traffic towards the neighbouring countries;
- violation of traffic regulations regarding colour of the traffic signs, size of the letters, numbers of roads;
- inadequate selection of the names of target places and their frequent disappearance and appearance of new names of target places;
- lack of harmonisation of the existing direction signalisation with the changes occurring in the road network;
- lack of compatibility of the existing direction signalisation with the newly set signalisation;
- lack of harmonisation with administrative changes.

Traffic guidance using direction signalisation in the cities has certain specific characteristics. For example, due to the density of intersections and locations of the direction signs in the cities it is often impossible to apply a higher grade of the method of informing the traffic participants about the desired destinations, and in such cases certain modifications are necessary. For vehicle guidance to various destinations, the tendency is to use roads of highest capacity, which are not always the shortest ones, but the speed of movement there is higher, thus shortening the travel time.

The tourist and other signalisation is characterised by several specific characteristics which somewhat change the approach to the project regarding the direction signalisation. Briefly, these characteristics can be summarised as follows:

- in the cities, a large number of buildings and points of importance and of wider interest are located on a relatively small space,
- the objects do not have the same importance (e.g. hospitals, hotels, etc.).

A large number of objects can result also in high concentration of signs on one place, and instead of providing clear information this may have a completely opposite effect. In order to eliminate this, it is necessary to apply an approach of evaluating the objects according to their "importance". The criteria used for the evaluation may be different and depend first of all on the type of the object. Such evaluation determines the catchment zone of an object and determines the location for signalisation installation. The implementation of such a concept solves in a systemic and consequent manner the problems of installing the tourist and other signalisation and the objects are assigned signalisation that is adequate to their tourist values. It should be noted that the systems of direction, tourist and other signalisation are not independent systems, but are rather designed to complement each other. In the City of Zagreb, the condition with direction and tourist signalisation, until the year 2005 had been inadequate, as in the majority of other Croatian cities as well. The direction signalisation, as part of total traffic signalisation in the City of Zagreb, had not been systemically planned nor designed until then.

The analysis of the existing condition included 200 intersections with 715 approach roads. Some of the characteristic data include the following: out of 715 approach roads 537 had portal structures for the installation of all types of signalisation; only 99 portal structures (18%) had direction signs; on 16 portals (3%) the direction signs were designed and set properly; out of 438 portals that have no direction signs 166 portals (38%) had a structure prepared for the direction signs.

This started the activities to install this type of signalisation in a systemic manner, which was preceded by several studies and projects. The following table gives an overview of the carried out studies and projects, and their realisation in the field.

In selecting the retroreflective material for the direction and tourist signalisation in the City of Zagreb the achievements of advanced technology are taken into consideration and all the signs have been made of Class III retroreflective material (Diamond Grade Cubed). The retroreflective sheeting Diamond Grade DG3 provides excellent luminance of the signs on short and mid-distances with wider visual angles. Although some projects have not been realized yet, one may notice a large shift forward in relation to the previous situation. New 1779 signs that are part of the total system of the traffic signalisation have significantly facilitated the orientation of drivers on the Zagreb road network.

Table 1 Projects of direction signs and tourist signalisation in Zagreb

	PROJECT TITLE	NUMBER OF DESIGNED SIGNS	NUMBER OF INSTALLED SIGNS
1.	Direction signalisation of the City of Zagreb	808	808
2.	Tourist signalisation of the City of Zagreb – phase I (city centre)	359	359
3.	Traffic guidance towards hotels in the City of Zagreb	524	524
4.	Tourist and other signalisation in the City of Zagreb	785	not installed
5.	Annex to the project "Tourist and other signalisation of the City of Zagreb" for the needs of the museum memorial centre Dražen Petrović	21	21
6.	Tourist signalisation of the City of Zagreb for the needs of the city theatres	36	not installed
7.	Annex to the project "Tourist signalisation of the City of Zagreb – Phase I" for the needs of the Croatian State Archives, Gliptoteka, Croatian School Museum and the Croatian Natural History Museum	67	67
8.	Annex to the project "Tourist signalisation of the City of Zagreb – Phase I" for the needs of the Typhlological Museum	3	not installed
	Total	2603	1779

4 Conclusion

A systemic approach to solving of the problems of installing the direction signalisation is necessary to provide the traffic participants with timely and clear information towards the target they are interested in. This increases in a certain way the traffic throughput capacity in the cities, the traffic safety, and also leaves a positive image about the city and the environment in the eyes of the passengers (tourists). The methods used in solving the problems are based on the specific characteristics of the urban environments, professional experiences and application of the regulations on traffic signalisation. Also, after having installed the new direction signalisation it is important to continue complementing and maintaining it, since new technical solutions are appearing, improving the traffic signalisation, and the cities, as "living beings" are changing and these changes have to be accompanied, among other things, also by the adaptation of the direction, tourist, and other signalisation to the actual situation.Many examples have proven that adequate use of traffic signalisation and application of high-quality materials for its production can substantially reduce the number of traffic accidents. In this context, the retro reflection of traffic signalisation is of great importance, providing significantly higher visibility at night and in adverse weather conditions. With the development of high technologies and advanced knowledge about their application, new retro reflective materials offer optimal adaptability to direct traffic participants with minimal energy requirements and negligible impact on the environment.

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6 GEOTECHNICAL WORKS