

SHORT GUIDELINES

FOR ROAD CONSTRUCTION AND MAINTENANCE

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This edition of the "Short Guidelines" does not claim full coverage on the subject of road construction and maintenance. The contents correspond to the foreseen volume of pages as per Project N 2007CB16IPO006-2009-1-7. The author has selected the most important qualifications, classifications and types of road construction and maintenance.

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The *Roads Law* defines the term road as a stripe of land surface specially designed for traffic of vehicles and pedestrians and matching specific technical requirements.

I. State classification and numeration of roads

Roads are *republic and local*.

- **Republic roads are motorways and first, second and third class roads**, which provide traffic connections having national significance and forming the state road network. Several republic roads are included in the transeuropean road network.
- **Local roads are municipal and private, open of public use**. They provide transport connections having local significance and connected to the republican roads or streets.

The lists of republican and municipal roads and their revisions are subject to approval by the Council of Ministers following suggestions made by the Minister of Transport and the Minister of Regional Development and Public Works after coordination with municipality mayors.

Motorways are the highest class roads and are designated for high-speed vehicle traffic.

Motorways have separate lanes in each traffic direction with a dividing line between them, emergency lane and they cross other roads at different levels. Entering and exiting traffic in motorways is done only in specially designated locations /road connections/.

Numeration of motorways includes the symbol **A** and the relevant following

Number	Name
A1	“TRAKIA” Sofia – Plovdiv - Burgas
...
A6	“CHERNO MORE” Burgas - Varna

number / **A-1, A-2....A-6** /.

First class roads are designated for transit traffic at large distances /mainly from border to border/ They service large territories and match the directions in the basic transport flows in the country. They are numbered from **1 to 9**.

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I - 1	Border Rumania – Vidin – Sofia – Kulata
...
I - 9.	Border Serbia – Kalotina – Sofia – Plovdiv – Kapitan Andreevo – border Turkey

Second class roads are designated for transit traffic at average distances. They have distributing functions in the transport system and provide optimal routes in the transport traffic to different regions in the country. They are numbered **11 to 99**.

Number	Name
II - 11	(O. P. Vidin – Dimovo) – Archar – Lom – Oryahovo – Gulyantsi – (Debovo - Nikopol)
...
II - 63	Pernik – Breznik – Tran – Strezimirovtsi – border Serbia
...
II – 99	(Burgas - Marinka) – Sozopol – Primorsko – Tsarevo – Malko Tarnovo

Third class roads are designated to distribute traffic inside the territories adjoining to the higher class roads or providing connections between separate municipalities. They add to the efficiency of the republic road network in the country and provide connections to the local roads. They have **three- and four-digit** numeration.

Number	Title
III - 101	Vratsa – Krivodol – Boychinovtsi station – Glozhene – (O.P. Kozludui - Oryahovo)
...
III - 992	(Burgas - Sozopol) – Rosen – Veselie – Yasna polyana – Primorsko
...
III - 1901	Bansko – Banya – (Yakoruda – O. P. Razlog)
...
III - 9901	Tsarevo – Varvara – Ahtopol – Sinemorets - Rezovo

Local roads serve municipal interests and are used for connection between the small residential areas and the republican road network.

The "Sluzheben Glasnik" newspaper, issue 14 dated 27.02.2012 published the “Ordinance for categorization of state roads” in the Republic of Serbia

This ordinance categorizes state roads as follows

I-st line and II-nd line state roads on the territory of the Republic of Serbia. I-st line state roads are categorized as I A line state roads and I B line state roads.

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Registration

I A line state roads are numbered with one digit from 1 to 6

Number	Name
1.	National border with Hungary (Horgosh) – Novi Sad – Belgard– Nish– National border with Macedonia (Preshevo)
...
6.	Uzhitse – border with Cherna Gora (Gostun)

I B Line state roads are numbered with two digits from 11 to 36

Number	Name
11.	Horosh – Choka – Kikinda – Zrenyanin– Karnacha
...
36.	Ivanitsha – connect to state road No15 (Uzhche)

II-nd line state roads are numbered with three digits from 100 to 181

Number	Name
100.	National border with Hungary (Bala) – Novi Knezhevats – Mokrin – Kikinda – Voivoda Stepa
...
136.	Vladichin Han – Surdulitsa – Vlasinsko ezero – National border with Bulgaria (Strazimirovtsi)
...
181.	State road – I B Vlasotintse – Cherna Treva – Bosilegrad – National border with Bulgaria (Ribartsi)

Local roads and non-categorized roads are maintained by the municipalities in the Republic of Serbia

Roads in the Republic of Bulgaria are managed as follows:

1. Republic roads – by the National Agency “Road Infrastructure” at the Ministry of Councils;
2. Municipality roads – by the municipality mayors;
3. Private roads – by their owners.

Municipalities and private road owners coordinate with the National Agency “Road Infrastructure” their projects for construction and connection of these roads to the republic roads.

NA “Road Infrastructure” implements the activities related to the construction, repairs and maintenance of republic roads, and (with the

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collaboration from the municipal authorities) of republic roads in urbanized territories. The structure, activities and organization of the agency is regulated by the “Guidelines for the structure, activities and organization of work of the National Agency “Road Infrastructure” and its administration ”.

- Construction, repairs and maintenance of underground facilities, pavements, cycling lanes, car parks, pedestrian underpasses, lighting and landscaping along the republic roads in urbanized territories are organized by the relevant municipalities.
- Construction, repairs and maintenance of local roads are carried out by the municipalities.
- Construction, repairs and maintenance of private roads is carries out by their owners.

Elements	Bord ers	Applicat ion
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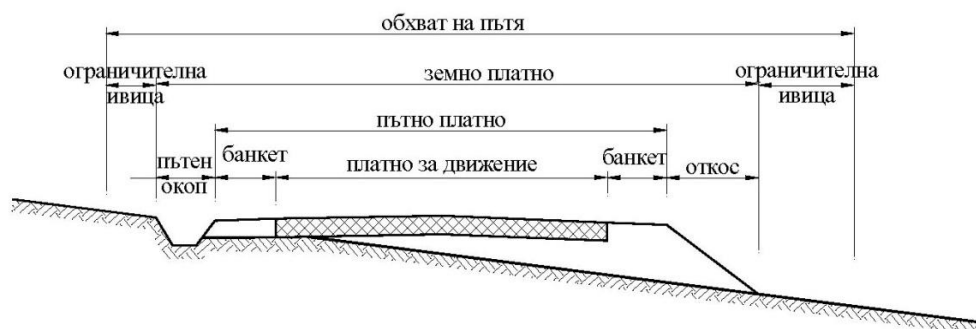
II. Road elements

Roads have: **1. Range** **2. Facilities** **3. Accessories**

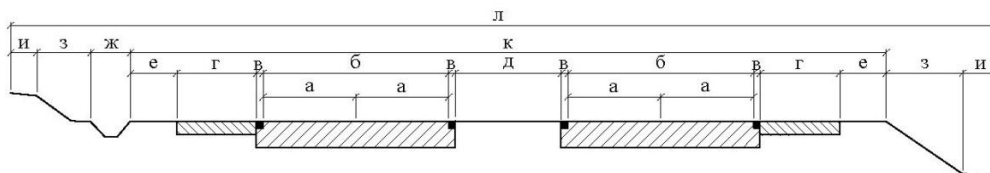
Road ronge

The road range is the surface on which the land subgrade and the dividing lines on its both sides are locates, together with the air surface above it at height determined by the road designing standards. The road range along road facilities for removal of obstacles and above tunnels includes horizontal projection of the facilities over the terrain and its restrictive lines on both sides of the projection. The width of the road range outside residential areas and within urbanized territories with unregulated adjacent terrains are defined in the road project. The subgrade is a part of the surface of the road range which includes: the traffic lane(s), dividing lines, embankments, pavements, dividing and directing islands, green areas, roadside drainage and protective trenches, slopes and other road constructive elements.

Elements of the cross-section profile of a non-motorway road are shown in fig.1



Elements of the cross-section profile of a motorway road are shown in fig.2



a – traffic lane; б (б) – traffic lane; в (в) – leading section; г (г) – emergency lane; д (д) – middle dividing line; е (е) - embankment (or separating line if necessary); ж (ж) – draining trench; з (з) - slope; и (и) – restrictive line; j (к) - subgrade; k (л) – motorway range.

Constitutive elements of the types of subgrades

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Designation	Subgrade / m /	Traffic lanes /quant ity/	Size of traffic lanes / m /	Leading sections / m /	Emergency lanes / m/	Middle dividing line / m /	Embankment /m /		
1	2	3	4	5	6	7	8	9	10
A 35,00	35,00	2 x 3	3,75 + + 2 x 3,50	0,50 (0,75)	2,50	3,50	1.25	50 000 - 80 00 0	AM
A 32,50	32,50	2 x 3	3 x 3,50	0,50	2,00	3,00	1.25	50 000 - 80 00 0	AM
A 29,00	29,00	2 x 2	2 x 3,75	0,75	2,50	3,50	1.25	20 000 - 70 00 0	AM
A 25,50	25,50	2 x 2	2 x 3,50	0,50	2,00	3,00	1.25	20 000 - 65 00 0	AM
Г 20	20,00	2 x 2	2 x 3,50	0,25	-	2,00	1,50	12 000 - 30 00 0	I
Г 12	12,00	2	2 x 3,75	0,50	-	-	1,75	5 000 - 20 00 0	I
Г 10,50	10,50	2	2 x 3,50	0,25	-	-	1,50	5 000 - 20 00 0	I, II
Г 9,00	9,00	2	2 x 3,0	0,25	-	-	1,25	0 - 15 00 0	II, III

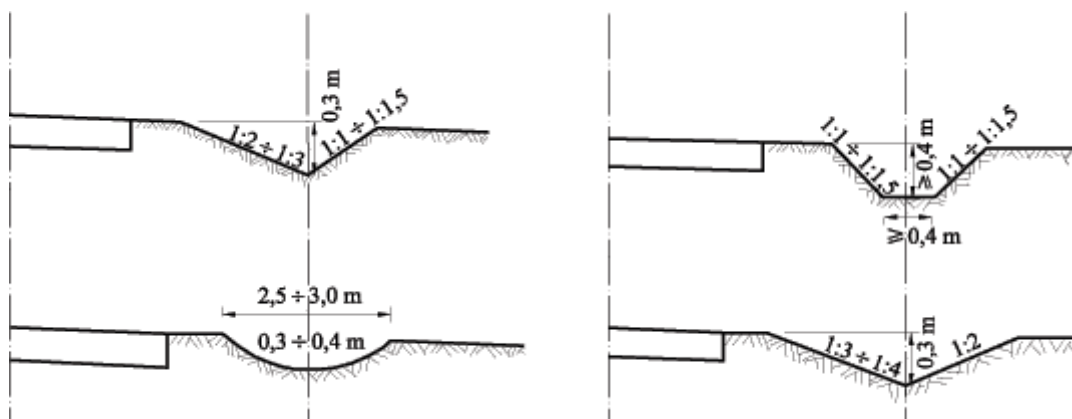
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Г 8,00	8,00	2	2 x 2,75	0,25	-	-	1,00	0 – 5 000	III class local roads
Г 6,00	6,00	1	1 x 3,50	-	-	-	1,25	-	local roads

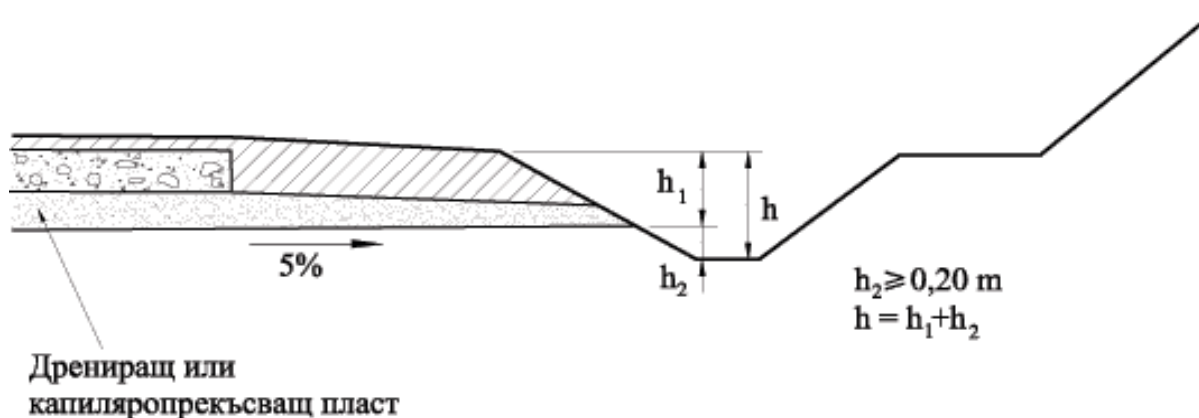
*Borders of application are tentative

Road ditches are set up next to the subgrade for directing surface and underground waters in a trench in the cases of section with zero longitudinal profile and small embankments, as well as embankments in sloping terrains.

Cross section of road trenches may be trapezium-shaped, triangle, oval, etc.



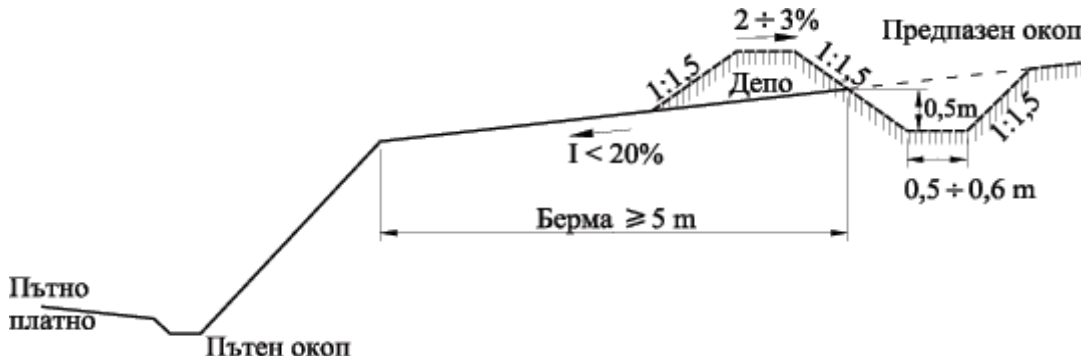
In some of the cases road trenches absorb earth waters from drainage layers, as well as atmosphere waters.



The size and form of the cross section of road trenches depend on the hydrological, earth and climate conditions, as well as on the traffic safety requirements. The sizes of road trenches are proven with hydraulic measuring.

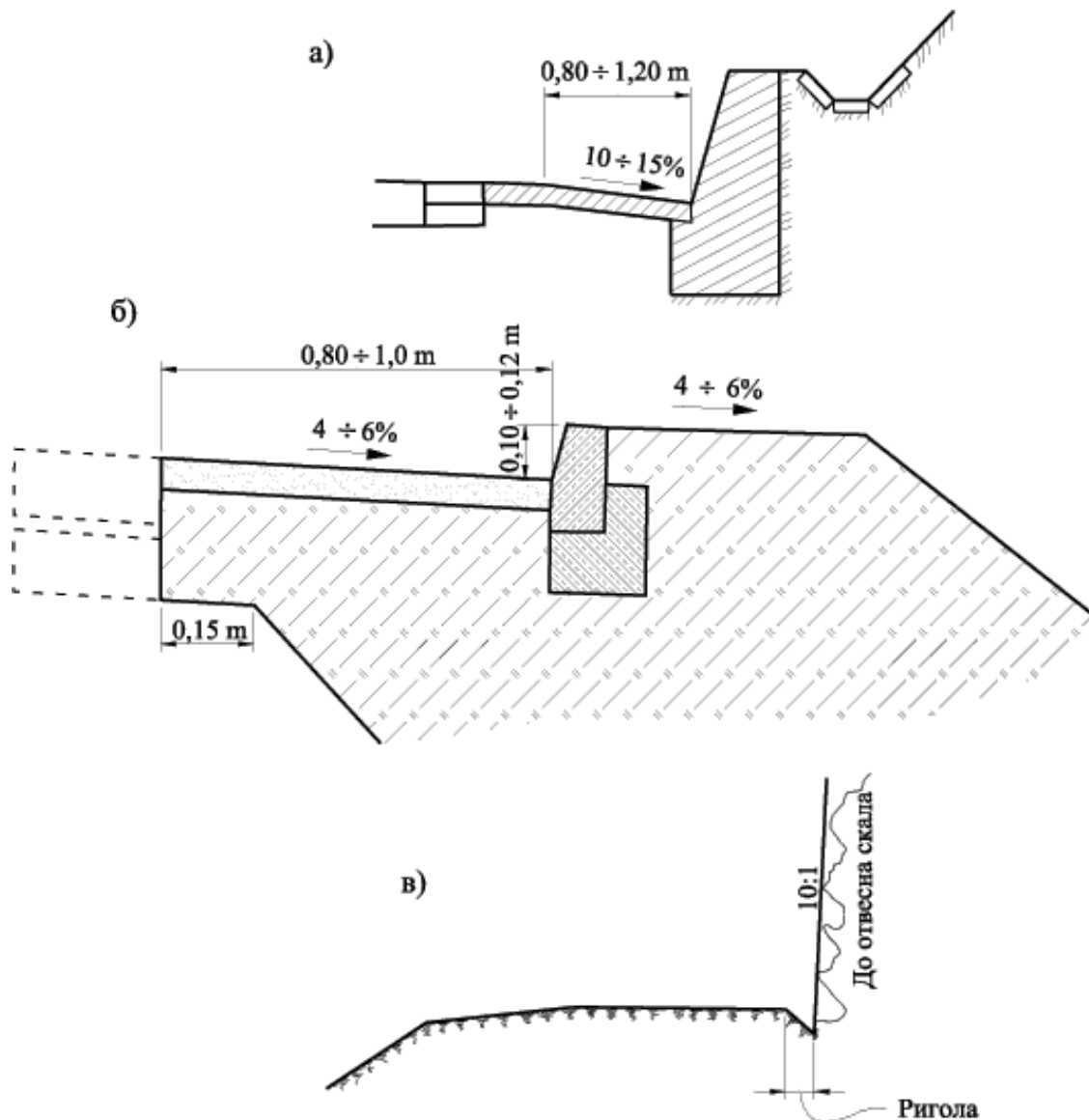
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The minimal permissible longitudinal slope of a road trench is 0,5 %. Protective trenches collect surface waters flowing down to the earth and lead them to the closest facility or to the lowest location of the relief. Their longitudinal section is subject to hydraulic measuring at a minimum depth 0,5 m.



Rigolas are a part of the embankment or the whole embankment, formed with a larger slope (10 - 15 %), and are designated for collection and leading surface waters away from the road subgrade. They are strengthened or covered with pavement.

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Road facilities

Road facilities are as follows: bridges, viaducts, trestles, overhead crosses, underpasses, tunnels, culverts, retaining and decorative walls, water, draining and cleansing equipment.

In highly sloped terrains embankments are often supported by retaining walls; in these cases the layers of the embankment are formed with a slope to the retaining wall; fortification and system barbicans in the wall itself are used for unobstructed collection and draining of the rain and other water collected behind the wall.

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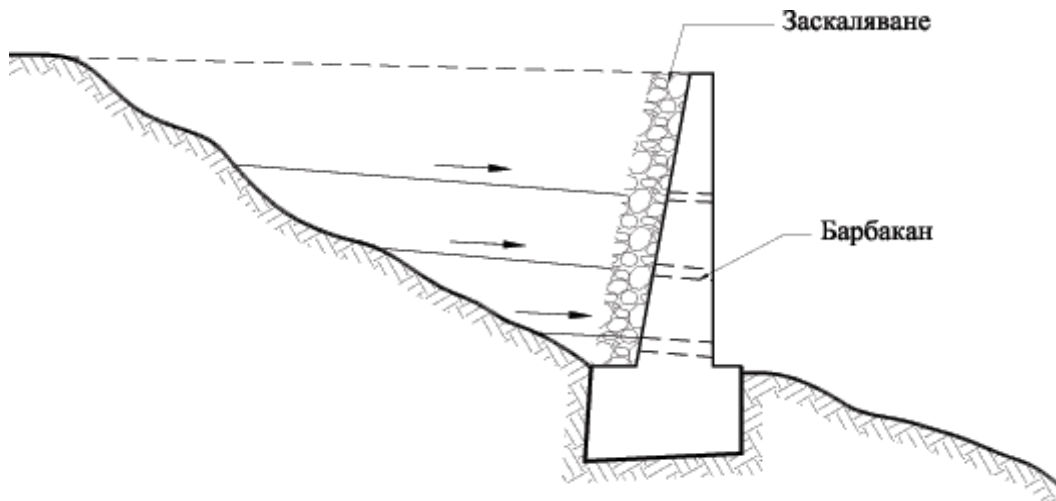
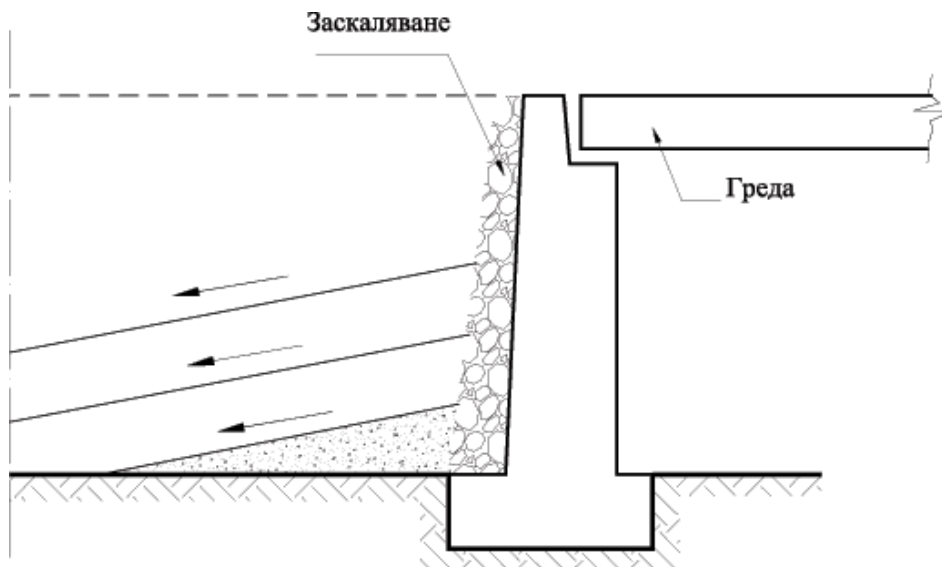


Diagram of the implementation of layers behind bridge piers

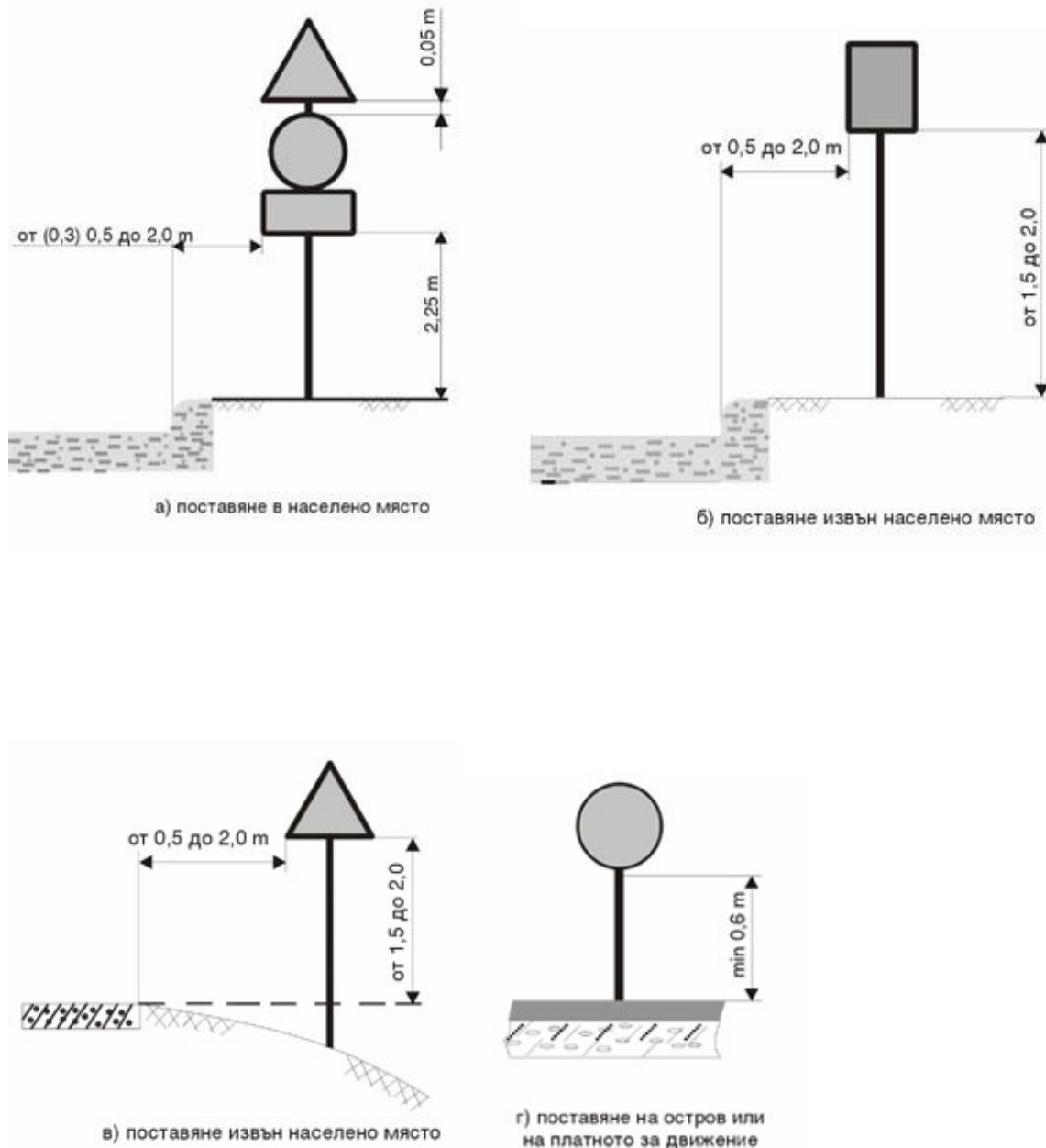


Road accessories

Road accessories are as follows: bases for maintenance of republic roads, road signs, road marking, traffic lights, autonomous phone booths, roadside plants, emergency areas, roadside fountains and rest areas, energy-supplying and lighting equipment together with their adjoining terrains; protective fences; directing poles, snow-protecting equipment; other technical equipment for traffic organization and regulation.

-installation of road signs

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Horizontal marking must be laid on the road surface with the sizes and locations defined in the project.

All marking materials must be accompanied by Technical Specification and Technical Guidelines for the conditions of laying issued by the manufacturer. Laying of the marking must be done with strict observation of the Technical Guidelines for the conditions for laying of the relevant material.

Laying of marking material and glass pearls is done mechanically with approved road marking equipment or manually (in the cases of symbols and arrows) by using stencils.

Road surface must be dry and dust-free, without any contaminations from mud or other substances. The axes of the separate lines of the road marking must be outlined in advance through marking at every 1÷2 m. Outlining must be done with the assistance of a stretched cord in the axis of the marking line.

The indicators of the environment and expenditure standards for the different materials included in the marking shall be observed in accordance with BDS EN 1824.

A protocol shall be drawn up for every layer with completed marking

The indicators of the environment and expenditure standards for the different materials included in the marking shall be observed in accordance with BDS EN 1824.

III. Classification of road surfaces

According to their constructive implementation the road surfaces used in our country for republic and local roads are divided into:

- 1. Road surfaces with crushed-stone coverage**
- 2. Road surfaces with pavement coverage**
- 3. Road surfaces with asphalt coverage.**

T.1 Road surfaces with crushed-stone coverage

Road surfaces with crushed-stone coverage are used for local roads with very light and light traffic.

Crushed-stone coverage is produced by non-volatized magma, sedimentary and metamorphic rocks with grain sizes from 31,5 to 63 mm, stabilized and made thicker by smaller fractions and sand with optimum water content.

The base of stone-crushed surfaces is usually produced by basic cobblestone, sand layers, cinder or different earth stabilizers.

In the cases when the earth base consists of rocks, gravel or sand, the crushed stone surfaces may be laid without a basic layer.

T.2 Road surfaces with pavement coverage

Depending on the type and quality of the used stone materials, the thickness of the basic and sub-basic layers and the water aptitude of the earth base, pavement surfaces may be used in all traffic categories. Most often they are used for roads with heavy and very heavy traffic, which is why they are laid on a solid base /crushed stones with cobblestone, concrete or other base/.

Surfaces with pavement coverage are also used in the cases when there are risks of spilling of organic oil, solvents or other polluting agents which have destructive effect on other surfaces.

Pavement surfaces are constructed from different prism blocks which are usually made of natural stone materials /granite, syenite, basalt, porphyry, etc/.

Pavement blocks form other materials /most often different slag materials from the metallurgic industry/ are also used.

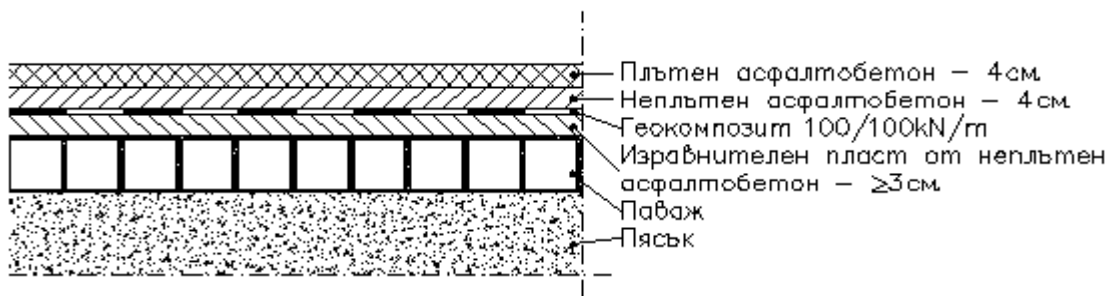
Concrete or crushed-stone pavements / 8÷10 cm / over basic cobblestone /20÷25 cm/ are used as base for pavement surfaces. The leveling layers is made of lightly compacted sand with thickness 4÷5 cm.

Relaying of pavement surfaces with asphalt layers

Most frequently two layers of asphalt mixtures (thick & non-thick) are laid on pavement surfaces to improve their exploitation qualities.

The described activities are implemented in the following technological order:

1. Cleaning the surface of the pavement coverage and its gaps from dust, mud and other pollutants. Cleaning is done with pressurized air jet or combined with water.
2. After the pavement surface is dry a quickly dissolving bitumen emulsion (cation or anion) is spread on it with quantity of 1,0÷1,2 kg/m². The cation and anion bitumen emulsions must be in compliance with *BNS EN 13808* and “Technical specification - NARI”.
3. Laying of two layers (thick and non-thick) bituminous concrete with total thickness 15,0 ÷ 17,0 cm. This thickness may be decreased if the construction includes layers of geo-composite material with minimum straining pressure in both directions of 100 kN / m at relative extension at breaking less than 5 %.



T.3 Pavements with asphalt coverage

Depending on the type and characteristics of used materials, quantity and thickness of the separate constructive layers, asphalt cover layers are used for the construction of road surfaces designated for all traffic categories.

Most generally the asphalt cover layers are mixtures of grain materials /different size stone fractions, sand, ground stone, etc./, processed with a thin film of organic connecting substance /natural asphalt, bitumen, tar or emulsions/. According to the type of used materials and their implementation technologies, asphalt cover layers are divided into cover layers produced by:

3.1. bituminous concrete

3.2. surface processing

3.3. impregnation

34. slurry seal, etc.

T.3.1 Bituminous concrete cover layers are asphalt mixtures, prepared in asphalt bases through mixing heated stone fractions, crushed or natural sand, ground stone /if necessary/ and road bitumen taken in different ratios.

Bituminous concrete mixtures are used for cover layers and road surfaces for all traffic categories, including motorways, streets, squares, lanes, platforms, car parks, etc.

Their purpose determines the selection of the type of bituminous concrete mixtures and the used materials which must be in compliance with the relevant technical specifications.

T.3.2 Cover layers with **surface processing** are of the type thin layers / 12÷20 mm / which is achieved by spreading organic connecting substance /bitumen or bituminous emulsion / and immediately after that laying unprocessed or preliminarily processed with organic connection agent stone fractions.

Spread fractions are compacted, mainly with a pneumatic roller in order to ensure their settling and durable sticking to the surface of the pavement.

Depending on the implementation technologies surface processing may be single or double.

Surface processing is implemented most often for surfaces over crushed-stone pavements and for restoration of existing old asphalt surfaces.

Sealing, i.e spreading of bitumen in quantity 0,9 l / m², spreading of sand at 0-4 mm and compacting, may be done during single or double processing.

The type of used surfaces processing and requirements for mineral materials and connecting substance as described in the relevant Technical Specifications.

T.3.3 Impregnated surfaces are a light type of surfaces, usually with thickness from 40 to 80 mm.

The technology of their construction includes: spreading of stone fraction / 12-31,5 mm / with quantity 4,5 ÷ 5,2 m³ / 100 m²; compacting with static or pneumatic-wheel rollers; spreading hot bitumen / 140 ÷ 1600 C / with quantity of 3,0 ÷ 3,2 l / m²; application of fraction 4-12 mm with quantity 1,0 ÷ 1,2 m³ / 100 m²

Most frequently impregnations single surface processing is done over impregnated surfaces.

The requirements for the mineral materials and connecting agents used for the preparation of impregnated surfaces are indicated in the relevant Technical Specifications.

3.4 Surfaces type —slurry seal is a thin layer made of bitumen emulsion, ground stone, small-grain fractions and / or sand in a certain ration.

The mixture is produced and applied in cold conditions. It is most commonly applied to repaired existing asphalt layers to restore the surface characteristics - roughness and water resistance.

Slurry seal type surfaces are usually laid with thickness of 3 to 6 mm in one layer. It is possible to use two layers in the cases when the first is used for levelling, and the second - to achieve homogeneous surface texture.

Anionic or cationic emulsions are used, depending on the type of selected mineral materials. Cationic emulsions with mineral materials of eruptive origin are more commonly used.

The technical requirements for materials and mixtures are indicated in the relevant specifications.

IV. Classification of the types of activities in road construction

The road administration authorities organize the implementation of a complex road construction and exploitation activities to provide traffic safety and passengers comfort. These may be divided as follows:

- 1. New /capital / construction**
- 2. Reconstruction**
- 3. Basic repairs / rehabilitation/**
- 4. Maintenance**
- 5. Technical supervision**

T.1 New construction in the activity connected to building new roads /roads sections/, road facilities and accessories.

T.2 Road reconstruction is the activity implemented when the road elements need reorganization / reconstruction, but the basic direction of the existing road-bed is kept.

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Road construction includes changes in constructive elements, essential parts, facilities and engineering networks, as well as the implementation of new ones /when the road axis is corrected or the need for such arises additionally/. These increase land stability, load capacity of the road surface, as well as the capacity of bridge facilities.

Road reconstruction also includes change of geometrical elements of the road /road-bed, dimensions, radiuses of horizontal and vertical curves, cross and longitudinal slopes, etc/.

T.3 Basic repairs / rehabilitation / comprises the implementation of a complex of repair works with the purpose of restoring the exploitation conditions of the road. Basic repairs include partial restoration and /or partial replacement of constructive elements, essential parts and facilities, as well as construction and installation works for the replacement of worn-out materials, structures and constructive elements.

Basic repairs lead to restoration of the load capacity, smoothness and cohesion qualities of the road surface; safety of road surfaces; effective functioning of draining facilities; vertical signalization and horizontal marking; protective equipment, etc. These aim to provide traffic safety and extended exploitation life of the road.

Basic repairs may be implemented with leveling or partially situational changes of the road-bed, extensions of the road surface, etc. in the cases when they are within the restrictive road line.

Basic repairs activities include:

- Restoration of trenches, drains and other drainage facilities;
- Adjustment and displacement of the existing road axis in separate sections with bad conditions, leveling or visibility;
- Stabilizing landslides and landslips
- Amplification and / or widening of the pavement with replacement of the individual structural layers if necessary
- Formation of overshoots and widening in horizontal curves;
- Repairs of existing bridges to adjust their dimensions and load capacity to the standards corresponding to the class of road and traffic requirements;
- Restoration of old retaining walls, protective, strengthening regulatory and other facilities;
- Recovery of tunnels and protective galleries;
- Landscaping restoration and cultural shaping of the road;
- Complete repairs of existing buildings and other auxiliary equipment of the road services in connection to the repairs of roads, etc.

T.4 Road maintenance is activity aiming to provide the necessary conditions for uninterrupted, safe and convenient traffic and to protect road from untimely wearing out.

According to their purposed the road maintenance activities may be divided into:

4.1 Preventive maintenance;

4.2 Current / routine / maintenance;

4.3 Damage-restoration works in average situations;

4.4 winter maintenance.

PREVENTIVE ROAD MAINTENANCE is a planned, economically effective strategy for preservation of surfaces, road facilities and equipment, extension of their exploitation period and increasing the comfort and safety of passengers. It is applied to roads and facilities in good condition.

Preventive road maintenance includes the following basic activities:

1. Closing surface cracks;
2. Completion of new carrying layer of coating / re-pavement / of cobblestone, pavement, asphalt and concrete surfaces; Stabilization of embankments / using mechanical or chemical methods /;
3. Reinforcement of slopes
4. Conducting periodic remedial activities of road construction equipment
5. Conducting periodic remedial activities of road construction equipment (road signs, safety fences, rails, safety nets, lighting systems, etc.).

1. Closing surface cracks;

The closure of surface cracks is most often done by sealing with diluted bitumen emulsion, asphalt compounds and other relevant materials developed on the base of thermo-modified bitumen.

Repairs are carried out in dry weather, air temperature over 5°C in shade and include the following processes:

1. Cleaning the surface of the pavement from stone grains, mud, dust and other contaminants.

2. Evenly spreading cold or hot molten materials in a quantity of 0,45 ÷ 0,70 kg/m² depending on the texture of the coating. There may be one or two layers for the purpose of better penetration of the binder.

Traffic must be stopped for about 4 hours after these procedures. Failing that,

the speed must be limited to 30 km / h and there must be signs in the section indicating the danger of slipping.

Used materials be in compliance with the requirements

2. Completion of new carrying layer of coating / re-pavement / of cobblestone, pavement, asphalt and concrete surfaces;

- *Laying of crushed stone surfaces* is done in the following technological order: road cleaning; removing the entire surface of the pavement, transferring the broken material and cleaning it; adding new cobblestone material, shaping and leveling the crushed-stone layer; filling the embankment and compacting the pavement.

Compacting of the pavement is done with rollers $8 \div 10$ t, starting from the edges toward the center. 3-4 passes of the roller are done in the beginning along the edge of pavement on each side. After that rolling continues to the axis of the road by overlapping tracks with half width of the rear shaft.

Sealing of the cobblestone layer continues until the roller stops leaving traces on the surface and the ripples are removed. Cobble-stone fractions $12 \div 20$ mm in the amount of $1,15$ m³ per 100 m² are spread over the sealed layer and are rolled again. After that fractions size $4 \div 12$ mm in the amount of $0,75$ m³ per 100 m² are used and again compacted several passes of the roller. To facilitate the compacting the surface is irrigated with water. The water consumption varies from 10 to 20 liters per 1 m² depending on the weather and type of base.

Sand / $0 \div 4$ mm / amounting to $1,0 \div 1,5$ m³ per 100 m² is spread after the final compaction of the surface and is compacted with 2-3 passes of the roller. During exploitation the protective sand layer over the surface is maintained by systematic sweeping.

- Under the influence of traffic and weather conditions *pavement surfaces* often undergo the following damages and deformations:

- a) Swelling and collapse of individual pavement blocks and sections with sizes from several blocks to square meters.
- b) Formation of tracks parallel to the axis of the road, covering two or three pavement blocks in the opposite direction.
- c) Transverse waves and subsidence perpendicular to the axis of the road.
- d) Destruction of separate sections with broken connections between stone blocks and padding layer disposed to the surface.
- e) Displacement of side pavement blocks, accompanied by displacement or destruction of stone curbs.
- f) Displacement of cobblestone blocks and widening of the gaps between them.

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- g) Destruction of individual stones of weaker types or rounding /scouring/ of the edges etc.

These repairs include the following technological order:

The section subject to repairs must be cleaned of dust and dirt. Filling sand and stone blocks are removed, the latter being stored according to their sizes. The main layer / mostly cobble-stone / is levelled with tamped small-grain fraction for small local pitting or all layers of the earth bed are removed, non-solid soil is replaced with appropriate soil - gravel, sand or coarse aggregate. New basic layers are laid and properly sealed; they should be of the same material used for the construction of the adjacent solid sections. New padding sand layer is applied for leveling and compacting. Stone blocks are reordered by placing them in the sand layer so as to raise them by 2 ÷ 3 cm above the existing pavement, after which they are and slightly tamped. Fraction 8/12 / ÷ 16/20 / is sprayed on the surface and is brushed into the gaps between blocks. Cobblestone pavements are re-tamped with mechanic rammer with mass 25 ÷ 30 kg. Compaction is carried out from the final lines towards the medium ones and follows their order / right, diagonal or segment. Fraction 4 ÷ 8/12 / is spread again with subsequent compaction, while the level of the repaired area remains approximately 1,0 cm above the existing pavement / with view of further compacting caused by traffic/. Backfilling of repaired areas with a layer of coarse sand with thickness 1,5 ÷ 2,0 cm, which is brushed into the gaps between the cobblestones.

- ***Re-laying of asphalt surfaces*** includes restoration of the surface or increasing its cohesion qualities by means of new layers.

In the cases where repairs cover small areas and do not need deep penetration into the pavement, the most commonly used machines are compressors for cleaning, hand sprayers for bitumen emulsion and floor-saws.

3. Reinforcement of slopes

The basic methods for reinforcement of road slopes are as follows:

- a) Strengthening of ready reinforced concrete elements.
- b) Biological reinforcement by grassing or planting shrubs and trees.
- c) Strengthening of rock slopes with steel nets
- d) Strengthening of geo-textile products / geo-nets, woven and nonwoven geo-textile products/.
- e) Strengthening by fascines, gabions, etc.

These reinforcement methods may be applied separately or combined depending on the specific conditions on site.

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4. Conducting periodic remedial activities of road construction equipment

Remedial activities on bridge constructions built from concrete and reinforced concrete include:

- a) Reinforcement of the concrete surface /surface scratching, chipping and shelling of the material/.
- b) Filling of cracks

CURREN / ROUTINE/ ROAD MAINTENANCE is planned everyday activity aiming to provide better conditions of the road, road facilities and equipment and the relative approved level of servicing. Current maintenance includes activities connected to removal of single damages and deformations of the elements in the range of the road, road facilities and equipment and preventing further spreading/development of such.

Current maintenance includes the following basic activities:

- Permanent control over the operational status of elements of the road, road facilities and accessories;
- Cleaning of small landslides, rock falls and debris;
- Mowing, leveling and shaping of embankments;
- Mowing of slopes, restrictive and dividing lines, rest areas and other green areas;
- Filling and reinforcement of slopes in different areas;
- Cleaning and / or restoration of retaining and supporting walls and equipment;
- Cleaning and removal of small damages to the road surface;
- Cleaning and / or restoration of damaged draining facilities - ditches, rigolas, gutters and drainages in separate areas;
- Cleaning the road-bed and repairs of individual damages - holes, cracks, edges, etc.;
- Removal of deformations - ripples, tracks and other uneven areas;
- Repairs and filling of closed gaps of road facilities;
- Cleaning of culverts, bridges and their openings from mud, ice, sediments and other materials;
- Removal of structural damages of the road-bed, top-constructions, bearings, substructures and riverbeds;
- Painting steel structures of bridges, parapets, safety fences, elements of road signs, etc.;
- Restoration of horizontal markings;
- Installation of new or replacement of old damaged traffic signs, protective fences and directing poles, as well as installing additional ones if necessary;

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- Cleaning and removal of damage in roadside areas, fountains, monuments, gazebos and other items of roadside facilities;
- Maintenance of roadside plants, hoeing, spraying, whitewashing, etc., as well as replacement of damaged and dead plants with new ones;
- Maintenance, cleaning and removal of small damages to buildings and facilities of traffic services, etc.

Damage-restoration works in average situations are implemented to restore minimal level of servicing after average situations / serious traffic accidents, snow storms, avalanches, freezing, land-sliding, collapses, destruction of bridge facilities, etc./, in order to ensure traffic safety and to protect road elements and road facilities from more serious damages.

Preventive activities, coordination and management of damage-restoration works in the average area are defined and stipulated for in the Law on disaster protection and the related documents.

Winter maintenance of roads is a complex of activities aiming to provide accessibility of roads in winter conditions and removal or limitation of the adverse effects of ice and snow on the traffic conditions. The type and volume of winter maintenance works depend on the affirmed level of winter maintenance for a certain road.

T.5 Technical supervision is a combination of activities for certification and licensing the exploitation conditions of the road elements. It comprises:

- organizing and conducting inspections, examinations and tests of the road elements to establish their operational status and to compile a road data bank;
- surveys and studies to determine the causes of damages and defects, as well as their impact on functionality, durability, load / load capacity / of the structural elements of the road-bed, road facilities and equipment, in view of planning their maintenance and repairs;
- counting and forecasting traffic;
- creating systems for management of roads and road facilities;
- protection of road elements, etc.

Organization of road maintenance and repairs is defined and stipulated for in the Law on roads and the relevant regulation acts and documents describing ownership, management and exploitation of the roads in the country.

V. Basic activities for winter maintenance

Basic activities for winter maintenance include preparation works: preparation of plans for winter maintenance, technical tests and examinations of machines and equipment, preparation of roads for exploitation in winter conditions, provision of required materials, etc.

1. Planning for winter maintenance includes:

- Relevant data for companies /Contractors / which signed agreements with Contraction authorities to carry out winter maintenance of roads in the area;
- Exact name and location of the road segments, which each company has undertaken to implement winter maintenance;
- Degrees and levels of winter maintenance of individual sections of the road. Degrees and levels are determined and updated each year;
- Areas with the highest probability of snowdrifts.
- Areas for installation of temporary snow-protection equipment / protective fences of portable inventory shields/. Chapter twelve describes requirements for their characteristics and location;
- Timetable for carrying out tests on the conditions of road sections, particularly drainage facilities - road ditches, drainage gutters, bridges and culverts. These identify concrete measures and deadlines for their cleaning and necessary repairs. Tests are carried out jointly by the officials of the Contractor Authority and the Contractor;
- Timetable of technical inspections of machinery and equipment which the Contractor will use to perform snow cleaning and prevention of sliding in the road sections. These inspections are attended by officials of the Contractor Authority and the Contractor; expert evaluation must be given on the suitability and optimal composition the machinery proposed by the Contractor;

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- Determining the financial resources for payment of the winter maintenance activities implemented by the Contractor - to be done according to pre-approved methodology;
 - Selection of schemes for cleaning snow from the road surface – to be performed as per requirements;
 - Selection of schemes for clearing snow in embankments and clearing snowdrifts and compacted snow layers.
- 2. Snow protection of roads:** construction, production and installation of snow-protecting devices - constant /roadside green stripes, earth embankments, etc. /, temporary /portable inventory shield fences/, as well as mowing of grass areas, cutting of shrubs, removal of materials and other objects in the range of the road which could cause snowdrifts;
- 3. Snow cleaning (patrol and periodic) of roads** to achieve relevant degrees and levels of winter maintenance, clearing snowdrifts and removal of thick frozen ice & snow layers; Snowdrifts with thickness up to 0,60 m may be cleared with heavy snow-ploughs and auto-graders. Snow masses which were pushed aside by the machines must be discarded by rotor snow ploughs or to be shaped with graders outside the road-bed.

Thicker snowdrifts may be cleared with rotor snow-ploughs or bulldozers. For universal bulldozers the blade should be placed at an angle and the snow should be gradually pushed outside the road-bed.

Different sets of machinery – rotor snow-ploughs and bulldozes are used for clearing big snowdrifts with thickness above 1,5 m. Clearing is done in layers or through pushing the snow with a bulldozer towards a rotor snow-plough which discards it outside the road.

Thickened snow layers are best removed with auto-graders. Frozen layers and layers tightly stuck to the road surface are pre-processed with salt in quantities of 25 g / m² magnesium lye in quantities of 100 g / m².

- 4. Anti-sliding measures for roads:** spraying with mineral materials and chemical substances. Anti-sliding measures are implemented when the road surface is frozen or snowbound. The aim is to remove or limit the adverse effects of winter sliding on the traffic conditions and safety.

Anti-sliding measures are implemented through spraying/spreading of mineral materials (sanding) or chemical substances which melt ice and snow. The separate methods may be applied individually or in combination.

The recommended ratio sand-salt mixture is 150÷200 kg salt to 1 m³ sand. Salt and sand should be well mixed in advance.

Expenditure standards for mineral materials for sanding are 100÷300 g / m² for road sections with normal traffic conditions and 300 ÷ 500 g / m² for road sections with heavy traffic conditions.

For intermediate sanding during snowfall the expenditure standards are 100÷200 g /m².

Magnesium lye is a waste product from the production of sea salt. The magnesium lye used for winter maintenance be in compliance to the relevant requirements.

Requirements for spraying / spreading machinery and equipment

Road snow clearing is done mechanically with:

- **Specialized snow-plough machines;**
- **Road machines for general purposes;**
- **Attachable snow-ploughs.**

Winter anti-sliding materials are spread with specialized equipment, mounted on heavy-load vehicles. The equipment must have dosing devices.

The dosing device for solid materials must allow regulation of the expenditure standards within 5÷50 g / m² for chemical substance in crystal form and 100÷500 g / m² for mineral materials.

The device must allow regulation of the quantity of spread materials depending on the speed of the used vehicle.

The device for spraying water solutions of chemical substances must have spraying pump under pressure of 0,2÷0,3 MPa. The dosing device must allow regulation of the sprayed quantities water solutions within 30 to 150 g / m².

The spraying device must ensure even distribution of materials on the road surface. For the purpose it must allow regulation of the spraying width within 2 to 6 m for devices with one sprinkler and 4 to 12 m for devices with two sprinkler.

VI. Basic transport and exploitation characteristics of the road

Transport and exploitation characteristics of the road are in direct relation to the measuring of the structures of road surfaces and to the determining the type and volume of road repair works. The basic ones are as follows:

1. **Traffic intensity.**
2. **Load capacity of the road construction.**
3. **Evenness of the road surface.**
4. **Sliding resistance of the road surface.**
5. **Damages of the road elements.**

T.1 Traffic intensity

Traffic intensity is essential both for determining the main elements for newly built roads and for planning and selection of the type of road repair works. It is defined in compliance with *BNS 16578*

Essential for the planning of repair works are the **measuring intensity** and **measuring load**.

Measuring intensity/MI/ is the number of measuring vehicles which pass along the measuring lane daily, calculated as an average value for the measuring period.

Measuring vehicle/MV/ is a vehicle which has certain back and front axle load - respectively 100 or 115 kN for the back axle and 60 or 70 kN for the front axle.

Measuring load /ML / is the total number of measuring axles.

T.2 Load capacity of the road surface

Load capacity of the road surface characterizes the strength qualities and total workability of the road surface. It sets the conditions for traffic with certain intensity and axle load.

T.3 Evenness of the road surface

Evenness of the road surface is characteristics for the exploitation qualities of the road surface and affects the safety and comfort of passengers, as well as the dynamic load of the pavement and the prime cost of the vehicle haulage.

Having in mind the road class and its projected speed, and depending on the measured values of specific indicator, the evenness of the tested road surfaces is classified in separate exploitation states which are a part of the complex assessment for the condition of the road surface in connection to its repair works.

Measuring the indicators for evenness and assessment of the exploitation state of the surface in view of the evenness of the road are implemented in compliance with “*Methodology for measuring and assessment of the evenness of road surfaces*”.

T.4. Sliding resistance of the road surface

Sliding resistance of the road surface is a basic indicator providing conditions for sustainable and safe traffic of vehicles with the approved speed.

Sliding resistance depends on many and different factors, connected to the type of vehicle, tires, traffic regime, road-bed, type and state of the road surfaces, drainage, environment, etc. Among the factors directly related to the road surface the most important for the sliding resistance of the road are the roughness of the surface and its momentary condition - dry, wet, muddy, frozen, etc.

T.5. Damages in the range of the road surface

The state of the road surface, road facilities, draining facilities and other road elements are determined through checks implemented visually or with specialized equipment.

There are two types of damages: **destructions and deformations**.

Destructions include: netlike cracks, cracked caused by volume changes, single cracks, crack near the edge of the surface, cracks caused by sliding, holes, accelerated wearing of the surface, sweating of the surface, etc.

Deformations include: tracks, cross ripples and pushing aside, compacting, swelling, etc.

VII. Signalization of road repair activities

A project must be prepared for the signalization of road repair activities in compliance with the requirements of “*Ordinance No4 dated 04.05.2001 for the range and contents of investment projects*” and “*Ordinance No16 dated 23.07.2001 for the temporary traffic organization when implementing road and street construction and repairs*”.

Signalization in the repair sections is temporary. It is done with the use of standard road signs and other means of signaling – cones, barriers, directing and restrictive sign posts, closing sign posts, constant or flashing lights, warning flags, portable traffic lights, etc. Portable road signs attached different types of paltforms are most commonly used for signalization of repair works.

Road signs for constant signalization which are inconsistent with the established temporary signalization are either removed or covered with non-transparent texture or film cases until completion of the repair works.

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When implementing road maintenance and repair activities all works must be dressed in orange work clothes and light-reflecting signaling vest.

VIII. Organization and management of maintenance activities

There are different ways of organization, management and implementation of the maintenance activities for republic roads, namely:

- Organization, management and implementation of different types of activities are carried out by the state road administration;
- Organization and management of activities is carried out by the state road administration and their implementation is assigned to specialized companies;
- State administration assigns the management and implementation of different types of maintenance activities to private associations
- Concession of state roads.

In the recent years in our country most commonly accepted is the following practice - the state administration represented by the National Agency Road Infrastructure through its territorial centres (District road offices) organizes the management of maintenance activities for the republic roads and signs public procurement contracts with companies for the implementation of maintenance activities for specific road sections for certain periods of time /usually 4 years/.

The contracts must be in compliance to the requirements of the Public Procurement Act and contain:

- definitions;
- declarations from the parties;
- subject of the contract;
- terms for the implementation of the activities of the contract;
- assigning the activities of the contract
- prices and methods of payment;
- rights and obligations of the Contracting Authority
- rights and obligations of the Contractor;
- technical capacity of the Contractor;
- Contractor staff;
- Sub-contractors;
- guarantees;
- insurances;
- control and handover of works;
- responsibilities in case of breach of contractual obligations;

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- confidentiality;
- archive documentation. Audit and supervision;
- conflict of interests;
- force major stay of execution

Amendment, supplement and termination of the contract;

- general clauses.

The contract has enclosures which include:

- works which need to start within 48 hours;
- works which need to start immediately after the relevant necessity arises;
- degrees and levels of winter maintenance;
- constant and seasonal works which must be done with preliminary approval or specific instructions from the Contracting authority;
- methodology for updating of prices, implementation of maintenance contracts (preventive, current, winter or during average situations).

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