

REPUBLIC OF SERBIA
TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL SPECIFICATIONS

2.7 TRAFFIC SIGNALIZATION AND EQUIPMENT

BELGRADE, 2012.

Publisher: Roads of Serbia, Inc., Bulevar Kralja Aleksandra 282, Belgrade

Publications:

No.	Date	Description of amendments
1	30.04.2012	First edition

CONTENTS

2.7.1	INTRODUCTION	1
2.7.1.1	NORMATIVE REFERENCES	1
2.7.1.2	TERMINOLOGY	2
2.7.2	TRAFFIC SIGNS	3
2.7.2.1	BASIC MATERIALS	3
2.7.2.1.1	Foundations	3
2.7.2.1.2	Bearing constructions	3
2.7.2.1.3	Traffic signs	3
2.7.2.2	MATERIAL QUALITY	4
2.7.2.2.1	Foundations	4
2.7.2.2.2	Bearing constructions	4
2.7.2.2.3	Traffic signs	5
2.7.2.3	METHOD OF EXECUTION	8
2.7.2.3.1	Foundations	8
2.7.2.3.2	Bearing structures	8
2.7.2.3.3	Traffic signs	8
2.7.2.4	QUALITY OF EXECUTION	10
2.7.2.5	QUALITY CONTROL	10
2.7.2.6	MEASURING AND TAKING OVER OF WORKS	10
2.7.2.7	CALCULATION OF WORKS	10
2.7.3	ROAD MARKINGS	10
2.7.3.1	BASIC MATERIALS	11
2.7.3.2	QUALITY OF MATERIALS	12
2.7.3.3	METHOD OF EXECUTION	13
2.7.3.4	QUALITY OF EXECUTION	15
2.7.3.5	QUALITY CONTROL	18
2.7.3.6	MEASURING AND TAKING OVER OF WORKS	19
2.7.3.7	CALCULATION OF WORKS	19
2.7.4	LIGHT SIGNALIZATION AND TEMPORARY TRAFFIC SIGNALIZATION	19
2.7.4.1	BASIC MATERIALS	20
2.7.4.1.1	Foundations	20
2.7.4.1.2	Direction signs and elevated light reflectors	20
2.7.4.1.3	Panel indicating the top of the splitter island	20
2.7.4.1.4	Traffic cones	20
2.7.4.1.5	Directed movement guardrails and barriers	20
2.7.4.2	QUALITY OF MATERIALS	20
2.7.4.2.1	Foundations	20
2.7.4.2.2	Direction signs and elevated reflectors	20
2.7.4.2.3	Panel indicating top of the splitter island and traffic cones	21
2.7.4.2.4	Directed movement guardrails and barriers	21
2.7.4.3	METHOD OF EXECUTION	21
2.7.4.3.1	Foundations	21
2.7.4.3.2	Direction signs and elevated light reflectors	21
2.7.4.3.3	Panel indicating top of the splitter island	23
2.7.4.3.4	Traffic cones	23
2.7.4.3.5	Directed movement guardrails and barriers	23
2.7.4.4	QUALITY OF EXECUTION	23
2.7.4.5	QUALITY CONTROL	23
2.7.4.6	MEASURING AND TAKING OVER OF WORKS	23
2.7.4.7	CALCULATION OF WORKS	23
2.7.5	BUMPERS AND HALF-BUMPERS	23
2.7.5.1	BASIC MATERIALS	23

2.7.5.2	QUALITY OF MATERIALS	23
2.7.5.3	METHOD OF EXECUTION	24
2.7.5.4	QUALITY OF EXECUTION	24
2.7.5.5	QUALITY CONTROL	24
2.7.5.6	MEASURING AND TAKING OVER OF WORKS	24
2.7.5.7	CALCULATION OF WORKS	24
2.7.6	TRAFFIC SAFETY EQUIPMENT	24
2.7.6.1	BASIC MATERIALS	25
2.7.6.1.1	Safety barrier	25
2.7.6.1.2	Wire safety fences	25
2.7.6.1.3	Crash cushions	25
2.7.6.1.4	Anti-glare equipment	25
2.7.6.1.5	Traffic mirrors	25
2.7.6.1.6	Warning device	26
2.7.6.1.7	Other equipment	26
2.7.6.2	QUALITY OF MATERIALS	26
2.7.6.2.1	Safety barrier	26
2.7.6.2.2	Wire safety fences	26
2.7.6.2.3	Crash cushions	26
2.7.6.2.4	Anti-glare equipment	27
2.7.6.2.5	Traffic mirrors	27
2.7.6.2.6	Warning device	27
2.7.6.2.7	Other equipment	27
2.7.6.3	METHOD OF EXECUTION	27
2.7.6.3.1	Safety barrier	27
2.7.6.3.2	Wire safety fences	28
2.7.6.3.3	Crash cushions	28
2.7.6.3.4	Anti-glare equipment	28
2.7.6.3.5	Traffic mirrors	28
2.7.6.3.6	Warning device	28
2.7.6.3.7	Other equipment	29
2.7.6.4	QUALITY OF EXECUTION	29
2.7.6.5	QUALITY CONTROL	29
2.7.6.6	MEASURING AND TAKING OVER OF WORKS	29
2.7.6.7	CALCULATION OF WORKS	29
2.7.7	OTHER TRAFFIC EQUIPMENT AND SIGNALIZATION	29
2.7.7.1	BASIC MATERIALS	29
2.7.7.1.1	Emergency call barriers	29
2.7.7.1.2	Traffic counting device	29
2.7.7.2	QUALITY OF MATERIALS	30
2.7.7.2.1	Emergency call system	30
2.7.7.2.2	Traffic-counting device	30
2.7.7.3	METHOD OF EXECUTION	30
2.7.7.3.1	Emergency call system	30
2.7.7.3.2	Traffic-counting device	30
2.7.7.4	QUALITY OF EXECUTION	30
2.7.7.5	QUALITY CONTROL	30
2.7.7.6	MEASURING AND TAKING OVER OF WORKS	30
2.7.7.7	CALCULATION OF WORKS	30

2.7.1 INTRODUCTION

Traffic signalization and equipment must be specified in accordance with regulation requirements in project documentation. During the planning of signalization and equipment, we should keep in mind that their construction is legal, in principle, only in those places and in such volume, needed to secure adequate conditions for safe use of traffic surfaces to all traffic participants.

Traffic signalization and equipment must

- guide traffic participants,
- warn about permanent or temporary danger,
- announce limits, bans and traffic obligations,
- give necessary and useful announcements,
- provide other conditions for safe, comfortable and uninterrupted traffic flow.

Traffic signaling and equipment in this specification are classified as

- traffic signs
- markings on roads and sidewalks,
- light signals and temporary traffic signs,
- guardrails and barriers,
- traffic-safety equipment,
- other equipment.

2.7.1.1 Normative references

This guideline covers foreign standards and other technical regulations. It has been stated in text in the appropriate chapters. The final edition is always relevant for use.

- Rulebook on traffic signalization,
- SRPS Z.S.2.240 Colours for thin film road markings,
- SRPS U.S4.102:1987 Technical equipment of public roads - Wire safety fence – Construction Specifications,
- SRPS EN 12899-1:2011 Fixed, vertical road traffic signs – Part 1: Fixed signs (Fixed, vertical road traffic signs - Part 1: Fixed signs),
- SRPS EN 12899-2:2008 Fixed, vertical road traffic signs – Part 2: Transilluminated traffic bollards (Fixed, vertical road traffic signs - Part 2: Transilluminated traffic bollards (TTB)),
- SRPS EN 12899-3:2008 Fixed, vertical road traffic signs – Part 3: Delineator posts and retroreflectors on roads (Fixed,

- vertical road traffic signs - Part 3: Delineator posts and retroreflectors),
- SRPS EN 12899-4:2008 Fixed, vertical road traffic signs – Part 4: Factory production control (Fixed, vertical road traffic signs - Part 4: Factory production control),
- SRPS EN 12899-5:2008 Fixed, vertical road traffic signs – Part 5: Initial type testing (Fixed, vertical road traffic signs - Part 5: Initial type testing),
- SRPS EN 1436:2011, Road-marking materials – Marking for road participants performance,
- SRPS EN 1824:2008 Road marking materials – Road tests,
- EN 1871:2000, Road marking materials. Physical properties,
- SRPS EN 13197:2011 Road marking materials – wear and tear simulators,
- SRPS EN 12802:2008 Road marking materials – Laboratory identification methods,
- SRPS EN 1317-1:2008 Road restraint systems – Part 1: Terminology and general criteria for test methods (road restraint systems - Part 1: Terminology and general criteria for test methods),
- SRPS EN 1317-2:2011 Road restraint systems – Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets (road restraint systems - Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets),
- SRPS EN 1317-3:2011 Road restraint systems – Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions (road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions),
- SRPS EN 1317-4:2011 Road restraint systems – Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers (road restraint systems - Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers),
- SRPS EN 1317-5:2011 Road restraint systems – Part 5: Product requirements and evaluation of conformity for vehicle restraint systems (road restraint systems - Part 5: Product requirements and evaluation of conformity for vehicle restraint systems),

- SRPS EN 10223-1:2009 Steel wire and wire fence products – Part 1: Steel barbed wire coated with zinc and zinc alloy,
- SRPS EN 10223-2:2009 Steel wire and wire fence products – Part 2: Steel net hexagonal openings for applications in agriculture, insulation and fencing,
- SRPS EN 10223-4:2009 Steel wire and wire fence products – Part 4: Welded intertwined fencing steel wire,
- SRPS EN 10223-5:2009 Steel wire and wire fence products – Part 5: Joint and knotted braided steel fencing nets,
- SRPS EN 10223-6:2009 Steel wire and wire fence products – Part 6: Chain connected steel fencing nets,
- SRPS EN 10223-7:2009 Steel wire and wire fence products – Part 7: Welded steel fencing panels,
- EN ISO 6892-1:2009 Metallic materials -- Tensile testing -- Part 1: Method of test at room temperature,
- EN 6507-1:2005 Metallic materials -- Vickers hardness test -- Part 1: Test method,
- ISO 2178:1999 Non-magnetic coatings on magnetic substrates -- Measurement of coating thickness -- Magnetic method,
- EN ISO 1461:2009 Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methods,
- ISO 2178:1999 Non-magnetic coatings on magnetic substrates -- Measurement of coating thickness -- Magnetic method,
- SRPS EN 12676-1:2008 Monitors for anti-glare protection of drivers on roads – Part 1: Performance and characteristics,
- SRPS EN 12676-2:2008 Monitors for anti-glare protection of drivers on roads – Part 2: Test methods.

2.7.1.2 Terminology

Traffic sign (saobraćajni znak) is a sign used by way of graphic or light or numerical or verbal markings or other symbols, to inform traffic participants about dangers on the road, advise them about limitations, bans and obligations, or provide information needed for safe travel on the road.

Base of the traffic sign (podloga saobraćajnog znaka) is an aluminium plate covered with a reflective sheet.

Face of the traffic sign (lice znaka) is the front side of a traffic sign used to show advise, information etc.

Reflective sheeting (reflektujuća folija) is self-adhesive foil, which, due to its general properties, in the presence of a light source (headlights) enables a reflection and hence the content to be seen.

Road markings (oznake na kolovozu i trotoaru) Road markings are used to let traffic participants know about limits, bans and obligations and to provide information, or to direct the movements of traffic.

Light reflectors (odbijači svetlosti) are made of light-reflecting plastic material or metal. They are fixed on to the carriageway and intended for traffic guidance, or for emphasizing road markings.

Panel indicating top of the splitter island (tabla za označavanje vrha razdelnog ostrva) is element of vertical road traffic sign to inform traffic participants about the top of the splitter island.

Delineator post (smerokaz) is a device intended to mark the edge of the carriageway, or the border lane or emergency lane.

Traffic cones (saobraćajne kupe) are elements of vertical road traffic signs for the highlighting of short-term road works.

Barriers and guardrails (branici i zapreke) are elements of vertical road traffic signs for the marking of obstacles on the road and places where road works are being executed.

Bumpers and half-bumpers (branici i polubranici) are devices intended for discontinuing the movement of vehicles, movement of pedestrians or horse riders in the direction in which they are heading. Bumpers block traffic across the entire width of the road. Half-bumpers close traffic on one half of the road.

Safety barrier (zaštitna ograda) is a construction intended to prevent the moving of vehicles away from the carriageway or the movement of vehicles into the opposite-direction traffic lane, or, to accept and stop vehicles moved away from the carriageway.

Wire safety fence (zaštitna žičana ograda) is a construction intended to prevent pedestrians and animals from stepping onto the carriageway, or from crossing the carriageway.

Crash cushions (ublaživači udara) are devices used to provide safety in extremely dangerous places on the road, preventing the risk of vehicles impacting a permanent barrier (e.g., pillars or stone road objects, islands and toll booths, etc.). Crash cushions are intended for cushioning the effects of impact on passengers, vehicles or permanent barriers.

Anti-glare equipment (ograda protiv zaslepljivanja) are nets and modules of anti-glare protection placed on roads with two physically separated carriageway and are used for anti-glare protection of drivers from the vehicles travelling in the opposite direction.

Traffic mirrors (saobraćajna ogledala) are devices intended for providing a greater visibility length.

Warning devices (uređaji za upozoravanje na opasnost) are devices warning of danger because of decreased visibility (i.e. fog), danger from gas concentration in the air and fire.

Emergency call system (sistem za poziv u slučaju nužde) is a system offering, aside from the possibility of voice communication between a highway user with an operator in the control centre, the collecting digital and analog data along the highway route, as well as managing warning devices to drivers.

Equipment for vehicle counting and classification (oprema za brojanje i klasifikaciju vozila) are devices enabling the collection of numerical data on traffic load and calculation of average daily traffic.

2.7.2 TRAFFIC SIGNS

Traffic signs must be placed in such a way, to enable traffic participants to easily notice them and, in accordance with the meaning of the signs, act accordingly. Traffic signs consist of

- foundation,
- bearing constructions
- base for the traffic sign.

Development of traffic signs covers all necessary ground works, acquisition of all appropriate materials and their installation in places specified by design documentation.

Generally, traffic signs are placed on roads as permanent. Traffic signs must be

replaceable (although they can be taken apart and reassembled again in case of damage due to vandalism, traffic accidents, etc.).

For fast adjustment to traffic conditions, the use of appropriate traffic signs with changing content (on a mechanical or light technology background) is possible.

Temporary road traffic signs must be basically adequate for all conditions specified for permanent traffic signs.

2.7.2.1 Basic materials

2.7.2.1.1 Foundations

Traffic sign foundations must be constructed of cement concrete. They may be entirely made in advance (e.g., refurbished with appropriate round cement concrete cross-section pipes as external rimming)

2.7.2.1.2 Bearing constructions

Bearing constructions of traffic signs are

- columns,
- pillars,
- bearing frame,
- semiportals and portals,
- stands (for temporary traffic signs).

In principle, bearing constructions must be made of durable materials: steel, aluminium, simple or enforced cement concrete or plastic.

2.7.2.1.3 Traffic signs

In accordance with their purpose, traffic signs are classified as

- warning signs (equilateral triangle),
- signs for prohibitory commands – bans and limits, requirements (circle, octagon),
- announcement signs (circle, square, rectangle, rectangle with arrow ending).

A complementary board, which is an integral part of the traffic sign and determines its meaning, may be placed together with the traffic sign.

Attachment devices should also be taken into consideration as integral parts of traffic signs.

Shape and size of traffic signs has been specified in great detail in the Traffic Signalization Rulebook.

Measurements (width) of complementary boards must be coordinated with basic traffic signs measurements.

When, due to traffic safety or traffic technical requirements, it becomes necessary, traffic signs may be placed with changeable content messages in the shape of

- rotating modules,
- rotating prisms,
- rotating surface
- luminous fields, added on to usual traffic signs,
- optical fibres,
- liquid crystals, or
- highly-luminous diodes.

Base

Traffic sign bases and housing of transilluminated traffic bollards must be made of

- polyester, impregnated with glass fibre, or
- tin (steel or aluminium).

Face of transilluminated traffic bollards must be made out of see-through or transparent plastic material (acrylic glass and sl.).

The face of the sign must be light reflective.

Signs and writings

Signs and writings on traffic signs may be:

- non-reflective: coloured or made of light non-reflecting materials (sheet),
- reflective: made of light-reflecting materials (type I, II, III),
- illuminated: internally or externally (with its own light source).

Housing of the internally illuminated traffic sign must be permeated by light on the surface, intended for the signs of writing.

Shape, size and variety of lamps and luminous bodies must be adjusted to the traffic sign. In principle, the following should be used

- for luminous traffic signs: halogen and regular luminous bodies,
- for lighted traffic signs:
 - externally: sodium and mercury high-pressure luminous bodies,
 - internally: fluorescent, LED or neon luminous bodies.

Attachment devices

In principle, traffic sign attachment devices (grip rings (clamps), screws, bolts and bases) must be made of steel, with adequate corrosion protection.

2.7.2.2 Material quality

2.7.2.2.1 Foundations

Unless otherwise specified in design documentation, or if not otherwise regulated by the engineer, cement concrete C 12/15 or C 16/20 must be used for road signs foundations. For bases of portals or semiportals adequate impregnated cement concrete must be used.

Since cement concrete circular pipes are primarily bases that are prepared in advance as the (prefabricated) foundations for columns, the quality of those pipes must be adequate to the required cement concrete quality of foundations.

2.7.2.2.2 Bearing constructions

Columns

By rule, traffic sign columns must be made of steel pipes, internally and externally protected by hot zinc or in another adequate way (plastic-coated, coloured, metalized)

Outer diameter of traffic sign pillars may be:

- 60.3 mm (63.5 mm), 88.9 mm or 102 mm.
- The shortest width of the pillar wall may be:
 - for a pillar with a diameter 60.3 mm (63,5 mm) – 2 mm,
 - for a pillar with a diameter 88.9 mm – 2.5 mm i
 - for a pillar with a diameter 102 mm – 2.5 mm.

In case of minimum deviation of the pillar diameter from the required, sign supplier is responsible for processing the clamps for attaching signs onto the pillar, in such a way that they can also be used on pillars specified in the first subpart of this item.

The connection between the sign pillar and a concrete foundation must be executed in such a way as to prevent turning the pillar around the longitudinal centre line. Turning prevention may be provided with the help of anchors or with the help of changing the shape of the pillar in the foundation region.

Top of the sign pillar must be closed in order to prevent collection of atmospheric water inside the pillars.

In extraordinary cases or with the consent of the engineer, columns made of other appropriate materials (aluminium, oak and pine tree, etc.) may also be used for erecting temporary traffic signs.

Pillars

Quality of material for vertical and cantilevered pillars, intended primarily for installing light traffic signs (traffic lights), must be in accordance with provisions intended in design documentation.

Bearing frame

Bearing frame for permanent announcement traffic signs (boards before interchanges, making turns, confirmation of direction, etc.) must be made of steel pipes with an adequate cross section.

Semi-portals and portals

Semi-portals and portals must be made of steel.

Steel quality must be in accordance with conditions stated in design documentation, as well as the quality of any other kind of material, which may be used for development of semi-portals or portals.

Stands for temporary traffic equipment must be made of a material that will, in a limited amount of usage time, fully serve its purpose (steel, aluminium, wood).

2.7.2.2.3 Traffic signs

Over duration time, shape and color of traffic signs must be durable, in order to keep the instruction and information, conveyed by the signs to the traffic participants, safe and unambiguous.

Over duration time, shape and colour of traffic signs must be durable, in order to keep the instruction and information, conveyed by the signs to the traffic participants, safe and unambiguous.

Traffic sign material must be resistant to

- weather and water impact (hydrophobic),
- chemical changes,
- excessive wear and tear, as well as
- burning and related dangers.

Base

Traffic sign base must be capable of enduring

- wind load in accordance with standard SRPS EN 12899-1:2011 and
- temperature changes from -35°C to 70°C within the limitations of approved voltages in the materials elasticity. At the same time, elasticity deformations must not diminish the traffic signs durability.

Thickness of the traffic sign base should be determined in accordance with

- required size of the traffic sign,
 - type of material, and
 - method of shaping and reinforcement.
- Tin, used for base, must be at least 2 mm thick.

Signs and writings

Reflecting foils, used for making the face of the sign, must be in compliance with all the requirements specified in item 4 of the standard SRPS EN 12899-1:2011, where, it must be taken into consideration that certain foil types must be in compliance with the following requirements:

- chromatic values and luminosity factor for foils type I and II – class CR2, according to table 2 SRPS EN 12899-1:2011,
- retroreflection coefficient RA for foils type I – the lowest class being RA1, according to table 3 SRPS EN 12899-1:2011,
- retroreflection coefficient RA for foils type II – the lowest class being RA2, according to table 4 SRPS EN 12899-1:2011, whilst bearing in mind that the use of a dark green colour (dark green) is not allowed,
- chromatic values and luminosity factor for foils type III in daylight, according to table 2.7.1,
- chromatic values for foils type III at night, according to table 2.7.2,
- lowest retroreflection coefficient (cd.lx-1.m-2) for foils type III, according to table 2.7.3,
- lowest retroreflection coefficient (cd.lx-1.m-2) for fluorescent yellow/green foil type III, according to table 2.7.4.

Table 2.7.1: Chromatic values and luminosity factor for foils type III in daylight

Colour	Coordinates					Luminosity factor	
		1	2	3	4	Class B1	Class B2
white	x y	0,305 0,315	0,335 0,345	0,325 0,355	0,295 0,325	≥ 0,27	≥ 0,40
yellow	x y	0,494 0,505	0,470 0,480	0,513 0,437	0,545 0,454	≥ 0,16	≥ 0,24
red	x y	0,735 0,265	0,700 0,250	0,610 0,340	0,660 0,340	≥ 0,03	≥ 0,03
green	x y	0,110 0,415	0,170 0,415	0,170 0,500	0,110 0,500	≥ 0,03	≥ 0,03
blue	x y	0,130 0,090	0,160 0,090	0,160 0,140	0,130 0,140	≥ 0,01	≥ 0,01
fluorescent yellow/green	x y	0,387 0,610	0,460 0,540	0,438 0,508	0,376 0,568	≥ 0,60	≥ 0,70

Table 2.7.2: Chromatic values for foils type III at night

Colour	Coordinates				
		1	2	3	4
white	x y	0,475 0,452	0,360 0,415	0,392 0,370	0,515 0,409
yellow	x y	0,513 0,487	0,500 0,470	0,545 0,425	0,572 0,425
red	x y	0,652 0,348	0,620 0,348	0,712 0,255	0,735 0,265
green	x y	0,007 0,570	0,200 0,500	0,322 0,590	0,193 0,782
blue	x y	0,033 0,370	0,180 0,370	0,230 0,240	0,091 0,133
Fluorescent yellow/green	x y	0,550 0,450	0,523 0,442	0,475 0,490	0,480 0,520

Table 2.7.3: Lowest retroreflection coefficient (cd.lx-1.m-2) for foils type III

Observation angle α [°]	Entry angle β_1 [°]	White	Yellow	Red	Blue	Green
0,1	5	850	550	170	55	85
0,2	5	625	400	125	40	60
0,33	5	425	275	85	28	40
0,1	20	600	390	120	40	60
0,2	20	450	290	90	30	45
0,33	20	300	195	60	20	30
0,1	30	425	275	85	28	40
0,2	30	325	210	65	20	30
0,33	30	225	145	45	15	20
0,1	40	275	175	55	18	25
0,2	40	200	130	40	13	20
0,33	40	150	95	30	10	15

Table 2.7.4: Lowest retroreflection coefficient (cd.lx-1.m-2) for fluorescent yellow/green foil type III

Observation angle α [°]	Entry angle β_1 [°]	Fluorescent yellow/green
0,2	5	375
0,33	5	270
1,0	5	70
0,2	30	200
0,33	30	140
1,0	30	43
0,2	40	36
0,33	40	24
1,0	40	9

Manufacturer of traffic signalization must guarantee that the reflecting foils will have the following characteristics:

- reflective foil type I will retain a minimum of 50% of its initial retroreflection seven years after the traffic signs installation,
- reflective foil type II will retain a minimum of 80% of its initial retroreflection ten years after the traffic signs installation,
- reflective foil type III will retain a minimum of 80% of its initial retroreflection ten years after the traffic signs installation,
- reflective foil type III of fluorescent yellow/green colour will retain its fluorescent properties at least five years after the traffic sign installation.

Traffic sign colours must not be sparkling, in order to prevent glare caused by vehicle headlights.

The back of a traffic signs colour (including all attachment devices) must be dirty grey.

Material for signs and writings on traffic signs (paints and foils) must be resistant to approved agents used in the cleaning of traffic signs.

Attachment devices

Devices for attachment of traffic signs onto the bearing construction must be manufactured of materials securing their impeccable use for the entire duration and they provide for economic traffic sign replacement.

Grip rings (clamps) and bases must be manufactured of appropriate steel tape, nuts and bolts of quality steel, and have protection from corrosion.

2.7.2.3 Method of execution

Vertical traffic equipment must be installed in places determined by adequate regulations and design documentation.

2.7.2.3.1 Foundations

Foundations must be executed based on previously executed statistical calculation. Detailed foundation construction method, suggested by the contractor, must be approved by the engineer, which may determine additional conditions in the execution of works.

2.7.2.3.2 Bearing structures

Construction method of bearings for road traffic signs must be specified in detail in the design documentation.

Every justifiable change, suggested by the manufacturer, must first be approved by an engineer.

Traffic signs must be designed and manufactured in a way that enables bearing capacity and stability in accordance with Item 5. of the SRPS EN 12899-1:2011 standard, while taking into consideration that traffic signs and their bearing constructions and/or frames must meet the following requirements:

- when determining the bearing construction and/or frame for traffic signs, with a surface greater than 12 m², and when determining the bearing construction and/or frame for traffic signs, placed above the carriageway, we need to take into consideration the values of the load safety factor class PAF 2 from table 6 and values of the wind load class WL8 from table 8,
- when determining the bearing construction and/or frame for traffic signs, not determined in the prior point, we need to take into consideration load safety factor values class PAF 1 from table 6 and wind load values class WL5 from table 8,
- when determining traffic sign elements, or traffic sign bases, not covered in prior lines, we need to take into consideration safety factor values class PAF 1 from table 6, wind load values class WL5 from table 8, values for dynamic pressure of snow DSL1 from table 9, values for the greatest temporary deformation TDB4 from table 11. The greatest permanent deformation must not be greater than 20% of the greatest temporary deformation value.

2.7.2.3.3 Traffic signs

Traffic signs may be one-sided or two-sided. In exceptional cases, on an appropriate base (table) several traffic signs may be attached together. On a single column no more than two traffic signs may be attached, each one with a complementary table.

Surface of traffic signs must be flat, smooth and closed. Light may be reflected only as long as it does not diminish discernability of signs and writings.

Traffic signs no bigger than 120 x 250 cm must be manufactured in a single piece.

Traffic signs bigger than 120 x 250 cm must be manufactured in the shape of complementary segments, where the minimum height of a singular segment may be 25 cm, while maximum height should not exceed 120 cm.

Reflective foil on all signs must be in a single piece, except when that is not possible, due to limitations of the foil dimensions (foil roll width). In cases when it is not possible to provide a foil in one piece, two foils must be joined together, in accordance with the instructions of the foil manufacturer.

Because of the decrease in light reflection and contrast between the signs and background, traffic signs must be placed on a 85° to 87° angle with the road centre line.

Base

All traffic signs must be manufactured with a strengthened edge. Face of the sign must be manufactured in class P3 from table 13. The edge of all signs, except for signs made of aluminium tin, attached to AL angles, must be manufactured in class E2 from table 14 of the SRPS EN 12899-1:2011 standards.

The front side (face) of the traffic sign must not show any strengthening tracks. If it is possible to expect in time, base should be adequately processed first.

Larger bases (tables) may be composed of several horizontal tapes, which must be adequately attached as a whole to a metal frame. Both types of material must first be compatible in shrinking and stretching.

Surface of the base must be flat and even, and without convexities. Construction of the base surface on the front side of the traffic sign must not be visible.

Back of the base must be smooth, closed and adequately protected.

Housing of an internally lighted traffic sign must be waterproof, so that it can withstand rain 3 mm/min strong, and powder, in order to prevent entrance to flint powder grains (size up to 200 mm), with a speed of 10 m/s.

Lighted and light traffic signs must be in compliance with electrical-engineering conditions (connection, grounding, insulation, photometric and calorimetric properties).

Light source must secure the required even illumination of the effective surface of the traffic signs internal or external lighting.

Signs and writings

Shape, colour, measures and graphical shaping of signs and writings on traffic sign bases are specified by regulations.

All materials for signs and writings must be applied onto the base in such a way that the contours, or edges appear sharp (by rule, using silk screen).

Paints for signs and writings must be applied evenly.

Application of paint onto the reflective foil is done by silk screen, except when the traffic sign does not allow that, and in that case, instead of a silk screen for paint application, a foil on foil application system may be used. Foil on foil application system is allowed for all black symbols on traffic signs. Silk screen is not used for paint applications to the back of the sign. Silk screen application must be executed in such a way and quantity that it secures after the application of paint, and life expectancy of the foil must remain the same.

Reflecting foil must be applied onto the traffic sign base in compliance with the foil manufacturer's instruction, while in case when the foil manufacturer does not prescribe any specific manner of adhesion, in order to secure quality adhesion, at least rollers should be used in the application (for self-adhesive foils), or special devices for gluing (thermo-vacuum foils). When the sign is generated by the use of foil on foil application, only the foils of the same manufacturer may be used on a single sign, except in the application of a black colour foil.

Light traffic signs

Lights for light traffic signs may be permanent and/or flashing or sparkling.

Number of heads and the light colour should be adjusted to the purpose of the light traffic sign. Generally, colours used for traffic signs are green, yellow and red, and occasionally, white. Heads may be installed individually or in a chain.

To a basic light traffic sign (e.g., with three heads) one or more additional heads may be added.

Light traffic sign management (manual, automatic, programmed) must be adjusted to the purpose of its use.

Attachment devices

Grip rings (clamps) used for attachments on traffic signs must be shaped in an appropriate way, and

attached by nuts, welded or stuck to the base or frame for strengthening the sign,

attached by nuts onto the bearing sign construction.

Attachment of the grip rings (clamps) must not be visible on the front side of the traffic sign.

Manner of traffic sign attachment must enable a certain position in all conditions for use.

The back of the traffic sign must contain a clearly specified place (notch, groove...) enabling correct placement of the sign.

2.7.2.4 Quality of execution

Traffic signs as a whole and individual materials must remain in compliance with measures within allowed boundaries, and after being exposed to mechanical load. Allowed deviation from measures is $\pm 2\%$, unless otherwise specified, or if the engineer has decided differently.

Traffic sign attachment must be able to withstand

- vertical pressure of 7.5 MN and
- horizontal pressure of 3 MN.

2.7.2.5 Quality control

Quality testing of installed traffic signs is regulated by terms specified in Item 1.2.1 of these technical requirements.

Individual works on traffic signs, executed in accordance with the requirements of this regulation, are essentially regulated by appropriate quality control regulations.

Manner and volume of tests during instalment of traffic signs is also determined by the engineer based on proposed design documentation and based on the progress of the works.

2.7.2.6 Measuring and taking over of works

Conditions for measuring and taking over of installed traffic signs are specified in Items

1.2.2.2 and 1.2.2.3 of these Construction Specifications.

2.7.2.7 Calculation of works

Calculation of installed traffic signs should be executed in accordance with terms in Item 1.2.2.4 of these Construction Specifications.

2.7.3 ROAD MARKINGS

Road markings must be made in such a way as to always enable the road participant's safe direction and safe driving.

Road markings may be

- longitudinal markings,
- cross markings,
- other markings

They may be executed as

- forewarnings,
- permanent, or
- temporary markings;

as well as

- not reflective light (non-reflecting) or
- reflective for light – reflecting (with sprinkled or with mixed in and sprinkled reflective glass beads).

By rule, all road markings must be sprinkled with appropriate reflective glass beads.

The location of a road marking determines whether it will be

- rarely,
- often, or
- constantly exposed to traffic loads.

Development of road markings covers traffic safety, all the necessary measuring and forewarnings, cleaning and preparing the pavement surface (including hollowing), acquisition of all the necessary materials and their installation in places as specified by design documentation.

Longitudinal markings

Longitudinal road markings must be parallel with the road centre line. They may be

- dividing, if applied on the road centre line, in between driving lanes or in between other traffic surfaces,
- marginal, if applied on the carriageway edge, and
- guiding, for traffic guidance in interchanges.

Longitudinal road markings (lines) may be executed as

simple:

- unbroken,
- broken: normal, warning lines, short and wide,

doubled:

- unbroken
- broken
- combined.

Cross markings

Cross and angular road markings are intended for the marking of surfaces with traffic limitations. They may be marked with unbroken or with broken lines. Such road markings are:

- stop line (unbroken and broken),
- angled line (for closing and opening),
- limiters,
- pedestrian crossings,
- cycle path crossings.

Other markings

Other road markings have a special shape. Those are

- arrows,
- traffic direction fields,
- directional lines,
- writings (for additional information, traffic signs, symbols, names of places and road numbers),
- markings of traffic surfaces for special use (BUS, TAXI, etc.),
- parking slot markings
- vertical markings on objects at carriageway edge (permanent obstructions within the dimensions of the free road profile).

Light markings

Light markings with light reflectors on the carriageway are primarily intended for better traffic guidance at night and in poor visibility conditions.

Light road markings are installed only as additions to other signs.

2.7.3.1 Basic materials

For road markings only those materials that are legal for use which, according to traffic-technical properties and quality, provide for good visibility of markings in daylight or nighttime driving conditions, appropriate sliding traction and durability in the required life expectancy period.

Basic materials for road markings are

- paints,
- application tapes and

- plastic mixtures.

Materials for road markings should be

- applied to road surface or
- installed in the hollowed surface of the worn layer.

For road surface applications the following may be used:

- thin-layer markings (thickness of dry matter layer is up to 400 µm) and
- mid- and thick-layer markings (thickness of the layer is above 800 µm and up to 3000 µm).

Relative to the contents and manner of material application and hardening, thin-layer road markings are made with

- single-component and
- multi-component paints,
- paints with a certain amount of reflective glass beads already premixed (premix paints) and
- hot-application paints (spraying at 60 to 100 °C).

With simple colours it is possible to provide adequate light reflection of markings by sprinkling reflective glass beads.

Thick-layer road markings may be:

- application tapes (for adhesion) or
- plastic mixes (for spreading or spraying hot of cold).

For placement into a deepened worn layer surface, appropriate plastic mixes should be used.

Road marking materials consist of binders, colouring agents, charging, melting agents, drying, softeners and mixed-in for reflection and friction increase. For multi-component materials a hardener is also needed.

Supporting materials for road markings are agents for previous applications, subsequent sprinkling (reflective glass beads), increasing of the sliding friction, as well as thinners and possibly other materials, specified in the contents by the manufacturer of road marking materials.

Light reflectors (dowels, delineators and markers) generally have to be made of appropriate artificial matter. Housing may also be made of metal ceramics. They may be placed as temporary or permanent. They have to provide white, red or yellow light reflection.

2.7.3.2 Quality of materials

Properties and quality of materials for road markings must be in line with required traffic load.

Materials for road markings must not have a harmful impact on materials placed in the worn layer of the pavement structure, which would cause damages on it (e.g., crack).

Road markings must fulfil their function of safe traffic guidance over their entire life span. In order to prevent unnecessary traffic distractions, they must fulfil the following requirements

- road markings must be clearly visible over the course of an entire day in all kinds of lighting and all weather conditions,
- they must be resistant to sliding (adhesion),
- they must adhere well to the base, be resistant to weather effects, and crude oil derivatives and salt,
- resistance to wear under expected traffic load (durability),
- thickness of road markings must not affect driving dynamics or drainage,
- must not generate cracks on the worn pavement layer,
- road markings must be visible in the daylight and nighttime,
- road markings must not deviate from the determined geometrical dimension,
- materials and their additions should be easy to use.

For thin-layer road markings the contractor must timely provide to the engineer, before use:

- proof of compliance of materials, at their disposal for road markings, which must contain:
- type and share of all components (binders, colouring agents, charging, etc.),
- density,
- colour viscosity before thinning,
- share of dry matter,
- combustibility point,
- infrared spectra of the binder,
- gas chromatogram of vaporable contents,
- X-ray/fluorescent analysis (dry content share),
- proof of properties of the thinner, which includes
- type,
- combustibility point,
- toxicity;

proof of properties of reflective glass beads, which includes

- glass chemical contents,

- light refraction coefficient
- fill volumetric mass,
- glass volumetric mass,
- moisture share,
- granulometrical contents,
- regular beads share.

Required evidence for material quality for thick-layer road markings must be determined by the engineer, in accordance with requirements for thin-layer markings, as well as by mutual agreement with the manufacturer.

Before use the contractor also has to share with the engineer data on conditions for use of materials for road markings:

- deadline for use,
- drying and hardening time, and
- thickness of wet (fresh) and dry (hardened) layer of material for markings

The contractor must also submit to the engineer the report on testing of materials for markings with the same properties, as the material intended for use, and as evidence that the required properties of road markings will be provided within the required time period. Together with the quality of materials, the report must also include evidence on properties of the applied layer of materials for markings, which includes

- binding power,
- elasticity,
- resistance to chemicals,
- resistance to ultraviolet light,
- resistance to wear and tear, and
- the report on traffic-technical properties of road markings:
 - durability, relative to traffic load, type and place of marking,
 - resistance to sliding,
 - daytime visibility,
 - colour coordination,
 - nighttime visibility in dry and wet weather conditions.

The contractor may use the material for road marking, which is already available, if the data in the report on the quality of the materials is equal to the data in the report on the material test. Otherwise, the contractor must discontinue such material for road marking and specifically mark it, and, at the request of the engineer, remove it from the construction site.

For certain thin-layer road markings the contractor may also use other materials, if the adequacy of such materials has been

previously determined, and if it has been approved by the engineer.

2.7.3.3 Method of execution

Road markings must be made in accordance with adequate instructions provided by the material manufacturer and the design documentation requirements.

Before the commencement of the works, the contractor is required to submit to the investors a technological elaboration showing:

- type of used materials, with all the "Product data" supplied by the manufacturer of paint or plastic or glass beads. Also, instructions for the execution of works should be supplied,
- data on equipment used for application of materials and a description of the method of execution of works,
- reference lab reports on testing of materials and characteristics of derived markings,
- reference list, with listed prior use of the suggested materials.

In principal longitudinal markings should be applied to the pavement with an appropriate machine. The manual application of markings (in exceptional cases only) must be approved by the engineer.

The surface of the pavement relative to the markings must be:

- completely dry
- without salt residue
- without larger grease stains,
- free of dust, sand, soil and other materials.

Before application of markings, a very rough pavement surface must be cleaned with brushes, air-blowing and rinsed. A very smooth pavement surface must be appropriately roughed before application.

Temporary markings should be applied to new pavement surfaces (primarily asphalt); permanent markings may be used only when bituminous or cement binders, or mortar, have been removed from the grain of a pavement surface.

With every change of road markings, the old markings need to be removed, in order to avoid possible ambiguities later on.

Instead of the damaged pavement surface (e.g., crack at the longitudinal connection in the middle of the pavement, if it has not been

filled properly) it is necessary to execute an appropriate parallel removed road marking, immediately adjacent to the damaged surface.

Representative of the client (engineer) may demand suspension of works and pavement cleanup, if they determine that the contractor is applying road markings onto an inadequately prepared pavement. Also, on a segment of an inadequately prepared pavement, where the markings have already been executed, they may demand cleanup and re-painting of the pavement at the contractor's expense.

The markings application procedure must not endanger the safety of traffic and/or of the contractor.

For thin-layer markings, in principal, the following should be taken into consideration

- work viscosity of paint at application,
- degree of thinning,
- required thickness of wet and dry layer,
- average amount of paint used on 1 m² of markings,
- hardening time until the moment the pavement is usable again,
- relative weather conditions during the execution of works,
- manner and conditions for preparations of pavement surface before the application of the markings,
- suggestion for the procedure and equipment in the execution of works,
- work-protection requirements,
- conditions for materials warehousing,
- fire-protection requirements.

Type, shape, measurements and place of road markings and manner of marking are determined by appropriate regulations.

If necessary, the executor of road markings is required to thin the paint before commencement of works, in accordance with the manufacturer's instructions and by use of the original thinner.

The thinning level is controlled by a viscosimeter. Should the paint manufacturer not determine otherwise, the flow-time of paint through the viscosimeter (before the flow of paint is interrupted), at machine paint application stage onto the pavement should be, by rule, as follows:

- a) 80–90 seconds at air temperature of +10 °C to +20 °C,
- b) 70–80 seconds at air temperature of +20 °C to +30 °C.

When revitalizing cross, and other road markings, it is mandatory to apply paint by sprinkling by compressor. Roller application of paint is not allowed!

Revitalizing of markings, arrows and symbols is executed by use of a stencil manufactured in accordance with existing standards.

Required application thickness and paint usage are prescribed by the paint manufacturer.

The thickness of paint application is controlled by the engineer, or authorized professional organization, in accordance with SRPS Z.S.2.240 Paints for thin-layer road markings and SRPS EN 1436:2011.

If the client's representative determines that more than 10% of samples tested are of a thickness lower than required, marking must be done again at the contractor's expense.

Road markings should be executed

- at air temperature of 10 to 30 °C,
- at road surface temperature of 5 to 45 °C,
- in dry weather conditions,
- with a maximum relative air humidity of 85%.

During the execution, eventual additional manufacturer's requirements should be respected.

Execution of works in weather conditions deviating from the aforementioned (which applies especially to temperatures of air and pavement lower than required) is not allowed.

Client's representative (engineer) may in certain exceptional cases approve the execution of markings in poorer conditions, by log entries, or by written order.

Reflective glass beads should be applied by machine spraying. Applied layer of premix paint should be applied to the surface with reflective glass beads.

All road markings must be sprinkled with glass beads, except for parking slot markings, as well as other parking and garage markings, which may be marked with materials with non-reflective properties.

During machine work execution the contractor is continuously responsible for quality control of the glass beads sprinkling. Glass beads consumption should be between 0,200–0,250 kg/m² of the painted surface.

The engineer mandates that redoing the markings not sprinkled with glass beads is at the manufacturer's expense.

Road markings (except for light reflectors) may reach no more than 3 mm above the pavement surface, in order not to overly interrupt water drainage. This limits the thickness of the material layer for thick-layer markings (application tapes and plastic mixes).

Plastic mixes, for installation into marking deepening's on the surface of the worn pavement layer, may be installed

- 3 to 7 mm
 - above 7 to 15 mm and
 - above 15 mm deep,
- relative to the properties of plastic mixes and required characteristics of road markings.

The contractor is responsible for executing the material application in a mechanical way. Additional sprinkling with glass beads must also be executed in a mechanical way. The contractor is responsible for depositing eventual material leftovers at an adequately equipped landfill.

During execution, the contractor must observe the preexisting markings. Regardless of the thickness of the existing paint layers, it is the contractor's responsibility to provide quality of the executed marking for the entire time of the warranty period and life expectancy of the marking. Should the contractor believe that the existing paint layer needs to be removed, it must be executed by using equipment specifically designed for the removal of markings, and not by using a milling machine for increasing roughness and/or asphalt removal.

The contractor must secure the executed road markings by using cones, placed at a reasonable distance from one another, and prevent road users from driving over fresh markings.

Application tapes for road marking should be adequately glued onto the pavement surface or a deepening in the worn pavement layer.

Light reflectors (dowels, delineators and markers) may be built into the surface of the worn layer (in principal, temporary), or adequately deepened (permanent). They must be adequately attached onto the base. Light reflectors may be no more than 29 mm above the carriageway.

Road markings are of a white colour, except for:

- marking of places on roads or sidewalks where parking is illegal;
- temporary road markings used during the execution of road works;
- lines for separating lanes for the movement of public transportation vehicles, and
- markings used for marking places of function (bus stops, taxis, emergency vehicles, police, etc.).

During the execution of road markings, the following should be supervised:

- types and quantities of used material (by measuring units),
- thickness of wet and dry marking layers,
- weather conditions (temperature, relative humidity).

2.7.3.4 Quality of execution

Road markings must be homogenous, of appropriate shape and must provide required

- durability,
- resistance to sliding,
- daylight visibility,
- visibility at night, in dry and wet weather conditions
- drying time and
- thickness of dry material layer.

Minimum required characteristics and control of thick-layer, mid-layer and thin-layer road markings are determined by SRPS EN 1436:2011, SRPS EN 1824:2008, EN 1871, SRPS EN 13197:2011, SRPS EN 12802:2008 and ZTV M 02 standards.

Treshhold values for required traffic-technical properties of road markings are listed in tables 2.7.5 and 2.7.6:

Table 2.7.5: Required properties of thin-layer, mid-layer and thick-layer road markings

Type of road		RL White	RL Yellow	RW (if applicable)	Qd White	S (SRT units)
Highway	New markings	≥200	/	≥35	≥130	≥50
	After two years (mid- and thick-layer markings)	≥100	/	≥35	≥130	≥45
I class State road, not a highway	New markings	≥200	≥200	≥35	≥130	≥50
	After two years (mid- and thick-layer markings)	≥100	≥100	≥35	≥130	≥45
	After one year (thin- layer markings)					
II class State road	New markings	≥200	≥200	≥35	≥130	≥50
	After two years (mid- and thick-layer markings)	≥100	≥80	≥35	≥130	≥45
	After one year (thin- layer markings)					
Municipal roads	New markings	≥200	≥200	≥35	≥130	≥50
	After one year (thin- layer markings)	≥100	≥80	≥35	≥130	≥45
Main roads	New markings	≥200	≥150	≥35	≥130	≥50
	After one year (thin- layer markings)	≥100	≥80	≥35	≥130	≥45
Other roads in a residential area	New markings	≥200	≥150	/	≥130	≥50

Type of road		RL White and yellow	RW (if applicable)	Qd Yellow	S (SRT units)
I class State road	New markings	≥200	≥35	≥100	≥50
	During exploitation	≥150	≥35	100	≥45
II class State road and municipal roads	New markings	≥200	≥35	≥100	≥50
	During exploitation	≥100	≥35	≥100	≥45
Main roads in a residential area	New markings	≥200	≥35	≥100	≥50
	During exploitation	≥150	≥35	≥100	≥45
Other roads in residential area	New markings	≥150	/	≥100	≥50

Legend:

RL – retroreflection coefficient (mcd x m⁻² x lux⁻¹);

RW – retroreflection coefficient in wet conditions (mcd x m⁻² x lux⁻¹);

Qd – illumination coefficient under diffused lighting (mcd x m⁻² x lux⁻¹);

S – resistance to sliding value (SRT)

B – Illumination factor (β) for all markings is $B3 \geq 0,40$

Table 2.7.6: Characteristics of colour coordinates

Characteristics of colour coordinates					
No. of angle spots		1	2	3	4
White road markings	x	0,355	0,305	0,285	0,335
	y	0,355	0,305	0,325	0,375

Table 2.7.7: Required quality of reflective glass beads

Characteristics	Measuring unit	Required value
Refraction coefficient	-	1,50 to 1,53
Voluminous glass mass	g/cm ³	2,4 to 2,6
Granulometric composition		
To 100 μm	m.-%	to 5
To 200 μm	m.-%	3 to 25
To 315 μm	m.-%	25 to 65
To 500 μm	m.-%	80 to 100
To 800 μm	m.-%	100
Share of regular beads, at least	m.-%	80

Quality of material, used for thin-layer road markings must be in compliance with the following requirements:

- allowed density deviation from the agreed values may amount to $\pm 5\%$,
- material for thin-layer markings must not contain insoluble mixtures, granules or hardened parts of the crust,

- colour (white, yellow) must be in compliance with the agreed colour, determined by appropriate colour cards,
- share of dry matter in material for markings must be at least 60 m.-%,
- warranty period for thin-layer road markings is 1 year,
- duration time of thin-layer road markings is 2 years.

Quality of reflective glass beads must be in compliance with the requirements in table 2.7.7.

Drying time of built-in material for thin-layer marking in legal terms must not exceed 20 minutes.

The least thickness of the dry-layer material for thin-layer markings is determined in table 2.7.8.

In justified cases, the engineer may approve thin-layer markings and smaller thickness of the dry layer of the material from the required in table 2.7.8, but not exceeding 50 μm .

Visibility of markings during the nighttime depends on quality of sprinkling with glass beads. It is of essential importance to have the entire surface homogeneously sprinkled with adequate amount of glass beads. Executed works are controlled for:

- homogenous application: the quality of sprinkling of the markings is determined by visual examination overnight, when road markings must homogeneously reflect light on 85% of the painted surface,
- reflection rate: a reflectometer is used to measure markings' reflection capability in

accordance with regulations SRPS 2.240 Colours for thin-layer road markings, SRPS EN 1436:2011. Rate of reflection for all markings, for the entire period until the next refurbishing, should be no less than 100 mcd lux -1 m^{-2} ,

- amount sprinkled: if the thickness of the dry layer of the roadside marking material, on more than 10% of the surface, is less than the required borderline thickness, the contractor must re-apply the marking without any additional reimbursement.

The lowest amount of reflective glass beads sprinkled for road markings must amount to 0,20 kg/m².

Table 2.7.8: Required borderline thickness of dry-layer material for thin-layer road markings

Type	Measuring unit	Traffic load	
	vehicles/day	to 4000	over 4000
Longitudinal	μm	200	250
Cross, angular	μm	250	300

The manner of execution of longitudinal lines of thick-layer materials (smooth, structured or profiled) is determined by the contractor, in compliance with the client's requirements, and with respect to characteristics listed in table 2.7.5 and 2.7.6.

Regrading roundabouts calculation of executed works is done by m² of actually marked surface.

Warranty period for thick-layer markings is 3 years.

Life expectancy period of thick-layer markings is 5 years.

Resistance to crude oil derivatives, salt, low and high temperatures – over life span of the material of the said matter, must not cause damage to materials possessing characteristics securing that at low temperatures cracking and deviations of material do not happen and that at high temperatures no deformations occur.

Contractor is not responsible for damages to thick-layer markings which came into

existence because of the winter road services (ploughing) executed by the regular contractor for routine maintenance of state roads.

2.7.3.5 Quality control

For determining the quality of executed markings, it is necessary to document data on execution of works on road marking:

- road segment,
- date and time of execution of works,
- equipment type,
- type of paint and other materials used,
- material consumption by the marking unit,
- weather conditions.

Thickness of wet and dry layers of the road markings should be examined in new constructions on every 1000 m¹ of the marked pavement, and in marking of the existing pavements on every 2000 m¹, unless the supervising organisation determines otherwise.

Adequacy of road markings, composed of one or more matters and one or more additions which must be in compliance with the requirements relative to the intended use, is evidenced by examination. Methods of examination are based on requirements of the EN 1871 and SRPS EN 13197:2011 standards, while the characteristics are determined by the SRPS EN 1436:2011 standard.

Testing of thickness, width and length of road markings

Wet layer paints thickness is determined by a thickness meter on the wet layer. Thickness of the plastic material layer is determined with the help of a stencil and a measuring dowel or in some other adequate way. Foil thickness is determined by a bottleneck measuring device.

Drawings, width and length of road markings are determined by regular meters with adjustable length.

Checking the additional sprinkling

Allocation and bilging, and the application of additional sprinkling of glass beads or anti-sliding devices are checked by visual examination. Detailed checking may be carried out through the use of a loupe or microscope.

Checking the drying time

Controlling the drying time is used to determine whether, after the expiration of a

specified time for a particular material, the contractor can allow traffic, without any damages to road markings. Detailed checking is done by a roller measure.

Checking daytime visibility

Checking daytime visibility is done by visual examination. If, after such an examination, there is doubt regarding the fulfilment of terms, measuring is done. Measuring procedures are described in the SRPS EN 1436:2011 standard, annex A.

Checking night time visibility

Control of nighttime visibility in dry conditions is done by allocation and inserting glass beads for improving nighttime visibility. If there are doubts about compliance with the requirements, examination is done by driving in the dark. If, after such an examination, there are still doubts about compliance with the requirements, measurements are done. Control of nighttime visibility in wet conditions is done by measuring. The measuring procedure is determined in SRPS EN 1436:2011 standard, annex B.

Checking lubricity

Control of lubricity is done by measuring. The measuring procedure is determined in SRPS EN 1436:2011 standard, annex D.

Checking the illumination factor

Control of the illumination factor is done by measuring. The measuring procedure is determined in SRPS EN 1436:2011 standard, annex C.

Checking colour coordination – chromaticity

Checking colour coordination x and y is done by measuring. The measuring procedure is determined in SRPS EN 1436 standard, annex C.

Checking resistance to wear and tear (durability)

Resistance to wear and tear is checked by visual examination. If, after such an examination, there are still doubts about compliance with requirements, the remaining segments are measured using regular length measuring devices or another measuring device.

2.7.3.6 Measuring and taking over of works

Basic conditions for measuring and taking over road markings are determined in Items

1.2.2.2 and 1.2.2.3 of these Construction Specifications.

2.7.3.7 Calculation of works

Calculation of road markings should be done in accordance with conditions in Item 1.2.2.4 of these Construction Specifications.

2.7.4 LIGHT SIGNALIZATION AND TEMPORARY TRAFFIC SIGNALIZATION

Light signalization and temporary traffic signalization is primarily intended for permanent or temporary marking or driving directions and obstacles in the region of the regulated free space above the road trunk, especially at night and in poor visibility conditions.

Light signalization and temporary traffic signalization consist of

- directional arrows and elevated light reflectors (dowels, delineators, markers),
- table for marking the top of the splitter island
- traffic cones,
- directional barriers and fences

Light signalization and temporary traffic signalization may be:

- non-reflective: painted with colour,
- reflective: with appropriate foil or artificial matter,
- illuminated:
 - externally or internally (with its own light source),
 - internally illuminated equipment for directing traffic must be transparent on adequate surface.

Temporary traffic signalization is installed in compliance with the approval of the traffic organization in the construction area. Light markings must be installed in compliance with the particular design documentation.

Placement of light markings and temporary traffic signalization on roads includes all necessary land works, acquisition of all the appropriate materials and their installation.

2.7.4.1 Basic materials

2.7.4.1.1 Foundations

Unless specified otherwise, foundations for traffic directing equipment must be made of appropriate cement concrete. They can also be developed in advance (prefabricated with adequate pipes with circular cross section, made of cement concrete as outside rim).

2.7.4.1.2 Direction signs and elevated light reflectors

Direction signs, which may be hollow, or with a full cross section, must be, in principle, made of plastic mixes.

Direction signs must be adequately fortified by anchors.

Plastic carrier, which must be white, has to be used for adequately attaching markings indicating direction in daytime or at night. Daytime markings must be, in principle, made of black plastic mix (rectangular or rhomboid shape) or of adequate black colour. For nighttime direction indication on a flat surface specifically, rectangles must be installed, and they may be made of reflective foil or adequately shaped other artificial reflective matters: on the right hand side of the carriageway in the driving direction rectangles are red, and on the left they are white.

Elevated light reflectors (dowels, delineators, markers) must be made of permanently elastic carriers and adequate artificial reflective materials.

2.7.4.1.3 Panel indicating the top of the splitter island

Panel indicating the top of the splitter island may be shaped as slabs or rollers (internally illuminated), marked with alternating black and yellow tapes. The foundation of the table for marking the top of the splitter island must be made of artificial matter (strengthened polyester or acrylic) or tin, and markings with reflective foil or transparent and simple paint.

2.7.4.1.4 Traffic cones

Movable (temporary) traffic cones must be made of appropriate coloured plastic mix or rubber, and also weighted. For traffic direction at nighttime, only traffic cones reflecting light on designated surfaces should be used.

For better visibility, flashers or appropriate blinkers should be placed on top of cones.

2.7.4.1.5 Directed movement guardrails and barriers

- Columns for directed movement guardrails and barriers must be constructed of appropriate metal pipes (steel, aluminium).
- Base of permanent directed movement guardrails must be made of
- tin (steel or aluminium) or
- polyester, strengthened with glass fibres.

For the base of directed movement guardrails and barriers, other materials are also usable, if they are durable enough and if their use is approved by the engineer.

Markings on directed movement guardrails and barriers may be executed

- with simple paint (if they have built in retroreflecting objects) or
- with reflective foil.

2.7.4.2 Quality of materials

2.7.4.2.1 Foundations

Conditions for cement concrete quality for foundations for light signalization and temporary traffic signalization are set in Item 2.7.2.2.1.

2.7.4.2.2 Direction signs and elevated reflectors

Conditions for quality of directed movement guardrails and barriers, also include light reflectors on them, as well as elevated light reflectors which should be agreed upon between the client and the contractor or manufacturer.

On public roads, only the road direction sign type D3 may be installed, determined by Item 5.1 of the SRPS EN 12899-3:2008 standard, where the following needs to be considered:

- road direction signs must be equipped by reflecting bodies type R2, set by Item 5.2 +,
- in consideration with static requirements, road direction signs must fall at least into class WL1, which is set by Item 6.4.1.1 of the SRPS EN 12899-3:2008 standard,
- taking into consideration the resilience to impacts, reflective bodies must fall at least into class DH1, which is determined by Item 6.4.2.1 of the SRPS EN 12899-3:2008 standard,

- materials used for construction in the road direction sign, after completed use, must not present a burden to the environment,
- road direction signs must be made of artificial material, in a way that enables the direction sign, in case of possibly being impacted by a vehicle, does not present danger for traffic participants in the vehicle,
- reflective bodies are attached to the body of a road direction sign by studs or screws,
- caps of a road direction sign must be attached to the body or the road direction sign in a way that disables cap removal,
- with road direction signs attached to foundations, constructed specifically for that purpose, dynamic characteristics of the road direction sign must be checked on road direction signs attached to the foundation.

The above-mentioned characteristics and identity of materials, used for making the road direction sign, have to be evidenced by appropriate statements issued by a verified institution for verification of required characteristics and identification of the material.

Elevated light reflectors must be elastic at even -20 °C and must not be broken.

2.7.4.2.3 Panel indicating top of the splitter island and traffic cones

Different materials (plastic mixed and metals) of the panel indicating top of the splitter island and traffic cones must be durable and compact at all temperatures and weather conditions,

2.7.4.2.4 Directed movement guardrails and barriers

Quality terms for columns are essentially determined in Item 2.7.2.2.2.

Base for directed movement guardrails and barriers, markings on bottoms and attachment devices must comply with all the conditions determined for traffic signs in Item 2.7.2.2.3.

2.7.4.3 Method of execution

Temporary traffic signalization is installed, based on the elaboration of the traffic organization in the construction area. Light markings must be installed in compliance

with required design documentation and relative regulations for certain conditions.

2.7.4.3.1 Foundations

Detailed manner of manufacturing foundations, suggested by the contractor, must be approved by the engineer.

2.7.4.3.2 Direction signs and elevated light reflectors

Road directional signs must be installed on the road in a manner, so that, during pavement maintenance or maintenance of the direction sign, the direction sign does not get pulled out i.e. unearthed.

Road direction signs are installed on both sides of the road, across the road from each other.

In horizontal curves, with a radius of less than 100 m, road direction signs on the inner side of the curve may be installed across the road from every other direction sign, installed on the outer side of the curve.

On the inner side of the curve and on road segments with no possibility of installing road direction signs at a required distance, minor deviation from the required distances is allowed, provided that the optical line does not get damaged; it must remain unbroken.

By rule, road direction signs are installed in a longitudinal direction at a mutual distance determined in tables 2.7.9 and 2.7.10.

Table 2.7.9: Mutual distance of road direction signs, relative to the horizontal curve radius

	Mutual distance of direction signs (m)			
Middle value of the horizontal curve (m)	In the curve	Before and after curve		
		First direction sign	Second direction sign	Third direction sign
20-50	4	8	12	24
Above 50-100	8	12	24	-
Above 100-300	12	24	24	-
Above 300-500	24	24	-	-
Above 500	24	-	-	-

Table 2.7.10: Mutual distance of road direction signs, relative to the vertical curve radius

	Mutual distance of direction signs (m)			
Middle value of the vertical curve (m)	In the curve	Before and after curve		
		First direction sign	Second direction sign	Third direction sign
100-250	4	8	12	24
Above 250—800	12	24	24	-
Above 800—3000	24	24	-	-
Above 3000	24	-	-	-

Road direction signs, in the cross direction, relative to the road centre line, are installed at a 75 cm distance from the carriageway

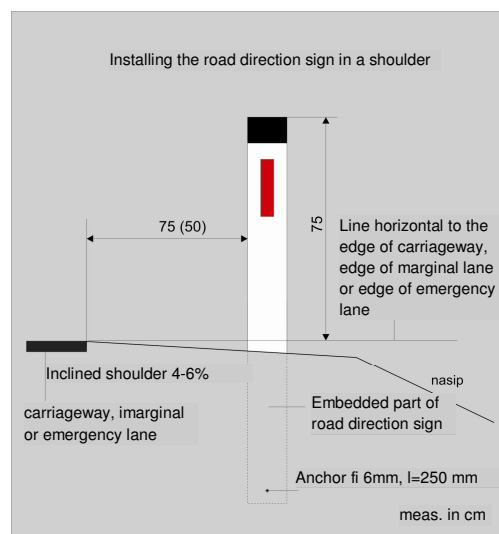
edge, edge of the marginal strip or edge of the emergency lane.

In exceptional cases, the distance from the former position may be 50 cm, in cases when the road direction signs are installed into a shoulder, 75 cm wide or less, and on the road segment, where the distance between installed safety barriers is less than 150 m.

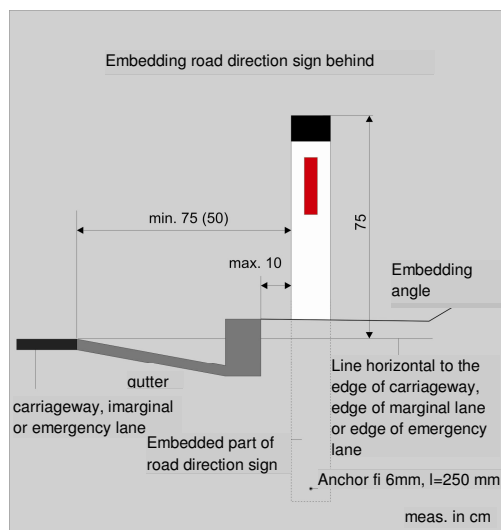
Upper edge of the road direction sign must be 75 cm above the carriageway edge, curve edge or the edge of the emergency lane, measured horizontally in relation to the carriageway edge, edge of the marginal strip or edge of the emergency lane.

When, right next to the carriageway, marginal strip of emergency lane, there is a gutter or a kerbstone taller than 7 cm, the road direction sign is installed directly behind the kerbstone, or at a distance not exceeding 10 cm from the kerbstone.

The position of the road direction sign in a cross direction of the road is shown in pictures 2.7.1 and 2.7.2.



Picture 2.7.1: Road direction sign embedded in a shoulder



Picture 2.7.2: Road direction sign installed along the curbstone

Elevated light reflectors must be installed in accordance with the design documentation for temporary traffic direction.

2.7.4.3.3 Panel indicating top of the splitter island

Panel indicating top of the splitter island may be installed individually or together with traffic signs.

In principle, panels must be installed at the top of the splitter island.

2.7.4.3.4 Traffic cones

Movable traffic cones must be placed in places enabling safe traffic direction.

2.7.4.3.5 Directed movement guardrails and barriers

Length of columns directed movement guardrails and barriers must be adjusted to the intended usage type of equipment.

Manner of inserting columns must be determined with the agreement of the traffic organization in the construction area. Every change must also be approved by the engineer.

Markings on directed movement guardrails and barriers must be made of inclined or conical alternating white and red or black tapes, as prescribed by the appropriate regulations.

2.7.4.4 Quality of execution

Traffic signalization as a whole and individually must retain their measures within permitted boundaries even after the effects caused by mechanical loads. Allowed deviation of measures is up to $\pm 2\%$, unless otherwise agreed upon, and unless the engineer determines otherwise.

2.7.4.5 Quality control

Quality control of light markings and temporary traffic signalization is based on the basic conditions, listed in Item 1.2.1 of these Construction Specifications.

Manner and volume of testing for installing light markings and temporary traffic signalization is determined by the engineer, based on the suggested documentation on quality and on the work flow.

2.7.4.6 Measuring and taking over of works

For measuring and taking over of light markings and temporary traffic signalization, the conditions have been determined in Items 1.2.2.2 and 1.2.2.3 of these Construction Specifications.

2.7.4.7 Calculation of works

Calculation of the installed light markings and temporary traffic signalization should be executed in accordance with the terms in Item 1.2.2.4 of these Construction Specifications.

2.7.5 BUMPERS AND HALF-BUMPERS

2.7.5.1 Basic materials

Bumpers and half-bumpers preventing the passage of vehicles on the road, must be made of materials in compliance with design documentation. For bumpers, metals may be used, as well as extremely and properly strengthened artificial materials or wood.

2.7.5.2 Quality of materials

Quality of materials for bumpers and half-bumpers must be in compliance with set requirements, based on loads, and with the

design documentation taken into consideration.

2.7.5.3 Method of execution

Bumpers and half-bumpers must be constructed in compliance with the agreed upon design documentation. Every change must be approved by the engineer.

2.7.5.4 Quality of execution

Bumpers and half-bumpers as a whole and individually must retain measures within allowed boundaries, even after the effects caused by mechanical loads.

2.7.5.5 Quality control

For quality control of bumpers and half-bumpers basic conditions hold, listed in Item 1.2.1 of these Construction Specifications.

Manner and volume of testing for installing of bumpers and half-bumpers are determined by the engineer, based on the suggested documentation on quality and on work flow.

2.7.5.6 Measuring and taking over of works

For measuring and taking over of bumpers and half-bumpers conditions have been determined in Items 1.2.2.2 and 1.2.2.3 of these Construction Specifications.

2.7.5.7 Calculation of works

The calculation of built bumpers and half-bumpers should be executed based on conditions in Item 1.2.2.4 of these Construction Specifications.

2.7.6 TRAFFIC SAFETY EQUIPMENT

Traffic safety equipment must be placed in such a way as to provide traffic participants optimal safety from dangers they may be exposed to while driving.

Traffic safety equipment consists primarily of

- safety barrier,
- wire safety fences,
- crash cushions ,
- anti-glare equipment,

- traffic mirrors,
- warning devices,
- other equipment.

Development of traffic safety equipment includes all the necessary land works, acquisition of all the relative materials and devices, as well as their installation in places determined by the design documentation.

Safety barrier

Safety barriers must comply with the requirements of the SRPS EN 1317 standard "Systems for retaining vehicles along roads". Compliance with the requirements needs to be evidenced by submitting appropriate test results.

Wire safety fences

Wire safety fences consists of

- foundations,
- columns and anchors for stability, and
- nets and wire for attachments.

Must be adjusted to surrounding wildlife species, which are being denied access to the carriageway.

See SRDM 6.3.2 Wire Fences

Crash cushions

Crash cushions are devices of parallel, or trapezoidal shape. Intended for dampening shock effects on passengers, vehicle or a permanent obstacle.

Compliance of the crash cushions confirmed in accordance with the certification procedure of the manufacturing standard EN 317-5:2007+A1:2008. Product requirements and checking the compliance of the system for the retaining of vehicles, or SRPS EN 1317-3:2011 standard for testing classes of serviceability, testing measures in case of impact and testing methods for crash cushions.

Crash cushions must enable functional attachment onto the existing road equipment!

Compliance of initial and final constructions is confirmed in accordance with the certification procedure of the manufacturing standard EN 317-5:2007+A1:2008. Product requirements and determination of compliance of the system for retaining vehicles, or the SRPS EN 1317-4:2011 standard for testing classes of serviceability, measures for testing in case of impact and testing methods for final and intermediate elements of safety barriers.

Anti-glare equipment

Anti-glare equipment consists of

- elements for reflecting light,
- carriers of light-reflecting elements, and
- agents for attachment of light-reflecting elements and carriers (screws, nuts, bolts).

They must be adjusted against blinding by a bright light, possibly emanating from vehicles and/or other light sources.

Traffic mirrors

Traffic mirrors are intended for securing visibility at greater distances and thereby improving traffic safety.

They are composed of

- foundations
- bearing construction (pillar or console)
- carrier of the traffic mirror, and
- housing.

They have to be adjusted to the intended traffic safety.

Warning device

In certain situations a device warning the traffic participants should be built, because of

- dangers due to low visibility (i.e. fog),
- danger from gas,
- fire.

For development of all those devices, a detailed design document needs to be completed.

Other equipment

The following items have been labelled as other equipment for traffic safety:

- reflectors: on barriers, barriers, etc.,
- blinking directional lights: autonomous, additional (on traffic signalization).

2.7.6.1 Basic materials

2.7.6.1.1 Safety barrier

Depending on their type and intended use, safety barriers are made of various materials: steel, concrete, wood or appropriate artificial materials.

Attachment devices must be made of materials compatible with the materials they connect.

See SRDM 6.3.1 Vehicle restraint systems.

2.7.6.1.2 Wire safety fences

Columns for wire safety fences must be made of

- steel or aluminium pipes of a specified diameter, or
- anchors for stabilizing columns must be made of steel or aluminium wire.

All columns are attached to the ground by casting or they are fastened to a concrete base.

Nets for a wire safety fences must be adjusted to various wildlife species (deer, roe-deer, wild boars), and constructed of plastic-coated steel or aluminium wire with appropriate openings. Wire for the attachment of wire to the columns must be made of appropriate steel or aluminium.

See: SRDM 6.3.2 Wire fences

2.7.6.1.3 Crash cushions

By rule, crash cushions must be made of:

- steel or aluminium frame, and
- charging: metal wire or artificial matter, all in accordance with the details of design documentation.

2.7.6.1.4 Anti-glare equipment

Plants used as anti-glare hedges must be specified in detail for the given conditions in the design documentation.

Light-reflecting elements must be made of synthetic matter resistant to UV rays, aluminium, while carriers of light-reflecting elements must be made of metal (aluminium or steel).

2.7.6.1.5 Traffic mirrors

Traffic mirror housing must be constructed of artificial mass.

The face of the housing must be covered by reflecting red-white signalization foil or by an appropriate application of paint.

Mirror must be made of materials which, and in such a way that, they prevent condensation formation on the external surface of traffic mirror.

Traffic mirror holder must be appropriately protected from corrosion (hot zincing).

2.7.6.1.6 Warning device

Warning devices must be made in such a way that, based on data obtained by measuring certain phenomena, their evaluation is possible.

Warning devices must be made of materials adequate for conditions in which the device will be installed.

2.7.6.1.7 Other equipment

Other equipment for directing traffic covers:

- reflectors: barriers, fences, etc.,
- blinking directional lights: autonomous, additional (on traffic signalization).

For other traffic directing equipment, appropriate types of durable materials should be used.

Carrier for the light reflector must be made of aluminium or hot zinc steel tin, and for light reflection reflective foil or appropriately shaped artificial red or white matter may be used.

2.7.6.2 Quality of materials

2.7.6.2.1 Safety barrier

Foundations, or places of installation, must be adjusted to conditions observed in test crashes, or they have to be adjusted to general standards for asphalt and concrete. Quality of all system components (anchors, screws, braids...) must be identical and equal to the quality of system components used in testing.

Capability of protective devices, according to SRPS EN 1317-2:2011, is differentiated, based on three essential criteria:

- retention degree,
- affected area class,
- impact intensity degree.

Required retention degree depends on application criteria and is regulated in the manual SRDM 6.3.1 Vehicle restraint systems.

Maximum affected area class depends on the situation at the location of installation and is regulated in manual SRDM 6.3.1 Vehicle restraint systems.

Degree of impact intensity A, for passengers in the vehicle turning away from the carriageway, presents lower load than

degree of impact intensity B, and in comparable circumstances it is given priority. At exceptionally dangerous places, where the primary importance is given to retention of vehicles turning from the carriageway (e.g., heavy vehicles), a good choice may be a protective device of degree of impact intensity C, representing the greatest load on the passengers in the vehicle.

All materials must be secured with appropriate corrosion protection.

2.7.6.2.2 Wire safety fences

Wire safety fences must be made of materials resistant to corrosion and UV rays.

Technical requirements for material and dimensions of the fence elements are in accordance with standard SRPS U.S.A.102, except for the wire braiding, determined by standards SRPS EN 10223-1, -2, -2/a1, -4, -5, -6, -7.

See: SRDM 6.3.2 Wire fences

2.7.6.2.3 Crash cushions

Capability of crash cushions, according to SRPS EN 1317-3:2011, are differentiated by the following criteria:

- degree of success / class of speed,
- class of permanent sideways movement,
- class of return area,
- degree of impact intensity.

Only the crash cushions which bounce back are installed.

Class of permanent sideways movement (minimum requirement D8) and the class of return area (minimum requirement Z4) are given in the test record, and the requirements are determined based on situations at the place of installation. The class of permanent sideways movement is chosen in such a way that the deformed shock damper reaches max. to the inner edge of the edge line.

Shape of the crash cushion should be adjusted to the geometrical situation at the location of installation.

Degree of impact intensity A for persons in the car moving away from the carriageway presents less of a load than the degree of impact intensity B. Under comparable circumstances it should be given priority for use.

Capability of initial and final constructions according to SRPS EN 1317-4:2011 is differentiated according to the following criteria:

- class of action effect
- class of vehicles bouncing area,
- class of permanent cross turning,
- degree of impact intensity.

Class of vehicles bouncing area (minimum requirement class Z4 and class of permanent cross turning (min. requirement classes X3 and Y4) are determined based on situation at the location of installation.

Class of permanent cross-turning should be chosen in such a way that the deformed initial and final construction reaches maximum to the inner edge of the edge line.

Degree of impact intensity A should be given priority in relation to degree B in comparable circumstances, because it presents less of a load for persons in the vehicle turning away from the carriageway.

All materials sensitive to corrosion must be adequately protected.

2.7.6.2.4 Anti-glare equipment

Anti-glare elements must be shaped in accordance with regulations on traffic safety and relative to the safety barrier to which they are attached, and in accordance with conditions of the SRPS EN 1317-2:2011 standard.

Anti-glare elements must comply with conditions from the standards:

- SRPS EN 12676-1:2008, Anti-glare screens – part 1: Performance and characteristics,
- SRPS EN 12676/A1-1:2008, Behaviour and characteristics,
- SRPS EN 12676-2:2008 Report on testing based on method standard.

All integral parts of anti-glare elements must be resistant to impact of rock pellets or other small particles falling off vehicles. They may be damaged only when impacted by vehicles, etc. Hollow parts in particular element parts must be closed on all sides.

2.7.6.2.5 Traffic mirrors

Unless specified otherwise in the design documentation or if the engineer determines otherwise, for the foundations of traffic mirrors cement concrete C 12/15 or C 16/20 must be used. Since the circular pipes made

of cement concrete are primarily the lining for previously prepared (prefabricated) foundations for columns, quality of those pipes must match the required quality of cement concrete for the foundations.

By rule, columns for traffic mirrors must be made of steel pipes ϕ 60.3 mm (63.5 mm), with wall thickness of at least 2 mm, outside and inside protected by hot zinking or in an appropriate alternative way (plastic-coated, coloured, metalized).

Housing of the traffic mirror must be made of a artificial material resistant to weather conditions, UV light, with stated material markings and recycling options.

2.7.6.2.6 Warning device

Measuring devices for poor visibility warning, based on measurements of transitions of light rays or dissipation of the light must provide measurement accuracy of $\pm 5\%$; the same holds for the device for measuring the danger of CO concentration in air (based on the procedure of infrared absorption or catalytic oxidation).

Measuring devices for fire warning must react to temperature level and to the speed of temperature growth. Values must be specified in design documentation.

2.7.6.2.7 Other equipment

Material quality for other equipment must be compact and provide required durability of such equipment as a whole.

2.7.6.3 Method of execution

2.7.6.3.1 Safety barrier

Safety barrier must be placed in such a way that the upper edge of the safety barrier is at least 0.75 m above the corner of the carriageway curb.

Distance between the front edge of the protective device and the starting line should be at least 0.5m (see critical distances in the manual SRDM 6.3.1 Vehicle restraint systems.).

Determination of appropriate characteristics of the safety barrier (steel, concrete, wood, etc.) is done in relation to:

- road category
- location of installation
- specificities of the land belt.

Final reflector parts must be adequately shaped: deepened or rounded.

Reflectors' connections must be covered in the driving direction, or gradual in the opposite driving direction.

In the area of transitory constructions on objects, safety barrier must be made in such a way that changes caused by external effects may be bridged without harmful consequences.

Retention degree of transitory constructions depends on the degree of retention of the connected protective devices.

The choice of maximum class of the area of influence of a transitory construction depends on the situation at the location of installation.

Degree of impact intensity of the transitory construction must not be higher than the strength degree of one of the connected protective devices.

2.7.6.3.2 Wire safety fences

Wire safety fences are installed on both sides along the entire road length. In places where the safety fences may be adequately replaced by a different road equipment or object (e.g., noise protection barrier), or where because of natural factors the road goes over surmountable objects or tunnels, we do not install a wire safety fence, but we adequately attach it to the object.

The designer determines the fences course and its height in accordance with the SRPS U.S4.112 standard, and relative to the very road route, topography and available land.

2.7.6.3.3 Crash cushions

Crash cushions, or the initial and final construction and protective device, which are lined up and functionally connected in such a way that functional properties have no negative effects on each other.

Functional properties of thusly connected systems, starting from crash cushions, or initial and final construction, should be evidenced by the manufacturer of crash cushions.

Manner of execution of crash cushions, or the initial and final construction, must be specified in detail in design documentation.

2.7.6.3.4 Anti-glare equipment

The manner of execution of anti-glare equipment must be in compliance with requirements specified in the SRPS EN 1317-2:2011 standard.

Light-reflecting elements must be attached to appropriate carriers, which must not be attached to the spacer of the safety barrier, except in case of concrete safety barrier, when the lower part of the anti-glare element must be 100 mm above the top of the concrete safety barrier.

Depending on the intended use, way must be cleared for persons carrying a stretcher over the anti-glare device, or the anti-glare barrier.

- in all places without the removal (installed at adequate distance) of light-reflecting elements, or
- only in certain places, with optional temporary moving of the light-reflecting elements (in urban areas).

Anti-glare equipment must protect traffic participants from the blinding light of vehicles travelling in the opposite direction at the entire height from the upper edge of the safety barrier, on top of which the light-reflecting elements are attached. The greatest approved longitudinal opening, between the upper edge of the safety barrier and the lower edge of the carrier or the light-reflecting element of the anti-glare equipment, may be 20 mm.

The height of the anti-glare elements must be in compliance with parameters for protection of freight vehicles in accordance with the SRPS EN 12676-1:2008 standard.

Also, SRDM 6.3.1 Vehicle restraint systems, , and details for attachment to the concrete safety barrier must be submitted.

2.7.6.3.5 Traffic mirrors

Traffic mirrors must be placed in a way to enable the improvement of visibility during inclusion of vehicles on the road with right of way, or improving visibility in curves with poor visibility.

2.7.6.3.6 Warning device

Manner of installation of warning devices must be specified in detail in the design documentation.

2.7.6.3.7 Other equipment

Elevated light reflectors must be installed primarily on safety barriers along the carriageway (left white, right red), on objects and in all places, where placement of directional arrows is not possible.

Places for installation of light reflectors, blinking lights, etc. must be specified in design documentation.

2.7.6.4 Quality of execution

Volume of testing for determining quality of traffic safety equipment is set by the engineer, based on submitted documentation on quality and based on the work flow.

2.7.6.5 Quality control

Quality control of steel mechanical characteristics should be executed in accordance with the EN ISO 6892-1-B30:2009 standard (using samples of spacers and columns) and in accordance with the EN 6507-1:2006 standard (using samples of connecting screws).

Steel chemical composition analysis is executed in accordance with the ASTM 415:2005 standard (using samples of spacers and columns).

Visual marks and testing the thickness of the layer gained by hot zincing of the surface, for protection of the road equipment from corrosion, is executed using samples in accordance with the EN ISO 1461:2009 and ISO 2178:1999 standards.

Quality adequacy of light-reflecting elements must be evidenced by testing:

- resistance to wind,
- resistance to aging,
- and by measuring anti-glare protection, all in accordance with the SRPS EN 12676-1:2008 standard.

For quality control of the traffic safety equipment basic conditions apply, stated in Item 1.2.1 of these Construction Specifications.

2.7.6.6 Measuring and taking over of works

Basic conditions for measuring and taking over of installed traffic safety equipment are

determined in Items 1.2.2.2 and 1.2.2.3 of these Construction Specifications.

The engineer may provide additional conditions.

2.7.6.7 Calculation of works

Calculation of traffic safety equipment should be executed in accordance with conditions in Item 1.2.2.4 of these Construction Specifications.

2.7.7 OTHER TRAFFIC EQUIPMENT AND SIGNALIZATION

As other traffic equipment and signalization in these special technical requirements, the following has been evaluated

- emergency call system, and
- traffic counting device.

Development of the stated road traffic equipment covers all the necessary land works, acquisition and installation of all the appropriate materials and devices and their installation in places, determined in the design documentation.

In principle, all the stated traffic equipment and signalization must be developed, or installed as permanent.

2.7.7.1 Basic materials**2.7.7.1.1 Emergency call barriers**

Emergency call system consists of

- hub (in the road base),
- columns (along the road), and
- section for feeding and telecommunications .

Type of materials, needed for the building of the emergency call system, must be specified in detail in the design documentation.

2.7.7.1.2 Traffic counting device

By rule, traffic counting device has foundations on electric bases, and exceptionally on a pneumatic base.

Types of materials needed for stated devices and their installation into the pavement structure must be specified in detail in the appropriate design documentation.

2.7.7.2 Quality of materials

All materials, used for the discussed road equipment, must be resistant to effects of weather and traffic, as well as being durable, as much as possible.

Used materials must have a stated strength and provide accurate and lasting measures. They must not be sensitive to effects of moisture, temperature, industrial atmosphere, salt, oil and light and must be resistant to burning.

2.7.7.2.1 Emergency call system

Material quality for emergency call equipment must be determined in the design documentation. If not, it is determined by the engineer.

2.7.7.2.2 Traffic-counting device

Material quality for a traffic counting device must be determined in the design documentation. If not, it is determined by the engineer.

2.7.7.3 Method of execution**2.7.7.3.1 Emergency call system**

Emergency call system must be developed in accordance with the design documentation. Every change must be approved by the engineer.

2.7.7.3.2 Traffic-counting device

Manner of installation of traffic counting devices must be determined in detail and executed in accordance with the design documentation.

2.7.7.4 Quality of execution

The volume of tests for checking the quality traffic safety equipment is determined by the engineer, based on the submitted documentation on quality and based on the work flow.

2.7.7.5 Quality control

For quality control of the discussed road equipment the basic conditions hold, stated in Item 1.2.1 of these Construction Specifications.

2.7.7.6 Measuring and taking over of works

Manner of measuring and taking over of works is determined in Items 1.2.2.2 and 1.2.2.3 of these Construction Specifications.

2.7.7.7 Calculation of works

Road equipment should be calculated in accordance with conditions in Item 1.2.2.4 of these Construction Specifications.