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ANALYSIS OF RETROREFLECTIVITY OF PAINT AND PLASTIC ROAD MARKINGS ON CROATIAN STATE ROAD D1

ABSTRACT

With the urbanization process constantly accelerating, road traffic safety becomes one of the biggest problems facing the society. Road traffic safety depends on the efforts of the entire society, through increased investment in road safety and traffic development of culture of all road users. Driving in the night and wet conditions reduces drivers' visual perception which as a result has decreased road traffic safety. The most common ways of performing road markings are by using paint or plastic materials. This paper will analyze how two types of road markings on one section of the road can influence traffic safety. Research has been done in the period of 2 years with dynamic retroreflectometer on Croatian state road D1 on section Junction Zaprešić (A2) and shopping mall ''West Gate''.

1. INTRODUCTION

Road traffic safety aims to reduce the harms (deaths, injuries, and property damage) resulting from crashes of road vehicles traveling on public roads. Main goal of road 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' behavior.

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. They represent part of the overall traffic signals and cannot be replaced by other signs or regulations. Road markings have the same legal value as the traffic signs and traffic light signals and can be set independently or in combination with them.

The main tasks of the road markings are:

- warning drivers about the situation in the area in front of vehicles that require special attention and caution for the continuation of safe driving
- guiding the drivers to their targets by identifying safe travel path
- inform drivers about the legal restrictions
- help in regulating traffic in an optimal way.

In night and in wet conditions, road markings play important role in road traffic safety and because of that different types on road marking have been developed to insure safety.

2. TYPES OF MATERIALS FOR ROAD MARKINGS

There are several types of basic materials for making road markings which differ according to the method of application, longevity, cost, and structural features. Existing road markings are made as follows:

- paint markings
- markings made of plastic materials
- tape markings

Selecting the right material for road markings depends on the situation of the road where the material is applied, which is the result of:

- the frequency of bad weather
- flow of vehicles
- diverting vehicles from other roads
- the frequency of application of asphalt layer
- duration of winter conditions.

2.1. Paint markings

Paint markings are thin film materials in a liquid state for making marks on the pavement. They consist of pigments, binders, fillers, and solvents. Can be a single component and immediately ready for installation or binary. Depending on the composition they are applied with hot or cold process. The thickness of layer is usually between 0.2 mm and 0.5 mm. Retroreflectivity of paint markings is achieved by installing retroreflective elements – glass beads. Glass beads can be incorporated in the color or add later during installation. Although widespread (especially in Croatia) represents the worst material for road markings and are mostly suitable for roads with low traffic intensity. Their main advantage over other materials for making markings on the pavement is a small price.

2.2. Markings made of plastic materials

Plastic materials are multicomponent and consist generally of synthetic binders, natural and synthetic resins, pigments, fillers, and glass beads. They belong to a group of thick road markings with thickness of layer between 1 and 3 mm. Road markings made of plastic materials can be placed on cold pavement or at elevated temperatures, and in this regard can be divided into two basic groups:

- cold plastic
- thermoplastic.

a) Cold plastic

Cold plastic is the material of the liquid state to which are added various additives and thickening mass. After initial densification, they are applied to the roadway where after twenty minutes they harden and can be driven over. Depending on the manufacturer can be embedded with glass beads or they can be added at the end of installation process. Their lifespan is relatively long, between 2 and 4 years. Cold plastic markings can be derived in various forms and regarding their form can be unprofiled and profiled.

b) Thermoplastic

Thermoplastic materials for road markings must be prior to the application heated to a 180 °C temperature. Ten minutes after the application mass hardens and over the marking can be normally driven. One of the advantages of thermoplastic materials is that the application is less sensitive to external temperature and pavement temperature in relation to the paint markings, which provides a longer period of time in a year when it can be applied. Road markings are made from this material are characterized by a very good visibility in all weather conditions, as well in the night and other conditions of reduced visibility during the whole year. Their lifespan is between 2 and 5 years.

3. ANALYSIS OF RETROREFLECTIVITY OF PAINT AND PLASTIC ROAD MARKINGS ON SECTION OF CROATIAN STATE ROAD D1

Dynamic method for testing retroreflection of road markings involves the measurement of night visibility with dynamic measuring device throughout its length. Measurements analyzed in this paper were performed with Zehntner ZDR 6020 dynamic retroreflectometer which measures night visibility R_L in the day and night conditions.

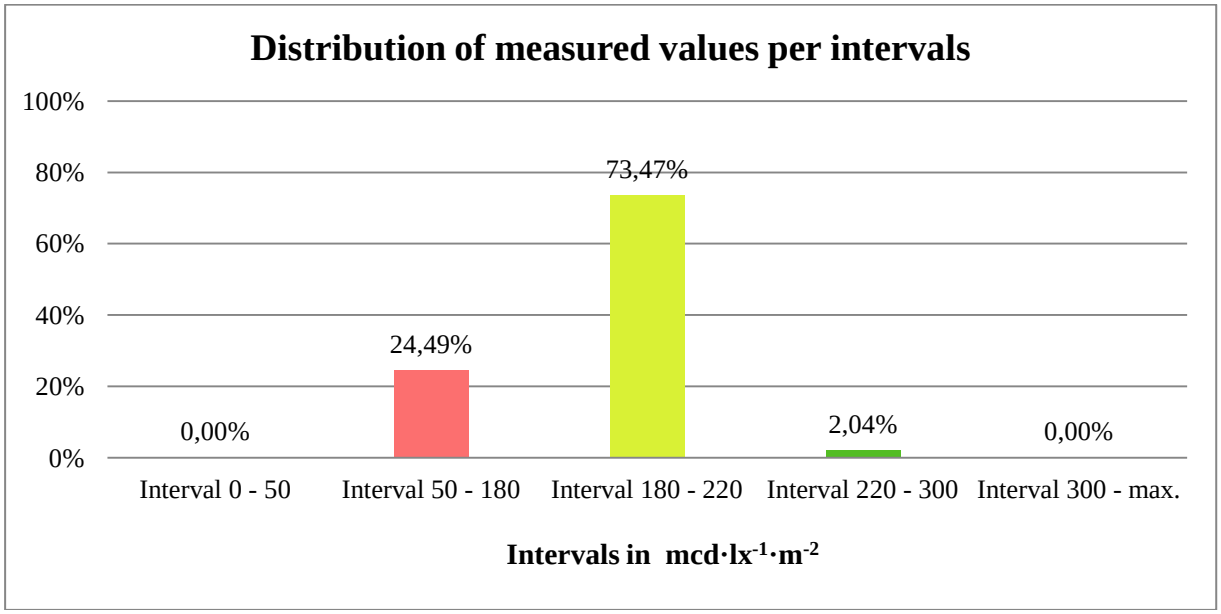
Zehntner ZDR 6020 measures retroreflection in accordance with EN 1436 which defines measuring methods and conditions. In the standard measuring condition, the directions of measurement and illumination define a plane perpendicular to the plane of the field, the observation angle is 2.29° and the illumination angle is 1.24°[2]. Observation distance is 30 m for short lights. Measuring was taken on state road D1 on section Junction Zaprešić (A2) and shopping mall ‘’West Gate’’. All measurements were taken on middle line of listed state road.

3.1. Analysis of paint road markings

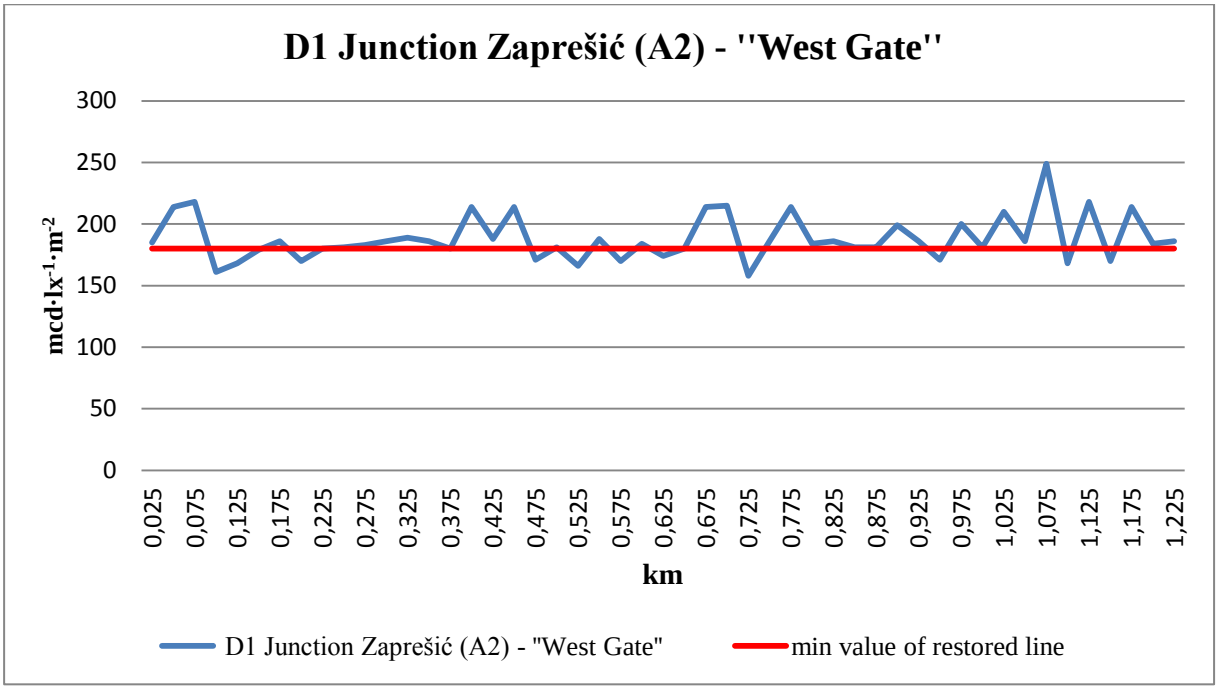
The paint road markings on a section of state road D1 – Junction Zaprešic (A2) – ‘’West Gate’’ were applied in June 2010. Paint that was use is Hempel KSS KW 567 based on chlorinated rubber and synthetic alkyd specially designed for use directly on asphalt or concrete. When applying road markings approximately 0.70 dg/m² of paint and 0.30 dg/m^2 of glass beads (280-800 T14) were used.

First measurement was taken in October 2010. Graph 1. presents distribution of measured values per intervals and it shows that 73.47% of measured values are between 180 – 200 mcd·lx^{-1}·m^{-2}. Minimal value for restored lines for Croatian state roads is 180 mcd·lx^{-1}·m^{-2}. 24.49% of measured values are below minimal which can be justified with entrance/exits from road and roundabouts. Graph 2. shows values of retroreflectivity per kilometer and minimal value of retroreflectivity for Croatian state roads. Graph 3. shows arithmetic mean of measured values per intervals. Arithmetic mean of measured values below minimal value is 169 mcd·lx^{-1}·m^{-2} which is near the minimal value. Overall arithmetic values of all measured values is 188.51 mcd·lx^{-1}·m^{-2}.

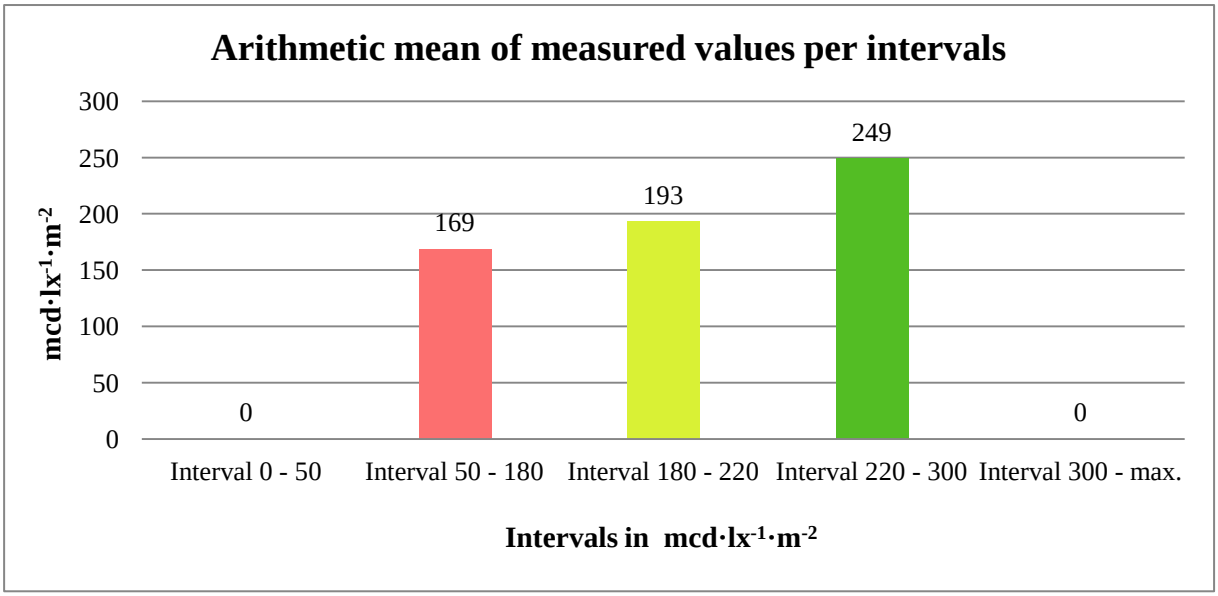
Graph 1 - Distribution of measured values per intervals for restored line



Graph 2 - Values of retroreflectivity for restored line

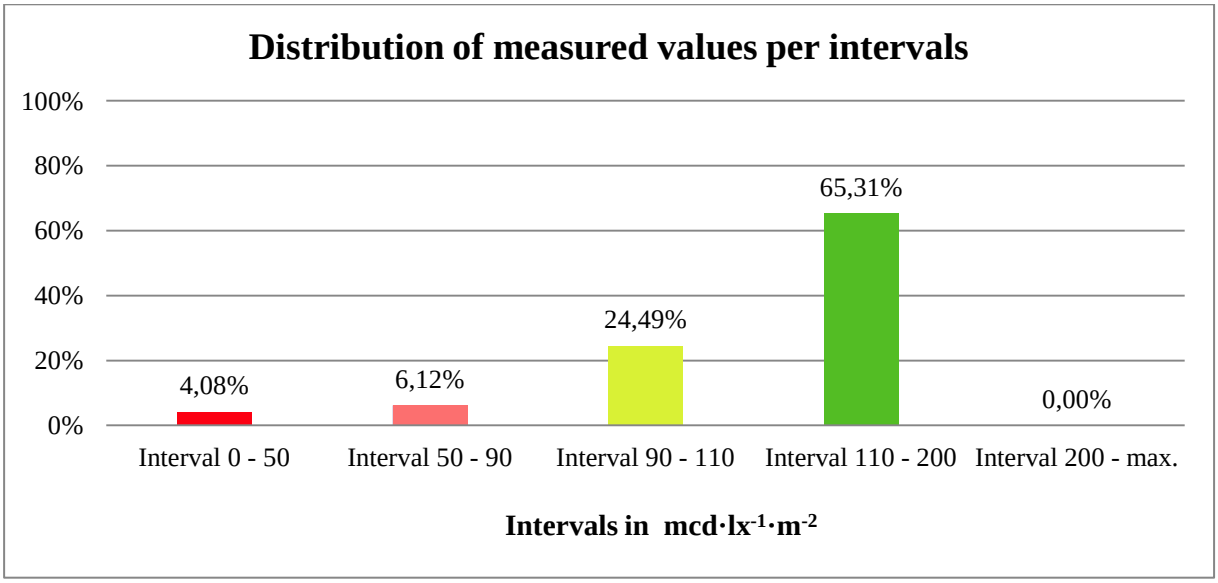


Graph 3 - Arithmetic mean of measured values per intervals for restored line

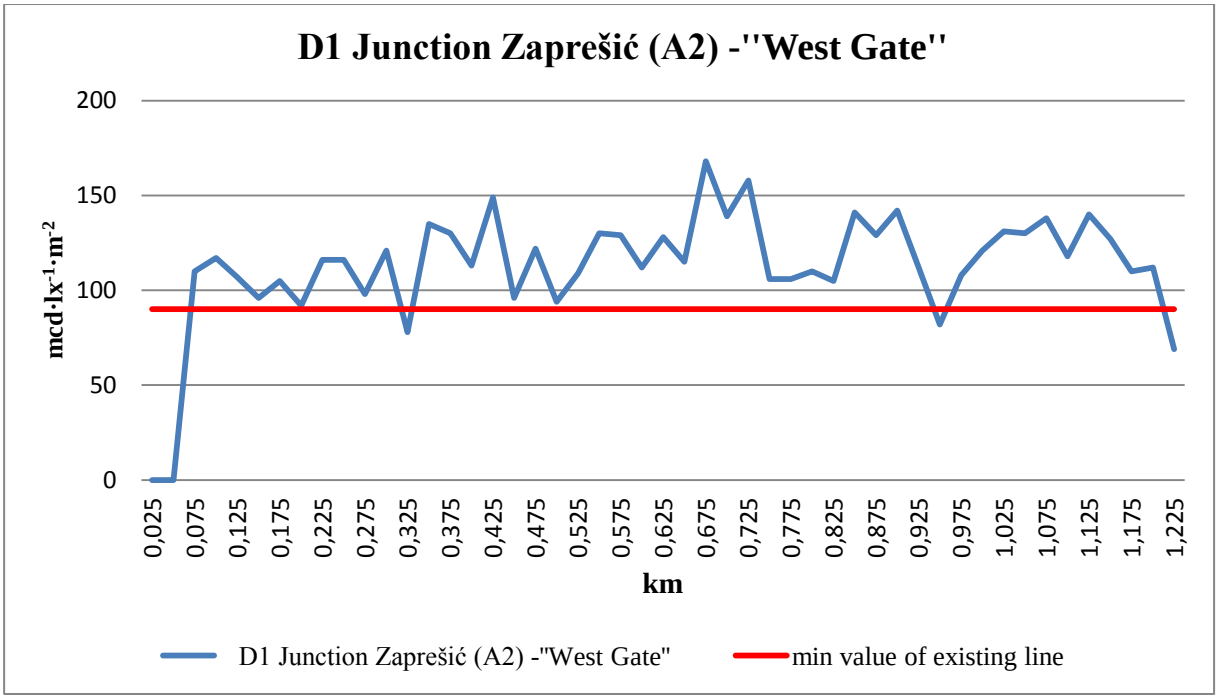


Second measuring was taken in April 2011. Measurement shows that 89.8% of measured values are over the minimal value (90 mcd·lx^{-1}·m^{-2}) for existing lines on Croatian state roads. 10.2% of measured values are below the minimal value. Graph 5. shows values of retroreflectivity per kilometer and minimal value of retroreflectivity for Croatian state roads. Graph 6. shows arithmetic mean of measured values per intervals. Overall arithmetic values of all measured values is 112.65 mcd·lx^{-1}·m^{-2}.

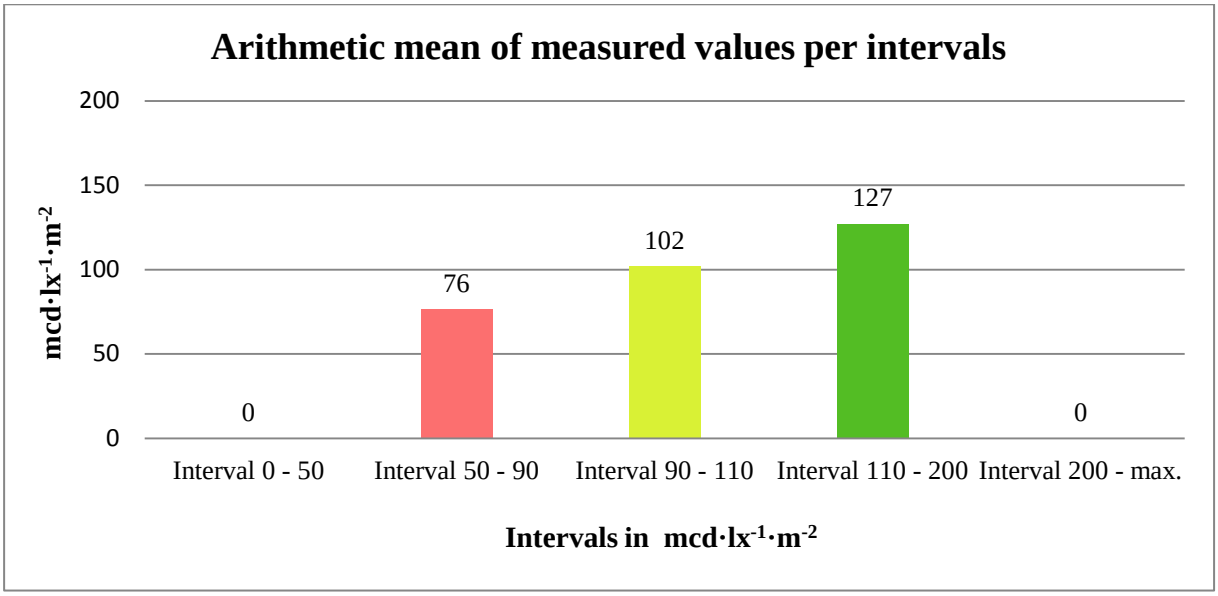
Graph 4 - Distribution of measured values per intervals for existing line



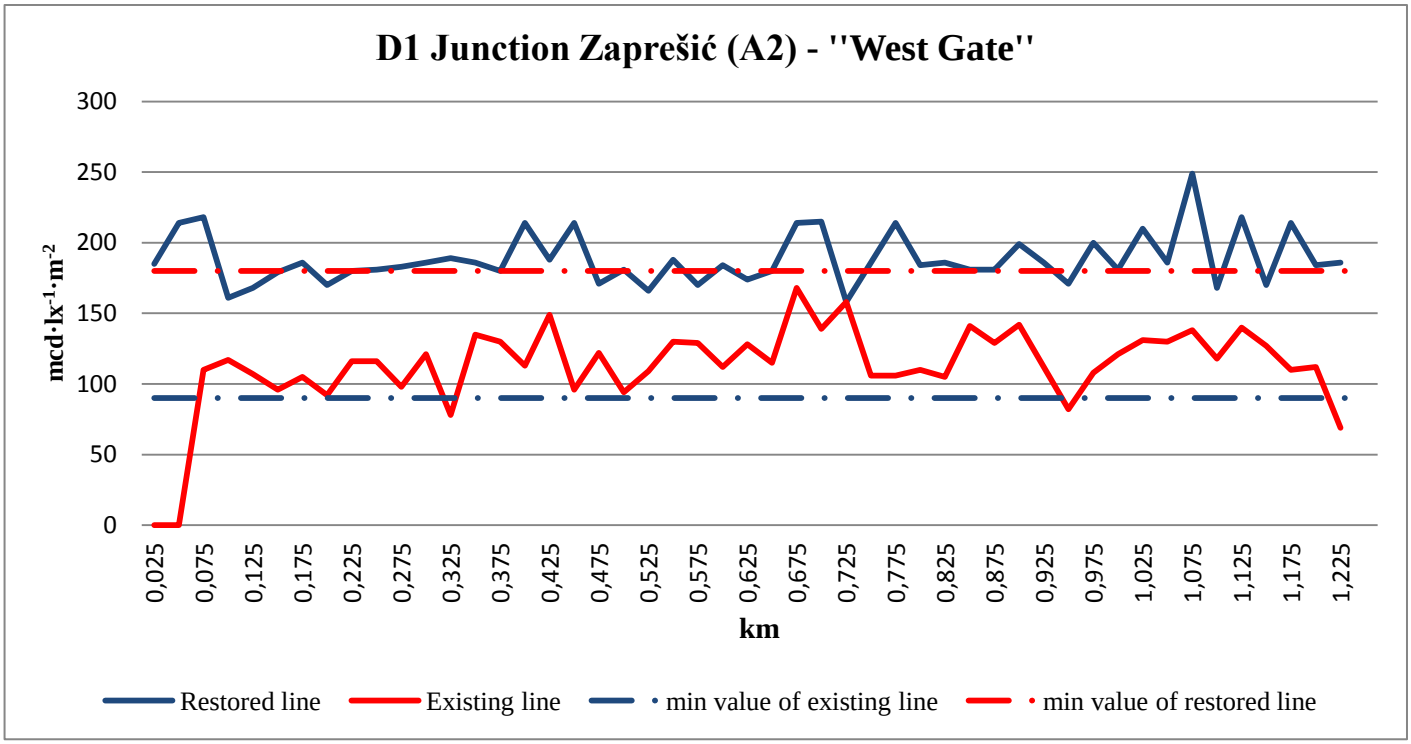
Graph 5 - Values of retroreflectivity for existing line



Graph 6 - Arithmetic mean of measured values per intervals for existing line



Graph 7 - Comparison of measured values of restored and existing line



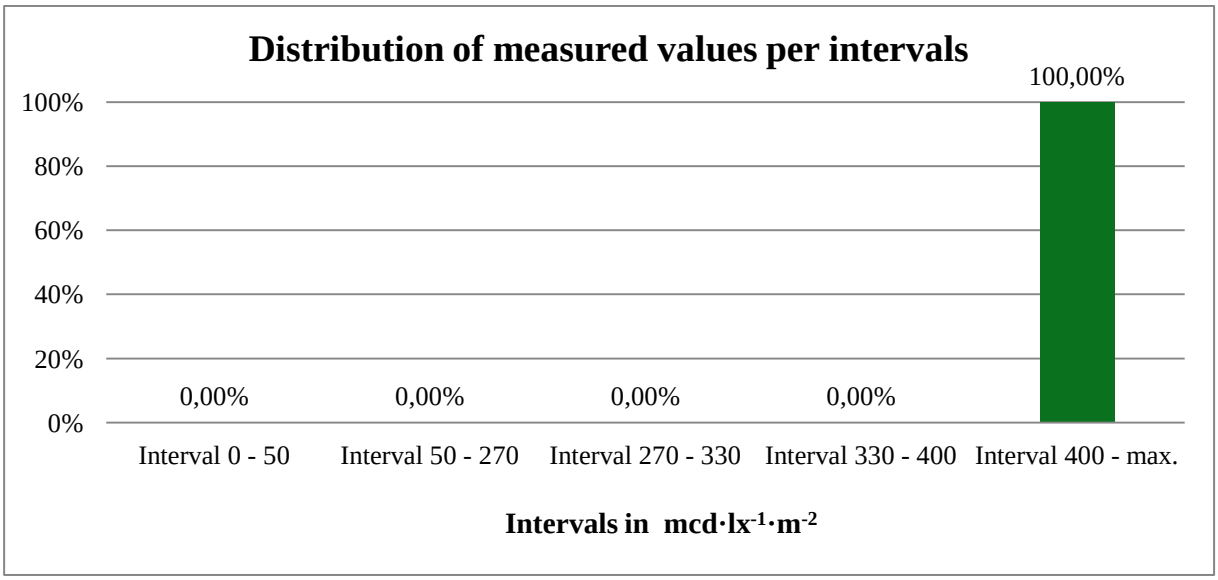
Graph 7. Shows comparison of measured values of restored and existing line. Dividing the mean of the two measurements it was concluded that the values of existing lanes fell by 40.25% in comparison to restored line. This result shows significant decrease of values in period of eight months.

3.2. Analysis of plastic road markings

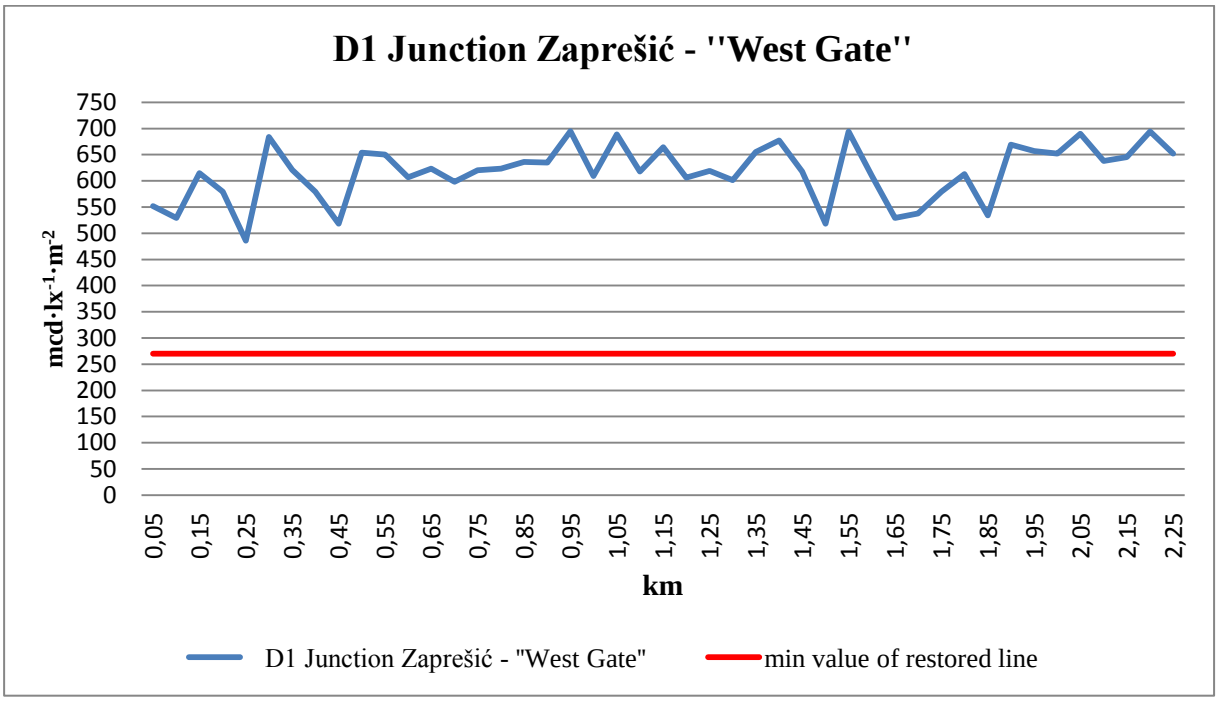
In early June 2011. on the part of state road D1 – Junction Zaprešic (A2) – ‘’West Gate’’ road marking were applied in agglomerate cold plastic TIP II. When applying road marking, 4 kg/m² of agglomerate cold plastic and 0.45 dg/m2 of glass beads (SOLIDPLUS 30 100-800 T18) were used.

First measurement was taken in July 2011. Measured values show excellent results, 100% of values are over the minimal value (270 mcd·lx^{-1}·m^{-2}) for restored TIP II lines for Croatian state roads and in interval 400 - max with overall arithmetic mean reaching 617 mcd·lx^{-1}·m^{-2} which is 40.29% higher than minimal value.

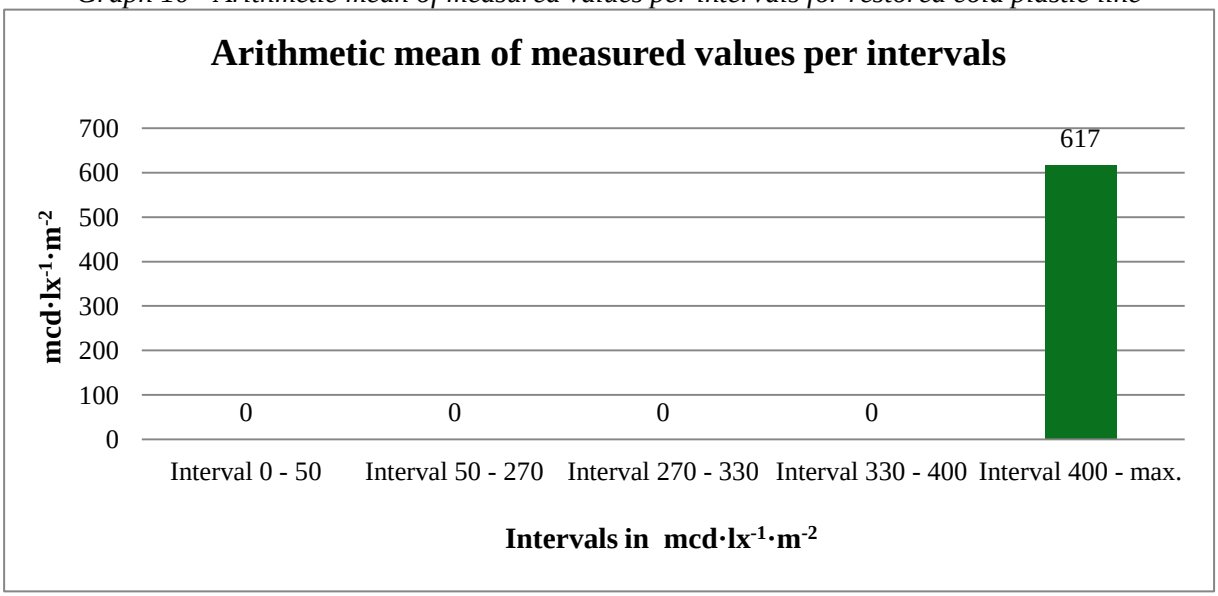
Graph 8 - Distribution of measured values per intervals for restored cold plastic line



Graph 9 - Values of retroreflectivity for restored cold plastic line

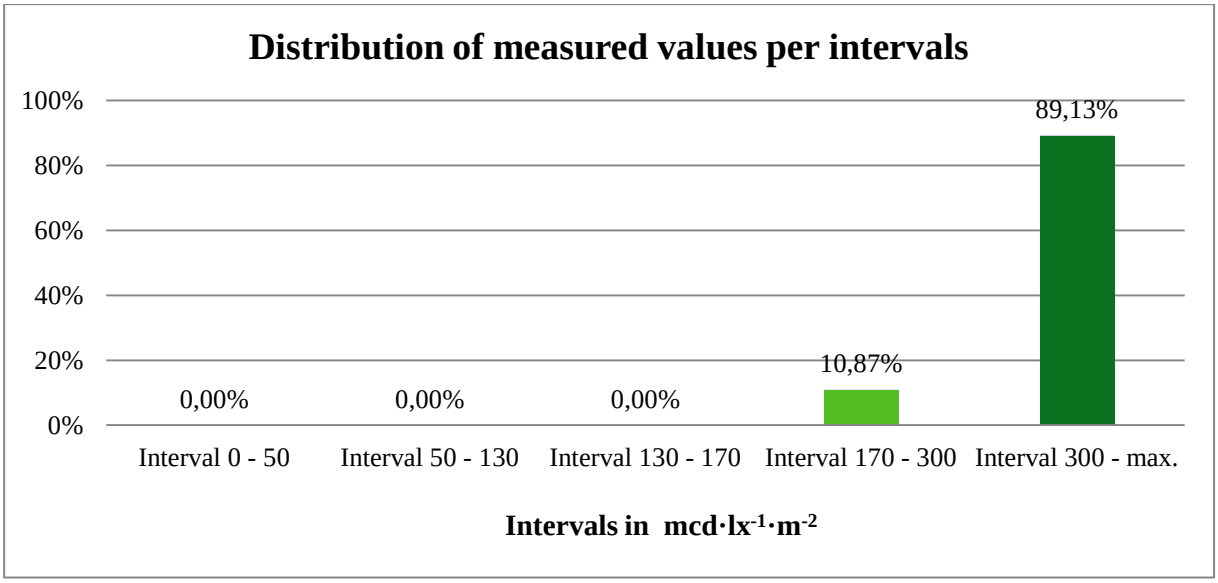


Graph 10 - Arithmetic mean of measured values per intervals for restored cold plastic line

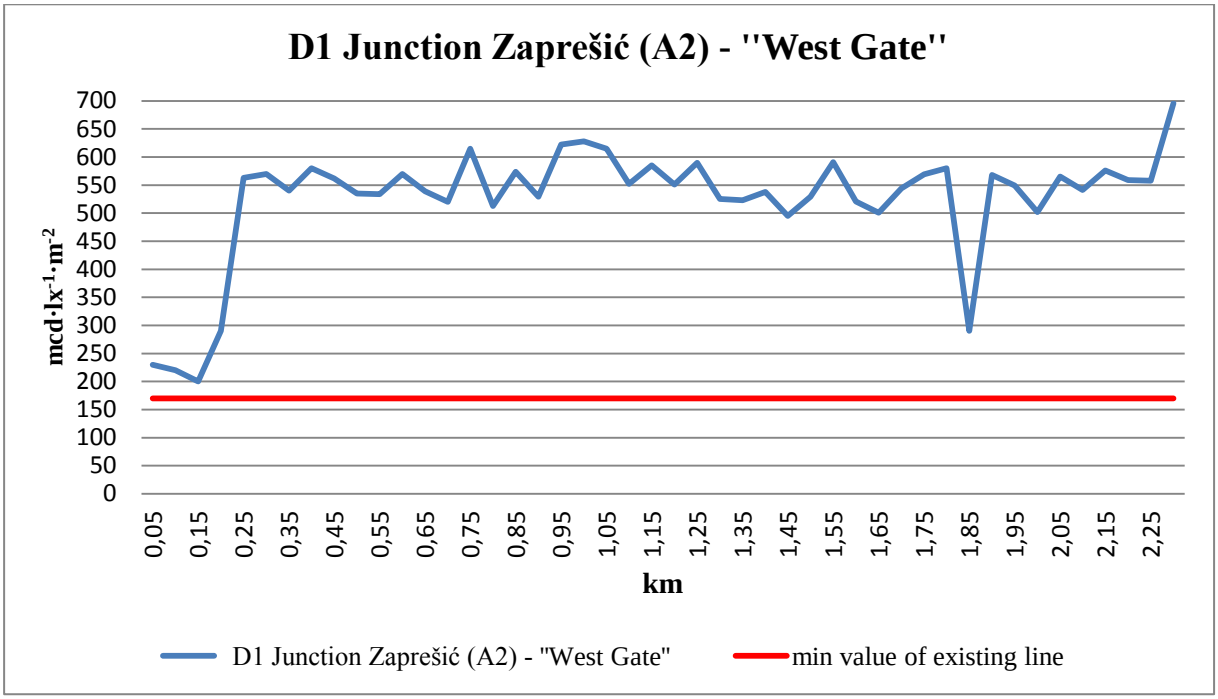


Second measuring was taken in November 2011. Measurement shows that all of measured values are over the minimal value (170 mcd·lx^{-1}·m^{-2}) for existing lines on Croatian state roads. Overall arithmetic values of all measured values is 524.93 mcd·lx^{-1}·m^{-2}.

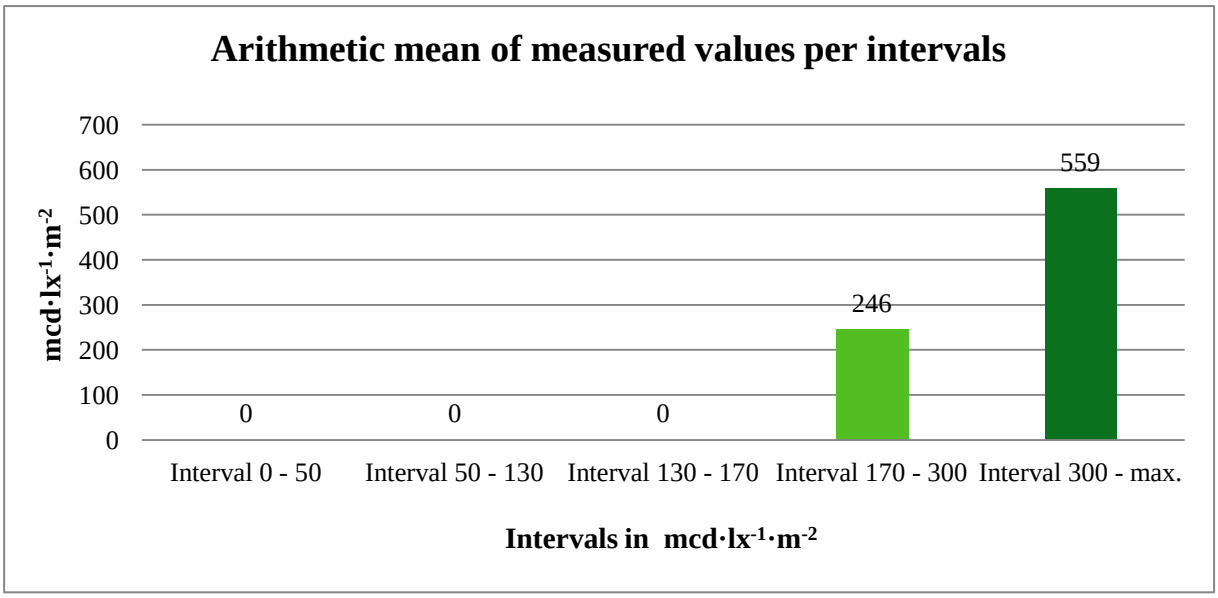
Graph 11 - Distribution of measured values per intervals for existing cold plastic line



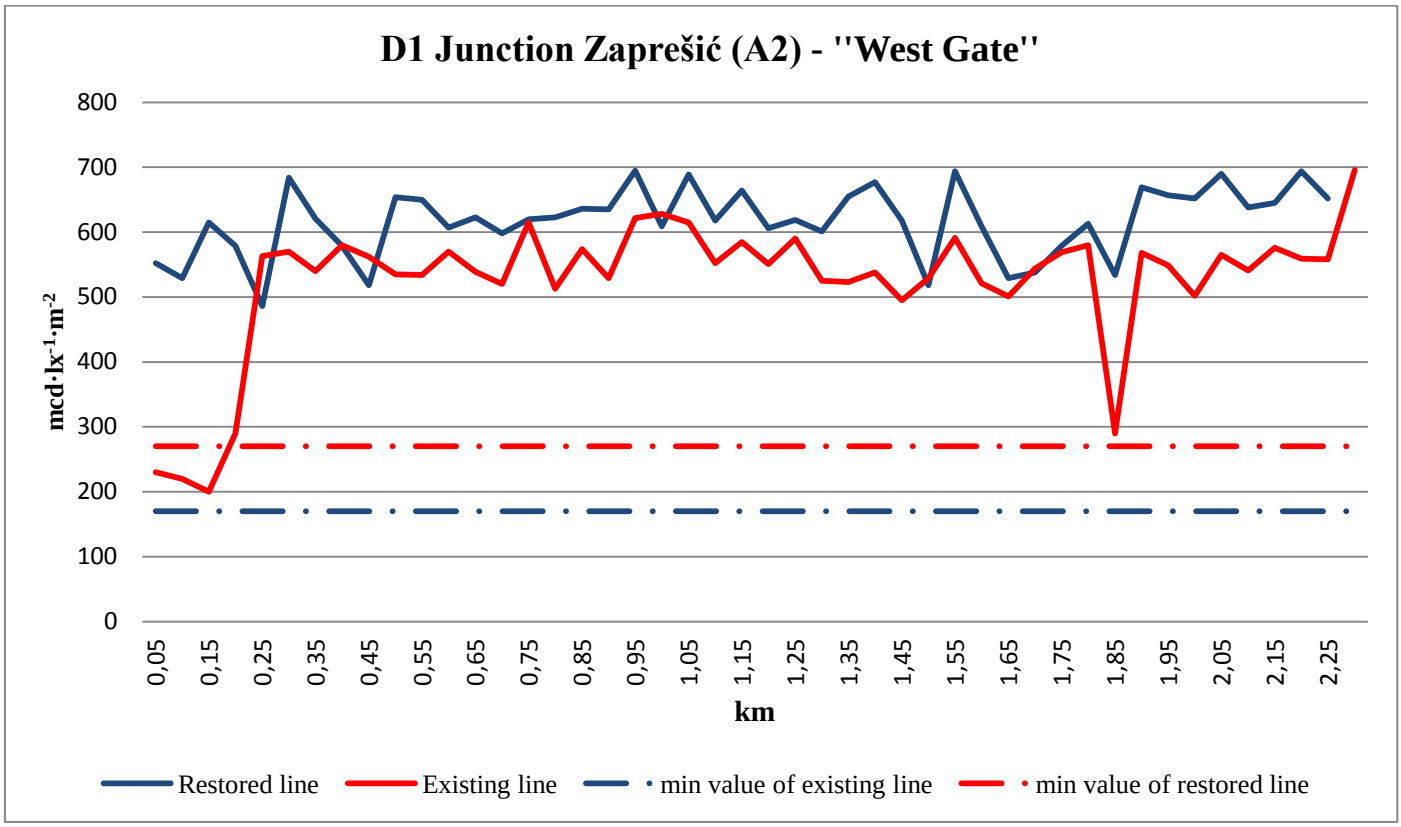
Graph 12 - Values of retroreflectivity for existing cold plastic line



Graph 13 - Arithmetic mean of measured values per intervals for existing cold plastic line



Graph 14 - Comparison of measured values of restored and existing cold plastic line



With the same principal as earlier with paint road markings, comparison of restored and existing cold plastic lines show that values of existing line had decreased for 14.93% in four months.

4. CONCUSION

Measurements taken in period of one year with different road marking materials show that decrease of plastic materials in four months was 14.93% and decrease of paint road markings in eight months was 40.25%. These numbers show that decrease of plastic materials is slower than decrease of paint road markings. Difference between those two decrease percentages is 25.32%. Although period between two measurements for paint road markings were four months longer than plastic road markings, values of retroreflectivity and lifespan for plastic road markings are significantly higher. Also, traffic on measured section after implementation of plastic road markings was higher than before due to opening of shopping mall ‘’West Gate’’ which has great influence on lifespan of road markings because of wear and tear during traffic.

Aldo, plastic road markings are at start more expensive and require complicated applying process, they provide greater retroreflectivity values in day, night and wet conditions and because of that significantly improve road safety.

ENDNOTES

[1] Dawson, J.: Part 1 - The EuroRAP Programme - an overview
[2] EN 1436