

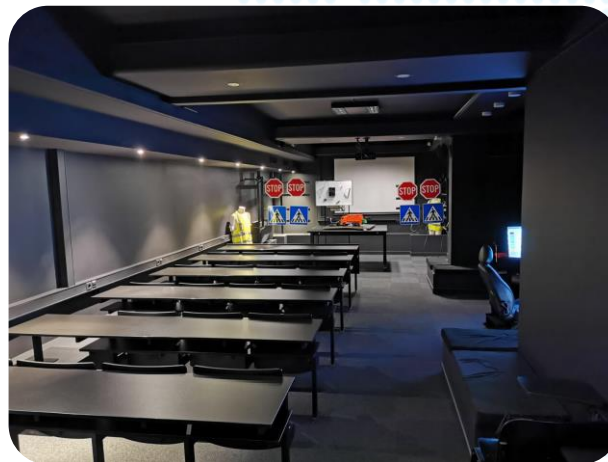
ASSESSING THE PERFORMANCE OF SAFETY ASSETS

Assoc. prof. Darko Babic
Faculty of Transport and Traffic Sciences
University of Zagreb

General Data of the Department for Traffic Signalization

- Department for Traffic Signalization established in year 2000.
- The structure of the Department:
 - **Head of Department:**
Prof. Anđelko Ščukanec, Ph. D.
 - **Permanent staff:**
Assoc. prof. Darko Babić, Ph.D.
Dario Babić, Ph.D.
Mario Fiolić, Ph.D.
Marko Ružić, mag. ing. traff.
Valentina Šnajder, mag. ing. traff.
Maja Modrić, mag. ing. traff.
- In the work of the department are engaged also **STUDENTS (9)**, who through various forms of cooperation acquire scientific and technical knowledge in the field of traffic signalization.

DEPARTMENT FOR TRAFFIC SIGNALIZATION - WORKING ENVIRONMENT



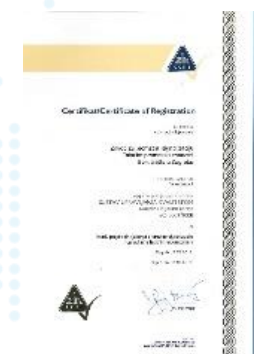
Projects of the Department for Traffic Signalization includes the following tasks:

- Research and testing of new materials and technology in traffic signalization
- Measuring of retroreflection (Road Markings and Traffic Signs) – **CORE JOB**
- Testing of dry film thickness of road markings
- Review of transport and traffic projects and their monitoring
- Projects for Temporary signalization
- Projects for “guiding” signalization
- Projects for Tourist signalization
- Participates in the development of basic, applied and developmental research projects co-financed by the Ministry of Science and Technology
- Cooperation with business entities and academic institutions at home and abroad



ACCREDITATION

- ❑ Testing Laboratory is in accordance with ISO 17025 and ISO 9001 standards.
- ❑ **Road markings accreditation:**
 - ❖ EN 1436:2007+A1:2008 - Measurement method for the luminance coefficient under diffuse illumination Qd
 - ❖ EN 1436:2007+A1:2008 - Measurement method for the coefficient of retroreflected luminance RL
- ❑ **Traffic signs accreditation:**
 - ❖ EN12899-1:2008 - Fixed, vertical road traffic signs - Part 1: Fixed signs
tč./art. 4.1.1.4. - 4.1.1.4 Coefficient of retroreflection RA class RA1 and RA2
CIE 054.2-2001
- ❑ **Coating thickness:**
 - ❖ HRN EN ISO 2360:2004 - Measurement of coating thickness - Amplitude-sensitive eddy current method (ISO 2360:2003; EN ISO 2360:2003)
 - ❖ HRN EN ISO 2808:2008 - Paints and varnishes - Determination of film thickness (ISO 2808:2007; EN ISO 2808:2007)
 - ❖ HRN EN ISO 2178:1999 - Measurement of coating thickness - Magnetic method (ISO 2178:1982; EN ISO 2178:1995)



Why we measure road markings quality?



Road markings quality control



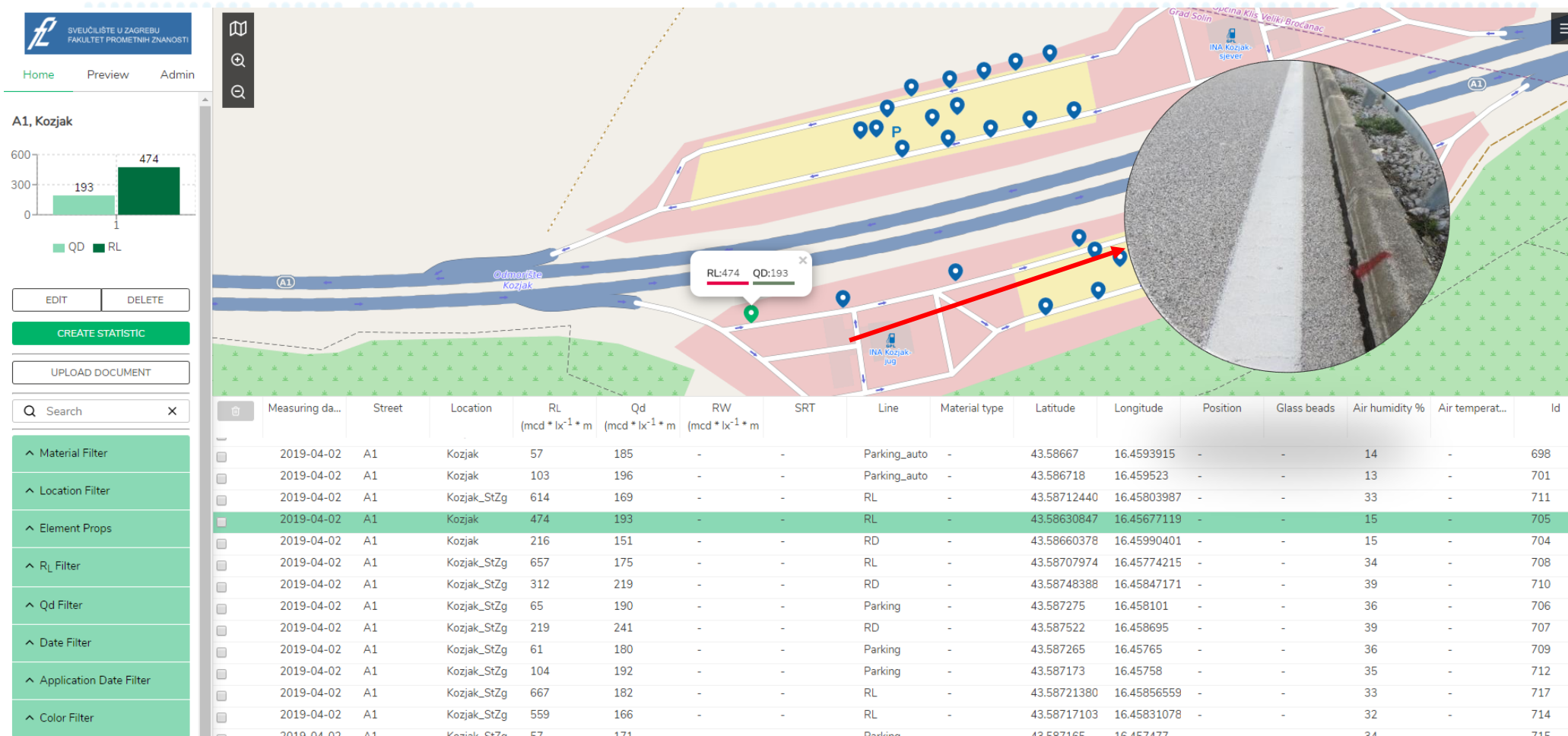
Retroreflectivity measurement



- ❖ Zehntner ZRM 6013 and ZRM 6014 are used for the measuring day and night visibility of road markings (horizontal signalization).

Retroreflectivity measurement

□ (<https://staticretro.smartview.hr/>)



Retroreflectivity measurement - DYNAMIC



- Zehntner ZDR 6020 (mounted on vehicle) is used for dynamic measuring of night visibility (retroreflection) of road markings (horizontal signalization). The ZDR 6020 is a dynamic measuring system for the fast and precise recording of the night visibility and important ambient data of long distances or large areas.

Retroreflectivity measurement - DYNAMIC



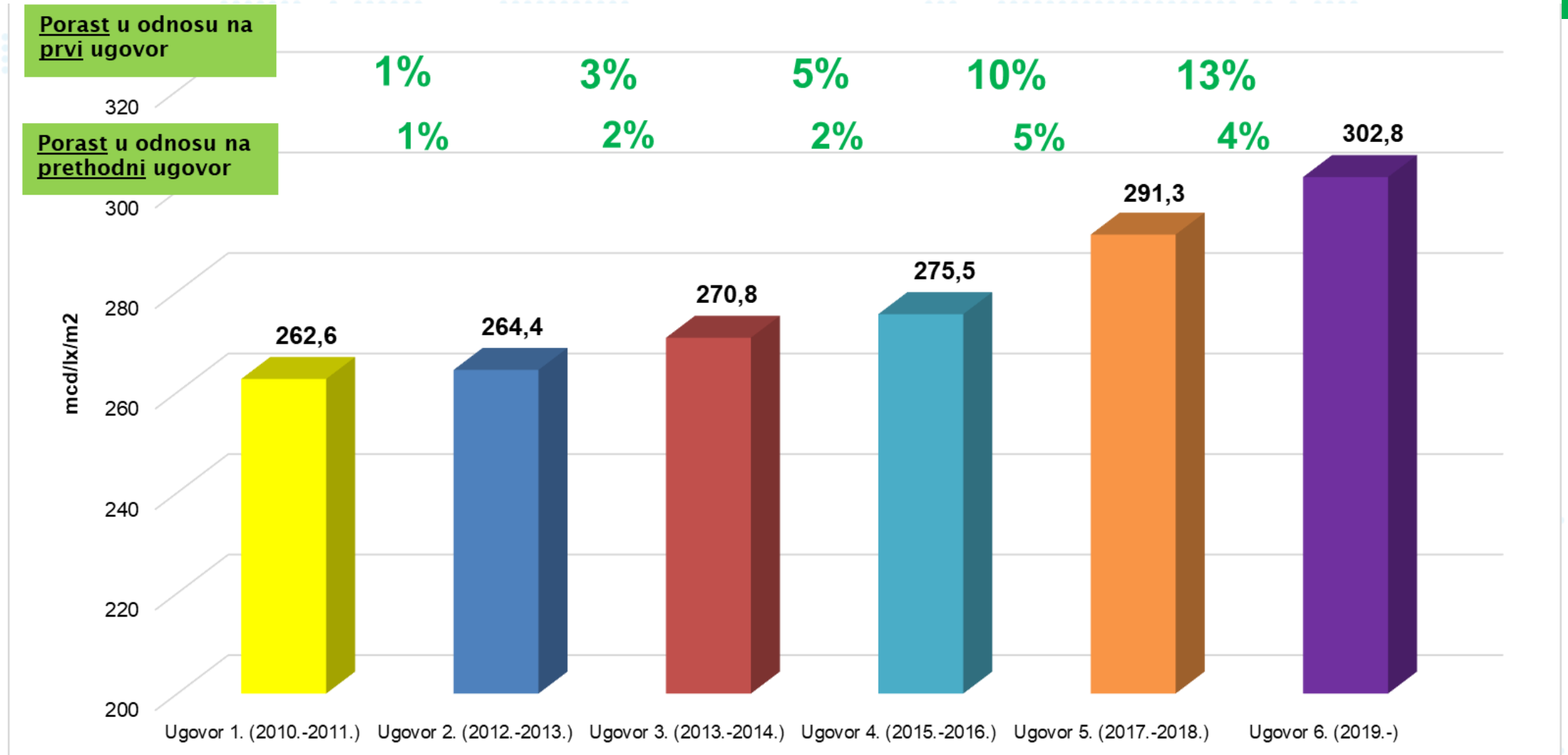
Dynamic retroreflection measurement of longitudinal road markings on Second Level Roads in Croatia 2010 - 2021



- **Period 2010. – 2011.** measured 14.096 km of lines
- **Period 2011. – 2013.** measured 17.918 km of lines
- **Period 2013. – 2014.** measured 13.591 km of lines
- **Period 2015. – 2016.** measured 23.377 km of lines
- **Period 2017. – 2018.** measured 10.453 km of lines
- **Period 2018. – 2019.** measured 10.043 km of lines
- **Period 2019. – 2020.** measured 10.368 km of lines
- **Period 2020. – 2021.** measured 9.633 km of lines

In TOTAL: 109.479 km (end 2021.)

Average retroreflection value (RL) on second level roads in Croatia 2010 - 2021



Dynamic retroreflection measurement of longitudinal road markings on Highways in Croatia 2019 - 2021



- Highway network – 1.300 km full profile
- We provide measurements every year
- Maintenance plan is made based on our results

Why we measure traffic signs quality?



Retroreflectivity measurement



- Zehntner ZRS 6060 is device used for measuring retroreflection of traffic signs (vertical signalization). Zehntner ZRS 6060 uses LED lighting and a 3.5 " high-resolution color touch screen with adjustable angle. Device is used for all types and colors of retroreflective material and automatically detects the color of retroreflective material. Device stores GPS coordinates and measurements can be evaluated with the included mapping and data analysis software "MappingTools".



Colorimetry measurement



CASE STUDY: Traffic signs retroreflection measurement on Croatia second level roads

- With retroreflection coefficient, on all traffic signs we collected info about all others relevant informations for traffic signs:
 - Number of the state road and road section
 - Chainage (road kilometer position of sign)
 - GPS coordinate of the sign
 - Traffic signs code according to the legislation
 - Direction of sign
 - Class of retroreflection material
 - Dimensions
 - Shape
 - Name of the manufacturer
 - Year of manufacture
 - Mounting characteristics and Plate thickness
 - Height of traffic signs
 - Distance from the edge of the pavement
 - Digital photography of traffic sign



CASE STUDY: Traffic signs retroreflection measurement on Croatia second level roads




BASIC FACTS

- Project was realized 2015-2017
- Within this Project we measured and registered **150 000** traffic signs
- After establishing “point Zero” we continued measurement till today on “critical” traffic signs

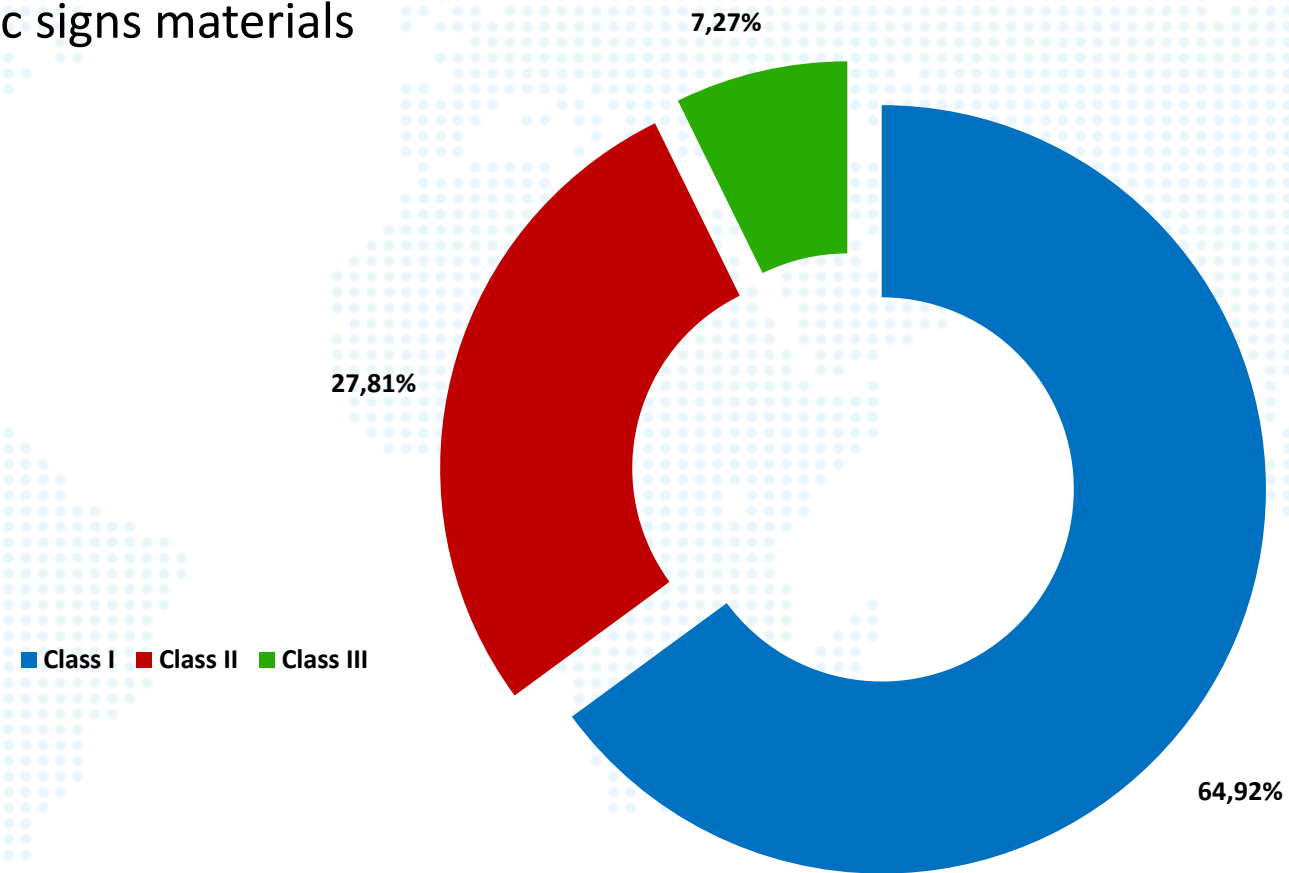


CASE STUDY: Traffic signs retroreflection measurement on Croatia second level roads

Redni broj ispitivanja: 1			
		Cesta:	DC58
		Dionica:	Šibenik (luka) - Boraja (g.ž.)
		Smjer:	SMJ
		Pozicija:	Desno
		Stacionaža:	002/9,993
		Datum ispitivanja:	30. 06. 2020.
		Ispitivao:	Zavod za prometnu signalizaciju Fakulteta prometnih znanosti
Podaci o prometnom znaku			
Šifra:	A05-3	Postava:	
Dimenzije:	120*120*120 cm	način:	Samostojeći stup
Oblik:	Trokut	visina:	-
Proizvođač:	Pismorad (2015-04)	udaljenost od ruba:	66 cm
Debljina lima:	2,1 mm	CE broj:	Ne
		Zaštitna ograda:	Da
Napomena:	-		
Podaci o retroreflektirajućoj foliji			
Klasa:	Klasa I	Vrsta retrorefleksije:	Prizmatična
Vrijednosti koeficijenta retrorefleksije [$cd \cdot lx^{-1} \cdot m^{-2}$]			
Boja	Minimalna vrijednost	Izmjerena vrijednost	Ocjena
Bijela	50,0	129,7	✓
Crvena	7,0	51,88	✓

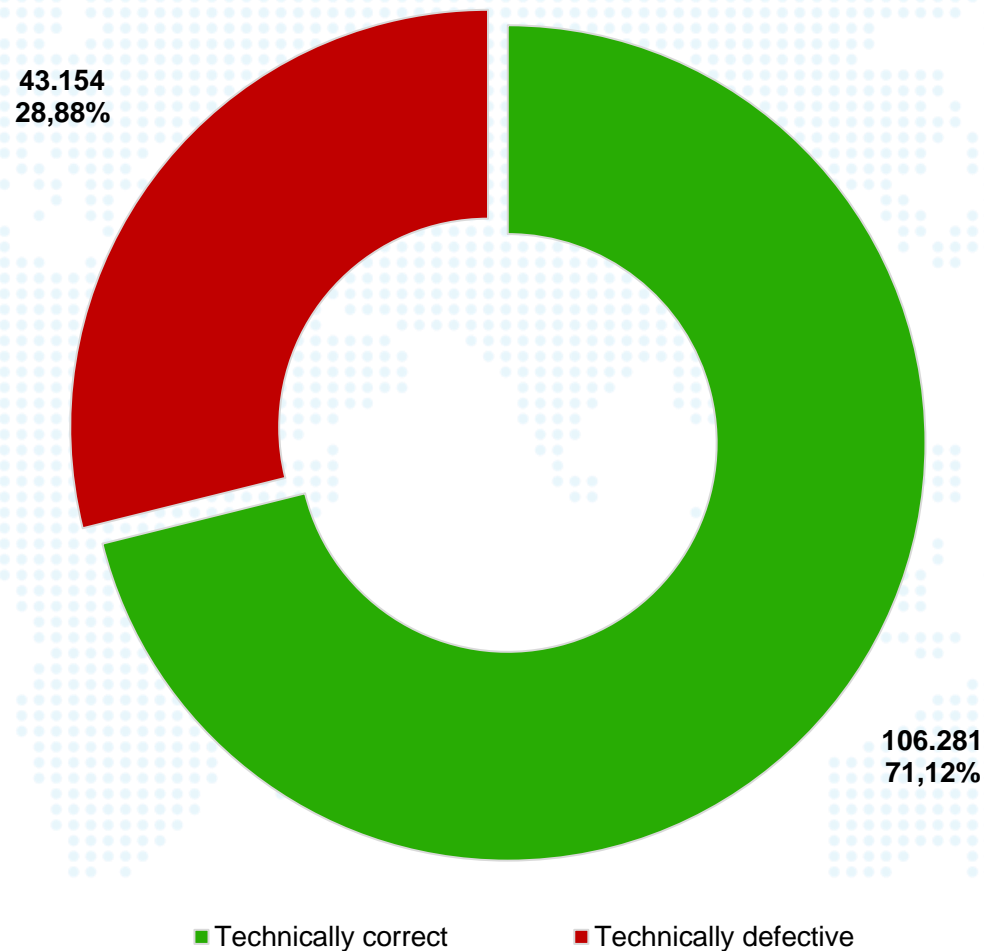
CASE STUDY: Traffic signs retroreflection measurement on Croatia second level roads

Percentage share of traffic signs materials



CASE STUDY: Traffic signs retroreflection measurement on Croatia second level roads

- Percentage share of traffic signs that meet and do not meet the technical requirements
- Average age of “good” signs is **6,34 years**
- Average age of “bad” signs is **11,54 years**



CASE STUDY: Traffic signs retroreflection measurement on Croatia Highways



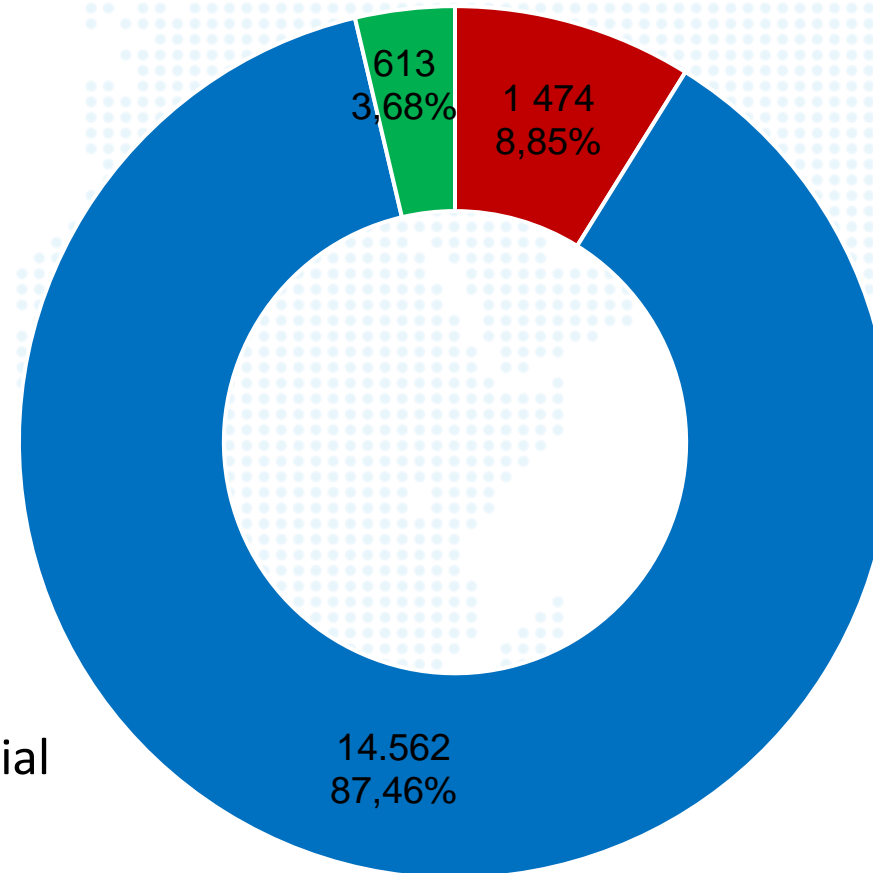
BASIC FACTS

- Project was realized 2020-2021
- Within this Project we measured and registered **16.764** traffic signs



CASE STUDY: Traffic signs retroreflection measurement on Croatia Highways

Percentage share of traffic signs materials



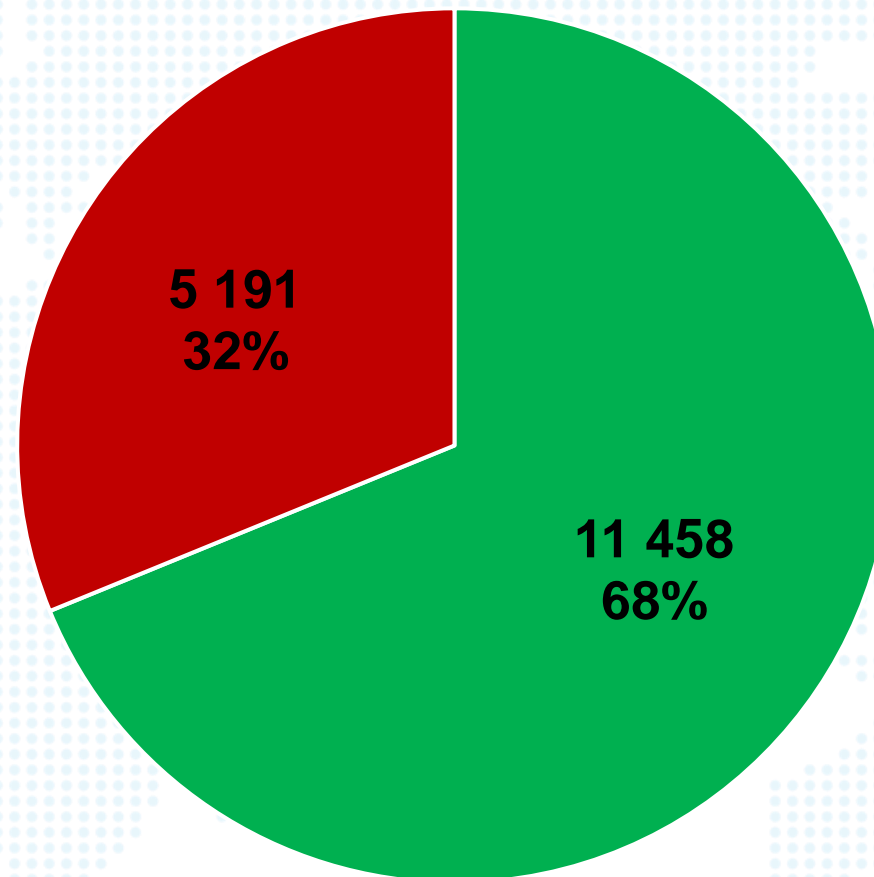
New regulation in Croatia from 2019:

- on Highways is minimum Class 2 material

■ Klasa I ■ Klasa II ■ Klasa III

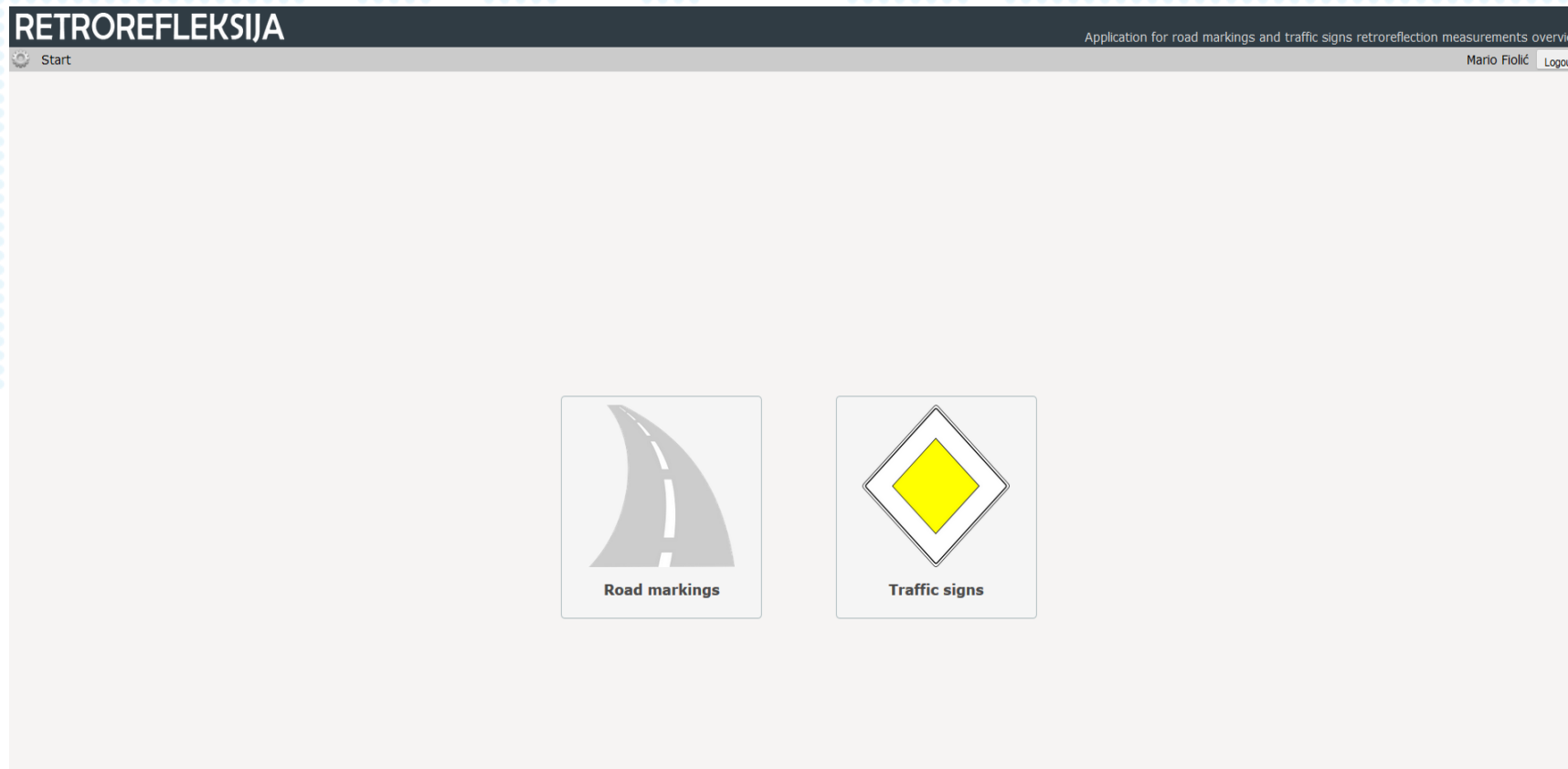
CASE STUDY: Traffic signs retroreflection measurement on Croatia Highways

- Percentage share of traffic signs that meet and do not meet the technical requirements
- Average age of “good” signs is **10,40 years**
- Average age of “bad” signs is **15,70 years**



■ Zadovoljava ■ Ne zadovoljava

SPECIALIZED SOFTWARE PACKAGE – Developed by Department of Traffic Signalization



- The Software developed by Department for Traffic Signalization is used to view the test results of night visibility (retroreflection) of road markings and traffic signs. It provided a detailed data analysis for further research, automatic generation of report for each test (vertical or horizontal signalization) and preparation of databases for tested traffic signs.

ROAD MARKINGS MODUL

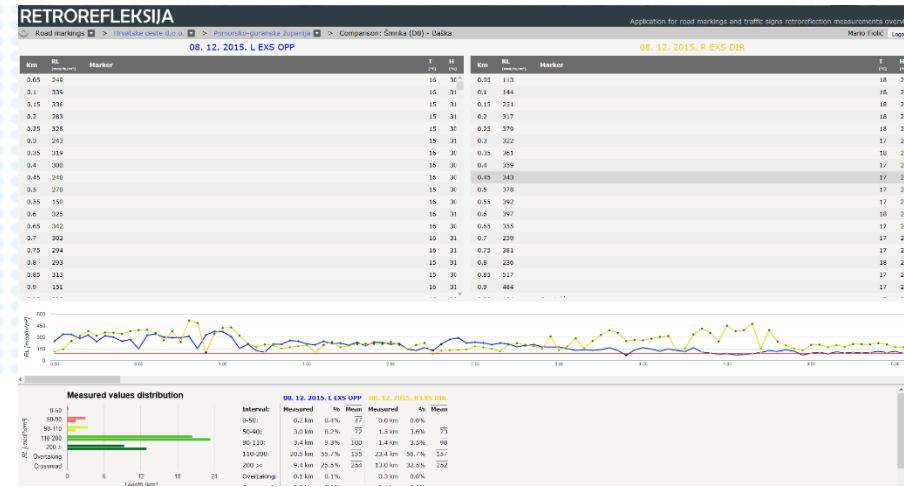
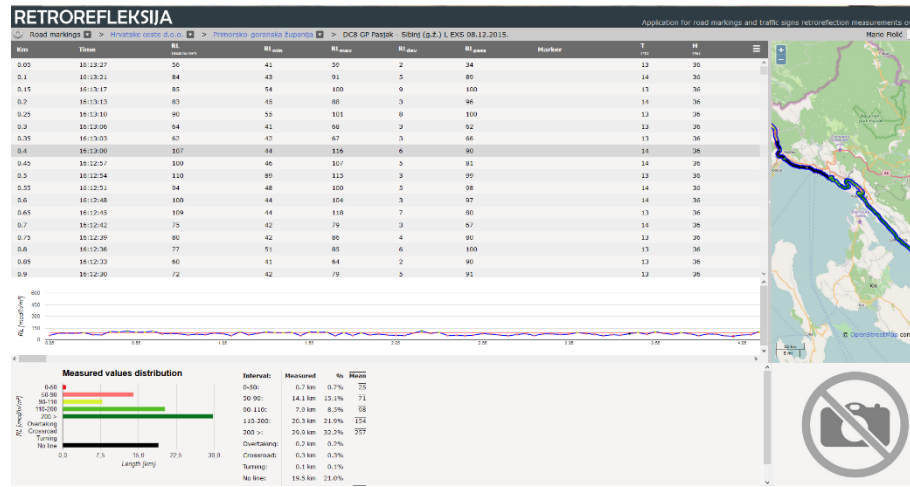


RETROREFLEKSIJA
Application for road markings and traffic signs retroreflexion measurements overview

Approval	Date	Road	Section	Completion	Status	Position	Type	Material	Details
08.12.2015.	DC106	0102 - Vabeka (opazna luka)		97%	Existent	L	Tip 1	P	Details
08.12.2015.	DC106	Zapov (g.2.) - Maraj (06)		99%	Existent	L	Tip 1	P	Details
08.12.2015.	DC104	0102 - Vabeka (opazna luka)		97%	Existent	R	Tip 1	P	Details
08.12.2015.	DC106	Zapov (g.2.) - Maraj (06)		99%	Existent	R	Tip 1	P	Details
08.12.2015.	DC8	GP Pasari - Sibinj (g.2.)		99%	Existent	L	Tip 1	P	Details
08.12.2015.	DC102	Šrnika (06) - Baška		82%	Existent	R	Tip 1	P	Details
08.12.2015.	DC102	Šrnika (06) - Baška		76%	Existent	L	Tip 1	P	Details
08.12.2015.	DC8	GP Pasari - Sibinj (g.2.)		99%	Existent	R	Tip 1	P	Details
07.12.2015.	DC24	Maslinac (04) - Zaton Oborovca (027)		98%	Existent	H	Tip 1	P	Details
07.12.2015.	DC424	Zadar (Jaka Sabrinca) - Zadar 2 (A1)		97%	Existent	LP	Tip 1	P	Details
07.12.2015.	DC309	Vr - Zadar (06)		100%	Existent	H	Tip 1	P	Details
07.12.2015.	DC303	Šopot (027) - Šopot (opazna luka)		99%	Existent	H	Tip 1	P	Details
07.12.2015.	DC502	Avr-Dono Zemunik (D424) - Konj (D27)		94%	Existent	H	Tip 1	P	Details
07.12.2015.	DC424	Zadar (Jaka Sabrinca) - Zadar 2 (A1)		98%	Existent	PP	Tip 1	P	Details
07.12.2015.	DC106	Žrnica (g.2.) - Posađanje (06)		101%	Existent	H	Tip 1	P	Details
03.12.2015.	DC114	Miha - Supetar (D113)		97%	Existent	R	Tip 1	P	Details
03.12.2015.	DC115	Gornji namac (D113) - Bol		93%	Existent	L	Tip 1	P	Details
03.12.2015.	DC113	Supetar - Sumartin (trajektna luka)		98%	Existent	H	Tip 1	P	Details
03.12.2015.	DC114	Miha - Supetar (D113)		98%	Existent	H	Tip 1	P	Details
03.12.2015.	DC115	Gornji namac (D113) - Bol		46%	Existent	H	Tip 1	P	Details
03.12.2015.	DC113	Supetar - Sumartin (trajektna luka)		46%	Existent	R	Tip 1	P	Details
03.12.2015.	DC113	Supetar - Sumartin (trajektna luka)		98%	Existent	L	Tip 1	P	Details
03.12.2015.	DC114	Miha - Supetar (D113)		98%	Existent	L	Tip 1	P	Details
03.12.2015.	DC115	Gornji namac (D113) - Bol		92%	Existent	R	Tip 1	P	Details
03.12.2015.	DC116	Vila (trajektna luka) - Šušva		49%	Existent	L	Tip 1	P	Details

FEATURES:

- Fast upload
- Measurement data review
- Measurement GPS coordinates and picture
- Data analysis
- Comparison data
- Full report



TRAFFIC SIGNS MODUL



FEATURES:

- Fast measurement data review
- GPS coordinate and road kilometer position of each traffic sign
- Data analysis
- Full report

RETROREFLEKSIJA
Application for road markings and traffic signs retroreflection measurements overview

Hrvatske ceste d.o.o. | Hrvatske ceste d.o.o. | Mario Polić | Logout

Approved	Date	Road	Section	Sign Count	Details
20.01.2016.	DC301	Novigrad (D713) - Ezer Nova Vas (A9)		57	Details
20.01.2016.	DC301	Novigrad (D713) - Ezer Nova Vas (A9)		71	Details
20.01.2016.	DC300	OP Plovanja - Ezer Buje (A9)		361	Details
20.01.2016.	DC300	Umag (D713) - Ezer Buje (A9)		306	Details
19.01.2016.	DC303	Rovinj - Ezer Karfanar (A9)		226	Details
19.01.2016.	DC304	Paštin (D443) - Vokalci (D366)		914	Details
19.01.2016.	DC303	Rovinj - Ezer Karfanar (A9)		225	Details
17.01.2016.	DC48	Ezer Baderna (A9) - Ezer Rogovci (A8)		186	Details
13.01.2016.	DC201	OP Pešana - Buzet (D44)		417	Details
12.01.2016.	DC302	Poreč (D713) - Ezer Baderna (A9)		345	Details
12.01.2016.	DC44	Ezer Nova Vas (A9) - Ezer Luoglav (A8)		1029	Details
12.01.2016.	DC48	Ezer Baderna (A9) - Ezer Rogovci (A8)		165	Details
29.12.2015.	DC203	OP Med na kapi - Delnice (D3)		213	Details
29.12.2015.	DC300	Ezer vrnjača (A9) - Krkan (D64)		438	Details
28.12.2015.	DC32	OP Pivod - Delnice (D3)		492	Details
23.12.2015.	DC23	Kapela (p.2.) - Sem (D8)		752	Details
22.12.2015.	DC306	W - Zadar (D8)		827	Details
22.12.2015.	DC218	Dobrasnica (p.2.) - D1		130	Details
18.12.2015.	DC338	Čvrižba sudover (A11) - Muljevec (D38)		40	Details
18.12.2015.	DC310	Zastrebarsko (D1) - Ezer Zastrebarsko (A1)		75	Details
16.12.2015.	DC128	Trogr (D115) - Slabina		211	Details
16.12.2015.	DC56	Dražić (D32) - Črniac (p.2.)		245	Details
16.12.2015.	DC27	Puhčanje (p.2.) - ER		166	Details
14.12.2015.	DC3	OP Medvođe - Ezer Ozanac (D8)		257	Details
14.12.2015.	DC62	Seitanovac (D39) - Veliki Priloz (p.2.)		921	Details

RETROREFLEKSIJA
Application for road markings and traffic signs retroreflection measurements overview

Hrvatske ceste d.o.o. | Istarska županija | DC300 Umag (D713) - Ezer Buje (A9) 20.01.2016. | Mario Polić | Logout

No.	Code	Symbol	Change	Direction	Pass	Valid	Note	Details
1	C92	1/0,082	DIR	✓	✓	✓		Details
2	B11	1/0,163	DIR	✓	✓	✓		Details
3	B34	1/0,163	DIR	✓	✓	✓		Details
4	D17	1/0,171	DIR	✓	✓	✓		Details
5	C132	1/0,200	DIR	✓	✓	✓		Details
6	A44	1/0,201	DIR	✓	✓	✓		Details
7	A09	1/0,201	DIR	✓	✓	✓		Details
8	A05	1/0,203	DIR	✓	✓	✓		Details
9	B01	1/0,264	DIR	✓	✓	✓		Details
10	D17	1/0,297	DIR	✓	✓	✓		Details
11	A05	1/0,412	DIR	✓	✓	✓		Details
12	B01	1/0,454	DIR	✓	✓	✓		Details
13	B32	1/0,777	DIR	✓	✓	✓		Details
14	A33	1/0,796	DIR	✓	✓	✓		Details
15	C79	1/0,821	DIR	✓	✓	✓		Details
16	B31	1/0,821	DIR	✓	✓	✓		Details
17	A33	1/0,818	DIR	✓	✓	✓		Details
18	E01	1/0,920	DIR	✓	✓	✓		Details
19	C44	1/0,950	DIR	✓	✓	✓		Details
20	C02	1/0,960	DIR	✓	✓	✓		Details
21	A05	1/1,038	DIR	✓	✓	✓		Details
22	C62	1/1,029	DIR	✓	✓	✓		Details
23	C82	1/1,020	DIR	✓	✓	✗		Details

RETROREFLEKSIJA
Application for road markings and traffic signs retroreflection measurements overview

Hrvatske ceste d.o.o. | Istarska županija | DC300 Umag (D713) - Ezer Buje (A9) 20.01.2016. | 1/0,163 E34 | Mario Polić | Logout

Road: DC300
Section: Umag (D713) - Ezer Buje (A9)
Direction: DIR
Location: Right
Chainage: 1/0,163
Test date: 20.01.2016.
Measured by: -

Traffic sign details

Symbol code: E34	Backing:
Dimensions: 60*30	backing: Freestanding
Shape: Rectangle	height: 174 cm
Manufacturer: Beal Signal	distance to road: 243 cm
Plate thickness: 2.1 mm	CE number: No

Retroreflective sheeting details

Color	Retroreflecting coefficient values [cd/m²/m²]		
	Minimum value	Measured value	Assessment
White	50.0	96.1	✓

Note: -

Back





SIGNING IS SAFETY!