

ANĐELKO ŠĆUKANEC, D.Sc.
E-mail: andelko.scukanec@fpz.hr

MARIO ŠAFRAN, D.Sc.
E-mail: safranm@fpz.hr

DARKO BABIĆ, M.Sc.
E-mail: dbabic@fpz.hr

University of Zagreb,
Faculty of Transport and Traffic Sciences
Vukelićeva 4, HR-10000 Zagreb, Republic of Croatia

Traffic Safety and Security
Review

Accepted: Feb. 28, 2006

Approved: Dec. 19, 2006

IN-VEHICLE SAFETY SYSTEM PERFORMANCE DEPENDING ON THE QUALITY OF ROAD MARKINGS

ABSTRACT

During driving one of the basic tasks of the driver is to follow the traffic route in such a way as not to endanger in the process other traffic participants. In order to improve the driving safety, the manufacturers install new safety systems in the cars. Thus, the safety system *ILAS* (Involuntary Lane-crossing Alert System) warns the drivers of the unintended and incorrect crossing of the full or broken line during driving. The proper functioning of *ILAS* requires high quality road markings on the carriageway in order to allow the mentioned safety system to identify them on time and correctly. Road markings can be defined as a set of longitudinal and transversal lines, signs and symbols, the combination of which designs the surfaces on the traffic infrastructure. They represent a part of the whole traffic signalization and cannot be replaced by other markings or regulations. The road markings have the task of visually guiding the driver, allowing the drivers to be able to forecast the route of their safe movement. Every crossing of the full or broken line at speeds higher than 80 km/h and without an activated indicator is identified by *ILAS* and the driver is warned by the vibration of the driver seat. Road markings are the best aid in side, i. e. transversal locating of the vehicle and they influence directly the operation of the safety system *ILAS* during driving.

KEY WORDS

road markings, safety systems, lateral vehicle guidance

1. INTRODUCTION

In order to increase the driving safety, the manufacturers install new safety systems into the vehicles. Thus, the safety system *AFIL* (French: *au franchissement involontaire de ligne*), i. e. in English *ILAS* (Involuntary Lane-crossing Alert System) warns the driver of unintentional and irregular crossing of the continuous or broken line during driving. Every crossing of the continuous or broken line at speeds greater than 80 km/h, without activated directional indicator, is identified by *ILAS* (Involuntary Lane-crossing Alert System)

which in turn warns the driver by seat vibrations. Road markings are the best aid in lateral, i. e. transversal determining of the vehicle position and they directly affect the operation of the safety system *ILAS* during the drive.

2. DEVELOPMENT AND IMPLEMENTATION OF IN-VEHICLE SAFETY SYSTEMS

In driving one of the basic driver's tasks is to follow the road in such a way as not to endanger other traffic participants. In order to increase the traffic safety, the manufacturers install new safety systems into the vehicles. A well-known Japanese car manufacturer is developing a safety system related to the protection of pedestrians on the roads. The mentioned system has two "infra-red" cameras installed in the front part of the vehicle which identify the pedestrian on the road in front of the vehicle before the driver does, by identifying the thermal radiation from the pedestrian, recognizing the size and form. After the safety system has identified the pedestrian on the road, it warns the driver by audio and light signals of the approach of the pedestrian. Such technical solution is of special advantage at night, i. e. under the conditions of poor visibility. Also, a well-known French car manufacturer has developed a safety system *AFIL* (French: *alerte au franchissement involontaire de ligne*), i. e. in English *ILAS* (Involuntary Lane-crossing Alert System) which warns the driver of unintentional and irregular crossing of the continuous or broken line during driving.

Every crossing of a full or broken line at speeds greater than 80 km/h, without the activated directional indicator, is identified by *ILAS* which warns the driver by driver seat vibrations.

Technically, "infra-red" sensors located in the front part of the vehicle, under the front bumper, dur-

ing the drive constantly read the continuous and broken line on the road, and identify when these are crossed by the vehicle. Every crossing of a continuous or broken line at speeds greater than 80 km/h, without the activated directional indicator results in the actuation of the vibrator located beneath the driver's seat which warns the driver about the unintentional crossing of the continuous or broken line.

The ILAS system has also other possibilities related to the position of road markings. Thus, transversal road markings can be designed with regular spacing representing the form of a bar-code on the road. The approach of an ILAS-system-equipped vehicle to such road markings results in the recognition of the transversal markings by the safety system and immediate warning of the driver by means of a vibrator installed in the interior of the vehicle. Such function of the safety system is made possible by the regularly spaced road markings in front of schools, busy intersections, etc. so that the safety system warns the driver of the "danger on the road".

From the moment of involuntary crossing of the continuous or broken line, i. e. crossing the transversal road marking, the *ILAS* system reacts within a time period of 200 ms, thus contributing significantly to safer driving.

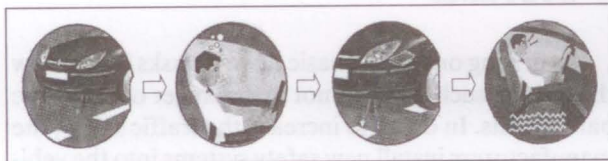


Figure 1 – Operation of the *ILAS* system

3. TESTING ROAD MARKING QUALITY AS TRAFFIC SAFETY ELEMENT

Road markings represent one of the most important components of the traffic equipment, since their location puts them into the central field of the driver's attention. They may be defined as a set of longitudinal and transversal lines, labels and symbols, the combination of which results in the forming of surfaces on the traffic infrastructure. It may be said that the road markings communicate to the driver in a special language what to do and how to react in certain situations in traffic, thus becoming an extremely useful co-driver.

Road markings have the task of visually guiding the driver, owing to which the driver can foresee the route of safe movement. The quality and quantity of visual guidance depends directly on the visibility so that reflexive properties of road markings are of basic significance. The presence and quality of the road markings affects the speed as well as the position chosen by the drivers.



Figure 2 – Non-profiled line made of thermoplastic material



Figure 3 – Transversal road markings

Road markings should first of all facilitate the performance of operative tasks, but should also affect the tactical tasks. The markings represent the best aid in lateral, that is, transversal positioning of the vehicle. Therefore, the drivers focus their attention often on the markings that are intentionally used for central observation, and in that case the markings are extremely significant, especially in conditions of reduced visibility.

The road marking quality is tested according to the EUROPEAN STANDARD EN 1436. This European standard was prepared by the Technical Committee CEN/TC 226 for road equipment. It was issued in 1997 and accepted in February 1998 in most of the European countries. In Croatia it has been accepted as the Croatian standard "HRN EN 1436:2001" - "Road marking materials" and proclaimed the Croatian standard in the bulletin of the State office for standardization and metrology" in No. 5-6 of 2001.

This standard requires minimal performance of the road markings according to the following aspects:

- retroreflexive luminance coefficient (RL),
- luminance coefficient under diffusion lighting (Qd),

- braking resistance,
- functional lifecycle,
- lighting factor (β) and coordinates of colours.

The main factors that influence the road marking visibility are their luminance, luminance contrast in relation to the carriageway, and their size. The luminance of road markings is achieved so that glass, or more recently ceramic spheres (beads) are added to the materials, thus achieving their reflexivity.

For retroreflexive markings the main visibility factor is the luminance which reaches the observer, and its visibility threshold depends on the luminance radiated by their environment. In order to evaluate the road marking visibility, photometric marking measurements have to be carried out. The photometric measurements include measurements of night and day visibility of the road markings, and these are carried out in laboratory conditions on trial plates or directly on the carriageway. Measurements are performed in good weather conditions.

The photometric measurements should simulate the usual situation during driving. Standard conditions are simulated in measurements, and these include:

- visual distance of 30m,
- height of the eye from the carriageway 1.2 m,
- height of the lights at 0.65m from the carriageway,
- angle of observation 2.29° (angle between the observation axis and the measuring area),
- luminance angle 1.24° (angle between the lighting axis and the measurement surface).

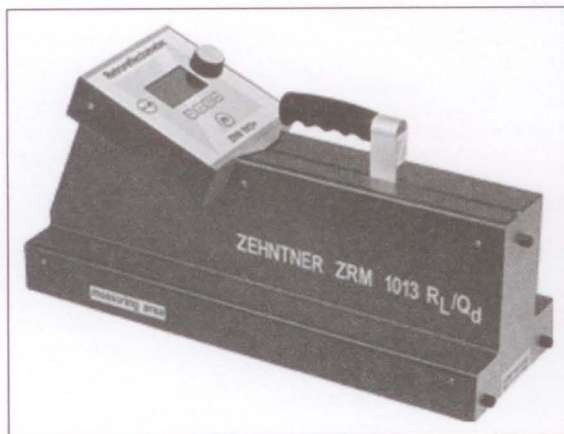


Figure 4 – Retroreflexometer ZEHNTNER ZRM 1013+ for testing road marking quality

4. ROLE OF ROAD MARKINGS IN THE OPERATION OF IN-VEHICLE SAFETY SYSTEMS

Road markings tend to be less observable in the conditions of lower visibility. Numerous traffic acci-

dents occur or can be related precisely to poorer visibility of road markings. When, due to poorer visibility conditions the drivers do not see the road markings, they often lose orientation regarding their current position on the road and therefore cross over to that part of the road which is intended for the movement of vehicles in the opposite direction or skid off the road since they cannot identify on time that they are driving along the edge of the carriageway.

The main component of road markings is their visibility which shall satisfy actual requirements of the traffic participants for visual guidance and which should influence:

- the driver's capability to foresee the area of safe driving in front of the vehicle,
- driver's perception of the position on the road,
- the choice of direction and driving speed.

Road markings should first of all facilitate the performance of operative tasks, but also influence the tactical tasks. Therefore, drivers often focus on the markings using these intentionally for central observation, and in that case the markings are of extreme significance, especially in conditions of reduced visibility.

The above discussion indicates that road markings are the best aid in lateral, i. e. transversal positioning of the vehicle and directly influence the operation of the safety system *ILAS* during driving.

5. CONCLUSION

Road markings have the task of visually guiding the drivers enabling them to foresee the route of their safe movement. The presence and quality of road markings affects the speed as well as the position selected by the driver.

During driving one of the basic tasks of the driver is to follow the road so as not to endanger other traffic participants by their actions. In order to improve the driving safety, the manufacturers install new safety systems into the vehicles. Thus, the safety system *AFIL* (French: *alerte au franchissement involontaire de ligne*), that is, in English *ILAS* (*Involuntary Lane-crossing Alert System*) identifies every crossing of the continuous or broken line at speeds greater than 80 km/h without the activated directional indicator, and alerts the driver by seat vibrations.

Road markings are the best aid in lateral, that is, transversal positioning of the vehicle and directly affect the operation of the safety system *ILAS* during driving.

Dr. sc. ANDELKO ŠČUKANEC

E-mail: andelko.scukanec@fpz.hr

Dr. sc. MARIO ŠAFRAN

E-mail: safranm@fpz.hr

Mr. sc. DARKO BABIĆ

E-mail: dbabic@fpz.hr

Sveučilište u Zagrebu, Fakultet prometnih znanosti

Vukelićeva 4, 10000 Zagreb, Republika Hrvatska

SAŽETAK

RAD SIGURNOSNIH SUSTAVA U AUTOMOBILU OVISNO O KVALITETI OZNAKA NA KOLNIKU

Za vrijeme vožnje jedan od osnovnih zadataka vozača je slijediti prometnicu na način da svojim postupcima ne ugrožava ostale sudionike u prometu. Zbog povećanja sigurnosti vožnje, proizvođači ugrađuju nove sigurnosne sustave u automobile. Tako sigurnosni sustav ILAS (Involuntary Lane-crossing Alert System) upozorava vozača o nenamjernom i nepravilnom prelaženju pune ili isprekidane linije za vrijeme vožnje. Za pravilan rad sustava ILAS potrebne su kvalitetno izvedene oznake na kolniku da bi ih navedeni sigurnosni sustav na vrijeme i pravilno prepoznao. Oznake na kolniku mogu se definirati kao skup longitudinalnih i transverzalnih crta, natpisa i simbola čijom se kombinacijom oblikuju površine na prometnoj infrastrukturi. Predstavljaju dio cjelokupne prometne signalizacije i ne mogu se nadomjestiti drugim znakovima ili propisima. Oznake na kolniku imaju zadatak vizualnog vode-

nja vozača, zahvaljujući čemu vozači tada mogu predvidjeti trasu svog sigurnog kretanja. Svako prelaženje pune ili isprekidane crte kod brzina većih od 80 km/h, a bez uključenog pokazivača smjera, sustav ILAS prepozna i upozori vozača vibriranjem vozačkoga sjedala. Oznake na kolniku najbolja su pomoć pri bočnom, odnosno poprečnom određivanju pozicije vozila i izravno utječu na rad sigurnosnog sustava ILAS tijekom vožnje.

KLJUČNE RIJEČI

oznake na kolniku, sigurnosni sustavi, bočno vođenje automobila

LITERATURE

- [1] J. Božičević, I. Legac: *Cestovne prometnice*, Fakultet prometnih znanosti, Zagreb 2001.
- [2] V. Cerovac: *Tehnika i sigurnost prometa*, Fakultet prometnih znanosti, Zagreb 1997.
- [3] S. Pašagić et al.: *Vizualne informacije u prometu*, Fakultet prometnih znanosti, Zagreb 2000.
- [4] T. Perić, Č. Ivaković: *Zaštita u prometu*, Fakultet prometnih znanosti, Zagreb 2001.
- [5] K. Rogić, M. Šafran, A. Ščukanec: *Vrednovanje vidljivosti oznaka na kolniku u cilju boljeg vizualnog vođenja vozača*, Proceedings, Znanost i razvitak prometa, Zagreb 2002.



Figure 4 - Retroreflective ZENITHER ERM 1013+ for testing road marking quality

A ROLE OF ROAD MARKINGS IN THE OPERATION OF IN-VEHICLE SAFETY SYSTEMS

Road markings tend to be less observable in the conditions of lower visibility. Numerous traffic acci-