ANALYSIS OF ROAD MARKINGS RETROREFLECTION MEASUREMENT ON CROATIAN STATE ROADS

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ABSTRACT

Road traffic safety depends on the efforts of the entire society, through increased investment in road safety and traffic culture development of all road users. One of the ways to increase road safety is by implementing quality traffic signalization, among which are road markings. Today there are several different techniques and technologies for road markings, from the cheapest (paint) to the most expensive (tape markings). Each technology has its advantages and disadvantages associated with the quality of performance, lifetime, price, implementation techniques, etc. Beyond just performance, it is important to periodically test the quality of road markings. Examining road markings, road authorities get insight look into their condition, need for renovation and quality. This paper will analyse current way of testing retroreflection quality of road markings.

Key words: road safety, signalization, road markings, retroreflection

1. INTRODUCTION

Road traffic safety aims to reduce the harms (deaths, injuries, and property damage) resulting from crashes of road vehicles travelling on public roads. The main goal of road
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traffic safety is protection and security of all those who travel on roads. Major factors that contribute to the road traffic safety can be grouped in three categories:\(^1\):

- roads
- vehicles
- drivers’ behaviour.

In this paper, focus will be on the road markings as one of key elements of roads. Road markings can be defined as a set of longitudinal and transversal lines, signs and symbols which combined form the surface transportation infrastructure. Today there are several different techniques and technologies for road markings, from the cheapest (paint) to the most expensive (tape markings). Each technology has its advantages and disadvantages associated with the quality of performance, lifetime, price, implementation techniques, etc..

Quality of road markings directly affects visibility and recognition of road geometry especially on roads without electric lighting. Visibility is especially important at night and wet conditions when the driver sees only what the lights from the headlights of vehicles lighten.

Road markings on Croatian state roads are primarily made from paint which has the shortest lifetime of all other road markings technologies. Because of the sort lifetime of painted road markings, road markings need to be restored mostly every year.

Measuring retroreflection of road markings give the road authorities an inside look at how road markings perform, in which condition they are, and how well conductors do their job. With this inside look, road authorities can create a plan of restoration based on measurement results. Roads that, according to measurements results, have satisfying retroreflection will not be restored until their retroreflection decreases below minimum levels. Restoring the road markings in this way can reduce road maintenance costs.

2. CURRENT WAY OF ANALYZING RETROREFLECTION OF ROAD MARKINGS

Department for Traffic Signalization on Faculty of Traffic and Transport Sciences has been performing dynamic testing of road markings retroreflectivity on the Croatian state roads since 2010. In collaboration with Croatian Roads Ltd., intervals of retroreflection values (RL)

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\(^1\) Šćukanec, A., Fiolić, M., Babić, D.: Analysis of retroreflectivity of paint and plastic road markings on Croatian state road D1, ZIRP2012 - Development of logistics business and transport system supported by EU funds, ISBN: 978-953-243-056-1
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are made so that the quality of road markings can be evaluated. These intervals are related to the state of line (restored or existing) and line type (type I and type II).

Minimum values that certain types of lines in certain states must satisfy are defined in technical terms Croatian Roads Ltd.

Table 1. Minimum values of retroreflection for restored lines type I

<table>
<thead>
<tr>
<th>VISIBILITY AND STATE OF PAVEMENT</th>
<th>MINIMUM VALUE</th>
<th>INTERVAL (mcd·m⁻²·lx⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime visibility, dry pavement</td>
<td>RL ≥ 200</td>
<td>180 ≤ RL ≤ 220</td>
</tr>
<tr>
<td>Daytime visibility, dry pavement</td>
<td>Qd ≥ 130</td>
<td>110 ≤ Qd ≤ 150</td>
</tr>
</tbody>
</table>

Source: Guidelines and technical requirements for the works on renewing road markings, Croatian Roads Ltd.

Table 2. Minimum values of retroreflection for restored lines type II

<table>
<thead>
<tr>
<th>VISIBILITY AND STATE OF PAVEMENT</th>
<th>MINIMUM VALUE</th>
<th>INTERVAL (mcd·m⁻²·lx⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night time visibility, dry pavement</td>
<td>RL ≥ 300</td>
<td>270 ≤ RL ≤ 330</td>
</tr>
<tr>
<td>Daytime visibility, dry pavement</td>
<td>Qd ≥ 160</td>
<td>140 ≤ Qd ≤ 180</td>
</tr>
</tbody>
</table>

Source: Guidelines and technical requirements for the works on renewing road markings, Croatian Roads Ltd.

Table 3. Minimum values of retroreflection for existing lines type I

<table>
<thead>
<tr>
<th>VISIBILITY AND STATE OF PAVEMENT</th>
<th>MINIMUM VALUE</th>
<th>INTERVAL (mcd·m⁻²·lx⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night time visibility, dry pavement</td>
<td>RL ≥ 100</td>
<td>90 ≤ RL ≤ 110</td>
</tr>
<tr>
<td>Daytime visibility, dry pavement</td>
<td>Qd ≥ 100</td>
<td>90 ≤ Qd ≤ 110</td>
</tr>
</tbody>
</table>

Source: Guidelines and technical requirements for the works on renewing road markings, Croatian Roads Ltd.

Table 4. Minimum values of retroreflection for existing lines type II

<table>
<thead>
<tr>
<th>VISIBILITY AND STATE OF PAVEMENT</th>
<th>MINIMUM VALUE</th>
<th>INTERVAL (mcd·m⁻²·lx⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night time visibility, dry pavement</td>
<td>RL ≥ 150</td>
<td>130 ≤ RL ≤ 170</td>
</tr>
<tr>
<td>Daytime visibility, dry pavement</td>
<td>Qd ≥ 130</td>
<td>110 ≤ Qd ≤ 150</td>
</tr>
</tbody>
</table>

Source: Guidelines and technical requirements for the works on renewing road markings, Croatian Roads Ltd.
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According to the Technical terms, if restored road markings after the dynamic measurements do not satisfy minimum values additional static measurements must be performed. If at first static measurement, road marking continues to fail it is necessary to perform additional measurements and if even then road marking does not satisfy the Contractor must perform application of new road marking at their own expense.

Problem with the current way of analyzing retroreflection quality of road markings is the term “state of road marking” and intervals for each state (restored and existing). Making differences between the restored and the existing lines prevents comparison of two measurements carried out in the same year on the same road. For example, Figure 1 shows the results of measurements performed on national road on 27th of April in 2012, when the line state of was “existing”, while Figure 2. shows measurements results of the same road carried out on 22nd June in 2012, when the state of line was "restored".

Figure 1. Results of measurement of road markings retroreflectivity on the national road, line state: existing

Source: Department for Traffic Signalization, Faculty of Traffic and Transport Sciences

Figure 2. Results of measurement of road markings retroreflectivity on the national road, line state: restored

Source: Department for Traffic Signalization, Faculty of Traffic and Transport Sciences
From this example, it can be concluded that the comparison of measurement results before and after the restoration is almost impossible.

Also, minimum levels of retroreflectivity after restoration should be increased to prolong the lifetime of road marking, to increase visibility at night and in wet conditions and with that to increase traffic safety overall.

Display of the current system of testing road markings quality is presented in Figure 3.

Figure 3. Display of current way of testing road markings quality according to the Technical requirements

Source: Prepared and adapted by authors
3. DEFICIENCIES OF THE CURRENT WAY OF TESTING ROAD MARKINGS RETROREFLECTION

As already mentioned above, comparison of measurement results in current system, before and after the restoration is almost impossible. In order to provide quality comparison, intervals should be the same regardless of when the measurements were performed.

Term line state (restored or existing) should be eliminated from use because it is very difficult to define the time in which the line changes state from restored to existing. This problem is basically defined in Technical terms, in the way that in period between 30 and 60 days after restoration line is in state “restored” and after the 60 days period line state is “existing”. The observation period (30 - 60 days) should continue to be in use only for measuring and analyzing newly restored lines.

Similar to the systems used in some European countries, especially in Great Britain, strict minimum levels of retroreflection should be defined. Minimum level of retroreflection (for new or newly restored road markings) in Great Britain is 150 mcd/lx/m². If the retroreflection value drops below 100 mcd/lx/m², road marking is included in the restoration plan, and if the value is below 80 mcd/lx/m², road marking must be restored immediately. The main disadvantage of the system used in Great Britain is that they do not include different criteria which have effect on road markings lifetime and retroreflection values. Without analysis of different criteria, most suitable technology and material for each road may not be implemented.

Unlike Great Britain, Austria has a scoring system in which following criteria are graded:

- the average annual daily traffic
- the width of pavement
- type of line location
- the impact on the environment and
- whether the road marking is applied for the first time or not.

After the grading is done, the total number of points for each road is acquired by sum of all points from each criterion and based on the total number of points, the type of material and restoration technology is determinant.

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2 http://www.rsma.co.uk/index.php/news.html?start=6 (15.01.2013.)
A combination of Great Britain and Austrian system could be suitable for implementation in Croatia. Austrian scoring system includes different criteria which impact on road markings lifetime, degree of degradation and retroreflection values. With analysis of these criteria, the most suitable type of material and technology could be implemented for each road. The main advantage of system used in Great Britain is the definition of minimum levels of retroreflection and implementation of restoration plan based on the measured retroreflection values.

Combining scoring system, minimum retroreflection values and restoration plan based on measurements could optimize the road maintenance system in Croatia. This optimization should theoretically result in increase of traffic safety and reduction of maintenance costs.

Based on an analysis of the current way of testing road markings quality the following conclusions can be made:

- distinction between restored and existing lines is not necessary,
- the existence of different intervals is also not necessary,
- the level of the minimum values should be increased,
- analysis of criteria that impact on road marking’s lifetime and retroreflection should be implemented,
- restoration plan based on the measured retroreflection values should be implemented.
4. CONCLUSION

Road markings have the task of visual guidance, allowing the drivers to be able to predict the route. Road markings are a segment of the road signalization made up of interconnected materials whose task is to ensure the visibility in bad weather conditions, durability, high coefficient of friction sliding and more.

The quality of road markings depends on many factors, and one of the most important is the level of quality and knowledge of the contractor. For this reason it is very important to evaluate the markings on the pavement after application in order to determine whether the contractor met all demands. In addition, measurement must be periodically conducted to gain insight into the state of road markings and by implementing specific measures ensuring a certain level of quality.

By raising the minimum values, visibility in night and wet conditions and lifespan of road markings would increase and with that safety of road traffic. Also, increase of minimum values would compel contractors to invest in technology and training of its employees in order to be able to meet the required demands.

In Croatia, a combination of Great Britain and Austrian system could be suitable for implementation. Combining scoring system, minimum retroreflection values and restoration plan based on measurements could optimize the road maintenance system. This optimization would result in increase of traffic safety and reduction of maintenance costs.

In order to define the model of maintenance of road markings, it is necessary to conduct further research to gain an insight into the relations between the various criteria and ultimately their impact on road marking and traffic safety.
5. LITERATURE


[6] Data for Department for Traffic Signalization, Faculty of Traffic and Transport Sciences