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"REPUBLIC OF SRPSKA ROADS "
Banja Luka

GUIDELINES FOR ROAD DESIGN, CONSTRUCTION, MAINTENANCE AND SUPERVISION

VOLUME I: DESIGNING

SECTION 1: ROAD DESIGNING

Part 5: TRAFFIC SIGNALIZATION AND EQUIPMENT

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SADRŽAJ:

0. GENERAL

The present guidelines regulate the type, meaning, form, colour, dimensions, and placing of traffic signs and traffic furniture on public roads (in further text: roads)

The aforementioned traffic signs and traffic furniture on roads are also used on non-classified roads on which the road traffic is admitted.

Traffic equipment and traffic furniture on roads consist of the following:

Traffic signs, which are:

- warning signs,
- prohibitory, restriction, and mandatory signs,
- informative signs,
- additional boars defining more precisely the meaning of a sign, to which they are appended, being a constituent part of the sign at which they are situated,
- markings on carriageway and other traffic surfaces,
- other signs to mark the works, other hindrances, and damages to carriageways,
- traffic lights and illuminated markings,
- signs of variable meaning,
- triopane (a pyramid), on which warning signs, prohibitory, restriction, and mandatory signs, and informative signs can be shown. The shape of informative signs can be in such a case adjusted to the triopane area. The police may also use a triopane to provide emergency information to the road traffic users.

Tourist signs and other informative signs consist of the following:

- informative signs for cultural, historical, and natural remarkableness and monuments,
- informative signs for the direction in which cultural, historical, and natural remarkableness and monuments are located, as well as for important structures and facilities within the remarkableness or settlement area,
- welcome signs at the entry to a state, region, province, municipality, or settlement,
- signs to indicate providing the traffic, tourist, and other information on the traffic surfaces outside the road carriageway (resting places, parking places), and on other surfaces at the road, which are appointed for secondary activities near the road.

Traffic furniture on roads (in further text: traffic furniture), consisting of the following:

- furniture to mark the vicinity of the carriageway, or the edge of the traffic lane, the crawler lane, or the emergency lane,
- furniture to control and canalize the traffic in the area of road works, other obstacles, and damages to the carriageway,
- safety barriers,
- protective fences,
- prefabricated physical speed stoppers – sleeping policemen,
- impact energy absorbers,
- pedestrian parapets,
- ramps and semi-ramps,
- furniture to clearly indicate the motorway or expressway course in case of a road split,
- traffic mirrors,

- anti-glare furniture.

The letterings on traffic signs are generally written with small letters. The title of an individual destination shall be written in a single line. Where the title of a destination is long, it may be written in two lines, provided that in the second line only the subordinate part of the traffic destination is written with smaller letters. The names of destinations and other information indicated on the traffic signs are written in _____ language in Cyrillic (Latin) writing.

Traffic signs can be made in such a way that their meaning is either permanent or variable.

The traffic sign surface shall be made of light reflecting materials of type I minimum, with the exception of motorways and expressways, where the traffic sign surface shall be made of light reflecting materials of at least type II.

Traffic signs can also be manufactured as signs with their own light source (internally illuminated) or with an external light source (illuminated externally by means of special lamps). When traffic signs on motorways and expressways are illuminated externally, their surface can be made of light reflecting materials of the type I.

The surface of tourist signs and other informative signs can be made of light reflecting materials of type I maximum, and the meaning must not variable.

The surface of the road traffic furniture used for regulating and canalizing the traffic in areas of road works, other obstacles, and damages to the carriageway, shall be at least partly made of light reflecting materials. The minimum requirement, however, is an additional marking by means of light reflecting elements.

The furniture for marking the vicinity of the carriageway edge or the vicinity of the crawler or emergency lane, as well as for marking safety barriers, shall be additionally equipped with light reflecting elements.

Traffic lights and signs of variable meaning can also be made of optic fibres or elements of a matrix shape (LED) on a black base. The performance shall be such as to preserve the meaning of the traffic sign or of a part of it even in case of light source failure.

Traffic signs placed onto the same support shall be uniform, without regard to being ordinary, reflecting, or illuminated by their own light source.

Traffic signs shall be placed on the right-hand side of the road next to the carriageway, in the direction of vehicle motion.

In case that a traffic sign cannot be positioned on the right-hand side next to the carriageway, in the direction of vehicle motion, it shall be placed above the carriageway or on the left-hand side of the road. Its meaning is the same as in case of a sign placed on the right-hand side of the road.

In case that at a location, where a traffic sign should be placed, the latter, due to the traffic density or to any other reason, could not be noticed by the traffic participants, it shall also be positioned on the left-hand side of the road or above the carriageway.

Traffic signs shall be so positioned as not to disturb the motion of vehicles and pedestrians.

As a rule, the letterings on the informative signs shall be written with small letters.

1. TRAFFIC SIGNALIZATION

1.1 VERTICAL TRAFFIC SIGNS

1.1.1 WARNING SIGNS

Warning signs are:

the sign »bend to the left« (I-1), the sign »bend to the right« (I-1.1), the sign »double bend or several successive bends, first to the left« (I-2), the sign »double bend or several successive bends, first to the right« (I-2.1), and the sign »dangerous bend« (I-2.2), which denote an approach to such a bend or bend that are dangerous for their physical properties or for the lack of visibility;

I-1 I-1.1 I-2 I-2.1 I-2.2

the sign »steep hill downwards« (I-3) and the sign »steep hill upwards« (I-4), which denote an approach to a dangerous descent or a dangerous ascent, if the height difference represents a danger resulting from these conditions;

I-3 I-4

the sign »road narrows on both sides« (I-5), the sign »road narrows from right-hand side« (I-5.1), and the sign »road narrows from the left side« (I-5.2), denoting an approach to a narrowing of the carriageway, which might represent certain danger;

I-5 I-5.1 I-5.2

the sign »bascule bridge« (I-6) denoting the vicinity of the location where a bascule bridge is situated on the road;

I-6

the sign »quayside« (I-7) denoting the vicinity of the location where the road encounters the shore or quay;

I-7

the sign »uneven road« denoting the vicinity of a road section where the carriageway is uneven due to dangerous convexities and concavities (I-8), due to concavities (I-9), or due to the vicinity of a dangerous bump or major boss on the road (I-10);

I-8 I-9 I-10

the sign »slippery road« (I-11) denoting the vicinity of a road section where the carriageway surface is slippery under certain atmospheric conditions or other circumstances;

I-11

the sign »loose stones« (I-12) denoting the vicinity or a road section where loose gravel is spread, or a road section strewn with small stones on a solid base, which represents an increased danger to other traffic participants;

I-12

the signs »risk of falling rocks or avalanche« (I-13 and I-13.1) denoting the vicinity of a road section where a danger of falling stones or of stones lying on the roadway exists;

I-13 I-13.1

the sign »pedestrian crossing« (I-14) denoting the vicinity of a location on the road where a zebra pedestrian crossing is marked;

I-14

the sign »children« (I-15) denoting the vicinity of a location on the road where children walk frequently and in large numbers (e.g. in front of schools, playgrounds, etc.);

I-15

the sign »cyclists« (I-16) denoting the vicinity of a location on the road where cyclists frequently come to the road from a side road or a cycle track;

I-16

the sign »cattle« (I-17) denoting a location where domestic animals, kept under control, cross the road or walk along the road;

I-17

the sign »game animals« (I-18) denoting particularly dangerous locations where game animals frequently cross the road;

I-18

the sign »road works« (I-19) denoting the vicinity of a location where road works are carried out;

I-19

the signs »traffic lights« (I-20 and I-20.1) denoting the vicinity of crossroads or marked zebra pedestrian crossing where the traffic is controlled by means of traffic lights;

I-20

I-20.1

the sign »vicinity of runway« (I-21) denoting a road section crossed by low-flying aircrafts during taking-off or landing;

I-21

the signs »gusts of wind« (I-22 and I-22.1) denoting the vicinity of a road sections where strong side wind blows;

I-22

I-22.1

the sign »two-way traffic« (I-23) denoting the vicinity of a location where the one-way traffic temporarily or permanently changes to a two-way traffic;

I-23

the sign »tunnel« (I-24) denoting the vicinity of a tunnel on the road;

I-24

the sign »other danger« (I-25) denotes the vicinity of a road section or of a location on the road where traffic participants are threatened by a danger, to which no special warning sign is assigned by these guidelines;

I-25

the sign »intersection of roads of the same ranking« (I-26) denoting the vicinity of an intersection of roads, none of them being preferential;

I-26

the sign »right angle intersection with secondary road« (I-27), the sign »right angle connection with secondary road from the left « (I-28), the sign »right angle connection with secondary road from the right « (I-28.1), the sign »acute angle connection with secondary road from the left« (I-29), and the sign »acute angle connection with secondary road from the right« (I-29.1), denoting the vicinity of crossroads (intersection), where a major road is intersected by or connected with a secondary road.

The symbols on the abovementioned traffic signs can also be of different shapes depending on the particular situation encountered on the road;

I-27 I-28 I-28.1 I-29 I-29.1

the sign »roundabout« (I-30) denoting the vicinity of crossroads where the traffic runs in circular flow;

I-30

the sign »tramway track« (I-31) denoting the vicinity of a location where the road crosses a tramway track at grade;

I-31

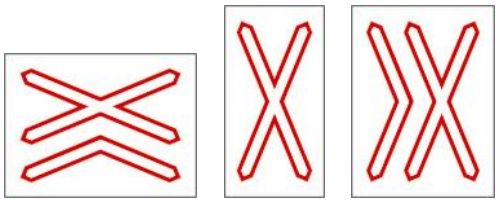
the sign »crossing railway – road at grade with barriers or semi-barriers« (I-32) denoting the vicinity of location where railway tracks cross the road at grade, such location being secured by means of railway barriers or semi-barriers;

I-32

the sign »crossing railway – road at grade without barriers or semi-barriers« (I-33) denoting the vicinity of location where railway tracks cross the road at grade, such location not being secured by means of railway barriers or semi-barriers;

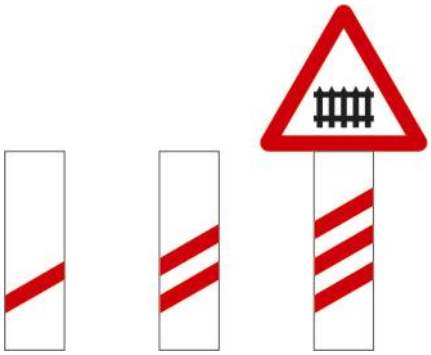
I-33

the sign »St. Andrew's cross« denoting a location where the road crosses a railway line at grade without being secured by means of barriers or semi-barriers; crossing of the road with a single-track railroad (I-34), or with a two-track or multiple-track railroad (I-34.1). To achieve better visibility, the sign may also be made on a white non-luminescent background. In case that there is not enough space for a normal placing of the signs, the latter may be executed with shorter horizontal side;



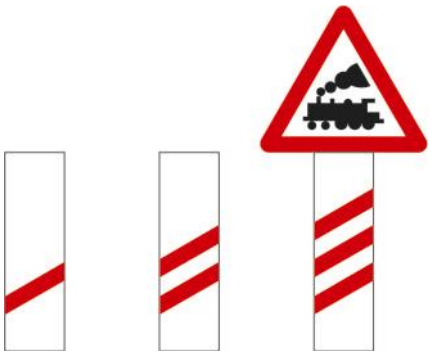
I-34 I-34.1 I-34 I-34.1

the sign »approaching the railway – road crossing at grade with barriers or semi-barriers« (I-35) denoting the distance between the sign itself and the railway – road crossing at grade, the latter being secured by means of barriers or semi-barriers;



I-35

the sign »approaching the railway – road crossing at grade without barriers or semi-barriers« (I-36) denoting the distance between the sign itself and the railway – road crossing at grade, the latter not being secured by means of barriers or semi-barriers;



I-36

the sign »slippery hard frost« (I-37) denoting the vicinity of a road section where the probability of hard frost formation is relatively high;

I-37

the sign »traffic jam« (I-38) denoting the vicinity of a road section where, under certain traffic conditions, a danger due to jammed vehicles exists;

I-38

the sign »soft shoulder« (I-39) denoting the vicinity of a road section with a non-consolidated shoulder next to the carriageway;

I-39

the sign »fire hazard« (I-40) denoting the vicinity of a road section located in the area where the risk of fire is relatively high;

I-40

the sign »traffic accident« (I-41) denoting the vicinity of the place on a road where traffic accident has happened;

I-41

1.1.1.1 Shape, colour, and dimensions of warning signs

Symbols on the warning signs I-14 (pedestrian crossing), I-15 (children), I-16 (cyclists), I-17 (cattle), I-18 (game animals), and I-21 (vicinity of runway) can be, in dependence on the direction where the danger threatens from, turned to other side as well.

Warning signs are equilateral triangles, with one horizontal side and the opposite apex oriented upwards.

The basic colour or the warning signs is white, with red edges of the triangle.

Irrespective of the abovementioned requirement, the basic colour of the warning signs is yellow, if the signs are temporarily used during road works.

The symbols on the warning signs are of black colour.

The length of sides of the warning sign triangles amounts to:

1) 120 cm on motorways, expressways (roads reserved to motor vehicles), on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
2) 90 cm on roads out of settlements whose carriageway is less than 7.0 m wide;
3) 60 cm on cycle tracks, on roads in areas of slow traffic, and on non-classified roads;
4) 45 cm, when the warning signs are used as inserted signs (i.e. the particular sign is only a part of the meaning of another sign) on traffic signs for traffic guiding the traffic in the drive direction;

If necessary, on roads indicated in point 3) above, the sides of warning sign triangles can be 90 cm long.

The size of symbols on warning signs shall be proportional to the size of the particular sign, while the symbol itself shall be drawn in such a way that it can be easily identified.

As regards the shape, colour, or dimensions, the following warning signs deviate from the abovementioned specifications:

1) As regards the shape:

- the signs I-34 and I-34.1 (St. Andrew's cross), consisting of crossed laths (two or four);
- the signs I-35 (approaching the railway – road crossing with barriers or semi-barriers), and I-36 (approaching the railway – road crossing without barriers and semi-barriers), which are of rectangular shape, with the shorter side as baseline;

2) As regards the colour:

- the symbols on the signs I-20 and I-20.1 (tricolour traffic lights), where the red light is above, the yellow light in the middle, and the green light below in the vertical axis, whereas the red light is on the left, the yellow light in the middle, and the green light on the right in the horizontal axis;

3) As regards the dimensions:

- the signs I-34 and I-34.1 (St. Andrew's crosses) consist of laths measuring 120 cm in length and 12 cm in width;
- the signs I-35 (approaching the railway – road crossing with barriers or semi-barriers), and I-36 (approaching the railway – road crossing without barriers or semi-barriers), where the longer side of the rectangle measures 100 cm and the shorter one 30 cm, and the 8 cm wide strips on the sign are placed at an angle of 30°.

1.1.2 PROHIBITORY, RESTRICTION, AND MANDATORY SIGNS

1.1.2.1 Prohibitory and restriction signs

Prohibitory and restriction signs are:

the sign »give way« (II-1) denoting the vicinity of an intersection where the driver must give preference of passing to all the vehicles driving on the road he is encountering;

II-1

the sign »stop and give way« (II-2) denoting the location prior to entering an intersection where the driver must stop his vehicle and give preference of passing to all the vehicles driving on the road he is encountering;

II-2

the sign »no vehicles in both directions« (II-3) denoting a road or a road section where the traffic is prohibited in both directions and to all the vehicles;

II-3

the sign »no vehicles in one direction (no entry)« (II-4) denoting a road or a road section where the traffic is prohibited to vehicles arriving from the direction towards which the sign is oriented;

II-4

the sign »no motor vehicles except solo motorcycles, scooters or mopeds« (II-5) denoting a road or a road section where the traffic of all motor vehicles except of motorcycles without sidecar, scooters, and mopeds is prohibited;

II-5

the sign »no buses« (II-6) denoting a road or a road section where the bus traffic is prohibited;

II-6

the sign «no lorries» (II-7) denoting a road or a road section where the traffic of lorries is prohibited, and the sign «no lorries of maximum admissible mass exceeding the prescribed mass» (II-7.1) denoting a road or a road section where the traffic of such lorries is prohibited whose maximum admissible mass exceeds the mass as indicated on the traffic sign;

II-7

II-7.1

the sign »no tank lorries« (II-8) denoting a road or a road section where the traffic of such vehicles is prohibited, which transport substances above the admissible quantity that might cause water-pollution;

II-8

the sign »no vehicles transporting explosives or inflammable substances above the admissible quantity« (II-9) denoting a road or a road section where the traffic of such vehicles is prohibited, which transport more explosive or inflammable goods than it is allowed; the sign »no vehicles transporting dangerous goods above the admissible quantity« (II-9.1) denoting a road or a road section where the traffic of such vehicles is prohibited, which transport more dangerous goods than it is allowed;

II-9

II-9-1

the sign «no motor vehicles to which trailers are attached except semi-trailers, light trailers, or camping trailers» (II-10) denoting a road or a road section where the traffic or those motor vehicles is prohibited, to which a trailer is attached except a semi-trailer, light trailer, or camping trailer; the sign «no motor vehicles to which trailers are attached except a light trailer or camping trailer» (II-10.1) denoting a road or a road section where the traffic of those motor vehicles is prohibited to which a trailer is attached except a light trailer or camping trailer; the sign «no motor vehicles to which trailers are attached» (II-10.2) denoting a road or a road section where the traffic of those motor vehicles is prohibited to which a trailer is attached;

II-10

II-10.1

II-10.2

the sign »no tractors« (II-11) denoting a road or a road section where the tractor traffic is prohibited;

II-11

the sign »no motorcycles« (II-12) denoting a road or a road section where the traffic of motorcycles and of motor vehicles with three wheels is prohibited;

II-12

the sign »no mopeds« (II-13) denoting a road or a road section where the traffic of mopeds with two or three wheels is prohibited;

II-13

the sign »no bicycles« (II-14) denoting a road or a road section where the cycle traffic is prohibited;

II-14

the sign »no animal-drawn vehicles« (II-15) denoting a road or a road section where the traffic of animal-drawn vehicles is prohibited;

II-15

the sign »no handcarts (II-16) denoting a road or a road section where the traffic of handcarts is prohibited;

II-16

the sign »no pedestrians« (II-17) denoting a road or a road section where the pedestrian traffic is prohibited;

II-17

the sign »no motor vehicles« (II-18) denoting a road or a road section where the traffic of all motor vehicles is prohibited;

II-18

the sign »no motor vehicles and animal-drawn vehicles« (II-19) denoting a road or a road section where the traffic of all motor vehicles and of animal-drawn vehicles is prohibited;

II-19

On the signs II-18 and II-19 intended for prohibitions imposed to different vehicle types or road users it is possible to employ and combine different symbols indicated under II-5 to II-17.

It is not allowed to place a sign containing more than two symbols out of populated areas, nor with more than three symbols within populated areas;

the sign »width limit« (II-20) denoting a road or a road section where the traffic of such vehicles is prohibited whose total width exceeds the width as indicated on the sign;

II-20

the sign »height limit« (II-21) denoting a road or a road section where the traffic of such vehicles is prohibited whose total height exceeds the height as indicated on the sign;

II-21

the sign »total weight limit« (II-22) denoting a road or a road section where the traffic of such vehicles is prohibited whose total weight exceeds the weight as indicated on the sign;

II-22

the sign »axle load limit« (II-23) denoting a road or a road section where the traffic of vehicles whose axle load exceeds the axle load indicated on the sign is prohibited; the sign »tandem axle load limit« (II-23.1) denoting a road or a road section where the traffic of vehicles whose tandem axle load exceeds the value indicated on the sign is prohibited;

II-23

II-23.1

the sign »length limit« (II-24) denoting a road or a road section where the traffic of vehicles whose total length exceeds the value indicated on the sign is prohibited;

II-24

the sign »smallest interval between motor vehicles« (II-25) denoting the minimum distance between two successive vehicles in motion to be respected by the drivers;

II-25

the sign »no left turn« (II-26) denoting an intersection where turning left is prohibited; the sign »no right turn« (II-26.1) denoting an intersection where turning right is prohibited;

II-26

II-26.1

the sign »no U-turn« (II-27) denoting a location where U-turn is prohibited;

II-27

the sign »no overtaking« (II-28) denoting a road or a road section where overtaking of all the motor vehicles except motorcycles without sidecar and two-wheel mopeds is prohibited;

II-28

the sign »no overtaking by lorries« (II-29) denoting a road or a road section where lorries whose maximum admissible weight exceeds 3.5 t must not overtake other motor vehicles, except motorcycles without sidecar and two-wheel mopeds;

II-29

the sign »speed limit« (II-30) denoting a road or a road section where the vehicle speed must not exceed the speed (in km/hour) as indicated on the sign.

In case that the sign is supplemented by a board indicating the vehicle weight (e.g. 5 t), the speed limit only relates to such vehicles whose maximum admissible weight exceeds the indicated one;

II-30

the sign »no horn« (II-31) denoting a road or a road section where the horn must not be used except in case of direct danger;

II-31

the sign »obligatory stop« denoting the vicinity of a location where a vehicle must stop. The words indicated on the sign shall explicate the purpose of the required stop: »CUSTOMS—DOUANE« (II-32), or: »POLICE« (II-32.1), or »TOLL—PEAGE« (II-32.2);

II-32

II-32.1

II-32.2

the sign »give way to oncoming traffic« (II-33) restricting a vehicle to enter a narrow road section before vehicles coming from the opposite direction have passed this section;


II-33

the sign »no stopping and parking« (II-34) denoting the side of a road where the vehicles must not stop nor park;


II-34

the sign »no parking« (II-35) denoting the side of a road where the vehicles are prohibited to park;


II-35

The signs II-34 and II-35 may be supplemented by a board indicating: 1) days in a week or a month, the time in a day to which the restriction relates; 2) the maximum time of stopping or and parking respectively; 3) category of vehicle to which the restriction relates;

the sign »alternating parking« (II-36) denoting a road section where the vehicles are prohibited to park on odd days;

II-36

the sign »alternating parking« (II-37) denoting a road section where the vehicles are prohibited to park on even days;

II-37

The symbols on the prohibitory and restriction signs II-20, II-21, II-22, II-23, II-24, II-25, and II-30 are indicated as an example, whereas the actual values are given according to the road conditions and traffic safety requirements.

1.1.2.2 Mandatory signs

Mandatory signs are:

the sign »minimum admissible speed« (II-38) denoting a road or a road section where, in normal circumstances, the vehicle speed must not be lower than the value indicated on the sign in km/hour;

II-38

The symbol on the above sign is indicated as an example, whereas the actual values are given according to the road conditions and traffic safety requirements.

the sign »tyre chains« (II-39) denoting a road section where the driving wheels of motor vehicles, except motorcycles, must be fitted out with appropriate winter equipment when the carriageway is covered with snow;

II-39

the sign »cycle track« (II-40) denoting a path or track where bicycles and motor driven bicycles must drive, while other vehicles are prohibited to drive on these traffic surfaces;

II-40

the sign »pedestrian path« (II-41) denoting a specially made lane on which pedestrians may walk, while other traffic participants are prohibited to use it;

II-41

the sign »cyclists and pedestrians only« (II-42) denoting a specially made lane on which cyclists and pedestrians may drive/walk, while other traffic participants are prohibited to use it;

II-42

the sign »separated lanes for pedestrians and cyclists« (II-43) denoting specially made lanes within the framework of the same traffic surface on which cyclists and pedestrians may drive/walk, while other traffic participants are prohibited to use it;

II-43

the sign »path for riders« (II-44) denoting a path intended for riders, while other traffic participants are prohibited to use;

II-44

the signs »mandatory traffic direction« (II-45), (II-45.1), (II-45.2), (II-45.3), and (II-45.4) denoting directions in which the vehicles shall drive;

II-45 II-45.1 II-45.2 II-45.3 II-45.4

the signs »admissible directions« (II-46), (II-46.1), and (II-46.2) denoting directions in which the vehicles may drive;

II-46 II-46.1 II-46.2

the signs »mandatory passing on the right« (II-47), »mandatory passing on the left« (II-47.1), and »roundabout traffic« (II-47.2) denoting a road or a road section where vehicles must drive when passing pedestrian refuges, traffic directing islands, and other structures on the carriageway;

II-47 II-47.1 II-47.2

1.1.2.3 Shape, colour, and dimensions of prohibitory, restriction, and mandatory signs

The prohibitory, restriction, and mandatory signs are of circular shape, with the exception of the sign II-1 (give way) and II-2 (stop and give way).

The basic colour of prohibitory and restriction signs is white, while for the mandatory signs it is blue.

The basic colour of prohibitory and restriction signs is yellow, if a sign is provisionally used during the road works.

Symbols and letterings on prohibitory and restriction signs are of black colour, whereas they are of white colour on mandatory signs.

The edge of the circle as well as the strips applied at angle on the prohibitory and restriction signs are red.

The circle diameter of prohibitory, restriction, and mandatory signs amounts to:

1) 90 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
2) 60 cm on roads out of settlements with a carriageway measuring less than 7.0 m in width;
3) 40 cm on cycle tracks, on roads of reduced traffic speed, and on non-classified roads;

4) 30 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the diameter of prohibitory, restriction, and mandatory signs mentioned in point 3) above can amount to 60 cm as well.

Strips on prohibitory, restriction, and mandatory signs shall be applied at an angle of 45°to the horizontal plane.

As regards the shape, colour, or dimensions, the following prohibitory, restriction, and mandatory signs deviate from the standard features:

1) As regards the shape:

- the sign II-1 (give way) is an equilateral triangle, with one horizontal side and the opposite apex oriented downwards;
- the sign II-2 (stop and give way) has a shape of regular octagon;

2) As regards the colour and symbols:

- the sign II-2 (stop and give way) is of red colour, while the edges and the symbol STOP are white;
- the symbol on the sign II-8 (no tank lorries) is of red colour, the vehicle and the axle with wheels are black, while the two wavy lines are blue;
- the symbols on the sign II-9 (no vehicles transporting explosives or inflammable substances above the admissible quantity) and on the sign II-9.1 (no vehicles transporting dangerous goods above the admissible quantity) are red, while the vehicle and the axle with wheels are black;
- the symbol on the sign II-12 (no motorcycles) can also be in a shape of a motor vehicle with three wheels;
- the symbol on the sign II-13 (no mopeds) can also be in a shape of a motor vehicle with three wheels;
- the symbol on the sign II-33 (give way to oncoming traffic) contains a red arrow indicating the restricted direction;
- the sign II-34 (no stopping and parking) and the sign II-35 (no parking) are of blue basic colour;
- the sign II-36 and the sign II-37 (alternating parking) are of blue basic colour, whereas the symbols are white.

3) As regards the dimensions:

a) the sides of the equilateral triangle of the sign II-1 (give way) are of the following lengths:

- 120 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
- 90 cm on the roads out of settlements whose carriageway is less than 7.0 m wide, and on the roads within settlements;
- 60 cm on cycle tracks, in areas of reduced vehicle speed, and on non-classified roads;
- 45 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the length of the triangle side of the signs II-1 can amount to 90 cm on cycle tracks, on roads of reduced vehicle speed, and on non-classified roads.

b) the symbol height of the sign II-2 (stop and give way) shall be equal to one third of the sign height. The diameter of the internally drawn circle of the sign II-2 shall amount to:

- 90 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
- 60 cm on the roads out of settlements whose carriageway is less than 7.0 m wide, and on the roads within settlements;
- 40 cm on cycle tracks, in areas of reduced vehicle speed, and on non-classified roads;
- 30 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the diameter of the internally drawn circle on the signs II-2 (stop and give way) can amount to 60 cm on cycle tracks, on roads of reduced vehicle speed, and on non-classified roads.

1.1.3 INFORMATIVE SIGNS

The informative signs provide the traffic participants with the necessary information of the road which they are using, names of places the road runs through as well as distances to these places, termination of validity of prohibitory, restriction, and mandatory signs, and of other information that might be useful.

The informative signs are:

the sign »priority over approaching traffic« (III-1) providing the driver with the information that he has the precedence over the vehicles approaching a narrow passage from the opposite direction;

III-1

Where the sign III-1 is used, at the opposite side of the narrow passage the sign II-33 shall be placed;

the signs »one-way traffic« (III-2) and (III-2.1) providing the traffic participants with the information of the one-way traffic;

The sign III-2 is placed upright to the carriageway axis, while the sign III-2.1 is placed almost parallel with the carriageway axis; on the arrows of these signs, the words »one way« can be written;

III-2 III-2.1

the sign »priority road« (III-3) denoting a road or a road section where the vehicles have the priority of passing the particular intersection over the vehicles arriving from a road, which crosses the aforementioned road;

III-3

the sign »end of priority road« (III-4) denoting the location where the priority road or a road section terminates;

III-4

the sign »cyclists crossing« (III-5) denoting the location where the crossing for cyclists is marked;

III-5

the sign »pedestrian zone« (III-6) denoting the place of entering a zone or public area reserved for pedestrians, and the sign »end of pedestrian zone« (III-6.1) denoting the place where the zone or public area reserved for pedestrians ends;

III-6

III-6.1

the sign »area of limited speed« (III-7) denoting the location within a settlement where the area of speed limitation as indicated on the sign begins, and the sign »end of area of limited speed« (III-7.1) denoting the location within the settlement where the area of speed limitation terminates;

III-7

III-7.1

the sign »pedestrian crossing« (III-8) denoting the location of a marked pedestrian crossing (zebra);

III-8

the sign »pedestrian crossing underground or above ground« (III-9) denoting the location of a pedestrian crossing located under the ground or above the ground;

III-9

the sign »intersection« (III-10) denoting the mutual position and directions of roads and names of towns to which the intersecting roads lead, as well as the road numbers and international road numbers.

The sign III-10 can be supplemented by additional board denoting the distance to the intersection to which the sign refers;

III-10

the sign »no through road« (III-11) denoting the vicinity and the position of a road without a way out (cul-de-sac). The position of the symbol on the sign III-11 shall correspond to the position of such a road with regard to the road on which this sign is placed;

III-11

the sign »direction of motion of a vehicle intending to turn left at crossroads where turning left is prohibited« (III-12) denoting a road on which the vehicle shall drive if it intends to turn left at the following crossroads where turning left is not admitted;

III-12

the signs »arrangement of lanes at an intersection« (III-13) and »arrangement of lanes at an intersection with names of towns, villages, and other places indicated« (III-13.1), providing the drivers with a preliminary information of how to arrange their vehicles at

crossroads on roads with several traffic lanes. The symbols on the signs III-13 and III-13.1 shall comply with the actual number of traffic lanes and with the way of arrangement on those lanes. The sign may contain the names of towns and villages as well (III-13.1);

III-13

III-13.1

the sign »route direction arrow« (III-14) denoting the location or a characteristic structure to which the particular road is leading. In case that the road number is required on the route direction arrow, it shall be written on the side opposite to the arrow, and shall be separated from other letterings by means of a line.

On a route direction arrow only two names of towns may be written, one under the other, as well as the distance (in km) to the town to which the road is leading;

III-14

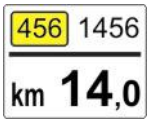
the sign »destination ahead, to the left, to the right« (III-15) denoting the road direction towards the populated place indicated on the sign. The sign can contain no more than three fields to indicate the directions. Where the sign is fixed on a portal above the carriageway, each field shall be placed as an extra sign above the traffic lanes it is referring to;

III-15

the sign »road number« (III-16) denoting the number of a road, the sign «mileage marking of a road section» (II-16.1) denoting the road number, the road section number, and the current kilometre of the particular road section, the sign «mileage marking of an approach road to the road section» (16.2) denoting the number of the approach road and the current kilometre of the particular road section, the sign «mileage marking of a structure on the road (III-16.3)» denoting the road number, the road section number or the approach road number, the number of the structure, the type of the structure ,and the current kilometre of the particular road section, the sign «mileage marking of a road

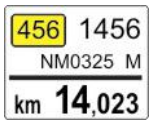
section on the boundary between two communities» (III-16.4) denoting the current kilometre of the point where the particular road section passes from the area of one community to the area of another community, and the sign «mileage marking of the cycle track section» (III-16.5) denoting the section number and the current kilometre of the particular cycle track;

III-16



III-16.1

III-16.2



III-16.3

III-16.4

III-16.5

the sign »international road number« (III-17) denoting the number on an international road, and the sign »motorway number» (III-17.1) denoting the number of a motorway;

III-17

III-17.1

the sign »motorway« (III-18) denoting the location where a motorway is beginning;

III-18

the sign »end of motorway« (III-19) denoting the location where a motorway is ending;

III-19

the sign »road reserved for motor vehicle traffic« (III-20) denoting the location where a road, on which only motor vehicles may drive, is beginning;

III-20

the sign »end of road reserved for motor vehicle traffic« (III-21) denoting the location where the road, on which motor vehicles may only drive, is ending;

III-21

the sign »name of town« (III-22) denoting the name of a town or village to which the road is entering, and the boundary line from which the particular town or village is beginning;

III-22

the sign »end of town« (III-23) denoting the location where the town or village, which the particular road runs through, is ending;

III-23

the sign »end of prohibition of overtaking of all motor vehicles except motorcycles without sidecar« (III-24) denoting the location where the prohibition of overtaking of all motor driven vehicles except motorcycles without a sidecar and two-wheel bicycles with a motor is ending;

III-24

the sign »end of prohibition of overtaking for all heavy lorries« (III-25) denoting the location where the prohibition of overtaking for all heavy lorries is ending;

III-25

the sign »end of speed restriction« (III-26) denoting the location where the speed restriction is terminating, and the sign »end of minimum admissible speed« (III-26.1) denoting the location where the prescribed minimum admissible speed is ending;

III-26

III-26.1

the sign »end of no horn« (III-27) denoting the location where the prohibition of using horn is ending;

III-27

the sign »end of all prohibitions« (III-28), the sign »end of tyre chain obligation« (III-28.1), the sign »end of cycle track« (III-28.2), the sign »end of pedestrian path« (III-28.3), the sign »end of path for riders« (III-28.4), the sign »end of pedestrian path and cycle track« (III-28.5), the sign »end of separated lanes of pedestrians and cyclists« (III-28.6) denoting locations on the particular road where the corresponding prohibitions are ending;

III-28

III-28.1

III-28.2

III-28.3

III-28.4

III-28.5

III-28.6

the sign »zone of restricted parking time« (III-29) denoting the location in a settlement where the zone of generally restricted parking time commences, notwithstanding whether the parking is paid or not, and the sign »end of zone of restricted parking time« (III-29.1) denoting the location in a settlement where the zone of restricted parking time ends. The sign may be supplemented by an additional board indicating days or hours to which the restriction applies;

III-29

III-29.1

the sign »slow traffic area (traffic integration zone)« (III-30) denoting the location in a town where the area of pedestrian preference and of playing children begins, and the sign »end of slow traffic area (end of traffic integration zone)« (III-30.1) denoting the location in a town where such an area is ending;


III-30


III-30.1

the sign »parking« (III-31), the sign »garage« (III-31.1) denoting the space out of the road carriageway, which is destined or specially arranged for parking the vehicles, and the sign »park and take ride« denoting the vicinity of a location, or the location itself, where vehicles can be parked and the drivers can continue their ride using public transportation means (III-31.2) or hired bicycle (III-31.3).

III-31

III-31.1

III-31.2

III-31.3

By means of corresponding symbols or letterings on the sign III-31 or on a supplemental board the following can be indicated: how to park, the direction in which the parking place is situated, the distance (in metres) to the parking place, categories of vehicles for which the parking place is intended, as well as eventual restriction of parking time. On the signs III-31.1 and III-31.3, the types of public transportation means and numbers of lines can also be indicated;

the sign »restricted parking time« (III-32) denoting the location where the time of parking the vehicles is limited;

III-32

the sign »hospital« (III-33) denoting the vicinity of a hospital and giving warning to drivers not to make sufficient noise;

III-33

the sign »first aid station« (III-34) denoting the vicinity of a location, or the location itself where a first aid station is situated;

III-34

the sign »post office« (III-35) denoting the vicinity of a location where a post office is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to mark the direction in which the particular location or service is situated, as well as the distance in metres;

III-35

the sign »car repair garage« (III-36) denoting the vicinity of a location where a vehicle repair shop is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-36

the sign »public telephone« (III-37) denoting the vicinity of a location, or the location itself where a telephone box is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-37

the sign »petrol station« (III-38) denoting the vicinity of a location where a petrol station is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-38

the sign »hotel or motel« (III-39) denoting the vicinity of a location, or the location itself where a hotel or a motel is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-39

the sign »restaurant« (III-40) denoting the vicinity of a location, or the location itself where a restaurant is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

On the part of the sign III-39, beneath the white field, the word »hotel« or »motel« can be written, depending on the type of facility.

III-40

the sign »coffeehouse« (III-41) denoting the vicinity of a location, or the location itself where a coffeehouse is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-41

the signs »public lavatory« denoting the vicinity of a location, or the location itself, where a toilet is situated with the possibility of washing the hands, either inside or outside (III-42), and where a toilet is situated including corresponding separate lavatories« (III-42.1). By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-42

III-42.1

the sign »lay-by area« (III-43) denoting the vicinity of a location, or the location itself where a lay-by area is arranged for picnickers and tourists. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-43

the sign »tent camping« (III-44) denoting the vicinity of an area, or the area itself where tent camping is arranged, the sign »caravan camping« (III-44.1) denoting the vicinity of an area, or the area itself where caravan camping is arranged, and the sign »tent and caravan camping« (III-44.2) denoting the vicinity of an area, or the area itself where tent and caravan camping is arranged. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;


III-44


III-44.1


III-44.2

the sign »waste tank discharge« (III-45) denoting the vicinity of a location, or the location itself where the station or the service allowing discharging waste water from camping vehicles is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;


III-45

the sign »car wash« (III-46) denoting the vicinity of a location, or the location itself where a car wash facility is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;


III-46

the sign »mountain cottage« (III-47) denoting the vicinity of a location, or the location itself where a mountain cottage is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-47

the sign »vehicle offering assistance on the road« (III-48) denoting the vicinity of a location, or the location itself where a service is situated, which can offer adequate help in case of damage of the vehicle.

III-48

By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres, and the telephone number of the service offering assistance on the road;

the sign »fire extinguisher« (III-49) denoting the vicinity of a location, or the location itself where the fire extinguishing service is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-49

the sign »industrial area« (III-50) denoting the vicinity of a location, or the location itself where an industrial area is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-50

the sign »bus stop« (III-51) indicating the location of a bus stop, the sign »tramway stop« (III-51.1) indicating the location of a tramway station, the sign »taxi rank« (III-51.2) denoting the vicinity of a location, or the location itself where a taxi rank is situated, and the sign »airport« (III-53) denoting the vicinity of an airport location, or the airport location itself. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;


III-51


III-51.1

III-51.2


III-51.3

the sign »drinking water« (III-52) denoting the vicinity of a location, or the location itself where drinking water is situated. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the potable water can be found, as well as the distance in metres;


III-52

the sign »water protective area« (III-53) denoting the location on the road where the water protective area begins, and where the vehicles transporting substances that might pollute the water shall drive particularly attentively;

III-53

the sign »harbour« (III-54) denoting the vicinity of a harbour, port, or ferryboat. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;


III-54

the sign »bypass for certain vehicle types« (III-55) informing the drivers of vehicles indicated on the sign to drive in the direction as determined by the traffic sign "mandatory traffic direction". By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction of the recommended road, its designation, or the destination;

III-55

III-55

the sign »tourist information« (III-56) denoting the vicinity of a location, or the location itself where tourist information can be obtained. By means of symbols or letterings on the sign or a supplementary board it is possible to indicate the direction in which the particular location or service is situated, as well as the distance in metres;

III-56

the sign »radio station transmitting information of road and traffic« (III-57) denoting the frequency and wave length of the radio station transmitting the programme, which periodically or permanently provides news of events and traffic on the road;

III-57

the sign »road passability« (III-58) providing information of whether a mountain road or pass is open or closed (the name of the town is given as an illustration only);

III-58

If the road is closed, the board is of red colour and contains the lettering »closed«. If the road is open, the board is of green colour and contains the lettering »open«. The letterings on the boards are white.

If the road is open, the board 3, in dependence on the road condition, contains the sign »tyre chains« (II-39), or the symbol »tyre chains or snow tyres«.

If the road is closed, the board 2 contains the name of the place to which the road is open.

The boards 2 and 3 are of white colour, while the symbols and letterings on them are black;

the sign »number of hairpin bend« (III-59) denoting the number of a hairpin bend including the height above sea level;

III-59

the sign »name of tunnel« (III-60) and the sign »name of viaduct« (III-60.1) denoting the name and the length of an important tunnel or viaduct;

III-60

III-60.1

the sign »mountain pass« (III-61) denoting a mountain pass including the height above the sea level;

III-61

the sign »river« (III-62) denoting the name of the river crossed by the particular road;

III-62

the sign »police station« (III-63) denoting the vicinity of a location, or the location itself where a police station is situated;

III-63

the sign »recommended speed« (III-64) denoting the speed, which is recommended on certain road section, and the sign »end of recommended speed« (III-64.1) denoting the location on the road where the recommended speed is ending.

III-64 III-64.1

the sign »confirmation of direction« (III-65) denoting a confirmation of the driving direction after passing an intersection.

The sign contains the name of the town and the distance in kilometres from the location where the sign is placed up to the particular town.

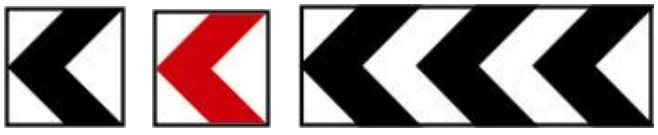
An individual sign may contain no more than five towns including an indication of the distance to these towns;

III-65

the sign »street or road name« (III-66) providing drivers and pedestrians with the information of the street/road they are passing or entering. The sign may also contain house numbers of certain street/road section;

III-66

the sign »direction arrows« (III-67) and (III-67.1) denoting the location where a sharp curve is encountered;



III-67 III-67 III-67.1

the sign »preliminary way-mark for exit« (III-68) denoting on motorways and roads with split-level intersections the direction of driving towards the towns as indicated on the sign;

III-68

the sign »way-mark for exit« (III-69) and (III-69.1) denoting on motorways and roads with split-level intersections the direction of driving towards the towns as indicated on the sign;

The signs III-69 and III-69.1 are fixed to portals above the carriageway;

III-69

III-69.1

the sign »exit« (III-70) denoting the location of leaving the motorway;

III-70

the sign located above the carriageway »arrangement of lanes« (III-71) informing the drivers of which traffic lane must be used to proceed to the town as indicated on the sign;

III-71

the sign »children on road« (III-72) denoting a place in whose vicinity a school or pedestrian crossings frequently used by children are situated;

III-72

the sign »traffic lane intended for public transportation vehicles« (III-73) denoting a traffic lane on which the public transportation vehicles must drive;

III-73

the sign »end of traffic lane intended for public transportation vehicles« (III-73.1) denoting the place where the traffic lane on which the public transportation vehicles must drive is ending;

III-73.1

the sign »restriction of maximum admissible speed on the roads in the Republic of Srpska« (III-74) denoting general limitation of the maximum admissible speed on different types of roads in the Republic of Srpska;

III-74

the sign »crawler lane« (III-75) denoting the beginning of the traffic lane where a slow vehicle must drive whose speed is less than the speed indicated on the inserted sign; the sign »end of crawler lane« (III-75.1) denoting the location where such a lane is ending;

III-75

III-75.1

the sign »preliminary way-mark for exit« (III-76) denoting on motorways and split-level intersections the position of road directions towards the towns as indicated on the sign;

III-76

the sign »multipurpose facility« (III-77) announcing of encountering a multipurpose facility on the road whose functions are marked by means of pictograms. Such a sign is of blue basic colour, the numbers and letters are white, while the symbols are black on a white base;

III-77

the sign »exit to multipurpose facility« (III-78) denoting a direct location of leaving the road and approaching the multipurpose facility. Such a sign is of blue basic colour, the numbers and letters are white, while the symbols are black on a white base;

III-78

the sign »intersection of motorways« (III-79) announcing an intersection of motorways to be encountered;

III-79

the sign "name of loop" (III-80) announcing a loop to be encountered. It is placed on roads with split-level intersections;

III-80

the sign "niche for vehicle stop" (III-81) denoting on a part of a motorway or of an expressway, without emergency lanes, a place only intended for emergency stops of vehicles. The sign is of red colour and with an lettering SOS, however only in case that an emergency call device is present at the niche. The sign must also be placed at a distance of 250 m before the particular place;

III-81

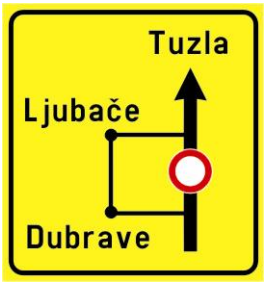
the sign "alternating precedence" (III-82) denoting the location on the road where two traffic lanes, none of them being preferential, are uniting to one traffic lane. The drivers must respect the zip system of driving;

III-82

the sign "school traffic service" (III-83) informing the driver of the vicinity of a location on the road where, in compliance with the Act of Road Traffic Safety, children are adequately safeguarded upon arriving to and leaving the school;

III-83

the "preliminary sign for bypass" (III-84) indicating the direction and the course of a bypass road serving to divert the traffic, when, for road works, provisional obstacle, or damage to the carriageway, the road is completely or partly closed. In case of longer bypasses, the sign shall be supplemented by an additional board with an lettering BYPASS ... km;



III-84

the sign "traffic lane closure" (III-85 and III-85.1) denoting the location where one of the traffic lanes in the same direction has been cancelled. The number of straight arrows shall correspond to the number of traffic lanes that are going on;

III-85

III-85.1

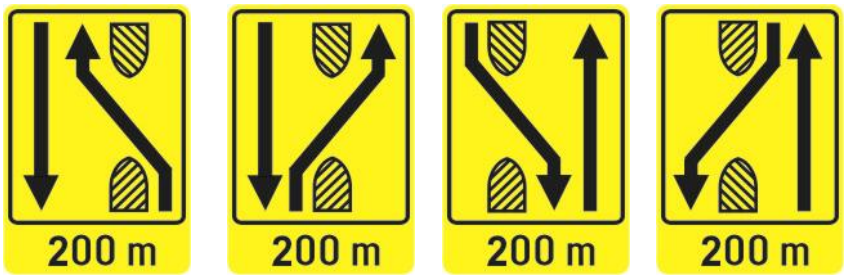
the "preliminary sign for traffic lane closure" (III-86 and III-86.1) denoting the distance to the place where one of the traffic lanes in the same direction has been closed or cancelled. The number of straight arrows shall correspond to the number of traffic lanes that are going on;

III-86

III-86.1

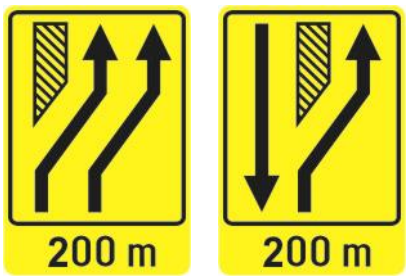
the "preliminary signs for diverting the traffic on a road with physically separated carriageway directions" (III-87 and III-87.1) denoting the direction and the mode of traffic diversion, when, for road works, temporary hindrance, or damage to the carriageway, the traffic is redirected from one one-way carriageway to the other one-way carriageway, normally intended for the vehicles from the opposite direction, thus requiring a provisional two-way traffic, and vice versa, at the transition from temporary two-way traffic (III-87.1) to the traffic regime which was valid before,

and the signs (III-87.2 and III-87.3) informing the driver of approaching the place on the road with a physically separated one-way carriageway, on which the traffic from the one-way carriageway intended for the vehicles in the opposite direction is diverted on the one-way carriageway, on which the driver is driving (III-87.2), and when the driver is informed of approaching the place on the road, from where a two-way traffic is temporarily established on the one-way carriageway, on which the driver is driving (III-87.3). The number of arrows on the sign shall correspond to the number of the traffic lanes on which the traffic is running;



III-87 III-87.1 III-87.2 III-87.3

the "preliminary signs for diverting the traffic" (III-88 and III-88.1) denoting the direction and the mode of traffic diversion, when, due to road works, temporary obstacle, or damage to the pavement, the traffic is diverted onto a specially made bypass road or onto any other existing road;



III-88 III-88.1

the "preliminary sign for manual traffic regulation" (III-89) providing the driver with the information of the vicinity of the place, where, for road works, provisional hindrance, or damage to the road, an alternating one-way traffic is arranged, which is manually controlled by two workers using prescribed means;

III-89

the signs "traffic lanes intended for certain vehicle type" denoting, by means of symbols (III-90) or inserted traffic signs (III-90.1), the number and purpose of the traffic lanes,

when, for ensuring the road passability in the area of road works, temporary obstacles, or damages to the pavement, the traffic is arranged in such a way that the traffic lanes are intended for certain vehicle type only;

III-90

III-90.1

the sign "free passage for vehicles" (III-91) informing the driver of the fact that, before the entrance where the sign is fixed, it is not allowed to stop or park in order to enable undisturbed passage of vehicles;

III-91

1.1.3.1 Shape, colour, and dimensions of informative signs

The informative signs are of quadratic, rectangular, or circular shape.

The basic colours of informative signs are:

- yellow with black symbols and letterings,
- blue with white or white and black symbols and letterings,
- green with white or white and black symbols and letterings,
- white with black symbols and letterings.

Only exceptionally it is allowed to use the red colour on the informative signs. However, the red colour must not prevail.

The circle diameter of informative signs amounts to:

1) 90 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
2) 60 cm on roads out of settlements with a carriageway measuring less than 7.0 m in width;
3) 40 cm on cycle tracks, on roads of reduced traffic speed, and on non-classified roads;
4) 30 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the diameter of informative signs mentioned in point 3) above can amount to 60 cm as well.

The side of the square of informative signs amounts to:

1) 90 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
2) 60 cm on roads out of settlements with a carriageway measuring less than 7.0 m in width;
3) 40 cm on cycle tracks, on roads of reduced traffic speed, and on non-classified roads;
4) 30 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the side of square of informative signs mentioned in point 3) above can amount to 60 cm as well.

The dimension of rectangular informative signs amounts to:

1) 90x135 cm on motorways, expressways, on roads out of settlements with at least two traffic lanes in the same direction, and on roads out of settlements whose carriageway is at least 7.0 m wide;
2) 60x90 cm on roads out of settlements with a carriageway measuring less than 7.0 m in width;
3) 40x60 cm on cycle tracks, on roads of reduced traffic speed, and on non-classified roads;
4) 20x30 cm when they are used as inserted signs on traffic regulation signs in the drive direction.

If required, the dimension of rectangular informative signs mentioned in point 3) above can amount to 60x90 cm as well.

The size of other informative signs shall comply with relevant standards.

As regards the shape, colour, and dimensions the following informative signs deviate from the standard ones:

1) As regards the shape:
   - the sign III-14 (route direction arrow) ends arrow-shaped;
2) As regards the colour and symbols:
   - the sign III-3 (priority road) and the sign III-4 (end of priority road) contain an inner square of yellow colour, while the zone between the inner square and the sign outer edge is white;
   - the sign III-14 (route direction arrow) can comprise an lettering, a symbol, or an lettering and a symbol, which define in greater detail the characteristic structure to which the sign relates;
   - the sign III-17 (number of international road) is of green colour, while the symbol and the sign outer edge are white;
   - the sign III-10 (intersection), the sign III-13.1 (arrangement of lanes at an intersection with names of towns, villages, and other places indicated), the sign III-14 (route direction arrow), the sign III-15 (destination ahead, to the left, to the right), the sign III-16 (road number), the sign III-22 (name of town), the sign III-23 (end of town), the sign III-65 (confirmation of direction), the sign III-68 (preliminary way-mark for exit), the signs III-69 and III-69.1 (way-out for exit), and the signs III-71 (arrangement of lanes) and III-76 (preliminary way-out for exit), when they relate to motorways, they are of green colour with white edge and white letters and symbols, when, however, they relate to roads reserved for motor vehicle traffic, they are of blue colour with white edge and white letters and symbols; when these signs are intended for trunk and regional roads, they are

yellow with black edges and black letters, while for local roads, for names of town parts, for important structures and buildings, stadiums, tourist sights, etc., they are white with black edges and letterings. The sign III-29 (zone of restricted parking time) is of white colour with the drawn sign II-35 . The sign III-10 (intersection) on the line of transverse directions my comprise inserted traffic signs;

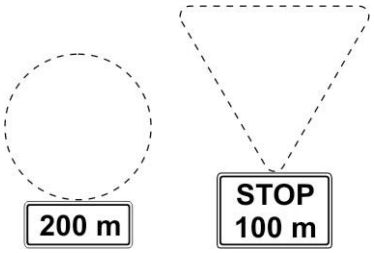
- the sign III-16.1 (mileage marking of a road section) and the sign III-66 (street or road name) are white with black frame and letterings;
- the signs III-19 (end of motorway), III-21 (end of road reserved for motor vehicle traffic), III-23 (end of town), III-26.1 (end of minimum admissible speed), III-28.1 (end of tyre chain obligation), III-28.2 (end of cycle track), III-28.3 (end of pedestrian path), III-28.4 (end of path for riders), III-28.5 (end of pedestrian path and cycle track), and III-28.6 (end of separated pedestrian path and cycle track) contain a strip of red colour applied at angle;
- the signs III-18 (motorway) and III-19 (end of motorway) are green, while the signs III-20 (road reserved for motor vehicle traffic) and III-21 (end of road reserved for motor vehicle traffic) are blue;
- the sign III-29.1 (end of zone of restricted parking time) is white, with the drawn sign II-35 (no parking) and black line applied at angle;
- the signs III-67 and III-67.1 (direction arrows) are white, while the arrows are black;
- the sign III-72 (children on road) is of white colour, the outer edge of the sign is blue, while the symbol is black.

1.1.4 SUPPLEMENTAL BOARDS

Warning signs, prohibition, restriction, and mandatory signs, and informative signs, can be equipped with supplemental boards as well.
The signs III-33 (hospital), III-34 (first aid station), and III-37 (public telephone) shall be equipped with a supplemental board where the vicinity of these facilities is not indicated on the particular sign itself.

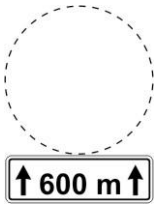
Supllemental boards are:

the supplemental boards IV-1 and IV-1.1 denoting the distance between the sign at which the particular supplemental board is placed and the beginning of the road section of the place which the sign is relating to;



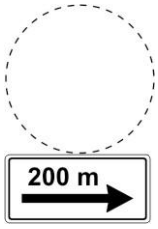
IV-1 IV-1

the supplemental board IV-2 denoting the length of a road section where the danger indicated on the sign is possible, or where a prohibition, restriction, or obligation provided by the sign is in charge, or to which the sign equipped with the particular supplemental board is relating;



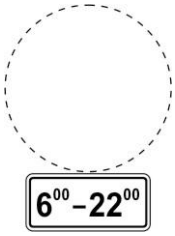
IV-2

the supplemental board IV-3 denoting the distance between the sign equipped with the particular supplemental board and the structure, facility, ground, or road section, which the information refers to;



IV-3

the supplemental board IV-4 denoting the time for which the restriction, prohibition, or obligation is in force, unless it is valid continuously;

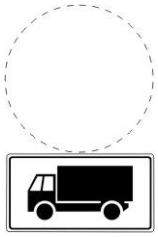


IV-4

the supplemental board IV-5 comprising a detailed explanation of the sign by means of words or some other way, unless this is already provided by the sign symbol;

IV-5

the supplemental board IV-6 comprising a symbol, which explains in greater detail the meaning of the particular sign;



IV-6

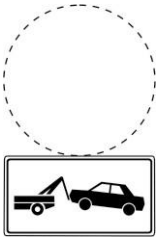
the supplemental board IV-7 denoting the location where parking is reserved for vehicles driven by invalids;

IV-7

the supplemental boards IV-8, IV-8.1, IV-8.2, IV-8.3, IV-8.4, and IV-8.5 denoting the application of prohibition of parking or stopping up to the sign, from the sign, or on either side of the sign;

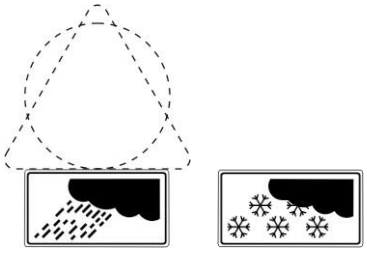
IV-8 IV-8.1 IV-8.2 IV-8.3 IV-8.4 IV-8.5

the supplemental board IV-9 denoting removal and carting-off of a vehicle from the place or road section where stopping or parking is prohibited by means of the traffic sign;



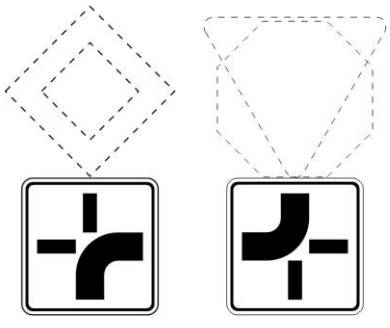
IV-9

the supplemental boards IV**-**10 "at rain" and IV-10.1 "at snow" denoting weather conditions in which danger, restriction, prohibition, or obligation provided by the sign are valid;



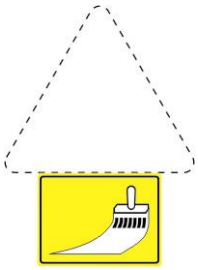
IV-10 IV-10.1

the supplemental board IV-11 explaining the driver on a priority road, where the direction of priority is going on, if it is not proceeding straight forward, and the supplemental board IV-11.1 explaining the driver on a side road how the priority road is proceeding through the crossroads. The position and the number of road shanks indicated on the supplemental board shall comply with the position and the number of road shanks of the particular crossroads;



IV-11 IV-11.1

the supplemental board IV-12 providing information of road works relating to carriageway marking;

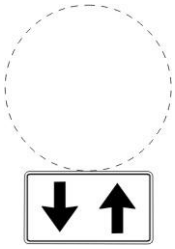


IV-12

the supplemental board IV-13 explaining that the sign, to which the supplemental board has been added, is placed due to ruts on the carriageway;

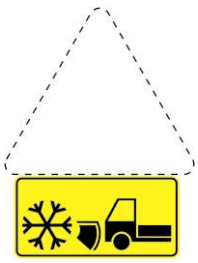
IV-13

the supplemental board IV-14 informing that the cycle track or the road marked with the sign II- (cycle track or road), to which the supplemental board has been added, is a two-way one;



IV-14

the supplemental board IV-15 "snow removal" denoting the location on the road where snow is being removed from certain road lane or section, or the works relating to the prevention or removal of frost are under execution (spreading adequate material on the carriageway). As a rule, the board is added to the sign I- (road works);



IV-15

1.1.4.1 Shape, colour, and dimensions of supplemental boards

The basic colour of any supplemental board shall be the same as the basic colour of the sign to which such a board is added, while the colour of letters and symbols on the supplemental board shall be the same as the colour of letters and symbols on the sign to which the board is added.

The width of any supplemental board added to the road sign must not exceed the length of that side of the sign to which the board is added, or the diameter of the sign, if the latter is of circular shape, except when the sign II-1 (give way) is in question.

The height of any supplemental board must not, as a rule, amount to more than a half of it length, with the exception of the supplemental boards IV-8.3, IV-8.4, and IV-8.5.

1.1.5 PLACING THE TRAFFIC SIGNS

1.1.5.1 General

Traffic signs on roads out of towns and villages are placed at a height of 1.5 m, except the signs III–16 (road number), III-16.1 (road mileage marking), III-17 (international road number), and III-70 (exit), which are placed at a height of 80 cm. Traffic signs in towns and villages, positioned at the carriageway, are placed at a height from 0.30 to 2.25 m, while the traffic sign, which hang or are situated above the carriageway, are placed at a height of 4.5 m or, exceptionally, even higher if so required.

The abovementioned height is considered from the carriageway surface to the lower edge of the particular traffic sign; where a sign is placed together with a supplemental board, the height is considered up to the lower edge of the supplemental board. The height and position of a traffic sign shall be such as not to jeopardize the pedestrians or not to be concealed by the pedestrians and vehicles.

Maximum two traffic signs may be fixed to one post.

The backside of a placed traffic sign shall be of grey colour.

Signs denoting temporary works or similar activities may be fixed to supports and raised by at least 0.30 m above the ground.

A traffic sign post shall be, as a rule, placed not more than 2 m away from the carriageway edge.

The horizontal spacing between the pavement edge and the nearest edge of the traffic sign shall amount to at least 0.30 m.

Exceptionally, a traffic sign may be fixed to:

- a cantilever beam, if it is better perceived by the traffic participants;
- a traffic light post, which may apply to the signs II-1 (give way), II-2 (stop and give way), II-4 (no entry), II-45, II-45.1, II-45.2, II-45.3, II- 45.4 (mandatory traffic direction), II-47.2 (roundabout), III-2, and III-2.1 (one-way traffic), III-3 (priority road), and III-66 (street or road name).

1.1.5.2 Placing the warning signs

As a rule, warning signs are placed outside settlements (towns, villages) at a distance of 150 to 250 m before the dangerous place on the road. In towns and villages, however, the warning signs may also be placed at a distance of less than 150 m before the dangerous place.

Warning signs mentioned above may also be placed at a distance of less than 150 m before a dangerous location on the road, if this is required by the conditions prevailing on this road section. If required by the traffic safety reasons, especially the speed of vehicles or the short sight distance on the road, the warning signs shall be placed at distance of more than 250 m before a dangerous place on the road.

To the warning signs placed at a distance of less than 150 m or more than 250 m, supplemental boards shall be added indicating the distance to the particular dangerous location.

On roads of short sight distance or higher speed, as well as in other cases where a driver can suddenly and unprepared encounter a dangerous place on the road, one or more signs of the same kind shall be placed between the sign mentioned above and the dangerous spot itself. Suitable boards indicating the distance to the dangerous place shall supplement these additional signs.

Temporary dangers on the road such as road works, falling stones, etc.) shall be marked by means of traffic signs as foreseen by the regulation providing instructions of how to denote permanent dangers of this kind.

Placing the signs I-19 (road works), I-23 (two-way traffic), I-26 (intersection of roads of the same ranking), I-27, I-28, and I-29 (intersection and connection with secondary road), I-31 (tramway track), I-34 and I-34.1 (St. Andrew's cross), I-35 (approaching the railway – road crossing at grade with barriers or semi-barriers), and I-36 (approaching the railway – road crossing at grade without barriers or semi-barriers) deviates from placing the remaining warning signs as follows:

- the sign I-19 (road works) is placed immediately before the place where the works are carried out; next to it, a special barrier is placed, which is equipped with a prescribed light signal being in function at night and when the visibility is reduced;
- the sign I-23 (two-way traffic) is placed at the location where the two-way traffic commences; if required, it is also placed on the road section where the traffic runs in both directions;
- the sign I-26 (intersection of roads of the same ranking) is placed, as a rule, on roads out of settlements;
- the signs I-27 (right angle intersection with secondary road), I-28 (right angle connection with secondary road from the left), I-28.1 (right angle connection with secondary road from the right), I-29 (acute angle connection with secondary road from the left), I-29.1 (acute angle connection with secondary road from the right), may only be erected, if on the secondary road crossing the priority road, the sign II-1 (give way) or the sign II-2 (stop and give way) is placed before the intersection;
- the sign I-31 (tramway track) is placed, as a rule, out of settlements, exceptionally, however, it may also be erected on roads within settlements, if so required by the traffic safety;
- the signs I-34 and I-34.1 (St. Andrew's cross) are only placed on railway - road at grade intersections, which are entirely unprotected, or protected by means of light and noise signals only, however without barriers or semi-barriers; they shall be placed at a distance of 5 m from the nearest rail; if circumstances require, this distance can be greater or smaller, however not less than 3 m and not more than 10 m;
- In case that the railway – road at grade intersection is secured by means of light signals, the St. Andrew's cross shall be fixed to the same post, above the light signals. The sign St. Andrew's cross shall be well visible on the road where it is erected, on a distance of at least 50 m;
- the signs I-35 (approaching the railway – road crossing at grade with barriers or semi-barriers) and I-36 (approaching the railway – road crossing at grade without barriers or semi-barriers) are placed in such a way that the rectangular sign with three strips applied at angle and corresponding warning sign is erected at a distance of 240 m before the railway – road intersection at grade, the sign with two strips applied at angle at a distance of 160 m, while the sign with a single strip applied at angle at a distance of 80 m before the mentioned intersection. The lower side of the strips applied at angle shall be next to the pavement. A warning sign may also be placed above the rectangular sign, which is erected 80 m before the railway – road intersection.

1.1.5.3 Placing the prohibitory, restriction, and mandatory signs

Prohibitory, restriction, and mandatory signs are placed immediately before the place where the traffic participants become liable to adhere to the prohibition, restriction, or obligation provided by the particular traffic sign.

If required, due to short sight distance on the road or to any other safety reasons, that the traffic participants are informed of a prohibition, restriction, or obligation in advance, the corresponding traffic sign may also be erected at an appropriate distance from the

spot where the prohibition, restriction, or obligations commences to be valid. To such a sign, a supplemental board shall be added indicating the distance to the location where the prohibition, restriction, or obligation begins.

Prohibitory, restriction, and mandatory signs shall be also placed after any intersection where the road on which such a sign is erected crosses another road, if the prohibition, restriction, or obligation is in force after such an intersection as well.

If a prohibitory, restriction, or mandatory sign is fixed to the same post as the board, which indicates the name of town or village, the particular prohibition, restriction, or obligation applies to the area of the entire settlement, unless some other prohibition, restriction, or obligation is imposed by another traffic sign placed on individual roads, streets, or parts of these roads or streets.

To denote prohibitions, restrictions, and obligations, which are in force in certain daily periods or on certain days only, such signs may be erected whose symbols and supplemental boards providing their meaning are only visible at the time to which the particular prohibition, restriction, or obligation apply.

Placing the signs II-2 (stop and give way), II-33 (give way to oncoming traffic), II-34 (no stopping and parking), II-35 (no parking), II-45, II-45.1, II-45.2, II-45.3, and II-45.4 (mandatory traffic direction), II-47 (mandatory passing on the right), II-47.1 (mandatory passing on the left), and II-47.2 (roundabout), deviates from placing the other prohibitory, restriction, and mandatory signs as follows:

- the sign II-2 (stop and give way) is erected, as a rule, on a spot where vehicles must stop to give way to the vehicles driving on a priority road. To the sign II-2, a transverse line on the carriageway is added as a rule, before the vehicle shall stop;
- the sign II-33 (give way to oncoming traffic) is erected at the location from where the road portion to which the prohibition refers can be easily seen;
- to the signs II-34 (no stopping sand parking) and II-35 (no parking) supplemental board with a drawn arrow can be added below the sign and parallel with the road longitudinal axis, indicating that the particular prohibition, restriction, or obligation only relate to the road section running in the direction as marked by the arrow, and at the distance as indicated near the arrow
- the signs II-45, II-45.1, II-45.2, II-45.3, and II-45.4 (mandatory traffic direction) shall be placed at crossroads only;
- the signs II-47 (mandatory passing on the right), and II-47.1 (mandatory passing on the left) are erected on the top or the edge of the pedestrian refuge, or the island for directing the traffic, or before other structures on the road carriageway;
- the sign II-47.2 (roundabout) is placed at the approach to an intersection, and on the top or the edge of the island at the location where vehicles enter the traffic roundabout.

1.1.5.4 Placing the informative signs

Informative signs are so placed as to provide the traffic participants with preliminary information, an information of changing the lanes, and of turning, a confirmative information of driving direction as well as an indication of a structure, building, facility, ground, street, road, or part of the road.

In case a structure, facility, or ground to which the particular sign relates is not situated on the road where the sign is placed, the required information may be provided by a supplemental board or by the traffic sign itself in order to allow the traffic participants to find such a structure, facility, or ground quickly and easily.

The signs III-1 (priority over approaching traffic), III-2 and III-2.1 (one-way traffic), III-3 (priority road), III-6 (pedestrian zone), III-7 (end of pedestrian zone), III-8 (pedestrian crossing), III-9 (pedestrian crossing underground or above ground), III-10 (intersection), III-12 (direction of motion of a vehicle intending to turn left at crossroads where turning

left is prohibited), III-14 (route direction arrow), III-15 (destination ahead, to the left, to the right), III-16 (road number), III-17 (international road number), III-22 (name of town), III-24 (end of prohibition of overtaking of all motor vehicles except motorcycles without sidecar), III-25 (end of prohibition of overtaking for heavy lorries), III-26 (end of speed restriction), III-27 (end of "no horn"), III-28 (end of all prohibitions), III-65 (direction confirmation), III-66 (street or road name), III-67 and III-67.1 (direction arrows), III-68 (preliminary way-mark for exit), III-69 and III-69.1 (way-mark for exit), III-70 (exit), and III-71 (arrangement of lanes), shall be placed as follows:

- the sign III-1 (priority over approaching traffic) is placed before a narrowed part of the road; on the opposite side of the narrowed part of the road, the sign II-33 (give way to oncoming traffic) is placed;
- the signs III-2 and III-2.1 (one-way traffic) are placed along the road with one-way traffic, i.e. at locations being suitable to vehicles driving on the particular road, as well as to those, who are entering the road;
- placing the signs mentioned in the above passage does not affect the obligation of erecting adequate prohibitory and mandatory signs at locations where vehicles from other roads are entering the one-way road; the sign III-2 shall be placed in such a way that the arrow is perpendicular to the road longitudinal axis, while the sign III-2.1 is such a way that the arrow is parallel with the road longitudinal axis;
- the sign III-3 (priority road) is placed, as a rule, on main roads within settlements and at entries to settlements, before intersections;
- the signs III-6 (pedestrian zone) and III-7 (end of pedestrian zone) are only placed directly before the area exclusively reserved for pedestrians;
- the sign III-8 (pedestrian crossing) and the sign III-9 (pedestrian crossing underground or above ground) are only placed directly before of above the marked pedestrian crossing or passage;
- the sign III-10 (intersection) is erected at a distance of at least 150 m before the subject intersection; on motorway and roads reserved for motor vehicles the sign III-8 may also be placed at a distance of at least 500 m before the intersection;
- the sign III-12 (direction of motion of a vehicle intending to turn left at crossroads where turning left is prohibited) is placed at the first crossroads before the crossroads at which a vehicle intends to turn left, where, however, turning left is prohibited;
- the signs III-14 (road direction arrow) and III-15 (destination ahead, to the left, to the right) are erected at such a location at an intersection (crossroads) where the particular road commences;
- the signs III-16 (road number) and III-17 (international road number) can be placed beneath or above other traffic signs; the sign III-17 is placed on international roads, while the sign III-16 on other roads;
- the sign III-22 (name of town) is erected at entries to a settlements, and denotes the spot where the particular traffic regulation begins;
- the sign III-24 (end of prohibition of overtaking of all motor vehicles except motorcycles without sidecar), the sign III-25 (end of prohibition of overtaking for heavy lorries), the signs III-26 and III-26.1 (end of speed restriction), and the sign III-27 (end of "no horn") are placed at locations on the road where prohibitions and restrictions indicated by these signs terminate;
- the sign III-28 (end of all prohibitions) is placed at a location on the road where all the prohibitions imposed by these signs terminate;
- the sign III-65 (direction confirmation) is placed at a distance of maximum 500 m from the last junction;
- the sign III-66 (street or road name) is placed at crossroads (intersection);
- the signs III-67 and III-67.1 (direction arrows) are erected at places where a sharp curve begins, or in the sharp curve itself;

- the sign III-68 (preliminary way-mark for exit) is placed at a distance of 500 m before the point where the deceleration lane begins; exceptionally, it may also be placed at a smaller distance, however not less than 250 m from the point where the deceleration lane begins;
- the signs III-69 and III-69.1 (way-mark for exit) are fixed to portals at locations where the deceleration lane commences;
- the sign III-70 (exit) is erected on the top of the dividing island;
- the sign III-71 (arrangement of lanes) is fixed to portals above each traffic lane.

1.1.5.5 Placing the supplemental boards

Supplemental boards are placed together with the traffic signs to which they refer; they shall be situated below the lower edge of traffic signs.

1.2 ROAD MARKINGS

Road markings are of white colour.

Notwithstanding the abovementioned rule, the following markings are yellow:

1) markings on carriageway and footway denoting prohibition of parking;
2) temporary markings of carriageway applying during road works;
3) lines marking the separation of lanes for public traansportation vehicles, taxies, and first aid vehicles;
4) markings denoting locations for special purposes (bus stops, taxi stops, police, etc.).

Road markings are drawn, painted, or imprinted onto the surfacing of roads of up-to-date pavements.

Road markings must not increase the carriageway skiddiness. They shall not extend by more than 0.6 cm above the carriageway level; if, however, metal heads are used as road markings, they must not extend by more than 1.5 cm above the carriageway level.

The following road markings are used:

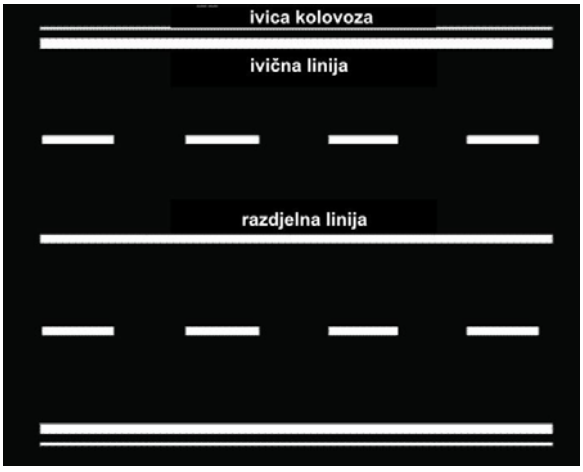
1) longitudinal markings;
2) transverse markings;
3) other markings on the carriageway and on the objects along the pavement edge;

1.2.1 LONGITUDINAL ROAD MARKINGS

Longitudinal road markings are unbroken lines, broken lines, and double lines. The width of carriageway longitudinal markings shall amount to at least 10 cm, and the spacing between parallel longitudinal double lines shall be 10 cm.

An unbroken longitudinal line can be a dividing line and a edge line.

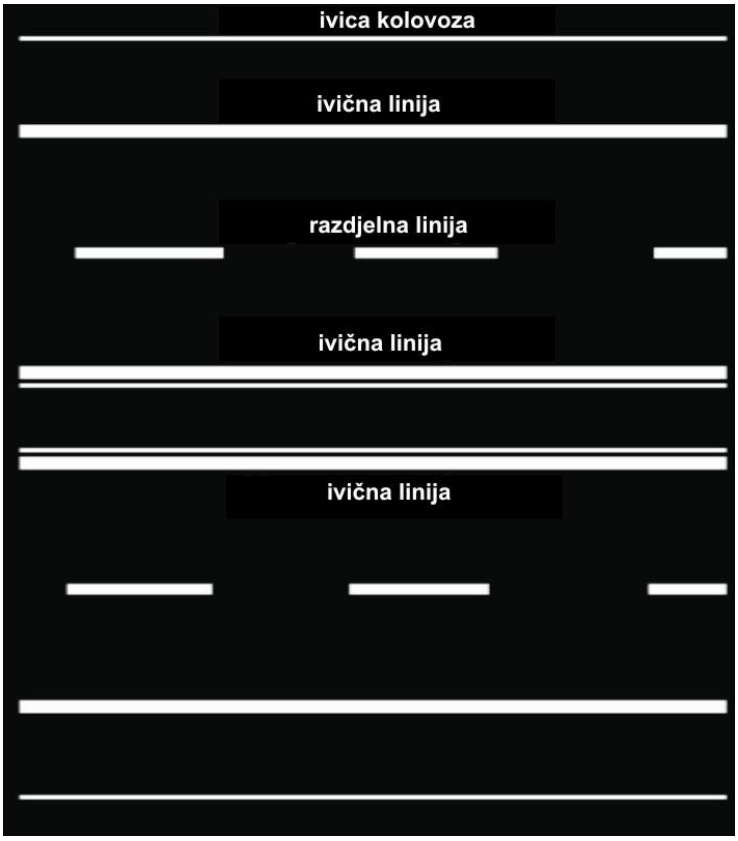
The dividing line serves to separate the two-way traffic surfaces in two different traffic directions (V-1).



V-1

ivica kolovoza = carriageway edge
ivična linija = edge line
razdjelna linija = dividing line

The edge line marks the carriageway edge (V-1 and V-1.1), and separates carriageway surfaces of special purpose, e.g. lanes for public transportation vehicles.

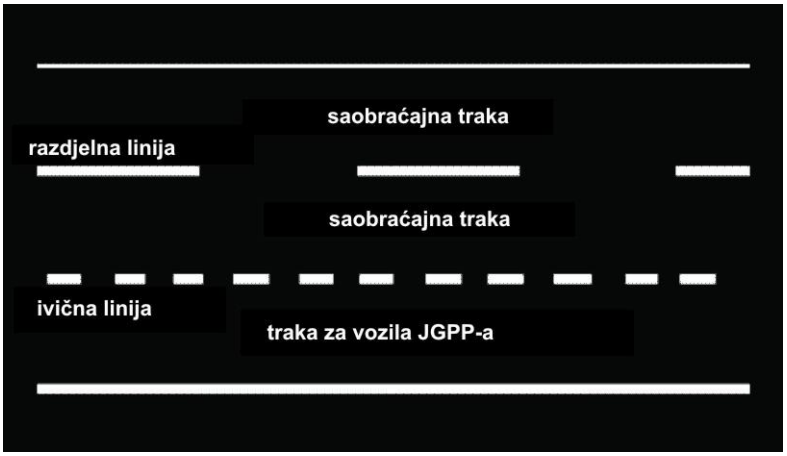


V-1.1

An unbroken longitudinal line denotes prohibition of overtaking and even of driving on it.

A broken longitudinal line can be common, warning, short, and wide.

A common broken line serves to separate pavement surfaces into traffic lanes (V-2).



V-2

saobraćajna traka = traffic lane

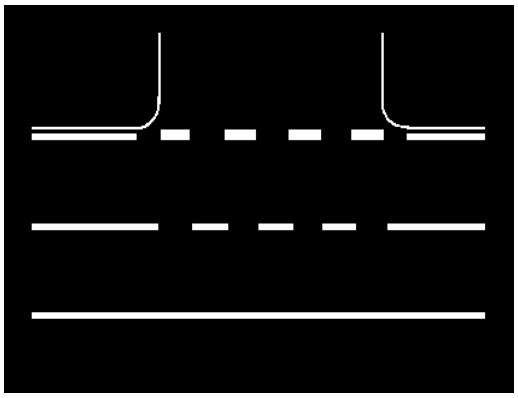
traka za vozila JGPP-a = public transportation lane

A warning line serves to announce the vicinity of an unbroken line.

A short broken line is intended to separate one-way carriageway surfaces in traffic lanes on intersection approaching roads, as a guiding line at the intersection itself, and to separate the public transportation lane at certain time intervals during the day (V-2).

A wide broken line serves as an edge line to separate the traffic flows at an intersection on the roads out of settlements, and as an edge line to separate niches for turning and

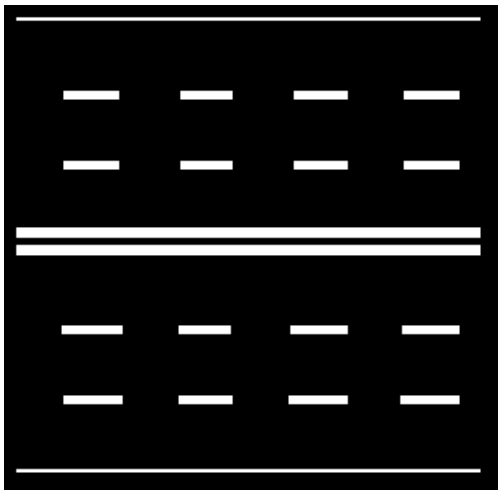
exiting or entering on motorways and roads reserved for motor vehicle traffic (V-3).



V-3

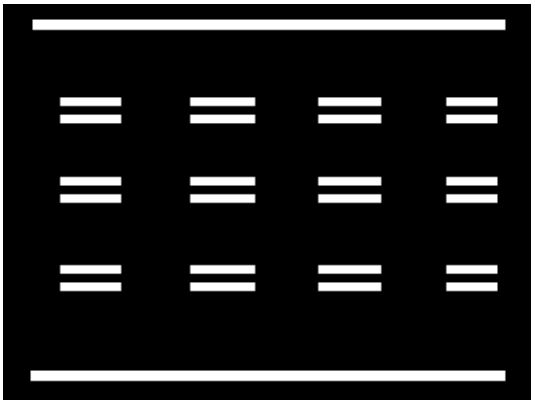
A double longitudinal line can be a double unbroken line, a double broken line, or a double combined line.

A double unbroken line is intended for separating two-way traffic surfaces in two different traffic directions (V-4).



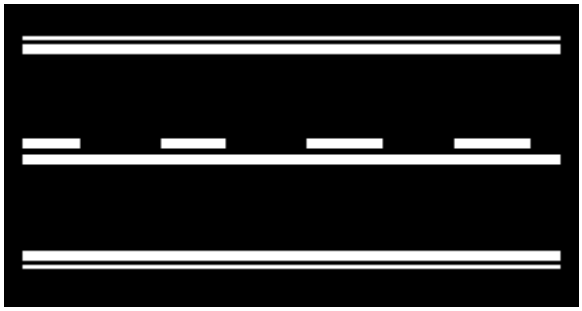
V-4

A double broken line serves for marking the traffic lanes with alternating traffic direction, where the traffic is controlled by means of traffic lights (V-5).

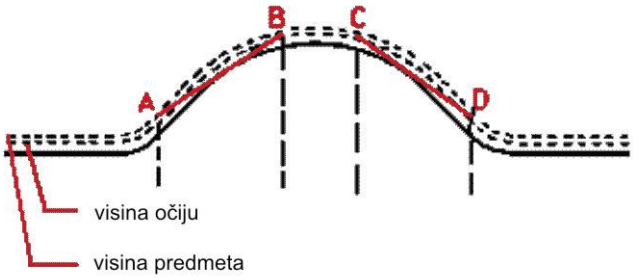


V-5

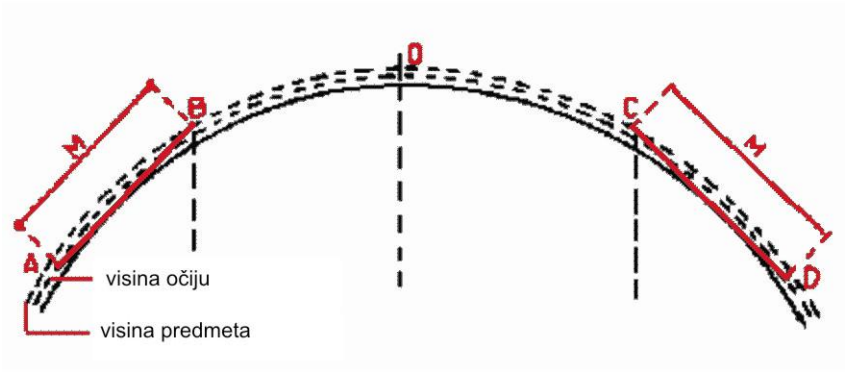
A double combined line is intended for separating the traffic lanes at locations where the sight distance conditions allow overtaking in one traffic direction only (V-6, V-6.1, V-6.2, V-6.3, V-6.4, V-6.5, V-6.6, and V-6.7).



V-6

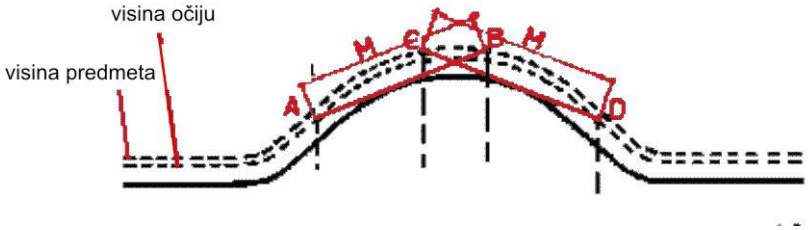


V-6.1

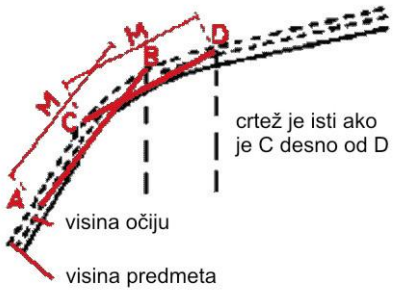


V-6.2

visina očiju = eye level
visina predmeta = object level

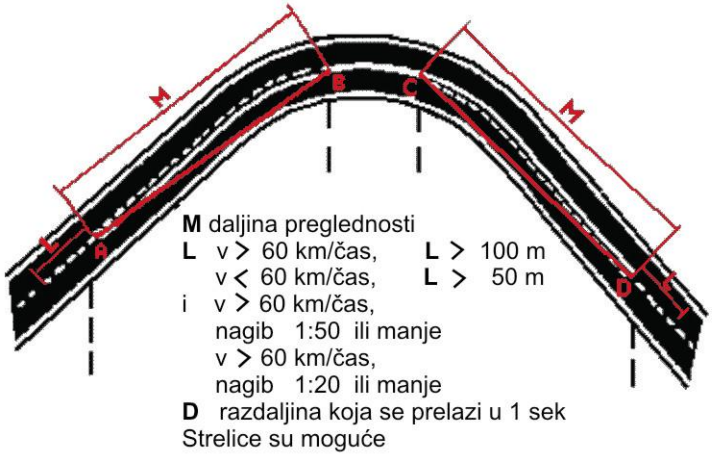


V-6.3



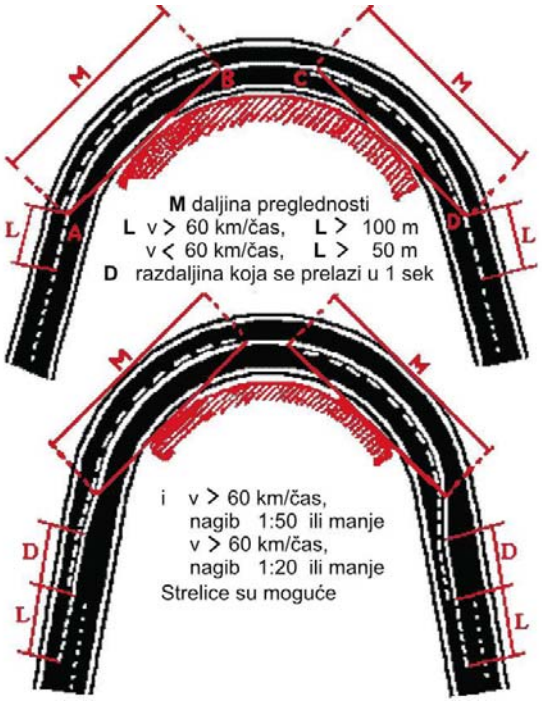
V-6.4

crtež je isti ako je C desno od D = the sketch is the same if C is on the right-hand side of D

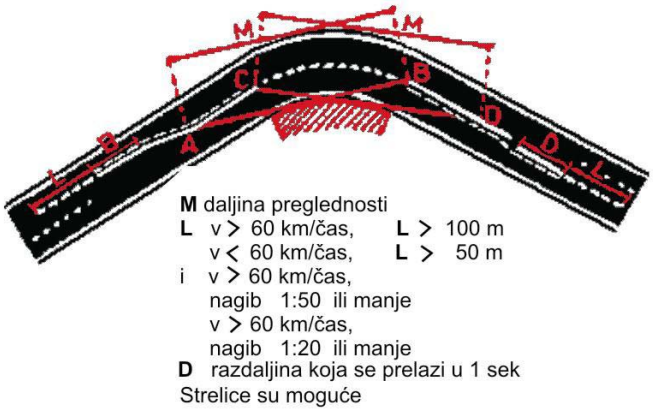


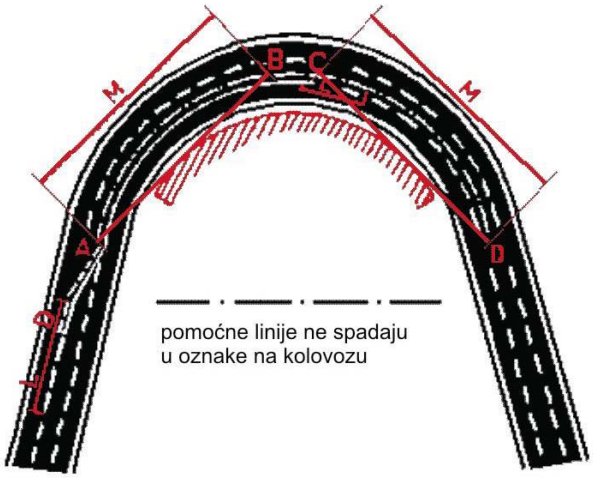
M sight distance
čas = hour
i = and
nagib 1:50 ili manje = slope of 1:50 or less
D distance passed in 1 sec
Strelice su moguće = arrows are possible

V-6.5



V-6.6





V-6.7

auxiliary lines do not belong to road markings

On a two-way traffic road consisting of three traffic lanes, the latter shall be marked, as a rule, by broken longitudinal lines (sketch V-3); in the vicinity of a slope top, of an intersection, of railway – road crossing at grade, and at locations where the sight distance is substantially reduced, one or two parallel longitudinal unbroken lines or a double line (an unbroken line + a broken line) may be introduced (V-6.1, V- 6.2, V-6.3, V-6.4, V-6.5, V-6.6, V-6.7).

The sight distance shall be defined according to the vehicle speed.

To determine the sight distance a speed not exceeding 85% of the vehicles speed or the design speed shall be introduced, whichever is higher.

1.2.2 TRANSVERSE ROAD MARKINGS

Transverse markings on carriageways are unbroken or broken lines, which can be drawn in such a way that one or more traffic lanes are comprised.

Transverse markings are: stop line, give-way lines, diagonal lines, closure lines, pedestrian crossings, and cycle track crossings.

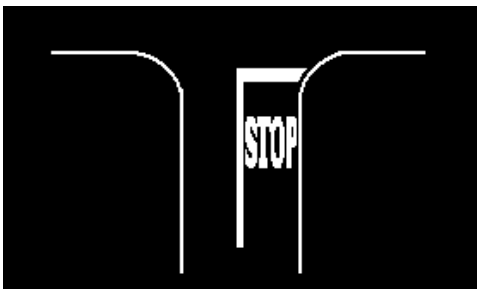
Transverse road markings are, in view of the angle at which they are seen by the driver, wider than the longitudinal ones.

The stop line marks a spot where the driver must stop his vehicle in order to give way to a priority vehicle or pedestrians.

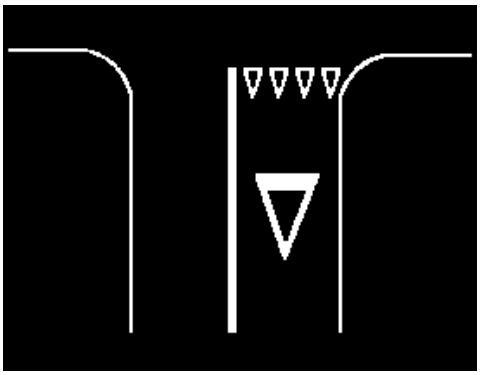
The stop line shall be unbroken. In case a stop line is broken or marked with triangles, a vehicle must stop before it only when another vehicle is approaching from the priority

direction, or a pedestrian is treading on a „zebra" pedestrian crossing.

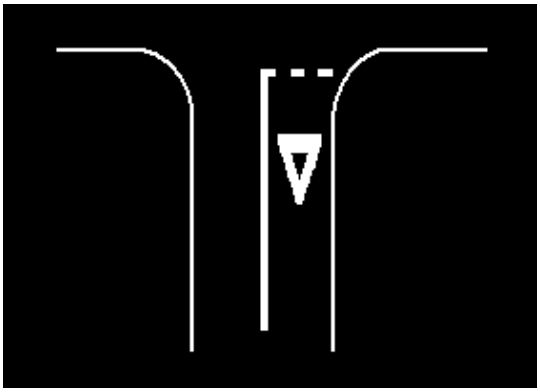
Before a stop line, in the driving direction a word "STOP" may be written (V-7) or a warning triangle (V-8, V-9) drawn on the pavement.



V-7



V-8



V-9

Diagonal line denotes the spot of closing the approach lane (V-10), of opening the exit lane (V-10.1), and closing the traffic lane reserved for public transportation vehicles (V-10.2).

V-10

V-10.1

V-10.2

Closure line denotes a spot of approaching where the carriageway portion, on which the traffic is prohibited, shall be separated (V-11).

V-11

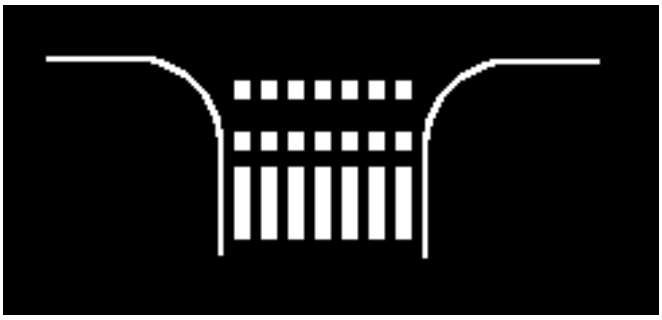
A pedestrian crossing denotes the portion of the carriageway surface allowing pedestrians to cross the road (V-12).

V-12

At locations where a pedestrian crossing cannot be marked with paint, it can be marked by means of steel elements, wedges, and appropriate reflecting materials. A pedestrian crossing may be raised in relation to the traffic surface intended for motor vehicles, where this is required by the traffic safety conditions.

On the carriageway next to a pedestrian crossing situated in the vicinity of a school, the word "SCHOOL" shall be written.

A cycle track crossing over the carriageway is a portion of the pavement surface exclusively intended for cyclists to cross the road (V-13).



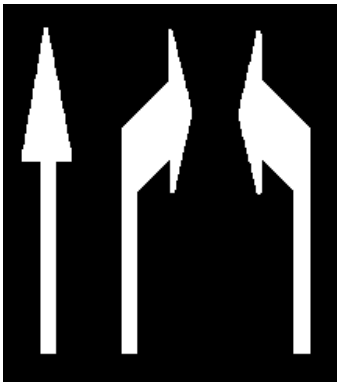
V-13

1.2.3 OTHER MARKINGS ON CARRIAGEWAYS AND OBJECTS ALONG PAVEMENT EDGE

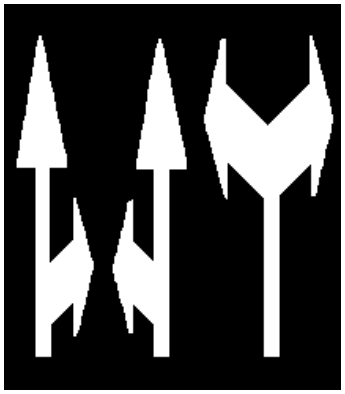
Other markings on carriageways and on the objects along the pavement edge are: arrows, fields for traffic direction, direction lines, letterings, markings for traffic surfaces of special purposes, marking the parking places, and vertical markings (markings on objects along the pavement edge).

An arrow drawn on the carriageway denotes the mandatory direction, if it is drawn on a traffic lane edged with an unbroken line, and informs the drivers of the purpose of traffic lanes, if it is drawn on a traffic lane edged with a broken line.

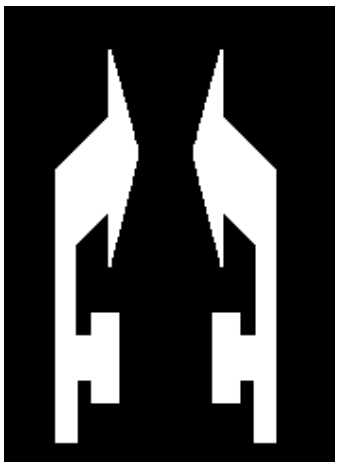
The following can be marked with arrows: one direction (V-14), two directions (combined) (V-15), changing the lanes at two nearby intersections where the lanes shall be changed before the first intersection (V-16), traffic direction in garages (V-17), and lane indication (V-18).



V-14



V-15



V-16

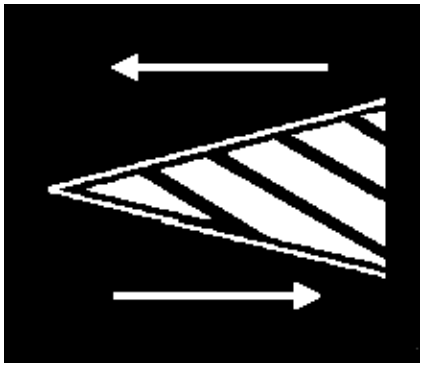
V-17

V-18

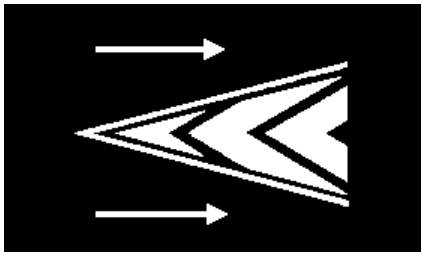
A narrow arrow indicating the lanes (a lane indicator) may be used instead of a warning line (V-18.1).

V-18.1

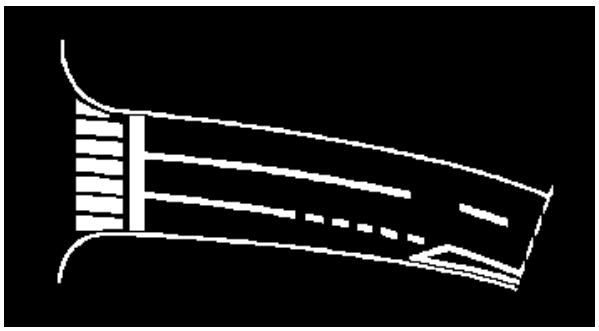
Traffic direction fields denote a surface on which the traffic is prohibited and on which stopping and parking is not admitted: between two lanes with opposite traffic directions (V-19), between two lanes with the same traffic directions (V-19.1), at the location where a special turning lane is opened (V-19.2), before the island for separating the traffic flows (V-19.3 and V-19.4), at motorway approaches (V-19.5), and at motorway exits (V-19.6).



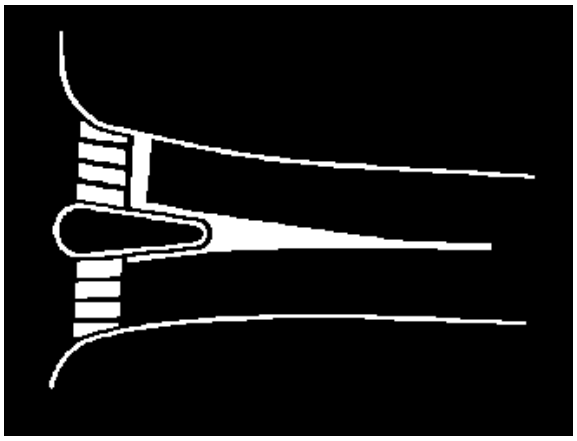
V-19



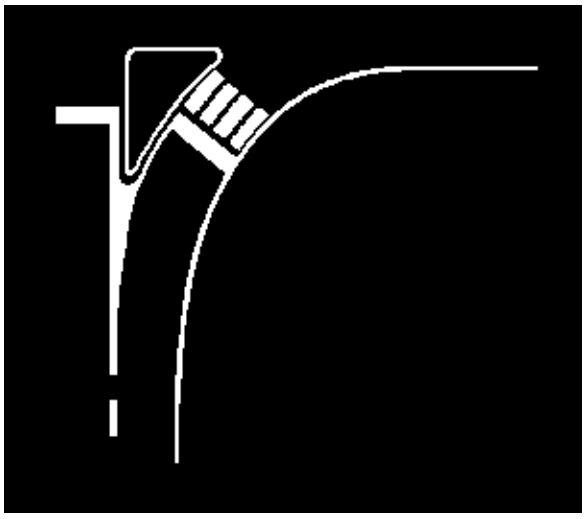
V-19.1



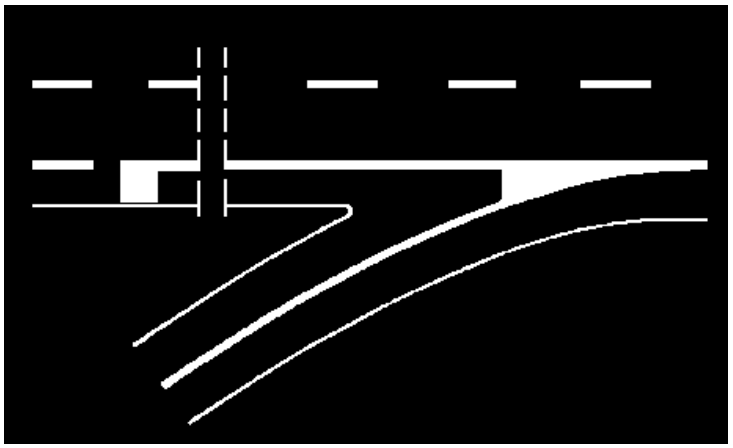
V-19.2



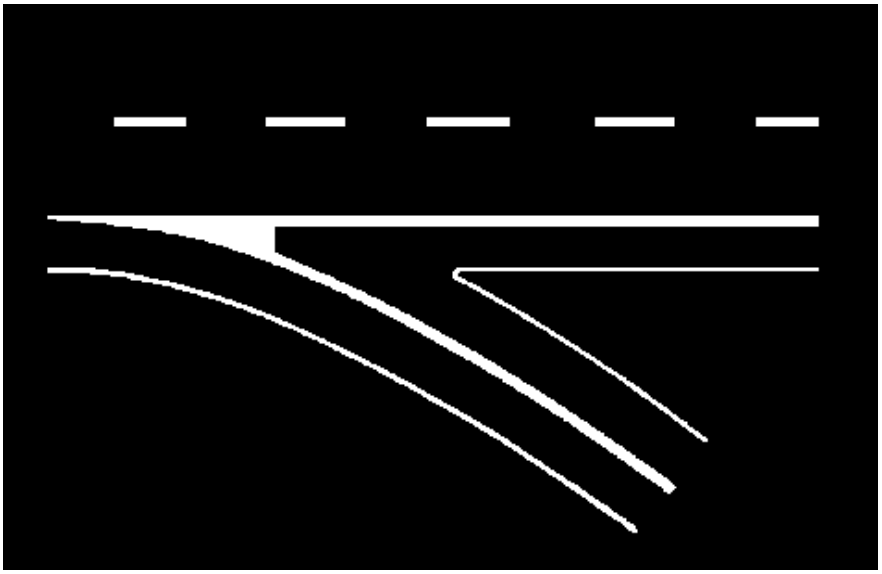
V-19.3



V-19.4

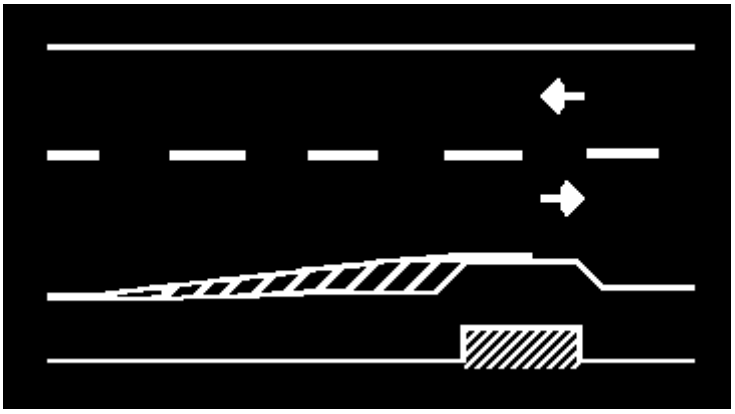


V-19.5



V-19.6

The direction line indicates the spot of changing the carriageway free surface before fixed obstacles situated either on the road or at the road edges. The direction lines can be located before the island serving the public transportation vehicles to change the lane (V-20), intended for marking an obstacle at the pavement edge (V-20.1), and for marking the effective surface of the carriageway (V-20.2).



V-20

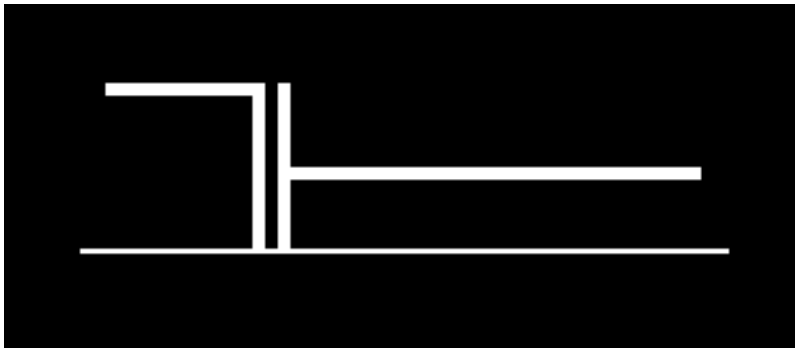
V-20.1

The letterings on the carriageway provide the traffic participants with required information such as: "STOP", "BUS", "TAXI" (V-21), as well as names of towns and villages, road numbers, etc.

V-21

V-21

Special road markings are intended to indicate prohibition of stopping – parking, to designate a bus stop in a niche after an intersection, to denote places reserved for taxies, as well to mark one or more cycle tracks (V-22, V-22.1, V-22.2, V-22.3, V-22.4, V-22.5, and V-22.6).



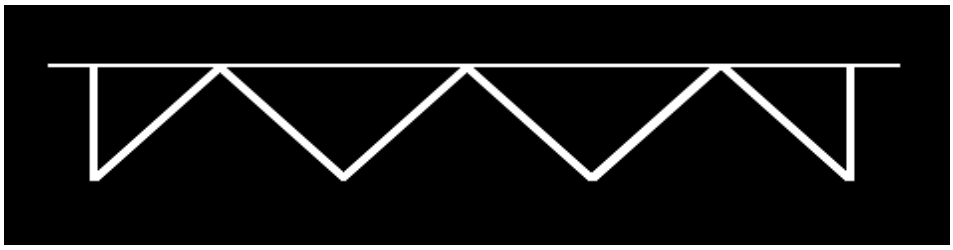
V-22

V-22.1

V-22.2

V-22.3

V-22.4



V-22.5

V-22.6

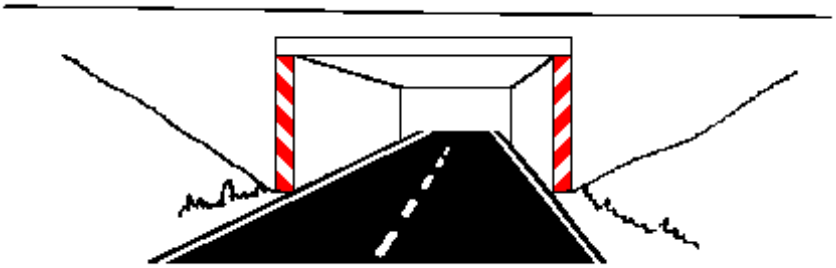
Parking places shall be denoted by means of suitable markings. The parking can be longitudinal (V-23), diagonal (V-23.1), or perpendicular (V-23.2).

V-23

V-23.1

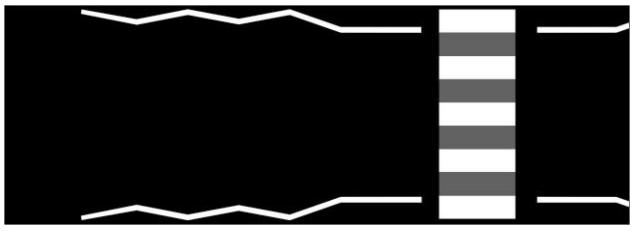
V-23.2

Elements of the structure and furniture of public roads, and other objects representing permanent obstacles within the road clearance gauge, shall be denoted with the marking (V-24).



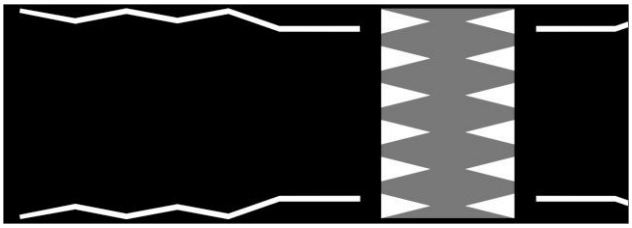
V-24

The locations on a carriageway on which provisional physical obstacles for speed reduction, i.e. sleeping policemen, are placed, shall be designated with the marking (V-25).



V-25

The locations on a carriageway on which permanent physical obstacles for speed reduction, i.e. sleeping policemen, are placed, shall be designated with the marking (V-26).



V-26

The locations on a carriageway where optical brakes for speed reduction are placed shall be denoted with the marking (V-27).

V-27

1.2.4 EXECUTION OF ROAD MARKINGS

Transverse unbroken lines at intersections shall be drawn in such a way that sufficient visibility over the intersection, other roads, vehicles, and pedestrians is provided to a driver, who must stop his vehicle in front of such a line (sketch V-7).

Transverse broken lines at intersections denoting a crossing with a priority road (sketches V-8 and V-9) shall be so drawn as to fulfil the conditions indicated in the above passage as foreseen for transverse unbroken lines.

1.3 SIGNS FOR MARKING ROAD WORKS, OTHER OBSTACLES, AND DAMAGES TO CARRIAGEWAY

Other signs for marking road works, other obstacles, and damages to the carriageway are:

the sign "frontal prohibition board" denoting the location of road works or of a temporary obstacle on the road, on either right side (VI-1) or left side (VI-1.1) in the driving direction;

VI-1

VI-1.1

the sign "directing prohibition board" denoting the location of road works or of a temporary obstacle on the road, and the direction in which the traffic is diverted, either to the right (VI-2) or to the left (VI-2.1);

VI-2

VI-2.1

the sign "vertical prohibition board" denoting the location of road works or of a temporary obstacle on the road, and the direction in which the traffic is diverted, either to the right (VI-3) or to the left (VI-3.1). In special cases on one-way roads where a two-way traffic is provisionally arranged, a vertical prohibition board may be introduced for physical separation of the traffic by driving directions. Such a board may also be used for marking a permanent obstacle within the road clearance gauge;

VI-3

VI-3.1

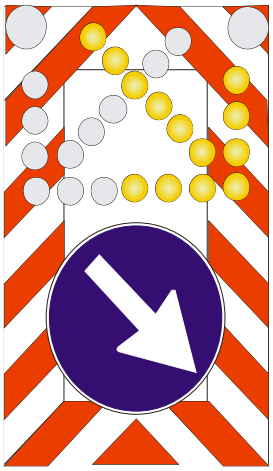
the sign "lateral prohibition board" (VI-4) denoting the location of road works or of temporary obstacle on the road in the longitudinal direction. Such a board may be used to mark a permanent obstacle above the pavement without the road clearance gauge;

VI-4

the sign "movable prohibition board with intermittent light signals and traffic signs" (VI-5) denoting the location of road works or of an obstacle on the road;

VI-5

the sign "movable prohibition board with flashing yellow arrow oriented diagonally downwards, and with a traffic sign" (VI-6) denoting the location on a road where the traffic lane is closed, and the direction in which the traffic is diverted due to road works or obstacle on the road;



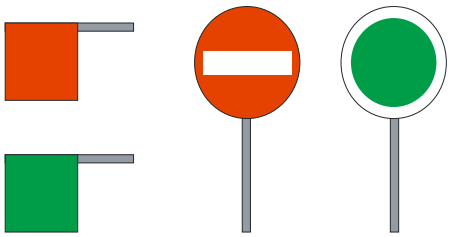
VI-6

the sign "movable signal board of variable meaning" (VI-7) announcing the vicinity of the location of either road works or an obstacle, or determining the behaviour of drivers approaching such a place. In addition to the signs indicated, which are given as an example only, other signs specified in the present guidelines may also be introduced;

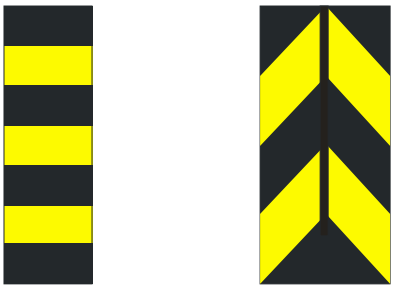
VI-7

"signs for manual traffic regulation" by means of which the workers on a road, where works are carried out or an obstacle is present, manually control the traffic. The signs for manual traffic regulation are:

- red and green flag of minimum dimensions 40×40 cm. The red flag, which a worker is holding perpendicularly to the driving direction, means a prohibition of passing, while the green one provides a free passing,
- circular board of 60 cm diameter, with the sign II-4 on one side, and with a green field with 6 cm wide white edge on the other side. The sign II-4 oriented towards the approaching vehicle means a prohibition of passing, while the green field allows a free passing;

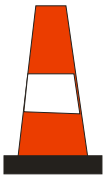


the "sign for marking a traffic island" denoting the apex of a traffic island at an intersection (VI-8), or the apex of a dividing island at motorway and expressway exits (VI-8.1);



VI-8 VI-8.1

the sign "traffic cone" (VI-9) denoting the location of short-term (daily) maintenance works on the road.



VI-9

1.3.5 PLACING THE SIGNS FOR MARKING ROAD WORKS, OTHER OBSTACLES, AND DAMAGES TO CARRIAGEWAY

Other signs for marking the road works, other obstacles, and damages to carriageways may be only placed in compliance with the programme of marking the provisional traffic regime, and with the regulation providing the marking of road works, other obstacles on the road, and damages to the carriageway.

1.4 TRAFFIC LIGHTS AND LIGHT MARKINGS

Signs in the form of traffic lights are used to control the traffic of vehicles and pedestrians, to regulate crossings, to mark railway – road intersections at grade, to control the bus, tramway, and trolleybus traffic, to control the traffic of cyclists, to control approaches, and to mark works and obstacles representing certain danger to traffic participants.

Traffic lights can be continuous or intermittent.

Light markings are signposts with reflecting glass or other material, metal elements with reflecting materials integrated, light posts, and other similar light markings.

1.4.1 TRAFFIC LIGHTS TO CONTROL THE TRAFFIC OF VEHICLES

Traffic lights to control the traffic of vehicles are: traffic lights to control the traffic of vehicles on the approach road to or on a shank of an intersection, traffic lights to control the traffic of vehicles by directions on the approach road to or on a shank of an intersection, traffic lights to control the traffic of vehicles on alternating traffic lanes, a supplemental traffic light to control the traffic of vehicles, a traffic light to control the traffic of vehicles without conflict, and traffic lights to control the vehicle speed.

To control the traffic on one or more approach roads to an intersection, or on one or more shanks of an intersection, if the vehicles are moving from more traffic lanes and from more directions simultaneously so that some minor conflict is possible, and to control the traffic by one or more traffic directions on approach roads to or on shanks of an intersection where no conflict is possible as to all other flows being in conflict with the moving flows the driving is prohibited, tricolour traffic lights are introduced.

The lights on the signs mentioned above shall be arranged in compliance with the Act of bases of road traffic safety. These lights are of circular shape (Figure 1) when used for regulating the traffic of vehicles on one or more approach roads to or on one or more shanks of an intersection; when, however, the traffic lights are used to control the traffic from one or more directions, the red and the yellow light are of circular shape with a black symbol in a shape of one or more arrows, while the green light is of a shape of one or more arrows placed within a black circle (Figure 2).

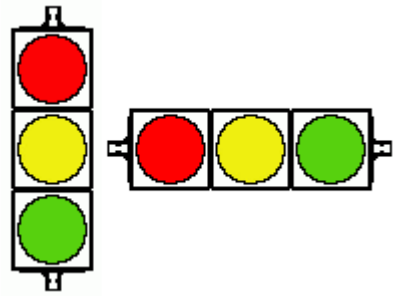


Figure 1

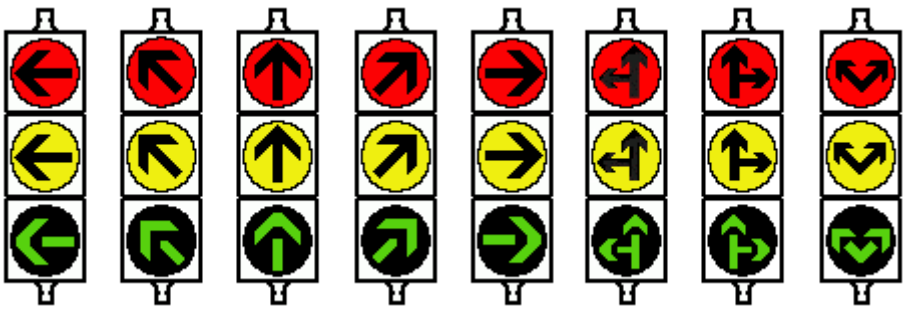


Figure 2

Traffic lights to control the traffic on alternating traffic lanes shall be in accordance with the Act of bases of road traffic safety (Figure 3).

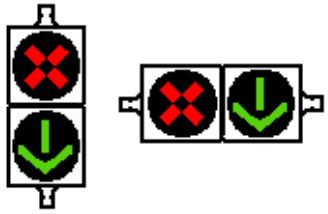


Figure 3

A supplemental traffic light to control the traffic shall be in compliance with the Act of bases of road traffic safety (Figure 4).

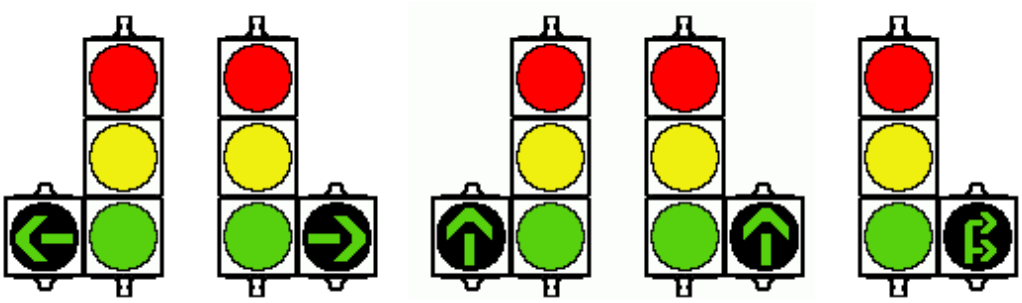


Figure 4

The traffic light to control the traffic of vehicles without being in conflict is used to accelerate the movement of vehicles at an intersection in certain time periods. Such acceleration is achieved in such a way that the drivers are informed by a traffic light of special shape that they have no conflict with other traffic flows at the particular intersection. The traffic light to control the traffic of vehicles without being in conflict is a yellow circular light with a black symbol in a shape of one or more arrows placed in the direction where no conflict exists (Figure 5).

Figure 5

The traffic lights to control the vehicle speed indicate the speed required to pass the subsequent crossroads at green light; they are introduced according to "green wave" system. Such traffic lights can be composed of several lights where the recommended speed value is indicated in white colour or in the colour of the light, located within a black circle (Figure 6).

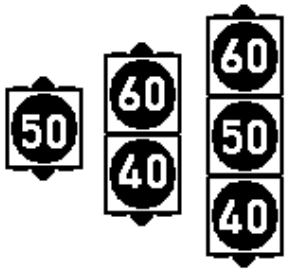


Figure 6

1.4.2 TRAFFIC LIGHTS TO CONTROL THE TRAFFIC OF PEDESTRIANS

In compliance with the Act of bases of road traffic safety, alternating red and green lights are provided by special devices to control the traffic of pedestrians. The green light may be so adjusted as to appear as an intermittent green light at certain time interval before being switched to red (Figure 7).

Figure 7

1.4.3 TRAFFIC LIGHTS TO CONTROL THE TRAFFIC OF BUSES, TRAMWAYS, AND TROLLEYBUSES

To control the traffic of buses, tramways, and trolleybuses, special devices providing single-coloured white lights can be used as well. The white lights are of a shape of horizontal, vertical, or diagonal line, or of combination of lines, all in compliance with the position of public transportation lanes at certain crossroads. The horizontal line denotes a prohibition of passing, while the vertical line, diagonal line, or combination of lines denote free passing in the corresponding direction (Figures 8 and 9).

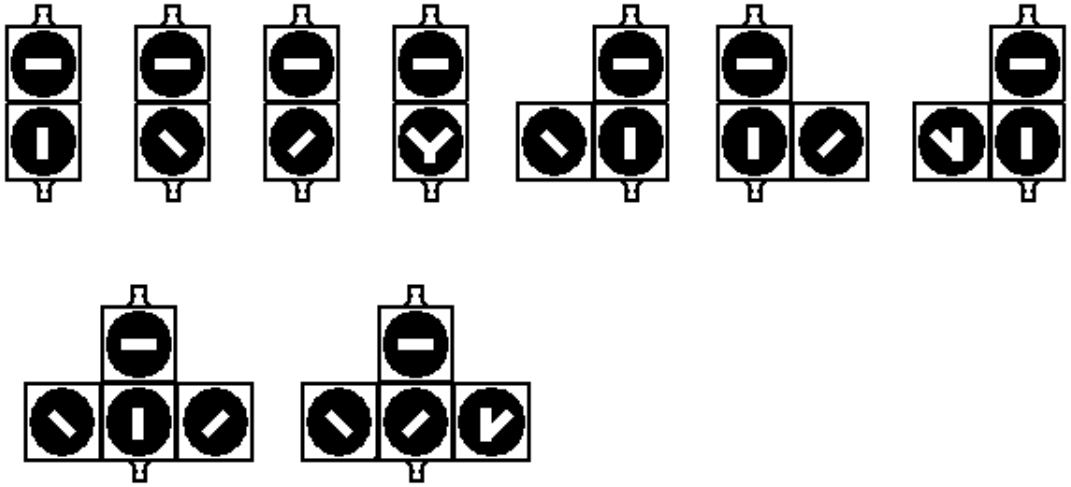


Figure 8

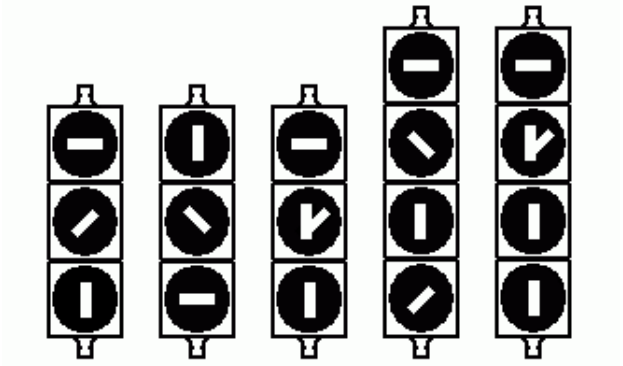


Figure 9

1.4.4 TRAFFIC LIGHTS TO CONTROL THE TRAFFIC OF CYCLISTS

The traffic of cyclists at certain crossroads may be controlled either simultaneously with the pedestrians or separately. Where the cyclists are controlled together with the pedestrians, the same traffic lights are used provided that the cycle track is situated next to the zebra pedestrian crossing. Where, however, a cycle track is situated outside the location of a zebra pedestrian crossing, or different elements of traffic light signalling are foreseen for cyclists, the traffic lights for regulation of the traffic of cyclists shall be used.

To control the traffic of cyclists, devices providing tricolour light signals, i.e. red, yellow and green colour shall be introduced; the lights are placed vertically, one beneath the other, i.e. the red light above, the yellow light in the middle, and the green light underneath. Both red and yellow light are of circular shape with a black symbol of a bicycle, while the green light is actually a black circle with a light green symbol of a bicycle (Figure 10).

Figure 10

1.4.5 TRAFFIC LIGHTS TO CONTROL CROSSROADS AND TO MARK RAILWAY – ROAD INTERSECTIONS AT GRADE

Traffic lights to control crossroads and to mark railway – road intersections at grade can be the lights to mark the barriers and semi-barriers, as well as the lights to announce the approach of a train or closing the railway crossing by means of barriers and semi-barriers.

To the traffic lights mentioned in the above passage, which announce the approach of a train, traffic lights to control the traffic of vehicles may be added, provided that their functioning is coordinated.

The barriers used to close the traffic over the entire road width at railway – road intersections at grade shall be marked with at least three red reflecting glasses, one of which being placed in the middle of the barrier, and the remaining two closer to barrier ends, or coated with reflecting material over the entire barrier.

Semi-barriers used to close the traffic over a half of the road width at railway – road intersections at grade shall be marked with at least three red reflecting glasses placed at adequate spacing over the entire semi-barrier length, one of them being located at the very end of the semi-barrier.

Barriers and semi-barriers shall be marked with red reflecting glasses, or red reflecting materials, even in case they are marked with special permanent or intermittent lights.

The area of an individual reflecting glass shall amount to at least 40 cm^2; reflecting glasses shall be so positioned as to be visible from the direction of the road on which the traffic is being closed. The dimensions of red lights on barriers and semi-barriers, as well as the appearance of barriers and semi-barriers, are specified by relevant standards.

When approaching of a train is announced by means of traffic lights at railway crossings at grade without barriers and semi-barriers, or lowering of a barrier or semi-barrier at a railway crossing equipped with barriers or semi-barriers is indicated, or when the traffic participants are informed by means of these traffic lights that a barrier or a semi-barrier is

in a closed position, the appropriate signals are provided by alternating turning-on the two circular red lights.

The traffic lights mentioned in the passage above shall be placed one next to the other in a horizontal axis, on a table of triangular shape with the apex turned upwards, of the colour and dimensions which correspond to the warning signs (Figure 11).

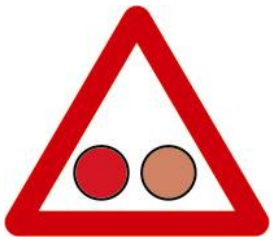


Figure 11

1.4.6 TRAFFIC LIGHTS TO CONTROL THE APPROACHES

Traffic lights to control the approaches are used at locations where the traffic participants are individually accepted, and where they shall be directed or informed, whether certain function or provision channel is opened or closed.

To control an approach, devices for providing light signals by means of double-coloured, i.e. red and green lights. These lights shall be placed vertically, i.e. one beneath the other: the red light above and green light below. The lights are of circular or square shape (Figure 12).

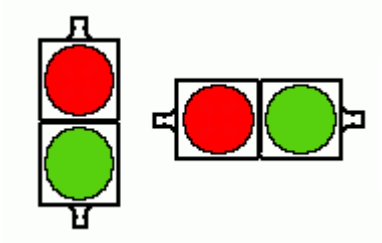


Figure 12

1.4.7 TRAFFIC LIGHTS TO MARK THE ROAD WORKS AND OBSTACLES REPRESENTING DANGER TO TRAFFIC PARTICIPANTS

A part of the road where works are carried out or where certain obstacles have come into being, which cannot be immediately removed, however representing danger to the traffic participants, shall be secured by placing prohibitory boards in compliance with the Act of bases of road traffic safety. By night as well as by day, when the visibility is reduced, an intermittent orange light shall be placed above the particular prohibitory board (Figure 13).

In case that a part of the road where works are carried out or where certain obstacles have come into being, which cannot be immediately removed, however representing danger to the traffic participants, or damages to the carriageway are provided with several intermittent lights, the latter can operate independently one from the other, or can be turned on one by another in time series.

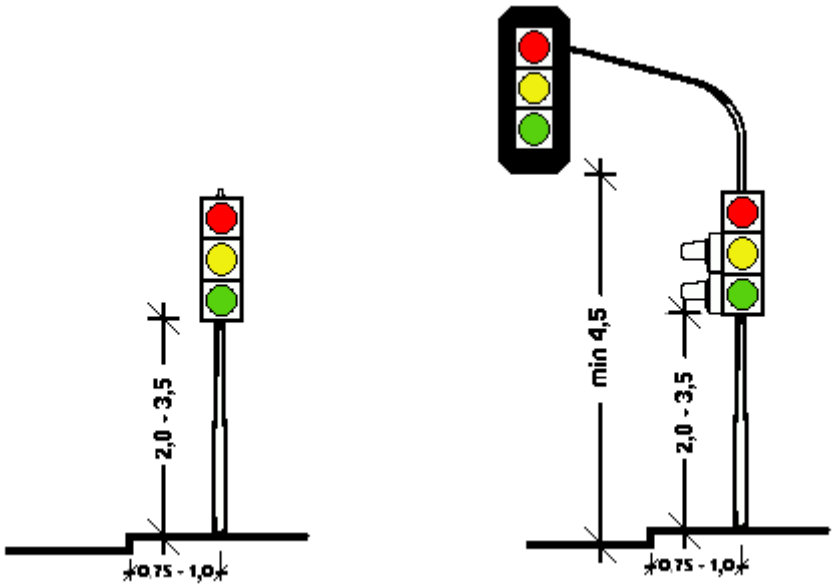
Figure 13

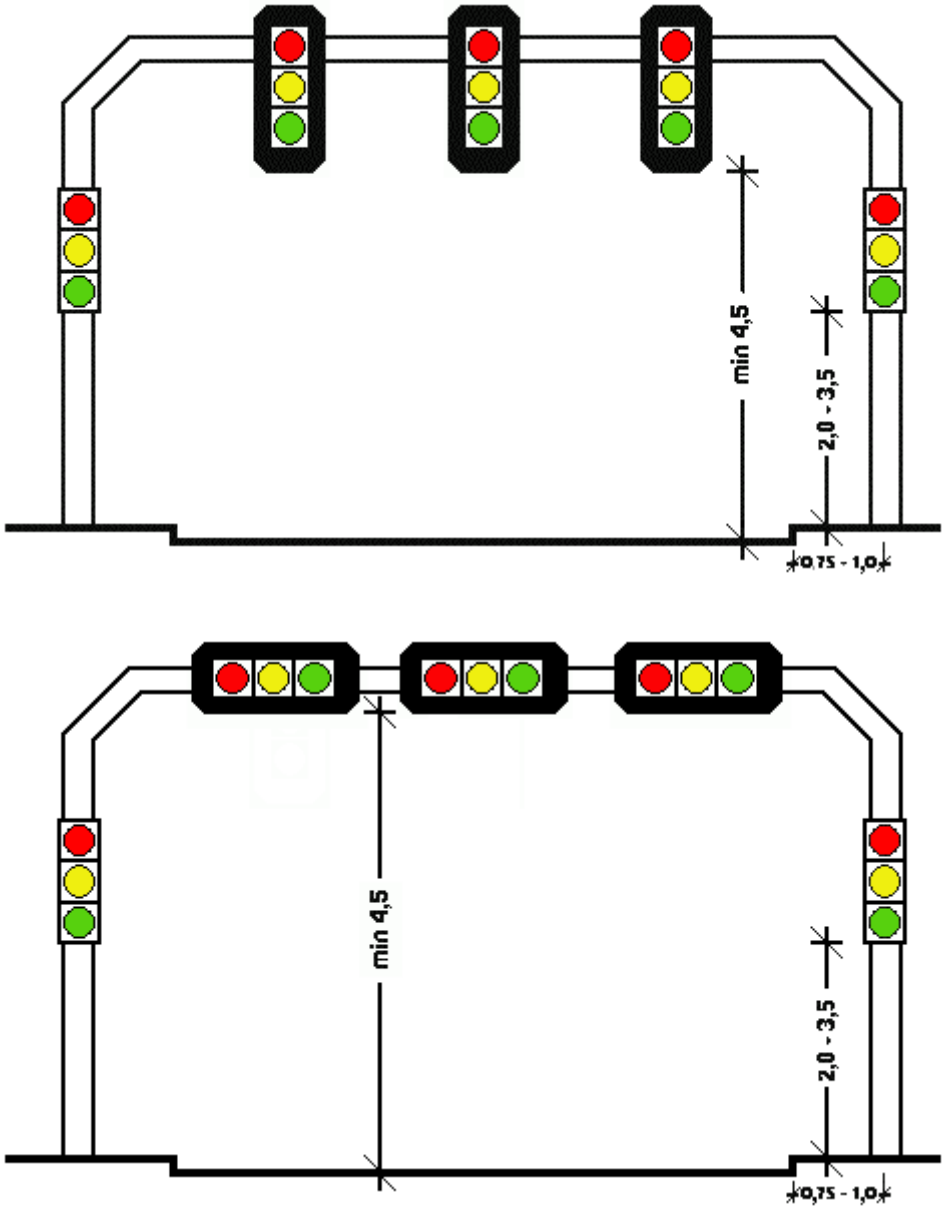
1.4.8 PLACING THE TRAFFIC LIGHTS

Traffic light devices for regulating the traffic at crossroads (intersections) shall be placed at the road edge and at a height of 2 to 3.5 m above the pavement surface.

On a post where a device mentioned in the passage above is fixed, a traffic light device can also be placed at smaller height and with less lights; such a traffic light device is intended for regulating the vehicles, bicycles, and pedestrians at crossroads (intersections).

In case the traffic lights are hanging above the carriageway, the lower edge of the traffic light device shall not be less than 4.5 m above the carriageway.





On barriers, intermittent traffic lights shall be placed in the centre of the barrier, while on semi-barriers they shall be placed at the end of the semi-barrier.

1.5 SIGNS OF VARIABLE MEANING

Due to the requirements relating to traffic safety as well as to technical conditions, traffic signs can also be carried through as signs of variable meaning.

The signs of variable meaning can be made in a shape of:

a) revolving lamellas,
b) revolving prisms,
c) conveyor belts,
d) lighting fields added to common traffic signs,
e) optic fibres, or
f) highlighting diodes (LED).

When traffic signs are executed as signs of variable meaning in a way as indicated in points a, b, c, and d above, the colour and the form shall fully comply with the colour and the form of invariable traffic signs.

When traffic signs are executed as signs of variable meaning in a way as indicated in points e and f above, and when the technology of fabrication of the signs does not allow the application of prescribed colours, the following colours may be introduced:

- non-glossy black colour instead of the basic colour of the sign,
- white or yellow colour instead of the black colour of the symbol.

1.6 TOURIST SIGNS AND OTHER INFORMATIVE SIGNS

Tourist signs are intended to inform the tourists of the tourist potentials and services, and to direct the tourists to these potentials and services (in further text: tourist destinations).

In dependence on their character, touris destinations are classified in:

- tourist destinations of extraordinary importance,
- tourist destinations of great importance, and
- tourist destinations of local importance.

Tourist destinations of extraordinary and of great importance are tourist places of the category I, cultural goods of great and extraordinary importance, national parks, biosphere reserves, and Olympic sports centres.

Tourist destinations not mentioned above are such of local character.

Tourist destinations of extraordinary and great importance are marked with tourist signs, if the access to the destinations is easily enabled to a wide range of tourist service users, provided that such destinations have parking places, lavatories, organized reception of guests, and access for tourists with special needs at their disposal.

Tourist signs are:

- the sign "cultural and historical remarkableness"
- the sign "natural remarkableness"
- the sign "accommodation facility"
- the sign "public facility"
- the sign "tourist remarkableness"
- the sign "tourist road"
- welcome signs
- the sign "tourist information board providing traffic, tourist, and other information.

To mark the tourist destinations, the following traffic signs are used:

- "tourist way-mark arrow"
- "tourist way-mark board"

- "tourist information board"
- "multipurpose facility"
- informative signs to direct the traffic in the crossroads area; such signs comprising names and symbols of tourist destinations can be in a shape of a special field and an inserted base.

the sign "tourist remarkableness" (VII-1) denoting a cultural, historical, or natural remarkableness or object. The sign is of rectangular shape and includes the name of the tourist destination, an artistic, graphic, or photographic description of, and the distance to the tourist destination. The tourist destination name shall be written in the upper part of the sign. The distance to the destination shall be written in the lower part of the sign, i.e. below the graphic presentation and symbol. The sign may also comprise the names of facilities and buildings within the particular tourist destination, or any detailed explanation related to that destination. The names of facilities, buildings, etc., and an eventual explanation shall be written under the artistic, graphic, or photographic description.

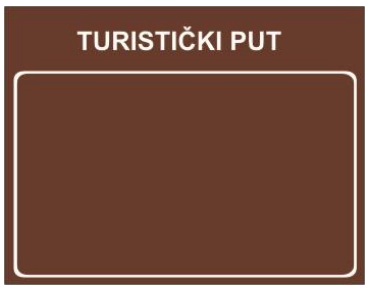
The sign may include symbols situated below the artistic, graphic, or photographic presentation, or below the name of facility, building, or object within the tourist destination, or below eventual detailed explanation relating to the particular destination. The maximum admissible area of such a sign amounts to 6 m^2. To indicate the tourist destination name, letter measuring 140 mm and 175 mm in height shall be used;

VII-1

the sign "tourist road" (VII-2) denoting the location on the road from where the road or a road section has been proclaimed as a tourist road, e.g. panoramic road, wine road, health paths, cultural paths, cycle tracks, etc.

The sign is of rectangular shape and contains a lettering "Tourist Roads of Federation of Bosnia and Herzegovina" or "Tourist Roads of Republic of Srpska" in its upper part; the sign also comprises the symbol as well as the type and title of the tourist road mentioned above.

The sign may also include a graphic presentation. The maximum area of the sign amounts to 6 m^2;



VII-2

the sign "cultural and historical remarkableness" (VII-3) denoting the direction to a cultural and/or historical remarkableness, monuments, and buildings or other objects in settlements, such as cultural monuments, spatial and cultural/historical units, archaeological sites, churches, chapels, libraries, etc.

The sign is of the shape of a "tourist way-mark board", with the shorter side of 30 cm, and containing one symbol, nor more than two letterings, and an arrow indicating straight on, to the left or to the right.

The lettering(s) shall be situated in the centre of the sign, between the arrow and the symbol. The field containing the symbol shall be separated from the field containing the lettering by means of a vertical line;

VII-3

VII-3

the sign "natural remarkableness" (VII-4) denoting the direction to a natural remarkableness, building, facility, etc. in the settlement (such as botanic garden, zoo, aquarium, etc.), or to a natural remarkableness located in a protected natural environment.

The sign is of the shape of a "tourist way-mark board", with the shorter side of 30 cm, and containing one symbol, mot more than two letterings, and an arrow indicating straight on, to the left, or to the right. The lettering(s) shall be situated in the centre of the sign, between the arrow and the symbol. The field containing the symbol shall be separated from the field containing the lettering by means of a vertical line;

VII-4

the sign "accommodation facility" (VII-5) denoting the direction to categorized accommodation facilities in settlements. The sign contains the type of the facility (a hotel, a motel, etc.), and the title of the facility.

The sign is of the shape of a "tourist way-mark board", with the shorter side of 30 cm, and containing one symbol, mot more than two letterings, and an arrow indicating straight on, to the left, or to the right. The lettering(s) shall be situated in the centre of the sign, between the arrow and the symbol. The field containing the symbol shall be separated from the field containing the lettering by means of a vertical line;

VII-5

VII-5

VII-5

the sign "public facility" (VII-6) denoting the direction to the public facilities in the particular settlement (passenger terminals, sports and recreation centres, hospitals, etc.). The sign is of the shape of a "tourist way-mark board", with the shorter side of 30 cm, and containing one symbol, mot more than two letterings, and an arrow indicating straight on, to the left, or to the right. The lettering(s) shall be situated in the centre of the sign, between the arrow and the symbol. The field containing the symbol shall be separated from the field containing the lettering by means of a vertical line;

VII-6

VII-6

VII-6

welcome signs are the sign "welcome" (VII-7) and the sign "so long!" (VII-8).

The sign "welcome" is of rectangular shape and contains a lettering to express welcome at the entry to a state, republic, region, province, tourist region, and community. The sign may contain either a symbol or a graphic presentation.

The welcome sign placed at the entry to the state or republic contains a lettering "Federation of Bosnia and Herzegovina" and "Republic of Srpska" respectively, the coat of arms of the Federation and of Republic of Srpska respectively, and the text "welcome" in _____ language and at least two foreign languages.

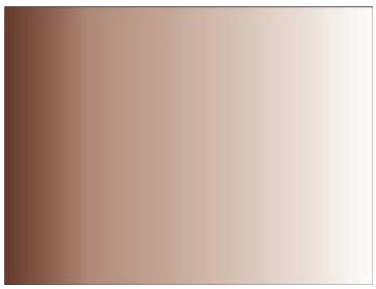
The sign "so long!" is of rectangular shape and contains a lettering "Federation of Bosnia and Herzegovina" and "The Republic of Srpska" respectively, and the text "so long!" in _____ language and at least two foreign languages.

The sign "welcome" to a region, province, tourist region, and community is of rectangular shape and contains the text «welcome», the name and the coat of arms of the region or province, the name of the tourist region, the name and the coat of arms of the community (municipality), and symbols.

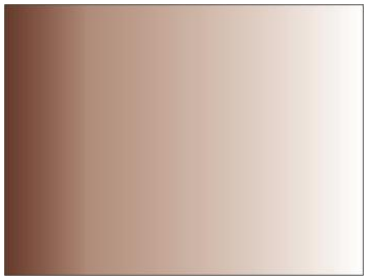
The sign "so long!" is of rectangular section and contains the lettering "so long!", the name of the region or province, of tourist region, and the community (municipality).

The maximum admissible area of the welcome signs amounts to:

- 12 m² for welcome signs placed at entries to the state and the republic,
- 6 m² for welcome signs placed at entries to a region, province, tourist region, and community (municipality);



VII-7



VII-8

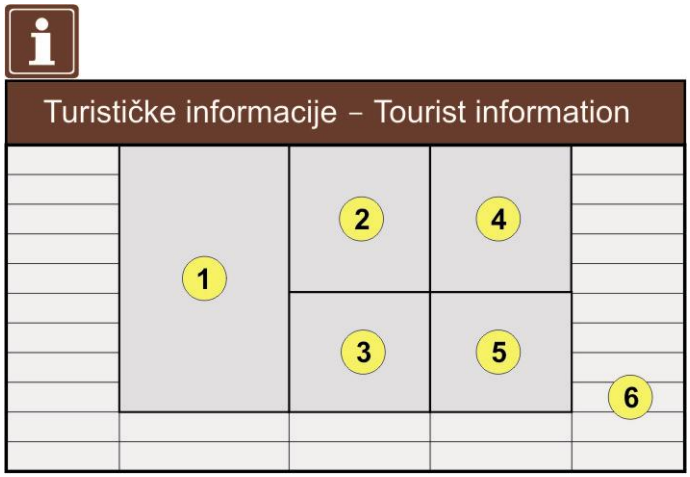
the sign "tourist informative board providing traffic, tourist, and other information" (VII-9) providing tourists in the town, municipality, tourist area, tourist place, or tourist locality with more detailed information.

The information mentioned in the above passage refers to the tourist services offered by a town, municipality, tourist area, tourist place, or tourist locality. The sign may also include service information such as hotel name, address, category, telephone number, or restaurant name address, category, telephone number, or car repair shop title, address, telephone number, etc.).

The sign is of rectangular shape and divided in two horizontal fields. The upper field is maximum 40 cm high and contains lettering "tourist information" in Serbian language and in at least one foreign language. The lettering is placed in the centre of the upper field.

The lower field contains artistic, graphic, cartographic, or photographic presentations, as well as written information of tourist services offered by a town, municipality, tourist area, tourist place, or tourist locality. In case the sign also includes service information, the latter is written in this particular field. If so, the field is divided in three longitudinal fields, so that two lateral fields together represent 1/3 of the entire field. The service information shall be indicated in both lateral fields.

The maximum admissible area of the sign amounts to 10 m² in settlements and 20 m² outside settlements respectively. The contents of a tourist informative board may also be provided in electronic form; in this case, the shape of the sign as prescribed by these guidelines will not be adhered to.



1 + 2 + 3 + 4 + 5 -- informativni deo

6 -- servisni deo (imena, naslov ili tel. brojevi hotela, servisa, itd.)

VII-9

informativni deo = informative part

servisni deo = service part (names, addresses or telephone numbers of hotels, car repair shops, etc.)

1.6.1 SHAPE AND COLOUR OF TOURIST SIGNS AND OTHER INFORMATIVE SIGNS

Tourist signs and other informative signs are of rectangular shape.

The colours of tourist signs are determined in dependence on the character of a tourist destination to which the particular sign is referring:

- for tourist destinations of local character, the basic colour of the sign is white, while the frame, letterings, and symbols are black, and
- for tourist destinations of extremely great importance, the basic colour of the sign is brown, while the frame and letterings are white, and the symbols black on inserted white base, unless provided otherwise in these guidelines.

Regarding the colour, the following tourist signs deviate from the standard features:

- the sign "cultural-historical remarkableness" is of green basic colour, the frame, letterings, and arrow are white, while the symbol is brown on inserted white base;
- the sign "natural remarkableness" is of brown basic colour, the frame, letterings, and the arrow are white, while the symbol or the logotype are green on inserted white base;
- the sign "accommodation facility" is of blue basic colour, the frame, letterings, and arrow are white, while the symbol is blue on inserted white base;
- the sign "public facility" is of white basic colour, the frame, letterings, and arrow are black, while the symbol is black on inserted white base;
- the signs "tourist remarkableness" and "tourist road" are of brown basic colour, the frame and letterings are white, while the symbols are brown on white inserted base. The artistic, graphic, or photographic description on the sign "tourist remarkableness", as well as the graphic description on the sign "tourist road", can be executed in several colours;
- the welcome signs are of blue basic colour, the frame and letterings are white, while the symbols are black on white inserted base;
- the sign "tourist informative board providing traffic, tourist, and other information" is of white basic colour, the frame, the dividing lines, and the field containing the text "tourist information" are brown. The text "tourist information" is of white

colour. Artistic, graphic, cartographic, and photographic descriptions, as well as the written information may be executed in several colours.

The symbols, which specify in greater detail a characteristic facility, structure, or building, and which are used on the tourist signs, belong to the group of symbols used on informative traffic signs, or to the group of graphic symbols for common application. A sign may contain not more than six symbols.

For denoting cultural-historical remarkableness on tourist signs, photographic description in several colours may be used instead of symbols.

The names of tourist destinations and other information on the traffic signs shall be written in _____ language with Cyrillic (Latin) letters and in at least one foreign language.

The tourist signs shall be light reflecting or illuminated and harmonized with other signs at which they are placed.

The tourist signs must not be used to advertise for tourist and other services.

1.6.2 PLACING TOURIST SIGNS AND OTHER INFORMATIVE SIGNS

Programmes of placing the tourist signs for tourist destinations of extremely great importance as well as of the sign "tourist road" are determined by the Tourist Organization of the Federation of Bosnia and Herzegovina and the Republic of Srpska respectively.

Programmes of placing the tourist signs for tourist destinations of local character, except for the sign "tourist road", are determined by local tourist organizations, however with the approval by the Tourist Organization of the Federation of Bosnia and Herzegovina and the Republic of Srpska respectively.

By the designs, which the programmes of placing the tourist signs are accomplished with, a continuous and multiple directing of users of the tourist services towards the selected destinations by means of tourist signs shall be ensured.

By the above mentioned projects the appearance of the signs "tourist way-mark arrow", "tourist way-mark board", "tourist informative board", as well as of the informative signs to direct the traffic in crossroads zones, and the sign "multipurpose facility", on which the names and symbols of the tourist destinations can be in a form of special field and inserted base.

Placing the tourist signs shall be carried out in accordance with the relevant regulations managing planning and constructing the facilities, and with regulations providing a safety traffic on the roads.

Tourist signs are erected in the vicinity of tourist destinations, the minimum at the last intersection, from which an access road is directly leading to the particular tourist destination. For tourist destinations of extremely great importance, tourist signs may also be placed at previous important intersections, as well as along the road directions.

The signs "tourist informative board" and "tourist remarkableness", when they are placed before the way-marks and way-mark boards, shall be erected individually, i.e. maximum two signs at different distances from the way-marks and way-mark boards, on each access road to the particular tourist destination.

The sign "tourist road" shall be placed at both initial and terminal point of the road or the road section proclaimed as a tourist road by a programme prepared by the Tourist organization _____ , or at the beginning of the circular way only.

Welcome signs are placed:

- at border crossings to the Federation of Bosnia and Herzegovina,
- on the border to the Republic of Srpska,
- at the location of entering a tourist region.

The sign "tourist informative board providing traffic, tourist, and other information" is erected at resting places and other areas along the road intended for rest. Before the sign, a sign "information" is placed, with supplemental boards denoting the distance in metres to the location where the sign is situated.

The bearing structure of the sign can be designed in accordance with the styling requirements of the immediate surroundings.

The signs "cultural-historical remarkableness", "natural remarkableness", "accommodation facility", and "public facility" are used as tourist signs intedned for directing the pedestrians. These signs are placed in areas destined for the pedestrians.

The supporting sign post shall be placed at a distance of at least 2 (two) metres from the carriageway.

Sign posts can be designed in accordance with the styling requirements of the immediate surroundings. The minimum height of placed signs measured from the pedestrian level amounts to 2.20 m.

The position, location of placing, and height of signs are determined in such a way that the tourist signs:

- do not conceal the placed traffic signs,
- do not distract drivers' attention from the placed traffic signs,
- do not endanger the movement of pedestrians, and
- are not concealed to pedestrians and parked vehicles.

By means of tourist signs placed on motorways, tourist destinations of extremely great importance located in the next vicinity of the motorway out of settlements, or such destination, to which special access road from the motorway exists, can be denoted.

With the exception of the above passage, in accordance with the proposal by the Tourist Organization of the Republic of Bosnia and Herzegovina and of the Republic of Srpska respectively, a cultural welfare of extreme importance located in the next vicinity of a motorway, can be marked on the particular motorway.

Tourist signs for hotels and motels are also placed at locations where some difficulties regarding the selection of adequate directions are encountered. In a town where a greater number of hotels and motels exist, the tourist signs shall comprise all such facilities.

Signs indicating tourist destinations, which do not operate in certain annual periods (e.g. skiing facilities, beaches, etc.), shall be temporarily removed or equipped with suitable supplemental boards denoting, either by symbols or words, in which period the particular sign applies.

Cultural, historical, and natural remarkableness, as well as monuments, being subject of informing and to which the traffic is directed by means of tourist and other informative signs, shall meet, in addition to the conditions provided by the road technical specifications, at least the following requirements:

- a remarkableness, a monument, an area, a building, or a facility shall be classified on an adequate list of cultural, historical, or natural heritage of category I,
- a remarkableness, a monument, an area, a building, or a facility can be visited all the year round as a rule,
- the road and the approach to a remarkableness, a monument, an area, a building, or a facility shall be safe and easily accessible to individual traffic participants it is intended for,
- a sufficient number of parking places out of the road carriageway shall be ensured,
- appropriate lavatories shall be available.

The provision indicated in the first paragraph of the above passage does not apply to placing the signs in towns.

Tourist and other informative signs shall be placed to the minimum possible extent, and only when there is no adequate sign or information available to denote certain area, space, building, or facility, or when such an area, a space, a building, or a facility cannot be clearly marked by informative traffic signs, to which commonly known or international symbols are added.

On motorways and expressways it is not admitted to erect tourist and other informative signs, except the signs VII-1 and VII-1.1 (informative board for tourist remarkableness), VII-7 (welcome to the Republic of Srpska or the Federation of Bosnia and Herzegovina), VII-7.1 (so long!), and VII-8 (tourist informative boards).

Tourist and other informative signs may only be placed at the carriageway, if the latter is intended for motor vehicles only. In case the carriageway is also intended for vehicles without motors, and for other traffic participants, then the tourist and other informative signs may also be placed above the traffic surface.

On roads outside settlements, tourist signs and other informative signs shall be placed at a height of 1.5 m above the pavement surface.

In settlements, tourist signs and other informative signs situated at the carriageway or any other traffic surface shall be placed at a height of 2.25 m above the pavement surface or any other traffic surface.

The height mentioned above is calculated from the surface intended for the traffic up to the lower edge of the traffic sign; when a supplemental board is added to a sign, the height is calculated to the lower edge of such a board.

The location of placing, the height, and the position of tourist and other informative shall be such as not to conceal the existing traffic signs, to distract drivers' attention from traffic signs placed, to endanger the pedestrians, and to be concealed by pedestrians and vehicles.

As a rule, a post for a tourist sign or other informative sign shall be placed maximum 2.0 m from the carriageway edge.

The horizontal distance between the outer pavement edge or marginal strip or crawler lane and the nearest edge of the tourist sign or other informative sign on roads out of settlements shall be at least 0.75 m, while on road in settlements it shall be at least 0.30 m if the road is bordered by kerbs.

Tourist and other informative signs may exceptionally be erected on:

- a cantilever beam, where a sign is perceived easier by the traffic participants;
- other posts or structures if prescribed by the decree of protection of cultural or natural remarkableness.

Informative signs for cultural, historical, and natural remarkableness, as well as for monuments VII-1 and VII-1.1 (informative boards for tourist remarkableness) may only be placed before intersections, which shall be carried out in the following way:

- on motorways and expressways, as a rule, at a distance of minimum 500 m and maximum 1,500 m before the traffic signs III-88 (preliminary signboard for diverting the traffic), or, if absence of the latter, before the sign III-89 (preliminary sign for manual traffic regulation);
- on motorways and expressways only one sign VII-1 or VII-1.1 (informative boards for tourist remarkableness) may be placed at an exit. The remarkableness or monument to which the particular sign refers must not be situated more than 30 km from the place where the sign is erected. As regards the remarkableness to which the sign VII-1 or VII-1.1 relates, the traffic at intersections may only be directed by means of traffic directing signs containing either the title of the

remarkableness or monument, or a symbol added to the name of the particular place,

- on trunk roads out of settlements, as a rule, at a distance of at least 250 m before the first informative traffic sign providing information of driving directions at crossroads,
- on other roads outside settlements, as a rule, at a distance of at least 150 m before the first informative traffic sign providing information of driving directions at crossroads,
- on roads in settlements, as a rule, at a distance of at least 100 m before the crossroads.

On the roads indicated in the first, second, and third paragraph above, it is allowed to place the signs only if all the conditions provided by these guidelines are fulfilled for the particular remarkableness or monument.

Informative signs denoting the direction in which a cultural, historical, or natural remarkableness, or a monument, important building, or facility is located within the area of the remarkableness and the settlement, may only be placed within this area or settlement, at a distance of 30 m, as a rule, before the first traffic informative sign denoting the driving directions at intersections. When no traffic directing signs are placed at the intersection, the signs may also be placed immediately before the intersection entry or at the intersection itself.

Exceptionally, the sign VII-4 (cultural or historical remarkableness, monument, or building in a settlement), may also be used on roads out of settlements for directing towards a historical or cultural monument, in case the conditions for denoting by means of the signs VI-1 or VII-1.1 (informative board) cannot be fulfilled.

The signs to provide traffic, tourist, and other information on the traffic surfaces outside the carriageway (resting places, parking places), as well as on other surfaces along the road, which are intended for accompanying activities at the road, shall be placed on such surfaces which are not intended for vehicles and which ensure safety to pedestrians, who are making acquaintance with the meaning of the particular sign.

On a road, next to which a resting place or any other area intended for resting of passengers is located, the traffic sign III-56 (tourist information) shall also be erected to provide information of the vicinity of the place, where the tourist or other informative sign is situated.

2. TRAFFIC FURNITURE

The following items belong the traffic furniture:

- furniture to mark vicinity of the carriageway edge, the edge of extra width, or the edge of emergency or crawler lane on roads where such lanes exist,
- furniture to control and canalize the traffic in the area of road works and damages to the pavement,
- safety barriers,
- protective fences,
- prefabricated physical speed stoppers – sleeping policemen
- impact energy absorbers,
- pedestrian parapets,
- barriers and semi-barriers,
- furniture to clearly indicate the motorway or expressway course in case of a road split,
- traffic mirrors,
- anti-glare furniture.

2.1 FURNITURE TO MARK VICINITY OF CARRIAGEWAY EDGE, EDGE OF EXTRA WIDTH, OR EDGE OF EMERGENCY OR CRAWLER LANE

The following items belong the the furniture to mark vicinity of the carriageway edge, or the edge of extra width, or the edge of emergency or crawler lane on roads where such lanes exist:

Road safety posts marking the vicinity of the carriageway edge, the edge of extra width, or the edge of the emergency or crawler lane, where such lanes exist, and simultaneously also marking the road course in the space. The shape, size, and performance of the safety posts shall be such as to be visible in all weathers, particularly at reduced visibility (darkness, fog, etc.). To the road safety posts, light-reflecting bodies shall be fixed, reflecting the red light on the right hand side, and the white light on the left hand side in the driving direction (Figure 1);

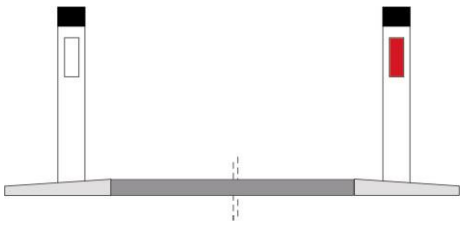


Figure 1

Safety posts for tunnels marking the vicinity of the pavement in the tunnel. The entire body of a tunnel safety post shall reflect the light, except the supporting parts. Such safety posts shall reflect the red light on the right hand side, and the white light on the left hand side in the driving direction (Figure 2);

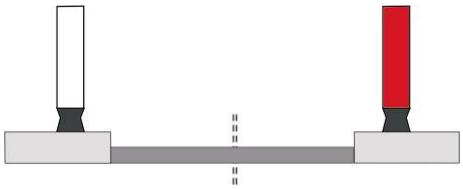


Figure 2

Light-reflecting bodies marking the vicinity of the carriageway edge, the edge of extra width, or the edge of eventual emergency lane or crawler lane, and which can be, by means of special supports, fixed to structure at such locations where traffic safety posts cannot be placed (Figure 3);

Marker posts for snow, which, in winter period, denote the vicinity of the pavement edge or the edge of an emergency lane or crawler lane, if any. Such posts are also used by snow removing services to mark the road course. The marker posts for snow are painted with alternating red and yellow fields. They can be additionally marked with light-reflecting bodies. Special marks can be fixed to these posts, being of certain importance for the snow removing services (Figure 4);

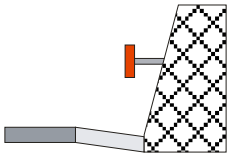


Figure 3

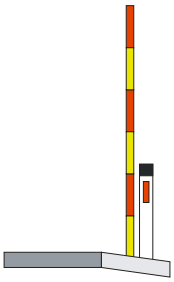


Figure 4

2.1.1 PLACING THE FURNITURE TO MARK THE VICINITY OF THE CARRIAGEWAY EDGE

As a rule, safety posts shall be placed at a distance of 0.75 m from the outer edge of the carriageway, from the esge of extra width, or from the edge of the emergency or crawler lane, while the top of a safety post shall be 0.75 m above the pavement level or above the edge of the emergency or crawler lane.

Where a safety barrier is placed at the carriageway, or at the edge of the extra width, or at the edge of the emergency or crawler lane, and when such a safety barrier is interrupted at minor length, the corresponding road section being equipped with safety posts, the latter shall be placed at the same distance from the carriageway edge, the edge of extra width, or the edge of the emergency or crawler lane, as the safety barrier is situated, however not less than 0.5 m.

Light-reflecting bodies fixed at the carriageway edge, and which cannot be mounted onto road safety posts or safety barriers, shall be fixed by means of supports at the same distance from the pavement edge and at the same height, as they are fixed to these items before the place marked with light-reflecting bodies on the supports.

Marker posts for snow shall be placed in accordance with the winter service programme.

Where the marker posts for snow are placed on the carriageway where the safety posts are placed as well, the marker posts for snow shall be situated on the left hand side of the safety posts in the driving direction, so that the light arising from the light-reflecting body on the safety posts is not concealed.

A marker post for snow shall also be placed at the beginning and the end of the safety barrier.

2.2 FURNITURE TO CONTROL AND CANALIZE THE TRAFFIC IN THE AREA OF ROAD WORKS, OTHER OBSTACLES, AND DAMAGES TO THE PAVEMENT

The furniture to control and canalize the traffic in the area of road works, other obstacles, and damages to the pavement comprises the following items:

Prefabricated guiding kerbs to canalize the vehicle traffic on traffic lanes; light-reflecting bodies shall be fixed to the kerbs to ensure adequate visibility at night and in conditions of diminished visibility (Figure 1). For better perception, the kerbs may be additionally equiped with markers (Figure 2);

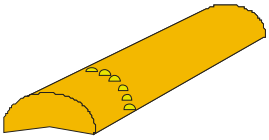


Figure 1

Figure 2

Markers on one-way roads where a two-way traffic is provisionally arranged, intended to clearly indicate the demarcation of the two traffic directions; the marker surface shall be made of light-reflecting material (Figure 3). The markers can be placed individually, or they can be fixed to guiding kerbs. Where the markers are fixed to prefabricated guiding kerbs, they shall be executed in such a way that the red and white stripes are directed from the marker top downwards towards the vehicle driving at the particular marker. In certain cases directing arrows of red colour on a white field can be used instead of diagonal lines (Figure 4);

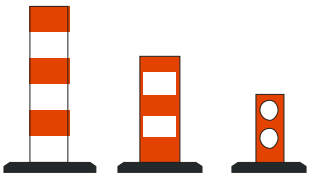


Figure 3

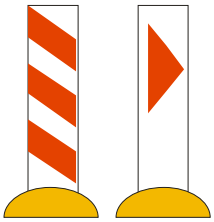
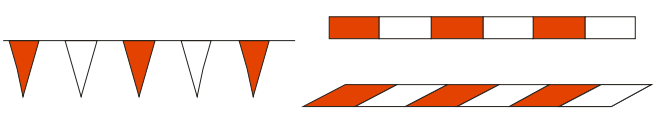


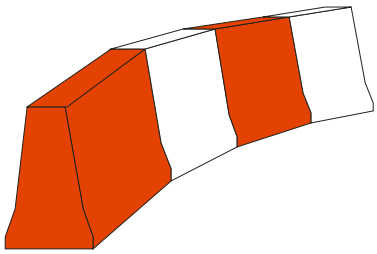
Figure 4

Light-reflecting bodies to clearly indicate, provisionally (yellow) or permanently (white), the traffic separating lines;

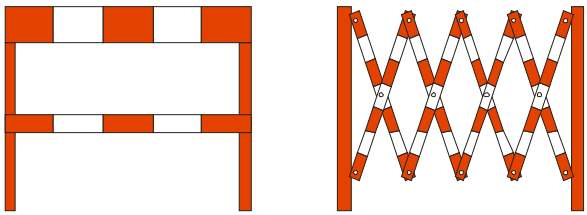
Strings and tapes to restrict or to mark minor job sites;



Provisional separating barriers made of synthetic materials, which physically divide the surfaces intended for the traffic running in opposite directions;



Extendible and folding barriers to secure minor job sites on pedestrian surfaces;



2.2.1 PLACING THE FURNITURE TO CONTROL AND CANALIZE THE TRAFFIC IN THE AREA OF ROAD WORKS, OTHER OBSTACLES, AND DAMAGES TO PAVEMENT

The furniture to control and canalize the traffic in the area of road works, provisional obstacles, and damages to the pavement may only be placed in compliance with the programme of marking a temporary traffic regime, and with the relevant regulations on marking the road works, other obstacles, and damages to the carriageway.

2.3 SAFETY BARRIERS

2.3.1 GENERAL

2.3.1.1 The purpose of guideline

This technical specification lays down the conditions and the method of installing steel, concrete and wooden safety barriers on public roads and non-categorised roads made available for public traffic (hereinafter: public roads).

2.3.1.2 The purpose of safety barriers

The purpose of safety barriers is to prevent skid (slip) of a vehicle from the road or the passage of a vehicle to the opposite carriageway and thus to prevent and reduce injuries of the passengers in the vehicle, the persons and facilities next to the roadway as well as to retain the vehicles which change the direction of the drive uncontrollably and to keep them on the carriageway.

2.3.1.3 Criterion for the use of safety barriers

Safety barriers certified in accordance with the European standards EN 1317-1 and EN 1317-2 may be installed on public roads.

2.3.2 DEFINITION OF TERMS

SF: safety barrier

SSB: steel safety barrier

CSB: concrete safety barrier

WSB: wooden safety barrier

Barrier: is a construction comprised of individual elements, positioned next to the roadway for protection purposes.

Beam (guardrail): is the element of the barrier made of the material possessing suitable mechanic characteristics, of certain length; in the event of an impact by the vehicle its rigid construction (concrete safety barrier) or deformation (steel and wooden safety barrier) softens the consequences of the impact.

Spacer: is the element of the barrier of certain dimensions; its purpose is to connect the beam with the post or bracket.

Post: supports the spacer and/or beam; it is made of a material that has suitable mechanic characteristics and is of certain length, so that the spacer is positioned at certain distance from and at certain height above the roadway.

Reflex reflector: is the element of the barrier attached to the beam marking the road route.

End treatment: is the part of the barrier at its start and end; its purpose is to lessen the consequences of a collision between a vehicle and the barrier.

Central reservation: is part of the roadway separating physically and/or by a marking the opposite carriageways; it is prohibited for traffic.

Removable section: is part of the barrier that is disassembled, if necessary.

Vehicle containment level (by safety barrier): according to the European standard EN 1317-2 represents the containment level of various types of vehicles preventing them from slipping (skidding) from the road or from the passage to the opposite carriageway; it depends on the category of each public road, AADR, specific roadside area or dangerous section of the road.

Deformation ("working width") of the barrier (W): in cross section represents the

distance between the front of the beam prior to vehicle impact and the furthest point on the barrier following deformation or deviation from the original position resulting from the vehicle impact.

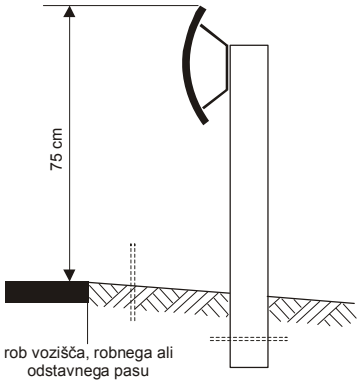
AADT: Average annual daily traffic

2.3.3 TYPES OF SAFETY BARRIERS

2.3.3.1 Steel safety barrier (SSB)

2.3.3.1.1 Single-sided

Single-sided SSB consists of a beam attached to the post (Figure 1). Single-sided SSB is designed for containing vehicles on one side.

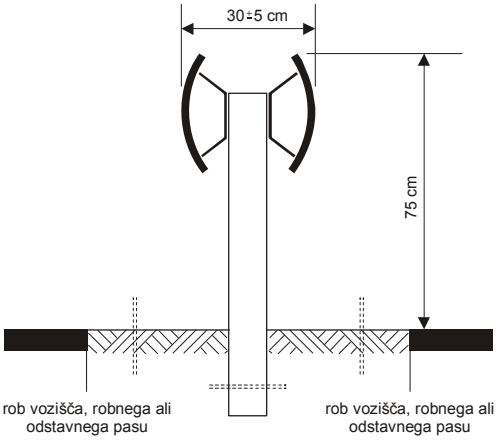


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 1: Single-sided SSB

2.3.3.1.2 3.1.2 Double-sided

Double-sided SSB consists of the beams attached to the post directly without spacer (Figure 2). Double-sided SSB is designed for containing vehicles on both sides.

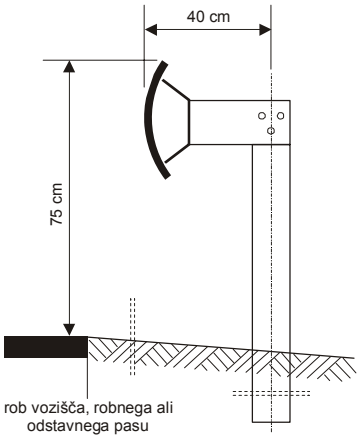


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 2: Double-sided SSB

2.3.3.1.3 Single-sided with spacer

Single-sided SSB consists of a beam attached to the post by a spacer (Figure 3). Single-sided SSB with a spacer is designed for containing vehicles on one side.

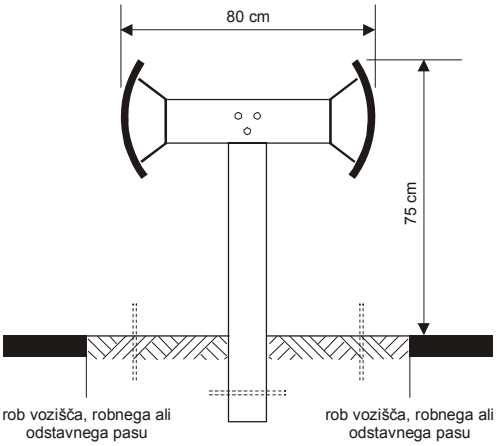


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 3: Single-sided SSB with a spacer

2.3.3.1.4 Double-sided with spacer

Double-sided SSB with a spacer consists of beams attached to the post by a spacer (Figure 4). Double-sided SSB with a spacer is designed for containing vehicles on both sides.

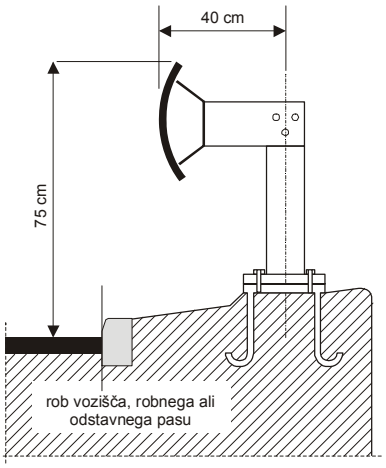


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 4: Double-sided SSB with a spacer

2.3.3.1.5 Singe-sided with a spacer anchored to the object

Single-sided SSB with a spacer anchored to the object consists of a beam attached to the post by a spacer which is anchored to the object (Figure 5). Single-sided SSB with a spacer anchored to the object is designed for containing vehicles on one side.

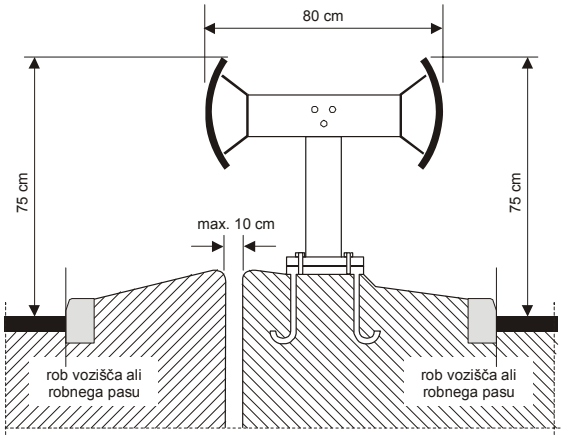


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard for emergency stop shoulder

Figure 5: Single-sided SSB with a spacer anchored to the object

2.3.3.1.6 Double-sided with a spacer anchored to the object

Double-sided SSB with a spacer anchored to the object consists of a beam attached by a spacer to the post which is anchored (Figure 6). Double-sided SSB with a spacer anchored to the object is designed for containing vehicles on both sides.

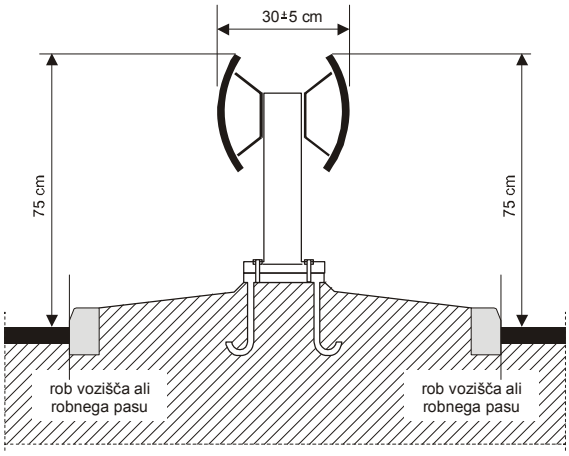


rob vozišča ali robnega pasu	edge of the roadway or extra width

Figure 6: Double-sided SSB with a spacer anchored to the object

2.3.3.1.7 Double-sided anchored to the object

Double-sided SSB anchored to the object consists of beams attached to the post which is anchored to the object (Figure 7). Double-sided SSB anchored to the object is designed for containing vehicles on both sides.



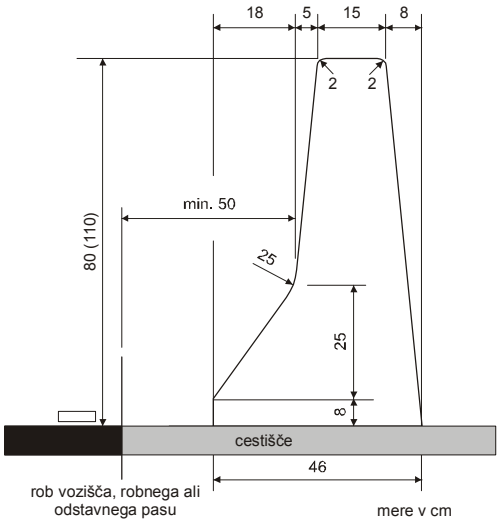
rob vozišča ali robnega pasu	edge of the roadway or extra width

Figure 7: Double-sided SSB anchored to the object

2.3.3.2 Concrete safety barrier (CSB)

2.3.3.2.1 3.2.1 Single-sided

Single-sided CSB 80 cm or 110 cm high (Figure 8) is designed for containing vehicles on one side.

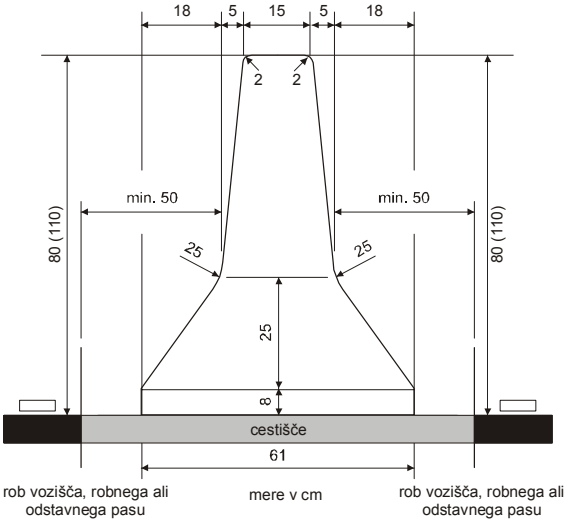


cestišče	roadway
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
mere v cm	dimensions in cm

Figure 8: Single-sided CSB

2.3.3.2.2 Double-sided

Double-sided CSB 80 cm or 110 cm high (Figure 9) is designed for containing vehicles on both sides.



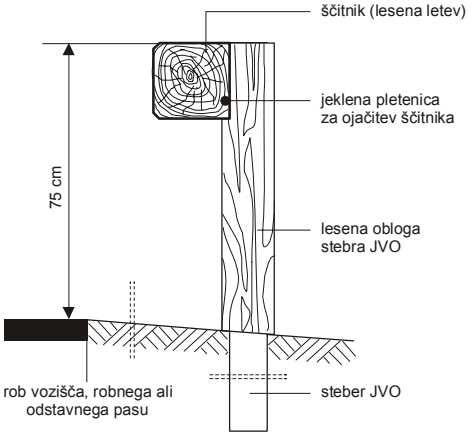
cestišče	roadway
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
mere v cm	dimensions in cm

Figure 9: Double-sided CSB

2.3.3.3 Wooden safety barrier (WSB)

2.3.3.3.1 Single-sided

WSB consists of a beam (wooden lath reinforced by steel weaving), attached to a steel post covered by wooden lining (Figure 10). Installation of a WSB on an object or wall is subject to the same principles and requirements as those applying to SSB. WSB is designed for containing vehicles on one side.



ščitnik (lesena letev)	beam (wooden lath)
jeklena pletenica za ojačitev ščitnika	steel weaving for reinforcement of the beam
lesena obloga stebra JVO	wooden lining of the SSB post
steber JVO	SSB post
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 10: WSB

2.3.4 SB INSTALLATION CONDITIONS

2.3.4.1 4.1 General

Safety barrier is installed at locations where the danger of injuries due to vehicle impacting a SB is smaller than the danger of a vehicle passing into dangerous zone, which is separated by the barrier.

On roads where SSB is usually installed, the CFS and the WSB have to be or may be used in particular cases.

Steel safety barrier:

- On the verge and the central reservation of a motorway and expressway a single-sided SSB with a spacer is installed.
- If there is insufficient space on the central reservation of a motorway and expressway to install a single-sided SSB with a spacer, a double-sided SSB with a spacer may be installed.
- On the verge and the central reservation of other public roads a single-sided SSB without a spacer is installed.
- If the space on the central reservation of roads referred to in the previous paragraph is insufficient for installing a single-sided SSB, a double-sided SSB may be installed.
- SSB with additional protection for motorcyclists is installed on public roads where an increase in motorcycle traffic is expected during the tourist season.

Concrete safety barrier:

CSB is installed:

- when it is impossible to provide the required vehicle containment level by a SSB,
- on double-carriageway roads with one traffic lane in each direction, with AADT of up to 7,000 or
- on double-carriageway roads with two traffic lanes in each direction, with AADT of up to 39,000,
- on roads crossing a water protection area to prevent spillage of dangerous substances into groundwater.

CSB heights

- 80 cm: when trucks and buses account for up to 15% of the stated AADT,
- 110 cm: when trucks and buses account for 15% or more of the stated AADT.

Wooden safety barrier

Wooden safety barrier is installed mainly on roads with low traffic, where SSB or CSB cannot be installed due to environmental or aesthetic reasons.

2.3.4.2 Safety barrier in urban area

In urban area a safety barrier need not be installed, unless the road is:

- parallel to a water course with medium water level of 2 m or more, which is $\leq$ 6 m away from the roadway edge
- routed over a high embankment (taking into account Figure 12 in Item 4.5), which is $\leq$ 6 m away from the roadway edge
- routed over a facility bridging a water course (with medium water level of 2 m or more), railway track or some other traffic surface or
- routed along a supporting wall which is $\leq$ 6 m away from the roadway edge

when there is no kerb 15 cm $\leq$ h $\leq$ 18 cm in height installed along the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop.

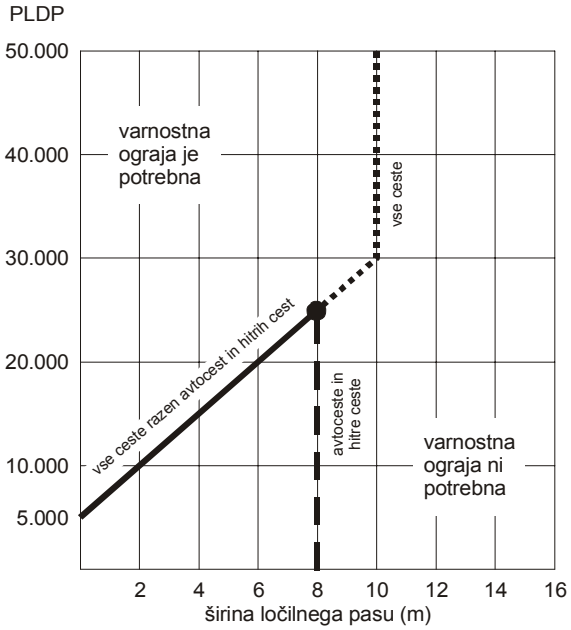
2.3.4.3 Safety barrier on central reservation

The parameters setting the installation of a SB on central reservation are the width of the central reservation and the AADT (Figure 11).

Irrespective of the provisions of the previous paragraph, the installation of a SB on a motorway or expressway central reservation that is less than 8 m wide is obligatory regardless of the AADT.

A removable SB is installed on the central reservation:

- on an open route, as a rule at every 3 km at the most,
- before tunnels and cut and covers,
- before large bridging structures.



varnostna ograja je potrebna	safety barrier is needed
Vse ceste razen avtocest in hitrih cest	All roads except motorways and expressways
vse ceste	all roads
avtoceste in hitre ceste	motorways and expressways
varnostna ograja ni potrebna	safety barrier is not needed
širina ločilnega pasu (m)	central reservation width (m)

Figure 11: Parameters determining the installation of a SB on central reservation

2.3.4.4 Safety barrier in water protection area

If a road crosses a water protection area outside urban area, a SB has to be installed along the roadway.

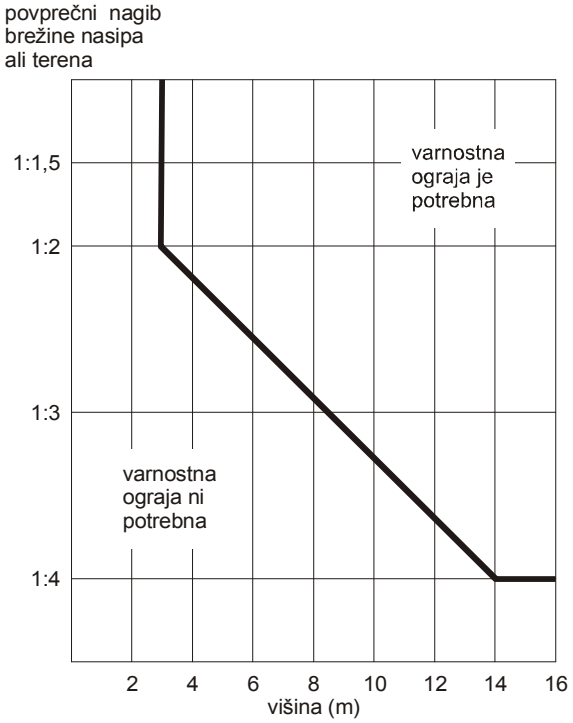
2.3.4.5 Safety barrier on embankment

Parameters that condition the installation of a SB on embankment are the height and average grade of the embankment or terrain slope as well as the distance between the start of the slope and the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop (Figure 12). When the height of the embankment and the grade of the embankment or terrain slope is determined, the ditches located next to the embankment foot are taken into account.

If the distance between the start of the slope and the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop:

- is greater than 10 m and the permitted speed is V ≥ 70 km/h and
- is greater than 6 m and the permitted speed is V < 70 km/h,

the SB need not be installed.



povprečni nagib brežine nasipa ali terena	average grade of the embankment or terrain slope
varnostna ograja je potrebna	safety barrier is needed
varnostna ograja ni potrebna	safety barrier is not needed
višina (m)	height (m)

Figure 12: Parameters determining the installation of a SB on embankment

2.3.4.6 Safety barrier at cutting / cut

SB at cutting / cut is not installed if the slope or surface between the cutting / cut and the roadway is smooth or such that a vehicle could skid.

2.3.4.7 Safety barrier in / at a structure

SB is not installed in tunnels, tunnels with side openings and the entry/exit sections of culvert ranging up to 150 cm, which are inbuilt in the embankment and have the same grade as the embankment slope.

2.3.4.8 Safety barrier in the area of a dangerous obstacle next to a road

A SB has to be relocated if a dangerous obstacle is ≤ 10 m away from the edge of the roadway, extra width or the hard shoulder for emergency stop.

A dangerous obstacle constitutes:

- water obstacle with medium water level of 2 m or more,
- tree-lined road with three radius exceeding 15 cm,

- portal or semi-portal support with external pipe profile in excess of 76 mm or wall width greater than 2.9 mm,
- post**:** of road lighting, electric mains, facility and similar,
- particularly dangerous facility with flammable substances.

2.3.4.9 Safety barrier in the vicinity of another traffic surface

The SB has to be installed in the vicinity of another traffic surface if:

- the edge of the other traffic surface is ≤ 10 m away from the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop,
- if the road is parallel to the railway track and if the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop is ≤ 10 m away from the nearest rail,
- if the railway track or another traffic surface is routed along the embankment slope foot or over the bottom of the terrain with an inclination of more than 1:3, while the distance between the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop and the nearest rail or the edge of another traffic surface is ≤ 30 m and the distance between the lower edge of the embankment and the first rail or the edge of another traffic surface is ≤ 10 m and the height difference between the level of the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop and the edge of another traffic surface or the top of the nearest rail is ≥ 3 m.

A SB has to be installed next to a raised traffic surface (first indent of Item 4.9) or along a road if a traffic surface on a lower level is a railway track.

A SB need not be installed in the vicinity of another traffic surface regardless of the provisions of the first paragraph hereunder:

- in crossroads zone,
- in bus stop zone,
- next to a railway track, when the track next to the other traffic surface is higher than that traffic surface and the top of the nearest rail is ≥ 2 m above the other traffic surface.

2.3.5 METHOD OF SAFETY BARRIER INSTALLATION

2.3.5.1 Height

2.3.5.1.1 Steel and wooden safety barrier

The upper edge of the SSB and WSB has to be 75 cm above the edge of the roadway, extra width or hard shoulder for emergency stop (Figures 1 to 7 and 10), measured from the horizontal line on the edge of the roadway, extra width or hard shoulder for emergency stop.

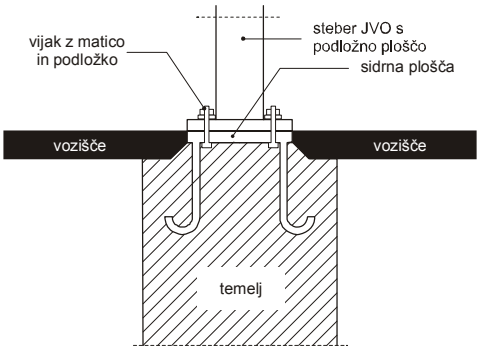
2.3.5.1.1.1 Post

The SSB and WSB post intended for piling is usually 1.9 m long.

Posts are placed at a distance of 1.33 m, 2 m and 4 m, depending on the necessary vehicle containment level.

A post has an inbuilt closed profile in the direction of the drive, except on the central reservation.

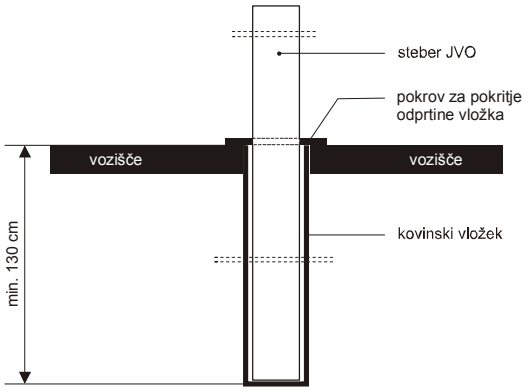
If the post cannot be driven into the terrain or when the SSB is installed at the passage across the central reservation, the post and the supporting plate have to be attached to the ground anchor inbuilt in the base (Figure 13).



vijak z matico in podložko	screw with a nut and washer
steber JVO s podložno ploščo	SSB post with supporting plate
sidrna plošča	ground anchor
vozišče	roadway
temelj	base

Figure 13: SSB and WSB post attached to the ground anchor by supporting plate

If the base cannot be provided, it is sensible to insert metal pieces in the road body into which the SSB or WSB post is placed (Figure 14). In such case the opening at the top of such piece has to be closed both when the SF is installed and when it is uninstalled.



vozišče	roadway
steber JVO	SSB post
pokrov za pokritje odprtine vložka	cover for closing the opening
kovinski vložek	metal piece

Figure 14: SSB and WSB post inserted in metal piece

2.3.5.1.2 Concrete safety barrier

The upper edge of the CFS is 80 or 110 cm (in the event of tall barriers) above the edge of the roadway, extra width or the hard shoulder for emergency stop (Figures 8 and 9).

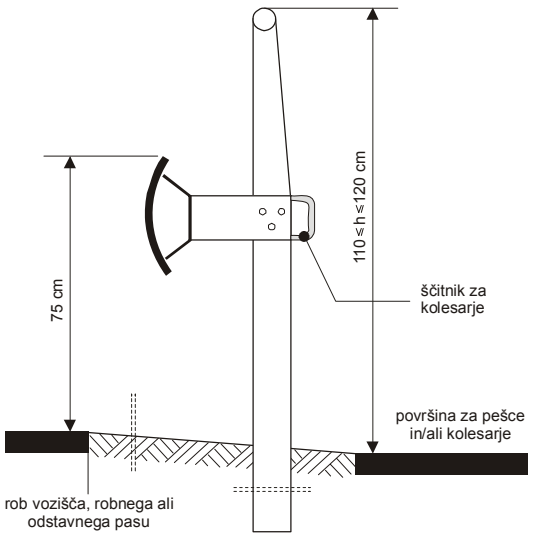
2.3.5.1.3 Pedestrian and bicycle barrier

The barrier intended to protect pedestrians between the roadway and the pedestrian surface is constructed as an upgrade of SSB (Figure 15), WSB or CSB.

The barrier designated for protecting cyclists has a beam for cyclists next to the upgraded barrier at the level of that barrier's beam.

On mixed surfaces the same protection is used as in the case of cyclists.

The barrier height is 110 cm $\leq$ h $\leq$ 120 cm (measured from the edge of the pedestrian and/or cyclist surface to the top of the rail).

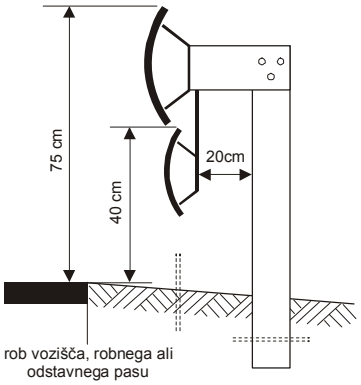


rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
ščitnik za kolesarje	beam for cyclists
površina za pešce in/ali kolesarje	pedestrian and/or cyclist surface

Figure 15: The barrier upgraded above the single-sided SSB and the cyclist beam are intended for the protection of pedestrians and cyclists.

2.3.5.1.4 Barrier with additional protection for motorcyclists

Barrier with additional protection for motorcyclists is intended to protect motorcyclists on public roads (Figure 16).



rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 16: Barrier with additional protection for motorcyclists

2.3.5.2 Length

The length of a SB at full height (75 cm, 80 cm or 110 cm), including the length before and after the dangerous section, is at least 100 m on motorway and expressway - except on branches of points of access - and at least 60 m on other public roads.

The positioning of SB at full height before and after the dangerous section which has to be protected depending on road category and AADT is presented in Tables 1 and 2.

Road category	before	after
	dangerous section	
- motorway	**60 m**	**20 m**
- expressway	**48 m**	**16 m**

Table 1: The length of SB at full height before and after the dangerous section on motorway and expressway

other public roads with AADT	before	after
	dangerous section	
- more than 7000	**48 m**	**24 m**
- from 3000 to 7000	**32 m**	**16 m**
- less than 3000	**16 m**	**12 m**

Table 2: The length of SB at full height before and after the dangerous section on other public roads depending on AADT

2.3.5.2.1 End treatment

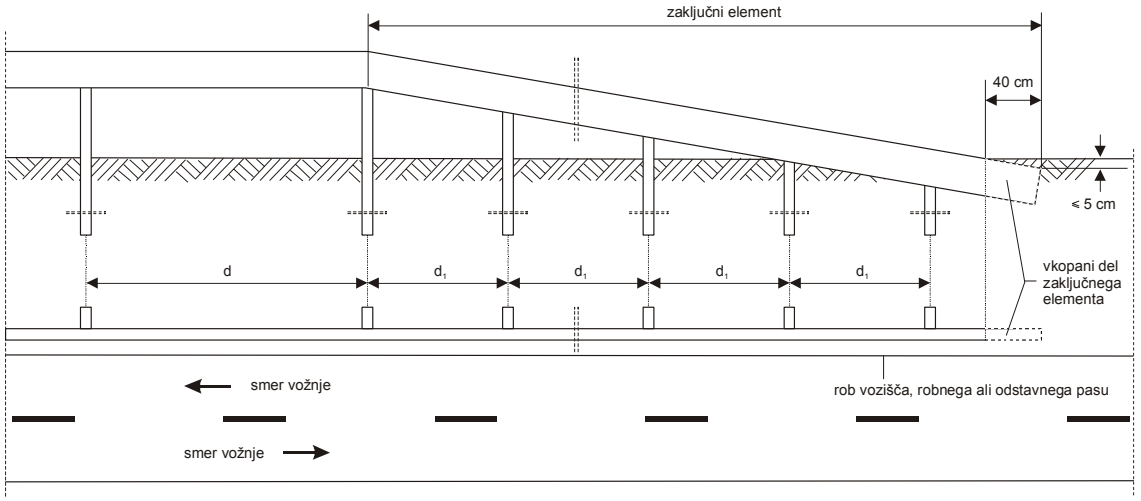
The length of the SB end treatment on motorway and expressway, except on entry points of access, and on public roads with AADT ≥ 3000 vehicles is 12 m, on the front and back side (Figure 17).

On other public roads with AADT < 3000 the length of the end treatment on the front and back side is 4 m (Figure 17).

The posts of the SB end treatment have to be installed so far apart that the same vehicle containment level is achieved

as that of a SB installed at full height. The distance between the posts has to be in accordance with the requirement referred to in Item 5.1.1.1.

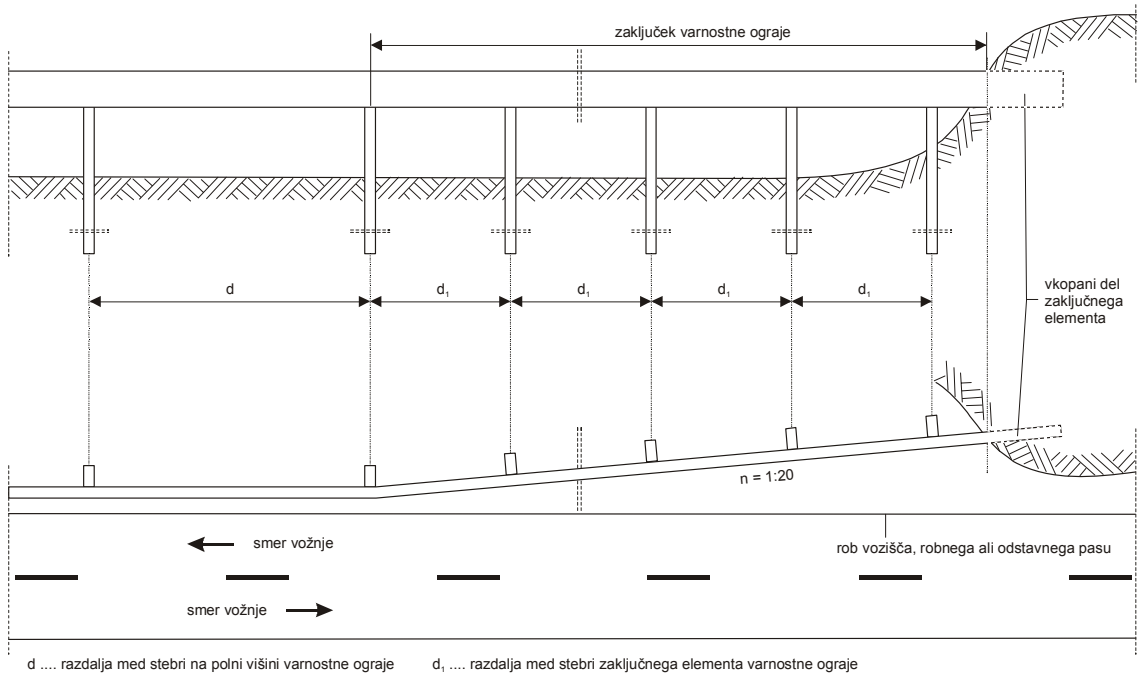
SSB, WSB and CSB terminal in the area where a cut passes into embankment or bridging structure can be installed also by directional shift with 1:20 inclination and dug in the slope (Figure 18).



d .... razdalja med stebri na polni višini varnostne ograje
d_1 .... razdalja med stebri zaključnega elementa varnostne ograje

zaključni element	end treatment
vkopani del zaključnega elementa	dug-in part of the end treatment
smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
razdalja med stebri na polni višini varnostne ograje	distance between posts at full height of safety barrier
razdalja med stebri zaključnega elementa varnostne ograje	distance between posts of the barrier's end treatment

Figure 17: Dug-in end treatment of a SSB at front and back side.



d .... razdalja med stebri na polni višini varnostne ograje d_1 .... razdalja med stebri zaključnega elementa varnostne ograje

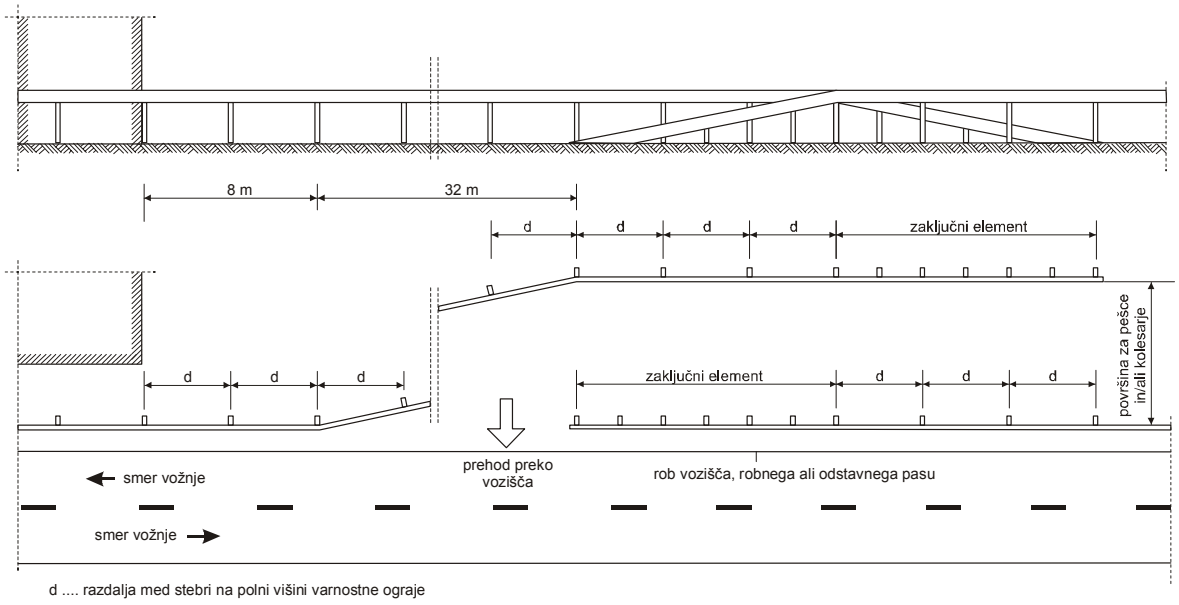
zaključek varnostne ograje	safety barrier terminal
vkopani del zaključnega elementa	dug-in part of the end treatment
smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
razdalja med stebri na polni višini varnostne ograje	distance between posts at full height of safety barrier
razdalja med stebri zaključnega elementa varnostne ograje	distance between posts of the barrier's end treatment

Figure 18: SSB and WSB terminal in the area where a cut passes into embankment or bridging structure

2.3.5.2.2 Discontinuance

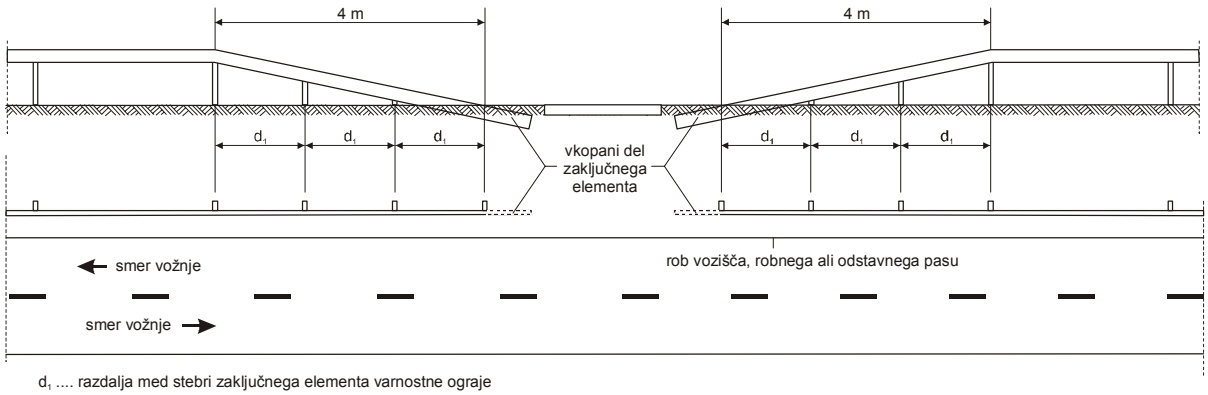
SB discontinuance at the pedestrian and/or bicycle crossing across the roadway or due to the cancellation of pedestrian and/or bicycle surface next to the roadway is provided by a switch as shown in Figure 19.

If it is not possible to discontinue the SB by a switch presented in Figure 19 on account of terrain conditions and if PLDP $\geq$ 3000, the discontinuance may be provided by a dug-in end treatment 4 m long as shown in Figure 20.



zaključni element	end treatment
površina za pešce in kolesarje	pedestrian and bicycle surface
smer vožnje	direction of the drive
prehod preko vozišča	crossing across the roadway
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
razdalja med stebri na polni višini varnostne ograje	distance between posts at full height of safety barrier

Figure 19: Discontinuance of SSB and WSB at the pedestrian and/or bicycle crossing across the roadway or due to the cancellation of pedestrian and/or bicycle surface next to the roadway

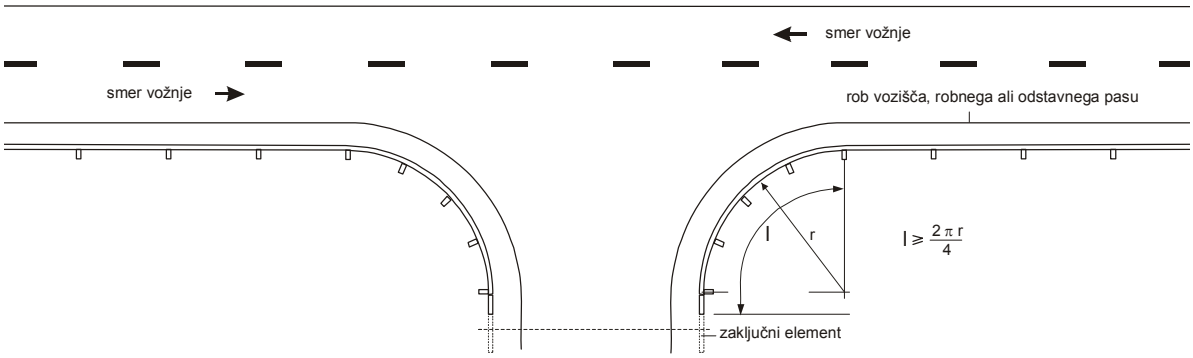


vkopani del zaključnega elementa	dug-in part of the end treatment
smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
razdalja med stebri zaključnega elementa varnostne ograje	distance between posts of the barrier's end treatment

Figure 20: Discontinuance of SSB and WSB with 4 m long end treatments

Installation of posts of the SB end treatment more closely together in the event of SB discontinuance (Figures 19 and 20) is subject to the same provisions as stated under Item 5.2.1.

Discontinuance of SSB, WSB and CSB due to a point of access has to be provided by rounding the barrier at full height at least over 16 m in length in the direction of the point of access (Figure 21).



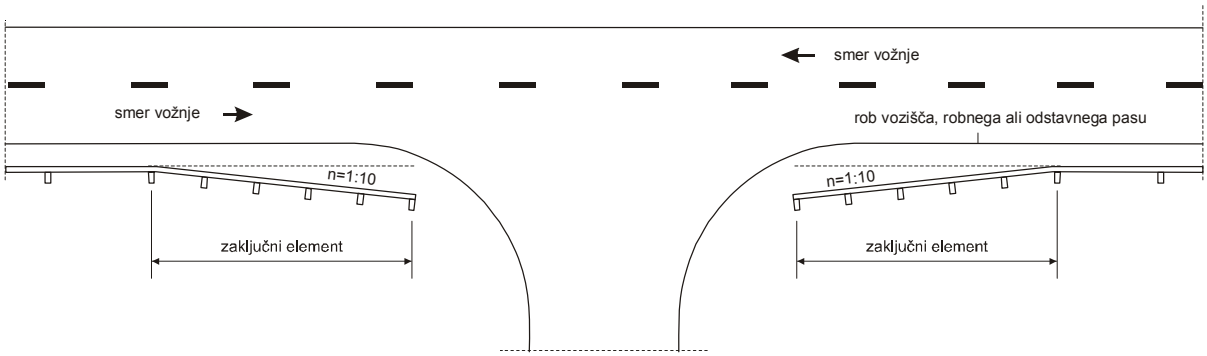
smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
zaključni element	end treatment

Figure 21: Discontinuance of SSB and WSB at a point of access

In special cases, when the SB rounding referred to in the previous paragraph cannot be provided, the barrier may be shifted with dug-in end treatment of suitable length as shown in Figure 22.

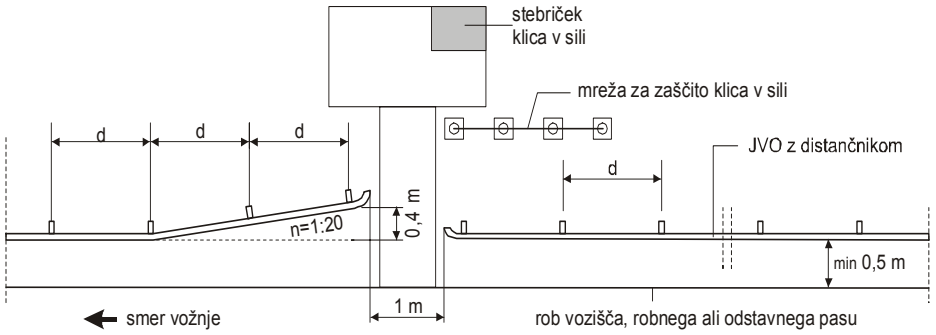
The SB in the area of the post equipped for emergency call is installed as shown in Figure 23.

The SB is not discontinued in the area of the emergency exit at the noise reduction barrier.



smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
zaključni element	end treatment

Figure 22: Discontinuance of steel or wooden safety barrier with dug-in end treatment



d .... razdalja med stebri na polni višini varnostne ograje

stebriček klica v sili	post equipped for emergency call
mreža za zaščito klica v sili	network for emergency call protection
JVO z distančnikom	SSB with spacer
smer vožnje	direction of the drive
rob vozišča, robnega ali odstavnega pasu	edge of the roadway, extra width or the hard shoulder for emergency stop
razdalja med stebri na polni višini varnostne ograje	distance between posts at full height of safety barrier

Figure 23: SSB and WSB in the area of the post equipped for emergency call

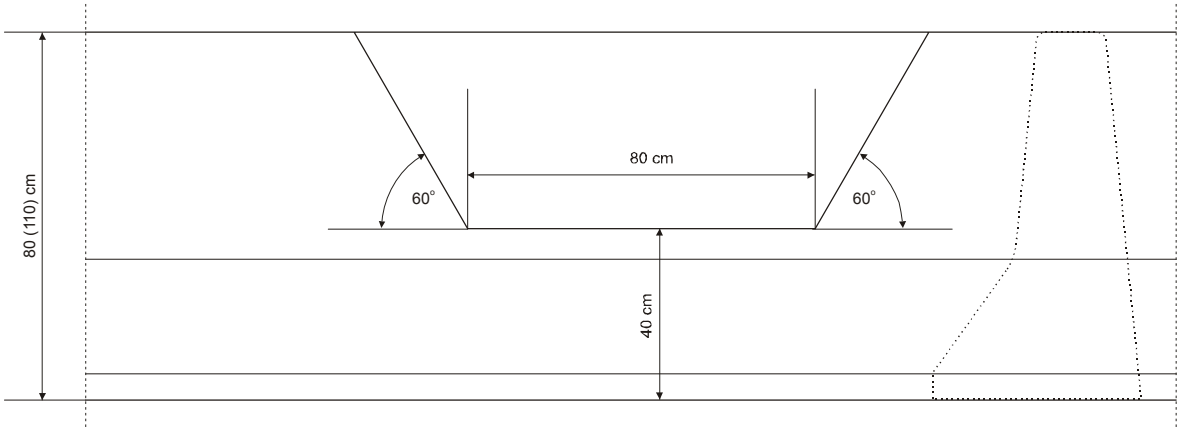


Figure 24: CSB in the area of the post equipped for emergency call

2.3.5.2.3 Connection between two barriers

Two SB are connected if the distance between sections where a barrier at full height is planned to be installed is less than 50 m.

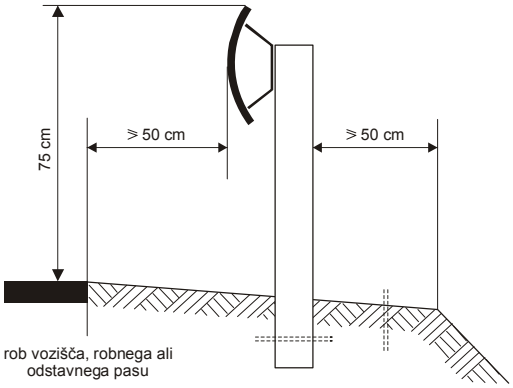
2.3.5.3 5.3 Distance

2.3.5.3.1 From verge

The distance of the SB beam from the edge of the roadway, the edge of the extra width or the hard shoulder for emergency stop has to be at least 50 cm (Figure 25).

Steel and wooden safety barrier

- The distance of the outer side of the driven SSB and WSB post from the edge of the slope must as a rule be at least 50 cm (Figure 25).



rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 25: The distance of SSB and WSB elements from the edge of the roadway, extra width or the hard shoulder for emergency stop and the embankment in the event of barrier installation on verge

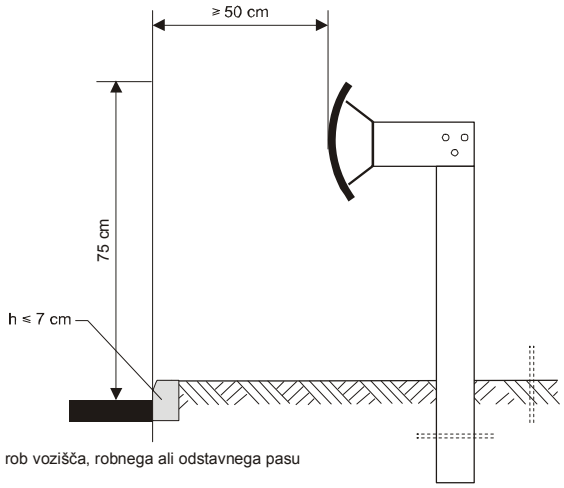
2.3.5.3.2 From kerb

In the case of a kerb ≤ 7 cm high the SB beam can be at any distance from the kerb line in accordance with the conditions for installing SF, but no less than 50 cm (Figures 8, 9, 26, 28).

When a SB is installed next to a kerb > 7 cm high, the SB beam has to be in line above

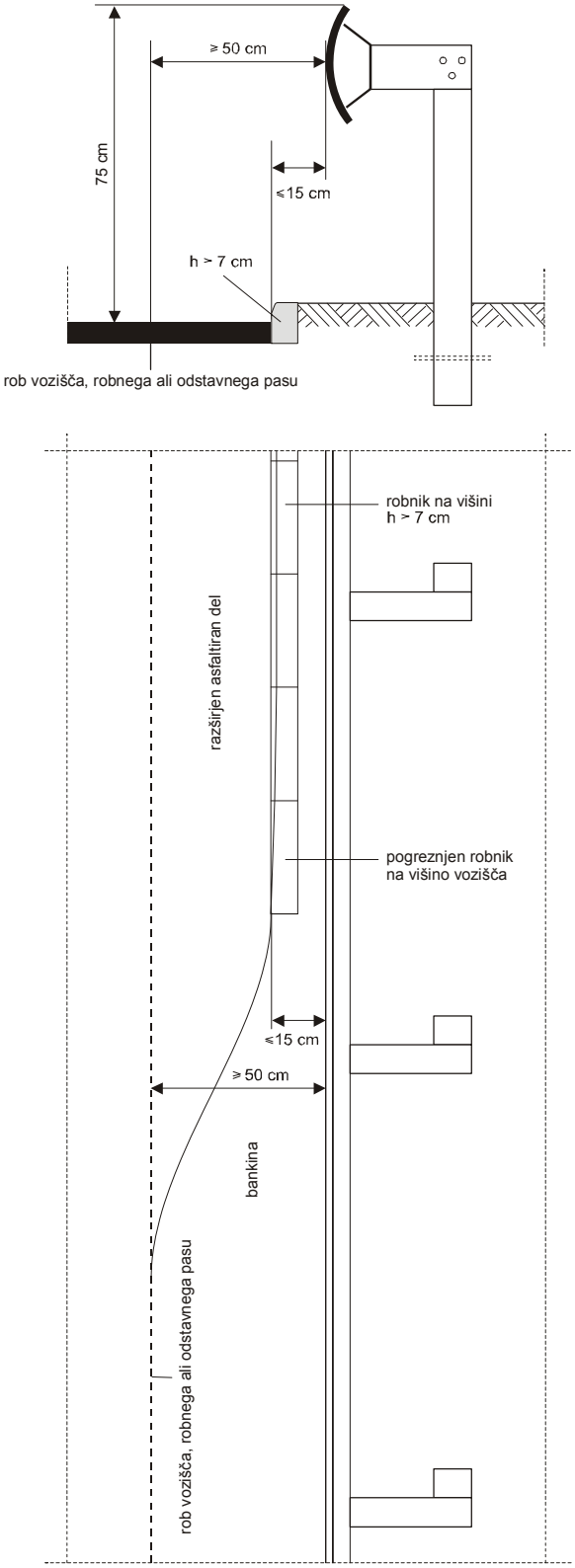
the kerb (for SSB and WSB) and ≤ 15 cm away from the kerb edge (Figure 27).

The SB beam has to be ≥ 50 cm away from the (notional) line of the edge of the roadway, extra width or the hard shoulder for emergency stop.



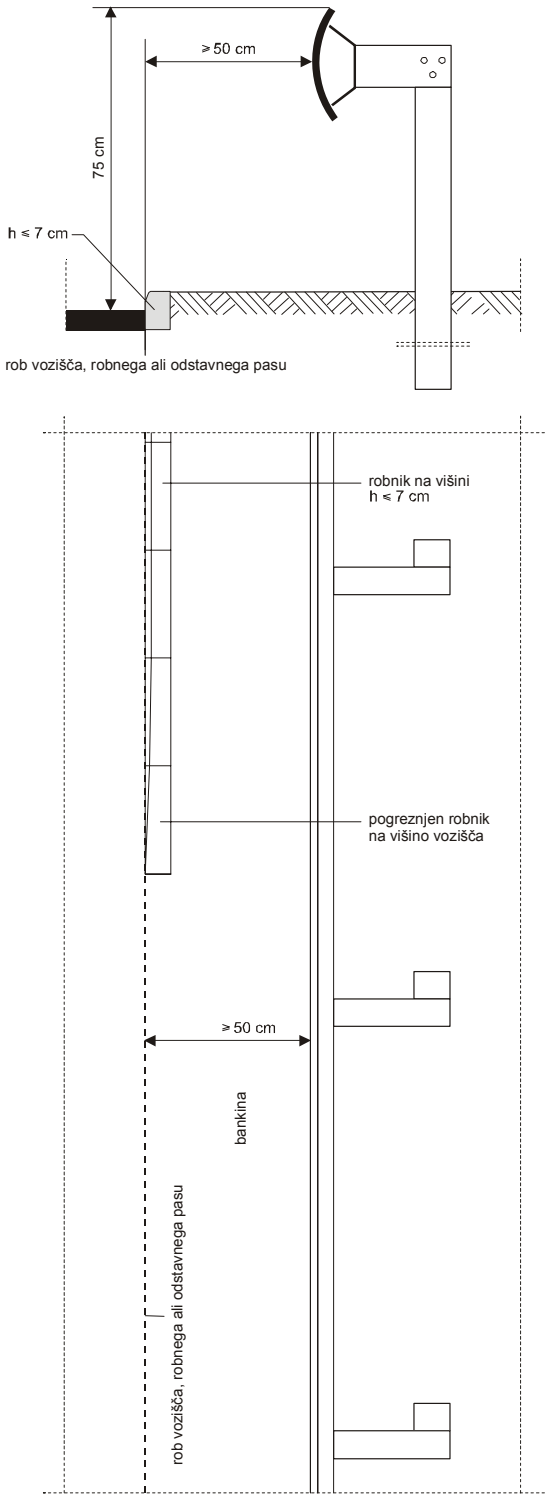
rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop

Figure 26: Installation of SSB and WSB at kerb ≤ 7 cm in height.



rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop
robnik na višini	kerb at height
razširjen asfaltiran del	expanded asphalt coated part
pogreznjen robnik na višino vozišča	sunken kerb at roadway level
bankina	verge

Figure 27: Installation of SSB and WSB next to the roadway with a transition into the area of "high" kerb (> 7 cm)



rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop
robnik na višini	kerb at height
razširjen asfaltiran del	expanded asphalt coated part
pogreznjen robnik na višino vozišča	sunken kerb at roadway level
bankina	verge

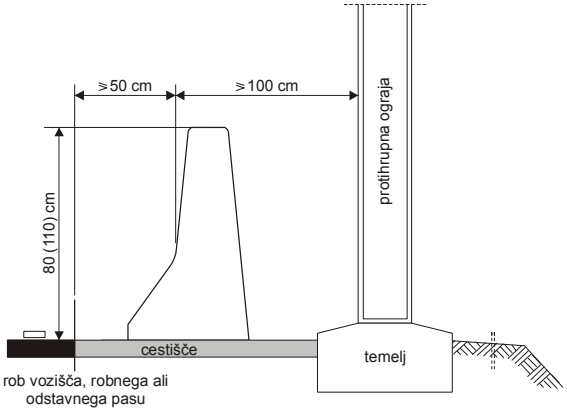
Figure 28: Installation of SSB and WSB next to the roadway (with extra width or hard shoulder for emergency stop) with a transition into the area of "low" kerb (≤ 7 cm)

2.3.5.4 Position

2.3.5.4.1 Next to the roadway

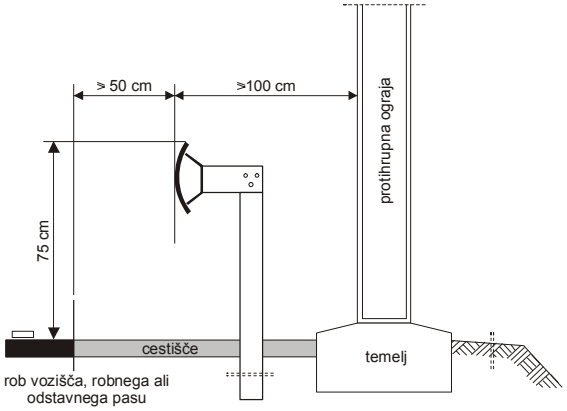
2.3.5.4.1.1 With obstacle

Before an obstacle represented by a noise reduction barrier (NRF) a SB is installed so that the distance between the front of the barrier and the obstacle is at least 100 cm (Figures 29 and 30).



rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop
cestišče	roadway
protihrupna ograja	noise reduction barrier
temelj	base

Figure 29: Installation of a single-sided CSB for protection against obstacle represented by a NRF.

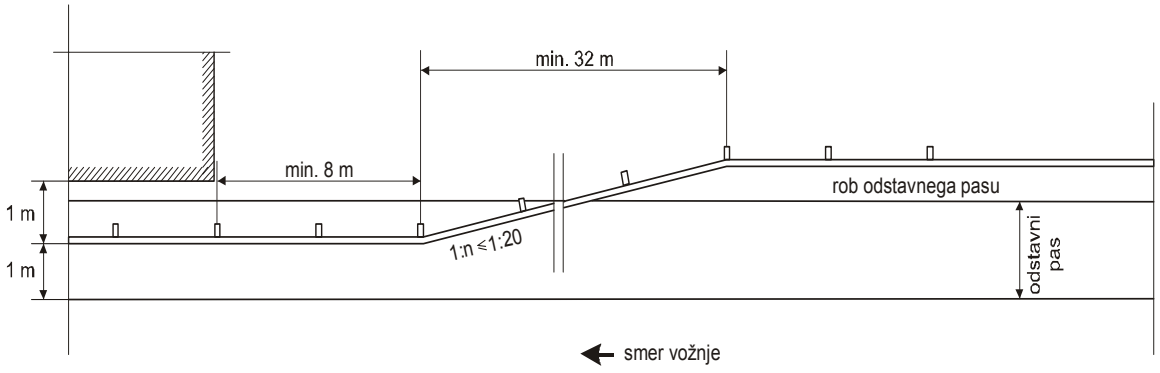


rob vozišča, robnega ali odstavnega pasu	the edge of the roadway, extra width or the hard shoulder for emergency stop
cestišče	roadway
protihrupna ograja	noise reduction barrier
temelj	base

Figure 30: Installation of a single-sided SSB for protection against obstacle represented by a NRF.

A NRF can be exceptionally installed on CSB next to the existing public road and on bridging structure. Its deviation from the vertical line is ≥ 10 °, measured from the roadway outward.

Installation of SSB, WSB and CSB in the event of a nearby obstacle on roadway with hard shoulder for emergency stop is as a rule provided by shift with an inclination of 1 : n ≤ 1 : 20 (Figure 31).



rob odstavnega pasu	edge of the hard shoulder for emergency stop
odstavni pas	hard shoulder for emergency stop
smer vožnje	direction of the drive

Figure 31: The shift of SSB and WSB due to an obstacle next to the roadway with hard shoulder for emergency stop

2.3.5.4.2 On central reservation

Steel safety barrier:

- s a rule, on central reservation ≥ 2.8 m a single-sided SSB with a spacer is installed.
- A double-sided SSB with a spacer may be installed in the event presented in Figure 32.
- -When installing the barrier the "working width" of the barrier (W) has to be considered.

Wooden safety barrier:

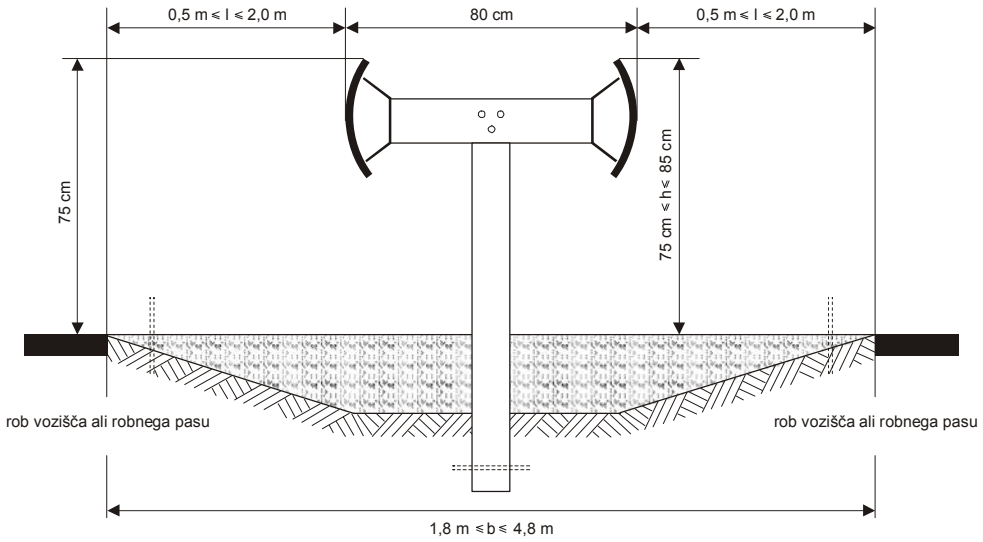
- WSB is not installed on central reservation.

Concrete safety barrier:

- -CSB may be installed on central reservation < 2.8 m in width. When two single-sided barriers are installed, the space between them has to be filled with a suitable material. A stabilised area has to be planned between the edge of the roadway, extra width or the hard shoulder for emergency stop and the CSF (Figure 33).

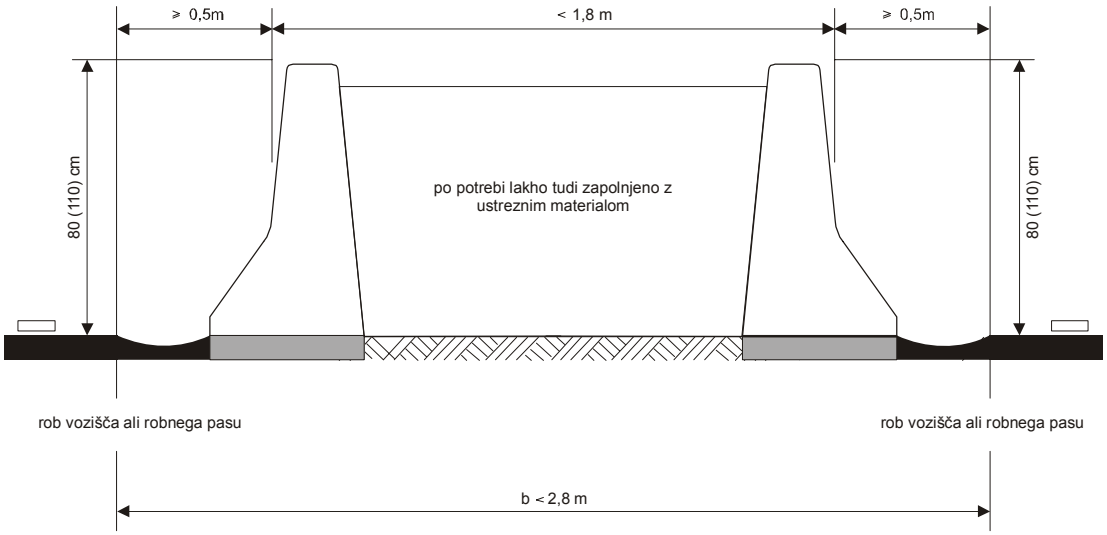
2.3.5.4.2.1 Without obstacle

The method of installing different types of SSB on central reservation without obstacle is shown in Figures 31 and 34 to 38.



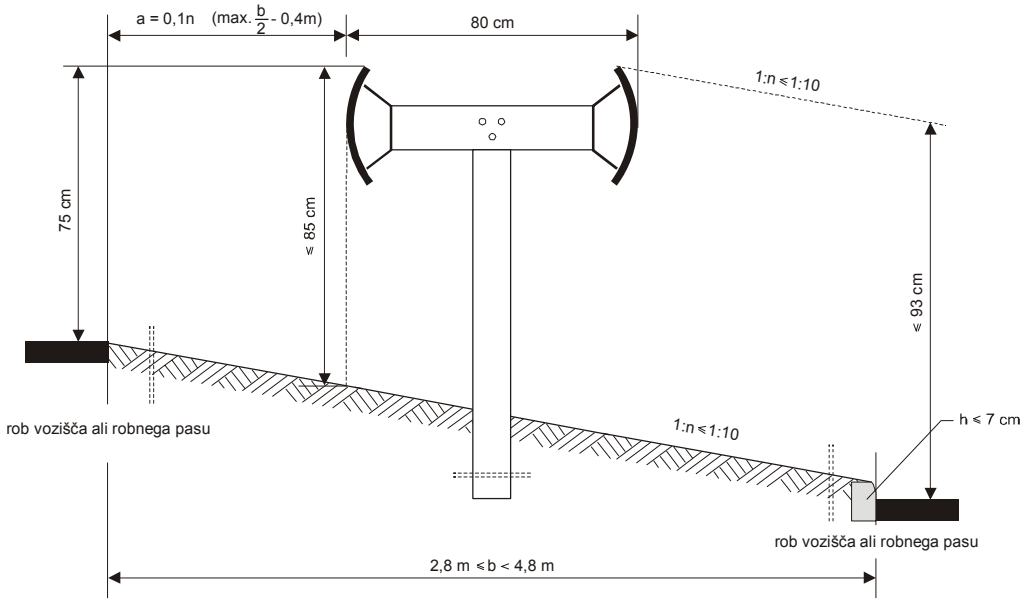
rob vozišča ali robnega pasu	edge of the roadway or extra width

Figure 32: If the height of a double-sided SSB with a spacer on central reservation is > 85 cm (measured from the top of the barrier beam to the terrain under the vertical line of the beam front), while the beam is 50 cm ≤ l ≤ 200 cm away from the outer edge of the roadway, extra width or hard shoulder for emergency stop, the central reservation has to be raised by stone material to the height of 75 cm ≤ h ≤ 85 cm.



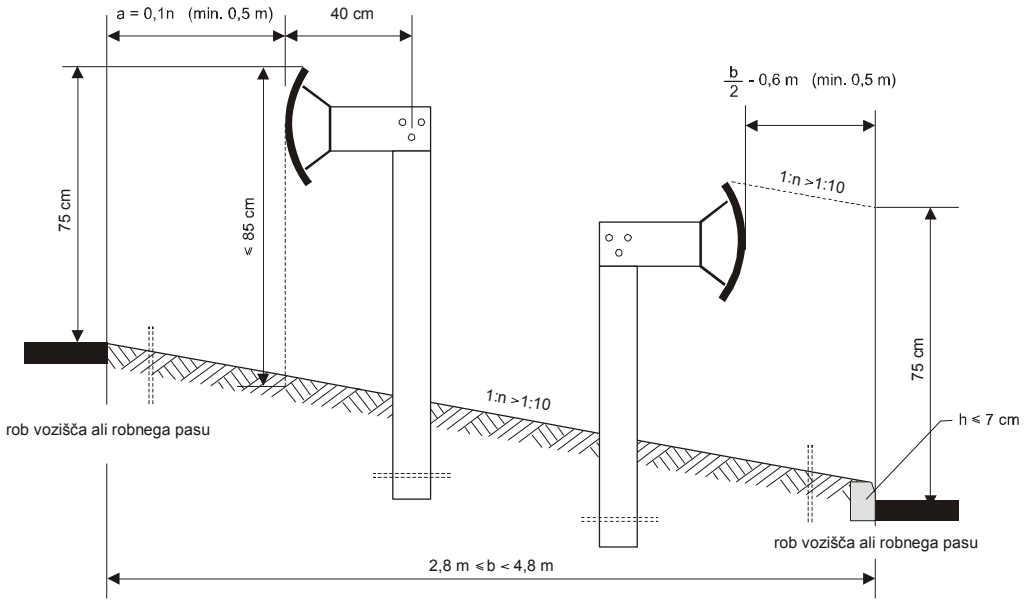
po potrebi lahko tudi zapolnjeno z ustreznim materialom	if necessary, filled in by suitable material
rob vozišča ali robnega pasu	the edge of the roadway or extra width

Figure 33: Two single-sided CSB on the central reservation which is < 2.8 m wide, with the space between them filled by suitable material, if necessary.



rob vozišča ali robnega pasu	the edge of the roadway or extra width

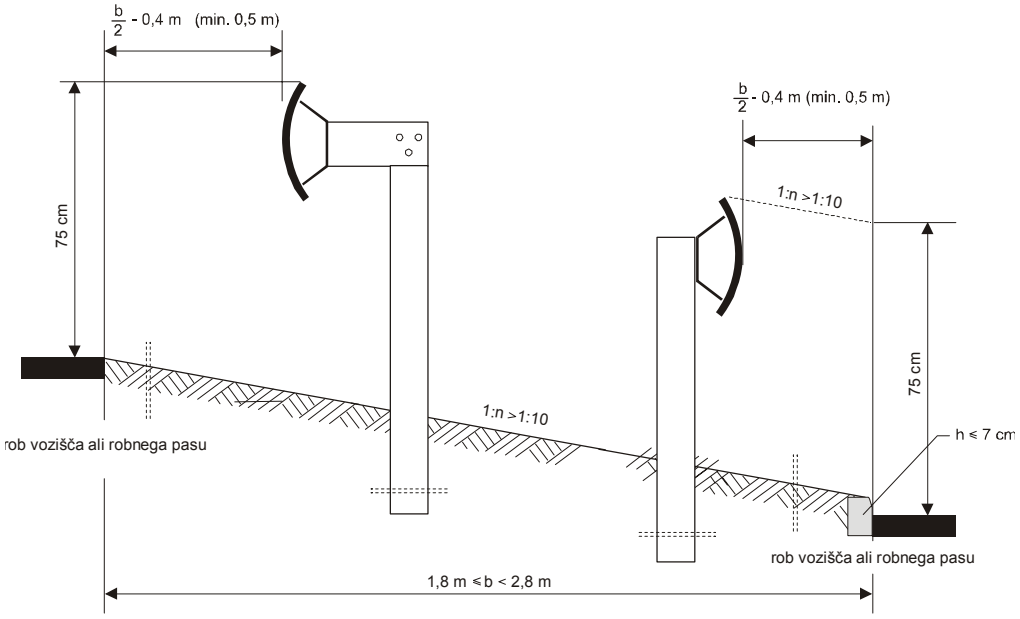
Figure 34: Double-sided SSB with a spacer on the central reservation with width of 2.80 m ≤ b < 4.80 m and a cross fall of 1 : n ≤ 1 : 10. In the calculation formula a = 0.1 n (max (b / 2) – 0.4 m) the value b is considered in metres.



rob vozišča ali robnega pasu	the edge of the roadway or extra width

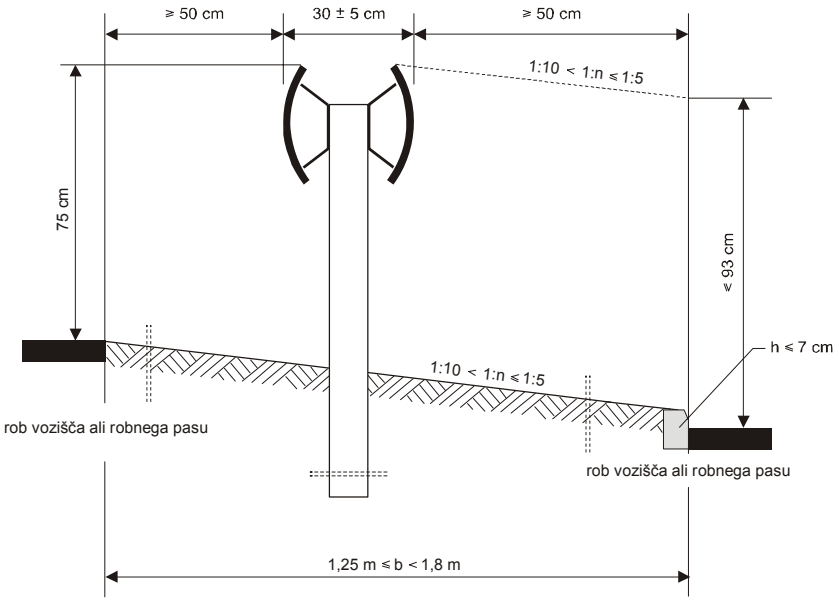
Figure 35: A combination of two single-sided SSB with a spacer on the central reservation with width of: 2.80 m ≤ b < 4.80 m and a cross fall of 1 : n > 1 : 10

Note: Parameter »n« in Figures 34 and 35 in value »a« (distance between the beam and the edge of the roadway) represents the same value as »n«, which is described under figures (without measuring units).



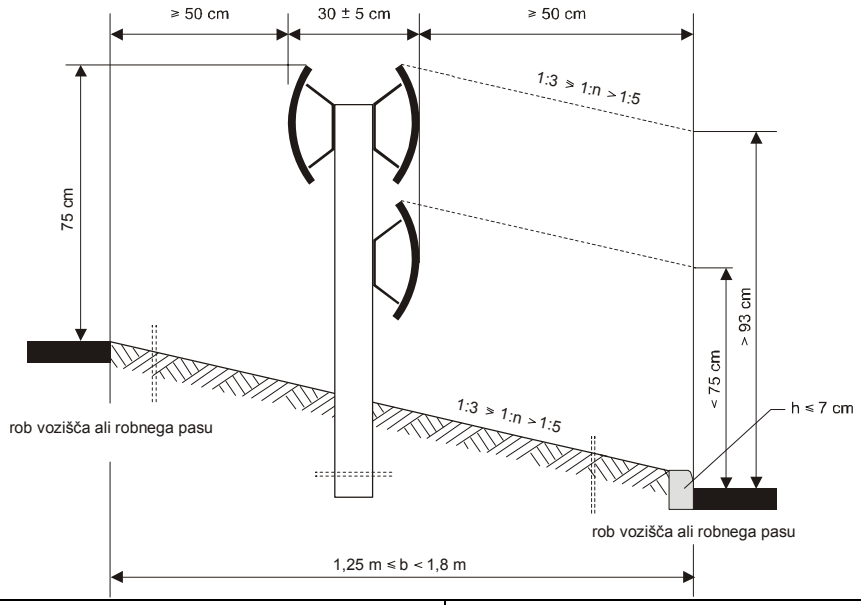
rob vozišča ali robnega pasu	the edge of the roadway or extra width

Figure 36: Combination of single-sided SSB with a spacer and single-sided SSB without a spacer on central reservation with width of 1.80 m ≤ b < 2.80 m and a cross fall of 1 : n > 1 : 10



rob vozišča ali robnega pasu	the edge of the roadway or extra width

Figure 37: Double-sided SSB without a spacer on the central reservation with width of 1.25 m ≤ b < 1.80 m and a cross fall of 1 : 10 < 1 : n ≤ 1 : 5.



rob vozišča ali robnega pasu	the edge of the roadway or extra width

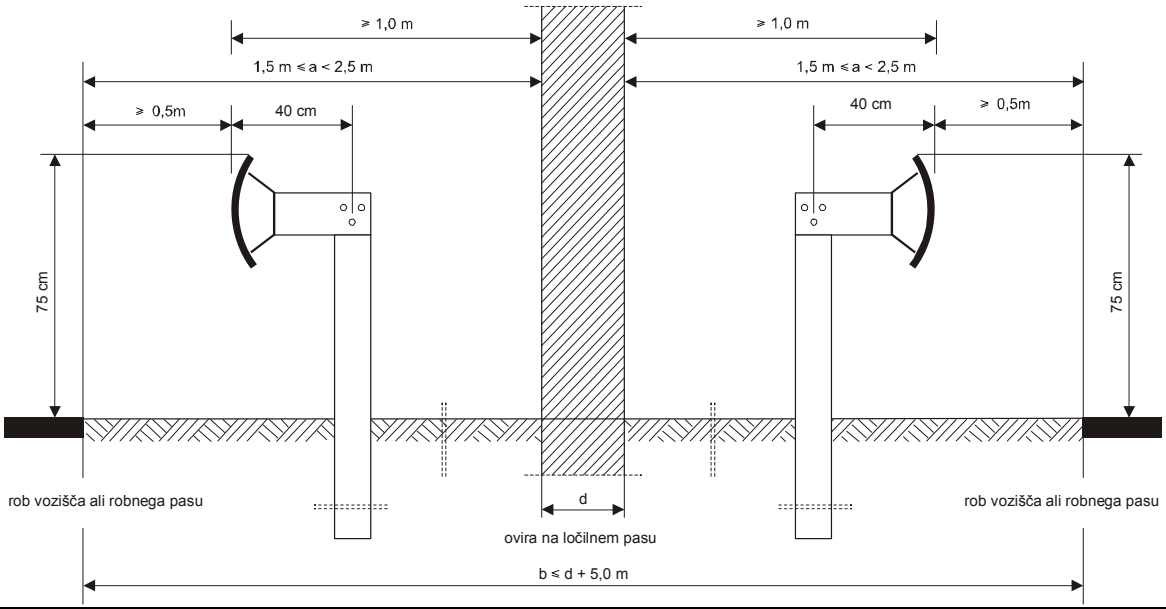
Figure 38: A combination of a double-sided SSB without a spacer and with an additional beam on the side of the lower road on the central reservation with width of 1.25 m ≤ b < 1.80 m and a cross fall of 1 : 3 ≥ 1 : n > 1 : 5

2.3.5.4.2.2 With obstacle

The method of installing single-sided SSB with a spacer on the central reservation with an obstacle is presented in Figures 39 and 40.

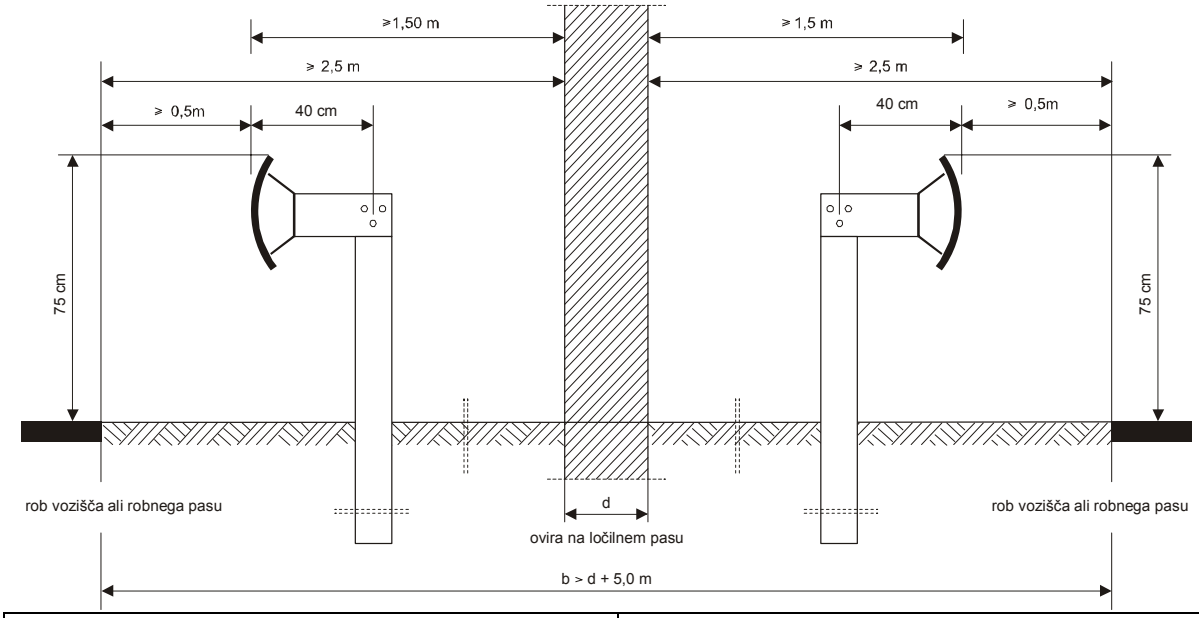
Single-sided SSB with a spacer on the central reservation is installed on both sides of the obstacle.

Transition from the double-sided to a single-sided SSB with a spacer in the obstacle area on the central reservation is provided as shown in Figure 41.



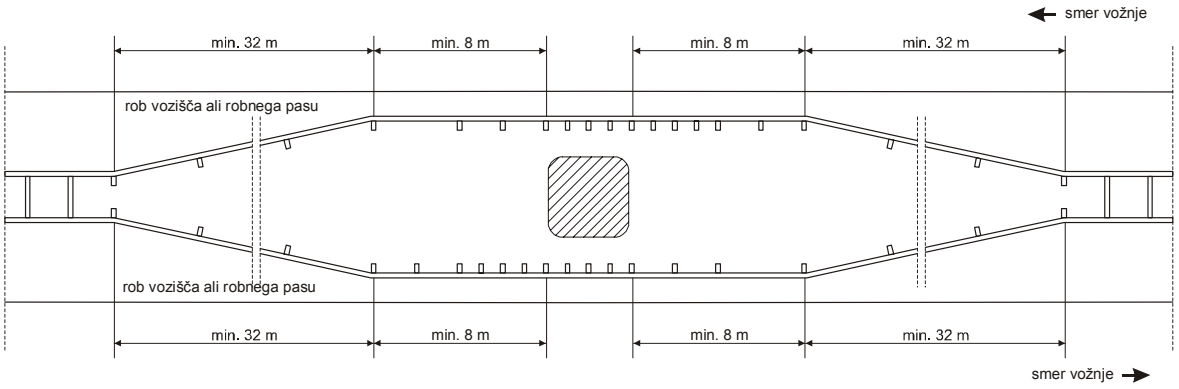
rob vozišča ali robnega pasu	the edge of the roadway or extra width
ovira na ločilnem pasu	obstacle on central reservation

Figure 39: Single-sided SSB with a spacer on the central reservation with an obstacle, with the obstacle 1.50 m ≤ a < 2.50 m away from the edge of the roadway, extra width or hard shoulder for emergency stop



rob vozišča ali robnega pasu	the edge of the roadway or extra width
ovira na ločilnem pasu	obstacle on central reservation

Figure 40: Single-sided SSB with a spacer on the central reservation with an obstacle, with the obstacle a ≥ 2.50 m away from the edge of the roadway, extra width or hard shoulder for emergency stop



rob vozišča ali robnega pasu	**the edge of the roadway or extra width**
smer vožnje	**direction of the drive**

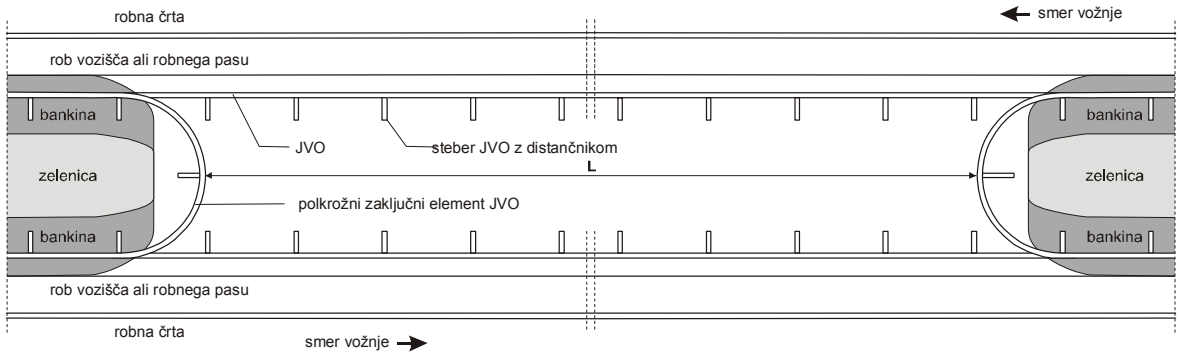
Figure 41: Transition of a double-sided SSB to a single-sided SSB with a spacer in the area of the obstacle on central reservation

2.3.5.4.2.3 On the crossing over the central reservation

On the crossing over the central reservation a single-sided SSB with a spacer is usually installed, so that it follows the line of the barrier positioned on both sides of the discontinued central reservation to which a semicircular end treatment is attached at the beginning and the end, which connects the single-sided barriers with the spacer (Figure 42).

The length of the removable section (L) for two-way traffic on the double-carriageway road is 90 m, when one lane passes into the opposite carriageway, and 135 m, when two lanes pass into the opposite carriageway.

On the crossing across the discontinued central reservation the SB posts are attached as prescribed in Item 5.1.1.1.



robna črta	edge of the roadway marking
smer vožnje	direction of the drive
rob vozišča ali robnega pasu	edge of the roadway or extra width
bankina	verge
zelenica	green area
JVO	SSB
JVO z distančnikom	SSB with a spacer
polkrožni zaključni element JVO	semicircular end treatment of SSB

Figure 42: Single-sided SSB with a spacer at the crossing across a central reservation

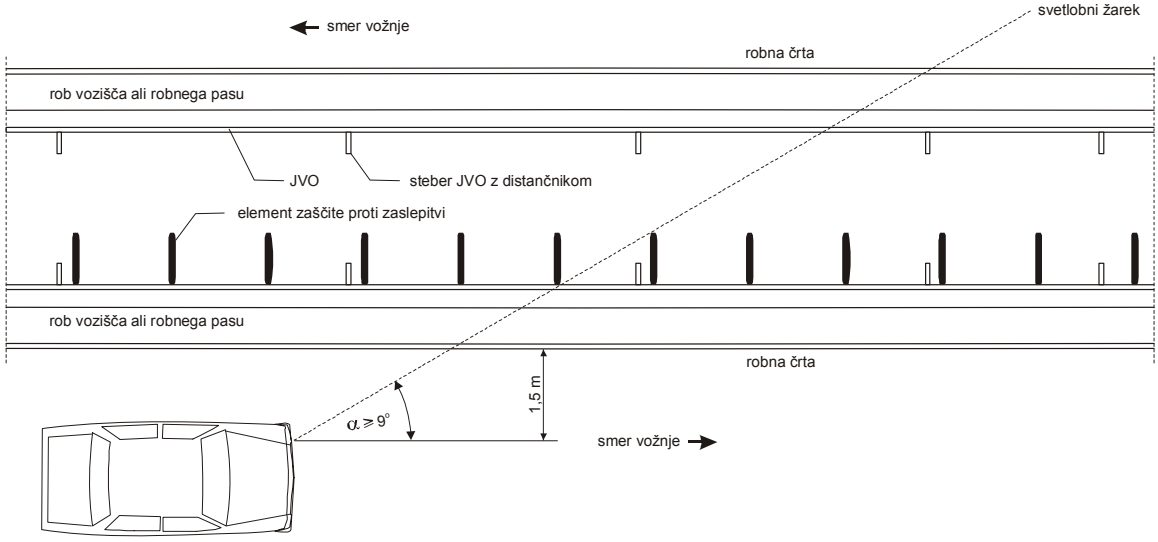
2.3.5.4.2.4 Glare protection

Glare protection is installed on SB which is positioned on the motorway or expressway central reservation.

The protection is planned at locations where the drivers of vehicles coming from the opposite direction can be blinded.

The width of the central reservation for which glare protection is obligatory is < 2.8 m. Protection is provided so that the glare protection angle equals $\alpha \geq 9\,°$ (Figure 43).

On the central reservation which is ≥ 2.8 m wide, glare protection can be provided by planting.



smer vožnje	direction of the drive
robna črta	edge of the roadway marking
rob vozišča ali robnega pasu	edge of the roadway or extra width

JVO	SSB
JVO z distančnikom	SSB with a spacer
element zaščite proti zaslepitvi	glare protection element

Figure 43: Glare protection installed at SB on the central reservation

2.3.6 REQUIRED VEHICLE CONTAINMENT LEVEL BY A SAFETY BARRIER

Basic vehicle containment level by a safety barrier is determined according to the road category (Table 3).

Vehicle containment level by a safety barrier is increased in specific roadside area, at dangerous road section (Table 4) and in the area of bridging and other structures as well as dangerous road sections in front of them (Table 5).

In Tables 4 and 5 the maximum vehicle containment level is considered, in the event of dense traffic and a higher share of truck traffic.

The permissible "working width" of a safety barrier transversally in the case of a car colliding with the barrier is set in the road project.

The transition of the safety barrier from lower to upper vehicle containment level is in the area of a road where the vehicle containment level has to be increased provided by a "transitional" barrier of 24 m in length.

The vehicle containment level of the "transitional" barrier must not be more than two levels greater than the vehicle containment level of the previous part of the barrier or more than two levels lower than the vehicle containment level of the following part of the barrier.

Road category	Vehicle containment level
- motorways - expressways - main roads - regional roads of class I - regional roads of class II - roads with physically separated carriageways outside urban areas	min. N2
- other public roads	N1 to N2
- see Table 4 for central reservation	

Table 3: Vehicle containment level by a SB on roads of various categories

	Specific roadside area and dangerous road sections	Vehicle containment level
1	Road through water protection area (zone 1), with permitted driving speed is > 90 km/h	H2 to H3
2	Motorway, expressway, main or regional road of class I or II, routed parallel to the railway track with heavy traffic	
3	Road routed along particularly dangerous facilities that contain hazardous chemicals or flammable substances	
4	Motorway, expressway, main or regional road of class I or II, in the approximate vicinity of public areas with dense pedestrian traffic	
5	The area of supporting and base constructions next to the roadway	
6	Central reservation ≤ 2.80 m in width	

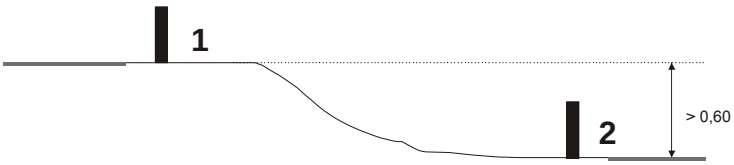
7	Central reservation	H1 to H2
8	Road with permitted driving speed of ≤ 90 km/h, parallel to railway or tramway track	
9	Between parallel roads of which at least one is classified as motorway, expressway, main or regional road of class I or II	
10	- Steep rocky slope deeper than 6 m and with an inclination exceeding 2:3 - On walls deeper than 2 m	
11	Dangerous areas, like curves with radius R < 300 m on a long downward gradient with a longitudinal cross fall of ≥ 4%, next to main or regional road of class I or II (does not apply to the area of crossroads, etc.)	
12	Road which is routed - parallel to a water course with medium water level of > 2 m - along a protected water course (regardless of the water depth) - through a water protection area (zone 2), with permitted driving speed > 90 km/h	N2 to H1
13	Road next to noise reduction barrier if not designed as a safety barrier	
14	Road along which there are sharp rocks or rocks with sharp or very cracked surface (vehicle cannot skid at obstacle)	
15	For separating traffic streaming on several levels (e.g. on central reservation or between parallel roads) 	1 H2 for motorways, expressways, major roads, roads of class 1 ad 2, H1 for other roads 2 N2

Table 4: Vehicle containment levels by a SB for the protection at dangerous road sections and roadside area

	Area of bridging and other structures and dangerous road sections before them	Vehicle containment level
1	Bridging structure in water protection area (zone 1) and bridging structure across a water course with average depth of 2 m, were permitted driving speed is > 90 km/h	H2 to H3
2	Bridging structure where permitted driving speed is > 90 km/h, parallel to railway track or crossing it	
3	Bridging structure were permitted driving speed is > 90 km/h, next to a public area with dense pedestrian traffic	
4	Bridging structure next to particularly dangerous facilities that contain hazardous chemicals or flammable substances where permitted driving speed is > 90 km/h	
5	Urban area along a road relating particularly to city viaducts where permitted driving speed is > 90 km/h	
6	Parallel roads with dense traffic (relating main urban viaducts and long supporting walls in cities over which	

	motorways, expressways, major and regional roads of class I or II are routed), which are higher than the level of structures in urban area	
7	The area of supporting and base constructions of another bridging structure next to the roadway	
8	Central reservation ≤ 2.80 m in width	
9	Central reservation	H1 to H2
10	Bridging structure parallel to railway or tramway track where permitted driving speed is ≤ 90 km/h	
11	Parallel pedestrian ways with dense pedestrian traffic and/or under bridging structure	
12	Bridging structure which - is parallel to a water course with medium water level of > 2 m - is located along a protected water course (regardless of the water depth) - passes through water protection area (zone 2) where permitted driving speed is > 90 km/h	
13	Dangerous areas of bridging and other structures, like curves with radius R < 300 m on a long downward gradient with a longitudinal cross fall of ≥ 4%, next to a motorway, expressway, main or regional road of class I or II (does not apply to the area of crossroads, etc.)	
14	Road next to noise reduction barrier if not designed as a safety barrier	
15	Crossing of two very busy roads on different levels	
16	Other dangerous areas (e.g. depth under bridge in excess of 10 m, etc.)	

Table 5: Vehicle containment levels by a SB for the protection of dangerous road sections, bridging and other structures and dangerous road sections before them.

Basic containment level at bridging structures is H1. In the case of bridging structures shorter than 5 m the vehicle containment level is the same as on the part of the road before the structure.

The markings for vehicle containment level by a safety barrier given in Tables 3 to 5 are adopted from European standards EN 1317-1 and EN 1317-2.

2.4 PROTECTIVE FENCES

Protective fences are:

- fences intended for the traffic protection on the road from game and other animals,
- fences on overpasses intended for traffic protection on the road running below the
- overpass.

Protective fences shall be made of materials resistant to corroison and ultraviolet light.

2.4.7 PLACING THE PROTECTIVE FENCES

Protective fences shall be so placed as to prevent the access of the game and other animals to the road. The total height of the fence shall amount to 1.8 m: the height of the wire mesh shall be 1.4 m, while the remaining 0.4 m consist of at least two tensioned wires spaced at 0.20 m. The gap between the mesh and the ground must not exceed 0.05 m.

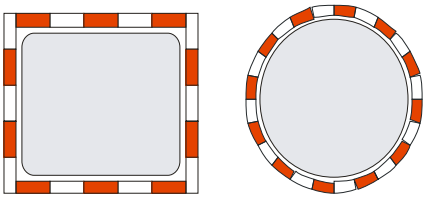
2.5 TRAFFIC MIRRORS

Traffic mirrors are intended for ensuring a minimum sight distance required at an intersection between a priority road and a secondary road.

Traffic mirrors shall be made of such materials or in such a way that formation of condensed water on the traffic mirror surface is prevented.

The outer edge of a traffic mirror shall be painted or coated with a material, which reflects the light, alternatively in red and white.

Traffic mirrors can be either of circular or rectangular shape.



2.6 ANTI-GLARE FURNITURE

The anti-glare furniture consists of anti-glare meshes and lamellas, which shall prevent drivers arriving from the opposite direction on a two-way road of being dazzled.

As a rule, the anti-glare furniture shall be placed on safety barriers located in the central reserve.

2.7 IMPACT ENERGY ABSORBERS

Impact energy absorbers are devices, which can be used to secure especially dangerous placed on the road, where a hazard of vehicle impact on a permanent obstacle such as piers, walls, islands, cabins, etc. exists. Impact energy absorbers are intended to reduce the consequences of the impact to passengers, vehicle, and permanent obstacle.

2.8 TRAFFIC CALMING DEVICES AND MEASURES

2.8.1 Subject of the guideline

The guideline for designing and implementing traffic calming devices and measures specifies the technical conditions for traffic and technical design of devices and measures for calming traffic on public roads and non-categorised roads where public transport is permitted, with the exception of prefabricated physical obstacles for calming traffic prescribed by the Rules on Traffic Signs and Equipment on Public Roads.

2.8.2 Definition of terms

The meaning of the terms used in these guidelines is as follows:

Traffic calming devices are physical, light or other devices and obstacles which are used to physically prevent road traffic participants from driving at unsuitable speed or to caution them about a speed limit at a dangerous road section.

Traffic calming measures are technical solutions on the road network and roadway as well as traffic surface design.

Change of roadway means a change of the material and/or texture or colour of the wearing course of the roadway. Change of roadway warns a driver optically and/or audibly about the speed limit.

Optical brake is a traffic calming device warning a driver that (s)he is approaching a limited speed zone. It consists of a sequence of transversal stripes painted across the carriageway. The distance between the stripes depends on the initial and final speed of the vehicle.

Audio brake is a traffic calming device warning a driver by audible signal that (s)he is approaching a limited speed zone. It is comprised of a sequence of transversal stripes painted on the carriageway. The distance between the stripes depends on the initial and final speed of the vehicle.

Rumble strip is a traffic calming device, which is perpendicular to the road axis and raised above the roadway. Rumple strips are of trapezoidal and parabolic shape.

Speed table (plateau) is a traffic calming device, which is perpendicular to the road axis, raised above the roadway level and comprised of ramps and elevated platform.

Roadway narrowing is a traffic calming measure, whereby a speed reduction is achieved by narrowing of the roadway.

Carriageway deviation is a traffic calming measure, whereby a speed reduction is achieved by shifting of the drive axis.

V_{85} – actual speed is the speed enabled by technical elements of designed or existing road prior to the implementation of traffic calming devices and measures. It represents the speed of vehicles in free traffic flow on clean and wet roadway, achieved by 85% of vehicles on the observed cross section.

V_{85} – actual speed after the implementation of measures is the speed enabled by technical elements of designed or existing road after the implementation of traffic calming devices and measures. It represents the speed of vehicles in free traffic flow on clean and wet roadway, achieved by 85% of vehicles on the observed cross section.

V_{prev} - drive-over speed is the drive speed at the location of a traffic calming device. It is defined by the geometry of the traffic calming device and is lower than V_{85}` .

$V_{ž}$ - desired speed is the speed which we wish to achieve by introducing several consecutive traffic calming devices and/or measures on the observed section. It is defined by V_{prev} of the traffic calming device and the distance between such devices.

Marking element is traffic signalisation, urban equipment or planting which increases the recognisability of the traffic calming device or measure.

2.8.3 Purpose and area of application:

The use of traffic calming devices and measures is sensibly defined by the regulations on public roads and road traffic safety.

2.8.4 Road function, traffic conditions and additional criteria for selecting traffic calming devices and measures

2.8.4.1 Road function

The road function is of utmost importance for determining traffic calming devices and measures.

Public road categorisation defines the road category based on the road connecting function and traffic-technical characteristics of the road.

The connecting function is essential also on roads outside urban areas and on transit roads in urban areas, with an emphasis on the provision of suitable traffic-technical characteristics.

The above-mentioned categorisation relates also to urban roads, where in addition to traffic function the roads have a residential function that is typical of built-up areas.

Traffic function of roads in urban areas is divided into:

- connecting (flow) function (long distance traffic through built-up areas) and
- access function (access to residence).

Residential function of roads in urban areas is divided into:

- urban design function (aesthetic value, orientation and layout of buildings, architectural heritage) (see 4.4.8),
- social function (possibility of living and working on and next to roads),
- ecology function (microclimate, greenery, fauna, flora, recreation) and
- economic function (costs of construction and maintenance, influence on real estate prices, roadside advertising, etc.).

As the residential function of a road in built-up area increases, its traffic function decreases and the other way around. The latter is provided by suitable urban planning (4.4.8) and/or traffic calming devices and measures.

Tables 1 and 2 define the road categories outside and within urban areas where certain traffic calming devices and measures can be used.

2.8.4.2 4.2 Driving speed (V85`, $V_{Ž}$)

When the driving speed is set (V_{85}`, $V_{Ž}$) the regulations governing road traffic safety and the public road categorisation criteria have to be taken into account, defining the minimum and maximum permitted driving speed:

- road outside urban area 90 (100,130) km/h,
- road in urban area from 50 to 70 km/h,
- restricted speed zone 30 to 50 km/h,
- calm traffic zone up to 5 km/h.

City bypasses are a special case, as they are directly connected to motorways and expressways.

Table 3 defines the driving speed and permissible traffic calming devices and measures.

2.8.4.3 Traffic conditions

Traffic conditions for the use of traffic calming devices and measures are defined by the peak hour load (PCE/h) and the structure of vehicles. The maximum permissible peak hour load in calm traffic zone is up to 100 PCE/h, for areas with restricted speed this figure is 100 - 400 PCE/h and for other roads in urban area 400 - 600 PCE/h. If these

values are exceeded, the proposer of traffic calming devices and measures has to provide a suitable traffic study based on which the influence of the proposed devices and measures on the relevant and neighbouring sections to which traffic is rerouted is defined. The influence of the vehicle structure is defined in chapter 4.4.3 Bus and truck traffic and chapters 4.4.5 Noise annoyance and 4.4.6 Delays of intervention vehicles

MEASURE / category	Road category											
	Motorway, expressway			M1, M2			R1, R2			R3, TR, LR, PP		
LOCATION	I	P	N	I	P	N	I	P	N	I	P	N
5.1												
5.2												
5.3.x	1	1	1	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2
5.4.x								(1), (3)	(1), (3)		1, 2, 3	1, 2, 3
5.5.x					2.1, 3	1.1, 1.4, 2.1, 3			1.1, 2.1, 2.2, 3		1.1, 1.4, 1.5	1.1, 2.1, 2.2, 3
5.6.x					3	3		3, 4	3, 4		3, 4	3, 4

Table 1: Road categories where certain traffic calming devices and measures can be used

MEASURE / category	Road category				Area with special traffic arrangement	
	MR	CR	RR	PP	Restricted speed zone	Calm traffic zone
5.1						
5.2						
5.3.x	1, 2	1, 2	2			
5.4.x		(1), (3)	1, 3	1, 2, 3	1, 2, 3	
5.5.x		1.1, 1.4, 2.1, 2.2 3	1.1, 1.4, 1.5, 2.1, 2.2, 3	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 3,	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 3	
5.6.x	3	3, 4	1, 3, 4	1, 3, 4,	1, 3, 4	2

Table 2: Categories of local roads in urban area where certain traffic calming devices and measures can be used

MEASURE / speed	Speed (V_{85}`)			
	90 km/h	50 – 70 km/h	30 – 50 km/h	Up to 5 km/h
5.1				
5.2				
5.3.x	1, 2	1, 2		
5.4.x		1	1, 2, 3	
5.5.x			1.1, 1.2, 1.3, 2.1, 2.2, 3	
5.6.x		3	1, 2, 3, 4	2

Table 3: Speed and permitted traffic calming devices and measures.

on all road categories for all driving speeds

( ).....in special cases (see descriptions for particular devices and measures)

I.....outside urban area

P.....on the transition to urban area

N.....in urban area

2.8.4.4 Additional criteria

Additional criteria for the selection of traffic calming devices and measures are related to road dimensions and the arrangement along the road, the position of the road in environment and specific requirements which a road network, road or part of a road has to comply with and the consequences caused by traffic calming devices and measures. These include:

- roadway width with extra width and road-side arrangement,
- position of the road in environment,
- vehicle structure (bus and truck traffic),
- harmful emissions,
- noise annoyance,
- delays of intervention vehicles,
- road maintenance (winter service),
- urban conditions.

2.8.4.4.1 Traffic surface width

When the traffic calming devices and measures are selected, the information about the total traffic surface width available is important.

The width of the traffic surface includes the roadway, extra width, hard shoulders, central reservation and special lanes (parking lane, cyclist lane, pedestrian lane). The roadside arrangement includes green area, cyclist ways and pavements.

2.8.4.4.2 Bus and truck traffic

Traffic calming devices and measures must not be used on roads over which a public passenger transport line is routed, since due to their characteristics they significantly reduce the comfort of the drive.

If the traffic calming devices and measures have to be used also on roads over which a public passenger transport line is routed, they have to be planned in the approximate vicinity of bus stops or at locations where buses drive more slowly. The selection of the type of traffic calming device or measure is also important if milder measures (5.5, 5.6) are recommended or a device needs to be adjusted to bus traffic (relevant vehicles).

Similar applies in the event of a higher truck traffic share (e.g. access road to stores, warehouses, etc.), for which milder traffic calming devices and measures have to be selected. They have to be designed so as to enable a relevant vehicle pass.

2.8.4.4.3 Harmful emissions

The main pollutants emitted by motor vehicles are NO_x (nitrogen oxides), C_xH_y (carbon hydrogen), CO (carbon monoxide) and CO_2 (carbon dioxide). The emission of pollutants depends on the speed and method of driving (braking, acceleration) and the condition of the engine (cold, hot). In most cases harmful emissions increase at lower speed which is conditioned by traffic calming devices and measures that enable driver-over speed of up to 30 km/h. In the event of milder devices and measures that enable drive-over speed from 30 to 50 km/h or more, lower harmful emissions can be established.

Change of emissions in the case of different pollutants and various speed values is shown in Table 4.

Speed	NO_x	C_xH_y	CO	CO_{2+}
< 30	- -	+	++	+
30	-	-/+	+/-	+/-
50	-	-/+	-/+	-

Table 4: Change of harmful emissions in relation to speed

Key:
- decrease in emissions
+ increase in emissions
- - considerable decrease in emissions
++ considerable increase in emissions
-/+ decrease greater than increase
+/- increase greater than decrease

2.8.4.4.4 Noise annoyance

In traffic calming the problem of noise increase occurs, which is mainly the consequence of braking and acceleration between traffic calming devices and measures and in is special cases also caused by the change of roadway surface. As in the event of pollutants more severe traffic calming measures increase noise. Noise increase depends on the type of motor vehicles and equals up to 7 dB(A) for passenger vehicles and up to 17 dB(A) for trucks.

In the case of milder devices and measures the noise reduces by up to 7dB(A) due to lower speed.

The installation of traffic calming devices and measures in most cases results in the rerouting of traffic flows to parallel roads. The decrease in traffic load has a positive impact on noise. Noise reduction on account of lower traffic load is presented in Table 5.

Lower traffic load (%)	Noise reduction dB(A)
- 20%	1dB(A)
- 40%	2dB(A)
- 50%	3dB(A)

Table 5: Change in noise in relation to traffic load decrease

Generally, it can be concluded that the influence of traffic calming on noise is in the case of more severe devices and measures (in spite of lower traffic load due to the rerouting of traffic flows) unfavourable, while it is favourable in the event of milder devices and measures.

2.8.4.4.5 Delays of intervention vehicles

On main access roads leading to the facilities of public intervention services (fire department, rescue service, police, etc.) it is not recommended to use traffic calming devices and measures which make the drivers reduce speed (rumble strips, speed tables, tighter deviations). The above stated devices and measures cause additional delays and uncomfortable drive for patients in the case of rescue vehicles.

Delays due to driving over road humps represent 1 to 10 sec and depend on the type of vehicle, its characteristics (weight, acceleration, etc.) as well as the geometry of the traffic calming device.

Similar applies to delays resulting from driving through a roundabout. Delays decrease as the possibility for acceleration increases.

2.8.4.4.6 Road maintenance

If necessary, traffic calming devices have to be marked in winter so that maintenance vehicles and/or traffic calming devices do not suffer any damage.

Marking of traffic calming devices is the responsibility of the road maintenance provider.

2.8.4.4.7 Urban conditions and architectural design

The basic goal of traffic calming is the arrangement of traffic conditions in urban areas and other residential areas, so that they are suitable for residing and ensure comfort of the residents. In most cases these involve already built residential areas, where the mistakes made are being corrected.

Urban planning requires interdisciplinary approach that involves experts in the field of urbanism, architecture, traffic, utility infrastructure, sociology, economy and other. A major factor in urban planning is the dialog with the public.

Urban-architectural design of road space has to provide unity of the form and function of a road, street.

2.8.4.4.8 Urban conditions

When new residential areas are built or generally reconstructed or when the existing road network is subject to systemic measures (5.1), urban solutions on the road network level can be applied to ensure (from the traffic aspect) a suitable residential environment.

Road network can be divided into two basic types:

- traditional road network and
- modern road network.

Traditional road network is characterised by:

- small built-up quadrangles,
- grid road structure and
- straight road sections.

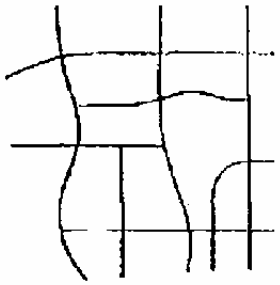


Figure 1: Traditional road network

Advantages and weaknesses of a traditional road network:

(+) high traffic dispersion,
(+) more direct connections,
(+) less travelled kilometres,
(+) favourable for pedestrians and cyclists due to direct connections,
(-) transit traffic through quadrangles,
(-) unfavourable for traffic calming.

Modern road network is characterised by:

- large built-up quadrangles,
- tree road structure (cul-de-sac),

- bent road sections (loops).

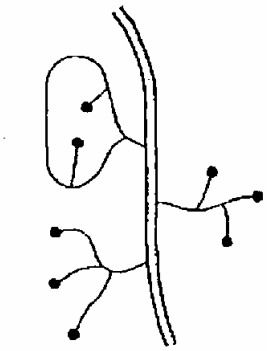


Figure 2: Modern road network

Advantages and weaknesses of a modern road network:

(+) transit traffic outside neighbourhoods,

(+) small traffic loads on residential streets,

(+) favourable impact on traffic calming,

(-) longer trips of pedestrians and cyclists,

(-) traffic concentration,

(-) the need for parallel arrangement of collector roads (to avoid multi-lane roads) and

(-) more travelled kilometres.

The advantages of both networks can be joined into the so-called hybrid network, which is based on the traditional network of main roads (MR) with which roads of lower categories are connected (CR, RR and PP), forming a modern road network.

Collector urban or regional roads (CR) are in the form of loops linked with main urban roads (MR). To the latter the urban or regional roads (RR) are linked in the form of short loops or cul-de-sacs. To regional roads public paths (PP) are linked, which are used for accessing residences and end as a cul-de-sac.

In modern design of road networks the time needed for driving from the local collector road (CR) to the access point (house, flat, place of work) should not exceed 1 (one) minute.

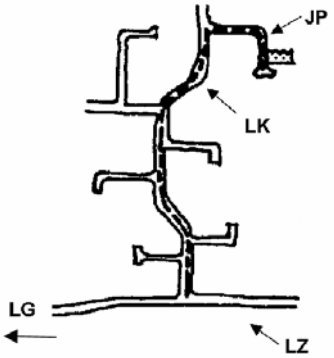


Figure 3: Hierarchy of access roads in modern road network

2.8.4.4.8.1 Architectural design

Architectural design is reflected in:

- materials on roadway and next to it,

- public lighting,
- planting,
- facades of houses and their elements and
- traffic signalisation, marking, routing and informing.

The materials for roadway surface and arrangement along the road have to comply with the road function, designed speed, roadside construction and uniform appearance of the road. Due to functional and aesthetic reasons the materials on a particular section are recommended to be uniform. Variations of surface appearance should be provided by various formats, direction and texture. For practical and economic reasons it is recommended that such materials are used whose characteristics do not significantly change with time (appearance, solidness, skidding resistance) and are simply replaced in the case of reconstruction. The use of different textures and/or colours at the locations of traffic calming devices helps to make the devices more recognisable.

Public lighting has to provide the drivers a clear sight of the route and road area. Particularly important is the illumination of critical points (crossroads, pedestrian crossings, traffic calming devices, etc.). Public lighting has to be adjusted to road function. On roads with distinct traffic function lights with high poles are installed (10 m), while on roads with distinct residential function lights with low poles are installed (3-5 m). Besides the height of the poles, the type of light plays an important role in creating the street ambiance. If necessary, traffic calming devices and measures have to be lit separately on account of better recognisability.

Planting along the road has an impact on the entire appearance of the road surface and may due to optical narrowing to smaller degree influence traffic calming. Planting is recommended at locations of traffic calming devices and measures, whereby better recognisability is achieved.

The facades of houses next to the road constitute the walls of the urban space. The elements of facades consist of building elements (windows, doors, roof, etc.), shades, advertisements, facade markings and lighting. Their design has to be harmonised with the environment.

Traffic signalisation is installed in accordance with the applicable rules.

2.8.4.5 Sequence of criteria for selecting traffic calming devices and measures

Traffic calming devices and measures are selected based on previously described conditions and criteria in the following sequence:

- specification of the processing area based on the road network plan of the urban area or town,
- specification of the function(s) or category(ies) of road(s) and selection of measures (4.1),
- specification of the speed of section and selection of measures (4.2),
- specification of traffic conditions and selection of measures (4.3),
- checking of additional criteria and selection of measures (4.4.1- 4.4.8).

2.8.5 Types of traffic calming devices and measures

Traffic calming devices and measures can be classified into several types:

- systemic measures (2.8.5.1),
- regulatory measures (2.8.5.2),
- warning devices (2.8.5.3),
- road humps and speed tables (2.8.5.4),
- roadway narrowing and carriageway separation (2.8.5.5),
- roadway axis deviation (chicane) (2.8.5.6).

2.8.5.1 Systemic measures

Systemic measures are specified by traffic arrangement, which is prescribed for a road or a part of it or for an urban area or part of it by the road manager. Traffic arrangement comprises:

- determination of priority directions as well as the system and method of traffic control,
- restrictions of usage of road or part of it depending on the type of traffic,
- restrictions of speed and specification of traffic calming measures,
- arrangement of stand still traffic,
- setting of restricted traffic zones, limited speed zones and pedestrian zones,
- specification of other obligations of road traffic participants.

2.8.5.2 Regulatory measures

Regulatory measures present a series of traffic rules defined by the regulation on road traffic safety. They are reflected in the installation of suitable traffic signalisation.

This type of measures does not have a particular impact on traffic calming, but these measures do clearly define traffic rules that apply to a road or part of it or an urban area or part of it.

2.8.5.3 Warning devices

Warning devices include optical and audible warning devices. Their function is to caution the drivers that they are nearing the speed restriction zone.

2.8.5.3.1 Optical warning devices – optical brakes

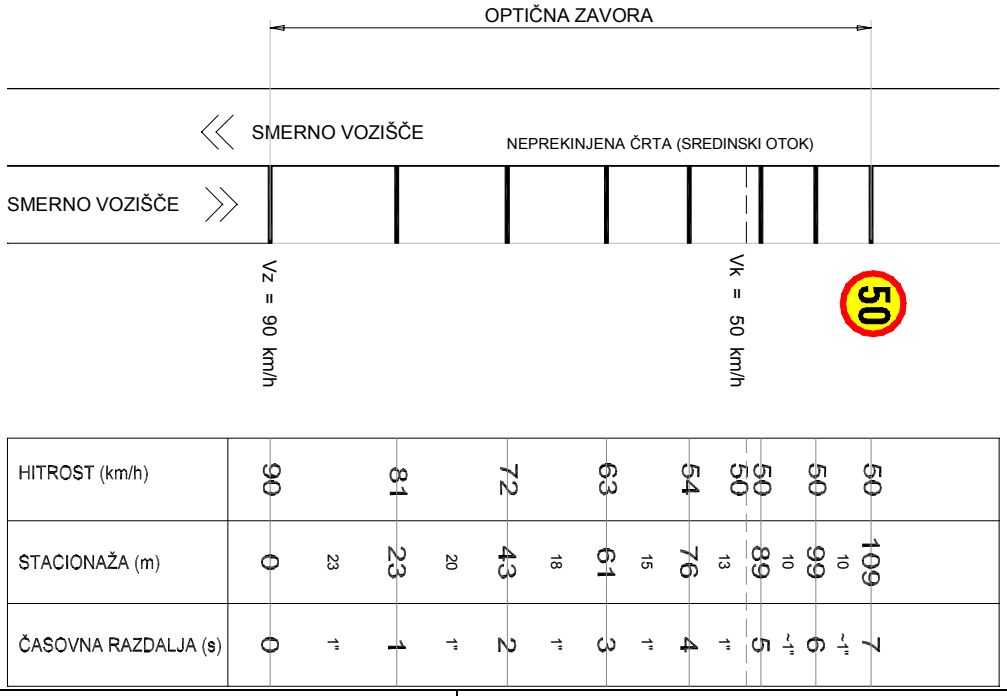
In addition to traffic signalisation optical warning devices are probably the mildest traffic calming measures and are used in front of traffic calming zones.

Optical brakes are stripes transversal to the direction of the drive painted across the entire width of the carriageway. Their purpose is to caution the driver so that (s)he can in due time and evenly reduce speed to the permitted limit. As the distance between the stripes is uneven, the driver has a feeling that (s)he is driving faster and faster, even though the speed remains the same.

The distance between the stripes changes depending on the initial and final speed which a vehicle should have before the restricted speed zone. The distance between the stripes (d_i) depends on initial speed (v_z) and final speed (v_k), deceleration (-1.5 m/s^2 in urban area and –2.5 m/s^2 outside urban area) and the time gap of 1 (one) second.

The length of the device (l) where a vehicle reduces speed equals the sum of all distances (d_i) between the stripes. For additional warning two more stripes are added at the end, 10 m apart, so that the total length of the optical brake (L) is extended by 20 m. At the end of the optical brake the restricted area zone starts.

Carriageways are separated by a continuous central no-passing line or the central reservation.



OPTIČNA ZAVORA	OPTICAL BRAKE
SMERNO VOZIŠČE	CARRIAGEWAY
NEPREKINJENA ČRTA (SREDINSKI OTOK)	CONTINUOUS LINE (CENTRAL ISLAND)
HITROST	SPEED
STACIONAŽA	POSITION
ČASOVNA RAZDALJA	TIME DISTANCE

Figure 4: Optical brake: Road outside urban area, Vz = 90 km/h; Vk = 50 km/h: a = -2.5 m/s^2

Area of application:
- they are installed as a preliminary warning in front of dangerous points or severe traffic calming measures, where a speed reduction is required.

Implementation:
- a white stripe of 40 cm in width across the entire width of the carriageway for speed up to 60 km/h,
- a white stripe of 1.0 m in width for speed over 60 km/h,
- carriageways are separated by a continuous central no-passing line or the central reservation,
- always in combination with a traffic sign restricting speed.

Dimensioning:

$$d_i = 0.5 \cdot \left(v_i + \left(v_i - a \cdot t\right)\right) \cdot t$$

$$l = \sum_i d_i = 0.5 \cdot \left(v_z + v_k\right) \cdot \frac{v_z - v_k}{a}$$

$$L = l + 20\ m$$

- the distance is rounded up to the length travelled by a vehicle during the last second before the speed is reduced to the prescribed limit.

Advantages:
- none advantages.

Weaknesses:
- small impact on traffic calming,
- uneven skidding coefficient of the roadway.

Possibilities of combination:
- optical brake can be followed by more severe traffic calming measures.

2.8.5.3.2 Audible warning devices – audio brakes

Audible warning devices are milder traffic calming measures used in front of traffic calming zones or within them where higher speed is expected. Audio brakes are pairs of stripes transversal to the direction of the drive and made from such a material which does not decrease the adhesion ratio. Audio brakes raised above the roadway with a relief and/or of different texture ensure audible and vibration effects.

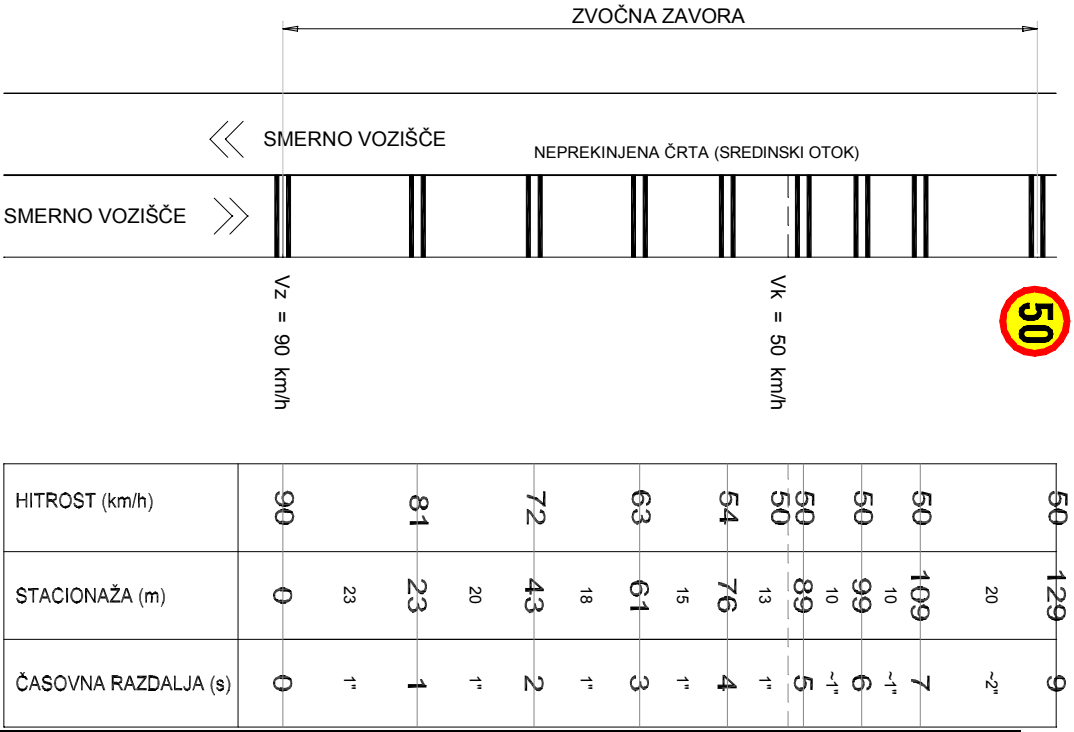
Audio brakes are comprised of a pair of stripes that are 40 cm wide and 2 m apart.

The purpose of audio brakes is to warn the driver by vibration effects so that (s)he can in due time and evenly decrease the speed to the permitted limit.

As the distance between the stripes is uneven and due to the accompanying audio and vibration effects the driver has a feeling that (s)he is driving faster and faster, even though the speed remains the same. The distance between the pairs of stripes changes depending on the initial and final speed which a vehicle should have before the restricted speed zone. Audio brakes are subject to the same parameters as optical brakes.

The distance between the stripes (d_i) depends on initial speed (v_z) and final speed (v_k), deceleration (1.5 m/s^2 in urban area and –2.5 m/s^2 outside urban area) and the time gap of 1 (one) second. The length of the device (l) where a vehicle reduces speed equals the sum of all distances (d_i) between the stripes. For additional warning two more stripes are added at the end, 10 m apart, so that the total length of the optical brake (L) is extended by 20 m. The restricted area zone starts 20 m after the end of the audio brake.

Carriageways are separated by a continuous central no-passing line.



ZVOČNA ZAVORA	AUDIO BRAKE
SMERNO VOZIŠČE	CARRIAGEWAY
NEPREKINJENA ČRTA (SREDINSKI OTOK)	CONTINUOUS LINE (CENTRAL ISLAND)
HITROST	SPEED
STACIONAŽA	POSITION
ČASOVNA RAZDALJA	TIME DISTANCE

Figure 5: Audio brake: Road outside urban area, Vz = 90 km/h; Vk = 50 km/h: a = -2.5 m/s^2

Area of application:
They are installed at locations where it was established that optical brakes did not have the desired effect,
on roadways with few cyclists.

Implementation:
- a pair of stripes that are 40 cm wide and 2 m apart, perpendicular to the direction of the drive across the carriageway,
- the stripes are made of material which does not diminish skidding resistance,
- carriageways are separated by a continuous central no-passing line or the central reservation,
- special attention has to be paid to drainage on roads enclosed with a kerb,
- always in combination with a traffic sign restricting speed.

Advantages:
none advantages.

Weaknesses:
- uneven skidding resistance of the roadway,
- greater noise emissions, which is why they are unsuitable for densely built-up areas.

Dimensioning:

$$d_i = 0.5 \cdot \left(v_i + \left(v_i - a \cdot t\right)\right) \cdot t$$

$$l = \sum_i d_i = 0.5 \cdot \left(v_z + v_k\right) \cdot \frac{v_z - v_k}{a}$$

$$L = l + 20\ m$$

- the distance is rounded up to the length travelled by a vehicle during the last second before the speed is reduced to the prescribed limit.

Possibilities of combination:
- audio brake can be followed by more severe traffic calming measures.

2.8.5.4 Road humps and speed tables

Road humps and speed tables are intended for forced speed reduction. They belong to more severe traffic calming measures and are installed at locations where we want to force a driver to reduce speed.

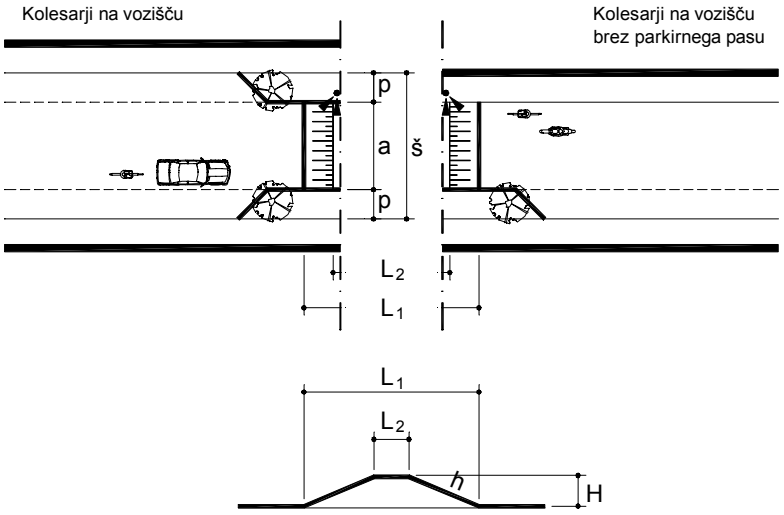
The effect of road humps and speed tables depends mainly on the shape of the ramps and in the case of a sequence of road humps or speed tables also on the distance between such devices (D).

The cross grade of the ramps is defined by the maximum permissible vertical acceleration 0.7 g.

The distance between road humps is determined based on the desired speed at a section ($V_{\check{Z}}$), which is chosen, and is 5 - 10 km/h higher than drive-over speed (V_{prev}) at the location of the hump or speed table.

2.8.5.4.1 Trapezoidal road hump V_{prev} = 30, 40 and 50 km/h

Kolesarji na vozišču	Cyclists on roadway



Kolesarji na vozišču brez parkirnega pasu	Cyclists on roadway without parking lane

Figure 6: Trapezoidal road hump V_{prev} = 30, 40 and 50 km/h

Area of application:
- 30 km/h ≤ V_{85} ≤ 70 km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 8.5 m,
- in urban area,
- only at straight sections with the grade of s_{abs} ≤ 8%,
- not in combination with a pedestrian crossing.

Implementation:
- trapezoidal shape,
- perpendicular across the entire width of the roadway,
- ensure recognisability,
- careful at drainage and
- lighting is obligatory.

Dimensioning:
- a = 4.5 – 6.0 m
- p = width of the parking lane or pavement
- V_{prev}= 50 km/h ⇒ L1 = 12.0 m, h = 2.5%;
  V_{prev}= 40 km/h ⇒ L1 = 7.20 m, h = 5%;
  V_{prev}= 30 km/h ⇒ L1 = 4.80 m, h = 10%;
- L_2 = 2.40 m (for all V_{prev}),
- H = 0.12 m (for all V_{prev}),
- distance from the crossroads at least 8 m.

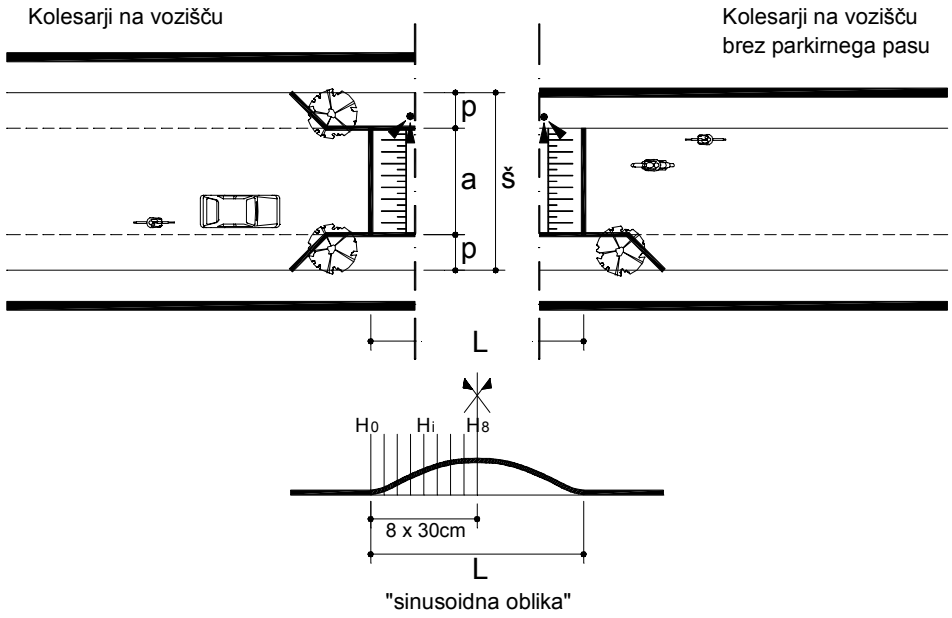
Advantages:
- road hump dimensions ensure V_{prev} = 30, 40 and 50 km/h and
- at lower speed their impact is negligible.

Weaknesses:
- greater gas, noise and vibration emissions (4.4.3. and 4.4.4),
- decreases the number of parking spaces on roadways with a parking lane,
- resulting in traffic rerouting (4.2),
- uncomfortable drive for cyclists and
- uncomfortable for trucks and buses.

Possibilities of combination:
- in combination with recognisability measures and
- use of several consecutive trapezoidal humps at axis distance (D):

$V_{ž}$ = 50 km/h ⇒ D = 100 – 200 m;
$V_{ž}$ = 40 km/h ⇒ D = 75 – 100 m;
$V_{ž}$ = 30 km/h ⇒ D = 50 - 75 m;

2.8.5.4.2 Parabolic road hump – V_{prev} = 30 km/h



Kolesarji na vozišču	Cyclists on roadway
Kolesarji na vozišču brez parkirnega pasu	Cyclists on roadway without parking lane
"sinusoidna oblika"	"parabolic shape"

Figure 7: Parabolic road hump V_{prev} = 30 km/h

Area of application:
- 30 km/h ≤ V_{85} ≤ 50 km/h (at the section),
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 8.5 m,
- in urban area,
- at straight sections with the grade of s_{abs} ≤ 8%,
- not used at pedestrian crossings,
- not used on roads over which a public passenger transport line is routed or truck traffic is greater.

Implementation:
- longitudinal profile of "sinusoid" shape,
- perpendicular across the entire width,
- ensure proper drainage,
- ensure recognisability,
- vertical traffic signalisation for marking the device is usually not used,
- lighting is obligatory.

Dimensioning:
- a = 4.5 – 6.0 m,
- p = width of the parking lane or pavement,
- L = 4.80 m,
- H = 0.12 m,

H1 = 5 mm, H2 =18 mm, H3 =37 mm,
H4 = 60 mm, H5 = 83 mm, H6 = 102 mm
H7 = 115 mm, H8 = 120 mm,
- Distance from the crossroads at least 8 m.

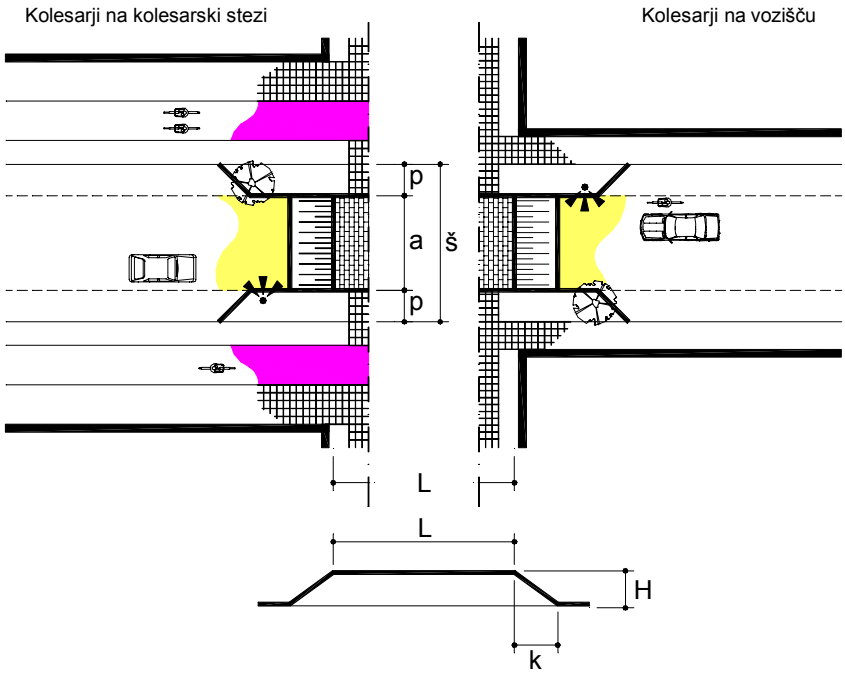
Advantages:
- dimensions of the hump ensure V_{prev} = 30 km/h, at lower speed its impact is negligible and
- calms also moped traffic.

Weaknesses:
- greater noise and vibration emissions,
- decreases the number of parking spaces on roadways with a parking lane,
- results in rerouting of traffic flows,
- uncomfortable drive for cyclists and
- uncomfortable for trucks and buses.

Possibilities of combination:
- in combination with recognisability measures and
- use of several consecutive parabolic road humps with the distance between them:

D(m) = 10·($V_{ž}$ - 30);
35 km/h ≤ $V_{ž}$ ≤ 40 km/h;
where $V_{ž}$ is the desired speed of driving at the road section (see 5.4).

2.8.5.4.3 Trapezoidal speed table



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 8: Trapezoidal speed table

Area of application:
- 50 km/h ≤ V_{85} ≤ 70 km/h (at the section),
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 8.5 m,
- at straight sections with the grade of s_{abs} ≤ 8%,
- used in combination with a pedestrian and cyclist crossing.

Implementation:
- longitudinal profile of trapezoid or parabolic shape (see measures 5.4.1 and 5.4.2),
- perpendicular across the entire width of the roadway,
- ensure proper drainage,
- ensure recognisability,
- vertical traffic signalisation for marking the device is usually not used,
- lighting is obligatory.

Dimensioning:
- a = 4.5 - 6.0 m
- p = width of the parking lane or pavement
- 3.0 m ≤ L ≤ 9.0 m
  - select the desired speed $V_{ž}$:

$V_{ž} - V_{prev}$ ≤ 25 km/h (1st condition),
18 ≤ V_{prev} ≤ 40 km/h (2nd condition),
H = 0.12 m,
k (m) = 19.2 / (47-V_{prev}),
- distance from the crossroads at least 8 m.

Advantages:
- speed reduction up to 25 km/h,
- suitable for pedestrian crossing,
- crossing a road without obstacle for the handicapped, facilitate pedestrian and cyclist way,
- speed reduction for mopeds

Weaknesses:
- greater gas, noise and vibration emissions,
- decreases the number of parking spaces on roadways with a parking lane,
- can result in rerouting of traffic flows,
- uncomfortable drive for cyclists and
- uncomfortable for trucks.

Possibilities of combination:
- in combination with recognisability measures,
- in combination with 5.5.1.x
- use of several consecutive trapezoid seed tables:

$V_{ž}$ = 50 km/h ⇒ D = 100 – 200 m;
$V_{ž}$ = 40 km/h ⇒ D = 75 – 100 m;
$V_{ž}$ = 30 km/h ⇒ D = 50 - 75 m;

2.8.5.5 Roadway narrowing and carriageway separation

Roadway width has a great influence on the speed of driving. If a roadway is narrowed, the driving speed is reduced and new areas are acquired, which can be designated for pedestrians and/or cyclists.

Roadway narrowing has a continuous impact on traffic calming.

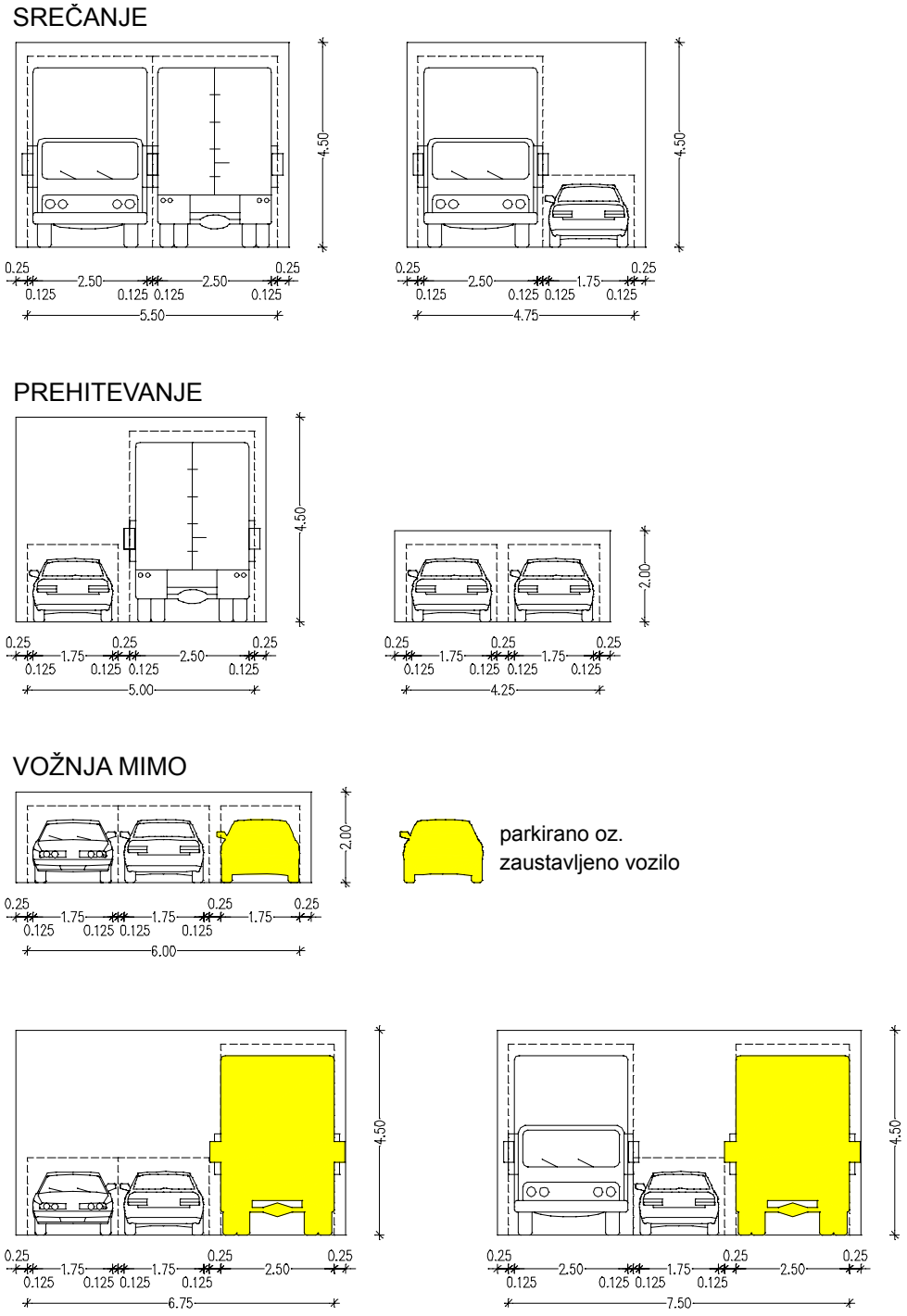


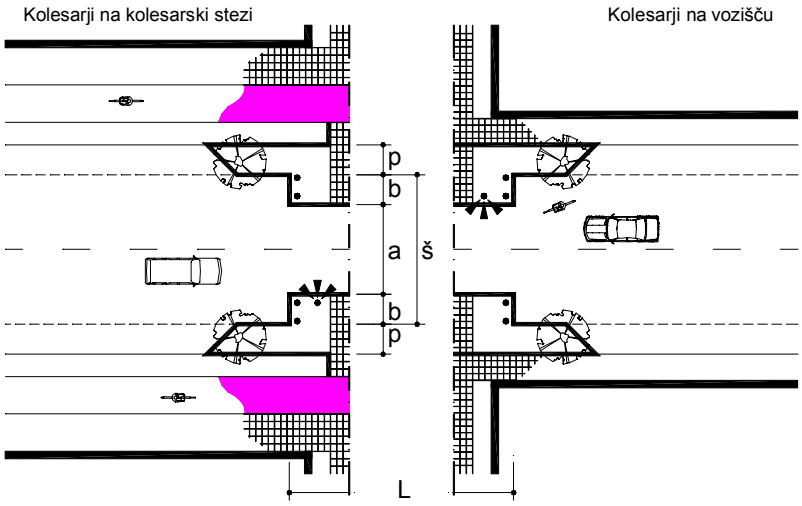
Figure 9: Minimum roadway width in the event of meeting, overtaking and passing-by.

SREČANJE	MEETING
PREHITEVANJE	OVERTAKING
VOŽNJA MIMO	PASSING BY
parkirano oz. zaustavljeno vozilo	parked or stopped vehicle

Road narrowings can be implemented from the side or the centre. As minimum roadway width is determined the following has to be considered: driving speed, various meeting, overtaking or passing by relevant vehicles.

Narrowings can be implemented from the side or the centre. At narrowing traffic can be either two-way or single-way.

2.8.5.5.1 Road narrowing from the side



2.8.5.5.1.1 Two-sided narrowing – two-way traffic at the location of the measure

Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 10: Two-sided narrowing – two-way traffic at the location of the device

Area of application:
- $V_{85} \leq 50$ km/h
- P ≤ 400 PCE/peak hour (see 4.3),
- Š ≥ 7.5 m (cyclists on bicycle way),
- Š > 8.0 m (cyclists on roadway),
- at the pedestrian and cyclist crossing,
- not to be used as an independent measure.

Implementation:
- subsided kerb at the pedestrian crossing,
- ensure proper sight distance,
- ensure suitable recognisability,
- lighting is obligatory.

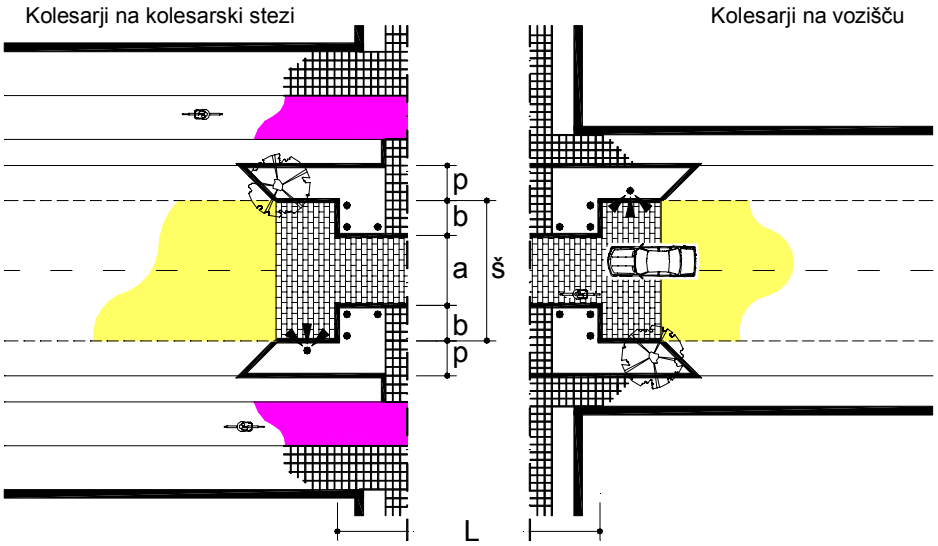
Dimensioning:
- a = 4.5 – 5.0 m (cyclists on bicycle way),
- a = 5.0 – 6.0 m (cyclists on roadway) or in the case of a regular bus line and a higher share of trucks,
- b ≥ 1.50 m,
- p = parking lane width,
- L = 5.0 – 10.0 m,
- in the event of several consecutive narrowings the distance between them should enable relevant vehicles to meet.

Advantages:
- reduces roadway crossing width,
- moderate speed reduction,
- good visibility at road crossing.

Weaknesses:
- decreases the number of parking spaces on roadways with a parking lane,
- at the narrowing cyclists are endangered if on the roadway.

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.1.2 Two-sided narrowing – alternate one-way traffic at the location of the measure



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 11: Two-sided narrowing – one-way traffic at the location of the device

Area of application:
- $V_{85} \leq 50$ km/h,
- P ≤ 400 PCE/peak hour (see 4.3),
- Š > 5.75 m (cyclists on bicycle way),
- Š > 6.25 m (cyclists on roadway),
- at the pedestrian and cyclist crossing,
- not to be used on MR and CR roads.

Implementation:
- ensure sight distance of the vehicles coming from the opposite direction,
- subsided kerb at the crossing location,
- ensure suitable recognisability,
- lighting is obligatory.

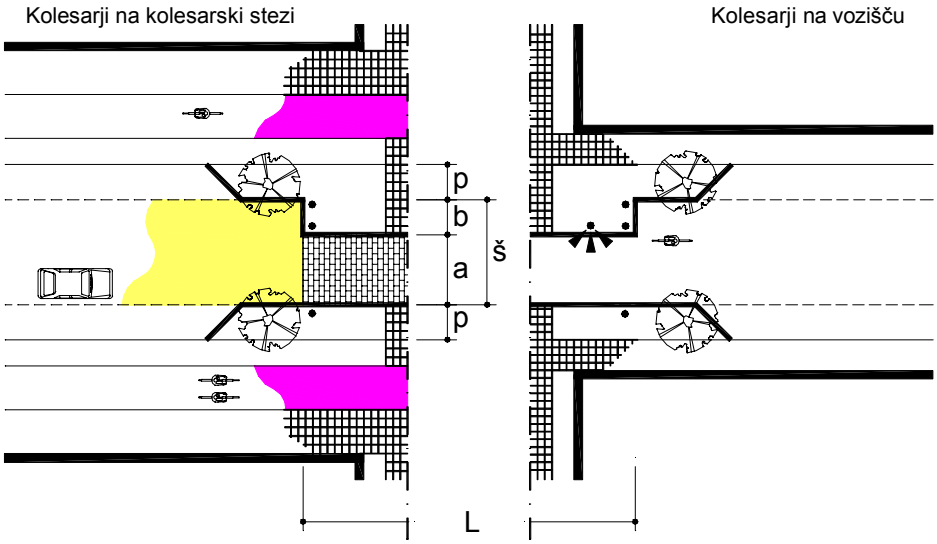
Dimensioning:
- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway) or in the case of a regular bus line and a higher share of trucks,
  - b ≥ 1.50 m,
  - p = parking lane width,
  - L = 5.0 – 10.0 m.

Advantages:
- reduces roadway crossing width,
- moderate speed reduction,
- good sight distance at the crossing location.

Weaknesses:
- decreases the number of parking spaces on roadways with a parking lane,
- at the narrowing cyclists are endangered if on the roadway.
- may cause higher speed at entry,
- can result in rerouting of traffic flows.

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.1.3 One-sided narrowing – alternate one-way traffic at the location of the measure



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 12: One-sided narrowing

Area of application:
- V_{85} ≤ 50 km/h,
- P ≤ 400 PCE/peak hour (see 4.3),
- Š > 4.25 m (cyclists on bicycle way),
- Š > 4.75 m (cyclists on roadway),
- at the pedestrian crossing location,
- not to be used on collector roads - CR.

Implementation:
- subsided kerb at the pedestrian crossing,
- ensure sight distance of the vehicles coming from the opposite direction,
- ensure suitable recognisability,
- lighting is obligatory.

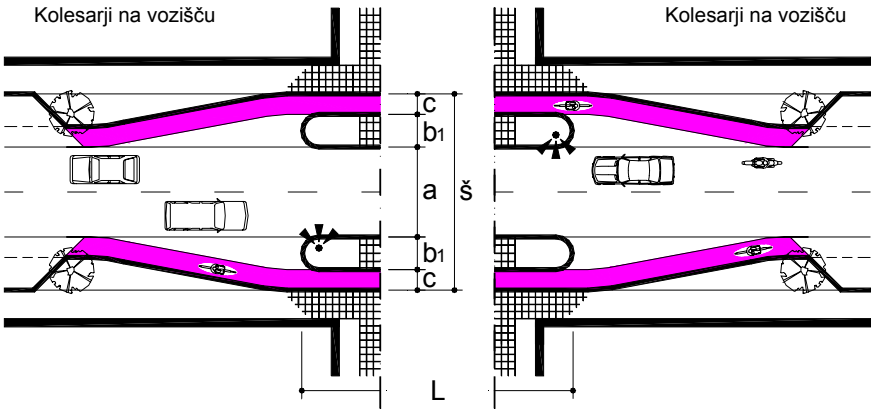
Dimensioning:
- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway) or in the case of a regular bus line and a higher share of trucks,
- b ≥ 1.50 m,
- p = parking lane width,
- L = 5.0 – 10.0 m,
- in the event of several consecutive narrowings the distance between them should enable meeting of two relevant vehicles.

Advantages:
- reduces roadway crossing width,
- moderate speed reduction,
- good sight distance at the crossing location.

Weaknesses:
- decreases the number of parking spaces along the edge of the roadway,
- cyclists are endangered at the narrowing location,
- can result in rerouting of traffic flows

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.1.4 Two-sided narrowing – cyclists on short bicycle way



Kolesarji na vozišču	Cyclists on roadway

Figure 13: Two-sided narrowing – cyclists on short bicycle way

Area of application:

- $V_{85} \leq 50$ km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 10.50 m
- at the pedestrian and cyclist crossing and
- two-way traffic.

Implementation:

- waiting island at crossing on roadway level,
- different colour and/or structure of bus stop,
- bicycle ways and pedestrian crossings on the roadway level,
- subsided kerb at the crossing location,
- traffic signalisation for passing by,
- ensure suitable recognisability,
- lighting is obligatory.

Dimensioning:

- a = 4.50 – 5.00m ,
- a = 5.00 – 6.00 m if the share of truck and/or bus traffic is high (cyclists on the roadway),
- b1 ≥ 1.50 m,
- c = 1.50 – 1.75 m,
- L = 5 – 10 m.

Advantages:

- reduces roadway crossing width,
- safe and comfortable routing of cyclists,
- moderate speed reduction.

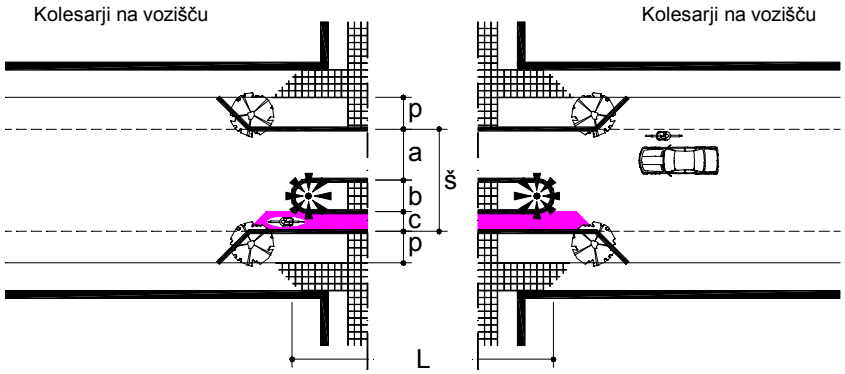
Weaknesses:

- relatively narrow waiting island at pedestrian crossing,
- decreases the number of parking spaces along the edge of the roadway.

Possibilities of combination:

- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.1.5 One-sided narrowing – cyclists on one side on short bicycle way



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 14: One-sided narrowing – cyclists on one side on short bicycle way

Area of application:
- $V_{85} \leq 50$ km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 6.10 m,
- at the pedestrian crossing location,
- two-way traffic,
- not on MR and CR.

Advantages:
- reduces roadway crossing width,
- safe and comfortable routing of cyclists,
- moderate speed reduction.

Implementation:
- waiting island at crossing on roadway level,
- different colour and/or structure of bus stop,
- bicycle ways and pedestrian crossings on the roadway level,
- subsided kerb at the crossing location,
- traffic signalisation for passing by,
- ensure suitable recognisability,
- lighting is obligatory.

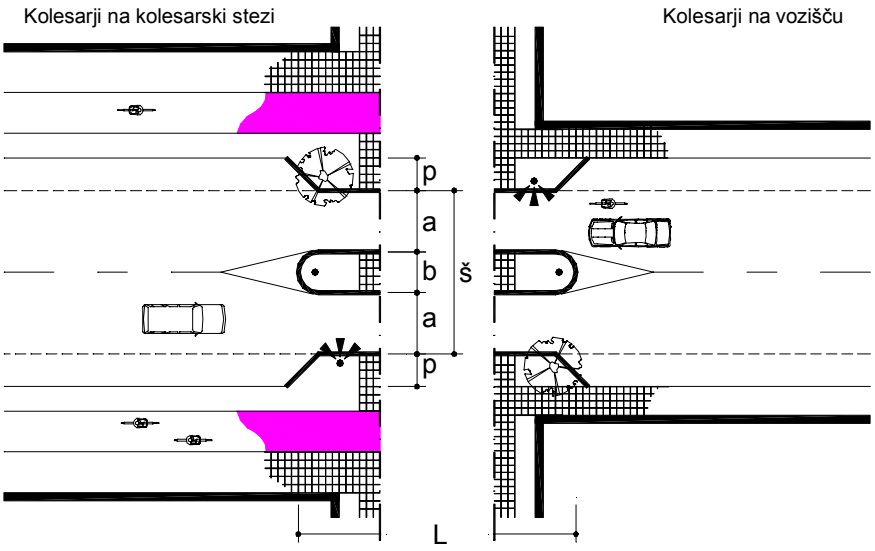
Weaknesses:
- relatively narrow waiting island at pedestrian crossing,
- decreases the number of parking spaces along the edge of the roadway,
- influences the rerouting of traffic flows.

Dimensioning:
- a = 3.25 – 3.50 m,
- b ≥ 1.50 m,
- c = 1.35 m,
- L = 5 – 10 m ,
- p = parking lane width,
- in the event of several consecutive narrowings the distance between them should enable meeting of two relevant vehicles.

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.2 Road narrowing from the centre (choker)

2.8.5.5.2.1 Splitter island at pedestrian crossing



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 15: Road narrowing from the centre - splitter island at pedestrian crossing

Area of application:
- $V_{85} \leq 50$ km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 7.00 m,
- two-way traffic,
- crossing of pedestrians and cyclists.

Advantages:
- reduces roadway crossing width,
- moderate speed reduction,
- the attention of drivers is greater,
- vehicle overtaking is not possible at crossing location.

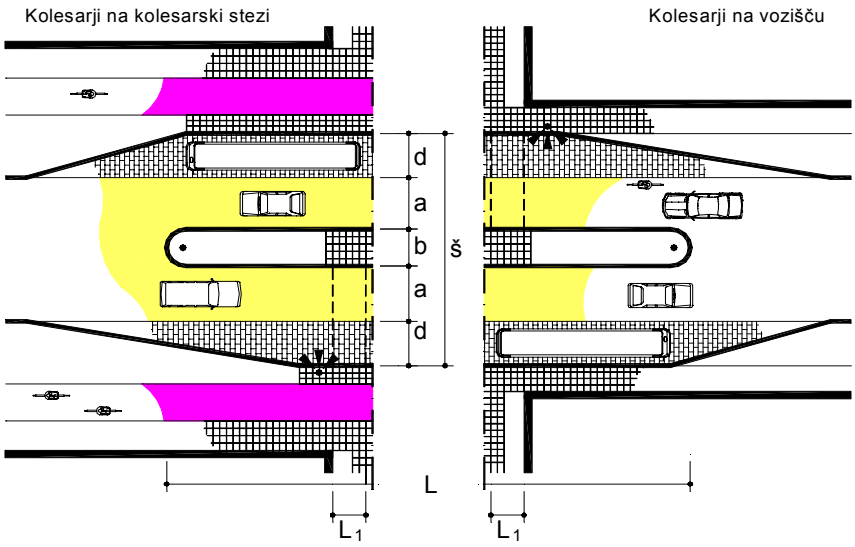
Implementation:
- symmetrical to the roadway axis,
- waiting island at crossing on roadway level,
- traffic signalisation for passing by,
- ensure suitable recognisability,
- lighting is obligatory.

Weaknesses:
- decreases the number of parking spaces along the edge of the roadway,
- limited size of the waiting island,
- can result in rerouting of traffic flows.

Dimensioning:
- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway) or in the case of a regular bus line and a higher share of trucks,
- b ≥ 1.50 m,
- p = parking lane width,
- L = 5.0 – 10.0 m.

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 5.4.3.

2.8.5.5.2.2 Splitter island at the bus stop location



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 16: Road narrowing from the centre - splitter island at the bus stop location

Area of application:
- $V_{85} \leq 50$ km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 8.5 m,
- at the pedestrian crossing location,
- two-way traffic.

Implementation:
- symmetrical to the roadway axis,
- waiting island at crossing on roadway level,
- different colour and/or structure of bus stop,
- crossing always behind the bus,
- traffic signalisation for passing by,
- ensure suitable recognisability,
- lighting is obligatory.

Dimensioning:
- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway),
- b ≥ 1.50 m,
- d = 3.0 m,
- p = parking lane width,
- L = The bus stop has to be designed according to the »Rules on Minimum Conditions for Bus Stop Design, Application and Construction«,
- L1 ≥ 4.0 m,
- routing railings at the waiting island with the width of b ≥ 3.0 m.

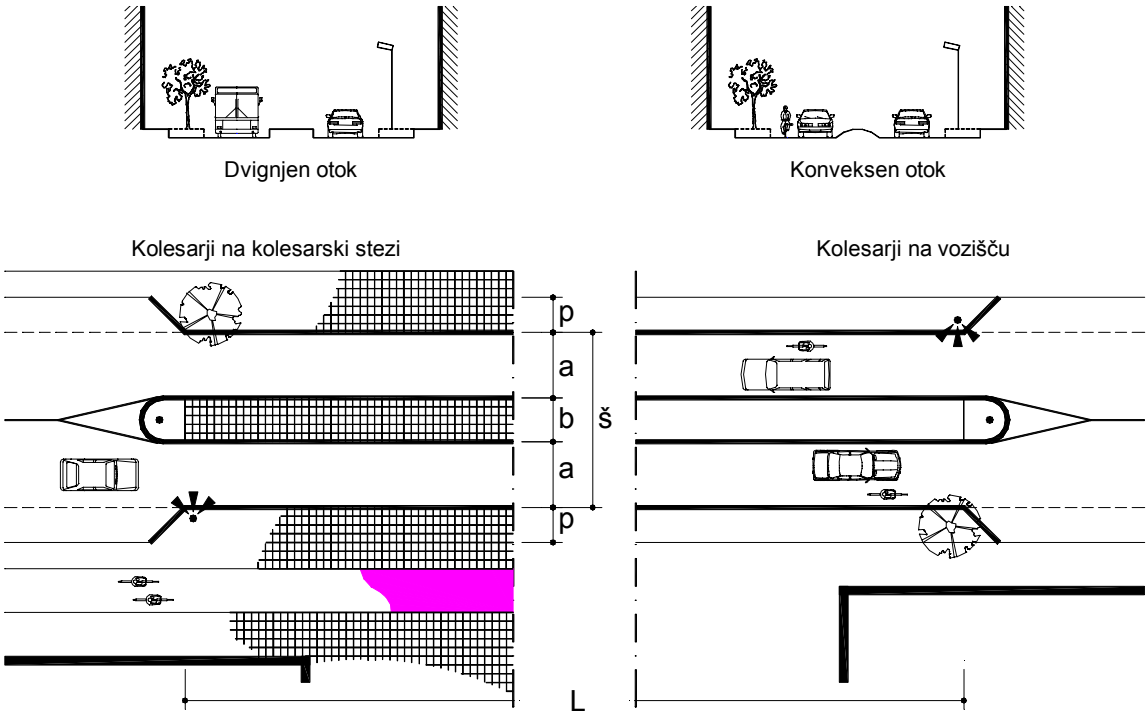
Advantages:
- reduces roadway crossing width,
- crossing behind the bus and
- moderate speed reduction.

Weaknesses:
- relatively long crossing area (carriageway and bus stop),
- decreases the number of parking spaces along the edge of the roadway,
- at the narrowing the cyclists are endangered if on the roadway.

Possibilities of combination:
- in combination with recognisability measures.

2.8.5.5.3

2.8.5.5.4 Carriageway separation



Dvignjen otok	Raised island
Konveksen otok	Convex island
Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 17: Road narrowing from the centre - carriageway separation

Area of application:

- $V_{85} \leq 50$ km/h,
- P ≤ 600 PCE/peak hour (see 4.3),
- Š ≥ 8.00 m,
- two-way traffic,
- even distribution of crossings.

Implementation:

- symmetrical to the roadway axis,
- traffic signalisation for passing by,
- ensure suitable recognisability and
- lighting is obligatory.

Dimensioning:

- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway),
- b ≥ 2.50 m,
- p = parking lane width,
- L = depending on the situation.

Advantages:

- reduces roadway crossing width,
- moderate speed reduction,
- overtaking is not possible.

Weaknesses:

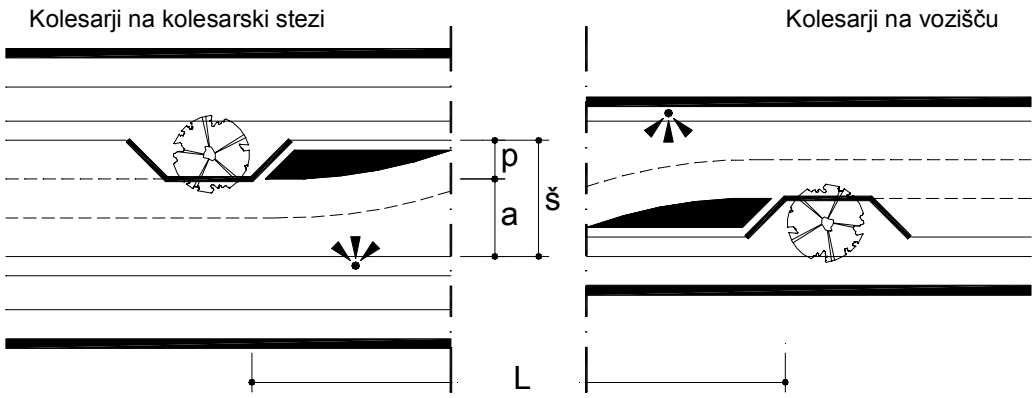
- significantly decreases the number of parking spaces along the edge of the roadway,
- the problem of passing by (carriageway block) unless in the event of a convex island which enables passability,
- long straight sections causing speed increase,
- at the narrowing the cyclists are endangered if on the roadway.

Possibilities of combination:

- in combination with recognisability measures (plant-scaping, etc.),
- in combination with the measure referred to in 5.4.3.

2.8.5.6 Roadway axis deviation (of carriageways)

2.8.5.6.1 Roadway axis deviation – alternate parallel parking



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 18: Roadway axis deviation – parallel parking

Area of application:
- $V_{85} \leq 50$ km/h,
- P ≤ 400 PCE/peak hour (see 4.3),
- Š ≥ 7.5 m,
- straight road section,
- possible also on one-way roads.

Implementation:
- change of parking side,
- ensure suitable recognisability,
- parking not allowed on both sides,
- lighting is obligatory.

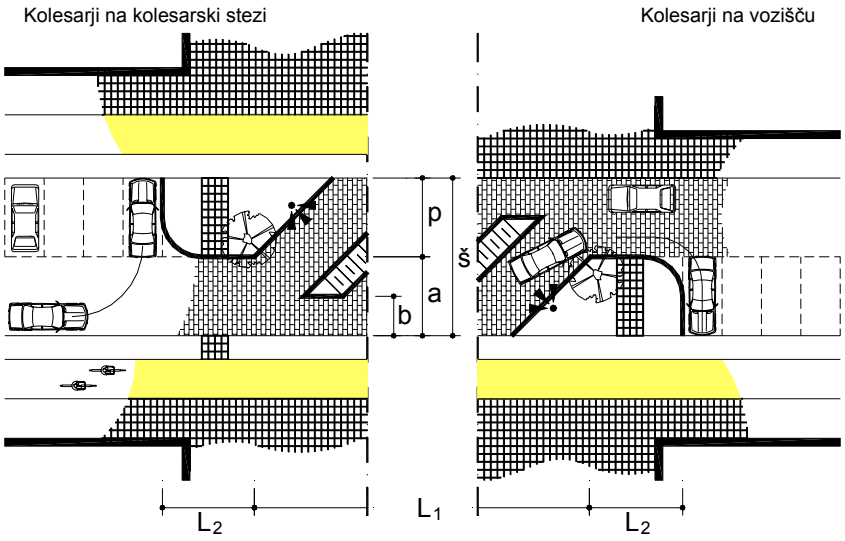
Advantages:
- reduces roadway crossing width,
- moderate speed reduction,
- overtaking is not possible.

Weaknesses:
- significantly decreases the number of parking spaces along the edge of the roadway,
- the problem of passing by (carriageway block) unless in the event of a convex island which enables passability,
- long straight sections causing speed increase.

Dimensioning:
- a = 5.0 – 5.5 m (cyclists on bicycle way) for two-way traffic,
- a = 5.5 – 6.0 in the case of a regular bus line and a higher share of trucks,
- a = 3.0 –3.5 m for one-way traffic,
- p = parking lane width,
- L = depending on the manoeuvring space of the relevant vehicle (trail and covered area).

Possibilities of combination:
- in combination with recognisability measures,
- in combination with the measure referred to in 2.8.5.4.3.

2.8.5.6.2 Roadway axis deviation – angle parking



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 19: Roadway axis deviation – angle parking

Area of application:
- $V_{85} \leq 50$ km/h,
- P < 100 PCE/peak hour (see 4.3),
- Š ≥ 9.50 m,
- two-way traffic,
- only in calm traffic zones,
- not at high parking turnover.

Advantages:
- good traffic calming measure,
- breaks long straight road sections,
- moderate speed reduction,
- overtaking is not possible.

Implementation:
- possible also without central island at deviation,
- suitable horizontal traffic signalisation,
- parking space dimensioning in accordance with the applicable regulations,
- ensure suitable recognisability,
- lighting is obligatory.

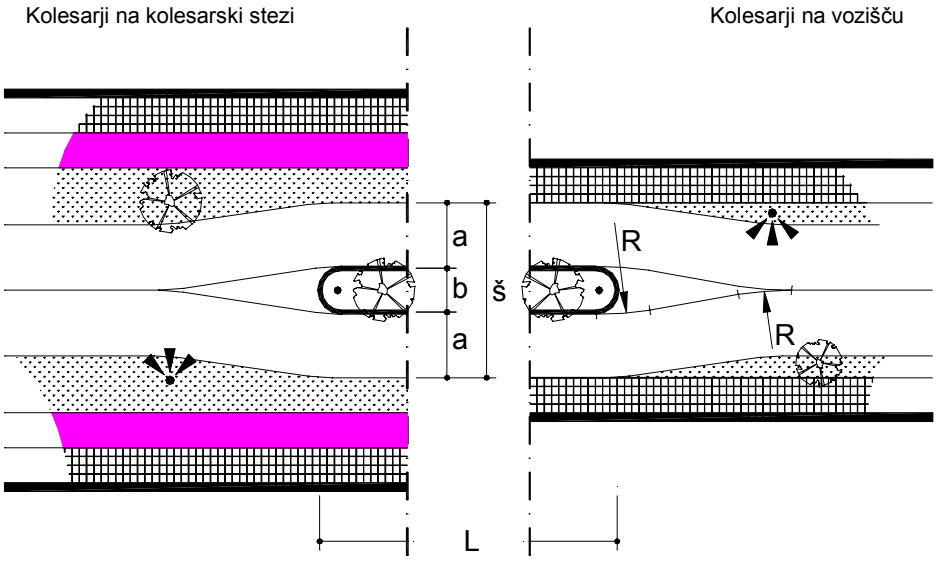
Weaknesses:
- danger for cyclists on the roadway and pedestrians on account of poor visibility at crossing zone.

Dimensioning:
- a ≥ 6.00 (5.00),
- b ≅ 2.50 m,
- p ≥ 4.60 m (see parking space dimensions),
- L_1 = depending on the manoeuvring space of the relevant vehicle (trail and covered area)
- L_2 = 5.0 – 6.0 m,
- deviation angle 1 : 1,
- central island stabilised, kerb height up to 7 cm.

Possibilities of combination:
- in combination with recognisability measures (plant-scaping, etc.).

2.8.5.6.3

2.8.5.6.4 Carriageway axis deviation symmetrically outward (by a central island)



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 20: Carriageway axis deviation - symmetrically outward

Area of application:

- $V_{85} \leq$ 50 km/h,
- P < 600 PCE/peak hour (see 4.3),
- Š ≥ 8.50 (7.00) m,
- two-way traffic,
- in urban area or at transition to urban area.

Implementation:

- symmetrical to the roadway axis,
- if b width is sufficient, the planting of the central island is proposed,
- traffic signalisation for passing by,
- ensure sight field,
- ensure suitable recognisability,
- lighting is obligatory.

Dimensioning:

- a = 2.75 – 3.25 m (cyclists on bicycle way),
- a = 3.25 – 3.50 m (cyclists on roadway), b ≥ 1.50 m,
- L = 5.0 m – 20.0 m,
- deviation ≤ 1 : 5,
- R = depending on the manoeuvring space of the relevant vehicle (trail and covered area),
- potential planting height ≤ 60 cm.

Advantages:

- the attention of drivers is greater,
- reduces roadway crossing width,
- moderate speed reduction (depends on b),
- overtaking is not possible.

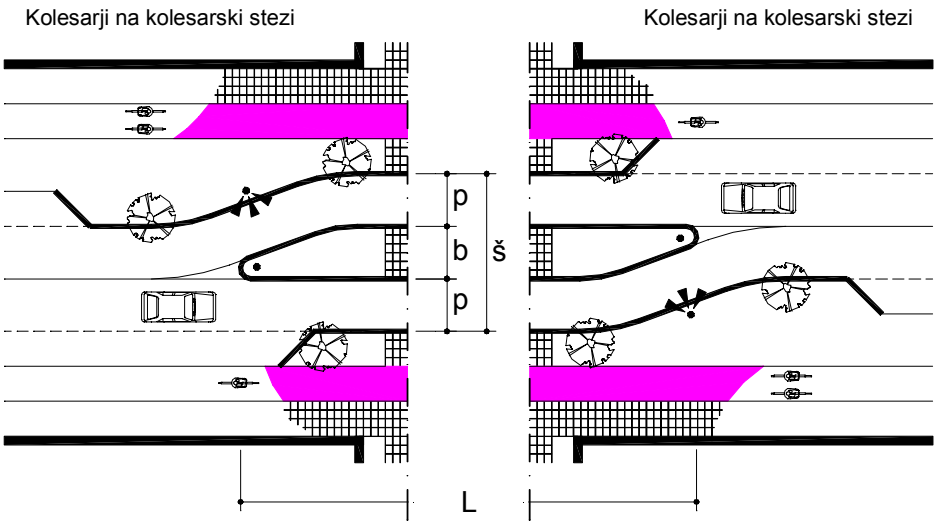
Weaknesses:

- decreases the number of parking spaces along the edge of the roadway,
- when dimensioned for heavy trucks, the traffic calming effect on passenger vehicles is small,
- drivers focus attention on deviation and not pedestrian crossing.

Possibilities of combination:

- in combination with recognisability measures,(plant-scaping, etc.),
- in combination with a pedestrian crossing.

2.8.5.6.5 Carriageway axis deviation asymmetrically (by a central island)



Kolesarji na kolesarski stezi	Cyclists on bicycle way
Kolesarji na vozišču	Cyclists on roadway

Figure 21: Carriageway axis deviation - asymmetrically

Area of application:
- $V_{85} \leq 50$ km/h,
- P < 600 PCE/peak hour (see 4.3),
- Š ≥ 8.50 m,
- in urban area,
- two-way traffic,
- at pedestrian crossing.

Implementation:
- the top of the island symmetrical to the roadway axis,
- if b width is sufficient, the planting of the central island is proposed,
- traffic signalisation for passing by,
- ensure sight field,
- ensure suitable recognisability,
- lighting is obligatory.

Dimensioning:
- a = 2.75 – 3.25 m (cyclists on bicycle way),
- b ≥ 1.50 m,
- L = 20.0 – 40 m,
- b ≥ 3.00 m,
- deviation shape depends on the manoeuvring space of the relevant vehicle and V_{85}.

Advantages:
- the attention of drivers is greater,
- reduces roadway crossing width,
- moderate speed reduction (depends on b),
- overtaking is not possible.
- breaks long straight road sections.

Weaknesses:
- decreases the number of parking spaces along the edge of the roadway,
- greater accent on crossing than on deviation,
- when dimensioned for heavy trucks, the traffic calming effect on passenger vehicles is small,
- drivers focus attention on deviation and not pedestrian crossing.

Possibilities of combination:
- in combination with recognisability measures,
  (plant-scaping, marking elements, etc.).

2.8.6 Key

Pozidano območje

Obstoječ rob ceste ali
horizontalna prometna signalizacija

Meja naprave ali ukrepa

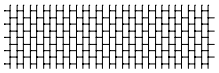
Označevalni element

Večji vertikalni element (drevo le kot oznaka)

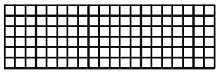
Javna razsvetljava - označeno samo v primeru
posebnih zahtev

Asfaltno ali betonsko vozišče

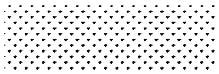
Barvni asfalt (rdeč)



Tlakovci (betonski, opečni, granitne kocke)



Plošče (betonske, kamnite...)



Netlakovana površina (trata)

Pozidano območje	Built-up area
Obstoječ rob ceste ali horizontalna prometna signalizacija	Existing edge of the road or horizontal traffic signalisation
Meja naprave ali ukrepa	Edge of the device or measure
Označevalni element	Marking element
Večji vertikalni element (drevo le kot oznaka)	Large vertical element (tree only as indication)
Javna razsvetljava - označeno samo v primeru posebnih zahtev	Public lighting - marked only in the event of special requirements
Aslafltno ali betonsko vozišče	Asphalt or concrete roadway
Barvni asfalt (rdeč)	Colour asphalt (red)
Tlakovci (betonski, opečni, granitne kocke)	Paving (concrete, brick, granite cubes)
Plošče (betonske, kamnite…)	Slabs (concrete, stone, etc.)
Netlakovana površina (trata)	Unpaved surface (turf)

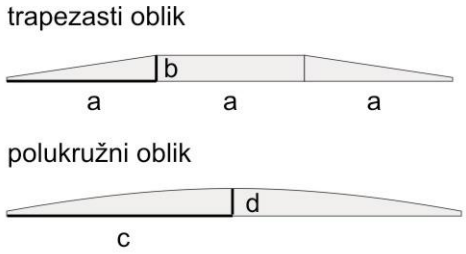
2.8.7 PREFABRICATED PHYSICAL SPEED STOPPERS

Prefabricated physical speed stoppers on a road are obstacles, which prevent vehicles to drive at speed higher than at the speed as indicated on the traffic sign.

Prefabricated physical speed stoppers shall be made in such a way and of such materials as not to create sufficient noise.

Prefabricated physical speed stoppers shall be on the side, from which the vehicles are approaching it, marked with light-reflecting materials or bodies.

Prefabricated physical speed stoppers can be of trapezoidal or semicircular shape. The height and the width, as well as the shape of the stoppers for individual speeds are indicated in the figure below.



v≤50 km/h	b = 30 mm	d = 30 mm
	a : b ≈ 6 : 1	c : d ≈ 10 : 1
v≤40 km/h	b = 50 mm	d = 50 mm
	a : b ≈ 6 : 1	c : d ≈ 9 : 1
v≤30 km/h	b = 70 mm	d = 70 mm
	a : b ≈ 6 : 1	c : d ≈ 8 : 1

trapezasti oblik = trapezoidal shape

polukružni oblik = semicircular shape

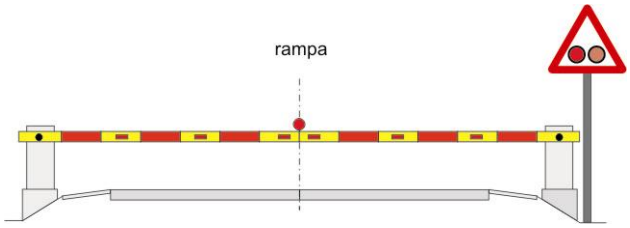
2.8.8 PLACING THE PREFABRICATED PHYSICAL SPEED STOPPERS ON ROADS – SLEEPING POLICEMEN

Prefabricated physical speed stoppers on roads called sleeping policemen may be only placed at such locations on the road, where the maximum admissible speed indicated by an adequate traffic sign must be ensured unconditionally.

Prefabricated physical speed stoppers (sleeping policemen) must not be placed on such road sections where they should be removed and re-installed for maintenance or any other reasons.

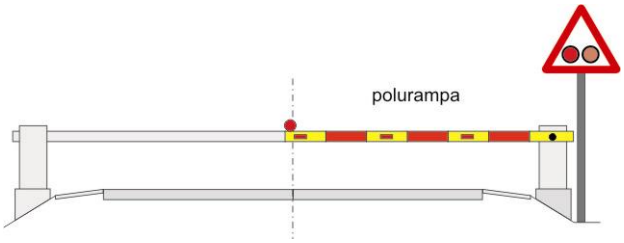
2.9 BARRIERS AND SEMI-BARRIERS

Barriers and semi-barriers are devices intended to prevent vehicles to proceed with driving, pedestrians with walking, and riders of riding in the direction transverse to the barriers. The barriers extend over the entire road width.



rampa = barrier

Semi-barriers extend up to the half-width of the road.



polurampa = semi-barrier

Barriers and semi-barriers shall be painted of coated with material, which reflects the light, alternatively red and white, except the barriers and semi-barriers located at road – railway crossings, where they are painted red and yellow, and marked with at least three glasses reflecting the red light.

Irrespective of the abovementioned rule, barriers or semi-barriers, when used to control the traffic at the entries to parking places and garages, can be painted alternatively yellow and black.

Barriers and semi-barriers can be additionally marked with special permanent or intermittent red lights.

2.10 ROAD LIGHTING

2.10.1 INTRODUCTION

Technical specifications (TSC) for road lighting were prepared on the basis of the final draft of European norm for lighting of traffic routes, and partly also took into account state-of-the-art foreign standards for road lighting and the documents of the International Commission on Illumination (CIE)

2.10.2 SUBJECT OF TECHNICAL SPECIFICATIONS

Technical specifications for road lighting provide guidelines for design, implementation and operations of lighting.

TSC does not specify which roads need illumination. The need for illumination is in most cases specified in spatial development acts and other documents related to spatial planning and traffic safety.

The guidelines given herein may be in part used to substantiate the need for illumination.

Technical specifications for road lighting do not apply to lighting of toll stations and tunnels.

2.10.3 SELECTION OF LIGHTING TECHNICAL CLASSES

2.10.3.1 Subject of the Section

Section three specifies the methodology for description of traffic areas with regard to parameters required for lighting. The relevant parameters are used to specify the appropriate lighting technical class with regard to traffic-technical characteristics of the traffic area.

The lighting technical class represents a collection of requirements regarding the quality of illumination with which lighting at the location in question must comply. In addition to requirements set in the lighting technical class, lighting shall also comply with the guidelines specified in item 4.3.

An overview of lighting technical classes and the appropriate requirements regarding the quality of illumination is provided in section 4.

2.10.3.2 Definition of Terms

Terms and definitions given below are in line with the draft European norm and apply solely for the purpose and use herein.

Traffic participants group:A traffic participants group shall be a category of persons or vehicles using the traffic area. Basic traffic participants groups are specified in items 3.2.2 through 3.2.5.

Motor traffic (M): Motor traffic shall be engine-driven vehicles not included in the slow vehicles category.

Slow vehicles (T): Slow vehicles may be engine-driven vehicles, e.g. tractors and farm machinery as well as animal-drawn vehicles with speed not exceeding 40 km/h.

Cyclists (K): The cyclists category shall include cyclists and riders of motorcycles with speed not exceeding 50 km/h.

Pedestrians (P): This category shall include pedestrians and disabled persons in wheelchairs.

Characteristic speed of the main traffic participants group: The speed of the traffic participants group, which is defined as the main group in the area in question. In case the main traffic participants group is a combination of motor traffic and one or more other groups, motor traffic shall be considered the main participants group.

Relevant area: The relevant area shall be the part of public traffic area to which lighting technical requirements apply[1].

Conflict area: The conflict area shall be the area where traffic flows from different directions meet or different types of traffic participants intertwine in the same relevant area.

Examples of conflict areas are: roundabouts, intersections, narrowing, transitions from two carriage lanes to one, points of access, etc.

Off-grade intersection: Off-grade intersections include entries and exits from the main road. Traffic in transversal direction flows outside the main road's level.

Intersection, intersection at grade: The area where two or more roads meet at the same level is categorised as intersection at grade.

Complexity of orientation: The effort required from the driver to select the right path and adjust the vehicle's position to other traffic participants, with regard to the traffic situation and visual information, shall be called complexity of orientation[2].

Average annual daily traffic: The average annual daily traffic shall be the average daily traffic in both directions expressed by number of vehicles/day.

Risk of crime: Criteria for the risk of crime shall be the risk of crime in the area in question compared to the risk of crime in the wider area.

Complexity of the sight area: If a lot of visual information appear in the driver's visibility field possibly resulting in wrong assessment of the information or interrupting visual perception, such situation shall be referred to as increased complexity of the sight area[3].

Luminance of surroundings: estimated luminance of surroundings[4]

Basic and specific parameters: Lighting technical requirements for individual road categories depend on traffic technical criteria described by a collection of **basic** and **specific** criteria.

Basic parameters form the basis for determining the group of lighting technical situations, while specific parameters are used for determining lighting technical requirements for the underlying traffic technical situation.

An overview of used parameters is contained in Attachment 2.

2.10.3.3 Description of the Lighting Technical Class Selection Procedure

Selection procedures for lighting technical class are specified in Attachment 1 (Table 3.1). The procedures are specified step by step.

2.10.3.4 Relevant Area for Individual Groups of Lighting Technical Situations

The description of lighting technical situations is also shown in Table 3.2.

Each area in question has specific requirements with regard to quality of lighting.

---

[1] Overview of relevant areas for individual groups of situations from Table 3.2 is specified in item 3.4.

[2] Visual guiding provided by road elements such as road markings, etc. forms a part of such information.

[3] Examples of interruptions of visual perception are glowing of advertisements, illumination of sports facilities, unclear layout of the road, poor visibility of guiding, etc.

[4] Dark surroundings correspond with rural areas.
medium illumination of surroundings – usually urban areas
light – urban area in town/city centres.

It is recommended that lighting technical requirements for two adjacent areas are not more than two comparable lighting technical classes apart[5].. Each group of situations presented in Table 3.2 corresponds to a particular relevant area.

The A Group describes traffic situations where traffic flows directly from one area to another (large town, etc.).

Relevant area for groups of situations A1, A2, A3

- If there are no hard shoulders for emergency stop, cyclist ways or pedestrian walkways along the carriageway, the relevant area shall be the entire road width.
- If the road in question has two directional carriageways and a separation green area, the relevant area shall be both directional carriageways and the green area, unless the green area's width allows us to treat each directional carriageway as a separate road.

In case the road has hard shoulders for emergency stop, two options shall be available:

- The relevant area may be the entire width of the carriageway including hard shoulders for emergency stop;
- Only the width of carriage lane is taken into account[6]..

In case of cyclist ways and pavements along the road, again two options exist:

- The relevant area to which lighting technical requirements apply shall be the entire road width including cyclist ways and pedestrian walkways;
- The relevant area shall be only the road width while pedestrian walkways and cyclist ways are handled in accordance with the criteria applying to pedestrian areas. See also Note 5.

In case the criteria regarding illumination of surroundings is taken into account for groups of situations A1, A2 and A3 (surroundings coefficient – KO), the surroundings coefficient shall relate only to the first carriage lane of the directional carriageway.

The B and C groups correspond to traffic situations inside a large area.

Relevant area for groups of situations B1 and B2

- If there are no pedestrian walkways and cyclist ways along the road, the road width shall be the relevant area;
- If pedestrian walkways and cyclist ways are along the roadway, requirements regarding lighting of cyclist ways and pedestrian walkways shall be taken into account separately from requirements for lighting of the carriageway.

Relevant area for the group of situations C1:

The relevant area shall be the entire area intended for pedestrians. In case the cyclist way and the walkway are parallel, they may be treated as a single area.

The D and E groups describe traffic situations with slow traffic in populated areas.

Relevant area for groups of situations D1, D2, D3:

- If there are no pedestrian walkways, the relevant area shall be the entire area in question.
- In case of separate pedestrian walkways, they may be handled separately from the rest of the area.

Relevant area for the group of situations D4:

- The relevant area shall be the entire area in question.

[5] This rule is particularly important in cases of roads where parallel areas being adjacent areas, e.g. carriageways, cyclist ways, pedestrian walkways, are handled separately.

[6] It is the second option, which is usually used, unless the possibility exists for the hard shoulder for emergency stop to be used as for example third carriage lane, in which case the first option is better advised.

Relevant area for the group of situations E1, E2:

The relevant area shall be the entire area intended for pedestrians. In case the cyclist way and the walkway are parallel, they may be treated as a single area.

2.10.3.5 Selecting Lighting Technical Class of Roads

In accordance with the procedures described in Attachment 1, the relevant area (item 3.4) and the group of possible lighting technical situations shall be established (steps 1 and 2).

The first step is determining the relevant area and the second determining the group of possible situations. We can select between possible groups of situations from A to E (Table 3.2).

The basic group of situations (12 possible groups) shall be determined by taking into account various types of traffic participants (M – motor traffic, K – cyclists, T – slow traffic, P – pedestrians).

Table no. 3.2.: Basic classification of lighting technical situations

Typical speed of main traffic participants	Main traffic participants	Other traffic participants allowed to use the traffic area	Groups of traffic participants prohibited from using the traffic area	Group of situations
High	M	-	TKP	A1
		T	KP	A2
		TKP	-	A3
Moderate	MS	KP	-	B1
	MSK	P	-	B2
	K	P	MT	C1
Low	MP	-	TK	D1
		TK	-	D2
	MK	TP	-	D3
	MTKP	-	-	D4
Very low	P	-	MTK	E1
		MTK	-	E2

Note:

– *High...>60 km/h*

– *Moderate >30 km/h and <60 km/h*

– *Low >5 km/h and <30 km/h*

– *Very low: walking.*

Step three: A pair of tables corresponds to the selected group of traffic situations, e.g. tables A1.1 and A1.2 corresponds to the group of situations A1, tables B1.1 and B1.2 to the group of situations B1, etc.

A group of three possible classes is determined by taking into account the basic parameters from the first table.

Step four: the class corresponding to the traffic situation in question is determined from the group of three possible classes, by taking into account the specific parameters.

Description of symbols in the table:

← Select the class entered on the far left of the group;

◦ Select the class entered in the middle of the group;

→ Select the class entered on the right of the group.

An overview of all steps required for determining the lighting technical class are given in Attachment 1, Table 3.1.

2.10.3.6 Example of Lighting Technical Class Selection

Example: the task is to determine the lighting technical class for a city radial road with the following specifications: speed limit 60 km/h, AADT 28000 vehicles, separate cyclist ways and pedestrian walkways, no parked vehicles, frequency of intersections > 3/km, light surroundings:

- The relevant area for determining the group of situations is the carriageway;
- The main group of traffic participants is M, the use of carriageway is prohibited for slow traffic (tractors, etc.), pedestrians and cyclists (T, P, K). (With regard to Table 3.2, the corresponding group of situations is A1);
- The appropriate group of classes is determined by using Table A1.1, by taking into account specific parameters. (group 3a,2,1 corresponds);
- The appropriate lighting technical class is determined in Table A1.2.

Meaning that of the possible selection of three classes 3a, 2, 1, the given traffic technical situation corresponds to the middle, i.e. lighting technical class M2 (marked in light grey).

In case of intersections (conflict area), the appropriate selection is the lighting technical class M1, or in accordance to the Table 3.5, class C1.

Table no. 3.3. (A.1.1.): Selection of lighting technical classes M for the group of situations A1

			Average annual daily traffic								
*			**< 15000**			**15000 to 25000**			**> 25000**		
	Distances between points of access	**No. of intersections per km**	←	o	→	←	o	→	←	o	→
Yes	> 3 km		5	4a	3a	4a	3a	2	4a	3a	2
	< 3 km		4a	3a	2	4a	3a	2	3a	2	1
		< 3	5	4a	3a	5	4a	3a	4a	3a	2
		> 3	4a	4a	3a	4a	3a	2	3a	2	1
No	> 3 km		4a	3a	2	3a	2	1	3a	2	1
	< 3 km		3a	2	1	3a	2	1	2	2	1
		< 3	4a	4a	3a	4a	3a	2	3a	2	1
		> 3	4a	3a	2	3a	2	1	2	2	1

* Separation of directional carriageways

Table no. 3.4. (A.1.2.): Selection of appropriate class from the group of situations in Table A1.1.

Conflict area	**Complexity of the sight field**	**Complexity of orientation**	**Luminance of surroundings**		
			Low	**Medium**	**High**
No	Normal	Normal	←	←	o
		Higher than normal	o	o	→
	High	Normal	←	o	o
		Higher than normal			
Yes			→		

2.10.3.7 Overview of Comparable Lighting Technical Classes

Regardless of the fact that individual groups of lighting technical classes are intended for evaluation of areas with varying traffic technical and safety requirements, individual classes may be compared with regard to quality of illumination. An overview of classes with comparable requirements regarding lighting is given in Table 3.5.

In case the relevant area has higher risk of crime (the need for face recognition) or the need to detect vertical surfaces, etc. the quality of illumination shall also be checked with regard to additional criteria taking into account vertical or semi-cylindrical illumination. In such cases, groups of classes EV and PC shall be used as additional groups with the basic groups of lighting technical classes C and P. An overview of comparable basic and additional classes is given in Table 3.6.

Table no. 3.5.: Overview of comparable lighting technical classes

Classes specified in individual columns are comparable								
C0	M1 C1	M2 C2	M3 C3 P1	M4 C4 P2	M5 C5 P3	M6 P4	 P5	 P6

Table no. 3.6.: Additional groups of classes PC and EV comparable with classes in groups C and P

Individual columns present basic and additional classes									
Basic class	C0	C1	C2	C3 P1	C4 P2	C5 P3	P4	P5	P6
Additional class	PC1	PC2 EV3	PC3 EV4	PC4 EV5	PC5	PC6	PC7	PC8	PC9

2.10.3.8 Groups of Lighting Technical Situations and the Appropriate Lighting Technical Classes

The following pages contain tables used for determining the lighting technical situation and the lighting technical class of roads.

The corresponding tables for the group of lighting technical situations A1 are tables A1.1 and A1.2, for the group of situations A2 tables A2.1 and A2.2, etc.

Table 3.7. (A.1.1.): Selection of lighting technical classes M for the group of situations A1

			Average annual daily traffic								
*			**< 15000**			**15000 to 25000**			**> 25000**		
	Distances between points of access	**No. of intersections per km**	←	o	→	←	o	→	←	o	→
Yes	> 3 km		5	4a	3a	4a	3a	2	4a	3a	2
	< 3 km		4a	3a	2	4a	3a	2	3a	2	1
		< 3	5	4a	3a	5	4a	3a	4a	3a	2
		> 3	4a	4a	3a	4a	3a	2	3a	2	1
No	> 3 km		4a	3a	2	3a	2	1	3a	2	1
	< 3 km		3a	2	1	3a	2	1	2	2	1
		< 3	4a	4a	3a	4a	3a	2	3a	2	1
		> 3	4a	3a	2	3a	2	1	2	2	1

Note:

** indicates separation of directional carriageways*

Table 3.8. (A.1.2.): Selection of appropriate class from the group of situations in Table A1.1.

Complexity of the sight field	Complexity of the visual task	Luminance of surroundings		
		Low	Medium	High
Normal	Normal	←	←	o
	Higher than normal	o	o	→
High	Normal	←	o	o
	Higher than normal	o	→	→

Table no. 3.9. (A.2.1.): Selection of lighting technical classes M for the group of situations A2

No. of intersections per km	Average annual daily traffic					
	< 7000			> 7000		
	←	o	→	←	o	→
< 3	5	5	4a	4a	3a	3a
≥ 3	5	4	3a	4a	3a	2

Table no. 3.10. (A.2.2.): Selection of appropriate class from the group of situations in Table A2.1.

Conflict area	Complexity of the sight field	Complexity of orientation	Luminance of surroundings		
			Low	Medium	High
No	Normal	Normal	←	←	o
		Higher	o	o	→
	High	Normal	←	o	o
		Higher	o	→	→
Yes				→	*

Note:

– In case of conflict areas, criteria regarding the quality of illumination shall be based on the LUMINANCE of the carriageway. In case the road's configuration prevents the use of these criteria, we may use the quality of illumination criteria with regard to ILLUMINATION of the carriageway (classes C).

Table no. 3.11. (A.3.1.): Selection of lighting technical classes M for the group of situations A3

*	No. of intersections per km	• Average annual daily traffic											
		< 7000			7000 – 15000			15000 – 25000			> 25000		
		←	o	→	←	o	→	←	o	→	←	o	→
Yes	< 3	5	5	4a	5	5	4a	5	4a	3b	4a	3b	2
	≥ 3	5	4a	3b	5	4a	3b	4a	3b	2	3b	2	2
No	< 3	5	4a	3b	5	4a	3b	4a	3b	2	3b	2	2
	≥ 3	4a	3b	3b	4a	3b	2	3b	2	2	3b	2	1

Note: *Separation of directional carriageways.*

Table no. 3.12. (A.3.2.): Selection of appropriate class from the group of situations in Table A3.1.

Conflict area	Complexity of the sight field	Still traffic	Complexity of orientation	Luminance of surroundings		
				Low	Medium	High
No	Normal	No	Normal	←	←	o
			Higher	o	o	→
		Yes	Normal	←	o	o
			Higher	o	→	→
	High	No	Normal	←	o	o
			Higher	o	→	→
		Yes	Normal	o	o	→
			Higher	→	→	→
Yes					→	*

Note:

– In case of conflict areas, criteria regarding the quality of illumination shall be based on the LUMINANCE of the carriageway. In case the road's configuration prevents the use of these criteria, we may use the quality of illumination criteria with regard to ILLUMINATION of the carriageway (classes C).

Table no. 3.13. (B.1.1.): Selection of lighting technical classes M for the group of situations B1

Physical barriers for slowing of traffic	No. of intersections per km	Complexity of orientation	Average annual daily traffic <7000			daily traffic >7000		
			←	o	→	←	o	→
No	< 3	Normal	6	5	4b	5	4b	3c
		Higher	5	4b	3c	5	4b	3c
	≥ 3	Normal	5	4b	3c	4b	4b	3c
		Higher	4b	3c	2	3c	3c	2
Yes			*			*		

Note:

Selection as above, however a class lower by one level shall be selected for areas with slowing of traffic.

Table no. 3.14. (B.1.2.): Selection of appropriate class from the group of situations in Table B1.1.

Conflict area	Complexity of the sight field	Still traffic	Luminance of surroundings					
			Low		Medium		High	
			Frequency of cyclists		Frequency of cyclists		Frequency of cyclists	
			Normal	Higher	Normal	Higher	Normal	Higher
No	Normal	No	←	o	←	o	o	o
		Yes	o	→	o	→	→	→
	High	No	o	o	o	o	o	o
		Yes	o	o	→	→	→	→
Yes					→ *			

Note:
In case of conflict areas, criteria regarding the quality of illumination shall be based on the LUMINANCE of the carriageway. In case the road's configuration prevents the use of these criteria, we may use the quality of illumination criteria with regard to ILLUMINATION of the carriageway (classes C).

Table no. 3.15. (B.2.1.): Selection of lighting technical classes M for the group of situations B2

Physical slowing of traffic	No. of intersections per km	Complexity of orientation	Average annual daily traffic					
			< 7000			> 7000		
			←	o	→	←	o	→
No	< 3	Normal	5	5	4b	4b	4b	3c
		Higher	4b	4b	3c	4b	4b	3c
	≥ 3	Normal	4b	3c	2	3c	3c	2
		Higher	3c	3c	2	3c	3c	2
Yes			*			*		

Note:
Selection as above, however 1 shall be selected for areas with slowing of traffic.

Table no. 3.16. (B.2.2.): Selection of appropriate class from the group of situations in Table B2.1.

Conflict area	Complexity of the sight field	Still traffic	Luminance of surroundings					
			Low		Medium		High	
			Frequency of cyclists		Frequency of cyclists		Frequency of cyclists	
			Normal	Higher	Normal	Higher	Normal	Higher
No	Normal	No	←	o	←	o	o	o
		Yes	o	→	o	→	→	→
	Higher	No	o	o	o	o	o	o
		Yes	o	o	→	→	→	→
Yes					→ *			

Note:
In case of conflict areas, criteria regarding the quality of illumination shall be based on the LUMINANCE of the carriageway. In case the road's configuration prevents the use of these criteria, we may use the quality of illumination criteria with regard to ILLUMINATION of the carriageway (classes C).

Table no. 3.17. (C.1.1.): Selection of lighting technical classes P for the group of situations C1

Physical slowing of traffic	Risk of crime	Face recognition	• Frequency of cyclists					
			Normal			Higher		
			←	o	→	←	o	→
No	Normal	Unnecessary	6	5	4	5	4	3
		Necessary	5	4	3	4	3	2
	High		4	3	2	3	2	1
Yes			3		2		1*	

Note:- *– For areas with slowing of traffic only.*

Table no. 3.18. (C.1.2.): Selection of appropriate class from the group of situations in Table C1.1.

Luminance of surroundings		
Low	**Medium**	**High**
←	o	→

Table no. 3.19. (D.1.1.): Selection of lighting technical classes C for groups of situations D1 and D2

Physical slowing of traffic	Risk of crime	Face recognition	Complexity of orientation	Frequency of pedestrians					
				Normal			Higher		
				←	o	→	←	o	→
No	Normal	Unnecessary	Normal	5	5	4	5	4	3
			Higher	5	4	3	4	3	2
		Necessary	Normal	4	4	4	4	4	3
			Higher	4	4	3	4	3	2
	High		Normal	4	4	3	4	3	3
			Higher	4	3	2	3	2	2
Yes							*		

Note: – Select as above only for areas of measuring of slowing of traffic (≤ 4).

Table no. 3.20. (D.1.2.): Selection of appropriate class from the group of situations in Table D1.1.

Luminance of surroundings		
Low	**Medium**	**High**
←	o	→

Table no. 3.21. (D.2.1.): Selection of lighting technical classes P for groups of situations D3 and D4

Physical slowing of traffic	Still traffic	Complexity of orientation	Frequency of pedestrians and cyclists					
			Normal			Higher		
			←	o	→	←	o	→
No	No	Normal	6	5	4	5	4	3
		Higher	5	4	3	4	3	2
	Yes	Normal	5	4	3	4	3	2
		Higher	4	3	2	3	2	1
Yes						*		

Note: – Select as above only for areas of measuring of slowing of traffic (≤ 4).

Table no. 3.22. (D.2.2.): Selection of appropriate class from the group of situations in Table D2.1.

Complexity of the sight field	Risk of crime	Face recognition	Luminance of surroundings		
			Low	Medium	High
Normal	Normal	Unnecessary	←	o	o
		Necessary	←	o	→
	High		o		→
Higher	Normal	Unnecessary	o	o	o
		Necessary	o	→	→
	High		→	→	→

2.10.4 LIGHTING TECHNICAL CLASSES AND LIGHTING REQUIREMENTS

2.10.4.1 Subject of the Section

The subject of the section are requirements regarding the quality of lighting to be fulfilled by the lighting in the area in question in order to provide appropriate visibility conditions for traffic participants.

The group of lighting quality requirements is the lighting technical class.

The criteria for evaluation of lighting are different for each group of lighting technical classes and correspond to specific traffic conditions.

Classes of the M group are intended for lighting of traffic routes where distances are large enough for the use of the **luminance** concept. They can be also partially used as requirements for lighting of housing areas.

Classes of the MW group are given in Attachment 3 (Table 4.12) for informational purposes. Classes of the MW group supplement classes of the M group and apply to climate conditions where roads are mostly wet.

Classes of the C group are intended for lighting of conflict points where distances are too small for the use of the luminance concept. Classes of the C group are determined on the basis of horizontal **illumination.** Conflict points are for example intersections, roundabouts, areas of narrowing (transition from two carriage lanes to one). Conflict areas are also shopping streets and streets with high frequency of pedestrians. The group of lighting technical classes C is also intended for use on pedestrian areas and cyclist areas.

Classes of the P and A groups are used for lighting of areas with slow speed of traffic flows, i.e. pedestrian and cyclist areas, hard shoulders for emergency stop, streets and roads with housing, parking lots, etc. The basic criteria for the group of lighting technical classes P is the horizontal illumination, and for the group of lighting technical classes A semi-spherical illumination. Lighting technical classes of the A group originate from Scandinavian countries.

Classes of the PC group are intended as an additional group of classes, including lighting requirements for areas with bigger requirements regarding recognition of persons and objects and for areas with high risk of crime. The level of **semi-cylindrical illumination** shall apply as the criterion.

Classes of the EV group are an additional group of classes combining requirements for areas where there are bigger requirements regarding perception of vertical areas (toll stations, barriers, etc.). The basic criterion for assessment of lighting is the level of vertical illumination.

2.10.4.2 Description of Terms, Abbreviations and Symbols

Visual guiding Optical and geometric means enabling the driver to receive appropriate information on the layout of the carriageway. Visual guiding relates to the perception aspect and optical guiding to the geometrical aspect. Visual guiding is used herein as a general aspect, which also includes optical guiding.

Average luminance (of the road area, carriage lane) Arithmetic mean value of luminance in individual points of the evaluation area.

The unit is cd/m^2.

General uniformity ratio of luminance U_o The general uniformity ratio of luminance of the road area is the ratio between the minimum luminance in any point in the evaluation area and the average luminance therein.

Longitudinal uniformity ratio of luminance of the carriage lane Longitudinal uniformity ratio of luminance is the ratio between the minimum and maximum luminance L_{min}/L_{max} on the carriage lane's symmetral.

Longitudinal uniformity ratio of luminance of the carriageway (*U*$_l$) The minimum value of longitudinal uniformity ratio of luminance of all carriage lanes on the carriageway.

The relative increase of the threshold is the criterion for reduced sight ability caused by disturbing glare of road lamps. *TI* is given in percents and represents the minimum value for which the level of median luminance of the carriageway shall be increased in order to provide equal visibility of an object as if no glare existed.

TI shall be calculated for the worst possible scenario, i.e. clean lamps and the initial lighting of illuminants.

Luminance of surroundings coefficient *Ko* The basic purpose of road lighting is enabling perception of objects and obstacles on the road. Hence the adequate contrast between the surroundings and the road area shall be provided. As the road area is not always the background, sufficient illumination of surroundings shall also be provided.

Luminance of surroundings coefficient is the ratio between illumination of the area delimited by the road's edge and the parallel outside the carriageway in the distance of 5 m from the road's edge, and the luminance of the road area 5 m from the kerb (or the width of one carriage lane – the smaller value is taken into account).

Average illumination of the road area *E* The average value of horizontal illumination on the road area – in the evaluation area.

General uniformity ratio (of luminance, semi-spherical illumination) The ratio between the minimum and average values.

Maintained value (of luminance, illumination, semi-spherical illumination, semi-cylindrical illumination, vertical illumination) The minimum still permitted value during operations of the facility.

Semi-cylindrical illumination The ratio between the light flow falling on the curved surface of a small semi-cylinder and the area of the semi-cylinder. The direction of perpendicular to the plane being the back side of the semi-cylinder is the direction of its orientation.

The unit is lx.

Vertical illumination Illumination on a vertical surface.

The unit is lx.

Semi-spherical illumination The ratio between the light flow falling on a small semi-sphere (its basis lies on a flat surface) and the area of the semi-sphere.

2.10.4.3 General Requirements to be Considered in Lighting Design

In addition to requirements regarding quality of lighting for a particular lighting technical class corresponding to the traffic area in question, the lighting design shall also take into account guidelines specified below.

2.10.4.3.1 Limiting glare

Glare poses a big problem in road lighting since it reduces the ability of visual perception. Hence requirements regarding limiting of glare shall be taken into account in all groups of lighting technical classes.

In lighting technical classes of the M group, requirements regarding limiting of glare are given in the form of the maximum permitted *TI* (*relative increase of the perception threshold*).

In lighting technical classes of the C group, the basic guidelines for limiting of disturbing glare is the value of *TI*, however the value of *TI* shall be calculated for all possible positions of the observer.

In case *TI* cannot be calculated or may be harder to calculate due to configuration of lighting spots, limiting of glare can be achieved by using lamps with limit values of

luminous intensity at all C levels for the given angles of the luminous intensity vector with regard to the vertical line not exceeding values given in Table 4.1.

Table no. 4.1.: Glaring classes and requirements regarding limiting of luminous intensity

Class of glare	Maximum luminous intensity [cd/klm]			Other requirements
	70 ^{o}	**80** ^{o}	**90** ^{o}	
M1		200	50	None
G2		150	30	None
G3		100	20	None
G4	500	100	10	Luminous intensity in the direction above 95[1] shall equal 0
G5	350	100	10	Luminous intensity in the direction above 95[1] shall equal 0
G6	350	100	0	Luminous intensity in the direction above 90[1] shall equal 0

[1] *Angle between the luminous intensity vector and the vertical line in any direction. Inclination of the lamp corresponds to the working position of the lamp.*

Classes for limiting of glow G1, G2 and G3 correspond to terms "half-screened" or "screened lamp" while classes G4, G5 and G6 correspond to fully screened lamp.

Note: The relative increase of the threshold TI is the criterion for reduced sight ability caused by luminance of screening because of the disturbing glare. The light flow of illuminants affects both the luminance of screening and the luminance of the road and has therefore no effect on requirements regarding limiting of glare.

As regards groups of lighting technical classes P (traffic areas intended for pedestrians and cyclists), classification given in Table 4.2 (classes of the D group) are used for evaluation of psychological (unpleasant) glare.

Class D0 includes lamps causing the most glare and class D6 lamps with the least glare.

Table no. 4.2.: Classification of lamps with regard to unpleasant glare index

Class	D0	D1	D2	D3	D4	D5	D6
Glare index	-	7000	5500	4000	2000	1000	500

Glare index is calculated by using the following formula:

$$D = \frac{I}{\sqrt{A}} \qquad (1)$$

where:

I *maximum value of luminous intensity on any C flat surface for the angle between the luminous intensity vector and the vertical line 85°;*

A *is the area of projection of the illuminating part of the lamp to the flat surface right-angled to the luminous intensity vector* ***I****.*

Note 1: In case the source of lighting is (partly or in full) directly visible in the direction of maximum luminous intensity, the glare index shall be D0.

Note 2: In accordance with the practice, the adequate accuracy shall be provided if the projection of the illuminating part of the lamp to the vertical plane is taken into account.

Example of the glare index calculation:

Example A) The lamp has a spherical shape with diameter of 0.6 m, luminous intensity of the installed illuminates in all directions equals 60 cd/1000 lm. The area of the lamp's projection in the vertical plane is:

$A = ¶ * 0.6^2/4\ m^2$ (2)

$A = 0.28\ m^2$

$D = \frac{60}{\sqrt{28}}$ D = 113 for 1000 lm of the light flow

In case we use a HST illuminant of 70 W power with the light flow of 5500 lm, the lamp shall correspond to the glare class D5.

Example B) The lamp has a protective glass resembling rectangular shape of 0.1 m in height, 0.3 m in length and 0.2 m in width. The maximum value of luminous intensity under 85° angle with regard to the vertical line is at the plane being right-angled to the longitudinal symmetric of the lamp and equals 50 cd/1000 lm.

$A = 0.3*0.2*\cos 85° + 0.3*0.1 * \cos (90°-85°)$

$A = 0.035m^2$

$D = \frac{50}{\sqrt{0,035}}$ D = 267 for each 1000 lm of the illuminant's light flow

In case the lamp has a HST illuminant of 70 W power, the lamp shall correspond to the glare class D4.

2.10.4.3.2 Colour appearance

Colour appearance shall be taken into account in any lighting technical situation, and may correspond to one of the following categories.

A) No particular requirements regarding colour appearance;
B) Lighting devices shall provide the level of colour appearance enabling the orientation of drivers and pedestrians (example: emphasising visual guiding, recognition of traffic signs);
C) Lighting devices shall provide the level of colour appearance enabling recognition of people or objects (example: recognition of parked vehicles, recognition of persons in areas with higher risk of crime).

Table 4.3 contains requirements with regard to the colour appearance for individual relevant areas and with regard to visual tasks, which may occur in night driving.

Table no. 4.3.: Requirements regarding colour appearance

Condition	Required colour appearance category
The relevant area is a conflict one	**B[1]**
Used measures for slowing of traffic	
More complex visual tasks (orientation)	
Still traffic (parked vehicles)	**C[1]**
Face recognition required	
Increased risk of crime	

[1]Note: In order to achieve the required level of colour appearance, a lighting technical class one level higher from the lowest required lighting technical class shall be selected in certain cases.

2.10.4.3.3 Changing levels of luminance and illumination during the night time

Requirements for lighting quality conditioned by individual lighting technical classes, shall be fulfilled always when the relevant parameters require a certain lighting quality (see also Section 3). In cases where for example traffic density or luminance of surroundings as the relevant parameters change during the night time, and the changed values correspond to a different lighting technical class, it is recommended to adapt the lighting quality to the changed conditions during the night.

In practice, changed conditions in most cases mean lower traffic density in late night hours, which means that a lighting technical class with a lower level of luminance may be appropriate.

Note: During the time when traffic technical conditions allow the class with a lower level of luminance, various devices for management of light flow of illuminants can be used to reduce the luminance on the carriageway while preserving the required uniformity ratio of luminance.

A reduction by turning off every second lamp shall not be allowed as the longitudinal uniformity ratio of luminance is reduced below permitted level.

2.10.4.3.4 Visual guiding

Good visual guiding shall be taken into account in placement of lighting devices. Visual guiding is in most cases provided by the appropriate placement of lamps. In certain cases it is recommendable to place even a lighting point or a small number of lighting points on a road otherwise not illuminated in order to provide visual guiding. Such examples include exits from main roads with higher driving speed, exits and entries with high frequency of fog, etc.

In case visual guiding is provided by an individual lamp or a small number of lamps, lighting shall correspond to the lighting technical class P7 or A6 and requirements regarding limiting of glare in accordance with Table 4.2 shall also be taken into account.

2.10.4.3.5 Appearance of lighting devices during daytime and night time and impact on the environment

Road lighting devices have an important impact on the road's appearance both during daytime as well as night time.

The following factors shall be foremost taken into account in selection and design of lighting devices:

Appearance during daytime:

- Selection of the appropriate method for installation of lamps, e.g. installation on consoles on buildings, installation on road lighting poles with or without handles, hanging on stranded wire, etc.;
- Appearance and colour of road lighting poles;
- Size of road lighting poles in comparison with other elements in surroundings (buildings, etc.);
- Placement points of road lighting poles with regard to appearance of surroundings;
- Appearance, design and inclination of handles on poles;
- Inclination of lamps;
- Selection of lamps – appearance, adjustment with regard to surroundings.

Appearance during the night time and comfort:

- Colour of light;
- Level of colour appearance enabled by lighting;
- Height of lamp installation;
- Appearance of lamps during the night time;

- Visual guiding enabled by lighting devices;
- Reduction of luminance levels during the time of smaller traffic volumes.

Pollution with light has become an increasingly significant issue lately. The basic rule is that the light should be directed to where it is needed. It is a fact that the light reflecting from the illuminated road surface also contributes to creation of the so-called sky glow, however the major part of polluting light comes from unscreened lamps (notably spheres).

Limiting glowing of light in the sky and consequently limiting wasting of light can be achieved by selecting screened lamps (Table 4.1).

The problem of pollution with light is even more pressing in polluted areas where the light reflects from polluted air particles.

2.10.4.4 Overview of lighting technical classes

Values given in tables represent the minimum maintained value of illumination / luminance and other criteria regarding lighting quality, which shall be provided during the entire life span of the facility.

2.10.4.4.1 Lighting technical classes of the M group

Classes of the M group are intended for lighting of traffic routes where distances are large enough for the use of the **luminance** concept. They can be also partially used as requirements for lighting of housing areas.

Lighting technical classes of the M group are only used for road sections where the sight distance is at least 60 m.

The KO criterion shall only be used in case no other traffic areas, e.g. pedestrian walkways and cyclist ways, are placed along the carriageway.

Table no. 4.4.: Requirements for classes of the M group

Class	L_{sr}	U_o	U_l	*TI*	*KO*
M1	2.0	0.4	0.7	10	0.5
M2	1.5	0.4	0.7	10	0.5
M3a	1.0	0.4	0.7	15	0.5
M3b			0.6		
M3c			0.5		
M4a	0.75	0.4	0.6	15	0.5
M4b			0.5		
M5	0.5	0.35	0.4	15	0.5
M6	0.3	0.35	0.4	15	-

Note: Definitions of individual quantities (L_{sr}, U_o, *TI and Ko)* are given in item 3.

2.10.4.4.2 Classes of the C group

Classes of the C group are intended for lighting of conflict points where distances are too small for the use of the luminance concept. Classes of the C group are determined on the basis of horizontal **illumination.** Conflict points are for example intersections, roundabouts, areas of narrowing (transition from two carriage lanes to one). Conflict areas are also shopping streets and streets with high frequency of pedestrians. The group of lighting technical classes C is also intended for use on pedestrian areas and cyclist areas.

Table no. 4.5.: Requirements for classes of the C group

LIGHTING TECHNICAL CLASS	E_{SR} (lx) – MINIMUM VALUE OF MEDIAN ILLUMINATION OF THE ENTIRE AREA	U_O – MINIMUM UNIFORMITY RATIO OF ILLUMINATION
C0	50	0.4
C1	30	0.4
C2	20	0.4
C3	15	0.4
C4	10	0.4
C5	7.5	0.4

Lighting technical classes of the C group are thus primarily intended for motor traffic in areas where sight distances are shorter than 60 m on points where multiple positions of observers shall be taken into account.

At the same time, classes of the C group are also intended for providing sufficient sight conditions to other participants allowed to use the specific conflict area.

The glare criterion shall be used as an additional criterion with regard to lighting technical classes of the C group.

TI values shall be evaluated for all possible positions of observers and the highest calculated value shall be taken into account. It is recommended that the *TI* value does not exceed 15%.

Alternatively, glare may be limited by selecting semi-screened or screened lamps.

2.10.4.4.3 Classes of the *P* and *A* groups

Classes of P and A groups are used for lighting of areas with slow speed of traffic flows, i.e. pedestrian and cyclist areas, hard shoulders for emergency stop, streets and roads with housing, parking lots, etc.

The basic criterion for assessment of lighting is the **horizontal illumination**.

An alternative to P classes in Scandinavian countries are classes of the A group where the criterion is semi-spherical illumination.

Glare may be limited by selecting lamps corresponding to classes D1, D2… D6 (Table 4.2).

Classes of the A group are specified in Attachment 3 (Table 4.13).

Table no. 4.6.: Requirements for classes of the P group

LIGHTING TECHNICAL CLASS	AVERAGE HORIZONTAL ILLUMINATION (lx)	MINIMUM HORIZONTAL ILLUMINATION IN THE POINT (lx)
P1	15	5
P2	10	3
P3	7.5	1.5
P4	5	1
P5	3	0.6
P6	2	0.6
P7	No requirements	No requirements

2.10.4.4.4 Classes of the PC group

Classes of the PC group are intended as an additional group of classes, including lighting requirements for areas with bigger requirements regarding recognition of persons

and objects and for areas with high risk of crime. The level of **semi-cylindrical illumination** shall apply as the criterion.

Equal requirements as apply to classes of the P group shall apply with regard to limiting of glare.

Table no. 4.7.: Requirements for classes of the PC group

Minimum maintained value of semi-cylindrical illumination 1.5 m above the road's surface	
Class	**E_{pc}**
PC 1	10
PC 2	7.5
PC 3	5
PC 4	3
PC 5	2
PC 6	1.5
PC 7	1
PC8	0.75
PC 9	0.5

2.10.4.4.5 Classes of the *EV* group

Classes of the EV group are an additional group of classes combining requirements for areas where there are bigger requirements regarding perception of vertical areas (toll stations, barriers, etc.). The basic criterion for assessment of lighting is the level of vertical illumination.

Table no. 4.8.: Requirements for classes of the EV group

Minimum maintained value of vertical illumination	
Class	**E_v (lx)**
EV1	50
EV2	30
EV3	10
EV4	7.5
EV5	5
EV6	0.5

Regardless of the fact that individual groups of lighting technical classes are intended for evaluation of areas with varying traffic technical and safety requirements, individual classes may be compared with regard to quality of illumination. An overview of classes with comparable requirements regarding lighting is given in Table 4.9.

Table no. 4.9.: Overview of comparable lighting technical classes

Classes specified in individual columns are comparable								
C0	M1 C1	M2 C2	M3 C3 P1	M4 C4 P2	M5 C5 P3	M6 P4	 P5	 P6

In case the relevant area has higher risk of crime (the need for face recognition) or the need to detect vertical or semi-cylindrical illumination, groups of classes EV and PC shall be used as additional groups along basic groups of lighting technical classes C and P.

The overview of basic and additional classes is given in Table 4.10.

Table no. 4.10.: Additional groups of classes PC and EV comparable with classes in groups C and P

Individual columns present basic and additional classes									
Basic class	C0	C1	C2	C3 P1	C4 P2	C5 P3	P4	P5	P6
Additional class	PC1	PC2 EV3	PC3 EV4	PC4 EV5	PC5	PC6	PC7	PC8	PC9

2.10.4.5 Additional Lighting of Pedestrian Crossings

2.10.4.5.1 General

The provided lighting requirements for pedestrian crossings apply to crossings outside intersection areas. Intersections are in themselves conflict points and pedestrian crossings in intersection areas are subject to requirements of lighting technical classes of the C group. Pedestrian crossings are dangerous points as regards the traffic safety aspect. During the night time, road lighting shall provide visual conditions enabling safe driving with permitted speed on a particular road section. In case the road lighting is insufficient for providing visual conditions for seeing pedestrians on crossings, such crossings shall be additionally illuminated so that sufficient ***positive contrast*** of pedestrians with regard to surroundings / road section after the pedestrian crossing is provided.

Additional lighting provides visual conditions for the following:

- Perception;
- Recognition;
- Reactions of drivers guided by using sight.

The function of additional lighting on pedestrian crossings is also denoting the point of the crossing.

The crossing is denoted by:

- Different colour of light at the point of the crossing;
- Higher level of luminance of the carriageway at the point of the crossing.

Warning signal lights may also be placed at the point of the crossing in combination with the lighting, however they are not discussed herein.

2.10.4.5.2 Pedestrian crossings in urban areas with medium of low traffic density

The lighting requirements for pedestrian crossings vary with regard to the location of crossing.

As regards crossings in areas with medium or low traffic density – housing areas in towns, industrial areas with small traffic density – requirements specified in Table 4.11 in line with the publication CIE 136/2000 shall apply.

Table no. 4.11.: Lighting requirements for pedestrian crossings in urban areas

	Average E_h	Minimum E_h	Minimum E_{pc}
Trade and industrial areas	20 lx	7.5 lx	10 lx
Housing areas	10 lx	3 lx	5 lx

E_h ... Horizontal illumination
E_{pc}... Semi-cylindrical illumination

2.10.4.5.3 Pedestrian crossings on main roads and areas with higher density and speed of traffic flows

Lighting technical requirements and implementation method for additional lighting on pedestrian crossings on main roads and roads with high traffic density

In order to achieve sufficient positive contrast, the minimum median value of E_v equalling 40 lx 1 m above the carriageway shall be provided in the evaluation area, where the value of E_v shall at no point of the evaluation area be below 5 lx.

As regards roads with two-way traffic, the required value of median vertical illumination for each direction of driving can be achieved by using only two lamps, placed in front of the crossing viewed from the individual driving direction (outline – Attachment 4, Figure 4.1).

Additional lighting of pedestrian crossings shall not be required if on the part of the road where the crossing is located the placed road lighting provides the following values 50 m before and after the crossing:

- Maintained median luminance of the carriageway of 2 cd/m^2;
- Longitudinal uniformity ratio of luminance of 0.7;
- General uniformity ratio of 0.4;
- Limiting of glare: *TI* in the area of the crossing shall be up to 10% or screened lamps shall be used (lamps corresponding to class of glare between G3 and G6).

Evaluation area

The criteria for evaluation of additional lighting on pedestrian crossings on roads with larger traffic density shall be the *vertical illumination level* for individual driving directions.

For the purpose of uniform methodology of calculations and measurements in the pedestrian crossing area, the evaluation area shall be defined. The outline of the evaluation area is presented in Attachment 4, Figure 4.2. The evaluation area shall be delimited by two parallels transversely to the direction of driving (the beginning and end of the crossing) while longitudinally the evaluation areas shall be delimited by parallels in the distance equalling carriageway width and waiting areas width.

The widths of parking spaces and cyclist ways shall not be taken into account with regard to the evaluation area.

Evaluation points shall be on the symmetral of the carriageway viewed transversely to the direction of driving. The initial point shall be in the middle of the carriageway, and the subsequent points on the symmetral of the crossing in distances of 1 m in the direction towards the edge of the carriageway.

Lighting before and after pedestrian crossings

If the median luminance of the carriageway before and after the pedestrian crossing is less than 0.3 cd/m^2, road lighting providing the minimum average luminance of the carriageway equalling 0.3 cd/m^2 with the general uniformity ratio of luminance $U_0 \geq 0.3$ shall be placed 100 m before and 100 m after the crossing.

Additional lighting on pedestrian crossings shall be turned on during the entire period of darkness. The period of darkness shall be the time during which the average value of vertical illumination resulting from daylight in the area of pedestrian crossing is less than 40 lx.

The criteria for turning off and on of additional lighting on pedestrian crossing shall differ from the criteria for turning off and on of public lighting and it is therefore recommended that the turning off and on of additional lighting is performed by a special accurately set photocell. The practice has shown that the best photocells are those with the probe separately installed on the top of the lighting pole thus reducing the disturbing influence from surroundings to the minimum. In order to provide for long-term stable operations, the probe shall be protected by material resistant to ageing (e.g. hardened glass).

2.10.5 DESIGN CALCULATION OF ROAD LIGHTING

2.10.5.1 Subject of the Section

This section describes mathematical procedures and rules for calculations regarding road lighting. The purpose of harmonising procedures is to provide comparability of calculations having different sources of input data.

2.10.5.2 Definition of Terms

Terms given below are in line with the draft European norm regarding road lighting and apply for the purpose and use herein.

Basic photometric axis (of the lamp measured in (*C*, γ) co-ordinate system) The vertical axis through photometric centre of the lamp.

NOTE 1: The starting point of the (C, γ) co-ordinate system lies on this axis. See Figure 5.1.

***C* level of light beam** The vertical semi-plane defined by the basic axis of the lamp and vector of the light beam.

Angle of the *C* plane (azimuth of light beam) The angle between semi-plane of the light beam and the reference semi-plane through the basic photometric axis of the lamp.

NOTE 1: Measure: ° (degree).
NOTE 2: See Figure 5.1.

Vertical beaming angle (of light beam) (γ) Angle between the light beam and the basic photometric axis of the lamp.

NOTE 1: Measure: ° (degree).
NOTE 2: See Figure 5.1.

Entry angle of light (of light beam in the point on the driving area) (ε) Angle between the light beam and perpendicular to the driving area.

NOTE 1: Measure: ° (degree).
NOTE 2: See Figure 5.4.

Deflection angle (in relation to luminance coefficient) (β) The complementary angle between the vertical plane through the lamp and the observed point and the vertical plane through the observer and the observed point.

NOTE 1: Measure: ° (degree).
NOTE 2: See Figure 5.4.

Luminance coefficient (on the part of driving area in the given direction, under certain illumination conditions) (*q*) Luminance coefficient of the element of surface in the given direction and illumination thereof.

NOTE 1: Measure: sr^{-1}.

NOTE 2: $$q = \frac{L}{E}$$.

where:
q *is luminance coefficient in sr^{-1}*
L *is luminance in cd/m^2*
E *is illumination in lx*

Reduced luminance coefficient (in the point of surface) (*r*) The reduced luminance coefficient is the luminance coefficient multiplied by the third exponent of cosine of entry angle of light in a point.

NOTE 1: Measure: sr^{-1}.

NOTE 2: It may be described by formula:

$$r = q \cdot \cos^3 \varepsilon$$

where:
q *is luminance coefficient in sr^{-1}*
ε *entry angle of light in degrees*

NOTE 3: The angle of observing α (Figure 5.4) affects the value of r. It is agreed that the angle of observing of 1° is taken into account for calculation of road lighting. The value of r is relatively constant for angles α between 0.5° and 1.5°.

Inclination during measurement (of lamp) (θ_m) The angle between the measurement axis of the lamp and the horizontal line when the lamp is set for measurement.

NOTE 1: See Figures 5.1 and 5.8.

NOTE 2: The measurement axis of the lamp may be determined by any characteristic of the lamp.

As regards lamps for placement on a leg, the measurement axis is mostly determined as the axis of the leg.

As regards lamps for putting on a pole, the measurement axis is generally determined by the axis of the cover.

Inclination during operations (of lamp) (θ_f) The angle between the measurement axis of the lamp during operations and the horizontal line.

NOTE 1: See Figures 5.1 and 5.8.

Orientation (of lamp) (ν) When the basic photometric axis of the lamp is vertical, the orientation of the lamp shall be the angle between the selected reference direction and the direction C = 0°, γ = 90° during measurement of the lamp.

NOTE 1: measure: ° (degree).

NOTE 2: When the road is flat, the reference direction shall be longitudinal.

NOTE 3: The agreed markings are evident from Figure 5.7.

Turn (of lamp) (ψ) Is the angle between the basic photometric axis of the lamp and the right-angled projection of the lamp when the inclination during measurement equals zero.

NOTE 1: measure: ° (degree).

NOTE 2: The agreed markings are evident from Figure 5.7.

Longitudinal direction The direction parallel to the road's axis.

Transversal direction The direction lying right-angled to the road's axis.

NOTE: The transversal direction in a curve is the one lying on the curve's radius in the point of interest.

Azimuth of placement (with regard to the point of the road's surface and the particular lamp in the measurement position) (φ) When the lamp is in the basic measurement position, this is the angle formed by the selected reference direction – longitudinal for the flat road – with the vertical plane through the given point and the first photometric axis of the lamp.

NOTE 1: measure: ° (degree).

NOTE 2: See Figure 5.4.

2.10.5.3 Mathematical agreements

The basic agreements regarding mathematical procedures given are as follows:

- The lamp is taken into account as a point light source;
- The light reflected from surroundings and the light resulting from multiple reflections is disregarded;
- Screening of light due to trees and other objects is disregarded;
- The road surface shall be flat and have constant reflection characteristics in all area taken into account.

2.10.5.4 Photometric Data

2.10.5.4.1 General

Photometric data of lamps used are required for calculation of criteria regarding lighting quality.

Data are given in the form of tables (I tables), which specify values of luminous intensity in all main directions.

Photometric data on reflectance of the road surface in the form of a *r*-table (example – Attachment 6, Table 5.2) are required for calculation of luminance of the road surface.

Tables specify values for particular angles.

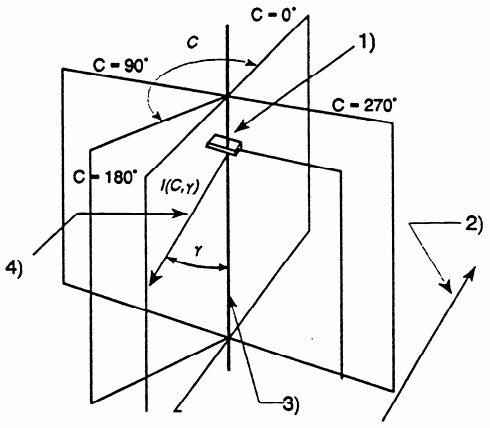
Values for points lying outside the given angles are determined by using interpolation.

2.10.5.4.2 Table of luminous intensity distribution

Tables of luminous intensity shall comply with requirements of the prEN 13032-1 standard.

The co-ordinate system used for road lamps shall be (C, γ) and is presented in Figure 5.1. The co-ordinate system (B, β) may be used for reflector lighting. Figure 5.1 presents the lamp with inclination during measurements.

Luminous intensity of the lamp is given in candelas per thousand lumens (kilolumens). The unit is cd/klm.



1) Lamp with basic inclination.

2) Longitudinal direction.

3) Basic photometric axis.

4) Direction of luminous intensity.

Figure 5.1: Direction of C, γ co-ordinate system with regard to the longitudinal direction of the roadway

In order to provide adequate accuracy of calculations, intervals between given angles shall not be greater than:

Intervals for angles in the vertical plane (γ) for all lamps shall be maximum 2.5° from 0° to 180°. Angles of directions of C planes shall change with regard to symmetry of luminous intensity distribution:

A) Non-symmetric lamps with regard to C plane = 0°; intervals between angles shall be maximum 5°, with the beginning at 0° and up to 355° with regard to the measurement position of the lamp;

B) Lamps with symmetry with regard to C plane = 270° - 90°; intervals between angles shall be maximum 5°, beginning at 270° with regard to the measurement position of the lamp and ending at 90°;

C) Lamps with symmetry with regard to C plane = 270° - 90° and 0° - 180°; intervals between angles shall be maximum 5°, beginning at 0° with regard to the measurement position of the lamp and ending at 90°;

D) Lamps with even distribution of luminous intensity at all C levels: only measurement for all gamma angles in any C plane is required.

2.10.5.4.3 Methods for interpolation into values in the "I table"

Values of luminous intensity are given only for certain intervals of gamma angles and C planes. The required intermediate values shall be interpolated.

Linear or square interpolation is required.

Linear interpolation is the simplest procedure and may be used if data regarding luminous intensity distribution in intervals of angles in accordance with requirements specified in Item 5.2 are available. In case data are given for bigger intervals between angles, square interpolation shall be used.

Linear interpolation

In order to determine luminous intensity values $I(C, \gamma)$, interpolation shall be made by using four values of luminous intensity lying the closest to the direction (C, γ) as presented in Figure 5.2.

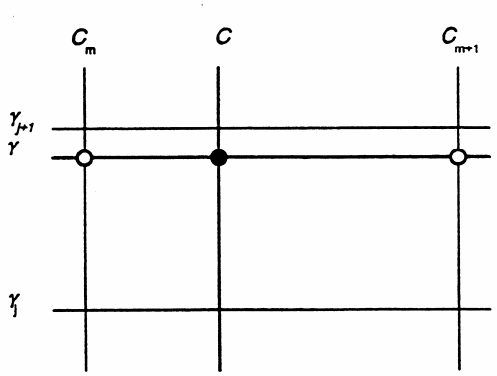


Figure 5.2: Angles required for linear interpolation of luminous intensity

The following formulas or their mathematical equivalents are used for this purpose:

$$K_1 = \frac{C_m - C}{C_m - C_{m+1}} \qquad (3)$$

$$K_2 = \frac{\gamma_j - \gamma}{\gamma_j - \gamma_{j+1}} \qquad (4)$$

where:
K_1 and K_2 are constants determined by formulas
C is the azimuth measured with regard to the first photometric axis
γ is the vertical angle measured from the first photometric axis
j, j+1, m, m+1 are whole numbers indicating the row or column of the I-table

$$I(C,\gamma_j) = I(C_m,\gamma_j) - K_1 \times \left[I(C_m,\gamma_j) - I(C_{m+1},\gamma_j)\right] \qquad (5)$$

$$I(C,\gamma_{j+1}) = I(C_m,\gamma_{j+1}) - K_1 \times \begin{bmatrix} I(C_m,\gamma_{j+1}) - \\ I(C_{m+1},\gamma_{j+1}) \end{bmatrix} \qquad (6)$$

$$I(C,\gamma) = I(C,\gamma_j) - K_2 \times \left[I(C,\gamma_j) - I(C,\gamma_{j+1})\right] \qquad (7)$$

where:
$I(C_m,\gamma_j)$ indicates luminous intensity in the column m and the row j in the table of luminous intensity distribution and correspondingly for other similar symbols.

In formulas 3 to 7, interpolation is first made by angles γ and then in C planes. The order may be changed (interpolation is first made by angles γ and then by C planes).

Square interpolation

For square interpolation we need three values from the I-table for each interpolated luminous intensity value. The procedure is presented in Figure 5.3. If we want to determine the value I at (C, γ), then we first interpolate values from the three nearest columns in the table of luminous intensity distribution enclosing the point. This enables us to determine three values I at the angle γ. Then we interpolate by using other values from the table in order to determine the required value at (C, γ).

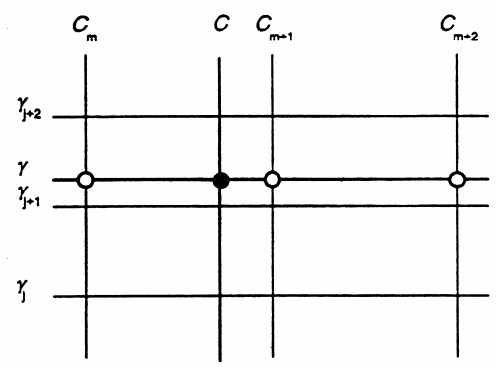


Figure 5.3: Values required for square interpolation

Inaccuracies resulting from the interpolation should be reduced as much as possible, hence the following two rules are used for selection of values used in interpolation formulas:

1. First, two values adjacent to the interpolated angle are selected from the table. They are used in formulas and for calculation of the average value.
2. If the angle for interpolation is smaller than the calculated average, then the third value of the angle selected from the table shall be the next smaller value in the table (as presented for γ in Figure 5.3), if the searched angle is larger then the calculated average, then the third value selected shall be the next larger value in the table (as presented for C in Figure 5.3);
3. On the edge of the table of luminous intensity distribution it may occur that the angle for interpolation lies for example between 355° and 360°, in such a case the next larger value in the table selected would be 5°, etc.

The following formulas or their mathematical equivalents are used for square interpolation:

$$K_1 = \frac{(C - C_m) \times (C_{m+2} - C)}{(C_{m+2} - C_{m+1}) \times (C_{m+1} - C_m)} \qquad (8)$$

$$K_2 = \frac{(C - C_m) \times (C - C_{m+1})}{(C_{m+2} - C_{m+1}) \times (C_{m+2} - C_m)} \qquad (9)$$

$$K_0 = 1 - K_1 - K_2 \qquad (10)$$

where:

C is the angle where I is to be determined by interpolation

m, m+1, m+2 are whole numbers indicating columns of the I-table

K_0, K_1 and K_2 are constants to be determined by using formulas and used in subsequent formulas.

$$I(\gamma_j, C) = K_0 \times I(\gamma_j, C_m) + K_1 \times I(\gamma_j, C_{m+1}) + K_2 \times I(\gamma_j, C_{m+2}) \quad (11)$$

$$I(\gamma_{j+1}, C) = K_0 \times I(\gamma_j, C_m) + K_1 \times I(\gamma_{j+1}, C_{m+1}) + K_2 \times I(\gamma_{j+1}, C_{m+2}) \quad (12)$$

$$I(\gamma_{j+2}, C) = K_0 \times I(\gamma_{j+2}, C_m) + K_1 \times I(\gamma_{j+2}, C_{m+1}) + K_2 \times I(\gamma_{j+2}, C_{m+2}) \quad (13)$$

where

γ *is the angle where I is to be determined by interpolation*

j, j+1, j+2 are whole numbers indicating rows of the I-table

γ_j, γ_{j+1} *and* γ_{j+2} *are values for appropriate consecutive numbers of rows. They are selected as follows:* $\gamma_{j+1} < \gamma < \gamma_{j+2}$ *unless j = 0, then* $\gamma_1 < \gamma < \gamma_2$

$I(\gamma_j, C_m)$ *is the value I for* γ_j *and* C_m.

The following formulas are used for determining constants k_0, k_1 and k_2;

$$k_1 = \frac{(\gamma - \gamma_j) \times (\gamma_{j+2} - \gamma)}{(\gamma_{j+2} - \gamma_{j+1}) \times (\gamma_{j+1} - \gamma_j)} \quad (14)$$

$$k_2 = \frac{(\gamma - \gamma_{j+1}) \times (\gamma_{j+1} - \gamma)}{(\gamma_{j+2} - \gamma_{j+1}) \times (\gamma_{j+2} - \gamma_j)} \quad (15)$$

$$k_0 = 1 - k_1 - k_2 \quad (16)$$

from which follows:

$$I(\gamma, C) = k_0 \times I(\gamma_j, C) + k_1 \times I(\gamma_{j+1}, C) + k_2 \times I(\gamma_{j+2}, C) \quad (17)$$

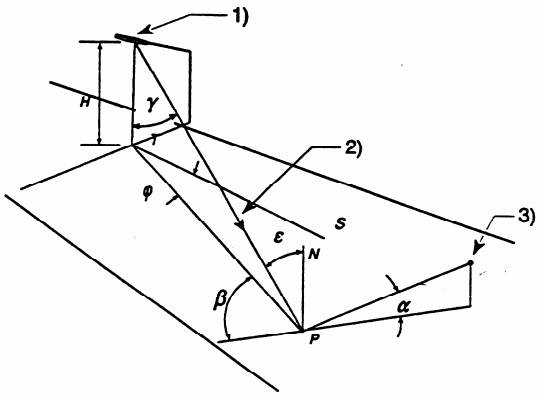
Linear interpolation is used for values *I* being at the end of the table.

The interpolation in the described mathematical procedures is performed first by columns of the table of luminous intensity distribution and only then by rows.

The procedure may be reversed, if formulas are first brought in line thus providing identical results.

2.10.5.4.4 Table of *r*-values

Data on reflectance of road surface are given as reduced luminance coefficients multiplied by 10,000. The table is presented in Attachment 6, Table 5.2. The meaning of angles β and ε is presented in Figure 5.4.



ST Longitudinal direction
Q Photometric centre of the lamp
QT Basic photometric axis of the lamp
PN Perpendicular to the road surface in P
-2) Azimuth of placement
-1) Complementary angle
0) Entry angle
1) Lamp
2) Light beam
3) Observer

Figure 5.4: Description of angles for the lamp in the position of measurement, observer and point of observation

2.10.5.4.5 Interpolation in the table of *r*-values

When we need the value *r* for values tan ε and β lying between values given in the *r*-table, the use of square interpolation is obligatory. For that we need three values from the *r*-table for each interpolated value. The interpolation procedure is presented in Figure 5.5. If we want to determine the value *r* at (tan ε, β), then we first interpolate values from the three adjacent columns in the *r*-table enclosing the point. Thus we find three values *r* at tan ε. Then we carry out cross interpolation across the table and determine the required value at (tan ε, β).

For the purpose of reducing the error to the minimum, we shall take into account the following rule for selecting values from the table to be inserted in formulas:

- We select two values from the table being adjacent to the interpolated value. The third value from the table shall be the next larger as shown in Figure 5.5.

The mathematical procedure is equivalent to the procedure for determining luminous intensity from the table of luminous intensity distribution (Section 5.4.2).

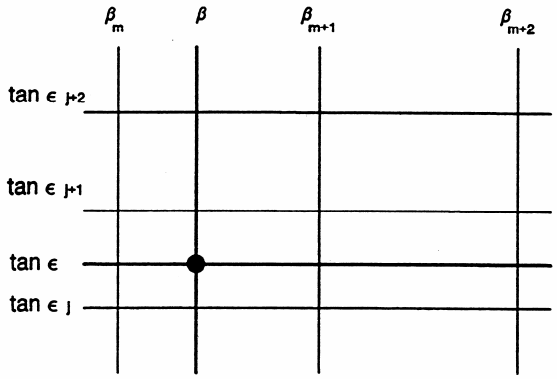
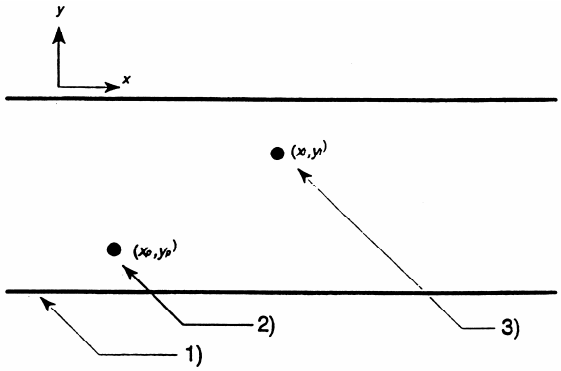


Figure 5.5: Values required for the interpolation procedure in the *r*-table

2.10.5.5 Calculation of I(C, γ)

In order to determine luminous intensity of the lamp in the direction of the point, we shall determine the vertical beaming angle (γ) and photometric angle *C* of the light beam towards the point. In order to determine these values, we shall take into account the inclination during the measurement, inclination during operations, orientation and turn of the lamp. For that purpose we shall specify the mathematical agreement for measuring distances on the road and for turns around the axis. We use clockwise Cartesian co-ordinate system.

2.10.5.5.1 Mathematical agreement for distances measured on the road



1) Roadway edge
2) Calculation point
3) Lamp

Figure 5.6: (*x, y*) co-ordinate system for placement of the lamp in the plan

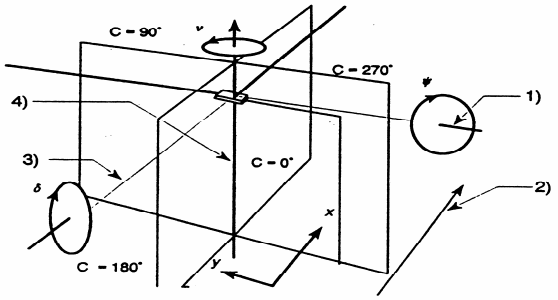
We use (*x, y*) co-ordinate system (Figure 5.6). The abscissa is aligned with the reference direction lying in the longitudinal direction for a flat road. Then:

$$x = x_p - x_l \qquad (18)$$

$$y = y_p - y_l \qquad (19)$$

where:
(x_p, y_p) are co-ordinates of the calculation point
(x_l, y_l) are co-ordinates of the lamp.

2.10.5.5.2 Mathematical agreement for rotations



1) Axis II
2) Longitudinal direction
3) Axis III
4) The first photometric axis I

Figure 5.7: Axes of turning with regard to (*x, y*) co-ordinate system

Figure 5.7 presents axes of turning with regard to (*x, y*) co-ordinate system and the direction of turning.

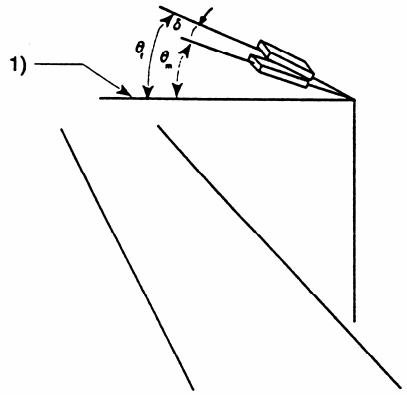
Axis I is constant in space while axes II and III may be turned around axis I. Additional charts are given in prEN 13032-1.

Figure 5.8 presents the relation between the inclination for calculation, the inclination during measurements and inclination during operations. The figure shows that:

$$\delta = \theta_f - \theta_m \qquad (20)$$

where:

δ *is the inclination for calculation in degrees*
θ_f *is the inclination during operations in degrees*
θ_m *is the inclination during measurement in degrees.*



θ_f *inclination during operations*
θ_m *inclination during measurement*
δ *inclination for calculation*
1) Horizontal line

Figure 5.8: Inclination during measurement, operations and inclination for calculation

2.10.5.5.3 Determining azimuth φ

The function arctan $\frac{y}{x}$ gives us:

$$-90° \leq \arctan \frac{y}{x} \leq 90° \qquad (21)$$

We must determine the quadrant where the angle lies for values x and y:

for x >0, y >0

$$\varphi = \arctan \frac{y}{x} \quad \text{or} = 0° \leq \varphi \leq 90° \qquad (22)$$

for x < 0, y >0

$$\varphi = 180° + \arctan \frac{y}{x} \quad \text{or} = 90° \leq \varphi \leq 180° \qquad (23)$$

for x < 0, y < 0

$$\varphi = 180° + \arctan \frac{y}{x} \quad \text{or} = 180° \leq \varphi \leq 270° \qquad (24)$$

for x > 0, y < 0

$$\varphi = 360° + \arctan \frac{y}{x} \quad \text{or} = 270° \leq \varphi \leq 360° \qquad (25)$$

2.10.5.5.4 Calculation of C and γ

The calculation is made in three steps:

1) Substitution ν, ν, ν, x and y in formulas:

$$x' = x(\cos\nu \cdot \cos\psi - \sin\nu \cdot \sin\delta \cdot \sin\psi) + y(\sin\nu \cdot \cos\psi - \cos\nu \cdot \sin\delta \cdot \sin\psi) + H \cdot \cos\delta \cdot \sin\psi \quad (26)$$

$$y' = -x \cdot \sin\nu \cdot \cos\delta + y \cdot \cos\nu \cdot \cos\delta - H \cdot \sin\delta \quad (27)$$

$$H' = H \cdot \cos\delta \cdot \cos\psi - x(\sin\nu \cdot \sin\delta \cdot \cos\psi - \cos\nu \cdot \sin\psi) + y(\sin\nu \cdot \sin\psi - \cos\nu \cdot \sin\delta \cdot \cos\psi) \quad (28)$$

where:

x and y are longitudinal and transversal distance between the observer and the plinth of the lamp as presented in Figure 5.6

H is the height of the lamp above the calculation point

x', y' and H' are distances required for calculation of C and γ and may be treated as temporary variables

ν,δ and ψ orientation, inclination for calculation and turn

2) calculation of C

$$C = \varphi - \nu \quad (29)$$

where:

φ *is the azimuth of placement in degrees*

ν *orientation in degrees (see Figure 5.7).*

3) Calculation of γ

$$\gamma = \tan^{-1}\frac{\sqrt{(x')^2 + (y')^2}}{H'} \quad (30)$$

2.10.5.6 Calculation of Photometric Quantities

2.10.5.6.1 Luminance

Luminance in point (of surface)

Luminance in point shall be determined by using the following formula or its mathematical equivalent:

$$L = \frac{I \times r \times F \times MF \times 10^{-4}}{H^2} \quad (31)$$

where:

L is maintained luminance in cd/m^2

I is luminance in direction (C, γ) as presented in Figures 1 and 4 in cd/klm

r is the reduced luminance coefficient in sr^{-1} for the entry point of the light beam with polar co-ordinates (ε, β)

F is the initial light flow of light sources in each lamp in klm

MF is the dusting and ageing factor

H is the height of placement of the lamp on the road surface in m

The luminance *I* is determined from the table of luminance distribution (see 5.4.2) after the correction has been made for orientation, inclination for calculation of the lamp and linear interpolation has been carried out, if need be. Similarly, the value *r* for tanε and ε_I is determined where square interpolation is used, if need be.

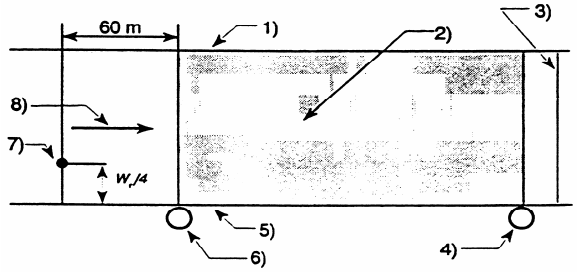
Total luminance in point

Total luminance in the point of surface L_s is the sum of contributions L_1, L_2, L_3, ...L_n from all lamps.

$$L_s = L_1 + L_2 + L_3 + \cdots + L_n = \sum_{k=1}^{n} L_k \qquad (32)$$

Area of luminance calculation

In the longitudinal direction of the appropriate surface the area of calculation is limited by two lamps in the same row (Figure 5.9). The first lamp shall be 60 m in front of the observer. When there are several types of lamps and the distances between them vary by row, the area of calculation shall be between two lamps in a row with the biggest distance between lamps.



1) Edge of the appropriate area
2) Area of calculation
3) Width of the appropriate area W
4) The last lamp in the area of calculation
5) Edge of the appropriate area
6) The first lamp in the area of calculation
7) Observer
8) Direction of observation

Figure 5.9: Area of luminance calculation

Position of points for calculation

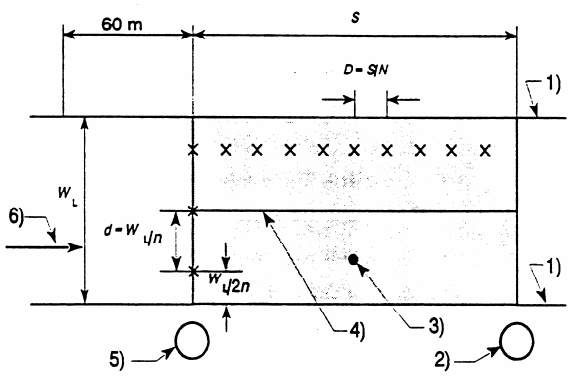
Points of calculation shall be evenly distributed in the calculation field. There are two calculation grids available.

a) Grid A: The first transversal row of calculation points lies in line with the first lamp in the area of calculation (Figure 5.10).

NOTE: In many software programs the use of this grid is linked to use of tables of luminance distribution with bigger distances by angle for which square interpolation is recommended.

With the use of modern software programs the use of this grid is slowly being abandoned.

It is recommended to use the grid B, where points for calculation of luminance are in line with points for calculation of illumination.

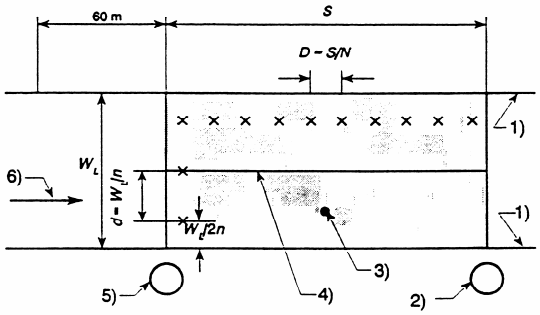


1) Edges of carriage lanes
2) The last lamp in the calculation field
3) Area of calculation
4) Centre line of the carriage lane
5) The first lamp in the calculation field
6) Direction of observation

X marks rows of calculation points in transversal and longitudinal direction.

Figure 5.10: Grid A: position of calculation points in the carriage lane

b) Grid B: The first and the last transversal row of calculation points lie on the half of the longitudinal distance between points from the border of the area of calculation (Figure 5.11).



1) Edges of carriage lanes
2) The last lamp in the calculation field
3) Area of calculation
4) Centre line of the carriage lane
5) The first lamp in the calculation field
6) Direction of observation

X marks rows of calculation points in transversal and longitudinal direction.

Figure 5.11: Grid B: position of calculation points in the carriage lane

Distances between points in the longitudinal and transversal directions are determined as follows:

a) In the longitudinal direction

$$D = \frac{S}{N} \quad (33)$$

where:
D *is the distance between calculation points in the longitudinal direction in m*
S *is the distance between lamps in the same row in m*
N *is the number of calculation points in the longitudinal direction with the following values:*

for $S \leq 50$ m, N = 10
for $S > 50$ m, the smallest whole number giving $D \leq 5$ m

b) In the transversal direction

$$d_L = \frac{W_L}{n} \qquad (34)$$

where:
d_L *is the distance between calculation points in the transversal direction in m*
W_L *is the width of the traffic lane in m*
N is the number of calculation points selected so that it is an odd number and that d_L is no more than 1.5 m.

Distance of outer calculation points from the edge of the carriage lane shall be $W_L/2n$.

When data on luminance of the driving verge is required, the distances between points shall be identical to those for the carriage lane.

Position of the observer

The point of observing of calculation shall be 60 m in from of the area of calculation and 1.5 m above the road surface.

As regards the transversal direction, the position of the observer shall be as follows:

a) For calculation of the average luminance and the general uniformity ratio, the observer shall be distanced from the edge of the appropriate area for a quarter of its width as presented in Figure 5.9. Examples showing from which edge the quarter of the area's width is to be measured are presented in Attachment X;

b) For calculation of the longitudinal uniformity ratio, the position of the observer shall be in the middle of each carriage lane.

Number of lamps taken into account in calculation

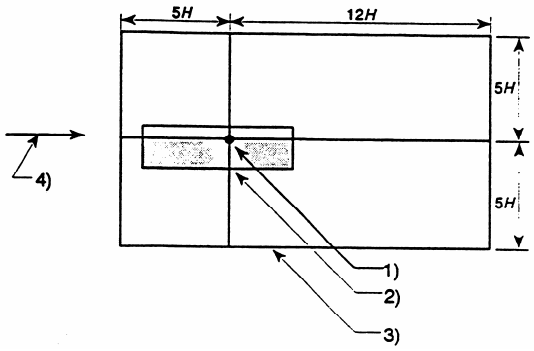
The calculation of luminance shall take into account lamps being within the area presented in Figure 5.12:

a) Borders on both sides of the observer; at least five times the height of lamp installation *H* on both sides of the calculation point;

b) The furthest border from the observer: at least 12 *H* from the calculation point in the direction away from the observer;

c) Border close to the observer: at least 5 *H* from the calculation point in the direction towards the observer.

NOTE: The scope of these borders is influenced by the area covered by the r-table on the road.



1) Calculation point
2) Borders of the area of calculation
3) Borders of the area for taking into account of lamps
4) Direction of observation

Figure 5.12: Borders of the area in which lamps taken into account in the calculation are placed

2.10.5.6.2 Illumination

We can calculate:

- Horizontal illumination;
- Semi-spherical illumination;
- Semi-cylindrical illumination;
- Vertical illumination.

Horizontal illumination in point

Calculation points shall be at the surface level.

Horizontal illumination in point is calculated by using the following formula (or its mathematical equivalent):

$$E = \frac{I \times \cos^3 \varepsilon \times F \times MF}{H^2} \quad (35)$$

where:

E *is the maintained horizontal illumination in the point in lx*

I *is the luminous intensity towards the point in cd/klm*

ε *is the entry angle of light in point in °*

H *is the height of lamp installation in m*

F *is the initial light flow of light sources in the lamp in klm*

MF *is the dusting and ageing factor*

Semi-spherical illumination in point

Calculation points shall be in a plane at the surface level.

Semi-spherical illumination in point is calculated by using the following formula (or its mathematical equivalent):

$$E = \frac{I \times \left[\cos^3 \varepsilon + \cos^2 \varepsilon\right] \times F \times MF}{4 \times H^2} \quad (36)$$

where:

E *is the maintained spherical illumination in the point in lx*

I *is the luminous intensity towards the point in cd/klm*

ε *is the entry angle of light in point in °*

H *is the height of lamp installation in m*

F *is the initial light flow of light sources in the lamp in klm*

MF *is the dusting and ageing factor*

Semi-cylindrical illumination in point

Calculation points shall be in a plane 1.5 m above the surface level.

Semi-cylindrical illumination varies with regard to the direction of interest. The shadowed plane in Figure 15, right-angled to the back flat surface, shall be placed parallel to the main direction of pedestrian movement, which is usually longitudinal for roads.

Semi-cylindrical illumination in point is calculated by using the following formula (or its mathematical equivalent):

$$E = \frac{I \times \left[1 + \cos \alpha\right] \times \cos^2 \varepsilon \times \sin \varepsilon \times F \times MF}{\pi \times (H - 1{,}5)^2} \quad (37)$$

where:

E *is the maintained semi-cylindrical illumination in the point in lx*

I *is the luminous intensity towards the point in cd/klm*

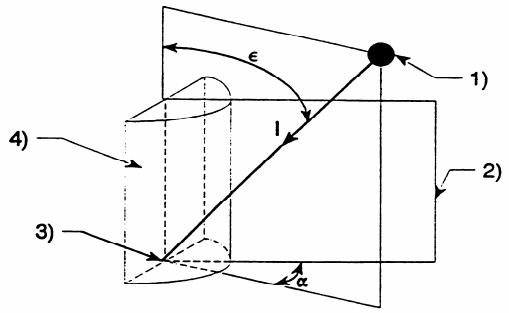
α *is the angle between the vertical plane including the entry light beam and the vertical plane right-angled to the back flat surface of the semi-cylinder as presented in Figure 5.13*

ε *is the entry angle of light towards the normal on the horizontal surface in the point*

H is the height of lamp installation in m

F is the initial light flow of light sources in the lamp in klm

MF is the dusting and ageing factor



1) Lamp

2) Vertical plane right-angled to the back flat surface

3) Calculation point

4) Flat surface of semi-cylinder

Figure 5.13: Angles used in calculation of semi-cylindrical illumination

Vertical illumination in point

Calculation points shall be in a plane 1.5 m above the surface level.

Vertical illumination varies with regard to the direction of interest. The plane of vertical illuminations in Figure 5.14 shall be right-angled to the main direction of pedestrian movement, which is usually longitudinal along the road.

Vertical illumination in point is calculated by using the following formula (or its mathematical equivalent):

$$E = \frac{I \times \cos^2 \varepsilon \times \sin \varepsilon \times \cos \alpha \times F \times MF}{(H - 1{,}5)^2} \qquad (38)$$

where:

E is the maintained vertical illumination in the point in lx

I is the luminous intensity towards the point in cd/klm

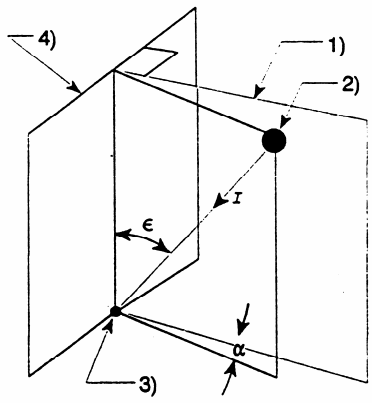
α *is the angle between the vertical plane including the entry light beam and the vertical plane right-angled to the vertical plane of calculation as presented in Figure 5.14*

ε *is the entry angle of light towards the vertical line on the horizontal surface in the point*

H is the height of lamp installation in m

F is the initial light flow of light sources in the lamp in klm

MF is the dusting and ageing factor



1) Vertical plane right-angled to the plane of vertical illumination
2) Lamp
3) Calculation point
4) Plane of vertical illumination

Figure 5.14: Angles used in calculation of vertical illumination

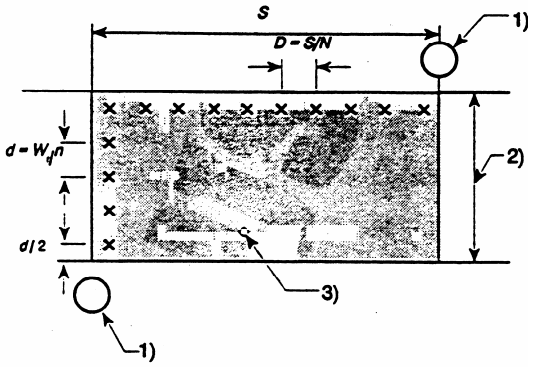
Total illumination in point

Total illumination in the point of surface E_s is the sum of contributions E_1, E_2, E_3, ...E_n from all lamps.

$$E_s = E_1 + E_2 + E_3 + \cdots + E_n = \sum_{k=1}^{n} E_k \qquad (39)$$

NOTE: Only illuminations of the same kind may be added together.

Area of calculation for illumination



1) Lamp
2) Width of the area taken into account
3) Area of calculation

Figure 5.15: Data for calculation of illumination, calculation points on the surface taken into account

The area of calculation shall be limited by longitudinal edges of the surface taken into account and transversal lines through two consecutive lamps as presented in Figure 5.15.

NOTE: For alternate placement, the consecutive lamps shall be on different sides of the usable area.

Position of points for calculation

The calculation points shall be evenly distributed through the calculation field (Figure 5.15) and their position and distance is determined as follows:

a) In the longitudinal direction

For areas on roadways designed with regard to the luminance criteria, distances between points shall be identical as for calculation of luminance. Otherwise the following rule shall apply:

$$D = \frac{S}{N} \quad (40)$$

where:

D is the distance between calculation points in the longitudinal direction in m

S is the distance between lamps in the same row in m

N is the number of calculation points in the longitudinal direction with the following values:
for $S \leq 50$ m, $N = 10$
for $S > 50$ m, the smallest whole number giving $D \leq 5$ m

b) In the transversal direction

$$d = \frac{W}{n} \quad (41)$$

where:

d is the distance between calculation points in the transversal direction in m

W is the width of the area taken into account in m

n is the number of calculation points in the transversal direction with the following values:
for $W \leq 5$ m, $n = 5$
for $W > 5$ m, the smallest whole number giving $d \leq 1.5$ m.

Points bordering with the edge of the area taken into account shall be distanced from the edge of this area by one half of distance between points.

NOTE: For calculation of semi-cylindrical illumination and vertical illumination, distances between points shall be selected so that no point is closer than 0.5 m from the standing point of the lamp.

Lamps taken into account in calculation

Only lamps contributing a significant share to calculated values shall be taken into account.

Traffic areas of irregular shape

As regards traffic areas of irregular shapes, the selected area for calculation of illumination may be rectangular and larger then the relevant area. Only points lying inside the relevant area shall be taken into account in the calculation.

Frequently, the distribution of lamps is not even in such cases, hence the area and grid for calculation cannot be determined by complying with requirements from Item…

For the purpose of calculating the vertical and semi-cylindrical illumination, the position of the observer is selected with regard to the planned main direction of traffic flow.

2.10.5.7 Criteria Regarding Lighting Quality

Quality criteria related to luminance or illumination shall be determined from calculated values in calculation points without any further interpolation.

In case the calculation points grid does not correspond to the carriage lane axis, luminance in points of the centre axis of each carriage lane shall be calculated for the purpose of calculating of longitudinal uniformity ratio of luminance.

As regards the calculation of initial values of luminance or illumination (new lighting), the dusting and ageing factor *MF* = 1.0 and the light flow of new light sources shall be taken into account.

But mostly we calculate the average values of luminance or illumination for lighting after a certain time period, hence the appropriate *MF* for lamps placed in given operating conditions as well as the light flow of light sources after the lapse of that certain time period are taken into account.

2.10.5.7.1 Average luminance

The average luminance (of surface) is calculated as the arithmetic mean value of luminance in the grid of points in the calculation area.

2.10.5.7.2 General uniformity ratio of luminance

The general uniformity ratio is the ratio between minimum value of luminance calculated in any point of the area of calculation and the average luminance.

2.10.5.7.3 Longitudinal uniformity ratio

The longitudinal uniformity ratio is calculated as the ratio between the minimum and maximum value of luminance in the longitudinal direction by the centre line of each carriage lane and hard shoulder for emergency stop in case of motorways. The number of points in the longitudinal direction (*N*) and the distance between them shall be identical as in calculation of average luminance.

The observer shall be in the same line as the row of calculation points.

The minimum calculated value of uniformity ratio of luminance for individual carriage lanes shall be taken into account as data for the road.

2.10.5.7.4 Relative increase of the threshold

The relative increase of the threshold is calculated by using the following formula (or its mathematical equivalent):

$$TI = \frac{650 \times MF^{0,8}}{(srednja\ svetlost\ vozišča)^{0,8}} \times L_v \qquad (42)$$

$$L_v = \sum_{k=1}^{n} \frac{E_k}{\theta_k^2} = \frac{E_1}{\theta_1^2} + \frac{E_2}{\theta_2^2} + \cdots + \frac{E_k}{\theta_k^2} + \cdots + \frac{E_n}{\theta_n^2} \qquad (43)$$

where:

MF is the maintenance factor used in the formula for calculating the average luminance of the carriageway

L_v *is the equivalent screening luminance in cd/m²*

E_k *luminance resulting from k lamp in the new condition to the plane right-angled to the direction of viewing at the height of the observer's eyes (in lx and on the basis of initial light flow of sources)*

θ_k *the angle between the direction of viewing and the joining line between the observer and k lamp Lamps with angle* θ_k *of more than 20° are not taken into account in the calculation.*

Influences of all lamps in the direction of observing in the distance of 500 m are added together.

The initial position of the observer is identical to that used for calculation of the average luminance. Then the position of the observer is moved forward by steps equalling a/50 where *a* is the length or the area of calculation in meters and the biggest value of *TI*. is found.

2.10.5.7.5 Surroundings coefficient *(Ko)*

The surroundings coefficient is the ratio between the horizontal luminance of two narrow longitudinal strips along the outer edges of the carriageway and the horizontal luminance of two narrow longitudinal strips along the edges of the carriageway on the carriageway. The width of an individual strip shall be determined by selection of the smallest value of the following options:

- 5 m;
- Half width of the carriageway;
- Width of unscreened strip along the carriageway.

As regards roads with separate directional carriageways, total width of the road is taken into account unless the separation lane between directional carriageways is more than 10 m.

The average horizontal illumination on narrow strips is calculated in accordance with the formula 35.

2.10.5.7.6 Average illumination

The average illumination is calculated as the arithmetic mean value of illumination in the grid of points in the area of calculation.

2.10.5.7.7 Minimum illumination

The minimum illumination is the minimum value of illumination in the point calculated anywhere in the calculation field.

2.10.5.7.8 Uniformity ratio of illumination

The uniformity ratio of illumination is calculated as the ratio between the minimum and the average illumination.

2.10.5.8 Data to the calculation of lighting devices

The following data shall also be included in the project regarding lighting:

a. Type of lamps;
b. Used table of luminous intensity distribution (*I*);
c. Used table of reduced luminance coefficients (*r*) except when only illumination is calculated;
d. Inclination of lamps during measurement;
e. Inclination of lamps during operations;
f. Turn of lamps if not zero;
g. Orientation of lamps if not zero;
h. Types of used light sources;
i. Light flow of sources used as the basis for calculation;
j. Used maintenance factors;
k. Definitions of the area of calculation;
l. Type of the grid of points used in calculation (A or B);
m. Positions of lamps – in the plan or expressed as numbers;
n. Height of lamp installation;
o. Directions in which we are interested in vertical and/or semi-cylindrical illumination;
p. Any deviations from procedures hereby prescribed.

2.10.6 PHOTOMETRIC MEASUREMENTS

2.10.6.1 General

Measurements of lighting are performed for the following purposes:

- Checking compliance with requirements specified in the project;
- Checking lighting and determining any requirements regarding maintenance;
- Comparing different lighting devices.

The methodology used for implementation of measurements shall be in line with the purpose of measurements. In case measurements are performed for the purpose of comparison with calculations, the same starting points shall be taken into account in implementation of measurements (positions of measurement points, the area of measurement) as in the calculation of lighting.

A simplified methodology may be used for checking lighting, however it is important that the measurement procedure is reproducible.

2.10.6.2 Conditions for Implementation of Measurements

2.10.6.2.1 Stabilisation Following Starting Up of Illuminants

Discharge lamps require a certain time period after start up for stabilisation of the light flow. Stable operations are provided by measuring horizontal illumination in a specified fixed point. Stable situation is ensured when the illumination ceases to change.

Stability of situation shall also be checked during measurements.

2.10.6.2.2 Weather conditions

Weather conditions may greatly influence the measurement results therefore it is important that measurements are carried out in weather conditions corresponding to those specified in the project.

In case mostly dry weather is taken into account in calculation of lighting, the effect of humidity shall be also excluded in implementation of measurements.

Condensation of humidity on the carriageway surface may completely alter the reflectance characteristics of the carriageway.

Extremely high or low temperatures may affect the light flow of illuminants or the accuracy of measurement instruments.

High wind speed may cause the lamps to vibrate and cooling of the air due to wind may result in reduced light flow of illuminants.

Humidity and pollution particles in the air may affect conductivity of the air with regard to light.

2.10.6.2.3 Impact of foreign light sources

Measurements are carried out for the purpose of checking lighting devices. The impact of other light sources directly or indirectly contributing to luminance and illumination of surface shall be excluded. In case such impact cannot be fully excluded, the impact of foreign light sources shall be evaluated in the measurement report.

Examples of foreign light sources are: light of shop windows, illuminated advertisements, light signal devices, light caused by vehicle headlights, sky glow, reflection of light on the snow, etc.

Foreign light sources may be temporarily excluded and in certain cases their impact may be evaluated by carrying out measurements with the road lighting turned off.

The area selected for implementation of measurements shall be free of objects on the carriageway, which may cast shadows (trees, still traffic, etc.).

2.10.6.2.4 Lighting technical measurements from a moving vehicle

Lighting technical measurements may be by using state-of-the-art measurement devices also carried out from a moving vehicle. The main differences between static and dynamic measurements are as follows:

- The number of measurement points is bigger in case of dynamic measurements;

- Requirements related to the area for calculation and calculation points for lighting are not always fulfilled in case of dynamic measurements.
- Requirements to be fulfilled in case of implementation of measurements from a moving vehicle:
- The position of the measurement device shall be linked with regard to the edge of the carriageway for each measurement point;
- The impact of the vehicle's shadow, reflected light and the impact of vehicle's electronic devices on measurement instruments shall be excluded;
- The measurement instruments used shall comply with requirements specified in Items 6.5 and 6.6,

2.10.6.3 Data not Directly Related to Measurements of Light

2.10.6.3.1 General

Data not directly related to measurements of light shall also be recorded in lighting technical measurements. The number of required data may depend on the purpose of measurements. In case measurements are performed for the purpose of checking the solutions envisaged in the project and compliance with calculations, more influential parameters shall be recorded while in case the purpose of measurements is only to check the conditions of lighting devices, the number of required data is smaller.

2.10.6.3.2 Data related to geometry of the carriageway

In most cases, data related to geometry of lighting devices are evident from the project. Only compliance of the actual situation with the project shall be checked in the field and any deviations recorded. In case of older installation where no technical documentation is available, the recorded data shall for example include: height of lamp installation, extension of the handle, inclination of lamps, carriageway width, pedestrian walkway width, cyclist way width, turn of lamps.

2.10.6.3.3 Voltage of power supply

The voltage of power supply network shall be recorded upon start of measurements. The voltage of power supply shall be measured for a larger number of lighting points. It is recommended to check the voltage several times during measurements.

2.10.6.3.4 Temperature

The temperature is measured 1 m above the ground in 30 minute time intervals.

2.10.6.3.5 Measurement instruments

Measurement instruments shall be calibrated in legally set intervals. Detailed requirements regarding measurement instruments for measuring luminance and instruments for measuring illumination are specified in publication CIE 109/1987 and publication CIE 53/1982, respectively.

2.10.6.4 Area for Carrying Out Measurements and Position of the Observer

As measurements are mostly implemented for the purpose of controlling the calculated values, the area and distribution of points for implementing measurements is identical to the area for calculation of lighting (Section 5).

Accurate measurements take a lot of time. In cases, when measurements are implemented for the purpose of checking the condition of installations, it shall be permitted to reduce the number of measurement points. Maximum and minimum values are determined by trials. The accuracy of such measurements is naturally correspondingly lower, however sufficient for assessing the condition of lighting devices.

2.10.6.5 Measurements of Illumination

With regard to criteria for individual groups of lighting technical classes, the following measurements are performed as regards road lighting:

- Horizontal illumination;
- Vertical illumination;
- Semi-cylindrical illumination;
- Semi-spherical illumination.

2.10.6.5.1 Requirements regarding measurement instruments

The illumination meter (luxmeter) shall satisfy the following requirements:

- The option to measure extremely low illumination values. Illumination levels may be extremely low, notably in lighting of housing areas. In order to calculate the uniformity ratio of illumination, the minimum illumination value in the given area of evaluation shall also be calculated. It is recommended that the minimum illumination value, which can be measured is less than 0.01 lx. Suitable instruments for measuring road lighting shall be those corresponding at least to the B class of accuracy (accuracy $\pm$10%);
- Correction of cosine of the entry light angle: The instrument shall provide accuracy of the measurement also in extremely low entry light angles and in cases where there are multiple light sources in surroundings, which simultaneously affect the illumination level. The so-called correction of cosine is particularly important in measurements of horizontal illumination, but cannot be ignored also in measurements of vertical and semi-cylindrical illumination.
- The photocell of the instrument shall be together with the measuring part adjusted with the greatest possible precision to the spectral sensitivity of human eye. The reason for such requirement lies in the fact that road lighting uses light sources with narrow spectral lines, e.g. high pressure mercury illuminants and high pressure sodium illuminants and exceptionally also low pressure sodium illuminants.

2.10.6.5.2 Implementation of measurements

In measurements of horizontal illumination the probe's surface shall be exactly horizontal, which can be achieved by special placement of the probe by using gimbals. Care should also be taken that one's own shadow does not cover the measurement probe of the instrument. It is recommended to use instruments with the measurement probe connected via a connecting cable. The cable shall be long enough to enable the probe to be outside the shadow of the meter.

Measurements of horizontal illumination

Measurements of horizontal illumination are performed in points corresponding to points for calculation of illumination. Measurements are performed on heights not exceeding 0.2 m. Care should also be taken that the person performing the measurements does not cast shadow on photocell of the instrument.

Measurements of vertical illumination

Measurements of vertical illumination are mostly performed in areas of pedestrian crossings and in areas where requirements of EV classes are taken into account as additional criteria due to increased risk of crime.

Care should be taken that the surface of the measurement probe is right-angled to the road surface and that the direction of the measurement probe is parallel to the road's axis.

Measurements in areas of pedestrian crossings are implemented at the height of 1 m while for other areas the height of measurement points shall be 1.5 m above the road surface.

Measurements of semi-cylindrical illumination

For the purpose of measuring semi-cylindrical illumination, the measurement probe of the instrument shall be equipped with a special accessory part offered by certain renowned manufacturers of measuring instruments as an accessory. The position of the observer shall be taken into account in measurements of semi-cylindrical illumination.

Measurements of semi-spherical illumination

For the purpose of measuring semi-spherical illumination, special accessory parts for the measuring probe shall be used, but they may also be performed by using the ordinary meter suitable for measuring horizontal illumination.

Description of the procedure:

First we measure horizontal illumination in the point E_{hz}. Impact of all lamps is taken into account. Then we measure the contribution of individual lamp $E_{I.}$ The component E_I is measured by directing the probe right-angled to the lamp. The impact of other lamps shall be excluded. Semi-spherical illumination is calculated by using the following formula:

$$E_{pc} = \frac{1}{4}(E_{hz} + \sum_{k=1}^{k=n} (E_I)_k)$$

$(E_I)_k$ *contribution of lamp k*

$\sum_{k=1}^{k=n}$ *means sum of all contributions of lamps 1...n*

2.10.6.6 Measurements of Luminance

Measurements of luminance are performed on flat section of the road (no large curves and altitude difference).

It is recommended that illuminants are turned on at least 100 hours prior to implementation of measurements. Prior to beginning of measurements it should be checked whether stable operations have been achieved (see also Item 6.2).

The area of measurements and the position of the observer for measurements of luminance shall be identical to the evaluation area for calculation of luminance.

The evaluation area stretches from 60 m to 160 m in front of the observer. The height of observing shall be 1.5 m and the position of the observer shall be in the middle of the carriage lane.

2.10.6.6.1 Measurement area of the instrument

In order to provide for accurate measurements of luminance in all points, the measurement area of the instrument shall not exceed 2 degrees in vertical direction and 20 degrees in horizontal direction. The area of measured surface ("measurement points") shall not exceed 0.5 m in the transversal direction and 2.5 m in longitudinal direction.

In case measurements are performed by using an electronic instrument with CCD sensor encompassing a larger area, the device shall have the option to additionally set the measurement area[7]. Measurements shall be limited to the relevant area only.

In case smaller accuracy of measurements is sufficient, the luxmeter with a larger measurement area may be used (the limit value shall be 30 separation minutes) and the

[7] The required measurement area of the instrument is very narrow for the purpose of preventing covering of measurement points.

position of the observer is accordingly placed closer so that the size of the measured area does not exceed 0.5 m in transversal direction and 3 m in longitudinal direction.

The report form for measurements is included in Attachment 7 (for information purposes).

2.10.7 GUIDELINES FOR IMPLEMENTING LIGHTING

2.10.7.1 General

Requirements regarding the geometry of lighting devices specify the following:

- Road situation;
- Lighting technical requirements;
- Peculiarities regarding traffic.

Basic data regarding the geometry of lighting devices are as follows:

a) Height of lamp installation;
b) Distance between lamps;
c) Road width;
d) Bracket of the lamp;
e) Inclination of the lamp;

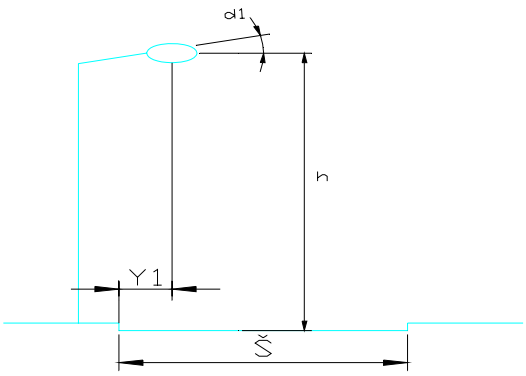


Figure 7.1: Presentation of geometry of lighting devices

2.10.7.2 One-Sided Installation of Lamps

One-sided installation of lamps is the most common in practice. In this type of installation the luminance on the side of the road more distanced from lighting points is usually lower than on the side of the road closer to lamps.

As good general uniformity ratio of luminance of carriageway and illumination of areas along the carriageway should be provided (illumination of surroundings coefficient), it is recommended that the height of lamp installation equals at least the effective width of the road (the effective width of the road is the distance between the lamp and the opposite edge of the road).

In one –sided installation of lamps, luminance conditions vary for different positions of the observer. For example, on a two-lane road the L_{sr} , U_o, U_l and TI values differ for the position of the observer on one or the other carriage lane.

One-sided installation of lamps provides good visual guiding.

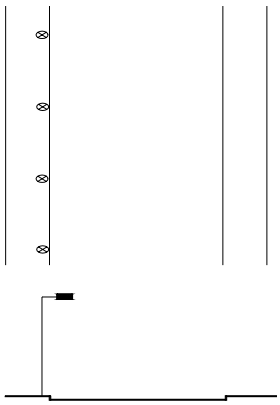


Figure 7.2: One-sided installation of lamps

2.10.7.3 Middle Installation of Lamps Above the Road Axis

Middle installation of lamps above the road axis is suitable for urban areas where lamps may be fitted to steel ropes between buildings along roads.

The height of lamp installation shall approximately equal the road width.

This placement of lamps achieve very good general uniformity ratio of luminance, good visual guiding, while the downside is potential swinging of lamps in strong wind and more complex maintenance of lighting devices as the maintenance vehicle disturbs traffic.

The middle installation is in some cases also a good solution for roads and streets having trees planted along the road.

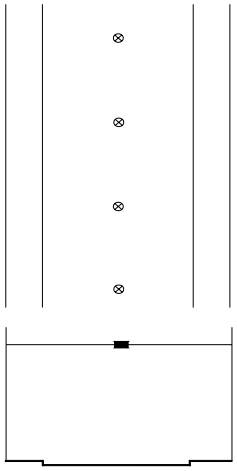


Figure 7.3: Middle installation of lamps above the road axis

2.10.7.4 Two-Sided Parallel Installation

Two-sided parallel installation is recommended for roads with larger width. The ratio between the height of lamp installation and the road width shall be less than 1.

With regard to optical characteristics of lamps, the recommended ratio between the height of lamp installation and the effective width of the road (h/w) shall be between 2/3 and 2/5.

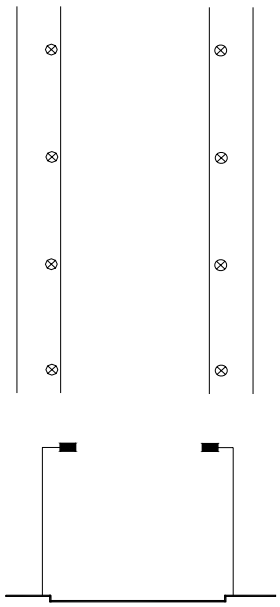


Figure 7.4: Two-sided parallel installation

2.10.7.5 Two-Sided Displaced Installation of Lamps

Two-sided displaced installation of lamps is used in cases where the ratio between the road width and the width of lighting points (h/w) is between 1 and 2.5.

The downside of such installation is poor longitudinal uniformity ratio of luminance due to displacement of lighting points. In general, two-sided parallel installation of lamps or one-sided installation with increased height of poles is better recommended.

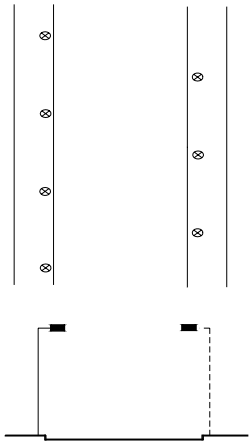


Figure 7.5: Two-sided displaced installation of lamps

2.10.7.6 Two-Sided Middle Installation of Lamps

Such installation has advantages notably in wide roads with the separation green area.

We can achieve good uniformity ratio of luminance and good visual guiding both during daytime and night time.

Installation in a single row enables simple implementation of electric installations. In order to provide good uniformity ratio of luminance, the height of installation shall exceed the road width.

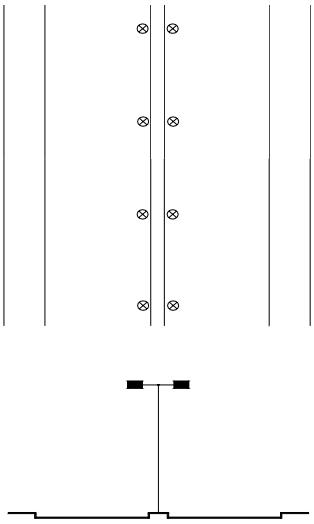


Figure 7.6: Two-sided middle installation

2.10.7.6.1 Transition from the Illuminated to the Non-Illuminated Part of the Road

As regards the transition from the illuminated to the non-illuminated part of the road during night time and in higher speed, the situation may be equal to that related to driving into a tunnel during daytime. Hence a gradual transition from the light to darkness shall be provided in case the driving speed is more than 60 km/h and subject to the condition that the level of luminance on the illuminated part equals or exceeds 1 cd/m^2.

The transition may be gradual by using illuminants with smaller light flow, and alternatively lighting can be implemented on the part of the road where there would otherwise be none, which provides roughly 1/3 of luminance of normally illuminated part of the road. The required length of the transition area depends on permitted driving speed, an overview of recommended distances is given in Table 7.1.

Table no. 7.1.: The required length of the transitional lighting with regard to permitted driving speed

Speed (km/h)	Required length of transitional lighting (m)
50	80
60	110
70	140
80	170
90 and more	200

2.10.7.6.2 Distribution of Lighting Points in Curves

Curves with radius of more than 500 m are handled identically as flat road sections. As regards curves with smaller radius, the distance between lighting points shall e reduced.

It shall be better with regard to lighting technical aspect, if lamps are placed on the outer side of curves as this achieves higher level of luminance and better uniformity ratio of luminance (notably during precipitations).

However, lamps and lighting poles on the outer side of curves may in case of accidents cause serious injuries, hence it is better on dangerous spots to place poles on the inner side of curves in spite of poorer lighting technical properties and worse visual guiding. The recommended distances between lighting points in case of a hairpin curve for both cases of placement of poles are presented in Figures 7.7 and 7.8.

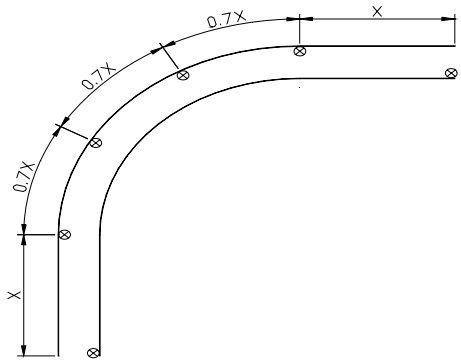


Figure 7.7: Placement of lamps in hairpin curves – lamps on the outer side of the curve

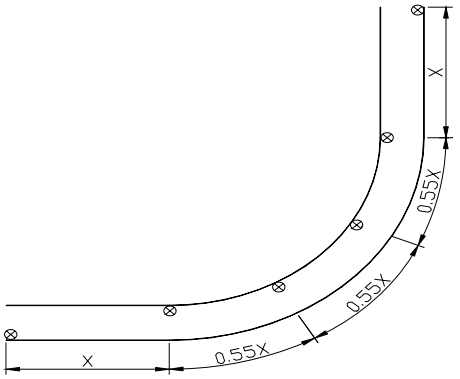


Figure 7.8: Placement of lamps in hairpin curves – lamps on the inner side of the curve

2.10.7.6.3 Intersections and Points of Access

Intersections, points of access and narrowing areas represent conflict points where in addition to requirements for higher levels of luminance and illumination, requirements regarding visual guiding are also extremely important.

Examples of distribution of lighting points for certain configurations of intersections and points of access are presented in Attachment 8.

It is recommended that lighting be placed in the entire area of intersections and points of access. In case it is not envisaged to place lighting in the entire area, then at least partial lighting of critical points shall be provided in areas with higher frequency of fog and areas with higher requirements regarding orientation. The attachment shows lamps for partial illumination as full circles.

2.10.8 ATTACHMENTS

Attachment no. 1:

Table no. 3.1.: Procedures for determining lighting technical class

STEP	DESCRIPTION	REFERENCE		
		TABLE	IN TEXT	PAGE
1	Specify the relevant area		Item 3.4.	7
2	Determine the group of situations	Table 3 2		8
3 4	Use the table corresponding to the selected group of situations Accurately specify the relevant area and	Tables 3.7 – 3.22		10 - 14
5 6	Select the appropriate group of three lighting technical classes Select the appropriate lighting technical class			
6a	In case of conflict areas – If distances of observing are short and it is not possible to sue the luminance concept i.e. lighting technical classes of the M group change the class of the M group with the appropriate class of the C group	Table 3.5	Item 3.7	10
6b	Traffic areas along the relevant area – Check if the appropriate lighting technical class differs by more than two classes – make appropriate adjustments on the basis of the table			
6c	Additional lighting technical classes to classes of the C and P groups			
	– Classes of the PC group – Classes of the *EV* group	Table		
6d	Replacement lighting technical classes In case of selection of lighting technical classes of the A group replace the class of the P group with the comparable class of the A group	Table 4.9		22
7 8	Search for requirements for lighting quality corresponding to the selected lighting technical class Take into account the general requirements and recommendations	Tables 4.4 – 4.8	Item 4.3	20 – 22 16 - 19

Attachment no. 2:

Table: Overview of parameters used for determining lighting technical class

Lighting technical requirements for individual road categories depend on traffic technical criteria described by a collection of **basic** and **specific** criteria.

Basic parameters form the basis for determining the group of lighting technical situations, while specific parameters are used for determining lighting technical requirements for the underlying traffic technical situation.

Overview of parameters:

1.	***Basic parameters***	***Possible selection:***
1.1.	Traffic participants:	
		Combination: – Motor traffic M
		– Slow traffic T
		– Cyclists K
		– Pedestrians P
1.1.1.	Main traffic participants:	Combination: M,T,K,P
1.1.2.	Other traffic participants allowed to use the traffic area:	Combination: M,T,K,P
1.1.3.	Traffic participants group prohibited from using the traffic area:	Combination: M,T,K,P
1.2.	Characteristic speed of the main traffic participants group:	
		High >60 km/h
		Medium >30 km/h and < 60 km/h
		Low <30 km/h
		Very low (walking speed)

2.	***Specific parameters***	
2.1.	Geometry of the traffic area:	
2.1.1.	Separation of carriage lanes for opposite directions of driving:	YES
		NO
2.1.2.	Type of intersections or points of access:	Intersections at grade
		Off-grade points of access
2.1.3.	Frequency of intersections or points of access:	
2.1.3.1.	Distance between off-grade intersections:	> 3 km
		< 3 km
2.1.3.2.	Frequency of intersections at grade:	< 3 intersections/km
		> 3 intersections/km
2.1.4.	Conflict area:	YES
		NO

Note: Conflict areas shall be points of access, intersections, areas of narrowing, etc.

2.1.5.	Physical barriers for slowing of traffic:	YES
		NO
2.2.	Nature of traffic:	
2.2.1.	Vehicles (AADT):	< 4000
		4000 to 7000
		7000 to 15000

	15000 to 25000
	25000 to 40000
	> 40000
In certain tables selection options are limited, namely:	
	> 7000
	> 15000
	> 25000
2.2.2. Frequency of cyclists:	Normal
	Higher
2.2.3. Frequency of pedestrians:	Normal
	Higher
2.2.4. Complexity of visual tasks (orientation):	Normal
	Higher
2.2.5. Still traffic (parked vehicles):	YES
	NO
2.2.6. Face recognition required:	Necessary
	Not necessary
2.2.7. Risk of crime:	Normal
	Higher than normal
2.3. Environmental effects:	
2.3.1. Complexity of the sight area:	Normal
	Higher
2.3.2. Luminance of surroundings:	Dark
	Medium
	Light

Note: Dark surroundings – correspond with rural areas
Medium luminance of surroundings – usually urban areas
Light surroundings – urban area in town/city centres

Attachment no. 3:

Table no. 4.12.: Classes of the MW group

Class	Luminance of road surface in wet and dry conditions				Relative increase of the perception threshold	Luminance of surroundings coefficient
	Dry conditions			Wet conditions:	***TI*** **in %** [2] **[maximum]**	***Ko*** [3] **(minimum value)**
	L **in cd/m²** **[maintained value]**	U_0 **[minimum value]**	U_I [1] **[minimum value]**	U_0 **[minimum value]**		
MEW1	2,0	0,40	0,60	0,15	10,00	0,50
MEW2	1,50	0,40	0,60	0,15	10,00	0,50
MEW3	1,00	0,40	0,60	0,15	10,00	0,50
MEW4	0,75	0,40		0,15	15,00	0,50
MEW5	0,50	0,35		0,15	15,00	0,50

[1] The application of this criterion is discretionary, however it may be adjusted for motorways.

[2] The permitted increase of TI by 5 percentage points shall be allowed in areas where light sources with weak luminance are used.

[3] This criterion only applies where there are no traffic areas linked to the roadway.

Table no. 4.13.: Classes of the A group

Class	Semi-spherical illumination	
	$\overline{E_{hs}}$ **in lx** **[minimum maintained value]**	U_0 **[minimum maintained value]**
A1	5,00	0,15
A2	3,00	0,15
A3	2,00	0,15
A4	1,50	0,15
A5	1,00	0,15
A6	No requirements	No requirements

Attachment no. 4:

Figure no. 4.1.: Placement of lamps on pedestrian crossings

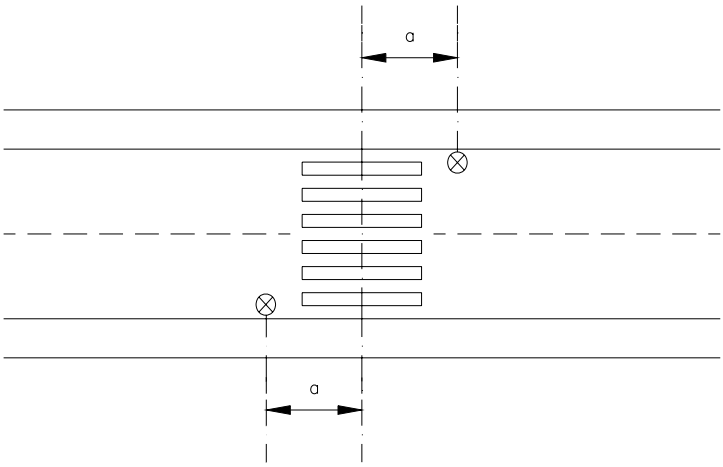
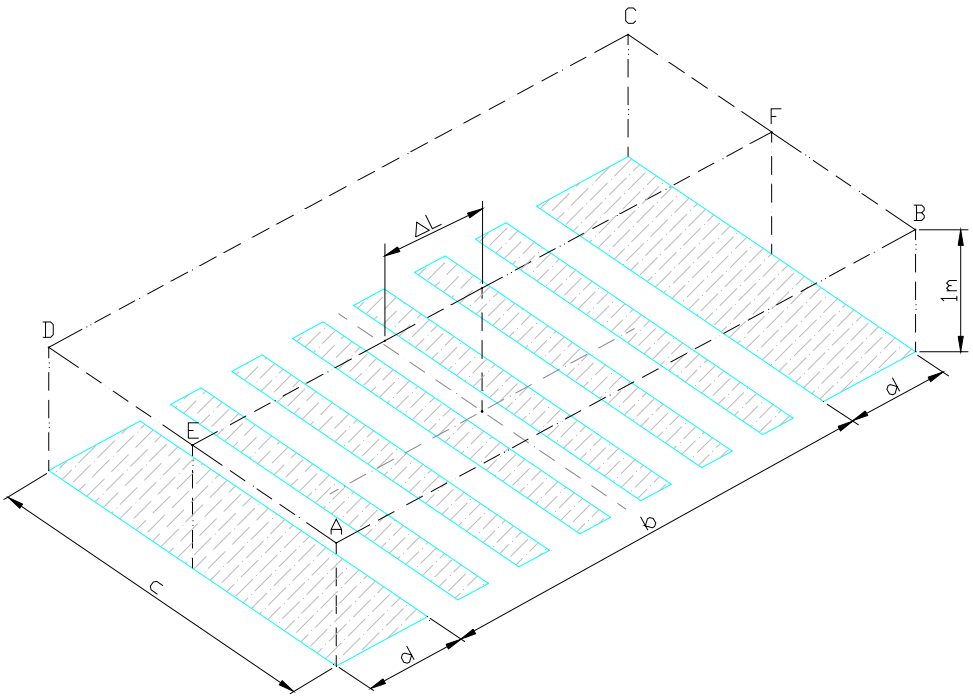


Figure no. 4.2.: Evaluation area



Attachment no. 5:

Table no. 5.1.: Symbols and abbreviations

QUANTITY SYMBOL	NAME OR DESCRIPTION	UNIT
C	Direction (angle) of photometric semi-plane (Figure 1)	° (degrees)
D	Distance between calculation points in the longitudinal direction	m
d	Distance between calculation points in the transversal direction	m
E	Illumination	lx
F	Light flow of illuminants in the lamp	klm
H	Height of lamp installation	m
j, m	Whole numbers indicating the row or column of the table	-
L	Luminance	cd/m^2
I	Luminous intensity	cd/klm
MF	Product of the ageing factor of the lighting source and the maintenance factor of the lamp	-
N	Number of points in the longitudinal direction	-
n	Number of points in the transversal direction	-
q	Luminance coefficient	sr^{-1}
r	Reduced luminance coefficient	sr^{-1}
S	Distance between lamps	m
TI	Increase of the threshold	%
L_v	Equivalent screening luminance	cd/m^2
W_L	Width of carriage lane	m
W_r	Width of appropriate area	m
x	Abscissa in (*x, y*) co-ordinate system (Figure 6)	m
y	Ordinate in (*x, y*) co-ordinate system (Figure 6)	m
α	The angle between the entry light beam and perpendicular to the flat surface of semi-cylinder, which is the basis for measuring semi-cylindrical illumination (Figure 15) or selected vertical plane on which vertical illumination is calculated (Figure 16)	° (degrees)
γ	Vertical beaming angle (Figure 1)	° (degrees)
θ_f	Inclination during operations (Figure 8)	° (degrees)
θ_m	Inclination during measurement (Figure 8)	° (degrees)
δ	Inclination in calculations (Figure 8)	° (degrees)
φ	Azimuth of placement (Figure 4)	° (degrees)
ψ	Turn of lamp (Figure 1)	° (degrees)

Attachment no. 6:

Table no. 5.2.: Example of the r-table

$\tan\varepsilon$	β **in degrees**																			
	0	2	5	10	15	20	25	30	35	40	45	60	75	90	105	120	135	150	165	180
0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
0.25	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
0.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
0.75	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.25	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.75	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5.5	x	x	x	x	x	x	x	x	x											
6	x	x	x	x	x	x	x	x	x											
6.5	x	x	x	x	x	x	x	x												
7	x	x	x	x	x	x	x	x												
7.5	x	x	x	x	x	x	x													
8	x	x	x	x	x	x	x													
8.5	x	x	x	x	x	x	x													
9	x	x	x	x	x	x														
9.5	x	x	x	x	x	x														
10	x	x	x	x	x	x														
10.5	x	x	x	x	x	x														
11	x	x	x	x	x	x														
11.5	x	x	x	x	x															
12	x	x	x	x	x															

Attachment no. 7:

Table: Report form for measurements (for information purposes)

A. 1. GENERAL INFORMATION

Location of measurement		
Date of measurement		
Time of measurement		
Measurement performed by (name and surname)		

A. 2. DATA ON GEOMETRY OF LIGHTING DEVICES

Description of the road and its surroundings and dimensions and positions of lighting Enclose photograph where possible. Position of the road infrastructure, parked vehicles and other facilities

A. 3. DATA ON ROAD SURFACE

Type of surface	
Age of surface	
Notes regarding the road surface condition	

A. 4. DATA ON LAMPS

Lamp (type 1)	Marking	
	Table of luminous intensity	
	Inclination (of luminous intensity)	
	Height of installation (m)	
	Age	
	Date of last cleaning	
	Installation method	
	Other data	
Illuminants/bulbs in lamps of type 1	Type/production	
	Power (W)	
	Age	
	Number of illuminants in the lamp	
	Control gear	
	Regulation method	
Lamp (type 2)	Marking	
	Table of luminous intensity	
	Inclination (of luminous intensity)	
	Height of installation (m)	

	Age	
	Date of last cleaning	
	Installation method Other data	
Illuminants/bulbs in lamps of type 2	Type/production	
	Power (W)	
	Age	
	Number of illuminants in the lamp	
	Control gear	
	Regulation method	

A. 5. DATA ON POWER SUPPLY NETWORK

Average voltage at the time of measurement	
Highest voltage at the time of measurement	

A. 6. DATA ON CONDITION OF THE SURROUNDINGS

Weather conditions	Beginning of measurement	End of measurement
Weather		
Temperatures ^{o}C		
Visibility		
Road surface (wet, damp, wet)		

A. 7. INSTALLATION DESCRIPTION

Arrangement of lamps	
Inclination of lamps	
Maintenance condition of lamps	
Other light sources	
Screening of light	
Remarks	

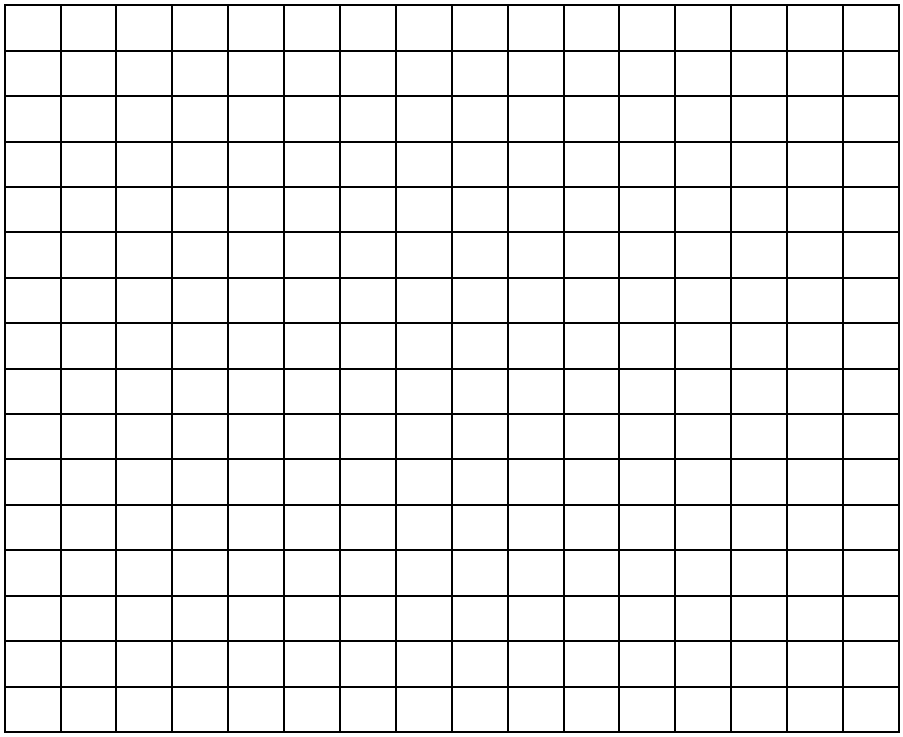
A. 8. MEASUREMENT INSTRUMENTS

	Brand	Model of instrument	Number of instrument	Calibration date	Certificate of instrument
Illumination					
Semi-spherical illumination					
Semi-cylindrical illumination					
Luminance (measurement area of the instrument in degrees)					
Voltmeter					

[1] Data shall be specified if required by the tender documentation.

A. 9. MEASUREMENT AREA (GRID)

meters



Type of measurement	
Height of measuring probe	
Number of instrument	
Used measurement area	
Position of the main probe	
Mark on the diagram the position of lamps, points of measurements, values measured with the probe and directions of illumination (semi-cylindrical, vertical)	

A. 10. MEASUREMENT MINUTES

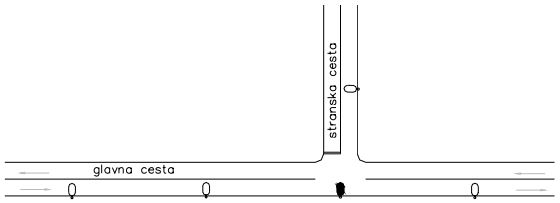
Time of turning on of the installation		
Time of beginning of measurements		
Location no. 1	Average illumination at the time of measurements	
	Standard deviation of measurements	
Location no. 2	Average illumination at the time of measurements	
	Standard deviation of measurements	
Location no. 3	Average illumination at the time of measurements	
	Standard deviation of measurements	

A. 11. MEASUREMENTS PERFORMED FROM A MOVING VEHICLE

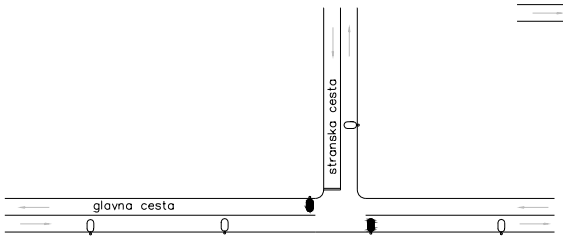
Measurements of luminance	Possible measurement methods: 1. Recording for laboratory analysis; 2. Recording with photometer	
	Correction due to measurements through the windshield	
Measurements of Illumination	Description of the measurement method, including the correction due to impact of the vehicle's shadow	
Measurements of luminance and illumination	The method of linking the geometrical position of the measurement instrument with the position of measurement points	
	Estimated inaccuracy of recorded values	
	Observations regarding the quality of calculated characteristics	

Attachment no. 8:

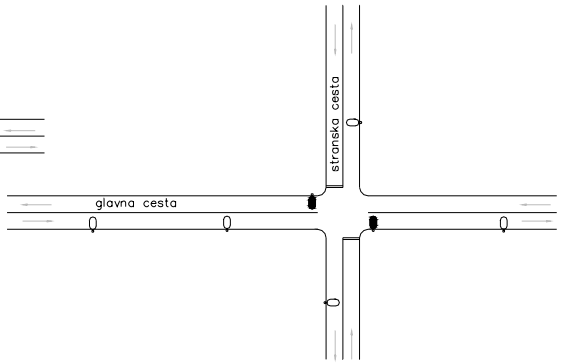
Table: Examples of distribution of lighting points for certain configurations of intersections and points of access



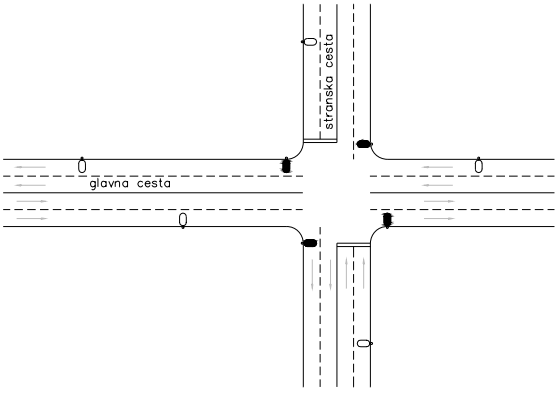
a). "T" križišče



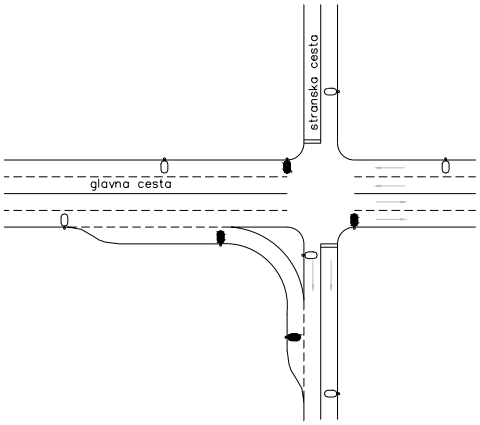
b). "T" križišče (variantno)



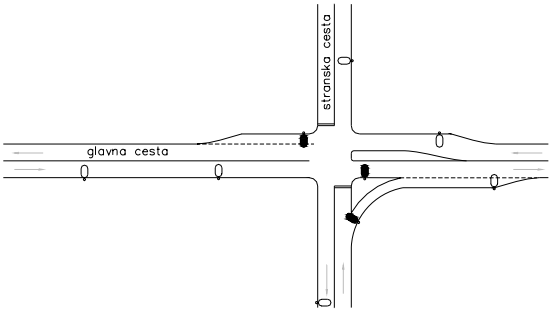
c). Križišče glavne in stranske ceste



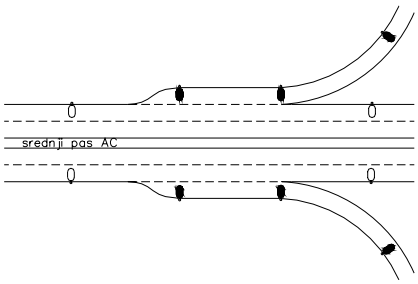
d). Križišče glavne in stranske ceste (variantno)



e). Odcep z usmerjevalnim otokom



f). Odcep z usmerjevalnim otokom (variantno)



g). Priključki in odcepi

Legenda: *Svetilke potrebne predvsem zaradi vidnega vodenja*

Svetilke za potrebe razsvetljave celotnih odsekov

Opomba: *Slike niso v merilu. Lokacije stojnih mest so približne in jih je potrebno prilagoditi konkretni situaciji. Enako velja za uporabljeno število svetilk.*

Translation of terms:

glavna cesta	main road
stranska cesta	side road
a). ˝T˝ križišče	a). "T" intersection
b). ˝T˝ križišče (variantno)	b). "T" intersection (variant)
c). Križišče glavne in stranske ceste	c). Intersection between a main and a side road
d). Križišče glavne in stranske ceste (variantno)	d). Intersection between a main and a side road (variant)
e). Odcep z usmerjevalnim otokom	e). Exit with a directional island
f). Odcep z usmerjevalnim otokom (variantno)	f). Exit with a directional island (variant)
sredji pas AC	Middle lane of the motorway
g). Priključki in odcepi	g). Entries and exits
Legenda:	Legend:
Svetilke potrebne predvsem zaradi vidnega vodenja	Lamps required foremost for visual guiding
Svetilke za potrebe razsvetljave celotnih odsekov	Lamps required for lighting of the entire sections
Opomba:	*Note*:
Slike niso v merilu. Lokacije stojnih mest so približne in jih je potrebno prilagoditi konkretni situaciji. Enako velja za uporabljeno število svetilk.	Figures are not in scale. Locations of placement points are approximate and shall be adjusted to the situation at hand. The same applies to the number of lamps used.

2.11 FURNITURE TO CLEARLY INDICATE THE MOTORWAY OR EXPRESSWAY COURSE IN THE ROAD SPLIT AREA

To the furniture to clearly indicate the motorway or expressway course in the road split area the following items belong:

- guiding cones, and
- direction posts.

The guiding cones are intended to warn the drivers against the vicinity of an area where the motorway or expressway is splitting in two directions (Figure 1).

The direction posts are intended to clearly indicate the motorway or expressway course, when the latter cannot be denoted by means of way-marks in the area where the road is splitting in two directions (Figure 2).

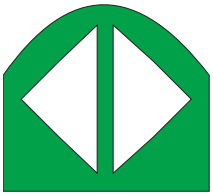


Figure 1

Figure 2

The arrow on the guiding cone and the marking on the direction post shall be of light-reflecting material.

2.12 EMERGENCY CALL

2.12.1 INTRODUCTION

This guideline specifies the investor's requirements regarding the design of the "Emergency call" system, based on co-ordinated technical solutions (building, technological and traffic) and being usable and safe for each user of the system.

The "Emergency call" system is intended for drivers on motorways as well as maintenance staff for establishing connections from certain locations along motorways with the competent motorway base or its dislocated unit. Safety and life of drivers on motorways may depend on perfect working condition of this system. Consequently, the technical solutions must provide for perfect working condition of the "Emergency call" system, regardless of various environmental conditions, which differ to a great extent in Bosnia and Herzegovina. The system is intended for users requiring assistance in case of an accident or defect on the vehicle.

2.12.2 TECHNICAL REGULATIONS

In preparation of the technical documentation, implementation of work and handing of the "Emergency call" system into operation, all standards listed above and any supplements thereof as well as all standards listed in these standards and all regulations, instructions and projects shall be complied with.

European standards:

- ENV 61024-1; 1995
- ENV 61312-1 (IEC 1312 – 1)
- EN 60068-2-6
- EN 50090-2-2/1996
- ETR 035/1992

Foreign national standards:

- DIN VDE 0816 Teil 1, Teil 2
- DIN VDE 0185 Teil 100, Teil 103
- DIN VDE 0800 Teil 2/07.85, Teil 1/10.87
- DIN VDE 0845 Teil 1/10.87, Teil 2/10.93
- DIN VDE 0675 Teil 6 Entw. 11.89
- DIN 48830; 1985 Description of the protection system against lightning
- DIN 48831; 1985 Report on measurements on the protection system against lightning
- DIN 48820: Plan of elements of surge protection and drawings
- DIN 48803; (March 1995) Protection system against lightning.

Guidelines for optical cables and networks:

1. Instructions on placement and installation of optical cables (PTT Vestnik no. 4/89);
2. Instructions on planning of optical cable sections and transmission systems (PTT Vestnik nos. 23/87, 6/91);
3. Instructions on measurements of optical and transmission characteristics of optical fibres (PTT Vestnik no. 21/87);
4. Instructions on measurements of telecommunication cables with optical fibres (PTT Vestnik no. 12/91);
5. Instructions on the scope of quality checking in acceptance of telecommunication cables with optical fibres (PTT Vestnik no. 27/90);
6. Instructions on technical records on long-distance and connecting telecommunication cables with optical fibres (PTT Vestnik no. 6/91);

7. Technical conditions for telecommunication cables with monomode optical fibres (PTT Vestnik no. 13/88);
8. Technical conditions for telecommunication cables with optical fibres without metal elements (PTT Vestnik no. 12/88);
9. Technical conditions for inlet telecommunication cables with a single optical fibre (PTT Vestnik no. 4/89);
10. Technical conditions for basic regeneration field of a telecommunication cable with optical fibres (PTT Vestnik no. 23/86);
11. Technical conditions for couplings for joining telecommunication cables with optical fibres (PTT Vestnik no. 4/89).

In case any standards or regulations specified herein are amended or supplemented by new standards or regulations during the period of design, the designer shall take into account and specify such new standards or regulations.

2.12.3 TECHNICAL REQUIREMENTS

2.12.3.1 "Emergency call" system composition

The "Emergency call" system shall be composed of the following equipment and installations:

- Six-duct cable line required for the EMERGENCY call system, placed in the middle of the hard shoulder for Emergency stop and standing and pulling shafts with installed membranes, placed in the verge or in appropriate distance from infrastructure facilities. The construction shall take into account any additional requirements specified by the Ministry of Defence. For the purpose of placement of road signs on passages across the middle separation lane, bridging shafts with metal covers (5 t) shall be prepared.
- For the purpose of energy supply (traffic management, various portals, weather stations, etc.), PVC pipes of 1 x 125 mm shall be placed simultaneously on particular sections with separate shafts roughly at each 250 m.
- The newly constructed communication means (the cable system) shall be used for connecting the Emergency call to the control communications centre as well as for other purposes.
- The system shall enable simultaneous transmittance of IT, signals and control of devices installed in the underlying section.
- The technological part of the control communications centre shall be the technologically integrated whole of the Emergency call system project, while the construction part of the control communications centre as regards the motorway base shall be the subject of the motorway base project. Both designers shall co-operate with each other. The project shall envisage possible stage construction and any implementation of a temporary centre.
- Call columns with placement points located along the motorway shall be numbered in line with the numbering project.
- The power supply system shall provide for two-sided (backup) power supply located in power supply points **.....** and **.....** The power supply sections shall not be longer than 10 km.

2.12.3.2 Environmental conditions

The "Emergency call" system shall be designed and constructed in a way providing, with regard to normal and predictable abnormal environmental conditions, perfect, reliable and safe operation given the following environmental conditions:

- Temperature range between –25*C and + 60*C;

- Relative humidity up to 98%;
- Vibrations in the frequency range between 10 Hz and 150 Hz in line with EN and ETSI standards.
- Lightning impact; The system for protection against lightning shall be selected for the entire Emergency call system with regard to frequency of lightning strikes in the area of the project (isoceraunic map – colour enclosure in the project). On the basis of isoceraunic and statistical data on lightning and specific resistance of the ground in the designed section, the designer shall assess the need for calculations of the probability of lightning strike, which should be a constituent part of the project;
- The impact of changeover phenomena, foreign electromagnetic fields of high-voltage facilities, impact of electrostatic discharges;
- The impact of straying earth currents;
- The impact of corrosive activity of soil.

The specified requirements apply to all devices of the system as specified in item 2.2 of this project task.

Prior to the beginning of preparation of the technical documentation for placement of the Emergency call system in a particular motorway section, types and scopes of environmental impacts for the section in question shall be previously assessed and appropriate technical solutions for the entire Emergency call system shall be selected in line with item 2.2.

2.12.4 SPECIFIC REQUIREMENTS FOR EQUIPMENT OF THE "EMERGENCY CALL" SYSTEM

2.12.4.1 Requirements for call columns

- Call columns in the "Emergency call" system for the section being the subject of the project shall be visually similar to housing colour RAL 2004.
- Call columns shall be placed so that the user looks at the right angle in the direction of driving when making a call.
- Housing of call columns shall be resistant against salt, road spreading substances and atmospheric impacts (humidity, rain, snow, sunshine, low temperatures, etc.). Upon snow clearing no movement or damage on call columns shall occur as the result of dynamic force of slush. Users of call columns shall also be protected from slush.
- Housing of call columns shall be designed and placed so that it offers protection against voltage in case of a lightning striking in the system (the same applies to impacts of high-voltage devices).
- Implementation of call columns shall comply with the Rules on Electromagnetic Compatibility.
- All points with which the user may come into contact shall be protected from too high touching voltage, which requires appropriate earthing system of call columns, the system for protection against lightning, construction of call column housing and arrangement of surroundings.
- The standing points by call columns shall be protected and arranged so that impermissible voltages of step in the event of lightning striking the call column is prevented.
- The housing of each call column shall have installed a red button (with bilingual sign) enabling establishing the connection with the control communications centre, light signal, and identification marking of the call column.

- Call columns shall be linked with the control communications centre by a full duplex link.
- Upon establishing of the connection, the control centre operator shall see the number of the call column from which the call is made, audio and video signal shall go off in the control communications centre and on the call column. When the operator answers the call, a quality audio link understandable in both directions shall be established.
- Only operator in the control communications centre shall be able to disconnect the call. If an incoming call comes from another call column while the connection between the control communications centre and a call column is established, the operator shall see the number of call columns from which calls are being made. The "Emergency call" system shall be able to register calls from at least four call columns. The control communications centre shall enable the operator to disconnect the first link, check waiting calls by talking and re-establish the connection with the first call column.
- Each call column shall be marked so that the intention of use of call columns (Emergency marking) and location of the call column (number) are clearly indicated to users, during the night the marking shall be visible at a distance of at least 500 m in both directions of driving.
- The "Emergency call" system shall enable physical delay of at least 300 m between call columns on the pair of the cable connecting columns of the same pair.
- The "Emergency call" system shall also enable official link between individual call columns and between call columns and the control communications centre, which shall be accessible only to system maintenance staff.
- Locations of call columns shall primarily provide for traffic safety of users during the time of use of call columns and shall be aligned with the planned functions of road facilities (e.g. rest areas, toll stations, motorway bases, tunnels, viaducts and bridges, motorway fork junctions).

2.12.5 CONTROL CENTRE

2.12.5.1 Requirements for the building

The building in which the electrical and electronic equipment for the "Emergency call" system is to be installed shall be equipped with a protection system against lightning (PSAL) with efficiency equalling at least 98%, which corresponds to the protection class I in case of a direct or indirect lightning strike. The protection system against lightning shall prevent damage in the building resulting from the following causes:

S1 – Voltage of step and touch due to direct lightning strike;

S2 – Fire, explosion, mechanical and chemical effects due to direct lightning strike;

S3 – Surge on equipment due to direct lightning strike;

S4 – Surge on equipment due to indirect lightning strike.

As regards dimensioning of the protection system against lightning (PSAL), requirements for the control communications centre and call columns are identical, whereby standards specified in Item 8 and additionally also standards included in these standards including supplements thereof shall be taken into account.

2.12.5.2 Requirements for electrical / electronic equipment

The control centre located in the motorway base building shall be equipped with devices enabling communications with persons near call columns, devices for power supply of the system and devices for indicating established and waiting connections. In case of the

planned stage construction of the motorway, stage connection of sections to the existing toll stations shall also be envisaged.

Electrical parameters for signals produced by call columns, weakening of the signal, the frequency of the calling signal, AC input voltage in call columns and power supply points shall be determined so that they enable reliable and safe operation of the "Emergency call" system subject to conditions of the environment where the system is installed.

- The highest input voltage permitted for use for power supply of the "Emergency call" system shall be 380 / 220 V.
- The control communications centre shall have the option to automatically control call columns. Any defect shall be immediately notified to the operator (information on cause and the number of the column in defect shall suffice).
- The Emergency call shall trigger a signal in the control communications centre, which will be active until the operator responds. In case of a call from a call column, the chart showing locations of call columns shall immediately respond by appropriate identification used by the operator for faster determining of the location of the call column from which the call is being made.
- A connection with the control communications centre is envisaged in this project for the purpose of providing reliability of the "Emergency call" system.
- The "Emergency call" system shall provide for compatibility of operation subject to familiarity of operational protocols of other systems.
- Each supplier of the "Emergency call" system shall, if need be, provide to the Client protocols for operation of the system in order to provide for compatibility with other systems.
- The control communications centre shall be designed so that it can be controlled by an operator with secondary education of any course with appropriate training.

2.12.6 POWER SUPPLY SYSTEM

2.12.6.1 Power supply system design

Power supply of the "Emergency call" system shall be in principle implemented by using separate (or public) low voltage network via the communications centre or power supply stations to individual call columns by using the SELV system.

The power supply unit in the control communications centre shall provide for uninterrupted power supply of the central and control board for at least six hours after power breakdown, where any hook-up to the already built central uninterrupted power supply system in the building shall be taken into account (the quality in accordance with the IEC for Aku battery class II – useful life exceeding 7 years). An identical power supply system shall also be used for two-sided (backup) power supply of individual sections along the motorway.

All devices ranging from the low voltage cable via the power supply unit to the hook up terminals on call columns shall comply with the applicable JUS NB2.741 standards and appropriate European (EN), international (ISO / IEC) or foreign national standards if harmonised with the European standards.

2.12.6.2 Surge protection of the power supply system

On sections where preceding environmental impact assessments on the "Emergency call" system show that the system is in danger resulting from surge, protection against surge shall also be implemented on all parts of the power supply system. The specification of surge protection and equipment for its implementation in the entire power supply system shall comply with the European (EN) standards or international IEC standards or appropriate national standards if harmonised with the European standards.

2.12.7 TRANSMISSION SYSTEM

2.12.7.1 Requirements for cables and classification of connections (design, placement, installation, measurements, preparing of the implementation documentation)

Requirements for cables and classification of connections (design, placement, installation, measurements, preparing of the implementation documentation)

In order to provide for quality and reliable connection of call columns with the equipment in the control communications centre, the cable construction shall be selected on the basis of preceding environmental impact assessments as specified in Item 3 herein.

The design of the communication cable construction shall be similar to that on existing motorway sections: at least ten low-frequency star four-pin with cable diameter of 0.9 mm. The isolation of the core of cable shall be from foam polyethylene across which there is a layer of full polyethylene (the skin) providing for appropriate bursting strength: core-coating-coating-earth, as well as appropriate bursting strength of insulation between individual cores.

Longitudinal and transverse water tightness shall be ensured.

Cable construction shall be selected so that it offers adequate protection against entrance of moisture in the cable, impacts of external electromagnetic fields and protection in accordance with the calculations of environmental impacts. Connections in the cable shall be classified as long-distance (TD marking). The requirements for cables shall comply with applicable national – European (EN) standards, international or foreign national standards if harmonised with the European standards and if determining the cable which is as regards construction the same or with higher quality than cables already placed along the motorway.

The following is required for the purpose of providing availability and reliability of connections via cables, complying with the above specified requirements:

- Implementing connectability of links in all cable ducts by implementing branches to both call columns via a cable termination in the call column or on splitter joints installed on a console in the cable duct;
- Envisage ending of the cable with a separation cable termination whereby enabling separation between cables and electronics in the call column (network termination – NT);
- Protection of cables shall be implemented behind the separation cable termination by using surge protection devices (SPD) and by complying with standards and regulations specified in Item 8 herein;

Design and installation of the long-distance cable shall be implemented in accordance with the instructions specified in PTT Vestnik nos. 3/73 and 6/76. (specify technical requirements for polyethylene pipes) and technical conditions specified in the Official Gazette of Telekom (Slovenije) no. 2-7. III. 1996.

Placement and installation of the long-distance cable shall be implemented in accordance with the instructions specified in PTT Vestnik nos. 2/71 and 23/91 and other regulations (ZJPTT).

The built section of cable connections shall be in line with the Instructions on checking the quality of telecommunication cables (List of provisions related to telecommunication cables and networks LN-1 Belgrade 1980).

Measurements on the built cable system and the project of implemented work shall be prepared in accordance with the "Instructions on technical records on long-distance cables" (List of regulations related to telecommunication cables and networks LN-1, Belgrade 1980), sections B10 and B7, and the "Instructions on assessment of quality of examination of telecommunication cables", which shall be supplemented in line with

special instructions of the company DARS d.d. or appropriate national or foreign regulations or standards as well as the "Instructions on preparation of the underground registry of laid installations on an electronic medium".

Measurements shall be carried out from the beginning to the end of the cable connection, without including the electronics of cable columns to cable pairs (between points of the NT).

2.12.7.2 Transmission system protection against environmental impacts

All previous environmental impact assessments regarding the "Emergency call" system shall be in a written form enclosed to the technical documentation of the Construction Permit Project, and the Works Execution Project. In specific cases (straying currents) measurements shall also be carried out after all work on the motorway route is concluded.

With regard to results of the environmental impact assessment, the implementation project shall present the protection against corrosive activity of soil and protection against mechanical, chemical and thermal damage of the cable. For the purpose of mechanical protection of the cable, construction of cable lines in line with applicable regulations of Telekom (BiH) and use of attested material shall be envisaged. The protection against lightning strike implemented during the construction of cable lines shall be in accordance with the "Instructions on protection of telecommunication cables against atmospheric discharges" (PTT Vestnik, no. 23/91). With regard to results of the environmental impact assessment, protection of telecommunication lines shall be envisaged against atmospheric impacts, impacts of energy facilities (transmission lines, DS, DTS) in normal operating conditions and in case of damaged lines, against impacts resulting from switches in the power supply high-voltage network, as well as protection against electrostatic discharges and impact of external electromagnetic fields, to be implemented in the control communications centre and all on call columns. For the purpose of implementing such protection, a special project may be prepared as a supplement to be considered a constituent part hereof. Economical implementation and elimination of any defects on the protection shall be taken into account when designing the surge protection.

An efficient earthing system shall be prepared for all control communications centres and call columns, by taking into account the danger level with regard to the system and in line with the applicable national standards and technical regulations, European (EN), international and foreign national standards.

Elements and sets used for the protection against surge shall be selected so that they comply simultaneously or in combination for all specified electrical environmental impacts. All installed surge protection devices, their connections and terminations shall have aligned bursting strength and shall comply with the relevant European (EN), international (ISO, IEC) and EN-harmonised national standards.

The project of implemented work shall be prepared after the concluded construction of the "Emergency call" system in accordance with the "Instructions on contents of the project of implemented work":

- Graphic list of cable lines along motorway;
- The project of implemented work shall be submitted to the Client on an electronic medium
- Technical records on laid telecommunication cables for the "Emergency call" system;
- Measurements on telecommunication cables for the "Emergency call" system
- Preparation of the project of implemented work regarding protection of the "Emergency call" system against environmental impacts;

- Measurements on electronic devices in the control communication centre and call columns including the preparation of technical records;
- Checking the functioning of the "Emergency call" system;
- The report on checking of the "Emergency call" system against environmental impacts up to the point of termination (NT), including the surge protection.

2.12.7.3 Testing of cable lines

Testing of cable lines shall be carried out with regard to transmission and tightness.

Testing shall be carried out in accordance with the regulations of Deutsche Telekom (Vorschriften ZTV – FLN 40).

2.12.7.4 Optical system of transmission

The following guidelines shall be taken into account in planning of the telecommunication model of Slovene motorways:

- Placement of optical cables in cable lines on all motorway sections.
- The system shall have appropriate transmission capacity, which will easily enable inclusion of digital services as well as transmission of data and video signals.
- The network shall be flexible, it shall enable simple upgrades with regard to data, audio, ISDN and video signals with the widest possible range of possible interfaces.
- The network shall be configured in a way providing protection of transmitted information.
- The option for upgrading with newer technologies such as the ATM shall be provided.
- Integrated remote control and management shall be provided in line with currently applicable standards and recommendations.
- The network shall provide for the option of connection with the Telekom's network.

The project shall include the following:

Implementation:

1. Placement method (laying and placing of the cable in PEHD pipes);
2. Installation, connections in buildings and termination of the cable;
3. Joining of the cable in cable ducts on envisaged locations;
4. Measurements of optical network parameters.

Equipment:

1. Cable (type, capacity, loading)
2. Joints
3. Splitters
4. FC/PC connectors

2.12.8 OTHER REQUIREMENTS

The list of material and work shall specify each work stage as the work shall be actually carried out and realistically evaluate it in the Construction Permit Project, the Works Execution Project, and the Project for the Tender.

The project and the list of equipment shall specify for each installed material the appropriate standard as well as the attestation issued for the underlying material.

The project shall specify the minimum permitted Mean Time Between Failure of the "Emergency call" system (MTBF >3000), and the maximum permitted Mean Time To Restore (MTTR <6h) for the system as a whole.

The system shall provide for upgrading of remote interventions, self-diagnostics of operation and peripheral expansion and compatibility with the existing system. It shall enable connection of the "Emergency call" system to the network of Telecom (BiH).

Management and control of operation shall be implemented by using a computer and the software selected by the Client, and shall also provide for "manual" operation of the system if need be.

Protection of the "Emergency call" system against vandalism shall be ensured.

The warranty period for the system and all elements thereof (except for consumable material as specified in the project) shall equal at least 3 years.

The warranty period for the cable line shall equal 10 years after successful testing thereof.

For the purpose of testing the compliance with prescribed system parameters, the commissioning / test operation period shall equal at least 6 months.