ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

REPUBLIC OF SERBIA

TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL TECHNICAL CONDITIONS

2.3 DRAINAGE SYSTEM

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2.3.1 MATERIALS

Various types of drainage works can be executed by the use of similar materials. The characteristics of these materials are elaborated in detail within these technical conditions.

All considered materials shall be used in compliance with requirements of technical documentation and these technical conditions. The selection and any change in materials shall be approved by the supervising engineer.

2.3.1.1 Description

The following materials are mostly being used in drainage works:
- mineral aggregates for bedding courses
- cement concrete mixes for bedding courses and drainage elements, and
- cement mortars.

2.3.1.2 Basic Materials

2.3.1.2.1 Mineral Aggregates

Mineral aggregates for bedding courses may consist of natural and/or crushed stone fractions.

2.3.1.2.2 Cement concrete

Mineral aggregates
Mineral aggregates for cement concrete mixes used for bedding courses (concrete underlay) and prefabricated drainage elements can consist of natural and/or crushed stone fractions. When using a mixture of natural and crushed mineral aggregates, the content of crushed stone must be at least 50 percent by mass in cement concrete of compressive strength class C30/37 or higher.

Binders
In cement concrete mixes of strength class C30/37 and higher, in compliance with EN 206-1, the following can be used:
- Portland cements, and
- Portland cements with addition of blast furnace slag.

In cement concrete mixes for bedding courses, Portland cements with addition of puzzolans can be used.

The cement type shall be determined according to cement quality and conditions of use of cement concrete, and shall comply with requirements of technical documentation and these technical conditions.

Upon the approval of the supervising engineer, the Contractor is allowed to use other hydraulic binders based on the Portland cement, provided that their applicability is adequately justified.

Water
Natural or treated water may be used in preparation of cement concrete mix for drainage works, provided that its applicability for this purpose has been confirmed .
Drinking water may be used for the preparation of cement concrete, in which case no additional evidence of its applicability for this purpose is required.

Chemical Additives
In order to improve certain properties of fresh and/or hardened cement concrete mixes, various chemical additives for plasticizing, aeration, and other modifications of the cement concrete properties may be used.
The application of additives shall be approved by the supervising engineer.
When using additives, the adherence to provisions of EN 206-1 and instructions provided by manufacturer of chemical additives is obligatory.

Protective Agents
For the protection and/or impregnation of fresh and/or hardened cement concrete surface against drying and/or wetting, various liquid agents can be used so as to insure forming of the uniform and impermeable film on the cement concrete surface. The application of chemical protective agents shall be approved by the supervising engineer. When using protective agents, the consideration of provisions of EN 206-1 and instructions provided by the manufacturer of the protective agent is obligatory.

2.3.1.2.3 Cement Mortar

Cement mortar to be used in drainage works shall consist of a mixture of sand, cement and water. In cement mortars, a mix of coarse sand (of granulation 0/4 mm) that may consist of natural and/or crushed fractions is usually being used.

In cement mortars, Portland cements specified in sections 2.4 and 2.5, are being used as a binder.

In general, the provisions of sections 2.5 and 2.5 of Technical Conditions shall apply for the water used in cement mortar.

2.3.1.3 Quality of Materials

2.3.1.3.1 Mineral Aggregate Fractions

Composition

The mineral aggregates used for bedding courses (concrete underlays) in drainage works shall consist of sandy gravel, crushed natural gravel, gravel or crushed stone, in order to ensure the composition of mixes within particle size limits shown in Figures 2.3.1, 2.3.2 and 2.3.3.

If the mineral aggregate composition for a bedding course is not specified by the technical documentation, it should be determined by taking into account that the course thickness shall be at least 2.5 times the diameter of the largest grain in a mix.

The content of mineral grains of size up to 0.063 mm may amount to:

- at a deposition site maximum 5% by mass
- after placing minimum 8% by mass

Grain size uniformity coefficient $U = d_{60}/d_{10}$ shall amount to:

- in mixes of natural grains from 15 to 100
- in mixes of crushed and mixed grains from 8 to 50.

The mineral aggregate composition shall be approved by the supervising engineer.

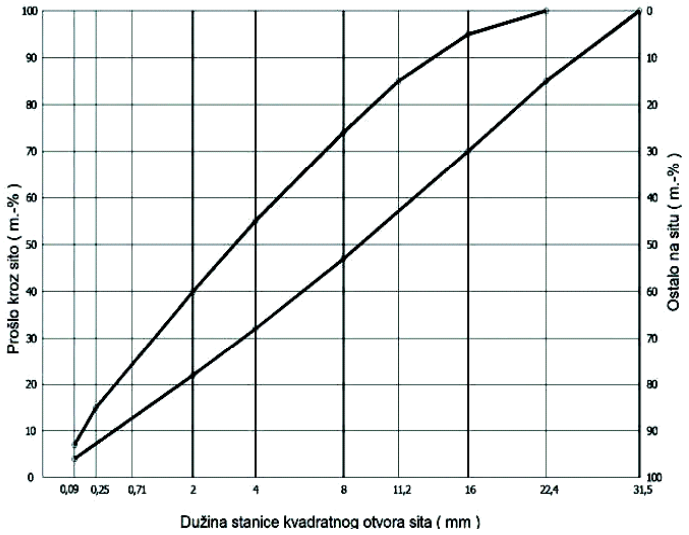

Figure 2.3.1: Partizle size limits for mineral aggregates of 0/22 mm for bedding courses

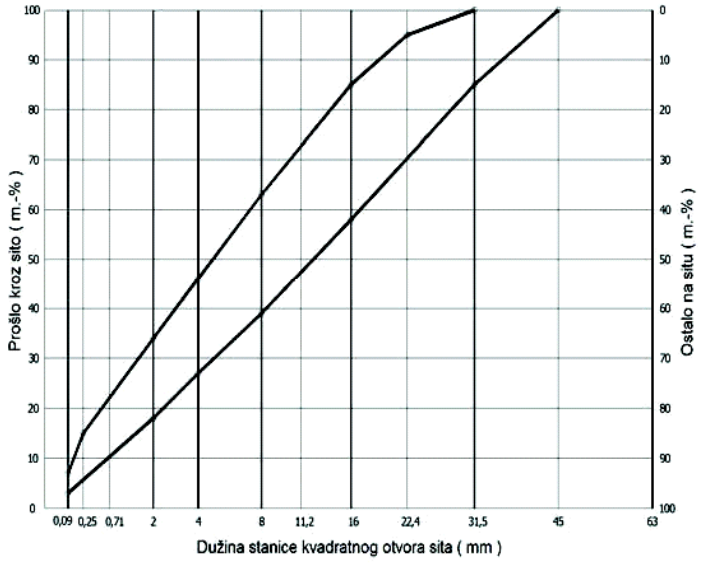

Figure 2.3.2: Partizle size limits for mineral aggregates of 0/32 mm for bedding courses

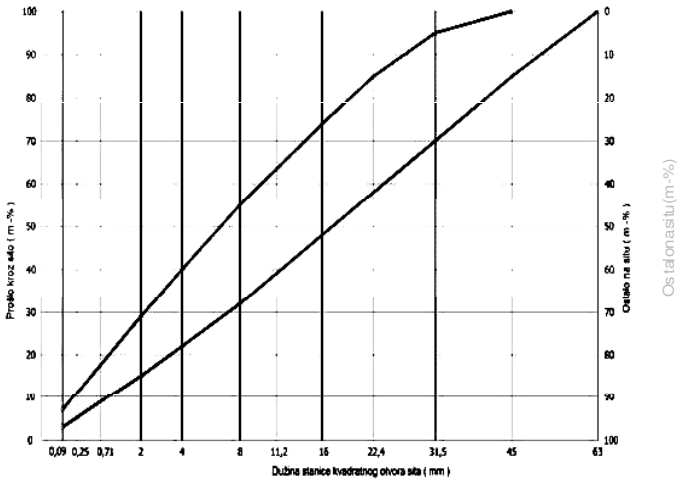

Figure 2.3.3: Partizle size limits for mineral aggregates of 0/45 mm for bedding courses

Mechanical Properties

Mineral aggregate resistance to freezing, determined by the magnesium sulphate test, shall comply with the MS25 category (according to EN 1367-2).

The organic matter content in the mixture shall not colour the solution of sodium hydroxide darker than the reference colour.(according to EN 1744-1).

Mineral aggregate resistance to crushing, determined by Los Angeles test, shall comply with the LA30 category (according to EN 1097-2).

Any mineral aggregate fraction to be used in drainage works for the bedding courses shall be tested prior to placing, in accordance with requirements specified by these technical conditions.

2.3.1.3.2 Cement Concrete

Mineral Aggregate

Composition

For cement concrete to be used in drainage works, mineral aggregates of 0/32 mm, exceptionally 0/16 mm, may be applied (category GA90 according to EN 12620). Particle size upper an lower limits are shown in Figures 4.4 (CB 16) and 4.5 (CB 32). The size of the largest grain in a mix shall not exceed 1/3 thickness of the cement concrete layer.

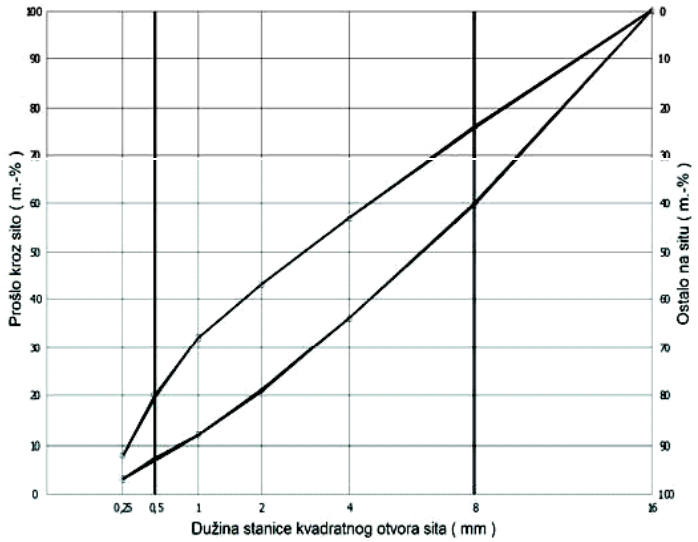

Figure 2.3.4: Particle size limits for mineral aggregates in CB16 cement concrete mixes

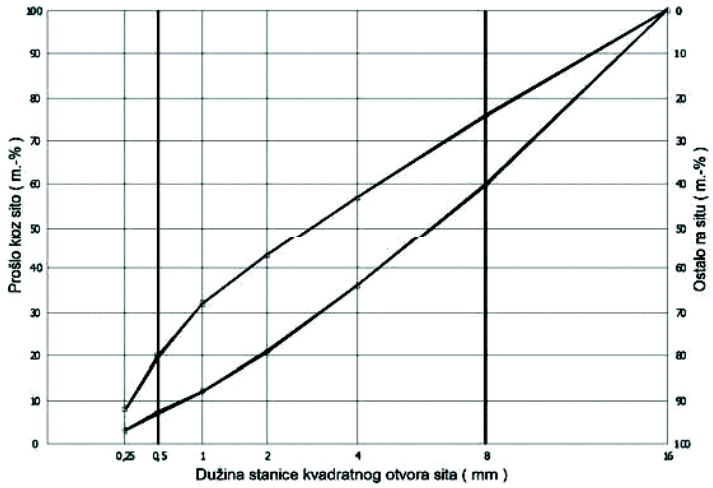

Figure 2.3.5: Particle size limits for mineral aggregates in CB32 cement concrete mixes

In addition, natural mineral aggregates may be used for the preparation of cement concrete of class 16/20 upon the prior consent of supervising engineer.

The organic matter content in the mineral mix shall not colour the solution of sodium hydroxide darker than the reference colour.
Stone grains shall be washed or aspirated and classified into fractions.

In preparation of cement concrete mix, the contractor may use mineral aggregates of different composition, under the condition he provides the supervising engineer with appropriate evidence that mechanical properties of such cement concrete mix meet the requirements of these technical conditions and technical documentation.

Properties
Mineral aggregates for the preparation of cement concrete mixes shall have the properties given in Table 2.3.1.

Table 2.3.1: Required properties of mineral aggregates used in cement concrete mixes

Mineral aggregates properties	Unit of measurement	Required value	Test method
resistance of mineral aggregate to freezing (magnesium sulphate test)	% by m.	MS25	EN 1367-2
content of poorly formed grains	% by m.	SI20	EN 933-4

Prior to the commencement of works, every mineral aggregate intended for the preparation of cement concrete mix shall be tested in accordance with requirements of these technical conditions. If the supervising engineer has already previously approved the application of the mineral aggregate in question, the tests need not be repeated.

The required properties of mineral aggregate shall be ensured (threshold values).

Binders
Cement used in cement concrete mixes for drainage works shall meet the requirements set in EN 197-1. The following are used in cement concrete mixes for drainage works:
- cement type CEM I, of strength class 32.5, and
- cement types CEM II/A-S and CEM II/B-S, of strength class 42.5.

For cements used in cement concrete mixes for drainage works, the following limitations apply:
- initial cement setting time at 20□C, not earlier than 1 hour,
- initial cement setting time at 30℃, not earlier than 45 minutes,
- final cement setting time, 10 hours.

The required cement properties shall be ensured (threshold values).

Water
The required water properties used in preparation of cement concrete mixes for drainage works are given in Table 2.3.2.

The required water properties shall be ensured (threshold value).

Testing of water to be used in preparation of cement concrete mix shall be required by the supervising engineer.

Table 2.3.2: Required properties of water to be used in cement concrete mixes

Water properties	Unit of measurement	Required value	Test method
pH value	-	4.5 – 9.5	EN 1008
Chloride content (Cl), maximum	mg/l	300	EN 196 21
Sulphite content (SO_4), maximum	mg/l	400	EN 196 2

Chemical Additives

The required properties of chemical additives for cement concrete are defined in EN 934-2.

Chemical additives may be used in preparation of cement concrete, provided they enable required improvements of cement concrete properties. The contractor shall preliminarily test the mineral aggregate, the binders and the water which he intends to use in preparation of cement concrete, and provide the supervising engineer with appropriate evidence of that in due time prior to commencement of works.

The evidence that chemical additives in cement concrete are in conformity with requirements of technical documentation and these technical conditions shall be issued by an authorized institution.

The application of chemical additives in cement concrete shall be approved by the supervising engineer.

Protective Agents

Properties of liquid chemical protective agents to be applied to cement concrete surface are defined in the instructions and technical conditions issued by the manufacturer of such agents.

The film of the chemical protective agent shall adequately protect the cement concrete surface and shall not adversely affect the cement setting process or the surface of placed cement concrete mix.

The evidence of quality of the protective agent for the cement concrete surface shall be issued by an authorized institution.

2.3.1.3.3 Cement Mortar

Mineral aggregates used in cement mortar for filling in the joints may be composed of sand with grading of 0/2 mm or 0/4 mm.

The required composition and properties of mineral sand aggregate are given in Tables 2.3.3 and 2.3.4.

Table 2.3.3: Required composition of mineral aggregate to be used in cement mortar testing according to EN 933-1)

Side length of a sieve's square opening (mm)	Natural or crushed sand	
	0/2 mm	0/4 mm
	passed a sieve (% by m.)	
0.09	up to 10	up to 10
2	at least 90	at least 65
4	100	at least 90
8	-	100

Table 2.3.4: Required properties of mineral aggregates to be used in cement mortar

Properties of mineral sand aggregate	Unit of measu-rement	Required value		Test method
		Natural sand	Crushed sand	
Content of grains up to 0,09 mm max.	% by m.	10	10	EN 933 -1
Uniformity coefficient of a sand grain	%I	SE_{60}	SE_{60}	EN 933 -8
Content of organic admixtures [1)]	-	-	-	EN1744-1

1) *A sodium hydroxide solution must not be coloured darker than the reference colour.*

The required properties of other materials used in cement mortars for filling in the joints (binders, water, additives) correspond to those specified in sections 2.4 and 2.5 of Technical Conditions.

2.3.1.4 Manner of execution

2.3.1.4.1 Deposition Sites of Materials

In due time prior to commencement of drainage works, the contractor is obliged to inform the supervising engineer of all materials he intends to use in the construction of bedding courses, or of cement concrete and cement mortar, to submit appropriate evidence of their conformity, and to obtain the consent of supervising engineer for the use of these materials.

All properties of materials as set in section 2.4 shall be ensured. The contractor shall eliminate from usage and specially mark the materials not meeting the specified requirements.

2.3.1.4.2 Depositing of Materials

When the contractor, prior to execution of drainage works, needs to temporarily deposit materials, he shall provide the appropriate space for such purposes. When selecting the space, he shall adhere to the storage instructions provided by the material manufacturer and to the instructions of supervising engineer.

The reserves of deposited materials must be such as to facilitate the continuous execution of works.

2.3.1.4.3 Production of Cement Concrete Mix and Cement Mortar

The production of fresh cement concrete mix and cement mortar shall be mechanical and carried out in an appropriate plant, where batch-based production is provided. Production capacities of the cement concrete and cement mortar production plant shall be certified.

Dosing equipment shall be such as to ensure the proper amount of all components in a mixture by mass.

Mixing time and other parameters that may impact the quality shall be adjusted so as to ensure the homogeneous and uniform mix of cement concrete and cement mortar.

If works are executed at low temperatures (lower than –3°C), the plant for production of cement concrete and cement mortar must be equipped for heating the mineral aggregate and/or water to the required temperature so as to ensure the temperature of the fresh cement concrete and cement mortar is between 10°C and 30°C.

The plant for production of cement concrete and cement mortar shall be protected from the elements.

The plant shall be provided with possibility of constant visual control of the dosing quantities of materials used in production of cement concrete and cement mortar mixes.

The produced cement concrete and cement mortar mix may be – upon prior approval by the supervising engineer – stored in appropriate silo within the production plant for a short period of time, or immediately transported to the placement site.

2.3.1.5 Quality of Execution

The contractor is obliged to provide supervising engineer, at least 7 days prior to commencement of works, with a document (technological elaborate) that includes the following data required according to these technical conditions, as follows:
- the design of cement concrete and cement mortar,
- certificates that all materials to be used are in conformity with requirements,
- a programme of internal and external control,
- a description of technological procedures and method statments.

Prior to start-up of equipment and facilities, their faultless functioning and capacity to ensure uniform quality, in compliance with these technical conditions shall be checked and verified. The capacities of all the equipment and facilities shall fulfil the requirements of technical documentation and these technical conditions.

2.3.1.5.1 Cement Concrete

Mixture Composition
Within the scope of initial testing of the composition of cement concrete mix for drainage works, the contractor shall submit to the supervising engineer the following:
- types and quantities of individual fractions and total grain aggregate (kg/m3)
- type and quantity of the binder (kg/m3)
- water quantity (l/m3)
- types and quantities of additives (in % by mass of cement or in kg/m3 of cement concrete)

The contractor shall prove that the composition of the mixture, prepared of proposed mineral aggregate fractions, binder, water, and additives, ensure the cement concrete quality required by these technical conditions and technical documentation.

The contractor shall not commence the placement of cement concrete mix without written consent of the supervising engineer for the usage of proposed composition.

If the contractor used the similar cement concrete mixtures for works execution in past period, than the results of executed composition may be adopted as internal control evidence. The decision on this shall be made by the supervising engineer.

Cement Concrete Properties

The quality of fresh cement concrete mix for drainage works shall meet the requirements given in Table 2.3.5.

Table 2.3.5: Required properties of fresh cement concrete for drainage works

Properties of fresh cement concrete	Units	Required value		Test method
		For bedding courses	For other concretes	
Content of micro-pores[1)]				EN 12350-7
CB16	% by v.	-	-	
CB32	% by v.	-	-	
Content of cement and fractions up to 0,25 mm:				
if the amount is ≤300kg/m^3	kg/m^3	400	400	-
if the amount is ≥300kg/m^3	kg/m^3	450 + (C-350)	450 + (C-350)	

1) for visible surfaces of cement concrete only

The required properties of hardened cement concrete are specified in Table 2.3.6.

The values of the micro-pore content are to be considered as the limit and threshold values.
The content of cement and grain mixture up to 0.25 mm are at the upper limiting values.

The values of compressive strength and tensile strength at bending are the lower limiting values.

The resistance to the water penetration is the lower threshold value.

The resistance to freezing and thawing is defined as the lower limiting value.

Table 2.3.6: Required properties of hardened cement concrete for drainage works

Properties of hardened cement concrete	Unit of measurement	Required value		Test method
		For bedding courses	For other concretes	
Compressive strength				EN 12390-3
– average	MN/m^2	C16/20	C30/37	
– individually	MN/m^2	C12/15	C25/30	
Tensile strength at bending	MN/m^2	-	≥ 4	EN 12390-5
Resistance to the water penetration PVII degree	mm	≤ 30	≤ 30	EN 1026
Resistance to freezing/thawing XF4 degree	mg/mm^2	-	≤ 0.40	EN 12390-8

Test Production and Placing / Test Area

By test production of the cement concrete mixture, the contractor shall verify the (laboratory) composition in production at the appropriate cement concrete production plant, the transportation to the site, and the placing, after it has been approved by the supervising engineer.

The test placing site shall be approved by the supervising engineer only after the prepared substrate formation has been verified.

Based on testing performed by an authorized institution, test production and placing shall be aimed at:
- establishing adequacy of deposition sites and cement concrete production plant, of transportation methods, of placing equipment and placing itself, all in accordance with requirements of these technical conditions;
- taking in-place samples of the mix for testing the conformity of fresh cement concrete;
- taking in-place samples of fresh cement concrete mix (a cube) for testing the characteristics of hardened cement concrete;
- establishing the protection of the cement concrete surface;
- establishing the thickness, evenness and inclination of the placed cement concrete layer.

If the contractor used the similar cement concrete mixtures for works execution during the past year, the results of executed composition may be adopted as test production. The decision on this shall be made by the supervising engineer.

Regular Production and Placing
The supervising engineer may authorize the contractor to start the regular production only on the basis of test production and placing results. The consent for continuous work also includes conditions regarding characteristics of cement concrete mixes and conditions of internal control, all in accordance with these technical conditions and technical documentation.

A consent for regular production and placing of cement concrete mixture shall also include additional requirements, if any, regarding surface finishing of a bedding course.

If during the process of cement concrete mix production or placing any modification occurs, the contractor is obliged to present a written proposal on such modification. Modifications may be executed only after they have been approved by the supervising engineer.

2.3.1.5.2 Cement Mortar

The cement mortar is used for filling in the joints (grooves) between drainage elements, unless otherwise required by technical documentation.

Composition of a Mixture
To the cement mortar composition to be used for filling in the joints between the drainage elements, the provisions given in sections 2.4 and 2.5 of these Technical Conditions in principle apply.

Required Properties
The quality of cement mortar mixes for filling in the joints shall comply with requirements specified in Table 2.3.7. All required values are limiting values.

Test Production and Placing
To test and regular production, as well as to placing of cement mortar for filling in the joints (grooves) between drainage elements, requirements specified in sections 2.4 and 2.5 of these Technical Conditions in principle apply.

Table 2.3.7: Required properties of cement mortar for drainage works

Cement mortar properties	Unit of measurement	Required value	Test method
Cement quantity, minimum	kg/m^3	600	-
Compressive strength	MN/m^2	C30/37	EN12390-3
Tensile strength at bending	MN/m^2	≥ 3.5	EN12390-5
Resistance to water penetration	mm	-	1026
Resistance to freezing/thawing	-	≤ 0.40	EN12390-8

2.3.2 SURFACE DRAINAGE

Surface drainage protects the road body from the atmospheric water which may have adverse effects to its durability.

For surface drainage the following are being used:
- channels and
- gutters.

Surface drainage shall be executed in dimensions defined by technical documentation and in compliance with these technical conditions. Any modification shall be previously approved by the supervising engineer.

2.3.2.1 Description

In surface drainage, the following are being used:
- channels, paved – lined with
  - quarry stone
  - bound crushed stone (“Colcrete”),
  - cement concrete slabs,
  - cement concrete cubes and prisms,
  - cement concrete segments,
  - cement concrete drain channels,
- top soiled channels and
- gutters
  - of cement concrete,
  - of bituminous (asphalt) concrete,
  - with riprap,
  - with coating of stone cubes,

The protection of rounded channels bottom may be executed with
- bituminous (asphalt) concrete,
- small stone cubes.

To protect the foot of slope of channels, the following may be used
- quarry stone and
- gabions.

The production of all above mentioned items to assure surface drainage includes supply and placing of all required materials at sites determined by the technical documentation.

These works do not include required earthworks, which are considered and thoroughly specified in section 2.2 of these Technical Conditions.

The method of coating, execution of gutters and protection of bottom and foot of channel slopes shall be defined by technical documentation. Otherwise, the supervising engineer shall decide on this.

2.3.2.2 Basic Materials

2.3.2.2.1 Quarry Stone

For coating of channels and gutters, as well as for the protection of the foot of the channel slopes, quarry stone of either igneous or limestone rock (of silicate or carbonate origin) can be used.

2.3.2.2.2 Prefabricated Cement Concrete Elements

For coating of channels and gutters, various prefabricated cement concrete elements can be used, which meet the conditions defined by technical documentation.

2.3.2.2.3 Cement Concrete Mixes

Cement concrete mixes can be used for concrete underlay – bedding courses and for execution of gutters.

Materials used for preparation of appropriate cement concrete mixes for above stated works are specified in sections 2.3 and 2.5 of these Technical Conditions.

2.3.2.2.4 Cement Mortar

Cement mortar for filling in joints – grooves – between pieces of quarry stone, prefabricated cement concrete elements or stone cubes, shall consist of mixture of sand, cement and water.

Basic materials used for preparation of appropriate cement mortar mixes for above stated works are specified in sections 2.3 and 2.5 of these Technical Conditions.

2.3.2.2.5 Bituminous (Asphalt) Concrete Mixes

For execution of gutters and the protection of rounded channels bottom, the mixture of bituminous (asphalt) concrete may be used. Materials used for production of bituminous mixes are specified in section 2.4 of these Technical Conditions.

2.3.2.2.6 Stone Cubes, Prisms

For the protection of rounded channels bottom, small stone cubes, derived from rocks of silicate or carbonate origin, may be used, and are specified in section 2.4 of these Technical Conditions.

2.3.2.2.7 Mineral Aggregate Fractions

Mineral aggregate fractions to be used in bedding courses for coating of channels are specified in section 2.4 of these Technical Conditions.

2.3.2.2.8 Gabions

Gabions are baskets made of steel or plastic mesh, filled with quarry stone, and exceptionally, with coarse gravel or fine crushed gravel.

2.3.2.3 Quality of Materials

2.3.2.3.1 Quarry Stone

Quarry stone for coating of channels and gutters must be from tough and homogenous rock, which is resistant to weather, water and salt impacts; quarry stone for channels coating shall be flat in shape. The compressive strength of quarry stone shall be at least 120 NM/m^2.

Quarry stone for the protection of the foot of slopes and for gabions shall be resistant to weather and water impacts.

The size of quarry stone pieces should be adjusted to the purpose defined by technical documentation.

2.3.2.3.2 Prefabricated Cement Concrete Elements

Prefabricated cement concrete elements, used for channel lining (slabs, segments, drain channels) and for gutters, shall be made of dense cement concrete, without any cracks, and shall match the requirements shown in Table 2.3.8.

Table 2.3.8: Required properties of prefabricated cement concrete elements

Properties of prefabricated elements	Unit of measurement	Required value	Test method
Deviation from dimensions, maximum	mm	± 5	-
Compressive strength			
– average	MN/m^2	C30/37	EN12390-3
– individually	MN/m^2	C25/30	
Resistance to freezing/thawing – XF4 degree, 50 cycles	mg/mm^2	≤ 0.40	EN12390-8

The supervising engineer may authorize the use of prefabricated elements of cement concrete with different properties.

If prefabricated elements are manufactured of two types of cement concrete (a core and a surface layer), a full coherence between them shall be ensured.

2.3.2.3.3 Cement Concrete Mixes

The quality of materials used in cement concrete mixes for bedding courses and gutters shall in principle comply with requirements specified in sections 2.4 and 2.5 of these Technical Conditions.

Cement concrete used for surface drainage shall comply with requirements set in sections 2.4 and 2.5 of these Technical Conditions.

2.3.2.3.4 Cement Mortar

The quality of materials for cement mortar, used for filling in the joints – grooves – in coating of channels, is thoroughly defined in sections 2.4 and 2.5 of these Technical Conditions.

Cement mortar shall match the requirements given in sections 2.4 and 2.5 of these Technical Conditions.

2.3.2.3.5 Bituminous (Asphalt) Concrete Mixes

For the execution of gutters and the protection of curve channels bottom, the required quality of bituminous concrete mix is defined in sections 2.4 and 2.5, for wearing courses for light and very light traffic loading. The voids content of the produced bituminous concrete mix shall be at the lower limiting value.

2.3.2.3.6 Stone Cubes, Prisms

The quality of these stone elements, used for coating of curve channels bottom, shall comply with conditions stated in section 2.4 of these Technical Conditions.

2.3.2.3.7 Mineral Aggregate Fractions

Mineral aggregate fractions for bedding courses and for filling in the joints, which are used in channel lining, may consist of sand fractions and bank gravel, or of crushed gravel. The quality of these mixes shall match the requirements given in sections 2.4 and 2.5 of these Technical Conditions. The size of grains in the mix shall be adjusted to the designed thickness of bedding course or to the designed width of the joint – groove.

2.3.2.3.8 Gabions

Gabions shall be made of quality galvanized steel wire or adequate plastic.

The cross-section of wire and plastic shall be adjusted to the size of a gabion and to the material that the gabion will be filled with. If requirements are not defined by the technical documentation, they will be determined by the supervising engineer.

2.3.2.4 Manner of Execution

All the stated methods of surface drainage consist of:
- bedding course (one or two) and
- lining.

2.3.2.4.1 Deposition Sites of Materials

In due time prior to commencement of surface drainage works, the contractor is obliged to inform the supervising engineer of all types of materials he intends to use and to submit appropriate evidence of their quality. This evidence shall be issued by an authorized institution.

The required properties, which are given in sections 2.4 and 2.5 of Technical Conditions, shall be ensured. The contractor shall eliminate from usage and specially mark the materials not meeting the specified requirements.

2.3.2.4.2 Depositing of Materials

Conditions for depositing of individual materials for surface drainage are specified in sections 2.4 and 2.5 of these Technical Conditions.

2.3.2.4.3 Substrate Preparation

As a rule, the substrate for the bedding course represents the formation of an excavation or a fill, which is prepared according to requirements of sections 2.2 and 2.4 of these Technical Conditions. Any deviation from stated requirements shall be previously authorized by the supervising engineer.

2.3.2.4.4 Production of Cement Concrete Mix and cement mortar

Conditions for the production of cement concrete mix and cement mortar are defined in section 2.4 of these Technical Conditions.

2.3.2.4.5 Production of Bituminous Concrete Mix

Conditions for production of bituminous concrete (asphalt) mix for execution of gutters and for the protection of rounded channels bottom are defined in detail in section 2.4 of these Technical Conditions.

2.3.2.4.6 Transport and Unloading of Materials

The transport and unloading of mineral aggregate fractions and cement concrete mix, for the bedding course and coating, onto the prepared substrate formation, which must not be frozen, may commence only after it has been approved by the supervising engineer.

Appropriately equipped vehicles shall be used for transportation. During the transportation, mineral aggregate fractions and cement concrete mix shall remain homogenous, and other properties of the cement concrete mix shall remain unchanged.

The number of vehicles, used for transportation of materials for the bedding course to the construction site, shall be adjusted so as to facilitate uniform placing in accordance with plant and equipment capacities, transportation distance, and placing capacity.

Supply of all other materials for coating and protection during surface drainage works shall be adapted to placing conditions.

2.3.2.4.7 Placing

Bedding Course

The bedding course may be constructed by the use of mineral aggregate and/or cement concrete mix.

When placing the unbound mineral aggregate as a bedding course, in dimensions defined by technical documentation and of the uniform thickness, it shall be executed so as to facilitate placing of a second bedding course and/or coating course, or to secure the required slope and adequate evenness. The same requirements also apply to the cement concrete bedding course in order to ensure proper dewatering.

Evenly and to the same thickness spread layer of the unbound mineral aggregate, or cement concrete mix for bedding course, needs to be overlaid so that, after the compaction and consolidation of the coating course, bedding course or courses maintain the thickness set by technical documentation.

Placing of cement concrete mix should be adjusted to the available space and equipment, but it must be executed in a single layer. As uniform as possible density of the cement concrete shall be ensured. Daily interruptions of placing works shall be treated as construction joint placed perpendicularly to the direction of placing.

The placing time of cement concrete mix shall not exceed one hour. The supervising engineer may authorize a longer placing time, provided that the contractor submits evidence that the required quality of cement concrete has been ensured.

When placing cement concrete in a bedding course, the air temperature should be considered and, if needed, proper measures should be taken accordingly.

To the placing of mineral aggregate, relevant conditions specified in these Technical Conditions apply.

Method and conditions for placing of bedding courses are determined by supervising engineer, unless they are appropriately specified in the technical documentation.

The contractor may start placing the coating course or protection of bottom and foot of channel slopes only after the bedding course has been taken over by the supervising engineer. For the entire period up to the placing of coating course, the contractor shall maintain the formation of the bedding course in the same condition as when taken over. The Contractor shall repair any damage that may occur.

Coating Course

The execution method of coating course for channel protection, together with all required dimensions, shall be defined in technical documentation.

To ensure the required shape of paved (lined) channels, gutters and protections, the inclinations need to be marked with rods.

Placing of materials for coating courses of channels is mainly executed manually. Besides manual placing by the use of a fixed formwork, a method of placing by means of a paver and slip form may also be applied in laying cement concrete gutters.

Joints – grooves – between pieces of quarry stone, slabs, segments, and channels paved with drain flumes, shall not be wider than 20mm. Joints shall be mutually staggered so that no more than three elements of coating course are joined at a single point.

As a rule, joints between elements of the coating course in lined channels and gutters are filled in with cement mortar, but crushed mineral aggregate may also be applied. When cement mortar is used, the depth of filling in joints shall be:

- in the bedding course of unbound mineral aggregate, at least 30 mm,
- in the bedding course of cement concrete mix, it shall reach in, to the depth of that course.

The thickness of individual crushed bank gravel grains used for filling in the joints shall not exceed 2/3 of the joint's width.

When quarry stone is used for channel lining, the ends along the edges shall be executed with larger pieces of stone.

If the coating course elements are to be placed onto the cement concrete bedding course, they shall be soaked in water prior to placement. The joints shall also be moistened before they are filled up with cement mortar.

To the placing of bituminous concrete into the coating course and protection of rounded channels bottom, conditions defined in section 2.4 of these Technical Conditions in principle apply. The supervising engineer may also specify additional conditions.

Protection of Slope Foot

The protection of channels' slope foot, by the use of quarry stone or gabions, shall be executed by placing them onto adequately prepared substrate in compliance with requirements of technical documentation and these Technical Conditions.

The size of single quarry stone pieces shall match the conditions of protection. The quarry stone is to be placed "in dry". The use of cement mortar or cement concrete mix, for binding and filling in the gaps between quarry stone pieces, shall be approved by the supervising engineer.

Every quarry stone piece shall be laid in a way that provides its stability and resistance to water flow.

2.3.2.5 Quality Control of Workmanship

In due time prior to commencement of works, the contractor shall provide the supervising engineer with evidence of quality of all the materials he intends to use for surface drainage. Placing of partly damaged prefabricated cement concrete elements may be authorized by the supervising engineer, provided that it does not decrease the quality of surface drainage

The contractor shall not undertake any works before prior obtaining consent of supervising engineer.

The required properties regarding basic materials quality are defined in sections 2.2 and 2.4 of these Technical Conditions and shall be considered as limiting values, unless otherwise agreed.

Permitted deviations from design values of evenness, height and inclination of bottom and slopes of encased channels and gutters, as well as of protection of channel bottom, are given in Table 2.3.9.

Table 2.3.9: Required properties of channels and gutters surface and of bottom protection

Properties	Unit of measure	Permitted deviation	
		Of bottom	Of slope
Channels and gutters			
- evenness	mm	- 15	- 25
– height	mm	± 10	± 50
– inclination	%	± 0.5	± 10
Bottom protection			
– evenness	mm	- 15	-
– height	mm	± 10	-
– inclination	%	± 0.5	-

*permitted deviation of a slope shall be uniform, without sharp edges

When deviations are frequent and close to limiting values, the decision on this shall be made by the supervising engineer.

2.3.2.6 Quality Control of Workmanship

2.3.2.6.1 Internal Control

The minimum testing frequency is defined in Table 2.3.10.

Table 2.3.10: Minimum testing frequency for internal control of surface drainage

Properties	Minimum testing frequency
compressive strength of crushed stone	800 m^1
characteristics of hardened cement concrete (properties according to Table 2.3.6)	200 m^1
characteristics of cement mortar (properties according to Table 2.3.7)	800 m^1
characteristics of bituminous concrete (properties according to Table 2.42)	500 t
characteristics of bituminous concrete (properties according to item 2.4)	500 t
channel surface (properties according to Table 2.3.9)	20 m^1

The extent of internal control for coating of channels and execution of gutters, protection of channels bottom, foot and slope, shall be defined in verified programme of average testing frequency. Testing for the internal control shall be carried out by an authorized laboratory. In case the programme has not been made, the supervising engineer shall prepare it and, based on random selection, define sampling and measuring points.

2.3.2.6.2 External Control

The extent of external control testing, executed by an authorized institution for the account of the client, is generally in the ratio of 1 : 5 relative to internal control testing. Sampling points for the purpose of external control shall be determined by the supervising engineer, according to the statistically random selection.

2.3.2.7 Measuring and Taking Over of Works

2.3.2.7.1 Measuring of Works

Executed works shall be measured according to general technical conditions and calculated in appropriate units of measurement. All the quantities shall be measured to the actually completed extent and for the types of works that have been

executed within dimensions specified by technical documentation or on the basis of amendments and additions authorized by the supervising engineer. All measured quantities shall be timely documented in writing.

2.3.2.7.2 Taking Over of Works

The supervising engineer shall take over the executed surface drainage according to quality requirements set in these Technical Conditions and in compliance with General Technical Conditions. Contractor shall remedy all defects established in accordance with these requirements prior to continuing the works.

2.3.2.8 Calculation of Works

2.3.2.8.1 General

Executed works should be calculated in accordance with General Technical Conditions.

Works, measured and taken over according to above described procedure, shall be calculated by contract unit prices.

The contract unit price includes all works and services required for full completion of works. The contractor is not entitled to claim any additional payment.

2.3.2.8.2 Deductions Due to Inadequate Quality

Quality of Materials
Since adequate quality of materials for surface drainage is specified by conditions and requirements, there will be no deductions in calculating the works.

If the contractor of surface drainage works places the material that does not meet the requirements of sections 2.4 and 2.5 of these technical conditions, the calculation method will be determined by the supervising engineer who, in addition, has the right to fully reject the executed works.

Quality of Execution
For the assessment of quality of execution, requirements given in Table 2.3.9 apply.

If the contractor fails to provide required quality of executed surface drainage, the calculation method will be decided by the supervising engineer.

2.3.3 SUBSURFACE DEWATERING – DRAINAGE

Subsurface dewatering with drainages is intended to prevent seepage of water into the road body, to facilitate dewatering and lowering of water table. It also promotes consolidation and stabilisation, while improving bearing capacity of highly compressible, low permeable and cohesive soil of very low bearing capacity.

Subsurface dewatering is ensured by drainages and accompanying facilities related to drainages.

Subsurface dewatering with drainage shall be executed in dimensions defined by technical documentation and in compliance with these technical conditions. Any modification that the responsible designer agreed to, shall also be approved by the supervising engineer prior to commencement of works.

2.3.3.1 Description

For this type of dewatering, the following are used
- shallow and deep longitudinal and transverse drainages, and
- vertical drainages and drainage boreholes.

Shallow and deep longitudinal and transverse drainages may be placed onto
- excavation formation,
- puddle layer,
- bedding course of cement concrete.

Vertical drainages and drainage boreholes may be
- drilled (with core removed) or
- impressed.

The execution of all types of drainage, for subsurface dewatering, includes the supply of all appropriate materials and placing them at sites and by the method defined in detail by technical documentation.

However, these works do not include the earth works, required for excavations and filling, which are considered and thoroughly defined in section 2.2 of these Technical Conditions.

Water from deep excavations for placing drainage systems shall be continually pumped out until the filling is executed up to

the water table. The contractor shall be responsible for any damage that might occur due to suspension of water pumping.

The method of drainage execution should be defined by technical documentation. Should this not be the case, it is determined by the supervising engineer.

2.3.3.2 Basic Materials

Basic materials for subsurface dewatering with drainage are:
- materials for bedding courses,
- drainage pipes,
- materials for drainage backfilling,
- drainage strips.

2.3.3.2.1 Materials for bedding courses

For deep drainage, the bedding courses of puddle layer or cement concrete mix are being used.

2.3.3.2.2 Drainage Pipes

Pipes for shallow and deep longitudinal and transverse drainage can be made of
- polymer (flexible or hard) or
- cement concrete.

Pipes may have either circular or tunnel shaped section. Pipes shall be perforated.

2.3.3.2.3 Materials for Backfilling of Drainages

Into shallow and deep, longitudinal and transverse drainages the following materials may be placed, either unwrapped or wrapped in geosynthetic material:
- mineral aggregate or
- cement concrete mixes.

Mineral sand aggregate, bank or crushed gravel may also be used for backfilling of drainage pipes and drainage ribs, as well as for filling the vertical drainages (boreholes).

2.3.3.2.4 Drainage Strips

For vertical draining, drainage strips made of geosynthetic material, reinforced with a finishing reagents, with or without a plastic core, are being used.

2.3.3.3 Quality of Materials

2.3.3.3.1 Materials for Bedding Course

Puddle Layer

The quality of material and workmanship for the course of puddle layer is thoroughly described in sections 2.2 and 2.4 of these Technical Conditions.

Cement Concrete Mix

The quality of materials for cement concrete mixes used in deep dewatering shall comply with requirements specified in section 2.4 of these Technical Conditions.

Unless otherwise specified by technical documentation, cement concrete used in bedding courses for drainages shall comply with requirements of section 2.4 of these Technical Conditions.

The supervising engineer may amend the above mentioned requirements for cement concrete used in bedding courses in special technical conditions.

2.3.3.3.2 Drainage Pipes

Polymer drainage pipes shall meet the requirements for:
- dimensions: pipe diameter and wall thickness,
- mass,
- distribution and area of drainage orifices for water,
- stiffness.

The quality of polymer pipes and fittings for shall comply with requirements of DIN 4262-1, Piping systems for underground drainage.

For all drainage pipes and formed elements made of polymer materials, the following information shall be included in technical documentation:
- diameter,
- required type of perforation: TP (360o), LP (220o), MP (120o), UP (without perforation) and
- pipe category, depending on the required pipe ring stiffness: ND or SD.

However, higher stiffness than its minimum value set by standard (non-standard requirements) may be required by technical documentation, although in such cases special pipes shall be fabricated.

For tunnel drainage, drainage pipes of types R2, C1 and C2 may be used. The type of drainage pipe shall be determined by technical documentation.
Pipes for tunnels drainage shall meet the following requirements:
- total area of drainage openings 200cm2/m1

- width of drainage openings 5 ± 1 mm
- perforation type (angle 220o) LP

In pipes of circular cross-section the central longitudinal axis of perforation shall be clearly marked.

Cement concrete drainage pipes shall meet the prescribed requirements for:
- dimensions: pipe length, diameter and wall thickness,
- evenness,
- distribution and the surface of inflow openings,
- resistance to vertex pressure and
- resistance to bending.

2.3.3.3.3 Materials for Backfilling

Mineral Aggregates
The composition of mineral aggregates for backfilling the transverse, longitudinal and vertical drainages, which are not wrapped in geotextile, shall comply with the following limit values:

$$12 < \frac{d_{15D}}{d_{15Z}} < 40$$

$$12 < \frac{d_{50D}}{d_{50Z}} < 52$$

where:

$d_{15\,D}$, $d_{50\,D}$ – grain diameter at 15% or 50% of screening of mineral aggregates for drainage backfilling,

$d_{15\,Z}$, $d_{50\,Z}$ – grain diameter at 15% or 50% of screening of earth materials around the drainage, which are to be prevented from entering the drainage.

The diameter of the largest grain in the mineral aggregate for drainage backfilling shall be 63 mm, unless otherwise required by the technical documentation and supervising engineer.

If mineral aggregate for backfilling is wrapped in geotextile, the aggregate shall be composed so as to ensure the permeability coefficient of $k>10^{-4}$m/s. The testing sample shall be prepared according to modified Proctor method.

The grading uniformity coefficient $U=d_{60}/d_{10}$ shall be greater than 8 for unwrapped mineral aggregates. When using wrapped aggregates, U shall be greater than 3 if the aggregate is composed of more than three grain-groups, whereas for aggregate of one grain-group (basic aggregate size), the lower value of U is not limited.

Geotextile
Geotextile for wrapping the mineral aggregate or cement concrete mix for deep drainage shall match the requirements shown in Table 2.3.11.

The lower limiting value shall not be lower than required value shown in Table 2.3.11.

Table 2.3.11: Minimum requirements for geotextile used for deep drainage

Properties of geotextile	Unit of measurement	Minimum requirements	Test method
Mechanical properties:			
– tensile strength – transversally, longitudinally	kN/m	> 14	EN ISO 10319
– elongation at failure – rupture	%	> 30	EN ISO 10319
– dynamic puncture resistance	mm	< 30	EN 918
– puncture resistance (CBR)	N	> 2000	EN ISO 12236
Hydraulic properties			
– typical pore size	mm	0.05 ≤O_{90} < 0.5	EN ISO 12956
– velocity index	m/s	3×10^{-3}	EN ISO 11058
– permeability coefficient at 20 kPa	m/s	>10 s_{oil}	E-DIN 60 500-4

Cement Concrete Mixes
Unless otherwise specified by technical documentation, the properties of cement concrete mix for drainage backfilling, used in deep dewatering, are similar to properties of bedding courses described in section 2.4. The composition of mineral aggregate for the preparation of cement concrete mix for drainage backfilling shall be such to ensure

the permeability coefficient of placed cement concrete of $k \geq 10^{-4}$ m/s.

2.3.3.3.4 Drainage Strips

Specified minimum requirements for drainage strips properties shall be harmonized with the conditions of geotechnical study.

The selection of drainage strip shall be based on the general description of the
- concept,
- type of material and
- dimensions.

Table 2.3.12: Required properties of drainage strips

Drainage strips properties	Unit of measurement	Minimum requirements	Test method
Mechanical properties of a core			
– tensile strength	N/cm	150	EN 527
– elongation at failure – rupture	%	25	
Drain capacity of a strip – longitudinally	m^3/s	5×10^{-5}	EN ISO 12956
Mechanical properties of a wrap – geosynthetic material			
– tensile strength	N/cm	120	EN 29073
– elongation at failure – rupture	%	40	
Filter-drain properties of a wrap – geosynthetic material			
– effective pore opening	μm	< 100	EN ISO 12956
– permeability coefficient	m/s	1×10^{-3}	EN ISO 11058
– permittivity	s^{-1}	1.2	EN ISO 11058

Requirements for drainage strips properties, shown in Table 2.3.12, shall be defined in geotechnical study.

The suitability of the drainage strip selection, relative to available technology of impressing, shall be verified at a test area. The lower limiting values shall not be lower than required values shown in Table 2.3.12.

For drainage strips, a solid or hollow core of ribbed section made of low density polyethylene shall be used, unless otherwise defined by technical documentation.

Dimensions of polyethylene core shall be specified in technical documentation. Permitted deviations shall be authorized by the supervising engineer.

2.3.3.4 Manner of Execution

2.3.3.4.1 Deposition Sites of Materials

In due time prior to commencement of deep dewatering works – drainage, the contractor is obliged to inform the supervising engineer of all the materials he intends to use and to provide appropriate evidence of their quality or conformity with the requirements of technical documentation and these Technical Conditions.

All required properties specified in section 2.4 shall be ensured, unless different properties are required by these technical conditions. The contractor shall eliminate and specially mark the material not meeting the specified requirements.

2.3.3.4.2 Depositing of Materials

When, prior to execution of works, the contractor needs to temporarily deposit required materials, he shall prepare the appropriate space for such purposes. Thereby, he shall adhere to the storage instructions, provided by the manufacturer of a certain material, and to the instructions of the supervising engineer, particularly regarding the exposure of polymer material to UV radiation.

The reserves of all deposited materials, required for deep dewatering with drainages, must be such to facilitate the continuous execution of works

2.3.3.4.3 Substrate Preparation

As a rule, the substrate of a bedding course for longitudinal and transverse drainage is the excavation formation, which shall be executed with appropriate slopes, in compliance with technical documentation.

The formation of the course or working field, for placing vertical drainage, shall be prepared in accordance with technical documentation and requirements of section 2.2 of these technical conditions.

Prior to placing of bedding course for drainage, the substrate formation shall be taken over by the supervising engineer.

2.3.3.4.4 Production of Cement Concrete Mix

The conditions for production of cement concrete mix are defined in section 2.4 of these technical conditions.

2.3.3.4.5 Transport and unloading of materials

The transport and unloading of cohesive materials for the puddle layer, or of cement concrete mix for the bedding course, onto the prepared substrate formation, which must not be frozen, may commence only after it has been approved by the supervising engineer.

The same conditions apply to mineral aggregate to be used for backfilling of longitudinal, transverse and vertical drainages.

For the transportation of strips, suitable vehicles shall be used so as to prevent changes in properties of materials during transportation.

The number of vehicles used for transportation shall be adjusted so that uniform placing of drainages for deep dewatering is ensured.

2.3.3.4.6 Placing

Bedding Course
A bedding course of puddle layer or cement concrete mix shall be placed in dimensions as specified in technical documentation, evenly and with designed slopes to ensure undisturbed water drainage.

The puddle layer or cement concrete mix used in bedding course are usually placed manually due to limited space.

The method and conditions for placing of bedding courses for deep dewatering are determined by the supervising engineer.

Drainage Pipes
The contractor may start the placing of drainage pipes or other drainage materials only after the bedding course has been taken over by the supervising engineer.

Joints of drainage pipes shall be executed according to the instructions of the manufacturer or supervising engineer. Tongue and groove joints shall remain unfilled, while connecting joints of drainage pipes to shafts shall be sealed as specified by technical documentation.

Backfilling
The contractor may start backfilling of drainage excavations with mineral aggregate or cement concrete mix, only after receiving approval by the supervising engineer.

Backfilling and compaction shall be carried out in layers, so that approximately 80% density of placed mineral aggregate is ensured (defined according to modified Proctor method). The drainage pipe shall not be endangered by compaction nor should stone grains be excessively impressed into the soil around the vertical drainage.

During backfilling, the outlet of bored vertical drainages shall be protected, while the rest of a borehole shall be protected only when that is necessary in order to ensure the specified quality of drainage backfilling.

Impressed vertical drainages with backfilling shall be executed by filling the impressed pipe with mineral aggregate and by appropriate dynamic compaction during pipe retrieval.

Final backfilling layer shall be functionally executed, in compliance with subsequent construction operations according to technical documentation.

Vertical Drainages and Strips
Vertical drainage, in the form of strips, shall be impressed into the soil by means of an appropriate device equipped with protective guide, so that the change in condition of earth materials around the drainage strip, after the protective guide has been pulled out, is as minimal as possible and that the drainage strip remains clean.

Any impressed drainage strip may be extended only once. The joint shall be executed by inclusion in a way that ensures free water flow and mechanical properties of a drainage strip that are required for the impress.

In soft materials the drainage strip shall be anchored at the bottom, so as to facilitate the designed drainage depth.

The cohesive soil, that accumulates at the outlet of impressed vertical drainage strip during pulling out of protective guide, shall be removed so as to ensure free water flow.

The impressed drainage strips shall be at least 30 cm above the formation of a layer they have been impressed from, or above the formation of a working field. That portion of the drainage strip shall be laid onto the formation and covered with appropriate permeable material.

2.3.3.5 Quality of Workmanship

In due time prior to commencement of works, the contractor shall provide the supervising engineer with evidence of quality of all materials he intends to use for deep drainage, according to the requirements of section 2.3 of these Technical Conditions.

Placing of partly damaged materials may be authorized by the supervising engineer, provided that it has no adverse effect to the quality of deep drainage.

The contractor shall not commence the works before obtaining approval from the supervising engineer.

The required properties regarding quality of basic materials are defined in section 2.4 of these Technical Conditions and shall be considered as limit values, unless otherwise specified. The threshold values for particular types of works are determined by the supervising engineer.

2.3.3.6 Quality Control of Execution

2.3.3.6.1 Internal Control

The extent of internal control testing for works of deep dewatering with drainage, which shall be performed by an authorized laboratory, is determined by the supervising engineer on the basis of submitted documentation, in accordance with requirements of section 2.4 and shall follow the progress of works.

The supervising engineer shall determine sampling and measuring points according to the statistical random selection.

The minimum scope of internal control testing for works of deep dewatering with drainage is shown in Table 2.3.13.

2.3.3.6.2 External Control

The extent of external control testing, executed by an institution authorized by the Client, is usually in the ratio of 1 : 5 relative to internal control testing.

Sampling points for the external control of conformity are determined by the supervising engineer according to the statistical random selection.

Table 2.3.13: Minimum testing frequency of internal control for deep dewatering with drainages

Properties	Minimum testing frequency
– puddle layer (according to section 2.2)	400 m^1
– cement concrete mixes (according to sections 2.4 and 2.5)	400 m^1
– drainage pipes (according to section 2.4)	400 m^1
– mineral aggregate fractions (according to section 2.4)	200 m^3
– geotextile (according to section 2.4)	4000 m^2
– drainage strips (according to section 2.4)	20000 m^1

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2.3.3.7 Measurement and Taking Over of Works

2.3.3.7.1 Measuring of Works

Executed works shall be measured according to General Technical Conditions and calculated in appropriate units of measurement.

All the quantities shall be measured to the actually completed extent and for the types of works that have been executed within dimensions specified by technical documentation, or on the basis of amendments and additions authorized by the supervising engineer. All measured quantities shall be timely documented in writing.

2.3.3.7.2 Taking Over of Works

The supervising engineer shall take over the executed drainage according to quality requirements set in these technical conditions and in compliance with General Technical Conditions. Contractor shall remedy all defects established according to these requirements prior to continuing the works.

2.3.3.8 Calculation of Works

2.3.3.8.1 General

Executed works should be calculated in accordance with General Technical Conditions.

Works, measured and taken over according to above described procedure, shall be calculated by contract unit prices.

The contract unit price includes all works and services required for full completion of works. The contractor is not entitled to claim any additional payment.

2.3.3.8.2 Deductions Due to Inadequate Quality

Quality of Materials
The quality of basic materials for drainages in deep dewatering is defined in terms of limiting values and, as a rule, they shall be ensured.

Should the supervising engineer define the limiting values for the quality, he shall also define the method for calculating the deductions if it differs from the one specified by provisions of General Technical Conditions.

If the contractor places materials that do not match the requirements of section 2.4 of these Technical Conditions into the drainage for deep dewatering, the calculation method will be determined by the supervising engineer who, in addition, has the right to fully reject the executed works.

Quality of Workmanship
The quality of deep dewatering with drainages shall be defined by technical documentation and properties which are determined by testing shown in Table 2.3.13. If the contractor fails to provide required quality of executed works, the calculation method will be decided by the supervising engineer.

2.3.4 CLOSED DRAINAGE SYSTEM

The sewerage is intended for deep drainage of surface, waste and sanitary waters. It shall be executed in dimensions defined by technical documentation and in compliance with these Technical Conditions. Any modification that responsible designer agreed to, shall be, prior to commencement of works, also approved by the supervising engineer.

2.3.4.1 Description

The sewerage may be constructed:
- of pipes,
- of prefabricated elements fixed to the bottom and/or arch made of cement concrete,
- by using bricks, blocks and/or cement concrete.

The execution of the sewerage includes the supply of all appropriate materials and placing them at sites and by the method described in technical documentation.

Earth works required for excavations and backfilling are not considered since they are elaborated and specified in detail in the section 2.2 of these Technical Conditions. Also, works executed at the construction site on producing large and/or special types of sewer cross-sections are also not considered since they are elaborated and specified in the section 2.4 of these Technical Conditions.

Water from excavations for sewerage shall be continually pumped out until backfilling has been executed up to the water table level. The contractor shall be responsible for any damage that may occur due to suspension of water pumping.

The construction method and testing of the sewerage are, as a rule, defined by technical

documentation. Otherwise, the decision on this shall be made by the supervising engineer.

2.3.4.2 Basic Materials

Basic materials for constructing sewerage systems are:
- materials for bedding courses,
- sewer pipes,
- materials for treatment of joints and
- materials for backfilling.

2.3.4.2.1 Materials for Bedding Courses

The bedding course under sewer pipes shall be built of:
– mineral aggregate fractions and/or
– cement concrete mix.

Exceptionally, sewer pipes may be placed directly onto the excavation formation.

2.3.4.2.2 Sewerage Pipes

The following materials are used for sewer pipes:
- polymer pipes (polypropylene, polyester, polyethylene, polyvinyl chloride),
- cement concrete pipes,
- ductile cast metal pipes,
- cast iron pipes.

The following are seldom used for sewers:
- steel pipes and
- ceramic pipes.

Sewer pipes are, as a rule, of circular cross-section, whereas cement concrete pipes in custom-built sewerage may also have an egg-shape or horseshoe-shaped cross-section with a half-round gutter.

The type of sewer pipe shall be determined by technical documentation.

2.3.4.2.3 Materials for Treatment of Joints

Cement mortar for treating the pipe joints shall be prepared by mixing sand, cement, and water.

Basic materials for the preparation of appropriate cement mortar mix are specified in sections 2.4 and 2.5 of these Technical Conditions.

Joints between sewerage pipes may also be filled with bituminous cord and bituminous mixture for sealing, rubber sealing rings (gaskets) or sealing putty.

2.3.4.2.4 Materials for Backfilling

Appropriate materials for backfilling of sewerage trenches are thoroughly defined in section 2.2 of these Technical Conditions.

2.3.4.3 Quality of Materials

2.3.4.3.1 Materials for Bedding Courses

Mineral Aggregate Fractions
The quality of mineral aggregate fractions, used for bedding courses under the sewer pipes, is defined in section 2.2 of these Technical Conditions.

Cement Concrete Mixes
The quality of materials for cement concrete mixes, used for bedding courses under sewer pipes, shall comply with requirements specified in section 2.2 of these Technical Conditions.

Cement concrete, used in bedding courses for the sewerage, shall comply with requirements of section 2.4 of these Technical Conditions, unless otherwise specified by technical documentation.

If sewerage is being built in special conditions, the supervising engineer may supplement the above mentioned requirements for cement concrete mixes used in bedding courses.

2.3.4.3.2 Sewer Pipes

The required quality of sewer pipes is defined by relevant regulations.

Sewer pipes shall have tongue-and-groove joints for the purpose of making interlocking connections. The employment of any other pipes shall be approved by the supervising engineer.

Sewerage pipes shall meet the requirements regarding:
- dimensions: diameter, length and wall thickness,
- impermeability,
- resistance to vertex pressure.

The quality of polymer pipes and fittings for the sewerage shall comply with requirements shown in Table 2.3.14.

If the pipes are not standardized, the required values shall be specified in manufacturer's documentation and technical documentation.

Table 2.3.14: Standards for defining the quality of polymer pipes and fittings for sewerage

Type of polymer pipe – formed element	Standard for testing
– with structured wall	EN 13476
– with solid wall: polyethylene	EN 12666
non-softened polyvinyl chloride	EN 1401
polypropylene	EN 1852
GRP based on polyester (UP)	EN 1636

2.3.4.3.3 Material for Treatment of Joints

Cement Mortar
The quality of materials for cement mortar, intended for treatment of sewer pipe joints, is thoroughly specified in section 2.4 of these Technical Conditions.

Other Materials
The quality of other materials for treatment of joints is defined on the basis of properties specified in manufacturer's documentation, and in accordance with decision of the supervising engineer.

Materials for Backfilling
The quality of cohesive or stone material for backfilling of sewerage ditches (water content, content of organic matter), shall comply with the conditions regarding compaction of placed materials:
- within road body area, it is defined by requirements of section 2.4,
- outside this area, the density shall be 95% relative to the density of backfilling material, as determined by standard Proctor method.

The material for backfilling of channels to the minimum height of 30 cm above the pipe vertex shall not contain fractions larger than 63 mm. In this area, material should be placed manually.

2.3.4.4 Manner of Execution

2.3.4.4.1 Deposition Sites of Materials

In due time prior to commencement of sewerage construction works, the contractor shall inform the supervising engineer of all materials he intends to use, and to provide relevant evidence of their quality and conformity with requirements of technical documentation and these Technical Conditions.

All required properties of materials, as specified in section 2.4, shall be ensured. Materials not meeting the specified requirements shall be eliminated and specially marked.

2.3.4.4.2 Depositing of Materials

The conditions for depositing of materials, required for sewerage, are specified in section 2.4 of these technical conditions.

2.3.4.4.3 Substrate Preparation

The excavation formation, prepared in accordance with requirements of section 2.2 of these Technical Conditions, may be used as the substrate of the bedding course for sewerage. Any deviation from these requirements shall be previously approved by the supervising engineer.

If pipes are placed directly onto the excavation formation, the substrate formation shall be taken over by the supervising engineer prior to placing of bedding course for the sewerage.

2.3.4.4.4 Production of Cement Concrete and Cement Mortar Mixes

Conditions for the production of cement concrete mixes for bedding courses, and cement mortar for treatment of pipe joints, are thoroughly described in section 2.4 of these Technical Conditions.

2.3.4.4.5 Transport and unloading of Materials

The transport and unloading of mineral aggregate or cement concrete mix for the bedding course onto prepared substrate formation, which must not be frozen, may commence only after it has been approved by the supervising engineer.

Appropriately equipped vehicles shall be used for transportation. During the transportation, the mineral aggregate and cement concrete mix shall remain homogenous, and other properties of cement concrete mix shall not change.

The number of vehicles used for transportation shall be adjusted to the conditions of uniform placing of sewerage.

2.3.4.4.6 Placing

Bedding Course
The bedding course of mineral aggregate or cement concrete mix, as well as the pads of cement concrete or wood, shall be placed with extra height, in dimensions specified by technical documentation, evenly or with designed slopes, so as to ensure placing and sealing of sewer pipes, and undisturbed disposal of surface, waste and sanitary waters.

Due to limited space, materials for bedding courses are usually placed manually.
Conditions for placing of bedding courses for sewerage pipes are defined by the supervising engineer.
The placing time of cement concrete mix shall not exceed one hour.

Sewerage Pipes
The contractor may start placing of sewer pipes only after the bedding course has been taken over by the supervising engineer.

Sewer pipes should be placed at the same time on the section between two adjacent shafts (manholes).

Sewer pipe joints shall be impermeable. The joint between sewer pipe and shaft shall be impermeable as well.

If joint detail is not included in technical documentation, the method of jointing shall be defined by the supervising engineer.

For jointing of polymer, cast iron and ductile cast metal sewer pipes, the manufacturer's instructions shall be considered. When jointing cement concrete sewerage pipes, joints shall be additionally treated with 3 to 5cm thick and 6 to 10 cm wide ring of cement mortar after the joint has previously been filled.

Backfilling
To backfilling of sewerage channel, the provisions of section 2.2 of these Technical Conditions in principle apply.

The compaction of backfilled materials to the height of 30 cm above the pipe vertex should be carefully executed and with appropriate equipment.

If the works are executed in other specific conditions, the method of backfilling shall be determined by the supervising engineer, together with conditions of quality.

Strengthening of Pipes
Structural calculation of pipelines is based on:
- envisaged loads,
- envisaged quality of earth material,
- envisaged method of execution (form of excavation), which are defined by technical regulation ATV A 127 – Guidelines for structural calculations of channels and devices.

If structural calculations shows that the declared strength of polymer pipes is insufficient, then pipes are to be strengthened with additional layer of cement concrete which shall be sized and executed so that it has capacity to take on the entire expected load. In such cases, polymer pipes are used only as formwork and to ensure impermeability of the system.

The method of execution and quality of cement concrete layers shall be determined by technical documentation.

The type and nominal strength of all pipes and fittings made of polymer materials, depending on loading conditions, shall be defined in technical documentation.

The coating of cement concrete, which has the quality specified in section 2.4 for bedding courses, may be used for strengthening of sewer pipes.

2.3.4.5 Quality of Execution

In due time prior to commencement of works, the contractor shall provide the supervising engineer with evidence of quality of basic materials he intends to use in sewerage works, in accordance with requirements of section 2.4 of these Technical Conditions.

Placing of partly damaged sewer pipes may be authorized by the supervising engineer, provided that these damages do not decrease the quality of executed works.

Prior to commencement of placing, the contractor shall submit the preliminary (laboratory) composition of the cement concrete mix he intends to use for the bedding course, as well as of the cement mortar. The preliminary mix shall include the data of all basic properties of cement concrete mix and mortar which are specified in section 2.4. Furthermore, he shall submit evidence of selection and usability of all materials used in preparation of preliminary composition. The contractor shall not

undertake the works before consent of the supervising engineer has been obtained.

The properties of the executed backfilling of sewer pipes shall be at least the same as those of the adjacent fill or of the foundation soil.

The required properties regarding quality of materials specified in section 2.4 of these Technical Conditions are to be considered as limiting values, unless specified otherwise. The limiting values for particular types of works shall be determined by the supervising engineer.

2.3.4.6 Quality Control of Execution

2.3.4.6.1 Internal Control

The extent of internal control testing during execution of sewerage, which shall be performed by an authorized laboratory, is determined by the supervising engineer on the basis of submitted documentation, in accordance with requirements of section 2.4 of Technical Conditions and should follow the progress of works.

The minimum extent of internal control testing during sewerage construction is shown in Table 2.3.15.

If by technical documentation the impermeability of constructed sewerage is required, testing of pipeline (which should have appropriate supports) prior to backfilling should be performed. At the lowest point of the pipeline, the pressure should be 1 m of water column above the water level line defined by technical documentation, while at the highest point, that pressure should not be more than 0.5 m above the water level. The pressure shall be maintained for 5 hours during testing. The method and other conditions for this type of testing is determined by the supervising engineer. In addition, the extent of geodetic measurements of placed sewer pipes is also determined by the supervising engineer.

Table 2.3.15: Minimum testing frequency for internal control during sewerage construction

Properties	Minimum testing frequency
– mineral aggregate fractions (according to section 2.4)	2000 m^1
– cement concrete mix (according to sections 2.4)	400 m^1
– pipes (according to section 2.4)	200 m^1
– cement mortar (according to section 2.4)	800 m^1
– backfilling material (according to section 2.2)	Table 2.3.16:

On the basis of statistical random selection, the supervising engineer shall determine sampling and measuring points.

2.3.4.6.2 External Control

The extent of external control testing, executed by an authorized institution for the account of the client, is usually in the ratio of 1 : 5 in relation to internal control testing. Sampling and measuring points for the purposes of external control shall be determined by the supervising engineer according to statistical random selection.

2.3.4.7 Measurement and Taking Over of Works

2.3.4.7.1 Measuring of Works

Executed works shall be measured according to general technical conditions and calculated in appropriate units of measurement.

All the quantities shall be measured to the actually completed extent and for the types of works that have been executed within dimensions specified by technical documentation or on the basis of amendments and additions authorized by the supervising engineer. All measured quantities shall be timely documented in writing.

2.3.4.7.2 Taking Over of Works

The supervising engineer shall take over the construed sewerage according to quality requirements set in these technical conditions and in compliance with general

technical conditions. Contractor shall remedy all defects established according to these requirements before continuing the works.

2.3.4.8 Calculation of Works

2.3.4.8.1 General

Executed works should be calculated in accordance with General Technical Conditions.

Works, measured and taken over according to above described procedure, shall be calculated by contract unit prices.

The contract unit price includes all works and services required for full completion of works. The contractor is not entitled to claim any additional payment.

2.3.4.8.2 Deductions Due to Inadequate Quality

Quality of Materials
The quality of basic materials for sewerage is defined in terms of limiting values and they shall be reached.

Should the supervising engineer define the limiting values as a measure of quality, he shall also appoint the method for calculating the deductions if differs from the one specified by provisions of these Technical Conditions.

Should the contractor of sewerage construction works use the material not comply to the requirements of these technical conditions, the calculation method shall be decided by the supervising engineer. The supervising engineer may fully reject the executed works.

Quality of Execution
The quality of constructed sewerage shall be defined by technical documentation and in accordance with properties determined by testing shown in Table 2.3.15. Should the contractor fail to provide required quality of executed works, the calculation method shall be decided by the supervising engineer.

2.3.5 SHAFTS

Shafts are intended for connection, control and maintenance of drainage system and sewerage.

The construction of shafts shall be executed in dimensions and conditions defined by technical documentation and in compliance with these Technical Conditions.

2.3.5.1 Description

The following types are used for drainage:
- inlet and
- revision shafts.

They can be built:
- of prefabricated elements,
- of pipe segments, and
- in-situ constructed of cement concrete.

All types of shafts can be of circular or square cross section, single or double with a transition.

In inlet shafts, the water inflow is coming through a screen placed on top or laterally. The lateral inflow can be executed through a gully or a cascade. The bottom of inlet shafts shall be built as a catch pit, usually in a form of a shallow oval – gutter. Pipe connection to shaft is in general executed on the bottom.

The execution of shafts includes the supply of all required materials and placing them at sites determined by technical documentation.

Earth works for excavations and backfilling are not considered here since they are considered and defined in detail in section 2.2 of these Technical Conditions. Likewise, shafts for special purposes and of special dimensions are not considered here, but in section 2.5 of these Technical Conditions.

Waterproofing of shafts, if envisaged by technical documentation, shall be executed in accordance with requirements of section 2.5 of these Technical Conditions.

Water from excavations for shafts shall be continually pumped out until execution of shafts and backfilling have been executed over the ground water level. The contractor shall be responsible for any damage that might occur due to suspension of water pumping.

The method of shaft construction shall be determined by technical documentation. Otherwise, the supervising engineer shall make a decision on this.

2.3.5.2 Basic Materials

Basic materials for shaft constructions include materials for
- bedding courses and
- shafts.

2.3.5.2.1 Materials for Bedding Courses

The bedding course for shafts is, as a rule, made of cement concrete mix and, in exceptional cases, mineral aggregate fractions may be used.

2.3.5.2.2 Materials for Shafts

The prefabricated elements of cement concrete, as well as of polymer and other materials, which meet the requirements of technical documentation, are mainly used for shaft construction.

The principles for construction of shafts made of polyester laminate are defined in EN 13598-1. The following semi-prefabricated products can be used for shafts:
- cement concrete pipes,
- polymer pipes (polyethylene, polypropylene, polyester laminate),
- ductile cast metal pipes,
- bottom formed of plastic or cement concrete,
- catch pits for sand, oil and fuel separators, and
- grids, screens and covers of cast iron, cement concrete covers, or of combination of cast iron and cement concrete.

According to intended use, there are walkable and drivable grids and drivable grids that may be designed for light loading (up to 15 Mp), medium loading (up to 25 Mp) and heavy loading (up to 40 Mp).

For the in-situ construction of shafts of cement concrete, with square or rectangular section, the following materials are required
- cement concrete mix,
- steel for strengthening (reinforcement),
- formwork.

Basic materials for the preparation of cement concrete mix for shafts are specified in sections 2.4 and 2.5 of these Technical Conditions. Formworks and reinforcement are thoroughly described in section 2.5 of these technical conditions.

2.3.5.3 Quality of Materials

2.3.5.3.1 Materials for Bedding Courses

Cement Concrete Mixes
The quality of materials for cement concrete mixes used for shafts shall comply with requirements specified in section 2.4 of these Technical Conditions.

Unless otherwise specified by technical documentation, cement concrete for bedding courses used for shafts shall comply with conditions of sections 2.4 and 2.5 of these Technical Conditions. The supervising engineer may amend the requirements with special conditions.

Mineral Aggregates
The quality of mineral aggregates used for bedding courses under the shafts is defined in section 2.4 of these technical conditions.

2.3.5.3.2 Materials for Shafts

Prefabricated Cement Concrete Elements
Prefabricated cement concrete elements used for shafts shall be made of dense cement concrete, without any cracks, and shall match the requirements shown in Table 2.3.8. The supervising engineer may authorize the use of prefabricated elements of cement concrete with different properties.

Prefabricated elements for shafts shall be produced in one piece, with built-in opening for water inflow.

Semi-prefabricated Products
The required quality of aforementioned semi-prefabricated products used for shaft construction is defined by relevant regulations or agreed conditions or by the manufacturer's documentation.

The quality of pipes as semi-products for the shaft construction shall meet the requirements as defined for sewerage in section 2.4. Should the technical documentation include special conditions regarding quality of semi-prefabricated products used for shaft construction, they shall be considered and adhered to.

Materials for the In-situ Construction
To quality of materials used for the preparation of cement concrete mix for shaft construction, requirements given in section 2.4 of these Technical Conditions in principle apply.

The quality of wood used for shaft formworks shall match the requirements of section 2.5 of these Technical Conditions.

When works are being executed under specific conditions, the supervising engineer may approve the use of materials of different quality and properties.

2.3.5.4 Manner of Execution

2.3.5.4.1 Deposition Sites of Materials

In due time, prior to commencement of works, the contractor shall provide the supervising engineer with all types of prefabricated elements, semi-products and materials he intends to use. For all materials, he shall submit relevant evidence of quality or conformity with requirements of technical documentation and these Technical Conditions.

Required properties, as specified in section 2.4, shall be ensured. The contractor shall eliminate and specially mark the materials not meeting the specified requirements.

2.3.5.4.2 Depositing of Materials

The conditions for depositing of materials required for shaft construction are generally specified in section 2.4 of these Technical Conditions.

2.3.5.4.3 Substrate Preparation

The substrate of bedding course usually corresponds to excavation formation which shall be executed in accordance with requirements of section 2.2 of these Technical Conditions. Any deviation from these requirements shall be previously approved by supervising engineer. The substrate formation shall be taken over by the supervising engineer.

2.3.5.4.4 Production of Cement Concrete Mix

Conditions for the production of cement concrete mix used for shaft construction are thoroughly defined in sections 2.4 and 2.5 of these Technical Conditions.

2.3.5.4.5 Placing

Bedding courses
Cement concrete mix or mineral aggregate fractions, used for bedding course under the shaft, may be placed onto the prepared substrate formation which must not be frozen. The bedding course is placed in dimensions specified by technical documentation so as to ensure the construction of shaft. Due to limited space, materials are usually placed manually. Conditions for placing of the bedding course are defined by the supervising engineer.

Shafts
The contractor may start the construction of shaft only after the bedding course has been taken over by the supervising engineer and working procedure has been approved. All works shall be executed so as to ensure the impermeability of shaft and all connections, good fitting of the grid or cover to the frame, all in dimensions specified by technical documentation. Any modification shall be approved by the supervising engineer.

2.3.5.5 Quality of Workmanship

In due time prior to commencement of works, the contractor shall provide the supervising engineer with evidence of quality of basic materials he intends to use in shaft construction, in accordance with requirements of section 2.4 of these Technical Conditions.

Placing of partly damaged prefabricated elements or semi-prefabricated products for shaft construction may be approved by the supervising engineer, provided such a damage does not decrease the quality of shaft.

Prior to commencement of placing, the contractor shall provide the supervising engineer with preliminary (laboratory) composition of the cement concrete mix he intends to use in shaft construction. The preliminary mix shall include the data of all basic properties of cement concrete mix, which are specified in section 2.4, as well as the evidence of origin and adequate quality of all materials used in preparation of the preliminary cement concrete mix.

The contractor may not undertake the works before approval of the supervising engineer has been obtained. The required quality of basic materials, defined in section 2.4 of these Technical Conditions, shall be considered as limiting values, unless otherwise agreed. Threshold values shall be determined by the supervising engineer relative to importance and properties of individual element.

2.3.5.6 Quality Control of Workmanship

2.3.5.6.1 Internal Control

The extent of internal control testing during construction of shafts is determined by the supervising engineer on the basis of submitted documentation, in accordance with requirements of section 2.4 of Technical Conditions and should follow the progress of works.

The minimum extent of internal control testing, which shall be performed by an authorized laboratory, is shown in Table 2.3.16.

Table 2.3.16: Minimum testing frequency for internal control during shaft construction

Properties	Minimum testing frequency
– mineral aggregate fractions (according to section 2.4)	200 m^1
– cement concrete mixes (according to sections 2.4 and 2.5)	20 m^1
– prefabricated elements (according to sections 2.4 and 2.5)	100 pcs
– semi-prefabricated products (according to sections 2.4 and 2.5)	100 pcs
– reinforcing steel (according to section 2.5)	5 t

2.3.5.6.2 External Control

The extent of external control testing, executed by the institution authorized by the client, is usually in the ratio of 1 : 5 in relation to internal control testing.

Sampling points for the external control of conformity are determined by the supervising engineer according to the statistical random selection.

2.3.5.7 Measurement and Taking Over of Works

2.3.5.7.1 Measuring of Works

Executed works shall be measured according to General Technical Conditions and calculated in appropriate units of measurement.

All the quantities shall be measured to the actually completed extent and for the types of works that have been executed within dimensions specified by technical documentation or on the basis of amendments and additions authorized by the supervising engineer. All measured quantities shall be timely documented in writing.

2.3.5.7.2 Taking Over of Works

The supervising engineer shall take over the constructed shafts according to quality requirements set in these Technical Conditions and in compliance with General Technical Conditions. Contractor shall remedy all defects established according to these requirements before continuing the works.

2.3.5.8 Calculation of Works

2.3.5.8.1 General

Executed works should be calculated in accordance with General Technical Conditions.

Works, measured and taken over according to above described procedure, shall be calculated by contract unit prices.

The contract unit price includes all works and services required for full completion of works. The contractor is not entitled to claim any additional payment.

2.3.5.8.2 Deductions Due to Inadequate Quality

Quality of Materials

The quality of basic materials for shafts is defined by limiting values that shall, as a rule, be reached.

Should the supervising engineer define the limiting values for the quality of basic materials, he shall also appoint the method for calculating the deductions if it differs from the one specified by provisions of General Technical Conditions.

If during construction of shafts, contractor uses materials that do not match the requirements of these Technical Conditions, the calculation method will be determined by the supervising engineer who, in addition, is entitled to fully reject the executed works.

Quality of Construction
The quality of constructed shaft shall meet the requirements of technical documentation and are defined in Table 2.3.16. If the contractor fails to ensure the required quality of construction, the calculation method will be decided by the supervising engineer.

2.3.6 SEDIMENTARY BASINS, OIL SEPARATORS

For the surface and ground water protection purposes, various structures and devices may be envisaged, including:
- collection tanks,
- settling tanks (catch pits),
- coarse and slow filters,
- light liquid separators, etc.

Structures and devices for the purposes of natural waters protection shall be executed in dimensions and with properties defined by the technical documentation, in compliance with conditions and requirements of competent authorities, and in accordance with these Technical Conditions. Any modification shall be previously approved by the supervising engineer.

Conditions and requirements regarding the types and quality of materials, manner of execution, quality of workmanship, quality control of workmanship, measurement and taking over of works, calculation of work, are defined in sections 2.3.4 and 2.3.5 of these special technical conditions, and may also apply to the protection of surface and ground waters.

Measurement and taking over of works shall also include testing of works and device efficiency, which is conducted according to the specific testing program and shall be approved by the supervising engineer. Test result should show that executed devices and structures fulfil the conditions specified by relevant water management authorities and environmental protection authorities.

Separators for light liquids (hydrocarbons) shall fulfil the requirements according to standard EN 858.

2.3.7 ABSORPTION WELLS, PITS, SINKHOLES

Arrangement of absorption wells, pits and sinkholes are intended for controlled dewatering form the road body area.

All aforementioned drainage methods shall be executed in dimensions defined by technical documentation and in compliance with these Technical Conditions.

2.3.7.1 Description

The arrangements of pits, sinkholes, and the execution of absorption wells, shall be adjusted to the specific conditions. The following are mainly used for the execution:
- prefabricated elements,
- perforated pipes,
- appropriate mineral aggregates,
- when arranging a sinkhole, methods shall be adjusted to the shape and size of the sinkhole, and to its natural function.

The execution of all above mentioned parts includes the supply of all appropriate materials and placing them at sites and by the method defined by the technical documentation.

Earthworks are not considered here since they are thoroughly considered in section 2.2 of these Technical Conditions.

The contractor shall ensure efficient dewatering of the working area. The contractor shall be responsible for any damage that might occur due to suspension of dewatering.

2.3.7.2 Basic Materials

Basic materials for the arrangement of pits and sinkholes are
- perforated pipes of cement concrete or polymer pipes,
- mineral aggregates.

In addition to above mentioned materials, for particular types of works the following may be used
- quarry stone,
- geosynthetics,
- cement concrete mix,
- cement mortar,
- reinforcing steel,
- formwork.

2.3.7.3 Quality of Materials

2.3.7.3.1 Perforated Cement Concrete Pipes and Polymer Pipes

The pipes quality used for arrangement of springs or pits, and execution of wells, shall meet the requirements that apply to pipes of circular section used in sewerage, as specified by these technical conditions.

The perforation of pipes shall be executed to the extent that ensures undisturbed water drainage.

2.3.7.3.2 Mineral Aggregates

The quality of mineral aggregate used for the execution of the above stated works shall comply with the requirements that apply to the mineral aggregates used for backfilling of drainages and are specified in section 2.4 of these Technical Conditions.

2.3.7.3.3 Quarry Stone

Quarry stone shall be water resistant and shall comply with requirements of section 2.4 of these Technical Conditions.

2.3.7.3.4 Geosynthetics

Geosynthetics of artificial fibres shall comply with requirements of section 2.4 of these Technical Conditions. Should the construction be executed in special conditions, the supervising engineer may demand the quality of geosynthetics to be specially adjusted to the specific use conditions, especially regarding the grading of the surrounding terrain.

2.3.7.3.5 Cement Concrete Mixes

The quality of material for cement concrete mixes used for above stated works, and for the cement concrete mix itself, shall comply with requirements specified in sections 2.4 and 2.5 of these Technical Conditions, unless otherwise determined by technical documentation.

2.3.7.3.6 Cement Mortars

The quality of materials for cement mortars used in above stated works, as well as the quality of cement mortar, shall comply with the requirements of sections 2.4 and 2.5 of these technical conditions.

2.3.7.3.7 Reinforcing Steel

The quality of reinforcing steel shall comply with the requirements of section 2.5 of these Technical Conditions.

2.3.7.3.8 Formwork

The quality of wood used for formwork and quality of formwork used for execution of above mentioned works shall comply with requirements of section 2.5 of these Technical Conditions.

2.3.7.4 Manner of Execution

2.3.7.4.1 Deposition Sites of Materials

In due time prior to commencement of above mentioned works, the contractor shall inform the supervising engineer of all materials he intends to use and to provide relevant evidence of their quality or conformity with requirements of technical documentation and these Technical Conditions.

Required properties of materials, as specified in section 2.4, shall be ensured.

The material not meeting the requirements shall be separated and specially marked by the contractor.

2.3.7.4.2 Depositing of Materials

The conditions for depositing of materials required for execution of said works are given in section 2.4 of these Technical Conditions.

2.3.7.4.3 Grubbing Up

The terrain for arrangement of springs, pits and sinkholes, and for construction of a well, shall be prepared in accordance with requirements of the technical documentation and the supervising engineer so as to ensure the quality execution of all required works.

2.3.7.4.4 Production of Cement Concrete Mix and Cement Mortar

Conditions for production of cement concrete mix and cement mortar, required for execution of above stated work, are given in sections 2.4 and 2.5 of these Technical Conditions.

2.3.7.4.5 Placing

Springs
Excavations in the area of the spring in the road alignment shall be executed to the extent that facilitates placing of a perforated pipe of appropriate section which, if necessary, may be wrapped in geosynthetics and backfilled with mineral aggregate fractions.

The water from arranged spring shall be disposed through pipes outside the road body.

If necessary, the spring shall be arranged so that harmful effects of traffic loads are prevented.

Wells
Excavations for wells shall be executed mechanically, by boring in dimensions that facilitate placing of pipes wrapped in geosynthetics. Pipes are perforated and may be of cement concrete or polymer, of appropriate diameter.

Each well shall be equipped with the connection for disposal of water.

Pits
For pits as well, excavation shall, as a rule, be executed by boring in dimensions that facilitate placing of perforated pipes of cement concrete or polymer.

Sinkholes
The foundation prepared of coarse mineral aggregate ("colcrete" procedure) is filled under pressure with cement mortar (shotcrete).

To ensure capacity of the mouth, it may be covered with slabs or the arch of reinforced concrete.

Similar conditions for this type of arrangement are defined in section 2.5 of these Technical Conditions.

2.3.7.5 Quality of Workmanship

In due time prior to commencement of works execution, the contractor shall provide the supervising engineer with evidence of quality of all basic materials he intends to use during the execution of works, in accordance with requirements of section 2.4 of these Technical Conditions.

Placing of partly damaged perforated pipes may be authorized by the supervising engineer, provided their usage will not decrease the quality of arrangement of a spring, well or a pit.

Prior to placing, the constructor shall deliver preliminary (laboratory) composition of cement concrete mix and cement mortar he intends to use. The preliminary composition shall include data of all basic properties of cement concrete mix and cement mortar, which are specified in sections 2.4 and 2.5. The contractor shall not undertake the works before approval of the supervising engineer has been obtained.

The required properties regarding the quality of basic materials are defined in sections 2.4 and 2.5 of these Technical Conditions, and they represent limiting values, unless otherwise agreed. Threshold values shall be determined by the supervising engineer relative to importance of particular works.

2.3.7.6 Quality Control of Workmanship

2.3.7.6.1 Internal Control

The extent of internal control testing, which shall be performed by an authorized laboratory, is determined by the supervising engineer on the basis of submitted documentation, according to requirements of section 2.4 of Technical Conditions, and on the basis of progression of works.

The minimum extent of internal control testing during execution of works is shown in Table 2.3.17.

The quality of executed works may be reached by implementation of other recognised procedures, but only with the consent of supervising engineer. Should this be the case, the supervising engineer shall define the criteria for quality assessment.

2.3.7.6.2 External Control

The ratio of external control, performed by an authorized institution, to internal control testing is 1 : 5. Sampling points for the external control of conformity are determined by the supervising engineer according to the statistical random selection.

Table 2.3.17: Minimum testing frequency of internal control of works for arrangement of springs, wells, pits and sinkholes

Properties	Minimum testing frequency
– mineral aggregate fractions (according to section 2.4)	100 m^3
– geosynthetics (according to section 2.4)	1000 m^2
– pipes (according to section 2.4)	100 pieces
– cement concrete mix (according to sections 2.4 and 2.5)	20 m^3
– cement mortar (according to sections 2.4 and 2.5)	20 m^3
– steel (according to section 2.5)	5 t

2.3.7.7 Measurement and Taking Over of Works

2.3.7.7.1 Measuring of Works

Executed works shall be measured according to general technical conditions and calculated in appropriate units of measurement.

All quantities should be measured to the actually completed extent and according to the types of works that have been executed within dimensions and in quantities specified by technical documentation, and should be timely documented in writing.

2.3.7.7.2 Taking Over of Works

The supervising engineer shall take over the executed works according to quality requirements set in these Technical Conditions, and in compliance with General Technical Conditions. Contractor shall repair all defects established according to these requirements before continuing the works.

2.3.7.8 Calculation of Works

2.3.7.8.1 General

Executed works should be calculated in accordance with General Technical Conditions.

Measured and taken over works shall be calculated by contract unit prices.

2.3.7.8.2 Deductions Due to Inadequate Quality

Quality of Materials
The quality of basic materials for above stated works is defined by limiting values which shall be reached.

Should the supervising engineer define the threshold values for the quality of basic materials, he shall also define the method for calculating the deductions, if it differs from the one specified by General Technical Conditions.

Should the contractor for the arrangement of springs, wells, pits and sinkholes, use the material not matching the requirements of these technical conditions, the calculation method shall be decided by the supervising engineer who, in addition, is entitled to fully reject the executed works.

Quality of Execution
The quality of executed works shall be determined by technical documentation. If the contractor fails to provide required quality of executed works, the calculation method will be decided by the supervising engineer.