ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

REPUBLIC OF SERBIA

TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL TECHNICAL CONDITIONS

2.2 EARTHWORKS

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2.2.1 INTRODUCTION

2.2.1.1 Technical regulations

The following technical regulations have been used within these earthwork guidelines in road construction:

EN 1997 Eurocode 7: Geotechnical design

EN ISO 14688 Geotechnical survey and testing – identification and classification of earth materials

EN ISO 14689 Geotechnical survey and testing – identification and classification of rocks

SRPS EN 14475 Execution of special geotechnical works – Reinforced soil

SRPS EN 13242 Aggregates for incoherent and hydraulically coherent materials used in construction works and road construction

SRPS EN 13249 Geotextile and geotextile-related products – Required characteristics for use in the construction of roads and other traffic surfaces

SRPS EN 13251 Geotextile and geotextile-related products – Required characteristics for the use in earthworks, foundations and supporting structures

SRPS EN 13252 Geotextile and geotextile-related products – Required characteristics for the use in drainage systems

SRPS EN 13256 Geotextile and geotextile-related products – Required characteristics for the use in tunnel construction

2.2.1.2 Terminology

The meanings of the technical terms used in the special technical conditions for earthworks in road construction are:

Shoulder (Bankett, bankina) is a mechanically stabilised part of the carriageway serving to support the pavement; it is not intended either for motor traffic or as emergency lane.

California Bearing Ratio (vrednost CBR) is the characteristic value of the deflection deformation of materials pressed cylinder.

Subgrade (donji stroj/nasip) is a constructed part of the road body (fill) between the foundation soil and pavement.

Frost depth (Dubina smrzavanja) is the maximum depth to which the isotherm 0°C reaches in long periods of frost.

Granulometric composition (granulometrijski sastav) is the grain size distribution expressed as a percentage of the weightafter the composition is sifted through a specific strainer.

Hydraulic binder (hidraulično vezivo) is a pulverized inorganic material; which forms a paste when mixed with water, , and due to reactions and hydration processes, sets and hardens; and after hardening remains firm and stable, even under water.

Hydrological conditions (hidrološki uslovi) are the conditions that determine the state of water in the soil near the road.

Mineral substructure/capping layer (kamena posteljica) is the final layer of fill and foundation soil made of a mechanically stabilised natural, mixed or mixture of crushed stone grains.

Stone material (kameni materijal) is a non-cohesive material consisting of natural or artificial stone grains, whose mechanical, chemical, and mineralogical properties do not change over the course of time due to the effects of water, air, and / or temperature, or change within the limits which allow the material to remain mechanically sound; stone material can be of a natural or artificial rock.

Drain capacity (kapacitet dreniranja) is the capacity of water drainage through connecting drainage spaces.

Climatic conditions (klimatski uslovi) the conditions set by the air temperature over time and at a specific location or area through which the road passes.

Backfill wedge (klin uz objekat) is the area between the coastal column (bank pier) and

the surrounding embankment, to ensure a stable transition between the bridge and embankment, a wedge should be built under special conditions.

Ice lens (ledeno sočivo) is characteristic of water in the pores that occurs during freezing due to increased water content in the material.

Frost insensible material (materijal neosetljiv na smrzavanje) is material in which the water freezing in pore spaces does not cause a significant increase in the bearing capacity, nor a significant decrease in the bearing capacity upon melting.

Micro-climate (mikroklima) is a group of equal conditions, such as temperature, sunlight, humidity, precipitation, snow conditions and windiness, characteristic of a restricted area.

Embankment (nasip) is a part of a road body between the formation level and the foundation soil, that is artificially constructed from soils and/or rocks to such a level above the ground surface that both slopes on the carriageway edges are inclined downhill.

Bearing capacity (Tragfähigkeit, nosivost) is the mechanical resistance of the embedded material formation against (short-term) loads.

Optimum water/moisture content (optimalna vlažnost) Is the proportion of water in the material at a maximum density, determined by the Proctor method.

Frost damage (oštećenje zbog smrzavanja) is damage to the structure by the direct or indirect result of frost action in regard to water, that can lead to structural failure.

Thaw (otapanje) is a set of physical phenomena occurring in materials when after a period of freezing temperatures climb above 0 °C.

Formation (planum) indicates an area with certain prescribed quality characteristics (height, roughness, density, deflection).

Capping layer (posteljica) is the upper (final) layer of the embankment and foundation soil, up to 50 cm thick, with special properties (increased bearing capacity, reduced susceptibility to the effects of frost) achieved by appropriate construction and technical operations (improvement, hardening, stabilising).

Mixing on site procedure (postupak mešanja na mestu ugrađivanja) is a procedure to improve, consolidate, and stabilise material: during which a range of mixers prepared at the site of the material, that rises and mixes with the binder and water as required.

Monitoring section (probna deonica) is part of the road, constructed in compliance with the applicable regulations and instructions, in professional methods which determine the behavior of building materials.

Working / hardened field (provozna podloga) is a filling layer of unbound mixtures of rock material embedded on the surfaces with the subsoil in order to facilitate transport and all other technological procedures that are needed to build the road.

All-in aggregate (sastavljeni/prirodni agregat) is a mixture of coarse and fine mineral particles (sand), produced without any separation into grain-groups, or by mixing grain-groups of coarse and fine grains, or of a natural source.

Soft soil/soil of low bearing capacity (slabo nosivo tlo) is a soil that contains a high percentage of water, thus having inadequate physical and/or mechanical properties, and slow draining properties.

Gauge (isotope) (sonda (izotopna)) is a flexible element of an isotope gauge, with a source of ionizing radiation (gamma rays) at the top of the lever.

External / third party control (spoljašnja/nezavisna kontrola) presents the activities performed by a supervisory institution established to verify the conformity of products or the approval of the internal control of the production and / or download of the built construction products, includes business, operations, independent testing and measurement in production and / or installation of building products.

Stabilisation (stabilizaicja) is a procedure that includes mixing a binder and water with the existing material which, with the appropriate compaction of the prepared mixture, permanently increases the resistance of the embedded mixture against

traffic load, as well as against climatic and hydrological effects.

Filter stability (stabilnost filtera) is the contact of two different-material-based layers depending on their granulometric composition which prevents the transfer of hard substances from one layer to the other, under the influence of permanent or variable water gradients, and of a dynamic traffic load.

Compaction degree (stepen zbijenosti) is the relationship between the measured (dry) density and the highest (dry) density of the material, determined by an appropriate procedure (e.g. Proctor) and expressed in %.

Voids/cavities (šupljine) are hollows in the material, which are filled up with air or fluid, which is accessible from the outside; water can penetrate into these voids/cavities.

Technical specification (tehnički uslov) is the applied document regulating the technical specifications for a construction product, as well as the procedures of internal and external controls, and the procedures of the determination of compatibility and confirmation; this may bestandard or part of a standard or an independent document.

Foundation soil/subgrade (temeljno tlo) is soils or rocks, normally found naturally, directly adjacent to the fill, pavement structure, or the foundation of a civil engineering structure, or is located immediately below it.

Soil/earth (tlo) is the surface crust layer (sediments and time degraded products) comprising incoherent and lightly coherent mineral and/or organic substances that are subject to mechanical degradation with no use of force (e.g. covering with water).

Road body (trup puta) is composed of all the materials used for embankments and the pavement between the foundation soil formation and the pavement surface, or any other finished surface.

Laying/placing (ugrađivanje) is the procedure which involves spreading and compaction of material to the required thickness.

Water permeability (vodopropusnost) is characteristic of a surface or a layer to

Backfill (zasipanje) indicates the filling of the installation trench to the formation of the embankment or filing the free space behind the supporting and end walls.

Compaction (degree of) (zbijenost) indicates the achieved level of density of the embedded material after completion of the compaction process.

2.2.2 DAILY EXCAVATIONS

2.2.2.1 Description

Daily excavations include:
- excavating the upper layer of fertile soil (humus) to the appropriate thickness (not more than 40 cm depth) moved to up to 50 m from the location or lloaded for transport to landfill
- all broad categories of excavation of earth materials and rocks that are designed to be moved up to 50 m or loaded for transport of the excavated material to embankments, backfill, wedges, and / or landfills, depending on how the material will be used during construction. These works also include all the excavations for stairs, excavations in borrow pits and road deviations, as well as wide excavations in the course of the execution of the structure work,
- all excavations for the structure foundations, canal and other trenches (for culverts, manholes, drains) of all-categories of materials and up to any depth
  - width up to 1.0 m,
  - width ranging from 1.0 to 2.0 m.

These works also include
- everything needed for lifting the excavated material to the required height,
- all construction pit excavations that are wider than 2.0 m in all categories of materials and to all depths, with the transport of excess material to landfills or the place of installation in the embankments, backfills, or wedges. Work includes raising the excess material to the required height,
- all excavations for canals of various depths and widths as well as similar works in all categories materials. These include the deepening and widening of existing canals,
- all excavations for drains and waterways near the side of the body of the road finished formation or the existing road, with the disposal of the excavated materials and/or loading and disposal at a landfill,

- all excavations for cobblestones and surface linings when planned, with disposal of the materials and/or loading and disposal at landfills and regulation of the formation.

The works also include
- all the necessary measures determined by the applied occupational health and safety regulations, such as bracing (including a structural analysis design,), grades, expansions, etc.,
- all works regarding atmospheric, spring and ground water in the course of construction (including the necessary pumping), in order to provide permanent and controlled drainage and prevention of water retention and adding water to the filled materials. This includes all the additional works for redirecting surface and spring water flows,
- all excavations, loading and unloading of any inappropriate or surplus materials moved to landfills off the site. Landfill areas off the building site, are too managed (spreading, sowing the grass, drainage) and provided by the contractor.

All works in this description are to be included in the unit price of material excavation and the contractor is not entitled to any additional payment.

Special technical conditions for the execution of earthworks within road tunnel construction are provided in detail in sub-clause 2.8 of these technical conditions.

2.2.2.2 Basic materials

The basic materials, obtained by the excavation works and/or at the borrow pits, are earth materials and rocks and are used for construction works.

All types of earth materials and rocks used for construction works are classified in the following nominal categories:

- fertile soil	category 1
- soft soil	category 2
- earth materials	category 3
- soft rocks	category 4
- hard rocks	category 5

The criterion for the classification of rocks and earth materials in the categories are specific properties that affect a particular construction work. Taking into consideration modern machinery to include excavations, transport and installation.

Earth material descriptions, the excavation method and the usability grade are all presented in table 2.2.2.1.

If the layers of earth material and/or rocks in the excavations are of a manner that making and the exact material classification is difficult or even impossible the average type and category of material may be used.

All materials excavated in the course of overburden stripping and wide excavations, excavations for foundations and trenches, as well as for construction pits and drainage channels, are to be classified according to the basics indicated in this chapter.

Prior to and in the course of works, samples for testing the usability of material for the intended use are to be taken with each change in the quality of material.

The contractor is to be provided with expert opinion on the usability of material for each significant excavation or area that might provide local material for stone grain mixtures for incoherent and/or coherent bearing and wearing road courses, for cement-concrete mixtures and filling material, and for material for preparatory loading and overloading. If the excavation material is to be used for any of these purposes, then the crumbly clay is to be removed prior to blasting and used for embankments or set aside at a location suggested by the contractor and approved by the supervisory engineer.

Table 2.2.1: Classification of earth materials and rocks

Cat.	Category Description	Material Description	Grain Size	Excavation Method	Usability Grade
1	fertile soil	located at the field surface: top soil and rolled turf, with mixtures of gravel, sand, dust and/or clay	-	bulldozer dredger	suitable only as a base for grassed area; neither bearing, stable nor erosion-resistant
2	soft soil	of lightly malleable to light-bodied consistency ($I_c \leq 0.5$); it may contain organic substances (peat, decay)	more than 15 m.- % Φ less than 0.063 mm	dredger, bulldozer	not applicable in its natural state
3	coherent and incoherent materials	located underneath the fertile soil - in medium malleable to solid consistency (earth, decay) or - in compacted state (sand, grit, broken stone, gravel, tailings)	more than 15 m.- % Φ more than 0.063 mm more than 15 m.- % Φ more than 0.063 mm more than 30 m.- % Φ more than 63 mm	bulldozer, dredger bulldozer with ripper (occasionally)	in natural state and in appropriate weather conditions applicable to embankments: the bearing and stability are dependent on external influences
4	soft rocks	marl, flysch, slate, tuff, conglomerate, cracked, grinding and crumbly sandstone, dolomite and limestone	more than 30 m.- % Φ more than 63 mm and Φ less than 300 mm	bulldozer with callipers, pin dredger, cutting, blasting (occasionally)	generally of high load bearing capacity and stability; with appropriate grain size for embankments and the formation layer
5	hard rocks (sedimentary rocks)[1)]	limestone, compact dolomite or material of more than 50 m.-% pieces Φ > 600 mm that are to be blasted	Φ less than 600 mm	blasting, cutting (occasionally)	With the appropriate grain size, extremely high load bearing capacity and stability, appropriate for embankments and/or processing

[1)] *Eruptive silicate rocks are not classified.*

2.2.2.3 Execution method

2.2.2.3.1 General

All excavations are to be executed in accordance with the profiles, recorded levels, grades and depths indicated in the design documentation, taking into consideration the properties of the appropriate material categories and the required properties for the intended use of excavated materials.

Surface removal of the top soil to the appropriate thickness is to be done where further excavation and/or foundation soil preparations are planned. The excavated fertile soil is to be removed in accordance with the design project and these technical conditions. All the excavated material is to be deposited along the road area outside the envisaged excavation area with the least amount of obstruction to the works. Filling and removal of the top soil to the landfill are to be performed with care in order to avoid mixing the material with other unfertile materials and to preserve the quality of the excavated top soil for subsequent use in arranging the slopes and grassed areas.

Controlled drainage is to be provided at the top soil landfill situated at the excavation area that contains atmospheric water retention and surface water collection.

While working in soft soil, all the excavated materials are to be transported and disposed of at special landfills outside the construction area (e.g. outside the lateral fill areas). Such landfills are to be appropriately managed.

All the remaining materials, determined to be useless for the road body construction, are to be disposed of. The contractor is to arrange the landfill for such materials at a location determined by the supervisory engineer.

The surplus materials are primarily to be used for embankment widening to create parking spaces and observation points, unless otherwise specified. Such areas are to be determined by the supervisory engineer, unless specified by the design documentation.

In the course of the excavation works, attention should be paid to the following:

1. All excavations are to be executed according to the designed and required cross-sections, envisaged height levels and grades in accordance with the design documentation and requirements stated by the supervisory engineer.

   The excavations must comply with all the applicable regulations on occupational health and safety in the course of the works (bracing, opening, terraced excavations, etc.) and secure all the existing structures, communications and devices, and provide regular maintenance of any in use public areas and accessible public roads.

2. Underground and wide excavations, as well as excavations for foundations and trenches, construction pits and canals are generally to be executed with mechanical and other equipment with the minimum amount of manual work. This is to be performed only when the mechanical equipment cannot obtain the required quality or where it is necessary due to the mechanical properties of the materials.

3. Soft soil is to be excavated with the appropriate mechanical equipment suited to the specific load and the surface bearing capacity. Partial manual work is necessary for the design of slopes and bottom, primarily for the removal of excavated materials. Removal of the excavated soft soil away is usually not optional. The only usable layer is the top soil, which may be used for the protection and sowing on the slopes and lateral embankments.

4. Hard and sometimes soft rocks are to be excavated with mechanical drilling, deep and regular blasting and additional blasting of large rocks, if requested by the future intended use of the excavated hard rocks. If flat excavation slopes are designed, then the appropriate smooth blasting method (pre-splitting) is to be used.

   The 25 to 30 cm thick surface (levelling) layer of the remaining rock is to be disintegrated by blasting to provide evenness to the foundation soil.

5. The grade of the excavated slope will depend on the soil category, moisture and stratification of the material. The geotechnical properties are indicated in both the design documentation and the geological-soil mechanical analysis.

Crumbly earth layers at the excavation, including crumbly layers in the top and middle areas, are to be used if the conditions allow. Otherwise, they are to be treated according to the regulations indicated in the design documentation and the instructions provided by the supervisory engineer.

The works include clearance of all the areas in need of protection and safety measures, such as the protection of crumbly areas, pockets, caverns, water springs, etc., unless such works are assigned elsewhere. In the course of excavation, the supervisory engineer, along with the contractor and skilled collaborators, are bound to determine any necessary changes to the excavation slope grades in accordance with the properties of the earth materials, geological conclusions and other aspects in the excavations; the contractor is to comply with the aforementioned instructions in the course of the works.

6. 1.0 – 1.5 m wide steps are to be excavated in the foundation soil on slopes with grades of up to 20°, where the embankments are to be built. The frontal surfaces of the steps are to be excavated with a slope of a 2: 1 ratio.

   The space between the steps is to be 1.0 m wide on the slopes with grades of between 20° and 30°.

   Interspace-free steps may be built on slopes with grades exceeding 30°.

   The grade of the steps in coherent earth materials is to be at least 3 % towards the frontal surface and at least 3 % in the longitudinal direction, in order to provide controlled drainage. If the design documentation excludes excavation of steps, the contractor is bound to execute them upon the recommendations of the supervisory engineer, if they are determined necessary.

7. The bottom and slopes of excavation in soft soil are to be flat in order to provide the possibility to place geotextile materials and/or permeable stone layers.

8. In the course of works, care should be taken to not undercut or damage the excavation slopes. Otherwise, the contractor is bound to repair any damage in accordance with the instructions provided by the supervisory engineer, with no claims for reimbursement or any additional payment for extra work.

   If there is an excavation exceeding the existing plan that has come about as a result of the contractor's error during the construction, the contractor is obliged to professionally repair it at his own expense and in a way as determined by the supervisory engineer.

9. The organization of excavation works should exclude any disturbances caused by atmospheric or any other water, and particularly applies to earth materials. Special care is to be taken of the drainage of the excavation (the easiest way) and excavating only the amount of earth that can be transported in one load that is then regularly transported and stored, taking into consideration the effects of machines and the means of transportation. The consequences that might arise if the instructions are not followed are to be borne by the contractor with no right to neither claim any reimbursement nor change in the working procedure to the detriment of the client.

10. In general, soft soil excavation must not be open for long periods of time: the excavation progress should be synchronized with the backfilling and slope preparation. Ground and atmospheric waters are to be regularly pumped out as necessary, until the fill exceeds the ground water level. Otherwise, any damage is to be borne by the contractor. The contractor is to clear locally damaged slopes (landslip) and fill them with appropriate material at his own expense.

    Due to the specific properties of coherent earth, the material excavation in the course of construction must not be deposited into or along the excavation, but is to be loaded directly onto transport vehicles during the excavation works.

    If the soft soil excavation is intersected by a reclaimed canal or a stream, a temporary culvert of appropriate section

is to be built or the water flow redirected to flow to another one, if this is possible.

11. If there is a danger of landslips or collapses, the slopes are to be executed gradually in order to prevent this or appropriate planking and strutting (primarily at great heights) are to be used.

12. When explosives are being used the contractor is bound to engage skilled and qualified labour. While blasting and digging, any disturbances to traffic, people and environment are to be kept to a minimum, and the appropriate traffic signs are to be used. The contractor is obliged to eliminate any possible deviations immediately and at his own expense.

    If the contractor damages a rock slope by blasting, he is bound to repair it at his own expense.

13. In the course of excavation works near communications systems or along the structures, special safety measures are to be used.

    When blasting or if the works are executed near power or telephone installations and devices, the appropriate regulations are to be followed and the relevant authorities' approval are necessary.

14. Construction pits are to be shaped and treated in accordance with the design documentation (the vertical walls of the excavation, the slopes and the bottom). The works include the preparation of drainage, canals and gullies in the course of construction as well as their removal in circumstances where the drainage of atmospheric and spring waters is required.

    If required by the soil mechanical properties of the earth materials as well as by the geological conditions, strutting and formwork are to be executed properly and professionally. The strutting methods of the excavated walls should be selected by the contractor himself, who is obliged to provide the supervisory engineer with the strutting plan (including a structural analysis), unless it is already contained in the design and then should be executed in accordance with this.. If there are any differences between the actual condition and the design documentation, the contractor is to take all necessary measures immediately and inform the supervisory engineer accordingly.

15. While performing canal excavation, the excavated material may be temporarily deposited at an appropriate distance from the canal top edge on both sides, providing it is possible in the terrain and other conditions. Otherwise, it is to be deposited on a single side. The top soil is to be separated from the rest of materials.

    The work organization is to include prevention from any damages to the completed works due to inclement weather. The contractor is, therefore, bound to pay special attention to any water runoffs (spring water included).

    If the design documentation excludes the use of excavated materials for certain purposes, the material is to be transported after completion of the works and spread at appointed deposit areas with the top soil on top.

    The works are to be executed in the specified cross and longitudinal grades in accordance with the design documentation. In general, at no time should water be at a standstill. All the roots, plants and other obstacles should be removed for no additional payment.

16. Canals are to be excavated in accordance with the design documentation. All the excavation surfaces are to be flattened and according to the specified grades and curves to prevent water from being at a standstill and any damages to the previously compacted soil.

    Weather and climate conditions adversely affecting the excavated surfaces are to be taken into consideration in the course of the work. The contractor is, thus, bound to organize works in such a way that they are completed simultaneously or prior to any canal works. Possible extra work or additional works due to the lack of specified drainage works are to be borne by the contractor.

    In the course of construction on soft soil where lateral embankments are

envisaged, lateral drainage channels along the outer edge of the lateral embankments are to be prepared prior to the excavation, and simultaneously with the ground levelling. After completion of the works, the drainage channels are to be finished and repaired. Permanent lateral drainage channels are to be linked with the existing regulated reclaimed canals or with other permanent drainage channels.

17. Excavations for cobblestones and linings are to be executed in full accordance with the design documentation or instructions provided by the supervisory engineer.

    The foundation soil formation for the cobblestones is to be in accordance with the specified conditions, depending on the planned type of cobblestones or coating.

2.2.2.3.2 Distribution of quantities

Materials obtained from the excavation works are to be used primarily for contracted works (embankments, backfills and wedges), while the remaining surplus or useless material is to be disposed of – in accordance with the design regulations – either in backfills or at landfills. The costs of loading, transport and unloading or ploughing the surplus material are to be included in the excavation unit price. If necessary, the supervisory engineer is to provide further instructions, unless the use of excavated units is specified in the design documentation.

The quantities are generally to be distributed in accordance with the design documentation, or with the quantity profile, which is only to provide assistance in calculating the bid price and does not oblige the client in the case of any potential alterations.

2.2.2.3.2.1 Borrow pits

If the design documentation includes a borrow pit, the contractor and the supervisory engineer are to survey the site prior to acquiring the material, if such acquiring is related to the measurement of the works. The survey reports – bilaterally approved and signed – are the basis for the calculation of qualities.

The contractor is bound to:

- prepare a proposal for the borrow pit arrangement after it has been used,
- acquire the approval for the proposed arrangement from the supervisory engineer, and
- Prepare the borrow pit based on the approved proposal.

If the design documentation for quantities excludes a borrow pit and there is a lack of materials in alignment, the contractor is then obliged to provide a borrow pit, In which case the contractor is (at his own expense) bound to acquire the approval from the land proprietor, prove the quality and quantity of the material for the proposed borrow pit and submit a proposal for a borrow pit (including a plan and the cross-sections) to the supervisory engineer for approval.

The location where the top soil and rest of the surplus or useless material are to be deposited must be indicated in the design plan. Based on the proposal and its verified quality, the supervisory engineer is to grant approval for its utilization.

The contractor must receive the supervisory engineer's approval in advance for any additional alterations (widening, deepening) to the borrow pit. The contractor is to bear all the work expenses that are not indicated in the design documentation, including reimbursement for use of the land, for crops and fields, as well as any other damages caused.

Unobstructed drainage of the atmospheric and spring waters is to be provided in the course of opening and using the borrow pit.

2.2.2.3.3 Openings

The contractor may execute openings for trenches and/or other procedures and work methods on condition that the construction method does not damage the quality of completed works and that the contractor is not to claim any payment for additional expenses.

2.2.2.3.4 Obstacles

The contractor is obliged to inform the supervisory engineer of any obstacles in the course of excavations, including installations, cables, canals, drains, structural elements, major separate rocks, etc., and the engineer is to instruct the contractor to take appropriate measures.

While taking safety measures for structures, installations, canals, drains, cables, etc., the contractor is obliged to comply with the regulations and instructions provided by the regulatory authorities for the aforementioned elements. Loads should not be applied to or walked over any elements that are to be supported or suspended by special structures in the course of the construction works.

2.2.2.3.5 Working space

A Maximum width of 50 cm is allowed for the contractor's working space between the structure and the construction pit wall. Proper working space width is defined as:

- unsupported construction pits as the horizontal distance between the heel of the excavated slope or the external side of the wall and the external side of the structural formwork,
- Supported construction pits as the clear distance between the pit formwork and the external side of the structural formwork. Additional excavation for working space is not acceptable after the cement concrete has been cast into the structure up to the excavation wall.

In excavations for trenches, the maximum required clear width of working space (unless otherwise specified in the design documentation) is the width of the external diameter, or the maximum width of the installation cross-section + 40 cm added to the external diameter, or to the maximum width of the pipe installation, but not less than 60 cm of the overall excavation width for a trench depth up to 2.00 m and not less than 80 cm width at greater depths. The clear width in unsupported trenches is the bottom width and in supported trenches, it is the formwork spacing.

The bottom depth and width is specified by the design documentation and necessary working space. The ultimate bottom depth must be specified in the design documentation.

The excavation bottom for foundations is to be horizontal, and graded at different depths.

The bottom for trenches and drainage is to be executed with the properly specified grade and in the designed shape.

The foundation pit bottom area should not be loosened. It is to be protected from any damage caused by transportation, spreading, washing out, and freezing. Any damage to the bottom of the coherent soil is to be excavated and replaced prior to any concrete works or building. Any damage to the bottom of the incoherent soil is to be treated by the appropriate compaction.

The excavation bottom of the foundation, construction pit and drainage channel is to be prepared in full accordance with the design documentation. Based on the design documentation, height deviations from the finished level of ± 2 cm are allowed, unless otherwise specified in the design documentation. The bottom flatness of a length of 4 m may deviate from the measuring bar by 3 cm maximum in one direction.

If the contractor is responsible for excavating too deeply, he is then obliged to perform any necessary repairs determined by the static conditions and the supervisory engineer with no additional payment.

In order to obtain a flawless foundation of coherent soil, the final excavation layer (of an appropriate thickness) should be set aside and protected from damage unless otherwise specified in the design documentation. The layer is only allowed to be removed immediately prior to the following construction (concrete works, pipe laying, etc.).

The contractor may proceed with the construction only after the excavation is completed and taken over.

2.2.2.3.6 Slopes for unsupported construction pits

The slope grades will depend on the properties of materials and the period of time during which the pit is to be open. In addition, all loads and vibrations that could be caused by working in or near the pit are to be taken into consideration.

For materials that could dry out, or are susceptible to water absorption, freezing or sliding, appropriate slight slopes are to be executed and all the necessary efforts should be made for water drainage, in order to avoid any damages.

The slope grade is to be selected by the contractor, unless otherwise specified in the design documentation. However, it is to be previously approved by the supervisory engineer. The contractor is responsible for

the safety and maintenance of the slopes during the course of the construction works.

At least a 60 cm wide clear protective area is to be maintained as a groyne at the top edge of the slope for unsupported construction pits.

2.2.2.4 Construction quality

Excavation works are to be executed to a high quality and in accordance with the regulations, design documentation and provisions and requirements determined herein.

All excavation finishes are to be in accordance with the requirements determined in the design documentation.

The width of the excavation bottom formation flatness, measured with a 4 meter bar, may deviate
- By up to 3 cm from the measuring bar or measuring plane in earth materials,
- Up to 5 cm in rocks.

Excavations for drainage channels are to be constructed in such a way to provide undisturbed water runoff.

Excavations for drainage channels with a planned lining or hardening are should match the design. Deviations to the detriment of the lining thickness or canal hardening are not allowed.

In the course of excavation works, the contractor is bound to inform the supervisory engineer of any problems that occur and affect the quality of executed works specified herein. If the contractor fails to do so, he is to take all the responsibility and possible repair expenses.

The contractor is bound to perform any necessary internal controls of the works in accordance with these technical conditions.

2.2.2.5 Measuring and taking over of works

2.2.2.5.1 Measuring of works

Measuring of completed works is to be in compliance with the sub-clause 1.2.2.2 of the general technical conditions and use the following provisions:
- All excavations (pits, wide cuts, foundations, trenches and construction pits, drainage channels) are to be measured according to actually executed quantities in cubic metres in various categories of materials according to the sub-clause 2.2.2.2.
- A survey of the cross-sections prior to and after the excavation is completed to determine the actual excavated quantities. The appropriate cross-sectional area, measured from the excavation top edge to the bottom (considering the thickness of certain layers and soil categories and cross-sectional spacing) is the actual accounting quantity, but only within the design documentation, and alterations approved and instructed by the supervisory engineer.

In the course of measurement, special attention should be made to the following:
- The pit includes a layer up to 40 cm thick.
- in wide excavations, the lenses, pockets and caverns not exceeding 1 m^2 (in cross-section) should not be deducted, while anything larger is deducted from the specific material category in the entire area.
- In excavations for foundations, trenches and construction pits, only the actual excavation is calculated according to the provisions stated in the sub-clause 2.2.2.3.6. The reference level for determination of the excavation depths is the average field level and excavation perimeter.
- The reference level in excavations for drainage channels is indicated by the average height levels of the field and excavation in cross-sectional axis, representing the medium value of both height levels at the canal end points.

All excavated materials used for any purposes other than for embankments, backfills and the formation level are deducted when calculating excavation quantities, unless the contractor has compensated for the material from the borrow pit (with no additional payment).

2.2.2.5.2 Taking over of works

The completed works are to be taken over in accordance with the provisions stated in the sub-clause 1.2.2.3 of the general technical conditions and according to the provisions stated in these special technical conditions.

2.2.2.6 Calculation of works

Completed works are to be calculated in accordance with sub-clause 1.2.2.4 of the general technical conditions.

Quantities determined in sub-clause 2.2.2.6.1 are to be calculated according to the determined unit price per 1 m^3 of the excavated materials, separately by the categories of materials, where the unit price includes:

- all the works related to excavation and removal to the specified location for usage or landfill, executed according to the design documentation and/or instructions provided by the supervisory engineer,
- all the works related to excavation and loading, executed according to the design documentation and/or instructions provided by the supervisory engineer,
- all the works related to transportation and unloading at the specified location for usage or landfill, executed according to the design documentation and/or instructions provided by the supervisory engineer,
- all the works related to spreading the surplus materials at a landfill,
- all the works related to removal of roots and stumps, along with excavation of the soft soil of malleable to light-bodied consistency,
- all the works related to the arrangement of permanent and temporary landfill for surplus or useless materials,
- obtaining the appropriate areas for permanent and temporary landfills with appropriate reimbursements,
- grading of all the excavated and damaged adjoining areas,
- site clearing after completion of the works and the transport of surplus materials,
- removal of all the obstacles occurring in the course of works, apart from the ones of cultural and historical significance,
- Maintenance of the executed works until the final takeover.

Apart from the aforementioned, the unit price also includes:

- in wide excavations:
  - slope arrangement and removal of individual rocks from the slopes and
  - excavation of steps, determined in the design documentation or due to subsequently determined purpose,
- in excavations for all the foundations and trenches:
  - all the necessary strutting and formwork in trenches for foundations or canals,
- in excavations for construction pits:
  - necessary formwork remaining in the construction pit,
  - restoring the structure and field affected by the construction works to its original condition
  - all the necessary strutting and formwork on the construction pit slopes
- in excavations for canals:
  - arranging the lining formation in accordance with the provisions determined in the design documentation; this provision is applied if the linings are carried out in the existing canals.

2.2.3 FOUNDATION SOIL FORMATION

2.2.3.1 Description

The arrangement of the foundation soil formation includes:

- foundation soil preparation for embedding the embankments, backfills, wedges and/or the formation level after the completed surface excavation of fertile soil or wide excavation in earth material or rocks, including
  - rough grading and
  - compaction of the foundation soil surface layers,
- upgrade-related hardening and/or stabilising with binders and
  - binder delivery and spreading,
  - wetting,
  - mixing and
- Maintenance of the foundation soil formation to the point of further construction.

2.2.3.2 Basic materials

The formation of natural, upgraded, hardened or stabilised foundation soil may be arranged in earth materials and rocks, which do not contain the materials that with biochemical processes could, change the mechanical and physical properties of the substance over time to the extent that they could damage the stability of the road body.

Earth materials and rocks in the foundation soil are to provide foundation soil compaction able to take the loads determined in the design documentation.

Dry hydrate and pozzolan or blast-furnace cement is to be used for upgrading, hardening and stabilising the foundation soil. In some cases of foundation soil upgrade, it

is possible to use mechanical stabilisation of the subgrade by embedding stone grains of an appropriate coarseness.

2.2.3.2.1 Earth materials and rocks

For earth materials and rocks in the foundation soil, the classification to be used is based on sub-clause 2.2.2.2. Earth materials and rocks in the foundation soil are to meet the following requirements:
- Moisture content in the earth material is to provide the specified density in the course of compaction. If the appropriate moisture content in the compacting material cannot be provided either by upgrading, hardening or stabilising, then another appropriate technical or technological procedure should be performed.
- Humus and organic mixture content must not exceed the quantity that will affect the colour of the sodium hydroxide solution to be darker than the reference colour in the course of testing according to EN 1744-1.

2.2.3.2.1.1 Coherent earth materials

Applicability of coherent earth materials in the foundation soil is to be determined by preliminary testing of typical samples. The following properties are to be tested:
- moisture content,,
- optimum moisture content and maximum density with the standard Proctor procedure,
- consistency limits and
- Humus and/or organic mixture rate.

Medium and high plastic clays (with liquid limit of W_L > 35 % and plasticity index of I_p > 12 %) are allowed to be set in layers underneath the foundation soil formation (up to a maximum of 0.5 m below the formation level), if they meet the CBR volume weight and do not swell.

The crucial criterion for determining the assessment of the earth material quality for hardening or stabilising is the endurance of the hardened or stabilised earth material.

The type and number of tests are to be determined by the supervisory engineer.

2.2.3.2.1.2 Incoherent materials

In general, all types of incoherent materials are appropriate for the arrangement of foundation soil formation.

If the required properties of the foundation soil formation cannot be provided due to the content of material, they might be upgraded by adding and mixing an appropriate stone grain aggregate.

If the material contains too much humus and/or organic admixtures, an appropriate test should be conducted at the request of the supervisory engineer.

2.2.3.2.2 Binders

All types of binders that provide the required properties of upgraded, hardened or stabilised material may be used for upgrading, hardening or stabilising coherent and/or incoherent materials underneath the foundation soil formation.

The application of binders is to be verified with the appropriate documents submitted by the contractor and they are to include:
- The binding capacity (compressive strength) and
- The commencement and completion of the binding.

The contractor is also to indicate the percentage of the applied binder.

2.2.3.3 Execution method

2.2.3.3.1 Rough grading

After the surface is executed or wide excavations are executed, the foundation soil formation is to be roughly graded in order to provide a high-level drainage for the appropriate terrain conditions The works are to be executed in accordance with the design documentation and technical conditions.

2.2.3.3.2 Upgrading, hardening or stabilising the foundation soil materials with the use of binders

Upgrading, hardening or stabilising the earth materials with the use of binders is necessary in order to provide the appropriate moisture and/or stability of the foundation soil.

Binders for upgrading, hardening or stabilising the coherent or incoherent materials are to be spread over previously roughly graded foundation soil formation in the amount and way that ensures the required uniformity of the added binder (dosing accuracy of ± 1 kg/m^2) as well as the required mixture properties.

The spread binder is to be mixed by the appropriate machines with earth material in, generally, at least a 20 cm thick layer, in order to provide uniformity of the earth material mixture with binder.

If necessary, an additional amount of water can be added to provide a uniform and optimum moisture content of the upgraded, hardened and/or stabilised material.

Mixing is to provide a uniform mixture of earth material and binder containing water in the entire planned layer thickness.

Upgrading, hardening and stabilising the coherent or incoherent earth materials in the foundation soil with the use of binders is only possible at temperatures above + 3℃ and in dry weather.

2.2.3.3.3 Compacting

After grading and mixing, the natural foundation soil and upgraded, hardened or chemically stabilised coherent or incoherent materials in the foundation soils are to be compacted for the full width of the layer with rollers with smooth and/or pneumatic wheels.

All areas inaccessible to rollers are to be hardened by compacting tools as required by the design documentation or by procedures approved by the supervisory engineer. The supervisory engineer is also to determine the conditions under which the tools or procedures are to be implemented.

The usage of compacting tools and technological procedure are to be previously tested in compliance with sub-clause 1.2.1.3 of the general technical conditions.

Prior to commencement of compaction, the layer of natural, upgraded, hardened and stabilised foundation soil or mixture should contain a sufficient amount of water appropriate for the compaction.

If necessary, the supervisory engineer may determine additional procedures that are to provide the appropriate moisture and embedding of the material and/or mixture.

If embedding of embankments, backfills or wedges is not performed immediately after the compaction and quality check of the foundation soil formation but after a prolonged l period of time and under various weather conditions, then the density of the layers underneath the foundation soil formation is to be rechecked prior to any continuation of works. The works are to proceed only if the quality is adequate.

2.2.3.3.4 Storing of binders

Binders for upgrading, hardening and stabilising the coherent and incoherent materials in the foundation soil are generally to be stored in silos or tanks.

2.2.3.4 Construction quality

2.2.3.4.1 Compaction

The contractor is to verify the compaction of the materials underneath the foundation soil formation by testing within the internal control, which is, in general, a short procedure of a non-destructive measurement with an isotope gauge.

The layer of natural, upgraded, hardened and stabilised materials underneath the foundation soil formation is to meet the require values of compaction and capacity in accordance with table 2.2.3.1.

The required compaction values indicated in table 2.2.3.1 are the average values. The lower value must not be more than 3 % lower than the required average value.

The compaction of the coherent and incoherent materials underneath the foundation soil formation is to reach the lower value at each measurement point. The contractor is bound to compact any inappropriately compacted material in accordance with the requirements provided in the technical conditions and with no additional payment.

If, based on the results of internal and/or independent tests, the supervisory engineer subsequently determines that there are inappropriate compaction spots in the foundation soil formation; he is to determine further measures himself.

Table 2.2.3.1: Requirements for compaction and capacity of the foundation soil formation

Description of works	Required compaction		Required capacity E_{v2}
	acc. SPP	acc. MPP	
	%		MN/m^2
Foundation soil formation more than 2 m underneath the formation level made of			
- coherent earth material	95	-	-
- upgraded coherent earth material	95	-	-
- hardened and stabilised coherent earth material	95	-	-
- incoherent earth material	-	95	-
Foundation soil formation less than 2 m underneath the formation level made of			
- coherent earth material	98	-	15
- upgraded coherent earth material	98	-	20
- hardened and stabilised coherent earth material	98	-	30
- incoherent earth material	-	98	60
Foundation soil formation at the formation level made of			
- coherent earth material	100	-	20
- upgraded coherent earth material	100	-	25
- hardened and stabilised coherent earth material	100	-	40
- incoherent earth material	-	100	80

SPP – standard Proctor procedure
MPP – modified Proctor procedure

2.2.3.4.2 Bearing capacity

The contractor is bound to verify the bearing capacity of the foundation soil formation (unless compaction measurement is executed) with the results of the capacity internal tests by measuring the static and/or the dynamic deformation moduli (E_{v2} i E_{din}).

The required average lower values of static deformation moduli E_{v2} in the foundation soil formation are indicated in table 2.2.3.1.

Informative lower values of the dynamic deformation moduli E_{vd} are approximately 50 % of the required lower values of the static deformation moduli E_{v2}.

The ratio of the static deformation moduli E_{v2} : E_{v1} must not exceed 2.2. If the measured value of modulus E_{v1} exceeds 50 % of the required value of modulus E_{v2}, the required ratio is not crucial for evaluation of the bearing capacity of the constructed foundation soil formation.

The required bearing capacity values based on table 2.2.3.1 are the lower values. The lowest value of an individual measurement (up to 5 % of the overall number of measurements) may up to 20 % lower.

In general, the capacity of the foundation soil formation made of binder-hardened or stabilised material can be tested only 7 days after the compaction process.

If, based on the results of internal and/or external tests, the supervisory engineer subsequently determines that areas of inappropriate capacity in the foundation soil

formation, he should determine further measures.

2.2.3.4.3 Hardened and stabilised coherent and incoherent materials

The contractor is bound to verify the properties of natural materials hardened or stabilised with binders by providing the test results within the internal controls, including:
- The compressive strength tests conducted on a specimen preserved for 7 days and prepared in accordance with the conditions based on the appropriate Proctor procedure and providing the following results:
  - a minimum of 0.4 MN/m² for coherent materials
  - a minimum of 1.5 MN/m² for incoherent materials and
- A specimen tested for endurance that was prepared under the described conditions, that is determined by the ratio of compressive strengths of the dry and moistened (for 24 hours) specimen after 7 days and should be at least 0.70.

If necessary, the supervisory engineer may alter the specified conditions for the quality of the stabilised natural materials of the layers underneath the foundation soil formation.

The required compressive strength values are the lower values. The lower value may be 0.1 or 0.2 MN/m², lower than the required one ², and the lowest value may be lower by 0.2 or 0.5 MN/m².

2.2.3.4.4 Evenness and height of the foundation soil formation

2.2.3.4.4.1 Evenness

The method of measuring the evenness is provided in the guidelines SRMG, sub-clause 3.1.3.1.

The foundation soil formation of a length of 4 m may deviate from the measuring bar or measuring plane (in any direction in regard to the road axis)
- In natural, upgraded, hardened and stabilised coherent materials
  max. 30 mm
- In incoherent materials
  max. 30 mm
- In rocks max. 50 mm

2.2.3.4.4.2 Height

The foundation soil formation may deviate from the designed level at any place
- In natural, upgraded, hardened and stabilised coherent materials
  max. ± 25 mm
- In incoherent materials
  max. ± 25 mm
- In rocks max. ± 40 mm

2.2.3.5 Quality control

2.2.3.5.1 Prior testing

Prior to hardening the foundation soil, the contractor is bound to check whether the properties of the materials, determined by prior geotechnical tests, comply with the properties of material samples taken at the beginning of works.

By conducting tests on the test area, the contractor is bound to check the properties determined in table 2.2.3.2. In accordance with the instructions provided by the supervisory engineer.

Prior to the commencement of works, a technology procedure is to be determined for each typical type of material underneath the foundation soil formation, as well as for any type of compacting tool and its depth effect.

2.2.3.5.2 Hardening control

2.2.3.5.2.1 Internal control

Based on the prior testing, the supervisory engineer is to determine the extent of internal control in the foundation soil formation hardening even if it has already been determined by the programme of the average control frequency.

Table 2.2.3.2: Prior tests for the foundation soil preparation

Material properties	Measurement Unit	Required Value	Testing procedure
- Applicability of material :			
- natural moisture	m.-%	sub-clause 2.2.3.2.1/1	
- Proctor-based testing			EN 13286-2
- optimum moisture	m.-%	-	
- maximum density	t/m^3	-	
- consistency limits:			TS CEN ISO 17892-12
- liquid limit w_L	%	≤ 35	
- plasticity index I_p	%	≤ 12	
- humus and/or organic mixture rate	-	sub-clause 2.2.3.2.1/2	EN 1744-1
- Binder applicability:			
- binding capacity:	m.-%	sub-clause 2.2.3.2.1/1	
- mixture compressive strength			EN 12390-2
- coherent earth material	MN/m^2	≥ 0,4	
- incoherent earth material	MN/m^2	≥ 1,5	
- endurance	-	≥ 0,7	-
- commencement and completion of binding	h	-	EN 196-3

The minimum internal control frequency in foundation soil formation hardening, including
- The testing of materials and
- The testing during incorporation,

Is determined in tables 2.2.3.3 and 2.2.3.4.

If, based on the results of the internal control tests, the supervisory engineer determines that there are higher deviations than in the results of prior tests or properties, indicated in the conformity certificates; he is entitled to alter the extent of the internal control. In cases of homogenous test results, the supervisory engineer is entitled to reduce the extent of internal controls.

2.2.3.5.2.2 Independent control

The ratio of the extent of independent control that is generally conducted by an institution is 1: 4 to internal control.

The internal control sampling areas and spots for measuring evenness, heights, densities, moisture and bearing capacity are to be determined by the supervisory engineer with a statistically random selection. The procedure is determined in the guidelines SRCS, sub-clause 1.4.1.

2.2.3.6 Measuring and taking over of works

2.2.3.6.1 Measuring of works

Completed works are to be measured in accordance with sub-clause 1.2.2.2 of the general technical conditions.

The quantities of the works executed on the foundation soil formation are to be measured in square metres.

All the quantities are to be measured according to the actually executed extent and the type of works within the design documentation.

The contractor is bound to submit the appropriate certificates of the quantities of the binders delivered to the site.

Table 2.2.3.3: The minimum material test frequency within the internal control of the foundation soil formation hardening

Foundation soil properties	Testing procedure	Minimum testing frequency
- natural moisture		per 40 m^1
- Proctor-based testing	EN 13286-2	per 400 m^1
- consistency limits	TS CEN ISO 17892-12	per 400 m^1
- humus and/or organic mixture rate	EN 1744-1	per 400 m^1

Table 2.2.3.4: The minimum incorporation test frequency within the internal control of the foundation soil hardening

Foundation soil properties	Testing procedure	Minimum testing frequency	Evaluation base
- moisture content and natural material density	EN 12390-3	20 m^1	sub-clause 2.2.3.2.1.1
- quantity of spread binder		100 m^1	sub-clause 2.2.3.3.2
- granulation:		100 m^1	
- moisture content and density		40 m^1	sub-clause 2.2.3.3.2
- compressive strength		100 m^1	sub-clause 2.2.3.4.3
- endurance		200 m^1	sub-clause 2.2.3.4.3
- foundation soil formation		100 m^1	
- compaction	SRCS, sub-clause 1.2.4	20 m^1	sub-clause 2.2.3.4.1
- bearing capacity (E_{vd})	SRDM, sub-clause 8.3.3	20 m^1	sub-clause 2.2.3.4.2
- evenness and height	SRMG, sub-clause 3.1.3.1	20 m^1	sub-clause 2.2.3.4.4

2.2.3.6.2 Taking over of works

The foundation soil formation is to be taken over by the supervisory engineer in accordance with the quality requirements within the technical conditions and in compliance with sub-clause 1.2.2.3 of the general technical conditions.

Prior to proceeding with works, the contractor is bound to remedy all the defects that have been found based on the quality requirements.

All the expenses for remedying defects are to be borne by the contractor, including those for measuring and testing to prove the appropriate quality of the executed works, thus resulting in additional work with repeating the quality testing after remedy of the defects.

The contractor is not entitled to claim any payment for any works not meeting the requirements determined in the technical conditions which he failed to remedy according to the instructions provided by the supervisory engineer. In such cases, the client is entitled to extend the warranty period for at least 5 years for any works depending on those not remedied.

2.2.3.7 Calculation of works

2.2.3.7.1 General

Completed works are to be calculated in accordance with t sub-clause 1.2.2.4 of the general technical conditions.

Quantities are determined according to sub-clause 2.2.3.6.1 and are to be calculated by the contract unit price.

The contract unit price is to include all the services necessary for the ultimate completion of works. The contractor is not entitled to subsequently claim any additional payment.

2.2.3.7.2 Deductions due to inappropriate quality

2.2.3.7.2.1 Materials

There is to be no deductions in the calculation of completed works due to the specified appropriate quality of materials.

2.2.3.7.2.2 Binders

There is to be no deductions in the calculation due to the specified appropriate quality of upgrading, hardening or stabilising the materials.

2.2.3.7.2.3 Compaction and bearing capacity

The lower values of compaction and bearing capacity as well as other values being at the lowest value (up to 5 % of the overall number of measurements) refer to 100 % of the value in terms of the tender unit price. There is to be no deductions in the calculation due to the specified appropriate compaction and bearing capacity.

2.2.3.7.2.4 Hardened and stabilised materials

The lower quality value specified in sub-clause 2.2.3.4.3 refers to 100 % of the value in terms of the tender unit price, and the lowest value is work with no value. Intermediate values are to be determined by linear interpolation.

2.2.3.7.2.5 Formation evenness

There is to be no deductions in the calculation due to the specified appropriate formation evenness.

2.2.3.7.2.6 Formation height

There is to be no deductions in the calculation due to the specified planned formation evenness.

2.2.4 BLANKETS, FILTER COURSES AND WORKING FIELD LAYERS

2.2.4.1 Description

Guidelines for pervious blankets, filter courses and working field layers include delivery and the incorporation of incoherent materials/mixture of stone grains, and secondary raw materials for the working field.

The guidelines also include specific conditions for geotextiles implementation in pervious blankets, filter courses and working field layers.

2.2.4.2 Basic materials

Mixtures of incoherent natural, crushed or either natural or crushed materials may be used for pervious blankets, filter courses and working field layers, provided that they meet all the regulations and technical conditions. Grain mixtures made of secondary raw materials may be used for in the working field.

Along with the incoherent material, geotextiles may also be used for layers, pervious blankets, and filter courses, providing that they meet the required technical conditions determined in the guidelines SRDM, sub-clause 8.1.4.

2.2.4.2.1 Incoherent materials

Incoherent materials for pervious blankets, filter courses and working field layers may be obtained directly through excavation and/or at the borrow pit (gravel pit, quarry) and/or by the indirect crushing of natural rocks or secondary raw materials.

Stone grain mixtures for pervious blankets filter courses and working field layers are to be comprised of certain fractions so to meet the specified requests, depending on the purpose.

Stone grain mixtures for pervious blankets, filter courses and working field layers are to be appropriate in terms of

- grain mixture composition,

- humus and/or organic mixture content and
- Stone grain endurance.

Stone grain mixtures for pervious blankets and filter courses are to meet the USBR conditions, specified by the screening curve yield values.

$$12 \langle \frac{d_{15F}}{d_{15Z}} \langle 40$$

$$12 \langle \frac{d_{50F}}{d_{50Z}} \langle 52$$

Where:

d_{15F},d_{50F} – grain diameter at 15 m.-% and at 50 m.-% of screened mixture for pervious blankets and filter courses

d_{15Z},d_{50Z} – grain diameter at 15 m.-% and at 50 m.-% of screened coherent earth material that is to prevent access to adjacent layers and filter courses

The diameter of the largest grain in the mixtures for pervious blankets and filter courses must not exceed 2/3 of the layer thickness, and in mixtures for the working field must not exceed 1/2 of the layer thickness.

If any geotextile material is incorporated as the middle layer between the pervious blanket or filter course made of incoherent material and the layer of coherent earth material, then the composition of the incoherent material mixture is determined by the ratio of grain size non-uniformity U = d_{60}/d_{10} and permeability ratio.

Denotation d_{60} refers to the stone grain diameter (screen opening) at 60 m.-% of the screen mixture, and d_{10} refers to the stone grain diameter at 10 m.-% of the screen mixture.

The ratio of grain size non-uniformity U is to be higher than 8 in mixtures for pervious blankets and filter courses, if the mixture is not incorporated with a middle layer made of another material. If a geotextile is placed between the pervious blanket or the filter course and the layer of coherent earth material, and the stone grain mixture and it comprises several basic fractions, then the ratio of the stone grain mixture non-uniformity U must be higher than 3. There is no lower limit value of the non-uniformity U ratio in equally sized stone grain mixtures (basic fraction).

The rate of the grain of up to 0.063 mm in the mixture for pervious blanket or filter courses, in cases that such course is placed in a frost prone a then the ratio is U ≥ 15, to comply with (according to EN 13242)

- category f_5 (up to 5 m.-%) at a landfill and
- category f_8 (up to 8 m.-%) in incorporated course.

If the ratio of non-uniformity is U ≤ 6, the rate of the grain of up to 0.063 mm in mixture for the incorporated pervious blanket or filter course is to comply with the category f_{15} (up to 15 m.-%).

If the coarse stone grain mixture is used in the working field (grain size 0/250 mm or more) the allowed rate of the grain of up to 0.063 mm complies with category f_{15} (up to 15 m.-%).

The permeability ratio of the stone grain mixtures for pervious blankets and filter courses (coated with geotextile) and working fields is to be at least 10^{-5} m/s. The specimen should be prepared according to the modified Proctor procedure.

Humus and/or organic mixture content in the stone grain mixtures must not affect the colour of the sodium hydroxide solution to be darker than the reference colour in the course of testing according to EN 1744-1.

Stone grain mixtures for pervious blankets and filter courses must not contain

- clay, shell and graphite slates,
- clay and lightly malleable sandstones nor
- marl grains.

Mechanical and spatial endurance, as well as resistance to water and frost are to be determined by a macroscopic mineralogical – petrographic analysis (according to EN 932-3) or additional tests (according to EN 1367-2).

If the grain mixtures based on secondary raw materials are used in the working field, then their chemical inertness and resistance to extraction are to be verified.

Prior to using any material, the contractor is bound to inform the supervisory engineer the location that the stone material is to be obtained from and used for layers for drainage, sliding and surface filtering. He is also to submit the appropriate quality certificates and acquire approval for using the material.

2.2.4.2.2 Geotextiles for separating layers, pervious blankets and filter courses

Geotextiles for separating layers, pervious blankets and filter courses are generally bound to comply with the properties specified in the design documentation and meet the requirements specified in guidelines for their usage SRDM, sub-clause 8.1.4.

The required minimum of geotextile properties for separating layers, pervious blankets and filter courses is to comply with the conditions determined in the geotechnical analysis and guidelines for the design and usage of geotextiles for separating layers, pervious blankets and filter courses in road construction (SRDM, tč. 8.1.4).

The selected geotextile for separating layers, pervious blankets and filter courses is to be determined with the general description of
- material type and
- dimensions.

In general, geotextile properties specified in tables 2.2.4.1 and 2.2.4.2 are to be defined and verified by carrying out geotechnical analysis.

The required minimum for pervious geotextiles is equals to that specified in table 2.2.4.2.

The minimum required property values indicated in tables 2.2.4.1 and 2.2.4.2 are to be provided with the appropriate verifications that are to be submitted by the contractor to the supervisory engineer prior to the commencement of works.

The mechanical and hydraulic properties of the pervious geotextiles are to be determined by the calculation within the design documentation indicated in table 2.2.4.3. When compressible geotextiles are used for pervious blankets, the external load effect on the reduction in their thickness and eventual reduction in permeability are to be calculated.

If a geo-membrane, rough foil or geo-mesh is planned to be included in the in separating layer, pervious blanket or filter course, the required properties are to be specified in detail in the design documentation.

Additional conditions for works involving geotextiles are specified in detail in the guidelines for design and usage of geotextiles for separating layers, pervious blankets and filter courses in road construction (SRDM, sub-clause 8.1.4).

If the contractor, in the correct timeframe, provides the supervisory engineer with the appropriate verifications regarding the quality of the materials used for the separating layers, pervious blankets and filter courses, additional prior tests are generally not necessary. Nevertheless, under special circumstances, the supervisory engineer is entitled to require such documents even after compatibility verification has been submitted.

The contractor is bound to provide all the verification documents regarding the compatibility of materials that are to be used, unless they are already provided in the design documentation or appendix.

The contractor is not entitled to claim any extra payment for additional tests.

Table 2.2.4.1: Minimum requirements for separating general geotextiles, with no selection according to the procedures provided in the guidelines, appendices or by geotechnical design

Geotextile properties	Measurement Unit	Minimum requirements	Testing procedure
- Mechanical properties:			
- cross-longitudinal tensile strength	kN/m	> 14	EN ISO 10319
- rupture stretching	%	> 30	EN ISO 10319
- resistance to dynamic break	mm	< 30	EN 918
- resistance to break (CBR)	N	> 2000	EN ISO 12236
- Hydraulic properties:			
- typical pore size	mm	$0.05 \leq O_{90} < 0.5$	EN ISO 12956
- velocity index	m/s	3×10^{-3}	EN ISO 11058
- permeability index at 20 kPa	m/s	$> 10\ k_{coh.\ mat.}$	E-DIN 60 500-4

Table 2.2.4.2: Minimum requirements for general filter geotextiles, with no selection according to the procedures provided in the guidelines, appendices or by geotechnical design

Geotextile properties	Measurement Unit	Minimum requirements[1)]	Testing procedure
- Mechanical properties:			
- cross-longitudinal tensile strength	kN/m	> 14	EN ISO 10319
- rupture stretching	%	> 30[2)]	EN ISO 10319
- resistance to dynamic break	mm	< 35	EN 918
- resistance to break (CBR)	N	> 1500	EN ISO 12236
- Hydraulic properties:			
- typical pore size	mm	$0.05 \leq O_{90} < 0.2$	EN ISO 12956
- velocity index	m/s	3×10^{-3}	EN ISO 11058
- permeability index at 20 kPa	m/s	> 10 $k_{coh.\ mat.}$	E-DIN 60 500-4

[1)] Recommended selection of the filter geotextile according to the guidelines
[2)] For wall drainages ≥ 10 %, for embedded vertical drainages ≥ 20 %

Table 2.2.4.3: Mechanical and hydraulic properties of pervious geotextile to be defined by calculation in the design documentation

Geotextile properties	Measurement Unit	Testing procedure
- Mechanical properties:		
- cross-longitudinal tensile strength	kN/m	EN ISO 10319
- rupture stretching	%	EN ISO 10319
- resistance to dynamic breakage	mm	EN 918
- resistance to breakage (CBR)	N	EN ISO 12236
- Hydraulic properties:		
- typical pore size	mm	EN ISO 12956
- velocity index	m/s	EN ISO 11058
- permeability index at 20 kPa	m/s	E-DIN 60 500-4
- transmissivity	m^2/s	EN ISO 125958

2.2.4.3 Execution method

2.2.4.3.1 Preparation of base formation

The base formation designed to accept the incorporation of the pervious blanket and/or filter course and working fields made of stone material is to be, prior to the commencement of incorporation, in accordance with the requirements specified herein and in the design documentation.

The base formation which is to accept the incorporation of geotextile for the separating layer, pervious blanket and/or filter course is to be previously prepared in accordance with the requirements specified in the technical conditions.

2.2.4.3.2 Transport of stone materials for works related to pervious blankets and filter courses and working field

The transport of stone materials for works related to pervious blankets and filter courses

and working field to the adequately prepared base formation (according to the requirements specified in sub-clause 2.2.4.3.1) may be commenced only after the formation is taken over and approved by the supervisory engineer.

The transport of the stone grain mixture for the working field is only possible over a previously spread layer of a stone grain mixture. Under no circumstances is transport of the grain mixture allowed to be carried out over previously arranged and taken over foundation soil formation.

Well-equipped spreading vehicles and/or machines providing the required distribution of materials in uniform layers or zones are to be used for transport. The layer thickness of the spread materials is to comply with the thickness specified in the design documentation.

In cases of multiple-layer incorporation, each separate layer must be appropriately shaped and compacted prior to providing materials for the following layer.

In the course of transport, lead openings of certain vehicles are to be distributed as equally as possible over the entire width of the spread layer to uniformly compact the pervious blankets, filter courses and working field.

Vehicles with muddy wheels or chassis must not move over the spread or compacted material.

For coherent earth material formation of an extremely low bearing capacity (e.g. swamps, moors) where special technological conditions for working field construction are envisaged in the design documentation, the following provisions are generally applied, unless otherwise specified in any additional technological conditions:

- stone grain mixtures (under sub-clause 2.2.4.2) are to be spread over previously laid geotextiles in accordance with the design documentation and technical conditions stated herein,
- Sections where vertical drainages are envisaged, the stone grain mixture for the working field is to be placed prior to the installation of vertical drainages, and the required mixture for pervious blanket and/or filter course is to be placed after the installation.

2.2.4.3.3 Spreading and profiling of the stone grain mixture for pervious blankets, filter courses and working field

After spreading, using the adequate machines, each layer is to be levelled in profile and graded, as required within the design documentation.

For coherent earth material formation of an extremely low bearing capacity where special technological conditions for the working field construction are envisaged according to the design documentation, the stone grain mixtures are generally spread with a light bulldozer or a grader.

2.2.4.3.4 Compaction of stone materials for pervious blankets, filter courses and working field

After spreading is completed, the full width of the course is to be compacted using rollers with smooth or pneumatic wheels.

In general, rolling is to be performed from the external course edges towards the middle and/or from the lower edge to the upper one. The number of necessary roller passing actions is to be determined by testing the compaction during the course of work. If course compaction is not possible to be carried out according to the design documentation, then additional compaction is to be performed in accordance with the instructions provided by the supervisory engineer.

Each area inaccessible to rollers is to be compacted with other compacting tools. The usage and conditions under which such tools are to be used is determined and approved by the supervisory engineer.

The application of the compacting tools and the technological procedure are to be previously tested in accordance with sub-clause 1.2.1.3.

If not otherwise specified by the technological conditions, for coherent materials of an extremely low bearing capacity where special technological conditions are envisaged in the design documentation for pervious blankets and/or filter courses and working field, only light rollers weighing up to 10 KN are allowed to be used for the compaction of the stone grain mixture (for surface shaping and preventing infiltration of fine particles filling from the subsequent layers).

2.2.4.3.5 Storing of stone materials and geotextiles

If the contractor has to store the incoherent materials and geotextiles for the separating layers, pervious blankets and/or filter courses and working file layers, then an area should be previously prepared and cleaned so as to prevent material contamination. The storing area for geotextiles for separating layers, pervious blankets and/or filter courses is to comply with regulations specified by the manufacturer.

2.2.4.3.6 Execution method for separating layers, pervious blankets and filter courses using geotextile

Geotextiles are only permitted to be incorporated in surfaces prepared in accordance with the technical conditions stated herein and in the following manner:
- by forming approximately 10 cm wide overlaps,
- by thermal welding of 10 to 15 cm wide overlaps,
- By 50 cm wide loose overlaps.

Laying geotextiles in separate strips with loose overlaps (50 cm each) is only permitted when the weather conditions prevent them from being formed or welded.

Laid geotextiles are generally to be covered with the filling material the same day, which is why it is to be laid in accordance with the work progress.

Geotextile windings are to be protected and stored according to the recommendations made by supplier or manufacturer.

Movement of vehicles over the laid geotextile is not permitted. Vehicle transport is only allowed for stone material layers for the working field of an adequate thickness (40 cm minimum), frontally spread over geotextiles.

2.2.4.4 Construction quality

2.2.4.4.1 Compaction of working field

Compaction of the stone grain mixture in the working field is generally to be determined by a swift and non-destructive procedure of density (and moisture) measuring, using an isotope gauge SRCS (sub-clause 1.2.4).

The compaction rate of the stone grain mixture incorporated in the working field is to be – related to the maximum density of the mixture according to the modified Proctor procedure – on average
- 95 %, if the working field is incorporated up to 2.0 m depth underneath the formation level, or
- 92 %, if the working field is incorporated deeper.

The lower value of an individual compaction result may deviate from the average value by up to 5 %.

2.2.4.4.2 Formation capacity

The bearing capacity of the formation for pervious blanket and/or filter course is to be specified in the design documentation. The requirements for such actions are to be specified in detail.

The bearing capacity of the formation for the working field is generally to be determined by measuring the static and dynamic deformation moduli specified in the guidelines SRDM, sub-clause 8.2.3.

The static deformation modulus E_{v2} on the working field formation should be a minimum of 50 MN/m^2, and the E_{v2} : E_{v1} ratio must not exceed 3.0.

The dynamic deformation modulus E_{vd} on the working field formation is to be a minimum of 25 MN/m^2.

The lower value of an individual result of the measuring static or dynamic deformation modulus may deviate from the specified value by 20%. The allowed number of such deviations must not exceed 10 % of the overall number of measurements.

2.2.4.4.3 Formation evenness

The formation pervious blanket and/or filter courses of a length of 4 m may deviate (in one direction in regards to the road axis) from the measuring bar or measuring plane by a maximum of 30 mm and from the working field formation by a maximum of 50 mm.

The specified evenness should be created. The contractor is not entitled to claim any additional payment for any necessary remedies of the completed works (for fulfilment of the aforementioned condition).

2.2.4.4.4 Formation height

The formation for the pervious blanket and/or filter course may deviate at one point from

the designed level by ± 30 mm maximum and from the working field formation by ± 50 mm maximum.

The specified height of the formation for pervious blanket and/or filter course and the working field layer should be created. The contractor is not entitled to claim any additional payment for any necessary remedies of the completed works for fulfilment of the aforementioned condition.

2.2.4.5 Quality control

Prior to the initial incorporation of the stone grain mixture and the geotextiles for pervious blankets, filter courses, separating and working field layers in the construction site, the institution (independent control) is bound to verify the certificates proving that all requirements have been met. When necessary, the institution may also conduct identification tests, if specified by the supervisory engineer.

2.2.4.5.1 Prior testing

At the beginning of the incorporation of the pervious blanket, filter course, separating and working field layers, the following is to be checked:
- The grain size of materials preventing access to subsequent or adjacent layers,
- grain size of materials planned for the pervious blanket, filter course and working field layer, and
- The geotextile properties.

Based on the aforementioned test results, the supervisory engineer may approve the incorporation procedure or require an alternate to the planned procedure or material and preparation, taking into consideration the incorporated/existing materials.

If the contractor, within the timelines, fails to provide the supervisory engineer with the applied verifications regarding the compatibility of the stone grain mixtures and/or the geotextiles planned for incorporation in the pervious blanket, filter course, separating and working field layers, then, under special conditions and if approved by the supervisory engineer, tests may be conducted at the beginning of the incorporation works in accordance with the technical conditions. The number of tests should be determined by the supervisory engineer, depending on the materials.

2.2.4.5.2 Incorporation verification

2.2.4.5.2.1 Internal control

The contractor should conduct internal controls to inspect the property compatibility of the stone grain mixtures in the pervious blankets, filter courses and working fields along with the incorporated course, as required within the design documentation and technical conditions.

The frequency and type of tests to be conducted by the internal control are determined in the approved programme of the average frequency and control. If these are not stated, they are to be determined by the supervisory engineer.

Sampling areas and measuring spots are to be determined by the supervisory engineer using a statistically random selection (sub-clause 1.4.1).

In the course of the incorporation of the stone grain mixtures in the pervious blanket or filter course and working field, the laboratory is to take samples and check the property compatibility with the frequency specified in table 2.2.4.4.

Table 2.2.4.4: Minimum frequency of stone grain mixture testing within the internal control for pervious blanket, filter course and working field layer

Stone grain mixture properties	Testing procedure	Minimum testing frequency for pervious blanket and filter course	Minimum testing frequency for working field
- mixture composition	EN 933-1	per 200 m^3	per 2000 m^3
- share of fine particles	EN 933-1	per 200 m^3	-
- density acc. modified Proctor procedure	EN 13286-2	per 400 m^3	per 8000 m^3
- humus and/or organic mixture rate	EN 1744-1	per 400 m^3	-

Table 2.2.4.5: Minimum testing frequency within the internal control for incorporated pervious blanket, filter course and working field layer

Properties of the incorporated course	Testing procedure	Minimum testing frequency for pervious blanket and filter course	Minimum testing frequency for working field
- moisture content and density of stone grain mixture	SRCS, sub-clause 1.2.4	per 20 m^1	per 40 m^1
- course capacity – dynamic deformation modulus E_{vd}	SRDM, sub-clause 8.3.3	per 40 m^1	per 40 m^1
- course capacity – static deformation modulus E_{v2}	SRDM, sub-clause 8.3.3	per 100 m^1	per 200 m^1
- course formation evenness and height	SRMG, sub-clause 3.1.2.1	per 20 m^1	per 40 m^1

The minimum number of tests within the internal control for stone grain mixtures in incorporated pervious blanket, filter course and working field layer is specified in table 2.2.4.5. course capacity – dynamic deformation modulus E_{vd}

2.2.4.5.2.2 Independent control

An Independent control should to supervise the internal control and determine the compatibility of the produced and incorporated mixtures of the stone grain and geotextile in the pervious blanket, filter course, separating and working field layers, testing the requirements provided in the design documentation and technical conditions.

The minimum testing frequency of the independent control for incorporation of the stone grain mixture in the pervious blanket, filter course and working field layer is specified in table 2.2.4.6.

The minimum number of tests within the independent control of the incorporated pervious blankets, filter courses and working field layers is specified in the table 2.2.4.7.

Table 2.2.4.6: Minimum testing frequency within the independent control of incorporation of layers for drainage, sliding and surface filtering

Properties of the incorporated materials	Testing procedure	Minimum testing frequency for pervious blanket and filter course	Minimum testing frequency for working field
- stone grain mixture composition	EN 933-1	per 1000 m^3	per 8000 m^3
- share of fine particles	EN 933-1	per 1000 m^3	-
- density acc. modified Proctor procedure	EN 13286-2	per 400 m^3	per 16000 m^3
- humus and/or organic mixture rate	EN 1744-1	per 4000 m^3	-

Table 2.2.4.7: Minimum testing frequency within the independent control of incorporated pervious blankets, filter courses and working field layers

Properties of the incorporated course	Testing procedure	Minimum testing frequency for pervious blanket and filter course	Minimum testing frequency for working field
- moisture content and density of stone grain mixture	SRCS, sub-clause 1.2.4	per 100 m^1	per 200 m^1
- course capacity – dynamic deformation modulus E_{vd}	SRDM, sub-clause 8.3.3	per 200 m^1	per 200 m^1
- course capacity – static deformation modulus E_{v2}	SRDM, sub-clause 8.3.3	per 400 m^1	per 800 m^1

2.2.4.6 Measuring and taking over

2.2.4.6.1 Measuring of works

The completed works are to be measured in accordance with the sub-clause 1.2.2.2 of the general technical conditions and the following provisions:

- The quantities of the stone grain mixtures incorporated in the pervious blankets, filter courses and working field layers in cubic metres in a compacted condition and in accordance with the actual quantity of the completed works within the design documentation. The value specified in the design documentation is to be considered as the limiting (top) thickness of the incorporated course
- The quantity of incorporated geotextiles in square metres in accordance with the actual quantity of completed works; the specified overlaps are not to be measured separately.

The contractor is bound to provide the supervisory engineer with the appropriate verifications regarding the geotextile quantities delivered to the site.

2.2.4.6.2 Taking over of works

The completed works are to be taken over in accordance with sub-clause 1.2.2.3 of the general technical conditions and according to the provisions of the special technical conditions stated herein.

The supervisory engineer is bound to take over the incorporated pervious blanket, filter course, separating and working field layers. The contractor is bound to submit in due time all the information and reports relating to the internal control of the compatibility and final evaluation of the compatibility, issued by an institution or an independent control.

The supervisory engineer is to take over the pervious blanket, filter course, separating and working field layers in accordance with the requirements specified in the technical conditions stated herein and according to any special and additional requests which are subject to contract documentation for the execution of works.

In case of any defects found in the taking over of the works, or the minimum quality requirements not being met, the contractor is bound to remedy the defects prior to the continuation of works. He is to remedy the defects at his own expense; including the costs of additional measuring and testing that are to be performed after the defects are remedied.

The contractor is not entitled to claim any payment for any work not remedied according to the supervisory engineer's instructions or not meeting the quality requirements specified in the technical conditions stated herein or in the design documentation and contract

In this case, the client is entitled to extend the warranty by 5 years for all the works depending on the incomplete works.

2.2.4.7 Calculation of works

2.2.4.7.1 General

The works are to be calculated in accordance with sub-clause 1.2.2.4 of the general technical conditions and the following provisions:

- Quantities determined in the sub-clause 2.2.4.6.1 are to be calculated according to the contract unit price which is to include all the works related to the delivery, transport, incorporation and all the other works envisaged by the design documentation and technical conditions and are compulsory for the completion of the works. The contractor is, thus, not entitled to claim any additional payment.
- Stone grain mixtures for the pervious blankets filter courses and working field layers are to be calculated in cubic metres of the incorporated materials.
- Geotextiles for the pervious blankets, filter courses, separating and working field layers are to be calculated in square metres of the incorporated materials.

If the contractor incorporates material not meeting the minimum requirements into the pervious blanket, filter course, separating or working field layers, or does not provide the required capacity of the working field formation, the calculation procedure is then to be determined by the supervisory engineer.

2.2.4.7.2 Deductions due to inappropriate quality

2.2.4.7.2.1 Stone material

The quality of the stone material for pervious blankets, filter courses and working field layers, determined in sub-clause 2.2.4.2.1, is to be provided.

There are to be no deductions in the calculation due to the required appropriate quality of the stone material.

2.2.4.7.2.2 Geotextiles

The minimum requirements for geotextiles for the separating layers, pervious blankets and filter courses, determined in sub-clause 2.2.4.2.2 and in the design documentation, are to be provided and, thus, there are to be no deductions in the calculation.

2.2.4.7.2.3 Compaction of stone material

The minimum requirements for compaction of the stone material incorporated in the working field, determined in sub-clause 2.2.4.4.1, are to be provided.

There are to be no deductions in the calculation due to the required appropriate quality of compaction of stone material.

2.2.4.7.2.4 Bearing capacity

The bearing capacity of the working field formation, determined in sub-clause 2.2.4.4.2, is to be provided and, thus, there are to be no deductions in the calculation.

2.2.4.7.2.5 Formation evenness

There are to be no deductions in the calculation due to the required appropriate evenness of the formation of pervious blankets, filter courses and working field layers (under sub-clause 2.2.4.4.3).

2.2.4.7.2.6 Formation height

There are to be no deductions in the calculation due to the required appropriate height of the formation of pervious blankets, filter courses and working field layers (under sub-clause 2.2.4.4.4).

2.2.5 EMBANKMENTS, FILLINGS AND FORMATION LEVEL

2.2.5.1 Description

The guideline for the embankments, fillings and formation level includes:
- The mechanical spreading of materials for embankments,
- The mechanical and/or the manual spreading of materials in foundation backfills, trenches, construction pits, reclamation and regulation canals and drainage channels,
- The mechanical and/or the manual spreading of materials in wedges for structures or at the transition areas from cuts to fills,
- The mechanical and/or the manual spreading of materials for the formation level in accordance with the requirements specified in the design documentation and/or by the supervisory engineer and according to the technical conditions stated herein,
- The moistening, mixing, rough grading and compaction of materials in embankments, fillings and wedges in doses and qualities specified in the design documentation and technical conditions stated herein,
- The mechanical spreading of materials for prior load and overload at areas envisaged by the design documentation and in accordance with the technical conditions stated herein,

- The formation level construction in dimensions and quality specified in the design documentation and technical conditions,
- The arrangement of formation for the top layers of the embankment, filling and formation level, as specified in the design documentation and according to the technical conditions stated herein.

2.2.5.2 Basic materials

2.2.5.2.1 Coherent and incoherent materials

2.2.5.2.1.1 General

For embankments, fillings and formation level, it is possible to use the appropriate coherent or incoherent materials according to the design documentation, including soft and hard rocks, fly ash from thermal and heating power plants, as well as the appropriate secondary raw materials (slag, recycled construction materials).

Neither humus, soft soil nor any other material subject to changes in mechanical and physical properties due to biochemical process over time is permitted to be incorporated in embankments, fillings and formation level.

Materials for embankments, fillings and the formation level may be obtained by excavations in alignment and/or borrow pits.

Materials used for the construction of embankments, fillings and formation level are specified in sub-clause 2.2.2.2 of the technical conditions stated herein.

Materials for embankments, fillings and formation level are to meet the following requirements:
- moisture content at a specified density in the course of compaction,
- Humus and/or organic mixture content in materials must not affect the colour of the sodium hydroxide solution to be darker than the reference colour in the course of testing according to EN 1744-1. Organic substances may also be determined with hydrogen peroxide or sulphuric acid.

The contractor is to acquire the supervisory engineer's professional opinion on the applicability of materials from each typical large excavation or area providing local materials or secondary raw materials for embankments, fillings and formation level.

2.2.5.2.1.2 Coherent earth materials

The applicability of the coherent earth materials is to be determined by preliminary testing of typical samples taken from the excavation and/or borrow pit. The following properties are to be tested:
- moisture content,
- optimum moisture content and maximum density obtained with the standard Proctor procedure,
- consistency limits and
- Humus and/or organic mixture rate.

Medium and high plastic clays (with a liquid limit of $W_L > 35$ % plasticity index of $I_p > 12$ %) are not permitted to be placed in the finishing layers unless they are to be hardened or stabilised with a binder. The crucial criterion for determining the assessment of the coherent earth material quality for hardening or stabilising with a binder is the endurance of the mixture.

It is not permitted to place dust and sand of equal grain size into the finishing layers of embankments, fillings and formation level since they might drain out with water.

The type and number of coherent earth material testings are to be determined in the programme of the average frequency and control. Otherwise, they are to be determined by the supervisory engineer.

2.2.5.2.1.3 Incoherent materials

The applicability of incoherent materials for embankments, fillings and formation level is to be determined by preliminary testing of typical samples taken from the excavation and/or borrow pit. The following properties are to be tested:
- grain size
- optimum moisture content and maximum density obtained with the modified Proctor procedure, and
- Humus and/or organic mixture rate.

The ratio of non-uniformity of incoherent materials $U = d_{60}/d_{10}$ for embankments, fillings and formation level is to be at least 6, with recommended values of $8 \leq U \leq 50$.

The largest grain in the incoherent materials for embankments, fillings and formation level must not be larger than 2/3 of the layer thickness (layer thickness corresponds to 1.5 of the diameter of the largest grain) but must not exceed 300 mm (in 10 m.-% of the total material mass grain diameter that can range

from 300 to 400 mm), unless otherwise specified in the design documentation.

The largest grain in the incoherent materials for the formation level must not exceed 1/2 of the incorporated layer thickness and, generally, must not be larger than 125 mm.

Any deviation from the abovementioned conditions may only occur if the required properties of the incorporated layer of incoherent material are verified by the incorporation in the testing section.

Prior tests for incoherent materials containing grains with a diameter above 30 mm are to determine:
- the density of the incorporated layer made of the appropriately thick material (replacement method under sub-clause 1.2.4.3) which may be used as a base for further compaction measurements of the top layer material, and
- the optimum moisture of material.

If the incoherent material is incorporated in embankments, fillings and formation level up to the critical frost depth h_{min}, determined by the pavement dimensioning procedure (in reference book SRDM, sub-clause 8.2.4), in unfavourable hydrological conditions (high water table, possibility of capillary water elevation), it may contain:
- when U ≥ 15:
  - in the landfill up to 5 m.-% of grain size up to 0.063 mm (category f_5),
  - incorporated, up to 8 m.-% of grain size up to 0.063 mm (category f_8),
- when U ≤ 6:
  - up to 15 m.-% of grain size up to 0.063 mm (category f_{15}),

The intermediate values between the abovementioned limiting values are to be determined by linear interpolation.

Within an area of frost penetration h_m (below the critical frost depth h_{min}), the mixture of the volume constant grains must contain ≤ 15 m.-% of grain size up to 0.02 mm (according to the USCS classification).

If the incoherent material for embankments, fillings and formation level is not resistant to decay, it is to be appropriately protected from the weather conditions immediately after incorporation.

Pre-consolidated clays, marls and other materials subject to disintegration due to weather conditions are to be crushed and incorporated in a way to avoid any remaining unfavourable effects.

2.2.5.2.2 Binders for upgrading, hardening and stabilising

Hydraulic binders such as dry hydrate, pozzolan or blast-furnace cement may be used for upgrading, hardening or stabilising natural materials in embankments, fillings and formation level. Fly ash may also be used. Depending on its composition and if necessary, an adequate quantity of lime for bind enhancing (electrostatic filter-based mortar) may be added.

Fly ash with fine pozzolan properties and volume constancy is appropriate for incorporating in embankments, fillings and formation level. The old crushed fly ash appropriate for binding can also be used.

When certain conditions require lightest lightweight of embankments, fillings and formation level, fly ash with the lowest volume weight is appropriate to use.

The typical properties of fly ash are optimum moisture content and maximum density, determined by the preliminary test according to the standard Proctor procedure. The type and number of tests are to be determined in the testing programme. Otherwise, they are to be determined by the supervisory engineer.

All the binders providing properties defined in sub-clause 2.2.5.4 may be used for upgrading, hardening and/or stabilising the natural materials in embankments, fillings and formation level.

Therefore, the applicability of any binders is to be verified with the appropriate certifications and preliminary tests regarding:
- binder type,
- binding capacity (compressive strength) and
- commencement and completion of binding.

The type and number of binding tests are to be determined by the programme of average frequency and control. Otherwise, they are to be determined by the supervisory engineer.

Prior to using, the binders for upgrading, hardening and/or stabilising the material should be properly stored (in silos and/or tanks).

2.2.5.2.3 Secondary raw materials

If secondary raw materials are used for embankments, fillings and/or formation level, then their chemical inertness and resistance to extraction are to be verified.

2.2.5.2.4 Prior testing of materials

Prior to incorporation into embankments, fillings and formation levels, all the required properties of the coherent and incoherent materials, binders and mixtures are to be tested, if so determined by the supervisory engineer.

In general, a single typical sample of the material is sufficient for the prior tests for the required properties of the materials. In special circumstances, the supervisory engineer is entitled to determine any additional number of samples.

At the request of the supervisory engineer, the contractor is bound to provide and conduct all the prior tests of applicability of the coherent and incoherent materials, binders, secondary raw materials and mixtures, unless the test results are already included in the design documentation or additional information. The contractor is not entitled to claim any additional payment for such tests.

2.2.5.2.5 Earth material depositing

The surface is to be properly prepared for temporary depositing. The typical properties of the temporary deposited materials are to be retained.

A permanent landfill is to be prepared and arranged in accordance with the design documentation, providing stability, drainage and adaptation to the environment.

2.2.5.3 Execution method

2.2.5.3.1 Preparation of the subgrade formation

The incorporation of embankments, fillings and formation level may commence when the subgrade (foundation soil) formation is arranged in accordance with the requirements specified in the design documentation and technical conditions stated herein under sub-clause 2.2.3 and/or separating layer, pervious blanket or filter course is incorporated according to sub-clause 2.2.4 and after the completed work is taken over from the supervisory engineer.

2.2.5.3.2 Transport of materials and binders

The transport of materials to the properly prepared subgrade formation (under sub-clause 2.2.5.3.1) may commence only after it is approved by the supervisory engineer. If there is a possibility of unfavourable weather conditions or the completed works protection is in danger the supervisory engineer

Materials for the embankments, fillings and formation level are generally not permitted to be distributed over the subgrade formation, but only over the spread material course. With the utilisation of machines, the prepared material is to be frontally or laterally moved to the incorporation spot.

The lead openings of the vehicles distributing the materials are to be distributed as equally as possible over the entire width of the spread layer formation.

Appropriate vehicles are to be used for the distribution of the binders for upgrading, hardening and/or stabilising the coherent and/or incoherent materials.

Vehicles with muddy wheels or chassis must not move over the spread or compacted stone grain mixture for the formation level.

2.2.5.3.3 Spreading and grading

Each material course for embankments, fillings and formation level should be spread and graded in a longitudinal direction along the slope, equal to the designed longitudinal road grade.

In the cross direction, each material course is to be spread in a single-sided or double-sided (roof) cross grade, which is to be at least 3 % for coherent material. For incoherent material, fly ash, secondary raw materials and hardened and stabilised coherent materials the cross grade of a course is to be similar to the designed grade of the road surface.

If, due to provided and field conditions, the arranged foundation soil formation does not have the appropriate cross grade for drainage (3 %), then the minimum cross grade is to be provided with the first incorporated course of the embankment or filling.

Each material course is to be immediately spread to the full width providing the required quality to the embankment edge (slope) after the rough grading and course compaction.

The thickness of each course of spread and graded material is to be in accordance with the depth effects of the planned compacting tools and properties of the used materials, which are to be tested by incorporation in the test section.
The material must not be spread nor incorporated on frozen surfaces, and frozen materials must not be incorporated in embankments, fillings and formation levels.

2.2.5.3.4 Upgrading, hardening and/or stabilising the materials

Material upgrading (coherent earth material above all) with binders is necessary in order to provide the appropriate quality for inappropriate materials for embankments, fillings and formation level.

Hardening and stabilising the materials with binders to provide preservation to enhanced the properties of natural materials under unfavourable weather conditions.

Binders for upgrading, hardening and/or stabilising the materials are to be spread over the previously properly prepared formation of the spread and profiled materials in the amount (according to the requirements specified in the design documentation and/or additional information) and the manner that will provide the required uniformity of the added binder (dosing accuracy ± 1 kg/m^2) and obtained properties of the material.

The spread binder is to be mixed with material utilising machines in the course which generally at least 15 cm thick is providing a uniformity of the mixture of material and binder.

To provide the uniform and optimum moisture content of the hardened and stabilised material, water is added where necessary. Mixing is used to provide uniformity to the mixture and of the material containing water for the entire designed course thickness.

Upgrading, hardening and/or stabilising the materials with binders are only possible at temperatures above + 3 ˚C and in dry weather.

As the angle of internal friction increases with the hardening and stabilising of the natural materials, an appropriate increase in the slope grade is also possible.

2.2.5.3.5 Incorporation of fly ash

Fly ash is generally be incorporated in the road body in an appropriate manner and with optimum moisture. The optimum moisture of the fly ash is to be provided (by homogenization) at the location of obtaining or incorporating. The moisture content of the fly ash to be transported by vehicle may be lower (approximately 15 m.-%), and the remaining amount of water that is necessary can be added be added at the location of incorporating.

The contractor may transport dry fly ash in tanks and homogenize it with water at the site. Additional silos and homogenization devices are necessary for such deliveries.

2.2.5.3.6 Compacting

After spreading and grading, the incoherent materials and coherent earth materials hardened and/or stabilised with binders are to be compacted to layers of an appropriate thickness (for the full width of the layer) with rollers with smooth or pneumatic wheels, and the appropriate natural and/or upgraded coherent earth materials are to be compacted with sheepsfoot rollers and those with smooth wheels.

In general, compaction is to be performed from the external edge towards the middle of the compacted surface and from the lower edge towards a higher one. To provide the appropriate compaction and bearing capacity over the entire designed width of the course, each edge should be widened by the designed course thickness + 10 cm.

The height of a single spread material course should be in accordance with the depth effect of the used compacting tools, the type of the embankment material and the required compaction of the material incorporated in the embankment.

All areas inaccessible to rollers are to be hardened by other compacting tools as required by the design documentation or by procedures approved by the supervisory engineer. The supervisory engineer also determines the conditions under which the tools or procedures are to be implemented.

The usability of the compacting tools and technological procedures should be

previously tested in the test section and in compliance with sub-clause 1.2.1.3 of the general technical conditions. The compacting tool rate is to be measured after each passing for each material course.

The following should be completed at the embankment course formation after the compaction is completed:
- Measurement of density and moisture content by a non-destructive procedure with an isotope gauge, and the results verified by conducting other appropriate procedures for determining the density and moisture content (sub-clause 1.2.4),
- Measurement of the bearing capacity by determining the static and dynamic deformation modulus according to the reference book SRDM, sub-clause 8.3.3, and
- Taking of samples of material from the testing area to determine the optimum moisture content and density using the Proctor procedure (EN 13286-2).

The technological procedure and compacting tool type are to be determined in detail prior to the commencement of the works and based on the results of the tests conducted at the test section.

If the density of the incorporated material is assessed by a procedure of continuous measurements, a system calibration should be conducted at the test section.

Prior to compaction, each course of materials and/or mixture must contain the appropriate amount of water to provide compaction to the material type to reach the required density.

If necessary, the supervisory engineer may determine additional procedures that will provide the appropriate moisture content of the material and appropriate incorporation.

If the contractor does not proceed with works on the subsequent course immediately after the compaction and quality check but after a prolonged period of time and under various weather conditions, the density of the incorporated material or mixture should be checked prior to continuation of the works. The works may proceed only if the quality is appropriate.

The construction of embankments, fillings and formation level is to be ceased when it is not possible to obtain the required material compaction due to atmospheric conditions.

If the contractor is responsible for any delays, the expenses for additional measurements and any additional necessary improvements are to be borne by the contractor. Otherwise, all the expenses are to be borne by the client.

The binder compaction of the hardened and stabilised materials should be completed during the period of time determined by the technological procedure.

The contractor has the right to propose an alteration of the technological procedure to the client. In such case, he is to verify the quality of the proposed alteration in comparison to the envisaged works by providing prior test results which he is to conduct at his own expense.

2.2.5.3.7 Storing of materials and binders

If, prior to incorporation, the contractor stores natural materials, fly ash and/or secondary raw materials planned to be used for embankments, fillings and formation level, then the area for such purpose must be previously appropriately prepared and cleaned in order to prevent the mixing of useful and inappropriate materials.

Binders for upgrading, hardening and/or stabilising of the materials are generally to be stored in silos or tanks.

2.2.5.3.8 Arrangement of formation level

The arrangement of the formation level includes
- for incoherent material – grading of the remaining peaks and, in some cases, filling of the stone grain mixtures for levelling (in course thickness of up to 10 cm), as well as spreading, wetting, fine grading and compacting the levelling course,
- Fine grading of the formation in the coherent earth materials, upgraded, hardened and/or stabilised natural materials and fly ash.

In cases where the high natural moisture content of the materials prevents the appropriate compaction of the formation level, the supervisory engineer is entitled to specify the necessary measures needed to provide the required quality of the executed works.

For material incorporation into embankments behind the end posts (wedges), additional

execution conditions are to be considered, alongside the specified ones.

The contractor is bound to fill the foundation excavation up to the field level in accordance with the technical conditions stated herein regarding works on embankments and this should be in alignment with the direct vicinity, which should be verified by measurement.

Embankments behind the end posts of the structure are to be constructed as follows (gradually in the completed embankment or field, if necessary)

- from the top to a 2 m depth below the formation level, the slope connected to the embankment to be graded 1:4,
- in the upper half of the remaining height, the grade is 1:3,
- in the lower half of the remaining height, the grade is 1:2,
- At the post foundation, the distance between the slope connected to the embankment and the post is at least 1 m.

Works above the foundation soil are general considered as embankments behind the end posts of the structure.

Embankment areas behind the end posts underneath the transition slabs are to be consolidated prior to slab installation to the degree specified in the design documentation.

Wedges between the embankment and the excavation area should be constructed in the excavation area

- up to a depth of 1.0 m in coherent earth materials, and
- up to a depth of 0.3 m in incoherent materials,

and in cases of a thicker decay layer, they should be placed deeper according to the supervisory engineer's instructions, and with a longitudinal grade of 1:4, allowing the decay i to be completely removed in the course of the contact between the embankment and excavation.

Transition embankments are to be constructed with materials similar to those used for the upper course of the adjoining embankment.

The connection of embankments in excavations in incoherent material to the levelling course of the stone mixture is to be executed to a thickness of 10 cm.

2.2.5.4 Construction quality

2.2.5.4.1 Compaction

The contractor is bound to verify the compaction of each course of the embankment, filling and formation level by providing test results (within the internal control) conducted by the procedure of (non-destructive) measuring the density and moisture content by an isotope gauge (sub-clause 1.2.4).

The required compaction values for materials incorporated in embankments, fillings and formation level are presented in table 2.2.5.1. According to the table, the required compaction values represent the average values. The lower value of a result must not be lower than the appropriate average value by more than 3 %. The permitted number of these deviations must not exceed 10 % of the overall number of measurements.

The compaction of material courses for embankments, fillings and formation level should reach the lower value at each measuring spot. The contractor is bound to compact the inappropriately compacted material courses in accordance with the conditions specified in the technical conditions and with no additional payment.

2.2.5.4.2 Bearing capacity

If the compaction has not been measured, the contractor is bound to verify the bearing capacity of the materials incorporated in embankments and fillings by providing the bearing results of the internal control.

The contractor is bound to verify the bearing capacity of the formation level by providing results of the internal control.

The bearing capacity should generally be determined by measuring the static and/or dynamic deformation moduli.

In general, deformation moduli are to be measured at the formation of the embankment upper course, but at the depth of not more than 0.5 m below the formation level, along with at the formation level.

Table 2.2.5.1: Requirements for the compaction and capacity of the embankment, filling and formation level

Description of works	Required compaction in regard to density of material acc. SPP | acc. MPP %		Required capacity E_{v2} MN/m^2
- Embankments and fillings over 2 m underneath the formation level made of			
- coherent earth material	95	-	-
- upgraded coherent material	95	-	-
- hardened and stabilised material and fly ash	95	-	-
- incoherent material	-	95	-
- Embankments and fillings less than 2 m underneath the formation level to the formation level made of			
- coherent earth material	98	-	15
- upgraded coherent material	98	-	20
- hardened and stabilised coherent material and fly ash	98	-	30
- incoherent material	-	98	60
- Embankments and fillings at the formation level made of			
- coherent earth material	100	-	20
- upgraded coherent material	100	-	25
- hardened and stabilised coherent material and fly ash	100	-	40
- incoherent material	-	100	80

SPP – standard Proctor procedure
MPP – modified Proctor procedure
E_{v2} – deformation modulus

The required lower values of the static deformation moduli E_{v2} are indicated for certain required measuring spots in table 2.2.5.1. The lowest value of an individual measurement (up to 5 % of the overall number of measurements) may be lower by 20 %.

The ratio of the static deformation moduli E_{v2}:E_{v1} for coherent and incoherent materials must not exceed 2.2. If the measured value of the static deformation modulus E_{v1} exceeds 50 % of the required value of the static deformation modulus E_{v2}, the required ratio is not crucial for the evaluation of bearing capacity of the incorporated material course.

For courses of incoherent materials for embankments and fillings, the ratio of the static deformation moduli E_{v2}:E_{v1} must not exceed 3.0.

The values of the dynamic deformation moduli E_{vd} may be at least 50 % of the specified values of the static deformation moduli E_{v2}.

The formation capacity of the course of fly ash, hardened and stabilised material may

generally be controlled only 7 days after compaction of the incorporated mixture.

The capacity of the material courses for embankments, fillings and formation level as a takeover criterion instead of compaction are to be approved by the supervisory engineer, who may also determine additional conditions for evaluating the capacity results.

2.2.5.4.3 Hardened and stabilised materials

The contractor is bound to verify the properties of the materials hardened and/or stabilised with binders (mixtures) by providing the internal control results regarding:

- The compressive strength of the specimen made of hardened or stabilised material and prepared in accordance with the conditions based on the appropriate Proctor procedure, conducted on a specimen preserved for 7 days and providing the following results:
  - 0.5 MN/m² for coherent materials,
  - 2.0 MN/m² for incoherent materials,
- The endurance of a specimen made of hardened or stabilised material and prepared under the described conditions which is determined by the ratio of compressive strengths of dry and moistened (for 24 hours) specimens after 7 days and is to be at least 0.70.

The supervisory engineer may alter the specified conditions for the quality of hardened and stabilised materials for embankments, fillings and formation level in accordance with the design.

The required mixture compressive strength values are the average values.

The lower value may be lower by 20 %, and the lowest value may be lower by 40 % than the specified required compression strengths.

2.2.5.4.4 Course evenness

The contractor is bound to incorporate each course of the embankment, filling and formation level in accordance with the conditions specified in sub-clause 2.2.5.3.

The top course formation evenness may deviate in one direction in regards to the road axis (except in the formation level) from a 4 meter long measuring bar or measuring plane by a maximum of

- 30 mm in coherent earth materials, upgraded, hardened and stabilised materials, fly ash and secondary raw materials,
- 50 mm in coarse-grained rocks.

The contractor is to remedy any defects due to the inappropriate evenness of the incorporated material courses for embankments and fillings, at his own expense.

If such evenness deviations are continuous, the supervisory engineer should determine remedial action

2.2.5.4.5 Formation level height and grade

Transport over the formation level is not permitted, as vehicle and machine movements could damage the formation level which might disturb the normal water runoff.

The formation level may deviate at any place from the designed level by a maximum of 20 mm.

The formation level grade is generally to be equal to the cross and longitudinal grades of the road surface and may deviate from the planned grade by a maximum of ± 0.4 % of the absolute grade value.

2.2.5.5 Quality control

Prior to commencement of works, a technology procedure should be determined for each typical type of material incorporated in the embankment, filling or formation level, as well as the type of compacting tool and its depth effect.

Completed works should be in accordance with the requirements specified in the design documentation and technical conditions and this will be verified by

- The prior testing of the properties of materials planned to be incorporated in the embankments, fillings and formation level, and
- An incorporation check by the internal or independent control.

2.2.5.5.1 Prior testing

At the beginning of incorporation of the earth materials in the embankment, filling and formation level, the contractor is bound to verify the material properties indicated in table 2.2.5.2.

2.2.5.5.2 Incorporation verification

2.2.5.5.2.1 Internal control

The contractor's internal control in the course of works must verify whether the properties of all materials used for embankments, fillings and formation level are in accordance with the requirements specified in the design documentation and technical conditions.

The frequency and type of tests within the internal control are to be determined in the approved programme of the average frequency and control. If not, they should be determined by the supervisory engineer.

Sampling areas and measuring spots are to be determined by the supervisory engineer using a statistically random selection (sub-clause 1.4.1).

Table 2.2.5.2: Prior testing of materials for embankments, fillings, wedges and formation level

Material properties	Measure-ment Unit	Required Value	Testing procedure
- Applicability of material:			
- natural moisture	m.-%	sub-clause 2.2.5.2	EN 13286-46
- Proctor-based testing:			EN 13286-2
- optimum moisture	m.-%	-	
- maximum density	t/m^3	-	
- consistency limits:			TS CEN ISO 17892-12
- liquid limit w_L	%	≤ 35	
- plasticity index I_p	%	≤ 12	
- humus and/or organic mixture rate	-	sub-clause 2.2.5.2	EN 1744-1
- granulometric composition of incoherent material	m.-%	sub-clause 2.2.5.2	EN 933-1
- Binder applicability:			
- binding capacity:			
- mixture compressive strength:			EN 12390-2
- coherent earth material	MN/m^2	≥ 0,5	
- incoherent material	MN/m^2	≥ 2,0	
- endurance	-	≥ 0,7	-
- commencement and completion of binding	h	-	EN 196-3

In the course of incorporation of materials in the embankment, filling and formation level, the laboratory is to take samples and check the property compatibility with the frequency specified in table 2.2.5.3.

If, based on the results of internal control tests, the supervisory engineer determines that higher deviations than in the results of previous tests have been seen; the extent of the internal control is subject to alteration. In case of homogenous test results, the supervisory engineer is entitled to reduce the extent of the internal control.

Table 2.2.5.3: Minimum frequency of material testing within the internal control of the incorporation of embankments, fillings and formation level

Material properties	Testing procedure	Minimum testing frequency
- granulometric composition of incoherent material	EN 933-1	1000 m^3
- natural moisture	EN 13286-46	1000 m^3
- Proctor-based testing	EN 13286-2	4000 m^3
- consistency limits of coherent earth material	TS CEN ISO 17892-12	4000 m^3
- humus and/or organic admixture rate	EN 1744-1	4000 m^3

The minimum number of tests is within the internal control of the incorporation of embankments, fillings and formation level is specified in table 2.2.5.4.

The quality of the incorporated courses may be determined according to other approved procedures, if agreed with the supervisory engineer. In such case, the supervisory engineer's consent must indicate the criteria for the incorporation quality as well as the manner and extent of testing.

Table 2.2.5.4: Minimum testing frequency within the internal control of the incorporation of embankments, fillings and formation level

Material properties	Testing procedure	Minimum testing frequency	Evaluation base
- moisture content and natural material density	TS CEN ISO 17892-12	200 m^3/20 m^1	sub-clause 2.2.5.2.1
- quantity of spread binder		100 m^1	
- granulation:			
- moisture content and density	SRCS, sub-clause 1.2.4	200 m^3	sub-clause 2.2.5.3.4
- compressive strength	EN 12390-3	100 m^1	sub-clause 2.2.5.4.3
- endurance		200 m^1	sub-clause 2.2.5.4.3
- coarse-grained rock density	SRCS, sub-clause 1.2.4	4000 m^3/200 m^1	sub-clause 2.2.5.4.1
- formation of embankment, filling and formation level			
- bearing capacity:	SRDM, sub-clause 8.2.3		sub-clause 2.2.5.4.2
- deformation modulus E_{vd}		10 m^1	
- deformation modulus E_{v2}		100 m^1	
- evenness	SRMG, sub-clause 3.1.3.1	20 m^1	sub-clause 2.2.5.4.4
- height		20 m^1	sub-clause 2.2.5.4.5

2.2.5.5.2.2 Independent control

The ratio of the extent of independent control that is generally conducted by an authorised institution is 1:4 to the internal control.

The sampling areas and spots for measuring evenness, heights, densities, moisture and bearing capacity are to be determined by the supervisory engineer with a statistically random selection (sub-clause 1.4.1).

2.2.5.6 Measuring and taking over of works

2.2.5.6.1 Measuring of works

Completed works are to be measured in accordance with sub-clause 1.2.2.2 of the general technical conditions and the following provisions:

- quantities of materials incorporated in embankments, fillings and formation level are to be measured in cubic metres
- Quantities of the incorporated material formation are to be measured in square metres.

All the quantities are to be measured according to the actually executed extent and type of works within the design documentation.

The contractor is bound to submit the appropriate verifications for all the quantities of binders, fly ash, secondary raw materials and other materials delivered to the site.

2.2.5.6.2 Taking over of works

Each completed course of embankment, filling and formation level is to be taken over by the supervisory engineer in accordance with the quality requirements specified in the technical conditions stated herein and according to sub-clause 1.2.2.3 of the general technical conditions. Prior to proceeding with works, the contractor is bound to remedy all the defects determined according to the requirements.

All the expenses for remedying defects are to be borne by the contractor, including the ones for measuring and testing proving the inappropriate quality of the executed works, thus resulting in additional work to test for quality after the adequate remedying.

The contractor is not entitled to claim any payment for any works not meeting the quality requirements determined in the technical conditions which he failed to remedy according to the instructions provided by the supervisory engineer. In such case, the client is entitled to extend the warranty period for at least 5 years for any works depending on the ones not remedied.

2.2.5.7 Calculation of works

2.2.5.7.1 General

Completed works are to be calculated in accordance with sub-clause 1.2.2.4 of the general technical conditions.

Quantities determined according to sub-clause 2.2.5.6 are to be calculated by the contract unit price.

The contract unit price is to include all the services necessary for the ultimate completion of works. The contractor is not entitled to subsequently claim any additional payment.

If necessary, the supervisory engineer is to determine delimitation of the works between the alignment earthwork contractor and structure contractor.

2.2.5.7.2 Deductions due to inappropriate quality

2.2.5.7.2.1 Materials for embankments, fillings and formation level

There are to be no deductions in the calculation of completed works due to the required appropriate quality of materials.

2.2.5.7.2.2 Binders for upgrading, hardening and stabilising the materials

There are to be no deductions in the calculation due to the required appropriate quality of binders.

2.2.5.7.2.3 Compaction and bearing capacity

The lower values of compaction and bearing capacity as well as certain values reaching the lowest value (up to 5 % of the overall number of measurements) refer to 100 % of the value in terms of the tender unit price.

There are to be no deductions in the calculation due to the required appropriate quality of compaction and bearing capacity.

2.2.5.7.2.4 Hardened and stabilised materials

The lower quality value specified in sub-clause 2.2.5.4.3 refers to 100 % of the value in terms of the tender unit price, and the lowest value is the work with no value. Intermediate values are to be determined by linear interpolation.

2.2.5.7.2.5 Formation evenness

There are to be no deductions in the calculation due to the required appropriate evenness of the formation (under sub-clause 2.2.5.4.4).

2.2.5.7.2.6 Formation height

There are to be no deductions in the calculation due to the required designed height of the formation (under sub-clause 2.2.5.4.5).

2.2.6 SLOPES AND LANDSCAPING

2.2.6.1 Description

The guideline determines the arrangement and protection against erosion of slopes, excavations, embankments and grassed areas by
- spreading humus and sowing grass,
- bio shotcrete with litter,
- planting decorative trees and shrubs,
- meshes,
- rubble placing,
- stone cladding (dry penning)
- shotcreting, and
- Using prefabricated elements (cribwork, cement concrete hollow elements, grassing slabs and similar elements).

The works include
- all materials, including loading, transport and unloading,
- surface preparation,
- sowing and planting,
- Incorporating and hardening the materials.

2.2.6.2 Basic materials

The execution of the works requires the utilisation of appropriate materials for the various methods of arranging and protecting slopes and grassed areas.

The following materials may be used for the vegetative protection of slopes and green areas:
- humus,
- straw and hay for the litter,
- osiers, seedlings,
- trees and shrubs, and
- grassing seeds.

Construction protection of slopes may be provided by
- using woven meshes,
- rubble placing,
- stone cladding (dry penning)
- shotcreting, and
- using prefabricated elements.

The quality of all used materials is to be in accordance with the general and special technical conditions and requirements specified for the materials.

Prior to the commencement of works, the contractor is bound to provide the supervisory engineer with the compatibility verifications of all the products he intends to use for slope protection.

2.2.6.2.1 Vegetative protection

2.2.6.2.1.1 Humus

Active humus material providing permanent growth is to be used for the arrangement of slopes and grassed areas.

2.2.6.2.1.2 Litter

The thickness of the litter made of straw or hay is to provide the grassing and a durable protection when appropriate fertilizing and bituminous emulsion spray are provided.

2.2.6.2.1.3 Wicker-work

For wicker-work, fresh and living osiers (selix purpurea) of 0.5 to 3 cm thickness or other types approved by the supervisory engineer are to be used. The types used are to provide vegetative reproduction.

It is also possible to use stronger and more stable anti-erosion witter-work with vegetative aquifers or seedlings. Props for witter-work are to be 70 to 80 cm long and 2 to 3 cm thick.

2.2.6.2.1.4 Trees and shrubs

The types of trees and shrubs should meet the biological conditions. Seedlings that provide permanent growth are to be selected.

The types of trees and shrubs that resist the effects of wind and snow are to be selected for locations exposed to wind.

2.2.6.2.1.5 Grassing seeds

Mixed grass and clover seeds that meet the biological (effects) conditions and that provide permanent growths are to be selected for grassing. It is also possible to use corn seeds for temporary protection.

2.2.6.2.2 Construction protection

2.2.6.2.2.1 Protection by meshes

Woven meshes of double-galvanized steel wire with a diameter from 1.6 mm to 3.1 mm and an overall thickness of the protective zinc coat of at least 0.07 mm may be used. The wires may be woven in meshes with rectangular or hexagonal openings of 5 to 10 cm in size.

Double-galvanized anchors made of steel with a 0.07 – 0.08 mm thick anti-corrosion protective coat may be used for fixing the meshes. Double-galvanized pipes of 3/2" diameter (external diameter 48.25 mm, wall thickness 3.5 mm) with at least a 0.07 mm thick protective zinc coat may also be used for additional fixing of meshes on the slopes.

Cement concrete weights of an appropriate shape and size according to the design documentation may be used for straining the protective woven meshes. The cement concrete for weights should be in accordance with the applied cement concrete requirements (EN 206-1).

2.2.6.2.2.2 Rubble placing and stone cladding (dry penning)

The rubble for placing and dry penning should be sound and durable.

Unfinished rubble is used for placing and dry penning. The thickness of the rubble for placing must not exceed 50 cm, and the thickness of the rubble for dry penning is not to exceed 30 cm.

2.2.6.2.2.3 Concrete spraying protection

Cement concrete and reinforcing steel meshes for the protection of slopes by shotcreting should be in accordance with the conditions specified in the design documentation.

2.2.6.2.2.4 Protection by prefabricated elements

Prefabricated elements for the protection of slopes should be in accordance with the applied technical regulations, including all the basic materials. Prefabricated elements are to be selected according to the intended purpose and to the instructions provided by the manufacturer.

2.2.6.3 Execution method

2.2.6.3.1 Vegetative protection

Vegetative protection is to be performed at locations and in the manner specified in the design documentation and the technical conditions stated herein.

The contractor is to perform the vegetative protection of works so that protected areas are optimally overgrown regardless of the required quality and conditions. The contractor is bound to subsequently repeat any unsuccessful works.

On slopes with smooth surfaces where landslips might occur, the roughness should be provided by 15 cm wide horizontal cuts with spacing of approximately 1.0 m.

Excavations and embankments are to be graded to provide stability and protection of the slope. If the instability is caused by water, then the slopes are to be properly drained.

The surface water of the slope catchment backing is to be drained in a controlled manner.

The edges of the embedded slopes and embankment heels are to be rounded off in a 3.0 m radius.

Trees swaying due to wind and loosening pf the ground are to be cut to an approximate width of 3 to 4 m from the excavation edge.

Slopes of the embankments and particularly of the excavations are to be roughly graded in order to provide the appropriate roughness for connecting the vegetative protection and the slope.

The thickness of the humus layer on the roughly graded slope must not exceed 10 cm in the course of spreading.

Fly ash embankment slopes are to be previously covered with filter material for road

protection. The surface water is to be drained in a controlled manner from the embankment formation.

Embankment slope surfaces may be treated by spreading up to a 20 cm thick layer of humus. At locations where the lateral embankment is envisaged by the design documentation, the filter coat is to be protected with a 20 – 30 cm thick course of stone material, which is to be covered with a humus coat. Grass should be sowed in the same manner as for the rest of slopes.

15 cm wide horizontal cuts with an approximate spacing of 1 m are to be made on slopes in excavations in crumbly and grained rocks which are stable but subject to rapid decay and are highly erosive (e.g. corruptible dolomite, mylonite parts in dolomite, marl, or flysch). If the earth material does not contain at least a minimum of an active coherent material (5 m.-% and more), the surface is to be treated with humus and covered with a layer of an active coherent material of 8 – 10 cm thickness (approximately 6 cm thickness when sunk).

Surfaces of such slopes are to be interlaced with wicker-work at approximately 5.0 m distance. The litter (approximately 60 kg of straw or hay per are), sprayed with bituminous emulsion (about 80 kg per are), is to be grassed by sowing approximately 0.5 kg of seeds per are. The amount of fertilizer to be used is to be approximately 8.0 kg per are. One seedling is to be sowed every 2 m^2 of the area.

For incoherent materials, decayed materials, alluvial deposits, coherent earth materials (loam, clay), decayed marl and flysch, along with the other earth materials that contain clay filling materials, the surface is usually sufficiently fertile and it is not necessary to treat the sloe with humus or grass,; however if this is not so the execution is the same as described above..

For embankments of the incoherent pervious material obtained by excavations in hard and semi-hard rocks, the slope surfaces are to be treated with humus in 10 cm thick layers, interlaced with wicker-work (approximately 0.2 m^1/ m^2) and grassed by sowing in canals (0.75 kg of seeds per are). Approximately 8 kg of fertilizer is to be applied. 0.4 seedlings of appropriate trees or shrubs per square meter are to be planted.

For embankments of materials obtained from the fills, or by excavating corruptible rocks, it is not necessary to treat the slopes with humus if the materials are sufficiently active (more than 5 m.-% of active particle mass). The surface should be interlaced with wicker-work (0.2 m^1/m^2). Approximately 8 kg of fertilizer per are should be applied. The litter (60 kg per are) made of straw or hay that will be sprayed with a bituminous emulsion (80 kg per are) should be spread for stability. 0.8 kg of grass seeds per are should be sowed in the prepared litter. 0.4 seedlings or aquifers per square meter are to be planted.

Embankment slope surfaces of coherent earth materials (clay, loam) should be interlaced with wicker-work (0.2 m^1/m^2). Approximately 8 kg of fertilizer per are should be applied and grassed in canals (batting) where the consumption of about 0.8 kg of seeds per are should be considered. Seedlings of the appropriate plants are to be planted (0.4 pcs. per m^2) and a partial additional spreading of humus should be considered.

Grassing by sowing, particularly in the litter protected with a bituminous emulsion or over the humus surfaces, should be performed to cover the area with grassy vegetation, without any weeds.

Wicker-work for prevention from batting due to water torrent and for hardening the surface layers of materials is to be fully incorporated so that the upper edge of the wicker-work matches the level of the finally graded slope surface.

Shrubs and trees should be planted in groups in humus-spread pits so they do not disturb grassed protective slopes and do not reduce visibility to road users. Therefore, striking trees and shrub groups should be placed particularly on the convex side of the road. For better protection of materials against erosion, trees and bushes should be planted in groups (approximately 1 seedling per m^2 on 50 % of the overall area), as agreed and instructed by the supervisory engineer.

After the works are completed, the constructor is bound to clear the site, restore the original condition and treat all vegetative protections until the ultimate taking over of works, which is at least for a year. The treatment involves additional sowing, regular fertilizing, cleaning surfaces from dirt, waste and weeds as well as watering the surfaces in case of drought.

2.2.6.3.2 Construction protection

2.2.6.3.2.1 Protection by meshes

The location and type of protection by meshes should be determined by the supervisory engineer in accordance with the requirements specified in the design documentation and the technical conditions stated herein. Prior to placing a mesh, the slope is to be arranged according to the design documentation and technical conditions. Anything that could prevent the mesh sinking into the ground is to be removed. For broken stone protection of steep slopes (3:1 to 2:1), hanging meshes are to be used, loaded with cement concrete weights in the lower part and anchored with anchors and pipes at the top edge, so the broken stones may slide down to the excavation plinth in a controlled manner.

Anchored meshes should be used for less steep slopes. The distance between the anchors should be set in accordance with the soil mechanical properties of the rock, with an approximate 1.0 m distance. In rocks where direct ramming of anchors is not possible, the holes should be bored for this purpose.

Some meshes are to be interlaced with double-galvanized wire of 3.1 mm in diameter and of the same quality as the mesh material.

2.2.6.3.2.2 Rubble placing and stone cladding (dry penning)

Rubble placing and dry penning are to be performed so the rubble is placed accurately in the embankment profile, as specified in the design documentation and marked by construction profiles at the site.

When dry penning, each stone is to be safely placed and secured with a wedge so there is no damage to the f embankment slope due to the instability of the rocks or for any other reason. The heel of the dry penned sloped should be firmly incorporated into the sound surface in a manner that will protect the dry penned slope from damage due to atmospheric effects or any other damages.

Dry penning finishing at the top of the slope should be performed in a manner to prevent any damage due to shoulders, etc.

2.2.6.3.2.3 Protection with shotcreting (sprayed cement concrete)

Cement concrete for slope protection should be sprayed over an appropriately prepared slope under pressure.

Reinforcing steel meshes should be previously fixed to the slope and covered with at least a 2 cm thick coat of sprayed cement concrete.

2.2.6.3.2.4 Protection by prefabricated elements

When protecting slopes with prefabricated elements (cribwork, cement concrete hollow elements and similar elements) most following the manufacturer's instructions and requirements of the design documentation is most important. For specific work, the appropriate prefabricated element is to be selected in accordance with the regulation specified in the design documentation or by the supervisory engineer.

The surface for slope cladding should be properly prepared. If the soil is sandy, sand of up to 4 mm grain size is to be used for the surface. The surface must be properly hardened and of a thickness of between 2 and 5 cm when compacted, depending on the purpose.

If the soil is of low bearing capacity, the surface thickness should be appropriately increased. In cases where additional atmospheric or ground water erosion effects to the cladding or higher loading are expected, the surface should be constructed of an appropriately thick cement concrete (according to the design documentation).

Prefabricated elements should be placed so they are separated with 3 – 5 mm wide joints. After placing, the prefabricated elements (mainly hollow) are to be filled with an appropriate material (humus, sand material, slag, etc.), depending on the purpose and requirements specified in the design documentation.

If the claddings are to be used for periodical traffic loads, then the laid claddings should be appropriately incorporated.

2.2.6.4 Construction quality

2.2.6.4.1 Vegetative protection

The contractor is bound to control the pedology properties of certain groups of earth materials for proper selection of plant and fertilizer types. Results of the internal control are to be submitted to the supervisory engineer for inspection.

The internal control of seed quality is to be conducted according to the generally applied regulations and generally applicable methods. Manufacturer's verifications regarding seed adequacy are to be submitted to the supervisory engineer prior to commencement of works.

2.2.6.4.2 Construction protection

2.2.6.4.2.1 Protection by meshes

The contractor is bound to provide the supervisory engineer with the manufacturer's verifications regarding the compatibility of the meshes and anchors, containing information on the quality of the basic materials and the quality of the anti-corrosion protective coating.

2.2.6.4.2.2 Rubble placing and stone cladding (dry penning)

The quality of the applied material should meet the endurance requirements.

Slope surfaces of dry penned embankments should be in accordance with the applied technical regulations and provisions specified in the design documentation regarding slope shaping.

Deviations from the planned surface are permitted to be within the limits of visible accuracy between certain constructions profiles according to the design documentation.

2.2.6.4.2.3 Concrete spraying protection

The quality of the applied cement concrete spray and reinforcing steel meshes should be in accordance with the requirements specified in the technical conditions stated herein (EN-206-1).

Completed works should be in accordance with the applied technical regulations and provisions specified in the design documentation, as well as with the requirements made by the supervisory engineer.

2.2.6.4.2.4 Protection by prefabricated elements

Only prefabricated elements providing the appropriate endurance and those the contractor submits with the appropriate compatibility verifications are to be used.

The quality of constructing the surface of prefabricated elements should be in accordance with the design documentation and requirements made by the supervisory engineer.

Slope shaping is determined by the design documentation or requirements made by the supervisory engineer. Therefore, deviations with no prior consent are only allowed within the limits of visible accuracy between certain construction profiles according to the design documentation.

2.2.6.5 Quality control

2.2.6.5.1 Vegetative protection

The supervisory engineer should check the selection and usage of plant and fertilizer types based on the provision specified in the design documentation and by conducting an internal control of the pedology composition of the earth material. The quality of seeds should also be checked according to the applied regulations and methods, or by testing or evaluating the manufacturer test results based on the proposed manufacturer's verifications regarding seed compatibility.

The final quality of works should be determined by the supervisory engineer and the contractor in the course of taking over of the works.

2.2.6.5.2 Construction protection

2.2.6.5.2.1 Protection

The supervisory engineer should check the compatibility verifications for the delivered meshes and anchors, as well as their protective coat. If he evaluates that the used material and proposed verifications do not provide a guarantee of quality, he is entitled to ask for additional verifications, or order additional tests.

2.2.6.5.2.2 Rubble placing and stone cladding (dry penning)

The supervisory engineer should check the quality of the delivered stone in terms of the specified properties and requirements. If he evaluates that the quality of stone material and work is not guaranteed, he is entitled to order additional tests.

2.2.6.5.2.3 Concrete spraying protection

The supervisory engineer is bound to check the quality of the delivered cement concrete, compatibility verifications for the delivered reinforcing steel meshes and their incorporation in accordance with the provisions specified in the design documentation.

2.2.6.5.2.4 Protection by prefabricated elements

The supervisory engineer is bound to check the quality of the delivered prefabricated elements and their compatibility according to the provisions specified in the design documentation, as well as the shape and surface construction and quality of the material incorporated in the prefabricated elements. The supervisory engineer should also check the quality of their incorporation, surface compaction and visual compatibility with the surroundings.

2.2.6.6 Measuring and taking over of works

2.2.6.6.1 Measuring of works

Completed works are to be measured in accordance with sub-clause 1.2.2.2 of the general technical conditions. Eventual additional provisions are particularly to be considered.

2.2.6.6.1.1 Vegetative protection

Surfaces covered with humus and grass should be measured in square metres and within the design documentation.

Surfaces treated with bio shotcrete and wicker-work should be measured in square metres and within the design documentation.

Seedlings of trees and shrubs should be calculated in areas of planted and grown living seedlings, separated by types.

2.2.6.6.1.2 Construction protection

Incorporated meshes within the design documentation should be measured in square metres.

Rubble placing should be measured in cubic metres and based on the design documentation.

Dry penned surfaces within the design documentation should be measured in square metres. The horizontal finishing embankment surfaces should not be measured and form part of the finishing dry penning works.

The cement concrete sprayed surfaces of slopes as well as slopes covered with prefabricated elements within the design documentation should be measured in square metres.

2.2.6.6.2 Taking over of works

The works should be taken over in accordance with the provisions specified in sub-clause 1.2.2.3 of the general technical conditions and according to the provisions of the special technical conditions stated herein.

The contractor is bound to remedy all the defects determined according to the quality requirements specified herein at his own expense and within a specified period of time. The contractor is also to bear the expenses of all the necessary measuring and testing indicating the inappropriate quality.

2.2.6.7 Calculation of works

2.2.6.7.1 General

Completed works are to be calculated in accordance with sub-clause 1.2.2.4 of the general technical conditions.

All quantities determined under sub-clause 2.2.6.6.1 are to be calculated by the contract unit price.

The contract unit price is to include all the services necessary for the ultimate completion of works. The contractor is not entitled to subsequently claim any additional payment.

The final taking over regarding horticultural works is to be executed only after an appropriate period of time determined by the contract, when permanent growth and

success of completed works can be provided. During this period of time, the contractor is bound to, at his own expense, replace any faded seedlings and repeat the sowing process until the ultimate success is reached.

2.2.6.7.2 Deductions

There are to be no deductions in the calculation of completed works due to the specified appropriate quality of certain works.

2.2.7 REINFORCED EARTH

2.2.7.1 Description

Reinforcing of earth materials within this guideline includes:

- The delivery and incorporation of
  - cement concrete for foundations,
  - cement concrete cladding elements,
  - wooden dowels and steel anchors,
  - stone material for pervious blanket behind the cladding elements, and
  - strips for reinforcing the earth materials,
- the delivery and incorporation of the steel mesh and other appropriate materials for reinforcing the earth material course, and
- spreading materials for the reinforced embankments and pervious blankets behind the cladding elements (only allowance for aggravated works), in full accordance with the requirements specified in the design documentation and made by the supervisory engineer as well as with the technical conditions stated herein.

The design of earth material reinforcing with geotextiles are completely processed and included in the guidelines SRDM, sub-clause 8.1.4.

2.2.7.2 Basic materials

All earth materials that are applicable for embankments according to sub-clause 2.2.5 of the technical conditions are appropriate for reinforcing.

2.2.7.2.1 Cement concrete for foundations

All types of cement concrete providing the designed construction of foundations, with the purpose and endurance according to the provisions specified in the technical conditions (EN 206-1 and SRCS, sub-clause 2.5.1) may be used.

2.2.7.2.2 Cement concrete cladding elements

Cladding elements are load bearing elements and must accept the overall load of the normal earth pressure elements; they are supported in areas where reinforcing strips are fastened (images 2.2.7.1 to 2.2.7.3).

The basic construction material and the constructed cladding elements must provide the designed reinforcement of earth materials and embankment stability, as well as to comply with the provisions of the technical conditions stated herein.

2.2.7.2.3 Dowels and anchors

Wooden dowels (made of hard timber) and steel anchors (made of reinforced steel) are to provide the appropriate interconnection and fitting of cladding elements. Their surfaces must be properly protected for endurance.

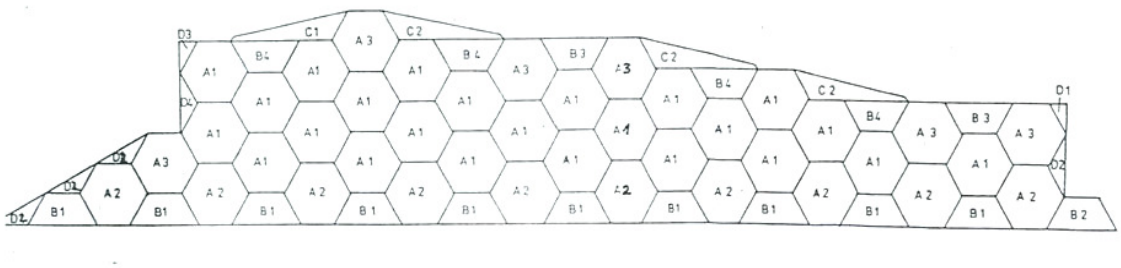


Image 2.2.7.1: Position of cement concrete cladding elements

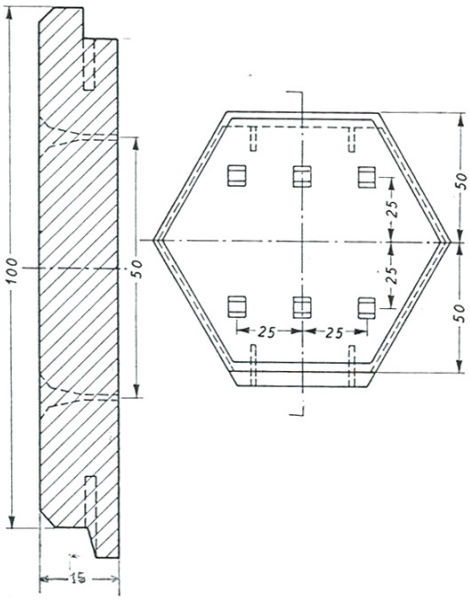
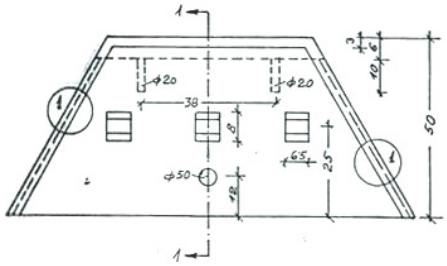


Image 2.2.7.2: Element A1 - details



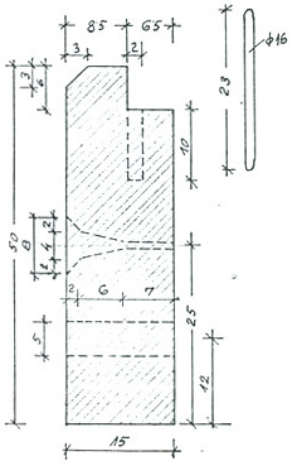


Image 2.2.7.3: Element B1 - details

2.2.7.2.4 Stone material for pervious blanket

For the pervious blanket behind the cladding elements, natural and/or crushed stone grain mixtures are applicable, in accordance with the provisions of the technical conditions for stone material for pervious blankets stated herein (sub-clause 2.2.4.2.1).

2.2.7.2.5 Reinforcing strips

Like anchors, the strips for reinforcing the earth material transfer earth pressure into the filled material. They may be made of:
- polyester laminate,
- protected or stainless steel sheet, or
- another appropriate material.

The strips for reinforcing the earth are to be in accordance with the requirements specified in the design documentation and provisions stated within these technical conditions:
- straining strength min. 3.3 kN/cm of strip width
- rupture stretching max. 1.5 %

The Bending strength, dynamic and tenacity strengths are generally conditioned by the type of the reinforcing strip. Therefore, when determining values of these and other properties (strip dimensions, surface processing, and material composition) the information from the manufacturer, which is part of the technical conditions, should be considered.

2.2.7.2.6 Steel meshes

Steel meshes providing reinforcement of earth materials and complying with the requirements specified in the design documentation and technical conditions stated herein may be used.

Steel meshes should be in accordance with the requirements specified in the design documentation for the reinforcement of earth materials.

The quality of the cement concrete for foundations and cladding elements, the quality of dowels, anchors and stone materials for the pervious blanket behind the cladding elements must comply with the general and special technical conditions and requirements specified in the design documentation. If there is no appropriate regulation for any of the materials, then the

instructions made by the supervisory engineer are final.

2.2.7.3 Execution method

2.2.7.3.1 Preparation of the foundation soil formation

The foundation soil formation, where a reinforced earth embankment is to be constructed, should be prepared prior to the commencement of spreading the earth material for the reinforced embankment, in accordance with the project documentation and the requirements of the technical conditions stated herein.

In general, the foundation soil formation should be sloped towards the reinforced earth embankment cladding and appropriately compacted. If this is not specified in the design documentation, then the supervisory engineer should decide upon the preparation of the foundation soil formation.

2.2.7.3.2 Construction with cladding elements

2.2.7.3.2.1 Foundation construction

Loading of the foundation is proportionally low due to the friction between the cladding elements and the embankment material. Therefore, the foundation is, above all, the sub-structural element of the reinforced earth cladding, and must provide the appropriate incorporation and stability of the first row of cladding elements (without any additional formwork).

2.2.7.3.2.2 Construction of reinforced earth embankment

Cement concrete cladding elements must structurally comply with their conditions of use and, thus, must be incorporated in the appropriate areas.

The first row of cladding elements should have appropriate openings to allow water drainage.

The required slope of the first row of cladding elements set into a groove in the foundation should have mortar appropriately incorporated into the prepared groove where cladding elements are to fit into the foundation.

The embankment material should be incorporated up to the level of (bottom row) the openings in the cladding elements. The following row of the cladding elements should then be set over the separate vertical steel anchors (in the first row of the cladding elements). The stable fitting of the cladding elements is made with sloped wooden dowels. All the cladding elements should be appropriately sloped towards the embankment.

Reinforcing strips should be pulled through the first row of openings in the cladding elements, then tensioned,, then they are to be manually covered with a thin layer of the embankment material (to protect the strips against mechanical damage) and finally, the remaining amount of earth material should be incorporated up to the required layer thickness – of the following rows of the openings in the cladding elements. The procedure should be repeated after the incorporation of the following layer of cladding elements.

The stone material for the pervious blanket, that is not necessary to be compacted with rollers, should be regularly incorporated in an approximately 50 cm thick vertical layer between the cladding elements and the filled earth material.

2.2.7.3.3 Construction by steel mesh

Embankments reinforced with steel mesh may be constructed on the prepared foundation soil formation by incorporating the proportionally clean stone material of a minimum of 30 cm thickness as the first layer which will provide flawless drainage over the reinforced material that is spread over the appropriate surface. After the correct compaction of this layer, the external side should be wrapped with the extended part of steel mesh bottom layer. The required wrapping length should be determined in the design documentation.

The next layer of steel mesh should cover the entire first incorporated layer of the embankment (stone material) and provide necessary length for covering the following layer of earth material, which could be up to 50 cm thick (compacted). The compacted earth material should be covered up to 50 cm from the slope of the reinforced earth material, which should be appropriately sloped (at least 4%).

In cases of higher embankments that are reinforced with steel mesh, the required reinforcing of the earth material, or the execution procedure, should be repeated.

2.2.7.4 Construction quality

2.2.7.4.1 Foundation soil formation

The required compaction or bearing capacity of the foundation soil formation, as along with the slope towards the cladding of the reinforced earth embankment are generally specified in the designed documentation, depending on the properties of the materials in the foundation soil and the embankment material.

2.2.7.4.2 Reinforced earth embankment

According to the provisions specified in sub-clause 2.2.7.3 of these technical conditions and prior to the incorporation of the reinforcing strips, the compaction of each (max. 50 cm thick) layer of earth material incorporated in the embankment should be performed up to 50 cm from the external edge of a layer. An average of 95 % rate of the incorporated material compaction (according to the modified Proctor procedure) must be obtained. The lower limit value that should be reached at each measuring site should not be lower then 3% of reduced required average value.

2.2.7.4.3 Reinforced earth embankment formation

If the reinforced earth embankment is constructed as a supporting structure, the bearing capacity value should be provided at the formation of t the embankment, i.e. a static deformation modulus E_{v2} of at least 45 MN/m^2 and a ratio of E_{v2} : The E_{v1} must not exceed 2.2. If the measured value of static deformation modulus E_{v1} exceeds 50 % of the required value E_{v2} the required ratio is not crucial for the evaluation of the bearing capacity of the reinforced earth embankment.

The minimum value of the dynamic deformation modulus E_{vd} should be at least 20 MN/m^2.

The indicated value of the bearing capacity is the lower value and is to be provided at each measuring point.

Unevenness determined by a 4 m long measuring bar must not exceed 25 mm in order to provide appropriate drainage of the reinforced earth embankment formation.

The reinforced earth embankment formation should be graded by at least 4 % towards the cladding (slope).

2.2.7.5 Quality control

2.2.7.5.1 Prior testing

Prior to the commencement of works related to the reinforcement of the earth material, the contractor is bound to check the properties of the materials specified in the table 2.2.7.1.

Table 2.2.7.1: Prior testing of materials for the reinforced embankment

Material properties	Measurement Unit	Required Value	Testing Procedure
- natural moisture of earth material	m.-%	-	
- Proctor-based testing:			
- optimum moisture	m.-%	-	EN 13286-2
- maximum density	t/m^3	-	
- grain size of material for pervious blanket	m.-%	sub-clause 2.2.4.2	EN 933-1

Prior to the commencement of reinforcing of the earth material, the contractor is to provide the supervisory engineer with all compatibility verifications for all the materials and products to be incorporated.

2.2.7.5.2 Incorporation verification

2.2.7.5.2.1 Internal control

The frequency and type of tests related to the reinforcing of earth material, which should be conducted in the internal control, are determined in the approved programme of the control frequency. If this is not so, the frequency and type of tests are to be determined by the supervisory engineer.
The contractor's laboratory should take samples in the course of reinforcing the earth material along with checking the property compatibility is in accordance with the frequency specified in table 2.2.7.2.

Table 2.2.7.2: Minimum frequency of material testing within the reinforcement of earth material

Material properties	Testing Procedure	Minimum Testing Frequency
- moisture of earth material	-	100 m^3
- Proctor-based testing	EN 13286-2	400 m^3
- grain size of material for pervious blanket	EN 933-1	100 m^3
- compressive strength of cement concrete in cladding elements (C 25/30)	EN 12390-3	1/100 elements

The supervisory engineer is entitled to alter the extent of material testing within earth material reinforcement if he determines higher deviations from previous test results.

The minimum frequency of testing within the internal control of the incorporation of the reinforced earth material is specified in table 2.2.7.3.

Table 2.2.7.3: Minimum frequency of quality testing of the incorporation of reinforced earth material

Material properties	Testing Procedure	Minimum Testing Frequency
- moisture content and density of incorporated earth material	SRCS, sub-clause 1.2.4	100 m^3/20m^1
- bearing capacity:		
- deformation modulus E_{vd}	SRDM, sub-clause 8.2.3	10 m^1
- deformation modulus E_{v2}	SRDM, sub-clause 8.2.3	40 m^1
- evenness measuring	SRMG, sub-clause 3.1.3.1	20 m^1
- embankment height measuring	-	20 m^1

Testing the quality of the incorporated materials and the incorporation of reinforced earth materials should be conducted by other approved methods, at the consent of the supervisory engineer. The consent must indicate the quality evaluation criteria to be used.

2.2.7.5.2.2 Independent control

The basic conditions for the independent control are specified in sub-clause 1.2.1.5. The ratio of the extent of independent control that is generally conducted by an institution is 1:4 to the internal control. The results of the independent control are to be provided in the final report and are the basis for taking over and calculation of works related to earth reinforcing.

2.2.7.6 Measuring and taking over of works

2.2.7.6.1 Measuring of works

Measuring of the completed works is to be in compliance with clause 1.2.2.2 of the general technical conditions and following provisions:

- The foundation soil formation surfaces underneath the embankment made of reinforced earth materials are to be measured according to the actual constructed amount in square metres,
- The foundation for the slope cladding, as along with the cladding elements, anchors, dowels and stone material for the pervious blanket are to be measured and determined according to the average value for each piece of the cladding element type and for the amount of materials,
- strips for the reinforcement of the earth materials are measured according to the actual incorporated quantities in metres,
- due to aggravated work, an additional payment for the incorporation of materials in embankments within the area of reinforcing strips is approved for the measured incorporated quantities in cubic metres,
- quantities of steel meshes and other materials related to the reinforcement of earth material is determined according to the actual incorporated quantity in square metres and a quantity evaluation of the actual reinforced earth material in cubic metres.

The contractor is bound to submit the appropriate compatibility verifications for all material quantities (related to the reinforcement of earth material) that were delivered to the site.

2.2.7.6.2 Taking over of works

The embankment of reinforced earth should be taken over by the supervisory engineer in accordance with provisions specified in sub-clause 1.2.2.3 of the general conditions, quality requirements and special technical conditions stated herein.

Prior to proceeding with works, the contractor is bound to remedy all the defects determined according to these requirements.

All the expenses related to remedying the defects are to be borne by the contractor.

2.2.7.7 Calculation of works

2.2.7.7.1 General

Completed works are to be calculated in accordance with sub-clause 1.2.2.4 of the general technical conditions.

Quantities determined according to sub-clause 2.2.7.6.1 of the technical conditions are to be calculated by the contract unit price. The contract unit price is to include all the services envisaged in the design documentation and those technical conditions that are necessary for the ultimate completion of the works. The contractor is, therefore, not entitled to claim any additional payment.

The arrangement of the foundation soil formation underneath the embankment that was made of reinforced earth materials should generally be calculated according to the provisions specified under sub-clause 2.2.3 of these technical conditions, and the embankment construction (excluding reinforcing works) should be calculated according to the provisions under sub-clause 2.2.5.

2.2.7.7.2 Deductions due to inappropriate quality

The quality of the cement concrete in the foundations and cladding elements is financially estimated according to the conditions for cement concrete and cement concrete-related works in accordance with sub-clause 2.5.1 and EN 206-1.

Compaction of embankment made of reinforced earth material should be estimated

according to sub-clause 2.2.7.4.2. The lower value, which is provided at each measuring point, refers to 100% of the value in terms of the tender unit price. Therefore, there are to be no deductions in the calculation of the completed works.

The bearing capacity of the embankment made of reinforced earth material should be estimated according to sub-clause 2.2.7.4.3. The lower value refers to 100% of the value in terms of the tender unit price. Therefore, there are to be no deductions in the calculation of the completed works.

There are to be no deductions in the calculation of the completed works due to the conditioned evenness of the reinforced earth embankment formation (under sub-clause 2.2.7.4.3).

The required properties of the reinforcing strips refer to (as lower values) 100% of the value in terms of the tender unit price. The lowest values may be lower than 10 % than the required (limiting) values and represent in some properties of the reinforcing strips and with them, the completed work with no value. The average values are to be determined by linear interpolation.

2.2.8 SPREADING OF SURPLUS MATERIAL

Provisions in this chapter include only technical conditions for spreading of surplus materials and conditions for execution, since spreading works are calculated in daily excavation unit price (sub-clause 2.2.2.1).

2.2.8.1 Description

The works include all types of spreading and filling of surplus materials from excavations of all types and categories, at landfills or along the alignment after completed work. Spreading and filling of surplus materials are to be performed as envisaged in the design documentation and in the manner determined by the supervisory engineer. In the course of spreading, the appropriate esthetical and technically proper shaping of spread material as well as proper stratification of various earth material types are to be considered.

2.2.8.2 Basic materials

All the inappropriate materials that are not useful and/or necessary for embankments, fillings or formation level, or which are surplus, are to be spread in accordance with the sub-clause 2.2.5.3 of the technical conditions stated herein.

There are no quality requirements for surplus spreading materials. Such materials may be excessively dry, wet or frozen.

2.2.8.3 Execution method

Execution of works, organization method and selection of types of machines or devices are to be selected by the contractor. The contractor is also free to select the depositing areas outside the alignment, as well their arrangement. In the course of works, the contractor is to follow the regulations specified in the design documentation as well as instructions provided by the supervisory engineer. In the course of works, the contractor is also to meet other technical conditions related to proper arrangement of material types, adaptation to the field and environment, dewatering in the course of spreading of materials and, afterwards, spreading humus and sowing grass over surfaces after spreading is completed. Areas of landfill and some courses are to be properly compacted to prevent excessive non-uniform settlements.

2.2.8.4 Construction quality

No special quality is required for landfills; there are only general requirements for aesthetic work, adjustment to surroundings, sowing grass and draining surface, ground and spring waters.

The existing natural conditions on surfaces envisaged for spreading of surplus materials must not deteriorate. It is desirable that they ameliorate.

2.2.8.5 Quality control

The quality is only visually checked according to the following criteria:

- adjustment to environment,
- suitability of layering,
- suitability of layer evenness,
- suitability of dewatering,
- suitability of grassing,
- suitability of arranging in accordance with the requirements specified in the design documentation and by the supervisory engineer.

2.2.8.6 Measuring and taking over of works

2.2.8.6.1 Measuring of works

Completed works are not to be measure, since the quantities are determined with determining categories of excavated materials in terms of provisions specified in the sub-clause 2.2.2.6.1.

2.2.8.6.2 Taking over of works

Completed works are to be taken over in accordance with the general requirements specified in the sub-clause 1.2.2.3.

2.2.8.7 Calculation of works

Completed works are to be calculated in accordance with the provisions specified in the sub-clause 1.2.2.4 of the general conditions and according to the contract unit price for cubic metre of spread surplus of coherent or incoherent earth material.