

REPUBLIC OF SERBIA
TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL TECHNICAL CONDITIONS

2.6 TRADE WORKS

BELGRADE, 2012

Publisher: **Public Enterprise Roads of Serbia, Bulevar kralja Aleksandra 282, Belgrade**

Edition:

No.	Date	Description of amendments
1	30.04.2012	First edition

CONTENT

2.6.1	CARPENTRY	1
2.6.1.1	INTRODUCTION	1
2.6.1.2	BASIC MATERIALS	1
2.6.1.3	QUALITY OF MATERIALS	1
2.6.1.4	METHOD OF EXECUTION	1
2.6.1.5	QUALITY OF WORK EXECUTION	2
2.6.1.6	QUALITY CONTROL OF WORK EXECUTION	3
2.6.1.7	MEASUREMENT AND TAKEOVER OF THE WORKS	3
2.6.1.8	CALCULATION OF WORKS	3
2.6.2	MASONRY AND STONECUTTING WORKS	3
2.6.2.1	INTRODUCTION	3
2.6.2.2	BASIC MATERIALS	4
2.6.2.3	QUALITY OF MATERIALS	4
2.6.2.4	METHOD OF EXECUTION	6
2.6.2.5	QUALITY OF EXECUTION	7
2.6.2.6	QUALITY CONTROL OF EXECUTION	8
2.6.2.7	MEASUREMENT AND TAKEOVER OF THE WORKS	8
2.6.2.8	CALCULATION OF WORKS	8
2.6.3	LOCKSMITH'S WORKS	9
2.6.3.1	INTRODUCTION	9
2.6.3.2	BASIC MATERIALS	9
2.6.3.3	QUALITY OF MATERIALS	9
2.6.3.4	METHOD OF EXECUTION OF WORKS	9
2.6.3.5	QUALITY OF EXECUTION OF WORKS	10
2.6.3.6	QUALITY CONTROL OF EXECUTION	10
2.6.3.7	MEASUREMENT AND TAKEOVER OF THE WORKS	10
2.6.3.8	CALCULATION OF WORKS	10
2.6.4	PROTECTION OF MATERIALS AND STRUCTURES	11
2.6.4.1	GENERAL	11
2.6.4.2	DESCRIPTION	11
2.6.4.3	BASIC MATERIALS	11
2.6.4.4	QUALITY OF MATERIALS	11
2.6.4.5	METHOD OF EXECUTION	12
2.6.4.6	QUALITY CONTROL OF EXECUTION	14
2.6.4.7	MEASUREMENT AND ACCEPTANCE OF WORKS	14
2.6.4.8	CALCULATION OF WORKS	15
2.6.5	WATERPROOFINGS	16
2.6.5.1	INTRODUCTION	16
2.6.5.2	BASIC MATERIALS	19
2.6.5.3	QUALITY OF MATERIALS	19
2.6.5.4	EXECUTION OF WORKS	28
2.6.5.5	QUALITY OF APPLICATION	36
2.6.5.6	QUALITY CONTROL OF WORKS EXECUTION	36
2.6.5.7	MEASUREMENT AND TAKEOVER OF THE WORKS	39
2.6.5.8	CALCULATION OF WORKS	40

2.6.1 CARPENTRY

2.6.1.1 Introduction

Both appearance and quality of structural surfaces, that is the quality of structures made of cement concrete, mainly depend on the carpentry carried out. Therefore, during the execution of this work it is necessary to make a selection of appropriate basic materials, and to provide the accuracy of structural execution as a whole and of particular parts in compliance with the design dimensions.

2.6.1.1.1 Description

Carpentry consists of

- supply and embedding of suitable material for scaffoldings and formworks,
- their placement and fixing,
- disassembling,
- cleaning and storing.

Scaffoldings and formworks have to enable the placement of cement concrete in dimensions specified by the design. The Contractor has to provide design documents for both scaffolding and formwork proving their bearing capacity and stability, unless such documents have already been attached to the contract documents. The Contractor also has to provide all the required documents (drawings, static analyses, certificates) for working and protective platforms, protective roofing, and other auxiliary and assembling equipment.

In formwork for exposed cement concrete surfaces and for pre-stressed structures, certain special requirements have to be met, if they are indicated in the design documentation or specified by the Supervising Engineer.

2.6.1.2 Basic materials

Basic materials for the carpentry are:

- planks
- formwork boards (wooden, steel)
- small beams
- beams
- steel props
- joining materials (nails, wire, clamps, couplers, anchors).

The Contractor is free to use other materials for the carpentry, provided that he has previously proven suitability of such

materials under certain conditions, and that he has obtained an approval by the Supervising Engineer.

2.6.1.3 Quality of materials

The quality of all the materials for the carpentry works has to comply with the requirements (type, dimensions, shape) provided by the design and corresponding Contractor's drawings.

Wood for the carpentry has to correspond with certain valid regulations for the:

- round technical wood
- hewn coniferous wood
- sawn coniferous wood

Planks and formwork boards for smooth exposed cement concrete surfaces have to be completely smooth (planed) and without any sharp edges. In this way, the wood can be used for making scaffoldings.

For scaffoldings and formworks used for non-exposed cement concrete surfaces can be used sawn or hewn wood with minor defects and errors which should not affect the reduction of resistance and durability of the structure below the required limit, provided by design documentation.

2.6.1.4 Method of execution

2.6.1.4.1 Placement of the scaffoldings and formwork

Scaffoldings and formworks should be placed in compliance with corresponding drawings including all the foreseen connections and joints, in order to be capable to carry the predicted load of the incorporated cement concrete and steel reinforcement, and to ensure their removal without any adverse consequences for the structure as well as for the scaffoldings and formwork.

As a rule, for all exposed-smooth cement concrete surfaces of the entire structure, the same type of formwork is used to the greatest extent, and with the same dimensions of individual elements.

Such elements should be embedded into the formwork and scaffolding structure, which allow the required adaptation of the formwork during placement of cement concrete and an adequate dismantling

(spindles, hydraulic presses, cranes). The use of wedges is not allowed.

The joints between individual formwork elements should be specified in advance in the carpentry plans. The distribution should be uniformed and continuous.

Before the closing of the formwork, all the inner surfaces have to be coated with the separating agent, which should not have the detrimental impact on the appearance and hardening of the cement concrete.

2.6.1.4.2 Fastening of the scaffolding and formwork

Scaffoldings and formworks should be anchored and propped in a way that ensures their stability from the displacement and deformations that occur during the placement of cement concrete that is for the displacements and deformations to remain within the designed values.

All the formwork fastening elements should be adjusted to allow each element, which remains in the concrete and may oxidize, to be covered by at least 3.5 cm thick cement concrete or cement mortar layer, or to be protected in some different way.

All transverse anchors have to be equipped with such anchoring elements that enable subsequent tensioning and easy removal without any damage to cement concrete. Openings from which the anchors or stressing heads are drawn should be filled with watertight material (with an exception of certain cases).

In exposed cement concrete surfaces, the disposition of the openings for anchoring the formwork has to be arranged to correspond both technologically and visually with the exposed cement concrete. Disposition should be specified in the formwork plan.

Fixing of formwork using coiled up wire for formwork fortification is not allowed.

2.6.1.4.3 Disassembling of the scaffoldings and formworks

Scaffolding and formwork disassembling can be done only after the cement concrete achieves such strength that ensures structural safety.

For the beginning of formwork removal from the cement concrete, which has a normal temperature conditions for hardening (above +5° C), the following common measures apply:

- lateral formworks after 2 days,
- scaffoldings and propping elements only after the cement concrete has reached the strength corresponding to 2.5 times the stress, which actually occur after the removal.

For pre-stressed structures, conditions related to the removal of scaffoldings and formworks should be specified in the design documentation.

In order to reduce the hazard of cracks and deformations due to cement concrete creep, the time periods for the removal of bearing scaffolding should be as long as possible. After disassembling the formwork, if possible, it is needed for the auxiliary propping to be reinstalled. During removal of the formwork, no damages to the hardening cement concrete must appear.

2.6.1.5 Quality of work execution

Inner surfaces of the formwork have to be smooth and shaped in geometrically correct way that is the way predicted by design documentation. If the boards are used for the exposed cement concrete surfaces, the joints between the boards should be formed as tongue-and-groove ones. For the accurate fabrication and sealing of the joints, water-tightness of the formwork has to be ensured. Runoff of water or laitance should be prevented. For sealing of the joints can be used only such material that does not adversely affect the set of fresh cement concrete and does not change the colour of the cement concrete surface.

Liquid absorbing formworks have to be suitably prepared prior to cement concrete placing (water saturation, protective coatings). It should be ensured that the formwork or the agent for protective coating does not chemically or however react nor it affects adversely the quality or appearance of the cement concrete, including its uniformed colour.

Boards and plates for formwork have to be thoroughly cleaned from all the harmful materials, including snow and ice, prior to embedding.

2.6.1.6 Quality control of work execution

The quality of preparation that is of placement and fastening of scaffoldings and formworks in the sense of the design requirements is checked by the Supervising Engineer prior to placement of reinforcement and cement concrete respectively. The Contractor has to remove all the deficiencies discovered on scaffolding and formwork prior to continuation of the works.

2.6.1.7 Measurement and takeover of the works

Placed scaffoldings and formworks are, as a rule, neither measured nor taken over as a work carried out independently. If specially agreed, the placed formwork is being measured in accordance with general technical conditions, and calculated to the actually executed extent within the dimensions from the design documentation. The measurement of the work done is expressed in m².

The embedded scaffolding and formwork should be taken over by Supervising Engineer by the quality requirements of these technical conditions and according to general technical conditions. The Contractor has to repair all the established defects on the basis of these requirements, prior to continuation of the works.

For all the works on the formwork that do not comply with the required design documentation quality and with these technical conditions, not repaired by the Contractor on request by Supervising Engineer, the Contractor is not entitled to payment for the formwork as well for the works on placement of cement concrete and reinforcement.

2.6.1.8 Calculation of works

As a rule, the placed scaffoldings and formworks are not being calculated separately, but are included in the unit price per cubic meter of cement concrete. If the Contractor failed to use adequate material for scaffoldings and formworks, or did not ensure suitable quality of the formwork, the Supervising Engineer decides upon the method of calculation.

2.6.2 MASONRY AND STONECUTTING WORKS

2.6.2.1 Introduction

Special technical requirements for masonry and stonecutting works consider only special works necessary for finishing surfaces on road facilities or their individual parts.

Masonry and stonecutting works have to be executed in the manner as well as in dimensions and quality as provided by the design documentation and in compliance with these technical conditions.

2.6.2.1.1 Description

Masonry and stonecutting works include purchase and embedding of all necessary materials for finishing and protection of facility surfaces or individual parts upon requests from design documentation.

Basic facility surface finishing manners include:

- panelling and building with stone, prefabricated elements made of cement concrete or adequate bricks,
- coating with cement or decorative mortar,
- sanding – stamping, milling,
- grinding.

The method of arranging and protecting the surface has to be specified in detail in the design documentation. If this is not the case, the Contractor proposes the solution to be approved by the Supervising Engineer.

The Contractor has to, on the demand of the Engineer, demonstrate on a test surface that he is capable to execute the required or offered arrangement of the surface.

2.6.2.1.2 Standards used

The following standards have been used in this guideline. Standards for procedures of certain material examination are listed in the tables of quality conditions.

EN 771-1

EN 771-3

EN 771-6

EN 772-1

EN 772-18

EN 998-1

EN 998-2

EN 13383-1

2.6.2.2 Basic materials

Basic materials for masonry and stonecutting works for arranging surfaces on road facilities or their individual parts are:

- natural stone (quarry and/or finished stone),
- prefabricated elements, finished or unfinished,
- solid facing brick
- mortar for masonry or plastering.

2.6.2.1.3 Stone

Quarry or finished stone from eruptive (silicate) or sedimentary (carbonate) rocks is used for arrangement of facility surfaces.

2.6.2.1.4 Prefabricated elements

Unfinished or finished elements of light-weight and normal-weight cement concrete, as well as autoclaved cement-silicate products have to fulfil the conditions specified by the design documentation for arrangement of facility surfaces or their components.

2.6.2.1.5 Solid facing brick

Facing brick used to line exposed facility surfaces has to meet the conditions foreseen by the design documentation.

2.6.2.1.6 Mortar for masonry and plastering

The mortar for building with stone, prefabricated elements, or facing brick for filling the joints between the specified materials and for plastering, should be composed of suitable mixture of sand, cement, water, and additives. Usually, a mixture of coarse sand of 0/4 mm composed of natural and/or crushed grains is being used.

Chemical and other additives to improve certain properties of mortar can be used, provided that they are foreseen by the design documentation and that the Supervising Engineer approved their application. Producer's instructions be obligatorily considered during use.

The value of the w/c ratio in the mixture of mortar should be less than 0.7, and the air

amount (micro-pores) greater than 10 V.-%.

For the protection of mortar, liquid chemical protective agents can be used to ensure uniformed and watertight film. Usage of protective agents has to be approved by the Supervising Engineer.

2.6.2.3 Quality of materials

2.6.2.1.7 Stone

Stone for lining or masonry should be of tough, uniformed rocks, resistant to influence of weather, water, and salt. Natural stone for masonry has to be in compliance with EN 771-6, and the stone for lining with the EN 13383-1 standard requirements.

The compressive strength has to be at least 120 MN/m², unless provided otherwise by the design documentation.

The size of individual pieces and the method of finishing respectively, have to be adapted to the design documentation requirements and to the purpose of use.

The stone has to comply with the requirements indicated in Table 2.6.2.1, unless provided otherwise by the design documentation.

Table 2.6.2.1: Requirements for the stone for lining

Material properties	Required value	Test method
- shape category	LT _A	EN 13383-2
- resistance to rupture	min CS ₁₂₀	EN 1926
- wearing resistance		EN 1097-1
- sand-carrying water courses	M _{DE10}	
- water courses	M _{DE20} M _{DE30}	
- no hazard of wearing		
- frost resistance	WA _{0.5}	EN 13383-2
- water absorption criterion	FT _A	
- freezing criterion		

The producer performs the quality control in compliance with the provisions of the standard, and obtains a production control certificate issued by the authorized institute. On the basis of the certificate the Contractor issues a statement on product conformity.

2.6.2.1.8 Cement concrete blocks

Cement concrete blocks, used for lining and masonry respectively, have to comply with the requirements of the EN 771-3 standard. Unless provided otherwise by the design documentation, they have to comply with the requirements indicated in Table 2.6.2.2.

Table 2.6.2.2: Requirements for the cement concrete blocks

Material properties	Required value	Test method
- dimensions and evenness of surface	D3	EN 772-16 and EN 772-20
- compressive strength	category I	EN 772-1
- water absorption	suitable for external use	EN 772-11

If prefabricated elements were produced of two types of cement concrete (the core and the surface layer), their complete coherence has to be ensured.

2.6.2.1.9 Blocks of lime and sand

Blocks made of lime and sand, used for lining and masonry respectively, have to comply with the requirements of the EN 771-2 standard. Unless provided otherwise by the design documentation, they have to comply with the requirements indicated in Table 2.6.2.3.

Table 2.6.2.3: Requirements for blocks of lime and sand

Material properties	Required value	Test method
- compressive strength	category I	EN 772-1
- durability	durable	EN 772-18

2.6.2.1.10 Blocks of clay

Blocks made of clay, used for lining and masonry respectively, have to comply with the requirements of the EN 771-1 standard. Unless provided otherwise by the design documentation, they have to comply with the requirements indicated in Table 2.6.2.4.

Table 2.6.2.4: Requirements for blocks of clay

Material properties	Required value	Test method
- compressive strength	category I	EN 772-1
- water soluble salts	S2	EN 772-5
- durability	F2	EN 772-18

2.6.2.1.11 Mortars for masonry

The mortar, used for masonry and lining respectively, has to comply with the requirements of the EN 998-2 standard. The requirements with regard to the mortar properties are being specified by the designer in design documentation.

The mortar to be used for lining and building of road facilities on roads respectively, has to be declared as "suitable for the harsh conditions of use".

2.6.2.1.12 Mortar for plastering

The mortar used for plastering has to comply with the requirements of the EN 998-1 standard. The requirements with regard to the mortar properties are being specified by the designer in design documentation.

Notwithstanding the design documentation provisions, the mortar for plastering has to have properties indicated in Table 2.6.2.5.

The mortar used for plastering of the facilities on/at the roads has to be additionally declared in compliance with the standard, as "suitable for the severe climate conditions".

Table 2.6.2.5: Requirements for the mortar for plastering

Mortar properties	Required value	Test method
- compressive strength	min. SC II	EN 1015-11
- adhesion after freezing	(declaration by producer)	EN 1015-21
- capillary water absorption	min. W 1	EN 1015-18

2.6.2.4 Method of execution

2.6.2.1.13 Materials deposit

The Contractor has to, timely and prior to commencement of the works, provide technological study to Supervising Engineer, for all types of materials he intends to use for masonry and stonecutting works, and to submit proofs of quality to obtain Engineer's approval for their usage.

All the properties specified in section 2.6.2.3 have to be ensured. Any material not complying with the requirements indicated must not be used.

2.6.2.1.14 Depositing the materials

if the Contractor, prior to the execution of masonry and stonecutting works, temporarily deposits the required materials, suitable space for this purpose has to be ensured and arranged. He should take account of the instructions issued by the producer of certain material for storing, as well as the Supervising Engineer's instructions.

Stocks of all the materials in deposits should be such as to ensure continuous work.

2.6.2.1.15 Production and quality of mortars for masonry and plastering

The production of cement mortar mixtures should be mechanical and carried out at suitable plant where batch-based production is provided.

Mixing time and other impacts on the quality shall be so adjusted as to ensure a uniformed mixture of cement mortar.

For the work at lower temperatures (up to +2°C), conditions for heating the mixtures of stone materials and/or water up to an adequate temperature should be ensured, so that the temperature of the fresh cement mortar mixture amounts to 5 – 30°C.

The mortar production plant has to be protected from weather influences.

Possibility of permanent visual control of dosing the quantities of individual materials for the mortar production has to be provided at the plant.

The produced mortar may be put at stock in adequate silos within the plant for shorter period, or it can be immediately transported to the application place.

The Contractor has to, by demonstrative production of mortar mixture, verify the preliminary (laboratory) composition in production at suitable plant. During the demonstrative production, states of stored material and mortar mixture production plant should be established in compliance with the requirements provided by these technical conditions. The control is performed by internal quality control Engineer, upon receiving the order from the Contractor.

The Supervising Engineer allows the regular production to the Contractor only on the basis of results of the demonstrative production. An agreement for a continuous work also includes conditions for the characteristic mortar mixtures, and conditions for the internal quality control provided by these technical conditions.

A permit for regular production of mortar mixture should also include requirements for any eventual additional works.

In case of any modification in the production of mortar, the Contractor has to present to the Supervising Engineer in writing a proposal on such modifications. These modifications are valid only after obtaining of approval from the Supervising Engineer.

2.6.2.1.16 Execution of works

2.6.2.4.4.1 Masonry and lining

Masonry and lining of walls with

- unfinished or finished quarry or hewn stone,

- suitably shaped prefabricated elements,
- adequate bricks

is executed with the use of mortar for masonry, that links individual with the substrate, and mutually.

In hot weather, the surfaces of walls must be maintained wet for at least 7 days, if cement mortar had been used.

Where provided by the design documentation, masonry or lining of the walls can be carried out without mortar (dry method).

2.6.2.4.4.2 *Plastering*

The surfaces of facilities or their individual components that will be plastered should be smooth and uniformed, previously cleaned and moistened.

Daily break in plaster application should be adequately performed to prevent the damage to such locations.

Plastering is not allowed if air temperature drops below +2°C.

Plastered surfaces, which can be finished by smoothing, or brushing, should be protected as to prevent the cement mortar temperature to drop below 5° C. Protection should last until the mortar attains at least 50% of the required compressive strength.

Plastered surfaces should be protected from weather influences immediately after surface finishing. The protection can be carried out by spraying appropriate chemical or any other protective agents. Technical conditions issued by the producer of the protective agents should be considered. The Supervising Engineer should approve the Contractor's proposal for protecting of finished surface.

2.6.2.4.4.3 *Milling - stamping*

Surfaces of individual structural members can be finished by means of special tools (stamping hammers) and/or by milling in order to become rough. During these works, it should be taken care that the surface layer of cement concrete or stone is damaged to the smallest possible extent. Individual superficial grains should stay firmly bound to the substrate.

Stamped surfaces should be well protected from weather influences. The Supervising

Engineer should approve the Contractor's proposal for protecting of finished surface.

2.6.2.4.4.4 *Grinding*

Grinding the cement concrete surfaces represents a measure for other works within the scope of the arrangement of surfaces of structures on roads. Grinding is performed in accordance with the design documentation provisions.

The ground exposed cement concrete surface should be protected from weather influences.

2.6.2.5 **Quality of execution**

During the embedding, for the purpose of internal quality control, the Contractor has to

- take specimens of the material for lining and masonry or plastering, and determine the properties by testing in compliance with section 2.6.2.3 of these technical conditions,
- determine the surface protection system and
- establish the quality of the constructed surface of the structure or an individual component (evenness, height).

Internal control must be performed by the constructor or authorized institution, upon receiving order from the Contractor.

The required properties specified in section 2.6.2.3 of these technical conditions are limiting values, unless provided otherwise.

The Contractor must not commence masonry and stonecutting works until he receives an approval by the Supervising Engineer to the proposed and demonstrated method of execution of the works.

2.6.2.1.17 **Masonry and lining**

All the materials for masonry and lining have to be solid and adequately moistened.

The mortar layer between elements should be at least 1 cm thick. All the joints between elements have to be perfectly filled up with mortar, and on the exposed side of walls finished as provided by the design documentation or by the decision of Supervising Engineer.

Unless specified otherwise by the design documentation, the exposed surface should be plane. Besides, the joints on the exposed surface should be appropriately arranged.

2.6.2.1.18 Plastering

The thickness of the mortar layer should be uniformed, in compliance with the design documentation thickness, and with uniformed density.

2.6.2.6 Quality control of execution

The extent of checking the quality of both arrangement and protection of the surface of structures or their individual members, in accordance with the design documentation and these technical conditions, approves the Supervising Engineer. Scope of the tests should be adapted to specific conditions of work.

The tests of individual properties of the mortar for masonry and plastering (in compliance with the requirements indicated in 2.6.2.4.3) should be carried to such an extent, which assures a timely intervention in case of need.

The Supervising Engineer may change the already specified extent of testing of the masonry and stonecutting works, if he establishes unequal quality of the executed works.

The extent of the external quality control testing to be executed by third party institution authorized by the client is usually in the ratio of 1:4 to the internal control testing.

2.6.2.7 Measurement and takeover of the works

2.6.2.1.19 Measurement of works

The executed works should be measured in compliance with general technical conditions and calculated in appropriate units of measures.

All the quantities should be measured to the actually completed extent and type of work having been executed within the dimensions or scope from the design documentation.

2.6.2.1.20 Takeover of works

Executed stonecutting and masonry works should be taken over by Supervising Engineer by the quality requirements of these technical conditions and according to general technical conditions. The Contractor has to mend timely all the established deficiencies with regard to those requirements.

2.6.2.8 Calculation of works

2.6.2.1.21 General

The executed works should be calculated in accordance with general technical conditions.

The quantities defined under section 2.6.2.7.1 and taken over in compliance with section 2.6.2.7.2 should be calculated by the contractual unit price.

The contractual unit price must include all the works and services required for a complete execution of the works. The Contractor has no right to claim any extra calculations.

2.6.2.1.22 Deductions due to insufficient quality

2.6.2.4.4.5 Quality of materials

Since the adequate quality of materials for masonry and stonecutting works is unambiguously specified, there is no deduction when calculating the executed works due to insufficient quality of materials.

In case the Contractor embeds such material, which does not meet the requirements indicated in 2.5.2.3 of these technical conditions, the Supervising Engineer appoints the method of calculation.

2.6.2.4.4.6 Quality of execution

If the Contractor did not ensure the required quality of the masonry and stonecutting works, the Supervising Engineer decides on the method of calculation, and he also has the right to reject the entire executed works.

2.6.3 LOCKSMITH'S WORKS

2.6.3.1 Introduction

Special technical requirements for locksmith's works consider only metal works necessary for arrangement of individual details on road facilities.

Locksmith's works are carried out in a manner and under dimensions, which are determined in detail in design documentation, and in line with these technical requirements.

2.6.3.1.1 Description

Locksmith's works cover purchase of all necessary materials, production of relevant components on facilities, and their preparation for embedding according to requests contained in design documentation.

Basic locksmith's works in construction of facilities on the road include manufacture of metal

- protective fences and nets,
- stairs and ladders in piers,
- angle profiles.

The manner of execution of individual part of the facility, manner of preparation and embedding should be processed in details in design documentation. Basics for that are determined in special technical conditions for details of the facilities.

Protective fences and nets and stairs and ladders for facilities on the roads can be

- of tubes with circular or rectangular cross-section and
- with vertical, horizontal or network fillers, in certain cases can be closed.

Angle sections or finishing profiles (with anchors and reinforcements) can be made of corresponding L, T or halved I profiles or flat.

All the steel structures for building into facilities on the roads should be protected from corrosion. The method and type of protection should be determined in design documentation.

2.6.3.2 Basic materials

Basic materials for locksmith's works are of appropriate steel. The type and the quality

should be adapted to their purpose and use. In the same way should other metal materials that will be used for certain locksmith's works be adapted to their purpose and use (e.g. aluminium for manufacture of protective fences and artificial materials to be used in combination with basic metal materials).

2.6.3.3 Quality of materials

The quality of all materials for locksmith's works that will be used for manufacture of certain parts for the facilities on the roads need to comply with valid provisions of corresponding regulations and should fully comply with the requirements of the design documentation and purpose of use.

For locksmith's works, structural steels with appropriate toughness and good weldness should be used, in compliance with EN 10025.

All the screws needed for fixing the metal parts for arrangement of certain details on facilities should be of stainless steel.

For stress relief that occur as a result of structure welding in the workshop stress annealing should be done.

If the design documentation indicates only conditions by which the used materials (steel, aluminium, artificial mixtures) will be implemented in particular parts of the facility, the Contractor should propose to the Supervising Engineer a list of all materials he intends to use and appropriate proofs that they are suitable for intended purpose. These proofs should be issued by authorized institution.

2.6.3.4 Method of execution of works

Execution of certain locksmith's works on road facilities has to comply completely with the provisions from design documentation. Equally, additional preparation of those parts for embedding into a structure should be in compliance.

All the additional construction works needed during embedding of steel structures, that are not part of locksmith's works, have to be executed by structural Contractor if they are in compliance with his plan of progress, verified by Supervising Engineer.

If the Contractor wishes to execute the locksmith's works in a way that's not provided by design documentation, he should prove that way to be corresponding with the quality requirements. For the proposed changes he has to obtain the approval from the designer and the Supervising Engineer. The Contractor must not execute the locksmith's works in a way opposite to the provisions of design documentation until he obtains the approval.

If special protection from the influences of the environment (corrosion) for metals used is provided by design documentation, method of protection should be elaborated in details.

2.6.3.5 Quality of execution of works

When purchasing certain materials or parts for the facilities, the Contractor should propose to the Supervising Engineer required proofs on quality of all the materials used for locksmith's works.

Quality of the executed locksmith's works should correspond to prescribed and agreed conditions. The same applies to the quality of embedding of individual parts in the facility construction, related to the locksmith's works.

Appropriate protection from the influence of corrosion should be implemented by the adequate provisions of these technical conditions. All the damages to the protection should be repaired before the embedding. The repair of damaged protection against the corrosion should be executing after embedding is finished too. The procedure and materials needed for these repairs should be proposed by the Contractor and approved by the Supervising Engineer. All the executed repairs have to be taken over by the Supervising Engineer.

2.6.3.6 Quality control of execution

The control of dimensions should be performed for each part, functionally related to other parts of the facility on the road. If the protection against the corrosion is provided, it should be controlled simultaneously.

The Contractor of the locksmith's works must remove all the defects before the embedding starts.

The scope of internal examination of locksmith's works should be adjusted to specific working conditions. Upon the proposal from the Contractor, the decision is made by the Supervising Engineer, for each type of work and each facility separately.

2.6.3.7 Measurement and takeover of the works

2.6.3.7.1 Measurement of works

The executed works should be measured in compliance with general technical conditions and calculated in appropriate units of measures.

All the quantities of locksmith's works should be measured to the actually completed extent and type of work having been executed within the dimensions from the design documentation or upon the additional order from the Supervising Engineer.

2.6.3.7.2 Takeover of works

The embedded parts on the facility are taken over by the Supervising Engineer according to the quality requirements from the design documentation and these technical conditions and in compliance with the general technical conditions. All the established deficiencies of embedded individual parts should be repaired by the Contractor, prior to continuation of the works.

2.6.3.8 Calculation of works

2.6.3.8.1 General

The executed locksmith's works should be calculated in accordance with general technical conditions.

The quantities defined under section 2.6.3.7.1 and taken over in compliance with section 2.6.3.7.2 should be calculated by the contractual unit price.

The contractual unit price must include all the costs and activities required for a complete execution of the locksmith's works. The Contractor has no right to any extra calculations.

2.6.3.8.2 Deductions due to inappropriate quality

Since the adequate quality of materials for manufacturing of individual parts for details arrangement on facilities and for the embedding of these parts is unambiguously specified, there is no deductions when calculating the executed locksmith's works.

If the Contractor embeds such material, which does not meet the requirements indicated in 2.6.3.3 of these technical conditions or he doesn't provide the embedding quality according to section 2.6.3.5, the Supervising Engineer appoints the method of calculation.

2.6.4 PROTECTION OF MATERIALS AND STRUCTURES

2.6.4.1 General

Technical conditions for works on reconstruction of concrete and reinforced concrete facilities, bridging and other facilities on roads are related to reconstruction, partial renewal or reinforcement of concrete or reinforced-concrete facilities with intention to prolong their life-span or improve their usability.

Technical conditions are intended for all types of structures of non-reinforced and reinforced cement concrete, pre-stressed concrete and for all types of structures (bridging facilities, high-structural facilities, water economy facilities, tunnels etc.).

Reconstruction work can be done only by qualified and adequately equipped Contractors.

2.6.4.2 Description

Reconstruction works on facilities include execution of procedures as required by SRPS EN 1504, establishment of the existing condition according to which the reconstruction, renewal and surface protection procedures are chosen. When establishing the existing condition of the facility, it is necessary to determine the nature and extent of the damage (damages due to frost and salt, moisture or water, carbonation or chloride, mechanical damages, cracks etc.), and to determine the condition of cement concrete surface, its remaining strength, penetration depth of

carbonation and chloride, as well as condition of steel reinforcement.

After determining the existing condition of the facility, it is necessary to prepare the design documentation for renewal according to SRPS EN 1504 requirements and provide the measures that will ensure required bearing capacity, usability and durability of the structure.

Reparation of facility's concrete includes the removal of damaged cement concrete, preparation of the surface, protection against the corrosion of the steel reinforcement, replacement of removed parts and implementation of surface protection. Other procedures like: anchoring, intrusion, reinforcement and protection by coating etc. also have to be in compliance with the SRPS EN 1504.

Works should be conducted when there is no precipitation during embedding and the air and surface temperature is from 5°C to 30°

2.6.4.3 Basic materials

Basic materials for reparation of facility's concrete can be used individually or as a part of the system. Used materials have to provide:

- protection against the corrosion of the steel reinforcement
- corresponding contact layer,
- necessary reshaping, as well as
- surface protection (hydrophobing, impregnation, paint coat or protective coat in thick layer).

By chosen basic materials the Contractor must ensure the properties of renewed element, provided in design documentation.

2.6.4.4 Quality of materials

Quality of all the materials used has to comply with the requirements provided by the design documentation for renewal, and by corresponding studies of the Contractors.

As a rule, quality of material for renewals has to comply with the requirements prescribed in the series of standards SRPS EN 1504 (1-10).

Suitability of chosen materials and procedures must be proven on the test surface.

2.6.4.5 Method of execution

2.6.4.5.1 Establishment of existing condition of cement concrete

During the establishment of existing condition of cement concrete in the structure, it is necessary to determine:

- depth of carbonation,
- penetration depth of chloride,
- remaining compressive strength of cement concrete and
- the cause of damage.

For determination of existing properties of concrete structure can be used

- non-destructive methods and
- destructive methods by drilling or cropping the required sample size

Testing of samples can be performed only in equipped laboratory.

2.6.4.5.2 Removal of damaged cement concrete

Damaged cement concrete is removed to a solid base that meets the requirements prescribed in the design documentation for renewal. Damaged cement concrete can be removed

- manually,
- by pneumatic or electrical machine equipment or
- by water under high pressure.

2.6.4.5.3 Preparation of the base

Base has to be prepared in such way for the optimal adhesion between the old cement concrete (base) and newly applied renewal materials to be achieved. Concrete base must be solid, with no weak and separating fractions or residues of old coats. By chosen preparation procedure of the base it is necessary to ensure the following:

- cleaning of the cement concrete surface,
- removing of cement crust,
- removing of old coats,
- removing of the damaged cement concrete surface,
- removing of the cement concrete to an existing steel reinforcement,
- cleaning of the corrosive steel damages and

- moisture of the base.

Base can be prepared by using the procedure of:

- removal by cropping,
- sawing,
- sanding by solid sanding agent (quartz sand, steel balls),
- water under high pressure,
- cleaning by water or vapour.

The Contractor has to determine the procedure of removal of the damaged cement concrete in the study, as well as the procedure of base preparation, all according to systematization SRPS EN 1504, and it needs to be verified by the Supervising Engineer.

2.6.4.5.4 Contact coating

For the insurance of appropriate connection between the old cement concrete and the new coat, it is necessary to apply the contact coating. Material for application of the contact coating must be in compliance with the material for carrying out the renewal. Contact coating can be

- polymer-modified cement coating (mixture of cement, polymers and water, and - if prescribed - mineral filler),
- polymer contact coating (artificial resin with or without filler).

2.6.4.5.5 Protection of steel reinforcement against corrosion

To provide the proper protection of steel reinforcement against corrosion, the following is required:

- cleaning of steel up to Sa2 level (by sanding or water under high pressure) and
- application of one or two coats of protective coatings (according to producer's instructions).

The type of protective coating and application procedure has to be provided by the Contractor in the technological study.

2.6.4.5.6 Application of reparation mortar

Before the application of mortar, it is necessary to ensure the suitable roughness and solidity of the base. Reparation mortar must not have the tension strength lower than 1.5 N/mm². Contact coating has to be applied

according to instructions from the producer of repair mortar.

Material for concrete repair has to be chosen according to requirements of design documentation and SRPS EN 1504. Material can be:

- cement repair mortar,
- polymer-modified cement mortar
- polymer repair mortar.

The size of the largest grain must be selected in regard to the thickness of required coats.

Application of the mortar for concrete repair can be performed:

- manually,
- by procedure of machine application (spindle drag pump) or
- by procedure of dry or wet spraying (thickness of one coat from 1 to 5 cm).

2.6.4.5.7 Filling cracks

Cracks on concrete structures can occur due to different causes. Cracks that occur on fresh or young cement concrete may be a consequence of:

- settling,
- contraction and/or
- temperature differences.

Cracks that occur later on hardened cement concrete may be a consequence of:

- external influences (loading),
- contraction or temperature change and/or
- corrosion effect, freezing etc.

Cracks can be active or stable, dry or with water running through them.

Renewal procedure depends on status of the crack and its cause.

Renewal of the cracks is done, as a rule, by injection. In relation to the size and depth of the crack are used:

- extensions for surface injection and
- extensions for deep injection.

According to the width and status of the crack (quiescent, active, dry or wet), a type of injection agent can be determined, that can be:

- cement mixture for injection
- mixture for injection with artificial resin (epoxy or polyurethane).

The procedure and filling material for the cracks have to be determined by design documentation; by application of mortar is necessary to ensure the suitable roughness.

2.6.4.5.8 Attachment of the binding plates

External reinforcing plates can be of structural steel or of composite fibre-reinforced material (e.g. carbon fibre) or of other material with appropriate standard capacity and durability. Usage of stainless or noble steel is not recommended.

Attachment of the binding plates has to be done according to SRPS EN 1504-4, EN 1992-2-4 and any other EN or European technical compliance.

Exposed concrete surfaces to which the binding plates are attached to, from outside, have to be clean and roughened, and the cavities machined according to instructions of these specifications. Before the attachment of external binding plates it is required to remove bad, damaged and disintegrated concrete, according to requirements for base preparation. Cracks wider than 0.1 mm have to be filled with appropriate structural repair material.

Tension strength of the base must be measured.

Status of the surface during the application of binding medium has to be in accordance with the specification.

Compensation of the removed concrete, filling of gaps and machining of the cracks have to be in accordance with the specification.

Surface of the steel plates for attachment has to be without rust and impurities and has to be cleaned up to Sa2½ (refer to SRPS EN ISO 8501-1).

Surface of the fibre-reinforced plates or other plates that will be attached, has to be prepared in accordance with the specification.

Glues have to be used in accordance with the specified environmental conditions.

Exposed surface of the plates has to be protected as stated in specifications.

2.6.4.5.9 Protection of the cement concrete surface

Procedure of protection of the cement concrete surface has to be provided by design documentation. For application of protection of cement concrete surface, the following can be used:

- hydrophobing - surface protection that prevents water penetration and dissolved pollutants in it
- impregnation - deep protection that improves the cement concrete properties near the surface,
- thin paint coating up to thickness of 0.3mm,
- thick protective coatings with thickness of over 0.3mm, bridging the cracks.

Material for application of protection of the cement concrete surface has to be provided by design documentation.

2.6.4.6 Quality control of execution

Scope of the quality control of execution according to requirements of the design documentation and these technical conditions is determined by the Supervising Engineer. If there are no special provisions, requirements from SRPS EN 1504-10 (Table 1) are valid. The scope has to be adjusted to specific conditions of works execution on facility and, as rule, should not deviate from the following requirements:

- surface control:
 - tension strength of the surface on 500 m² or at least 1x per structural part
 - surface moisture per each structural part
 - air and surface temperature 3x per day
 - dew point temperature 3x per day or when the conditions change
 - roughness depth on 500m² or at least 1x per structural part
- control during and after execution:
 - air and surface temperature 3x per day
 - dew point temperature 3x per day or when the conditions change
 - thickness of wet coating on 500m² or at least 1x per structural part
 - tension strength of protective coating on 500 m² or at least 1x per structural part
 - thickness of reparation mortar layer on 500m² or at least 1x per structural part

- tension strength of reparation mortar on 500m² or at least 1x per structural part
- tension strength of protective coats on 500m² or at least 1x per structural part

Specified measurements of temperature, moisture and dew points have to be performed by Contractor's internal control, with prescribed frequency. For other measurements frequency is specified by external control. Number of measurements by Contractor's internal control has to be 4x higher, as a rule.

Dew point temperature has to be at least for 3°C higher than the surface temperature.

Breaking strength of the reparation mortar should not be less than 1,5 N/mm², and individual measurement should not be less than 1,0 N/mm². Requirement is valid for structural reparation and dynamic load of the structure. For non-structural reparation is valid that the breaking strength of the reparation mortar should not be less than 1,0 N/mm² and individual measurement should not be less than 0,7 N/mm². Tension strength of protective coatings (painted and thick coatings) should not be less than 1,0 N/mm², and the smallest individual result should not be less than 0,8 N/mm².

2.6.4.7 Measurement and acceptance of works

2.6.4.7.1 Measurement of works

Executed works should be measured according to SRSC, chapter 1.3 of technical conditions and calculated in appropriate units of measure.

All the quantities should be measured to the actually completed extent and type of work having been executed within the bill of quantities from the design documentation.

2.6.4.7.2 Acceptance of works

Acceptance of works executed during the reparation of the facilities has to be performed by the Supervising Engineer, according to quality requirements of these technical conditions and of chapter SRSC 1.3. The Contractor has to mend timely all

the established deficiencies with regard to those requirements.

2.6.4.8 Calculation of works

2.6.4.8.1 General

Executed works have to be calculated in accordance with SRSC, chapter 1.3 of technical conditions.

Taken over quantities have to be calculated by agreed unique price.

The agreed unique price has to include all the services required for complete finalization of the works. The Contractor has no right to subsequently claim any extra payment.

2.6.4.8.2 Deductions due to inappropriate quality

2.6.4.8.2.1. Quality of materials

Since the adequate quality of materials for works on renewal of concrete facilities is unambiguously specified, there are no deductions regarding quality of materials when calculating the executed works.

In case the Contractor embeds such material, which does not meet the requirements of these technical guidelines, the Supervising Engineer appoints the method of calculation.

2.6.4.8.2.2. Quality of execution

If the Contractor does not provide required quality of works on renewal of the concrete facilities, the Supervising Engineer appoints the method of calculation.

Table 2.6.4.1: Guidelines regarding the acceptable maximal and minimal parameters for tests of individual features according SRPS EN 1504.10

No. of tests	Features	Method	Maximal and minimal value of the parameter
10	Surface temperature	All	Depending on the material, but usually between 5-30°C
23	Precipitations	All	Usually zero, but some materials can be applied on wet or moistened surfaces.
24	Wind speed	1.1, 1.2, 1.3, 2.1, 2.2, 5.1, 5.2, 6.1, 7.1, 8.1, 8.2, 9.1	Less than 8 m/s
25	Dew point	1.1, 1.2, 1.3, 2.1, 2.2, 4.3, 5.1, 5.2, 6.1, 7.1, 8.1, 8.2, 9.1, 11.1, 11.2	Depending on the material, but usually not used (inflicted, applied) on temperatures lower than 3°C above the dew point.
33	Gap filling degree	1.4, 1.5, 4.5, 4.6	80 % is usually acceptable.
35	Adhesion of mortar and concrete	3.1, 3.2, 3.3, 4.4, 5.1, 6.1, 7.1, 7.2, 7.4	Different, but can never be greater than the tension strength of the surface. The values on the field are in the range of 1.2 - 1.5 MPa for the structural repairs, and for non-structural repairs is acceptable minimal value of 0.7 MPa. Values for laboratory tests are provided in SRPS EN 1504-3.
35	Adhesion of surface coatings	1.2, 2.2, 5.1, 6.1, 7.1, 8.1, 9.1	Different, but can never be greater than the tension strength of the base. Values for laboratory tests are provided in SRPS EN 1504-2.
36	Compressive strength	3.1, 3.2, 3.3, 4.4, 5.1, 6.1, 7.1, 7.2, 7.3	Compatibility with the basic concrete is an important factor. Values for laboratory tests are provided in SRPS EN 1504-3.
44	Adhesion of the gap filling material to the base	1.5, 4.5, 4.6	Different, but can never be greater than the surface tension strength of the base. Values for laboratory tests are provided in SRPS EN 1504-5.

2.6.5 WATERPROOFINGS

2.6.5.1 Introduction

2.6.5.1.1 General

The concrete and embedded reinforcement or steel structure of the bridges and other facilities on the roads are, during the exploitation, exposed to various influences that affect the damages occurrence. Most numerous are the damages from penetration of precipitation water, salt water during winter and various chemical and physical influences. Damages in reinforced concrete and steel structures usually appear due to:

- inappropriate quality of the concrete,
- thin protective layer of concrete above the reinforcement,
- penetration of plain and salt water into concrete through the incurred cracks,
- carbonation of the concrete,
- inappropriate protection against the corrosion,
- high aggressiveness of the atmosphere due to the presence of sulphur oxides, carbon, nitrogen and other influences.

These influences can be predicted in advance to a large extent and be taken into account when designing the structure through the selection of an appropriate system of waterproofing protection.

The method of making and the quality of waterproofing directly affects the usability and durability of the structure in exploitation. Various and accepted materials for waterproofing can bear specific loads they are exposed to, without consequences to some extent. Therefore, selection of appropriate material for the waterproofing has the same importance as its embedding.

The selection of protection system is affected by pre-known parameters:

- traffic route category,
- category of the facility,
- climate conditions,
- structural system of the facility,
- selected material of whom the pavement structure is constructed,
- length and spans of the structure.

The objective of this guideline reflects in the detailed description of the modern procedures for sealing, by using materials that can provide the appropriate protection of the new facilities and renewal of the facilities that are in use for a long time.

These procedures are most applicable in the sealing of road facilities and ensuring of their protection from physical and chemical loadings caused by the surface water and groundwater and aggressive substances dissolved in it.

Guideline can be directly applied both on newly constructed facilities and facilities that are being renewed.

Provisions of other publications are included in this guideline, with dated and undated references. With dated references, all the subsequent amendments and changes have to be taken into account, if they are included through amendments or revision. With undated references, the last edition of the reference documentation is valid.

2.6.5.1.2 Standards applied

The following standards have been applied in this guideline. Standards for procedures of certain material tests are listed in the tables of quality conditions.

EN 1031
EN 1038
EN 1504-1
EN 13808
EN 13969
EN 14188-1
EN 14695

2.6.5.1.3 Interpretation of the terms

The terms used in this guideline have the following meanings:

Bitumen waterproofing sheeting (bitumenska traka, Bitumendlichtungsbahn) is the insulation strip with the bearing cartridge covered with bitumen compound. It is prepared for gluing or welding to the base.

Drainage epoxy concrete (drenažni epoksidni beton, Drän-Epoxidbeton) is the single-fraction concrete with a high share of transient micro-cavities; epoxy resin is used as a binder.

Drainage tape (drenažna traka, Dränband) is the tape embedded or manufactured on waterproofing bar with sidewalks on both side of the facility, and it allows the passage of water running through the asphalt layers or corridors of the facility.

Depth of roughness (dubina hrapavosti, Rauhtiefe) is the coefficient obtained from the volume of cavity on the surface of layer and

the corresponding surface. It is used as a measure of roughness, and is determined by propagation of sand (Sand-patch-method) or by measuring of the water leakage by Moore.

Joint (fuga, Fuge) is the space (groove) between the two elements of construction or space in a construction element that serves to prevent uncontrolled cracking or the harmonization of the changes in length due to temperature effects.

Wearing course (habajući sloj, Deckschicht) is the roofing - finishing layer of the surfacing pavement. The composition of materials mixture depends on the anticipated climate and traffic conditions.

Waterproofing (hidroizolacija, Wasser - abdichtung) means protection of the surface from water penetration.

Levelling with spatula (ravnanje lopaticom, Kratzspachtelung) represents a filling of depression that forms a surface roughness with suitable material which is embedded with spatula in the thickness up to the top of the grain in the base.

Waterproofing sheet sticking (lepljenje trake za zaptivanje, Kleben der Dichtungsbahn) means underflow of the heated bitumen gluing compound under the insulation tape, to achieve good connection with the base.

Gussasphalt (liveni asfalt, Gussasphalt) is the asphalt mixture that is in dense liquid state on high temperature, which is why during the embedding should not be thickened, but compressed.

Adhesive (glue) (masa za lepljenje-lepilo, Klebstoff) is the substance (based on bituminous base or artificial materials) used for gluing the sealing tape to the prepared base.

Joint sealing compound (masa za zaptivanje, Fugenvergussmasse) is cold or hot liquid compound without a form that is used for sealing joints and connections by bedding, and also provides the desired connection behaviour.

Bridge surfacing (obloga na objektu, Brückenbelag) consists of protective and wearing layer.

Primer (osnovni (temeljni) premaz, Grundanstrich/Grundierung) is the surface

coating (with epoxy resin or solution of bitumen binder) that is used for better adhesion of the next layers and filling of depressions.

Procedure with water jet (postupak sa vodenim mlazom, Wasserstrahlverfahren) is hydro-mechanical procedure of base preparation (cleaning, roughening).

Overlapping (prklop, Überlappung) means overlapping of the edges of two tapes that are embedded to each other.

Sealing (premaz za zalivanje, Versiegelung) means coat of uninterrupted film of binder to a spongy base.

Producer (proizvođač, Producent) produces materials that are being used.

Designer (projektant, Konstrukteur) is responsible for the designing, planning and technical conditions.

Shotblast (sačmarenje, Sandstrahlung) is the method of mechanical cleaning of the base (concrete or steel) by directed jet of metal granules (pellets).

Levelling course (sloj za ravnanje, Ausgleichschicht) is the layer that provides surface evenness and its appropriate heights.

Bonding layer (sloj za prijanjanje, Haftbrücke) represents the interlayer that improves adhesion and permanent connection of two layers.

Waterproof membrane (sloj za zaptivanje, Dichtungsschicht) represents the basic layer in sealing of the facilities.

Joint (spoj, Stoss) represents the planned or conditioned touching of two or more adjacent structural elements without mutual connection, linked by agents for closing of the joints.

Sealing strip (traka za zaptivanje, Dichtungsstreifen) is the agent with defined section for filling of the joints and sealing of the connections.

Bitumen waterproofing sheeting welding (varenje bitumenske trake, Schweissen einer Bitumendichtungsbahn) represents the uniformed heating of the base and surface of the bitumen waterproofing sheeting with appropriate burner along the entire width, to create the conditions for suitable softening of

bitumen compound and gluing the tape to the base.

Seal (zaptivanje - dihtovanje, Abdichtung) is combination of layers for sealing of the base. It consists of basic coating, coating for bedding or levelling with spatula, coating for sealing and protective layer.

Protective layer (zaštitni sloj, Schutzschicht) is the layer embedded for protection of the layer for sealing against the damages, and can improve sealing of the facility.

2.6.5.1.4 Features of the sealing procedures

Selection of procedures for waterproofing implementation depends primarily on:

- type and purpose of the road facility
- specific local influences: traffic, climate, road design, special structure construction properties and maintenance of the facility.

Facilities can be protected from adverse effects of the water in the following ways:

- by embedding of rigid materials (so called "white bathtub") and
- by application of various combinations of predominantly elastic layers for sealing (so called "black bathtub").

In procedure with rigid materials, the basic material that ensures the waterproofing is cement concrete. Important concrete properties limit his usage, mostly on parts of the road facilities that are not exposed to the influence of salt. Under these conditions is better to apply the procedure by which the binding materials are embedded on the base (glued insulation). In all the examples of such waterproofing, it is necessary to provide good and durable connection of insulation tape with the prepared base.

Implementation of the condition above demands the execution of the following preliminary works:

- infliction of basic coating,
- infliction of bedding coating or infliction of levelling layer with spatula.

The method of road facility sealing must be defined in details by the design.

Every sealing of the road facility with the glued materials-layers ("black bathtub") consists, as a rule, of gluing layers, sealing layers and layer for protection (Figure 2.6.5.1).

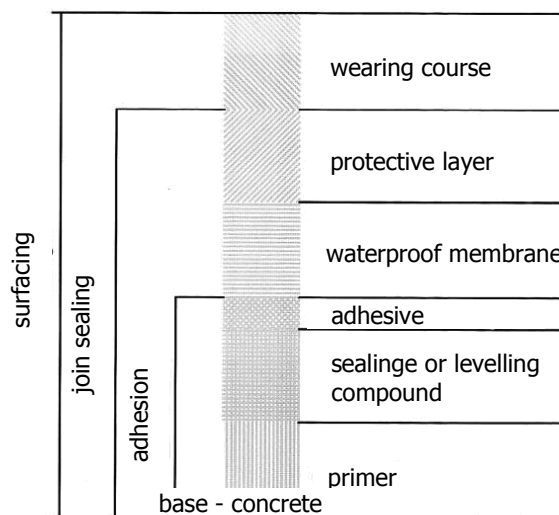


Figure 2.6.5.1: Composition of bridge surfacing ("black bathtub")

2.6.5.1.5 Surface primer

On vertical and high-sloped surfaces, where the water is not retained, previous coating is applied with the solution of bitumen binder, and represents the first procedure within the sealing. Application of previous coating conditions the bedding coating or levelling with spatula.

On low-sloped and horizontal surfaces, the primer should be applied (priming), as a rule, with two inflictions of epoxy resin, first one covered by quartz sand dried in the fire. Usually, the epoxy coating is applied in the period when surface temperature doesn't rise.

Surface coating must ensure the satisfying value of adhesion strength to the base, and on concrete facilities the blockade for vapour.

2.6.5.1.6 Waterproof membrane

Waterproof membrane must be made of material that is, by welding, gluing or spraying on the gluing layer adhesively tied to the base.

Waterproof membrane must have the ability to keep up with all the facility movements.

2.6.5.1.7 Protective layer

To protect the waterproof membranes on horizontal or low-sloped surfaces, protective layer has to be applied in such way to ensure, by gluing, the complete connection of the protective layer with the waterproof

membrane. On high-sloped surfaces, for protection materials can be used that ensure the required protection of waterproof membrane and with partial (dotted) connection to the base.

2.6.5.2 Basic materials

Usability (quality and compatibility) of all the materials provided for insulation of the road facilities has to be checked by appropriate previous tests, and proven by previously issued certificates.

For all the materials the producer's instructions have to be provided, with the exact description of materials usage.

2.6.5.2.1 Types of materials

All the materials used for the sealing of facilities have to be produced with bitumen binder or of artificial engineering substances. For certain layers within the insulation of the facilities, some other materials can be used.

2.6.5.2.1.1 Materials with bitumen binder

Materials with bitumen binder are suitable for usage in the following procedures:

- for layers that serve for adhesion,
- for primer: solutions of bitumen binders,
- for sealing or levelling with spatula: modified bitumen binders with polymers (and additives as required),
- for adhesive: bitumen binders with appropriate additives.
- for waterproof membranes:
- bitumen waterproofing sheeting for gluing,
- bitumen waterproofing sheeting for welding,
- modified bitumen binders with polymers,
- for protective layers and wearing courses:
- bitumen concrete,
- gussasphalt
- skeletal mastic asphalt,
- for coating of wearing course surface:
- solutions of bitumen binders,
- with polymers modified bitumen binders.

For sealing - filling of various joints on facilities (joints of two same or different materials) are used:

- bitumen compounds (kits) for filling - sealing of the joints
- bitumen waterproofing sheeting.

Before the use, in both procedures it is necessary to apply the previous coating with appropriate bitumen binder.

2.6.5.2.1.2 Artificial engineering materials

Artificial engineering materials can be used for sealing of the facilities in the following procedures:

- for layers that serve for adhesion:
 - for primers: liquid polymers - reactive (epoxy) resins,
 - for sealing or compound for levelling with spatula: liquid polymers (reactive - epoxy resins) with appropriate additives,
- for waterproof membranes:
 - liquid polymers for spraying,
 - polymer foils (for gluing),
- for partially protective layers (or for the separation layers on floating insulations):
 - polymer drainage fabric,
 - drainage netting,
- for sealing of the joints
 - of reactive engineering compound.

2.6.5.2.1.3 Other materials

For reinforcement of polymer-modified bitumen that serves as a waterproof membrane, appropriate nets of artificial materials, metal wires or appropriate fabrics of glass or polyester fibres, should be used.

Protective layers for sealing of the facilities or their parts located in the embankment, can be applied of cement mortar or concrete, prepared according the appropriate recipe.

For protection of the waterproof membrane of vertical concrete surfaces, various construction materials can be used, e.g. wooden plates, brick, polystyrene, styrodur, cork, etc.

2.6.5.3 Quality of materials

All the values conditioned for individual properties of basic materials are limits and have to be ensured.

2.6.5.3.1 Materials with bitumen binder

2.6.5.3.1.1 Bitumen emulsion

For primer is used cation emulsion of road bitumen or bitumen modified by polymers.

Technical conditions for properties of cation emulsions of road bitumen are indicated in Table 2.6.5.1.

Table 2.6.5.1: Technical conditions for properties of bitumen emulsions (according to standard EN 13808)

Property	Test regulation	Unit of measure	Type of bitumen emulsion			
			3	4	5	6
Stability	EN 13075-1	-	50 - 100	70 - 130	120 - 180	170 to 230
Stability with cement	EN 12848	g	≥ 2	-	-	-
Adding time of fine parts	EN 13075-2	s	≥ 300	-	-	-
Composition of the binder (for composition of the water)	EN 1428	m.-%	48 - 52	53 - 57	58 - 62	63 - 67
Composition of the binder (for distillation)	EN 1431	m.-%	≥ 48	≥ 53	≥ 58	≥ 63
Share of the oil component	EN 1431	m.-%	≤ 3.0	≤ 5.0	≤ 8.0	≤ 10.0
Leakage time, 2 mm, 40 °C	EN 12846	s	15 - 45	35 - 80	70 - 130	-
Leakage time, 4 mm, 40 °C	EN 12846	s	-	-	-	10 - 45
Sieve residue: - 0.5 mm - 0.16 mm	EN 1429	m.-%	≤ 0.2	≤ 0.5	-	-
		m.-%	≤ 0.5	-	-	-
Sieve residue 0.5 mm (after 7 days of storing)	EN 1429	m.-%	≤ 0.2	≤ 0.5	-	-
Settling (7 days of storing)	EN 12847	m.-%	≤ 10	-	-	-
Adhesiveness	EN 13614	% of the surface	≥ 90	-	-	-

For the primer can be used anionic bitumen emulsions too, if that is provided by the design or approved by Supervising Engineer.

2.6.5.3.1.2 Polymer-modified bitumen binder

For sealing of the facilities are used modified bitumen binders too, prepared in special plants as a homogeneous physical mixture or

as a product of chemical reaction of bitumen and high-temperature resistant polymer - elastomer.

Technical conditions for bitumen binders modified by polymers are indicated in Table 2.6.5.2.

Table 2.6.5.2: Technical conditions for properties of bitumen binders modified by polymers

Consistency with increased usage temperature	Property Softening point	EN 1427	°C	news	≥ 80	≥ 75	≥ 70	≥ 65	≥ 60	≥ 55	≥ 50	≥ 45	≥ 40
Cohesion	Ductility (with force measurement)	EN 13703 EN 13589	J/cm ²	news	≥ 3 at 5 °C	≥ 2 at 5 °C	≥ 1 at 5 °C	≥ 2 at 0 °C	≥ 2 at 10 °C	-	-	-	-
	Tensile strength at 5 °C	EN 13703 EN 13587	J/cm ²	news	≥ 3	≥ 2	≥ 1	-	-	-	-	-	-
	Vialit pendulum	EN 13566	J/cm ²	news	≥ 0,7	-	-	-	-	-	-	-	-
Durability	Mass oscilation	EN 12607-1 or EN 12607	%	news	≥ 0,3	≥ 0,5	≥ 0,8	≥ 1,0	-	-	-	-	-
	Sustained penetration level	EN 1426	%	news	≥ 35	≥ 40	≥ 45	≥ 50	≥ 55	≥ 60	-	-	-
	Increase of softening point	EN 1427	°C	news	≥ 8	≥ 10	≥ 12	-	-	-	-	-	-
Other properties	Burning point	EN ISO 2592	°C	news	≥ 250	≥ 235	≥ 220	-	-	-	-	-	-

Modified polymer bitumen binders are used as bedding coatings or for levelling with spatula, and form an integral part of the system for sealing of the facility.

2.6.5.3.1.3 Bitumen adhesive

Properties of bitumen compound for gluing of insulation tape (by hot method) to the base have to comply with the requirements indicated in Table 2.6.5.3.

Table 2.6.5.3: Technical conditions for properties of bitumen gluing compounds

Property of bitumen gluing compound	Unit of measure	Required value	Test regulation
Share of the filling	m.-%	0	EN 12697-1
Share of the ash, highest	m.-%	2	EN 12692-1
Softening point of bitumen by PK, lowest	°C	90	EN 1427
Fraas breaking point, highest	°C	-5	EN 1109
Penetration of bitumen	mm/10	20 to 30	EN 1426
Compound thrust resistance on 50 °C, lowest	N/mm ²	0.8	
Specific thrust deformation on 50 °C	%	quote	RVS 15.362

2.6.5.3.1.4 Bitumen waterproofing sheeting

Required properties of bitumen waterproofing sheeting for welding and gluing, used for sealing of horizontal and low-sloped surfaces, are indicated in Tables 2.6.5.4 and 2.6.5.5.

Required properties of bitumen waterproofing sheeting for welding, used for sealing of vertical and high-sloped surfaces, are indicated in Table 2.6.5.6.

Table 2.6.5.4: Technical conditions for properties of bitumen waterproofing sheeting

Method of application	Required value				Test regulation
	Procedure with gluing	Procedure with welding	Thickness	Composition	
	Thickness of the sheeting	Composition of bitumen binder	Thickness of the sheeting	Composition of binder	
	mm	g/m ²	mm	g/m ²	
With one sheeting, lowest	3.0	2000	4.5	4200	SRPS U.M8.080 EN 1849-1
With two sheeting, lowest	3.0	2000	3.6	3200	
Bandaging, lowest	2.0	1600	2.0	1600	

Table 2.6.5.5: Technical conditions for properties of bitumen waterproofing sheeting for horizontal insulations (EN 14695)

Property of bitumen waterproofing sheeting	Unit of measure	Required value	Test regulation
Durability on -5 °C(bending around the mandrel with r=30 mm)	-	durable	EN 1109
Durability on 90 °C, mean flow, highest	m	0.5	EN 1110
Breaking force, longitudinally and transversally (5 cm), mean, lowest	N	800	EN 12311-1
Elongation on rupture: - sheeting with glass fabric. mean lowest	%	2	EN 12311-1
Value - sheeting with polyester-polypropylene foil, the lowest mean	%	40	EN 12311-1
Shearing resistance on 50 °C: - sheeting: the lowest mean - bitumen compound: the lowest mean	N/mm ² N/mm ²	0.8 0.8	RVS 15.362
Bitumen compound for the sheeting: - softening point: lowest - linear contraction: highest	°C %	150 2	EN 1107-1
Compound of the girder - polyester polypropylene foils, lowest	g/m ²	200	ZTV TP-BEL/1
- thickness of the gluing compound on the lower side of the girder, lowest	mm	3	
- on upper side	mm	0.5-1.3	
Share of stone grains larger than 0.71 mm: highest	m.-%	5	EN 993-1
Water absorption - lowest	m.-%	5	
Water permeability (pressure 1 bar/24 hours)	-	water-resistant	EN 1928
Thickness of the sheeting	mm	≥ 5	EN 1849-1
Lowest individual value of sheeting thickness	mm	≥ 4.7	EN 1849-1

Table 2.6.5.6: Technical conditions for properties of bitumen waterproofing sheeting for vertical insulations (EN 13969)

Property of bitumen waterproofing sheeting	Unit of measure	Required value	Test regulation
Durability at 0° C	-	durable	EN 1109
Durability at 70° C			EN 1110
Breaking force, longitudinally and transversally:			EN 12311-1
- girder of glass mat: lowest	N	300/200	
- girder of polyester polypropylene felt: lowest	N	300/300	EN 12311-1
Elongation during rupture:			
- girder of glass mat: lowest	%	2	
- girder of polyester polypropylene felt: lowest	%	30	EN 12311-1
Thickness of the sheeting: lowest	mm	3.6	EN 1849
Water permeability	kPa	60	EN 1928

Bearing elements of the bitumen compound in the sheeting used for insulation of horizontal surfaces has to be of glass-fibre fabric or polyester felt. It must have appropriate resistance to rupture and resistance to heat.

Surface of the bitumen waterproofing sheeting must be homogeneous, dry and without impurities and cracks, and protected suitably by polyester foil or by sprinkling with small stone grains.

Aberration of average bitumen waterproofing sheeting thickness from the prescribed value should not be greater than $\pm 0,3$ mm.

Bitumen waterproofing sheeting for sealing has the width of 1000 mm, edges should be flat. Maximal allowed aberration of the width is ± 10 mm.

If insulation is performed by overlapping of bitumen waterproofing sheeting, the sheeting must have a wedge form on at least one longitudinal edge. The width of the wedge ranges from 80 to 100 mm.

Delamination along the thickness of the bitumen waterproofing sheeting must not be present, and the role should not be deformed.

2.6.5.3.1.5 Liquid polymer for spraying

Required properties of liquid polymers for spraying, used for sealing of horizontal and low-sloped surfaces, are indicated in Table 2.6.5.7.

Liquid polymer membrane is applied by spraying in two layers, each of which has to have thickness of at least 1 mm, and the total thickness must not be less than 2 mm. Materials for these two layers should be differently painted to facilitate the infliction control.

During the application, weather conditions prescribed by the producer of the material should be monitored.

Table 2.6.5.7: Technical conditions for liquid polymers for spraying

Property	Test regulation	Required value
Minimal thickness	By the approval of the Supervising Engineer	2 mm
Specific weight of the solidified membrane	BS EN ISO 2811-1-2011	>1.1 g/cm ³ at 23 °C
Elongation	ISO 37:1994; ASTM D638	>100% - <150%
Adhesion strength	ASTM 4541 BS 4624:2003	Concrete base > 1.5 MPa Steel base > 2.0 MPa
Permeability for vapour	ASTM E96-80	4 g/m ² /day at 23 °C
Tensile force	ASTM 638; ISO 37:1994	>11 MPa
Breaking force	ASTM D624; ISO 34-1 2004	70 N/mm
Hardness	ISO 868: 1985	>50 (Shore D)
Adhesion strength of asphalt superstructure		Refined asphalt > 0.9 MPa at 23 °C Hard-gussasphalt > 1.0 MPa at 23 °C
Surfacing shear compared to the waterproofing system	Rolled asphalt Hard-gussasphalt	>1.92 MPa at -10 °C >0.6 MPa at 23 °C >0.2 MPa at 40 °C >0.9 MPa at 23 °C
Breaking of concrete waterproofing	ISO8510-1:1990 (angle of 90°)	750 N/m
Bridging of the cracks	ASTM C836	>3.2mm at -26 °C

2.6.5.3.1.6 Asphalt mixtures for protective layers and wearing courses

Conditioned properties of asphalt mixtures for protective and wearing courses on facilities are similar as the ones of asphalt layers used on the pavement.

Selection of asphalt mixture (asphalt concrete, pored asphalt or skeletal mastic asphalt) for application of protective layer depends on the type, length and facility bow, and on expected traffic load. Gussasphalt is suitable for the facilities with longitudinal or transversal bow with value of over 5%.

For manufacturing of asphalt mixtures for protective and wearing courses of asphalt-concrete, skeletal mastic asphalt and

gussasphalt, fractions of stone material are used with size of 8 or 11 mm and appropriate modified bitumen binder.

For manufacturing of asphalt mixture for the protective layer, fractions can be of stone with carbonate origin.

Asphalt mixture of skeletal mastic asphalt must comply in every segment with the requirements for mixtures that are being embedded in pavement structures for heavy load.

With asphalt mixture for gussasphalt, used as the protective layer on facilities with larger traffic load (medium and heavy traffic), the penetration depth must be (5 cm², 40° C, 30

min., 525 N) after 30 minutes 1 to 2.5 mm, and for the next 30 minutes 0.4 mm at most.

2.6.5.3.1.7 Bitumen compound for filling of the joints

Properties of permanently-elastic bitumen compound for filling of the joints on border surfaces of different materials in the surfacing of the structure and surrounding elements, are indicated in Table 2.6.5.8.

2.6.5.3.1.8 Bitumen waterproofing sheeting for sealing of the joints

Properties of permanently-elastic bitumen waterproofing sheeting for sealing of the joints on border surfaces, primarily joints of protective and wearing course with curbs (within the structure corridors), have to be similar to the properties of the compound for filling of the joints, indicated in Table 2.6.5.8, except the properties of lines 1 and 2, which cannot be checked on these sheeting.

Table 2.6.5.8: Technical conditions for properties of bitumen compounds for filling of the joints (EN 14188-1)

Property of bitumen compound	Unit of measure	Required value	Test regulation
Bedding capability at 180° C	-	good	ZTV TL bittfug 82
Bedding temperature	°C	quote	
Softening point of the compound by PK, lowest	°C	85	EN 1427
Cone penetration at 25° C, (150 g, 5 s)	mm / 10	40 to 90	EN 13880-2
Flow at 60° C, (5 hours, 75° C), highest	mm	5	EN 13880-5
Flow after the overheating, highest	mm	5	EN 13880-5
Change of the softening point of the compound by PK after the heating (absolute), highest	°C	10	EN 1427
Change of the cone penetration after the heat treatment at 70° C, highest	%	25	EN 13880-4
Heat resistance by Nüssel at 45° C (24 hours), highest	-	6.5	EN 13880-2
Frost resistance by Hermann (-20° C, 5 hours)		withstands 3 to 4	DIN 1996-18
Ductility (20° C, 15x30 mm), lowest	mm	5	EN 13880-13
Softening resistance (150° C, 30 min.), highest	%	5	EN 13399

2.6.5.3.1.9 Bitumen coating for sealing of the surface

For coating and sealing of the wearing course surface of asphalt-concrete are used:

- bitumen emulsions
- bitumen polymer-modified binders
- bitumen compounds for gluing.

Properties of these materials must comply with the requirements from the Tables 2.6.5.1, 2.6.5.2 and 2.6.5.3.

2.6.5.3.2 Materials of artificial engineering substances

2.6.5.3.2.1 Reactive (epoxy) resins

For the primer (priming) of the facility cement concrete surface is used reactive resin without liquefying agent and filling, slightly viscous and heat resistant.

Reactive resin made on the basis of epoxy resins has to comply with the requirements indicated in Table 2.6.5.9.

Composition of epoxy resin should be determined by IR analysis. Properties of the

basic component and the hardener, of the extract and the reactive resin, should be determined by previous tests, and the results serve as the basis for further identifying.

2.6.5.3.2.2 Polymer foil

Foils for partially protected or separated layers have to be manufactured of polypropylene or polyester fibres. Selection of the foil type depends on the usage conditions.

2.6.5.3.2.3 Drainage fabrics

Properties of the drainage fabric for partially protected or separated layers have to be determined in the design. As a rule, basic

information on the fabric provided by the producer should be taken into account.

Properties of the drainage fabrics must comply with the values indicated in Table 2.6.5.10.

2.6.5.3.2.4 Sand for sprinkling

Sand for sprinkling of the primer with epoxy resin must have the properties required in Table 2.6.5.11, unless otherwise specified in the epoxy resin producer's instructions.

In certain cases, this sand is usable for sprinkling of the primer with bitumen binder, too.

Table 2.6.5.9: Technical conditions for properties of epoxy resins (EN 1504.2)

Properties of epoxy resin	Unit of measure	Required value	Test regulation
Viscosity: at 23° C, highest	Pa s	1	ZTV-BEL-B / 1995 Part 3
Viscosity: at 12° C, highest	Pa s	4	
Viscosity: at 8° C	Pa s	quote	
Density of individual component	g/cm ³	quote	
Annealing residue, highest	m.-%	1	
Processing time, lowest	min	10	
Hardening time:		quote	
- 46 hours, 8° C, relative humidity 75 % in the normal climate, highest	h	18	
- at 40° C, relative humidity, lowest			
- at 12° C in 75 % relative humidity, highest	h	2	
Content of non-evaporating substances, lowest			
Water absorption in solid state, highest	h	40	
Heat resistance (silicone oil), lowest	m.- %	98	
Adhesion force after the heating test, lowest	m.- %	2.5	
Storing resistance, lowest	°C	250	
	N/mm ² year	1.5 1	

Table 2.6.5.10: Technical conditions for properties of drainage fabrics

Properties of drainage fabrics	Unit of measure	Required value			Test regulation
		300 g	400 g	500 g	
Surface compound, lowest	g/m ²	300	400	500	DIN 53854
Allowed compound aberration, highest	%	10	10	10	DIN 53854
Thickness a_{200} of the compound, lowest	mm	2	2.5	3	DIN 53855/1
Allowed thickness aberration, highest	%	10	10	10	DIN 53855/1
Maximal tension force (longitudinal and transversal), lowest	N/50	150	200	250	DIN 53857/2
Elongation at maximal tension force, lowest	mm ^{*1}	60	60	60	DIN 53857/2
Penetration resistance, lowest *2	%	1.500	1.500	1.500	DIN 54307
Fire resistance *3	N	B2	B2	B2	ÖN 3800/1
Decay resistance *4	-				
Mountain water resistance *4	-		Resistant not soluble		
Water permeability, lowest	l/dm ² /min	60	60	60	Darcy

Legend:

*1 for needleloom drainage fabrics without reinforcement N/100 mm

*2 for drainage fabrics for tunnels at least 800 N, if sprinkled concrete base

*3 for tunnels

*4 polyolefin drainage fabrics comply with the requirements

Table 2.6.5.11: Technical conditions for properties of the sand for sprinkling of epoxy resins and bitumen binders

Properties of the sand for sprinkling	Unit of measure	Required value	Test regulation
- Fraction 0.2 / 0.7 mm			
- washed particles (< 0.063 mm), highest	m.- %	0.5	
- grains below the measure, highest	m.- %	5	
- grains above the measure up to 1 mm, highest	m.- %	10	
- Fraction 0.5 / 1.2 mm			
- washed particles (> 0.063 mm), highest	m.- %	0.3	
- grains below the measure, highest	m.- %	5	
- grains above the measure up to 2 mm, highest	m.- %	10	

TL Min - Stb

2.6.5.4 Execution of works

2.6.5.4.1 General

The main objective of a quality sealing - the facility insulation at all stages of construction and use, is to provide qualitative and harmless drainage of surface and seepage water from the facility.

As a rule, sealing of the facility is performed only in favourable weather conditions. The limit values must not be exceeded. These conditions limit the time in which the optimal conditions for carrying out of works exist, and condition the method of works execution in difficult conditions. Then, the special measures have to be provided to ensure the adequate protection of works and the quality of sealing application - embedding of the insulation.

The Contractor has to prove the suitability of the procedure to be executed in advance, that will ensure the quality of sealing - insulating of the facility. He must check the producer's instructions for the use of materials, or to establish that they are not inconsistent with the essential requirements, set in this guideline. These instructions must always be available on the construction site.

Prior to the commencement of works on the sealing - embedding of waterproofing, concrete must be at least 21 days old. With the repair works of limited scope, concrete must be at least seven days old. If the producer's instructions allow the sealing works - lying of insulation on surfaces that do not have the required age according to specially prepared procedure, that procedure must be tested under similar conditions to the ones provided for the works execution.

Individual methods from preparation of concrete base to the embedding of protective layer must be carried out and executed under conditions prescribed by the producers of materials. Individual layers of sealing must be glued or stuck mutually on the whole surface of concrete, if such procedure is provided by the design. Each subsequent layer of insulation can be embedded only after the quality control is performed on the works executed on the embedding of the previous layer.

Immediately before the embedding of each layer, the quality of surface drainage should

be controlled, and the execution of works should be adapted to existing conditions.

Walking or driving on waterproofing layer is permitted only to the extent needed for the embedding of the next layer. Turning of vehicles is not allowed. Protective layer should be embedded as soon as possible.

Traffic on protective layer is allowed only for vehicles needed for the embedding of the wearing course, which should be embedded as soon as possible.

If the traffic on protective layer must take place for some time, this layer should be temporarily upgraded, and if possible, protective and wearing course should be embedded separately.

Stopping of vehicles and working machines on the protective and wearing course is allowed if appropriate safety measures were taken.

Longitudinal and transversal joints on protective and on wearing course have to be mutually shifted.

For the coagulation of asphalt mixtures of protective and wearing courses, usage of oscillating and static rollers is allowed.

All the works related to sealing - embedding of waterproofing must be guided by qualified personnel with proven expertise.

2.6.5.4.2 Method of application

2.6.5.4.2.1 Preparation of the concrete base

Success in sealing of the facility depends on the quality of the prepared base, or the concrete surface to which waterproofing is being embedded respectively.

The surface or concrete surface respectively, has to be cleaned by the exhaustor or compressed air. All badly connected grains should be removed. Oil stains should be cleaned, the contaminated parts of concrete or additional mortars removed with mechanical tools, by sanding or water jet under high pressure. These procedures also ensure the prescribed roughness without sharp edges.

Roughness depth of concrete surface, which is achieved by sanding, should be:

- at least 0.8 mm
- to 1.5 mm for welded bitumen waterproofing sheeting,

- to 2 mm for glued bitumen waterproofing sheeting,
- to 4 mm at most on particular places.

Any cracks, wavy and segregated places on the concrete surface should be soaked with epoxy resin and sprinkled with quartz sand (grain size of 0.5/1 mm), and larger bumps previously repaired with other suitable material (e.g. epoxy mortar).

Concrete surface has to be dry prior to embedding of waterproofing. It can be partially moistened if materials that guarantee the adhesion by wet surface are used for primer.

Humidity of concrete surface is determined by gravimetric punched probes with depth of 2 cm, by measuring of electrical conductivity or by other verified methods. Allowed concrete surface humidity is 4 %.

Informatively only, and in exceptional cases, humidity can be determined by using

absorbent paper or newspaper. On this paper, pressed on the concrete surface, no traces of water absorption should remain. Humidity can be determined also by local heating of the concrete surface using the dry air, since the heated dry surface has a lighter colour.

Concrete surface on the facility has to be flat, as much is possible. Measuring with 4 m long ruler can have the following aberrations:

- on the length of 4 m at most 40 mm
- on the length of 2 m at most 20 mm
- on the length of 1 m at most 10 mm

To improve the flatness of the surface, levelling course can be embedded, but only above the insulation.

All the height aberrations above 40 mm should be repaired directly on the concrete, before the waterproofing is performed, as well as all the bumps (edges and ridges) that prevent the embedding of the protective layer with minimal thickness.

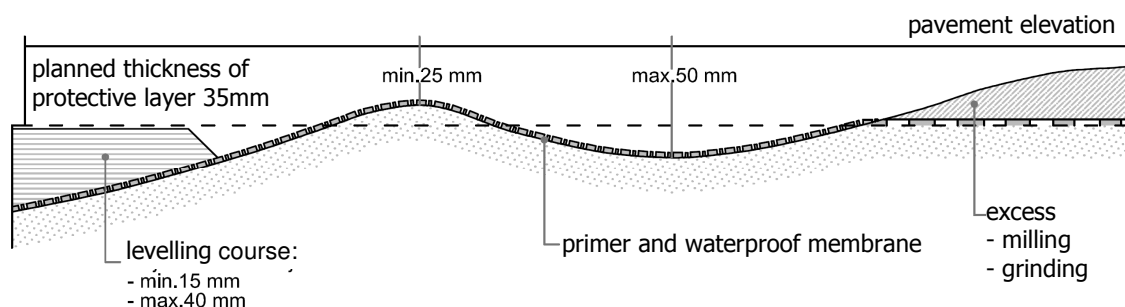


Figure 2.6.5.2: The method of levelling and insurance of the limits of protective layer thickness

Height aberrations of concrete surface between 15 and 40 mm below the projected dimension should be repaired by corresponding levelling layer of epoxy or micro-reinforced cement mortar. If these aberrations on the surface are of a smaller scale, manual embedding of levelling asphalt is permitted, directly on the insulation layer (Figure 2.6.5.2).

The method of required concrete surface levelling is determined by the Supervising Engineer, on the basis of geodetic measuring, evaluation and review of existing conditions.

The mean breaking resistance for sealing of the prepared concrete surface has to be at least 1.5 N/mm^2 (single value at least 1 N/mm^2), so that the solid and permanent connection with the upgraded layer is ensured.

2.6.5.4.2.2 Preparation of the steel base

Steel surface of the facilities has to be liberated from rolling mill scale, residual parts of welding in the assembling stage, technological openings have to be closed in a prescribed way, and the surface treated. Surface must be clean and free of grease and other contaminants.

The surface must be cleaned by sanding or sandblasting to metal gloss. Fineness of the sanded surface must range from SA 2.5 (for steel surfaces in the state of initial corrosion A and B) to SA 3 (for steel surfaces in the state of initial corrosion C and D). Sanded surface must be clean, dry and free of grease and other contaminants. Sanded surface can stay opened for at most four hours before the application of previous layer (relative humidity must not be over 75%).

Prepared base is taken over by the minutes, and the minutes are signed by the Contractor and the Supervising Engineer.

2.6.5.4.3 Primer

2.6.5.4.3.1 Primer with reactive resins

Primer should be applied with reactive resins sprinkled by the sand.

This primer cannot be inflicted without corresponding safety measures under the following conditions:

- during the precipitation, dew forming, humidity caused by the fog,
- if relative humidity is over 85%,
- if surface temperature of the concrete base is below + 8° C,
- if surface temperature of the base is above + 40° C,
- if temperature is rapidly rising or dropping.

The temperature of the base surface must be at least 3 °K above the dew point temperature.

Multi-component reactive resins should be mixed by the producer's instructions. Change of materials or of their composition and mixing ratio is not allowed, unless otherwise is specified in the instructions.

Surface roughness depth for the primer with reactive resin is not defined, as a rule.

Prepared base of the concrete surface should be protected (cracks filled) by inflicting of one or two coatings with epoxy resin. First layer is inflicted according to producer's instructions (by brush, roller, spraying). The resin in quantity of 300 to 500 g/m² should be evenly distributed on the surface, without pools. Fresh surface of the resin is sprinkled with quartz sand of 0.5/1.2 mm grain size, exceptionally 0.2/0.7 mm, in quantity of 1.5 to 2 kg/m².

Sprinkling material that didn't stick to the resin should be removed by broom or compressed air.

If there is a possibility of exposing of the interior concrete surfaces to the water influence, they should also be protected by coating of reactive resins and sprinkled with quartz sand.

Joints of primers of individual layers have to be performed stepwise, linearly and with mutual distance of 10 cm.

Mean breaking resistance of prepared concrete surface, treated with reactive resins, should be at least 1.5 N/mm². Breakage must appear in the concrete base.

Roughness depth of the surface covered with reactive resins and sprinkled with quartz sand should not be greater than 1.5 mm.

2.6.5.4.3.2 Primer with bitumen binders

In waterproofing of the facilities under the certain conditions, appropriate bitumen binders can be used for the primer. On high-sloped surfaces, this procedure is used to a larger extent, while on the low-sloped and more loaded surfaces is used in the smaller scope, mostly on facilities where the cement concrete is used as a protective layer.

Prepared concrete surface should be coated with cold solution of bitumen binder (applied by brush or roller), in quantity of 200 to 400 g/m². The quantity should be minimal and homogeneous (without interruptions).

If the bitumen solution is used in hot state, it is applied by spraying.

The temperature of the base surface during the infliction should be at least +5° C.

Only in exceptional cases and with prior approval from Supervising Engineer, unstable bitumen emulsion can be used.

Infliction of primer should be avoided early in the morning.

Roughness depth of the surface to which the primer of bitumen binder, sealing or levelling layer is applied, should be at least 0.6 mm.

2.6.5.4.3.3 Sealing

Sealing represents the additional layer of epoxy resin with thickness of 0.3 to 0.5 mm, used if necessary after the infliction of primer. Coating with bedding compound creates a thin film over the whole surface and covers eventual interruptions of the primer.

Sealing should not be sprinkled with quartz sand.

2.6.5.4.3.4 Levelling with spatula

For levelling with spatula, epoxy mortar is usually used.

Levelling is performed on fresh primer (with epoxy resin), and with approval from the

Supervising Engineer in exceptional cases can be used also on the hardened primer.

Epoxy mortar is levelled with spatula on the surface, filling the recessed rough concrete surfaces. Features of such prepared surface are similar to ones of the surfaces inflicted with primers. Levelled surfaces are sprinkled with quartz sand with granulation 0.5/1 mm without interruptions.

If bitumen waterproofing sheeting is used for insulation, suitable hot bitumen materials can be used for the levelling. Bitumen compound for gluing is mostly used. Usage of compound for gluing reduces the dependence of waterproofing on weather conditions. Compound consumption is 1.5 to 2 kg/m².

Levelling compound should not be covered on joints.

Excessive roughness of the surface (above 4 mm) on particular places should be levelled with epoxy mortar. Mixing ratio for epoxy resin: single-fractional sand is 1:3 to 1:4, unless otherwise is specified in the producer's instructions. Ready-prepared mixtures are usually used in practice.

2.6.5.4.4 Insulating layers

For insulating layer can be used:

- individual bitumen waterproofing sheeting (one-layer insulation) or
- polymer-modified bitumen or
- sprayed polymer membranes.

For joint (glued) insulation layers, that is for connection of the insulation layer with the gluing layers, a necessity for application of additional layer for gluing can arise. Application procedure for this layer is indicated in the producer's instructions. For this additional layer consumption is approx. 250 g/m².

For free (floating) vertical or sloped insulation layers on bridges, smooth, not glued or polymer foils with tenons can be used.

Special conditions and procedures of embedding of free insulation layers, as well as protection of polymer foils are given in the producer's instructions.

2.6.5.4.4.1 Bitumen waterproofing sheeting

With welded or glued bitumen waterproofing sheeting can be achieved:

- sealing of certain structural elements of the facility, e.g. below the corridor, edge cornices, curbs and
- upper sealing of the facilities on roads

Bitumen waterproofing sheeting between certain elements is usually embedded longitudinally attached to gluing compound that is located on primer of bitumen binder. They have to cross into the pavement area for at least 20 cm, which ensures qualitative joint with the sheeting of the upper insulation. Sheetting should be temporarily protected from mechanical damages, e.g. with bitumen roofing felt that is removed before the embedding of protective layer.

Mechanical properties of bitumen waterproofing sheeting for insulation that is embedded between the elements can partially deviate from the required values given in Table 2.6.5.6.

For upper sealing with individual bitumen waterproofing sheeting, procedure of welding to the base is used.

Reactive resin in the derived layer for gluing must at least 48 hours old and hardened enough.

If bitumen waterproofing sheeting is embedded as upper sheeting on primer of bitumen binder or on levelling layer of gluing compounds, made with spatula, levelling must be dry.

Air temperature during the embedding of bitumen waterproofing sheeting must be at least 5° C, and the base should not be frozen.

Bitumen waterproofing sheeting should be unwrapped and levelled firstly, longitudinally in the direction of the facility, as a rule. Overlapping widths should be taken into account in levelling (if frontal joining of sheeting is not provided), in widths:

- on longitudinal edges
- thickened at least 8 cm
- normal at least 10 cm
- on transversal edges at least 10 cm

Sheeting can be separated up to 10 mm, in frontal joining.

Transversal joint of the sheeting must be on distance of at least 50 cm.

Frontal joining of bitumen waterproofing sheeting should start on the higher side of

the facility, and if it's the overlapping connection, on the lower side.

If the bitumen waterproofing sheeting is protected by plastic foil prior to embedding, it should be removed if its thickness is greater than 0.05 mm.

Levelled bitumen waterproofing sheeting should be winded up on sleeves - rollers with appropriate compound.

During re-winding up, the bitumen waterproofing sheeting is heated along the entire width (by multiple burners or appropriate source of heat), and the bitumen compound below the sheeting should be melted by heating. Temperature of the source of heat and it's the distance from the sheeting and basic compound (burners on the bearing movable structure) should be adjusted to the weather conditions (temperature, the wind).

If the bitumen waterproofing sheeting is weld on the layer of reactive resin, the heating temperature of the base surface should not be higher than 250° C.

Basic conditions for heating of bitumen waterproofing sheeting for welding are determined by the producer. Usage of individual burners for heating can be applied only in exceptional cases with the approval of the Supervising Engineer.

Under certain conditions is allowed to embed the suitable bitumen waterproofing sheeting by gluing on primer (solution of bitumen binder) of hot bitumen compound. Temperature of this compound in underflow must comply with the conditions from producer's instructions. Heating of the bitumen compound for gluing must be performed in appropriate cauldrons with indirect heating, thermostat and mixer. During the heating and usage, compound should be constantly mixed and its temperature controlled. Consumption of the bitumen compound is 1.5 - 2.0 kg/m², which depends on the quality of prepared concrete surface.

In front of the bitumen waterproofing sheeting winded up on the roller, there should always be so much of melted (plasticized) compound to create a ridge.

Immediately after the unwrapping it is necessary to press the sheeting to the base,

to attach it with the entire width and remove the air from the joint.

Bitumen compound that does not flow out or was squeezed out on the edges should be uniformly levelled to the very joint. Larger quantity of squeezed out compound should be removed. If there is no squeezed out compound in the joint area and if there is a gap left on certain places, then that places should be additionally filled.

Penetration of bitumen compound, in the area of frontal joints into the upgraded asphalt layers should be prevented by covering of the joint in width of approx. 20 cm with the bandaging tape. This tape is glued to the surface by additional heating of the joint area.

Adhesion strength of the bitumen waterproofing sheeting must be at least 0.8 N/mm² for the average value of three samples that is at least 0.4 N/mm² for individual tests.

In Figure 2.6.5.3 is shown waterproofing with one bitumen waterproofing sheeting and in the Figures 2.6.5.4 and 2.6.5.5 is shown treatment and sealing of waterproofing joint and the asphalt layers with curbs.

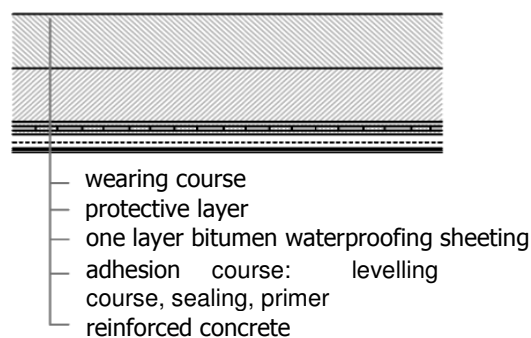
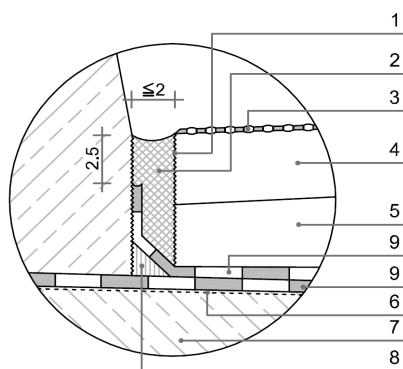


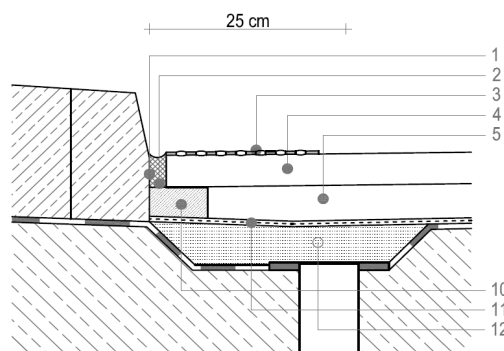
Figure 2.6.5.3: Structure waterproofing with one bitumen waterproofing sheeting

**Legend:**

- 1 primer
- 2 compound for filling of the joint
- 3 coating for closure of the asphalt layer surface
- 4 wearing course
- 5 protective layer
- 6 primer, sealing, levelling with spatula
- 7 reinforced concrete structure
- 8 bucketing of the edge by bitumen compound or cement mortar
- 9 bitumen waterproofing sheeting

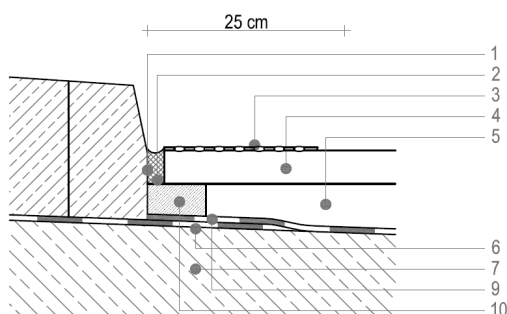
Figure 2.6.5.4: Detail of treatment of the joint along the curb

curb or element area, and guiding of that water into the drainage system of the facility.

**Legend:**

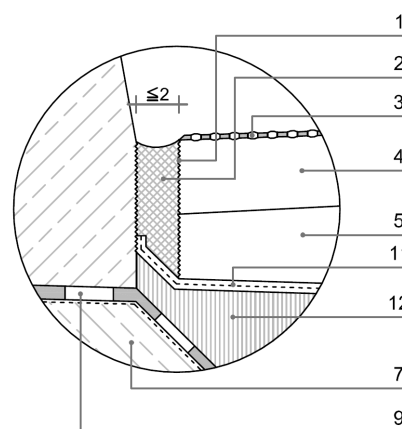
- 1 primer
- 2 sealing compound - filling of the joint
- 3 coating for closure of the asphalt surface of the wearing course
- 4 wearing course
- 5 protective layer
- 10 drainage epoxy concrete (drainage strip)
- 11 protective drainage felt
- 12 drainage epoxy concrete

Figure 2.6.5.6: Waterproofing around the drainage opening

**Legend:**

- 1 – primer
- 2 – sealing compound – filling of the joint
- 3 – coating for closure of the asphalt-concrete surfaces
- 4 – wearing layer
- 5 – protective layer
- 6 - primer, sealing, levelling with spatula
- 7 – RC structure
- 9 - bitumen waterproofing sheeting
- 10 – drainage epoxy concrete

Figure 2.6.5.5: Structure waterproofing along the edge of the pavement

**Legend:**

- 1 primer
- 2 sealing compound - filling of the joint
- 3 coating for closure of the asphalt-concrete surfaces
- 4 wearing course
- 5 protective layer
- 7 RC structure
- 9 bitumen waterproofing sheeting
- 11 protective drainage felt
- 12 drainage epoxy concrete

Figure 2.6.5.7: Detail of the insulation along the curb and the drainage opening

In Figures 2.6.5.6 and 2.6.5.7 is clearly shown waterproofing along the drainage openings, and in the Figure 2.6.5.8 is given more detailed display. Longitudinal rebate must provide separation of total seepage water that reaches the waterproofing in the

2.6.5.4.4.2 Polymer-modified bitumen

Polymer-modified bitumen binder is mostly used for injected waterproofing of concrete surfaces that have the large slope angle, and rarely for horizontal surfaces.

Consumption of such bitumen ranges from 2 to 3 kg/m² which depend on the surface roughness.

As a rule, this type of sealing is inflicted in several layers (approximately 1 kg/m² for one layer) on the prepared base of the gluing layer, and then its reinforcement by fabrics or nets of artificial fibres or metals is performed. This reinforcement should be applied before the infliction of final sprayed layer for sealing.

Sealing by modified bitumen binder with polymers should be protected on the surface by the appropriate material (e.g. felt, plastic foil with tenons, wooden plates, brick).

2.6.5.4.4.3 Sprayed polymer membrane

Sprayed polymer membrane can be used for sealing of both horizontal and vertical surface. It can be inflicted in one or two steps. In that case the second coat is differently coloured to facilitate the infliction control. On the surface of the polymer membrane is applied thermally active contact coating, which provides good connection with the chosen protective layer.

2.6.5.4.5 Protective layers

For the protective layers of horizontal or low-sloped waterproofing are mostly used mixtures of asphalt-concrete, skeletal mastic asphalt or gussasphalt. Under certain conditions can also be used cement concrete.

On shorter structures in length up to 30 m, for the protective layer is recommended usage of the gussasphalt.

To protect the waterproofing with larger slope, other suitable materials should be used, e.g. felt, polystyrene, plastic foils with tenons, wooden plates, brick etc.

To protect the insulation on vertical concrete surfaces, on frame structures should be used material that prevents any mechanical damages to the insulation.

During the material supply for the protective layer, attention should be paid that the vehicles don't damage the waterproofing.

Average value of the adhesive strength is at least 1.0 N/m², and the single value is at least 0.7 N/mm².

2.6.5.4.5.1 Asphalt protective layers

Asphalt protective layers are embedded only on the dry base, as a rule. Before the embedding of the protective layer, sealing must not be damaged to the extent that would endanger the complete protection.

Type of the asphalt mixture for the protective layer must be determined in the design.

Thickness of the protective layer should not be thinner than 2.5 cm, or thicker than 5 cm (Figure 2.6.5.2).

All the dents on the sealing, larger than 5 cm, should be levelled by appropriate asphalt mixture for levelling and by layers in thickness of 1.5 to 4 cm.

In machine embedding of asphalt mixture for protective layers usually are used finishers with wheels. If finishers with caterpillars are used, the sealing should be protected previously.

The largest bump on the machine embedded protective layer can be 6 mm, measured with ruler 4.0 m long.

During the embedding of protective layer there should be no injecting of bitumen mixture from the sealing into the protective layer that would adversely affect the properties of protective layer. Besides, there should be no moving of certain sealing layers.

Protective layer must be embedded as soon as possible, upon the embedding of sealing. Asphalt mixture temperature must not get over 160° C, and of gussasphalt over 250° C. Gradual heating of insulation is achieved by proper embedding of protective layer mixture. First, the smaller quantities are stretched, and right after that the remaining part. In this way is provided that bitumen waterproofing sheeting is not overheated.

Hot asphalt mixture can be retained in front of the finisher's leveller from one to three minutes, depending on the temperature of the environment. This rule applies to stopping of the finisher also. Embedding speed of the finisher must not be less than 2 m/min.

Working joints are applied by hot on hot method. Longitudinal joints must not be applied in the area of track width.

Crossing of the sealing can be allowed to the vehicles supplying the asphalt mixture and to the finisher, if the grains of the asphalt mixture from the previous transport are not scattered on the insulation.

Share of the pores in the asphalt mixture of the protective layer can be up to 4 V % (compaction degree of at least 98%). Equal conditions have to be met by the asphalt mixture that is embedding for levelling of the dents.

Working joints of protective layer of gussasphalt should be applied by hot on hot method. In other cases, working joints are formed as joints, and then are bedded.

If the protective layer made of gussasphalt on which the wearing course of asphalt-concrete or skeletal mastic asphalt is embedded, then on the surface of protective layer has to be injected approximately 1 kg/m² of crushed material with granulation of 2/4 mm or 4/8 mm, wrapped with a binder previously.

2.6.5.4.5.2 Other protective layers

Method of embedding of other materials for protective layers should be adjusted to their properties. Primarily, sealing has to be protected from the damages during the embedding of the protective layer.

2.6.5.4.6 Wearing courses

Wearing courses on facilities within the sealing structure have to provide the same conditions for driving as on the rest of the pavement, which is why they are constructed from the same material.

In embedding of wearing courses on facilities, limited usage of machines for vibrating compaction should be taken into account. In everything else the conditions for embedding are similar as the ones on surfaces outside the facility.

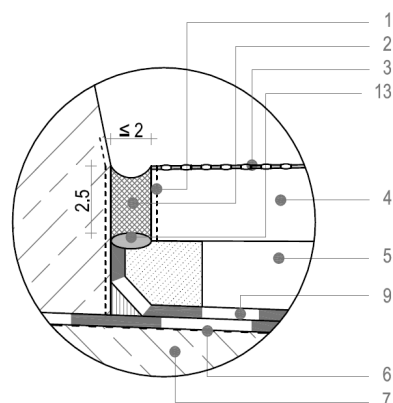
2.6.5.4.7 Insulation of the border surfaces - joints

Sealing must be connected with the border surfaces of the other structural elements. Because of that, on these border surfaces should appropriate spaces - joints be provided, in width of 15 to 20 mm, filled up with corresponding bitumen compounds or other sealing materials. Width of the joints

has to be determined in the design, and the bedding depth has to be applied according to instructions of the producer of sealing material.

Joints between the border surfaces of protective and wearing course and adjacent materials on the pavement should be filled separately. Along the curbs, the joint should be filled beside the protective layer with bitumen compound for sealing of the joints along the entire height. The joint beside the wearing course should be filled with bitumen compound a few cm above the wearing course. For that, under certain conditions up to a height of 2.5 cm, below the surface of the wearing course can be appropriate gasket be embedded (e.g. strip from the moulded rubber, Figure 2.6.5.8). These strips are not embedded on traffic surfaces.

Before the embedding of the joint sealing compound, all the surfaces in the joint - space must be dry, clean and coated with material suitable for the primer. Protection of curbs by primer or joint sealing compound has to be at least 2 cm above the dimension of the wearing course.



Legend:

- 1 primer
- 2 compound for sealing of the joint
- 3 primer
- 4 wearing course
- 5 protective layer
- 6 primer, sealing, levelling with spatula
- 7 reinforced concrete structure
- 9 waterproofing - bitumen waterproofing sheeting
- 13 gasket for sealing

Figure 2.6.5.8: Detail of the sealing beside the curb with the gasket

Bitumen compound used for the bedding should possibly be heated in special cauldrons according to the producer's instructions. It is allowed for the compound to be re-heated provided that it doesn't lose its

properties and requirements indicated in Table 2.6.5.8.

If the bitumen compound shrinks too much after the cooling, bedding should be repeated so that the joint is completely filled with the compound.

If the bitumen waterproofing sheeting is used for the sealing of the border surfaces of protective and wearing course, then it must be embedded, according to the producer's instructions, before the embedding of protective and wearing course.

Border horizontal surfaces on the wearing course beside the joint that are filled with the compound for joint sealing, should be coated with the compound for closure of the surface in width of approx. 25 cm from the curb (Figure 2.6.5.5). For this protection is mostly used compound for levelling with spatula that should be inflicted on the primer of bitumen emulsion or bitumen gluing compound. Additional coating of modified bitumen binder (from 1 to 1.5 kg/m²) and sprinkling with the sand (with granulation of 2/4 mm, up to 2.5 kg/m²) has to provide the complete sealing of the specified surface.

2.6.5.5 Quality of application

2.6.5.5.1 General

Before the usage of all the materials, machines and tools of which the quality of facility sealing depends, their correctness and suitability should be checked, that will guarantee the quality of executed works.

Apart from the general and special technical conditions prescribed by the client, all the conditions prescribed by the producers of basic materials, machines and tools should be taken into account, too. Conditioned test examinations that the producer has to provide:

- previous tests of usability,
- internal control of the tests,
- third-party control of the tests.

For the tests of asphalt mixtures for the protective and wearing courses, provisions that apply to the testing on pavement structures outside the facility are completely valid.

2.6.5.5.2 Type and the scope of the tests

Before the execution of works begins, the producer must provide appropriate proofs on

quality, issued by authorized institution, for all the materials that will be used in the application of sealing.

Minimal scope of the control tests of materials is indicated in Table 2.6.5.11.

Before the works begin, the Contractor is obliged to provide to the client for signature the recipes for asphalt mixtures of protective and wearing course, and the results proving the quality embedding of asphalt mixtures.

During the works execution, both internal and third-party (external) quality control has to be performed. Minimal scope of these tests is indicated in Table 2.6.5.12. Based on the results of these tests, the Supervising Engineer can change the scope of the tests. The Contractor has to maintain a detailed overview of the weather conditions during the execution of the works and taking of the samples.

The Contractor can continue with the works provided within the next stage only after the Supervising Engineer formally confirms and certifies that the works from the previous stage are accepted.

2.6.5.5.3 Previous tests

By previous tests in the previous procedure should the usability of materials provided in the design and the list of works be proven.

Usability of construction materials and procedures must be proven by the Contractor with valid certificate issued by the authorized institution. The Contractor has to enclose the proof and commend it to the client prior to commencement of works. The proof must fulfil all the properties indicated in Sections 2.6.5.3 and 2.6.5.4.2. The Contractor cannot use the materials before he obtains the consent from the client.

Costs of the previous tests for proving of usability of materials and procedures bears the producer or the Contractor.

2.6.5.6 Quality control of works execution

2.6.5.6.1 Internal quality control

Tests during construction have to be performed by the qualified Contractor or the authorized institution chosen by the Contractor. The quality of used materials and executed works is being proven by internal

quality control, according to agreed terms from the contract.

The scope of internal tests has to be determined for all the materials and procedures by the programme which is integral part of the contract.

Results of the internal tests have to be regularly delivered to the client or to the institute that performs a third-party quality control by the Contractor. In case that the Contractor establishes deviations from the required quality, he must take appropriate measures immediately.

Depending on the procedure of sealing application, the Contractor has to perform the internal tests:

on materials:

- to check the delivery notes and labels on the packaging (number of the batch),
- statuses and storing of the packaging and its content according to the instructions,
- mixing in the prescribed ratio,
- by appropriate mixing gear until the complete homogeneity,
- expiration date, that is date of production and allowed storing duration,
- eventual addition of other materials,
- mineral additives and grains for sprinkling in terms of composition, size and humidity.

on application:

- external conditions, that is the temperature of air, base, material, the dew point and relative humidity for so long that it can't affect the waterproofing anymore, or at least twice a day,
- moisture of the base surface of the reinforced concrete structure,
- adhesion strength of the surface of prepared base (for concrete and steel surface),
- layout quality of the treated surface,
- procedure of infliction of the reactive resin, that is bitumen binder for the primer in relation to the prescribed method,
- appreciation of the treatment period,
- surface layout of the individual layer in terms of homogeneity, covering and inappropriate places,
- appreciation of the prescribed waiting period,
- state of the applied primer, levelling with spatula and eventual layers for gluing prior to continuation of works in relation to the conditions from the contract,

- the scope and the position of the primer, and consumption of the material,
- roughness depth of the treated surface,
- thickness of waterproofing layer during the application,
- the content of the pores in the waterproofing layer,
- adhesion strength of the waterproofing,
- state of the gluing layer,
- adhesion strength of the welded bitumen waterproofing sheeting,
- quality of gluing of waterproofing with the base, and eventual bubbles and dents below the waterproofing or protective layer of the gussasphalt,
- temperature during the embedding of the protective layer,
- sprinkling in terms of the type and the quantity of the grains and the selection of the right time for sprinkling;

The Contractor has to enclose appropriate proofs on quality of the materials and sealing works execution for all the materials used and procedures for each facility.

All the costs of internal quality control of the materials and procedures within the contractual provisions are bared by the Contractor.

2.6.5.6.2 Third-party quality control

Third-party quality control is performed by the authorized institution, as a rule.

Third-party quality control serves for monitoring of the proper performing of the internal tests, embedding of materials and executing of the works in relation to the contract provisions. Results of the third-party quality control make the basis for taking over of the works executed.

Table 2.6.5.11: Minimal scope of the third-party control of the sealing materials

Type of material	Quantity tests
bitumen binders and emulsions	from each batch
modified bitumen binder	from each batch
bitumen gluing compound	from each batch
bitumen waterproofing sheeting	from each batch
bitumen compound for sealing of the joints	from each batch
bitumen waterproofing sheeting for sealing of the joints	1000 m
epoxy resin	from each batch
sand for sprinkling	20 t
liquid polymer for injection	from each batch
polymer foil	10.000 m ²
filter foil	10.000 m ²

Sampling and on site tests have to be performed in the presence of the Contractor and the client. If regularly summoned representative of the Contractor is not present, sampling and testing can be

performed without him. The Contractor is obligated to provide all necessary help during sampling and performing the third-party quality control.

If representative of the client is present during the performance of internal waterproofing tests, then the client can consider those tests as a third-party tests. From all the materials used, special samples should be taken (in the separate packaging) for eventual additional checks.

Every taken sample has to be recorded and carefully stored. After the application of sealing and embedding of the protective layer of gussasphalt, it is necessary to check if there are unattached places with presence of cavities and bubbles, using the control samples.

All the costs of the third-party quality control within the contract are completely bared by the client.

Costs for eventual additional control tests that can be requested by the client or the Contractor bares the purchaser of the testing, that is the Contractor, if the results weren't positive.

Table 2.6.5.12: Minimal scope of the internal and third-party quality control during the execution of the works on the sealing and protective layers

Type of check	On quantity	
	Internal tests	Third-party tests
Base surface:		
- status overview	250 m ²	1 x daily
- measurements: flatness	250 m ²	-
roughness depth	250 m ²	1 x daily
adhesion strength	250 m ²	-
Layers for gluing:		
- weather conditions	during the work	-
- properties of coatings with reactive resin	500 m ²	2,000 m ²
- properties of bitumen binder	-	for batch
- quantity of coating with bitumen binder	250 m ²	1 x daily
Sealing layers:		
Bitumen waterproofing sheeting		
- weather conditions	during the work	-
- properties of bitumen waterproofing sheeting	2,000 m ²	for batch
- properties of bitumen gluing compound	2,000 m ²	for batch
- method of sheeting embedding	during the work	1 x daily
- quantity of bitumen gluing compound	2,000 m ²	1 x on facility
- measurements of the adhesion strength		3 x on facility

Type of check	On quantity	
	Internal tests	Third-party tests
Polymer-modified bitumen		
- weather conditions	during the work	-
- properties of the polymer-modified bitumen	2,000 m ²	1 x on facility
- course thickness, thickness of course	1.000 m ²	2,000 m ²
Protective and wearing courses of asphalt-concrete and skeletal mastic asphalt:		
- weather conditions	every day	-
- properties of asphalt mixture	1x on fac./1,000 m ²	1 x on fac./2,000 m ²
- course thickness, thickness of course	1,000 m ²	2,000 m ²
- layer compactness	100 m ²	-
Protective and wearing courses from the gussasphalt:		
- property of asphalt mixture	every cauldron	1 x on fac./1.000 m ²
- course thickness, thickness of course	1.,000 m ²	2,000 m ²

2.6.5.6.3 Quality score

After the completion of certain stages of work, or the work in total, it is necessary to derive statistical analysis of the result of the interior and of the third-party quality control:

- of all the incoming basic materials and asphalt mixtures,
- embedded sealing and protective layers,
- asphalt mixtures of protective and wearing course

Statistical analyses of the results of control tests, as a rule, are being prepared by the performers of the interior and the third-party quality control, each for his own part. Comparison of the results of the statistical analysis represents the basis for the evaluation of the compatibility and the quality that is establishing of eventual corrective measures.

Evaluation of the compatibility of the results from the third-party quality control is prepared, as a rule, by the authorized institution.

2.6.5.7 Measurement and takeover of the works

2.6.5.7.1 Measurement of works

Executed works are measured according to general technical conditions, calculated in square meters.

All the quantities of executed works should be measured and calculated according to the

actual scope and compared to the measures and quantities from the design.

The Supervising Engineer takes over the existing sealing according to the requirements of this guideline and eventual additional requirements which are the subject of the contract documentation for the execution of works.

If during the acceptance of the works the deficiencies are established or the minimal requirements in terms of quality were not fulfilled, the Contractor must correct the deficiencies before proceeding with the works. He should correct the deficiencies on his expense, which implies all the costs of additional measurements and testing that should be done after the execution of works.

2.6.5.7.2 Takeover of works

Embedded sealing is taken over by the supervising service of the Employer (hereinafter »Supervising Engineer«), based on the written notice form the Contractor about the finalization of works.

The Contractor must timely present all the data and reports of internal quality control, and the final report on the quality issued by the authorized institution for performing the third-party quality control.

Papers that do not meet the quality or are not derived in accordance with the requirements of this guideline and conditions of the design, and they were the subject of the contract, the Contractor cannot calculate and charge if he didn't repair them as required by the

Supervising Engineer. In such cases the Employer may extend the guarantee period for at least five years for all the works that are not repaired.

2.6.5.8 Calculation of works

The executed works should be calculated in accordance with general technical conditions.

Quantities determined and taken over in accordance with the general technical conditions should be calculated at the agreed unit prices.

The contractual unit price includes all the costs and activities required for finalization of the works. The Contractor has no right to claim any subsequent payment.