ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

REPUBLIC OF SERBIA

TRANSPORT REHABILITATION PROJECT

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

1.0. GENERAL TECHNICAL CONDITIONS

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1.1 INTRODUCTION

1.1.1 CLASSIFICATION OF WORKS

1.1.1.1 General

"General technical conditions" (GTC) apply to all types of work in road construction as described in the approved project documentation, as well as for all other works that would possibly be required for the complete execution of contract work.

For individual structures that have certain features of special interest, the employer may determine the special technical conditions (STC) to perform such works.

1.1.1.2 Classification of Works

The works in road construction are categorised in the following areas:
- alignment
- deviations
- approaches
- regulations
- bridges and walls
- tunnels.

The following groups of works may occur in each of the aforementioned fields:
- preparatory works
- earthworks
- drainage systems
- pavement structures
- construction structures and support elements
- craftsmen works
- traffic signalization and equipment
- third party services.

Individual works foreseen within the aforementioned groups of works are discussed in the following chapters:
- description
- basic materials – the types and quality of materials
- manner of execution
- quality of execution
- quality control
- measuring and taking over of works
- works calculation.

1.1.1.3 Designation of works

The system of work description in the “Special Technical Conditions” manual is based mainly on the following designation:

(-) field of work
- group of works

-- special technical conditions

--- subgroup of works

---- chapter

Example:

(1) alignment

2.2 earthworks

2.2.2 daily excavations

2.2.2.3 manner of execution.

A designation of the field of work is generally used for an adequate classification in major works.

A designation of the group of works, subgroup of works, as well as the chapter, ensures the required uniformity of the basic classification.

The more detailed designation in special technical conditions is adapted to the basic classification and appropriate overview.

1.1.1.4 Abbreviations

The following abbreviations are used in these technical conditions:

TR	- Technical regulations
GTC	- General technical conditions
STC	- Special technical conditions
CEN	- Comité Européen de Normalisation
EN	- European Standard
EC	- Eurocode
DIN	- Deutsche Industrie Standard
ASTM	- American Society for Testing and Materials

1.1.2 TECHNICAL REGULATIONS

In these technical conditions, European Standards (EN) are specified as valid technical regulations.

For specific European standards, only designations of a group of standards are specified. Detailed designations of European standards, or relevant coordinated documents are listed in the processing of individual works, or the corresponding requirements. As a rule, the specific requirements for certain characteristic features should be specified in national annexes to European standards.

During construction, as determined by these technical conditions, the contractor must comply with all national annexes, if these technical conditions or additional written instructions of the engineer do not state otherwise.

The above technical regulations shall apply until new legislation, amendments to existing regulations or changes enter into force, replacing specified provisions with these technical conditions. Deviation from the above principle is possible only where this is clearly indicated in the technical conditions, and when approved in writing by the engineer.

When new legislation, amendments, changes or other official standards and guidelines allow less stringent conditions of these technical conditions, the contractor is not entitled to depart from these technical conditions without the written consent of the engineer.

1.1.3 TERMINOLOGY

In the general technical conditions for the construction of roads, the technical terms used have the following meanings:

European technical approval (evropska tehnička saglasnostl-ETA,) indicates a positive technical assessment that a product is suitable for the envisaged use, which is based on the fulfilment of vital technical requirements for civil engineering structures, for which the product is intended; it is awarded by an authorized body for issuing technical approval.

Harmonized European Standard (harmonizovana evropska norma,) is a standard formed by the European Organization for Standardisation (CEN) based on the mandate of the EU Commission, issued in accordance with the prescribed procedure.

Acceptance tests (ispitivanja pri preuzimanju radova,) is the testing of certain characteristics of built-in product in order to confirm or reject the existing conformity assessment of the product with regards to the prescribed characteristic prior to building-in the product.

Declaration of conformity (izjava o usaglašenosti) is a document issued by the manufacturer to approve conformity of a product with the prescribed requests.

Factory production control (kontrola proizvodnje u pogonu) is the activity performed by the manufacturer within the scope of the internal control, intended for managing the production, comprising services, procedures, internal testing and measurements during preparation (production) of the particular construction product. An integral component is the continual monitoring of compliance within the factory in which the product is produced in accordance with the requirements of the corresponding technical conditions.

Conformity control (kontrola usaglašenosti) includes the works, processes and tests for compliance within the framework of internal control, intended for compliance assessment.

Inspection body (kontrolni organ) is the authorized body, included in the determination of construction product compliance which, according to the prescribed criteria, performs the task of monitoring of the construction site or plant or anywhere else, providing assessments and recommendations for the taking over, valuation of manufacturing processes within the system of quality in a factory, as well as the selection and evaluation of the product compliance according to the prescribed measurements.

Laboratory (laboratorija) is a professional body performing conformity testing of construction and materials and fulfilling the prescribed requirements in the construction works on public roads.

Supervision (nadzor) indicates conformity assessment after obtaining the certificate by the certification (inspection) authority, verifying that the products meet the technical specifications.

Engineer (nadzorni inženjer) is the specialist organization selected by the client responsible for professional supervising the quality of the construction products, works and processes in accordance with the project documentation.

Client (naručilac) is a competent national body or a special administrative body for national roads.

External/third party control (nezavisna/spoljašnja kontrola) are the institution's activities, which are intended for the supervision of internal control with the aim of verifying the conformity of products or approving internal control for production and / or taking over of an built-in construction product, including works, processes, external tests and measurements in production and/or installation of construction products.

Conformity evaluation (ocenjivanje usaglašenostiindicates the systematic evaluation of compliance testing results in relation to the prescribed measures (criteria) of compliance, on the basis of which it is determined to what extent a certain type of construction product fulfils the prescribed requirements.

Preliminary inspection of mixture (početni sastav mešavine) means the careful selection of materials and the use of various grain sizes in the composition of mixture, which are necessary to ensure the design characteristics.

Initial type test (početno tipsko ispitivanje,) is the testing to verify and approve, prior to the routine production or upon any modification of the origin of constituents and/or their proportions as well as of the production method, the achievement of the required properties and the product suitability for its intended use; as dependent on the prescribed system of conformity assessment, these tests shall be carried out either by the manufacturer, the contractor or the institution.

Taking over of works (preuzimanje radova) is an activity performed by the engineer (after having been informed in writing by the contractor on completion of works) on the basis of a certificate or statement of conformity for the structural works in accordance with the requirements in the technical conditions and any additional requirements for the project, which are the subject of a contract on execution of works.

Conformity test (proba usaglašenosti (conformity test) is a trial for verification of the compliance of a product with the requirements of the technical conditions on randomly selected samples performed by the manufacturer.

Trial, Test, Testing (proba, opit, ispitivanjeh) is a technical activity to establish one or more fundamental characteristics of the product, method, or service in question, in accordance with an accurately defined procedure.

Test area (probna deonica) is a part of the construction site where, with respect to the envisioned goal, the construction materials, procedures and methods are professionally tested by varying individual parameters.

Certification (sertifikacija) is the process through which a third party issues a written that a product, process or performed work is in accordance with the established requirements.

Certification of (internal) production control (sertifikacija (unutrašnje) kontrole proizvodnje) includes the processes and tasks of the authorities involved in compliance confirmation; based upon which the certifying body issues a certificate of production control as a written that the production control is organized in accordance with the requirements of the appropriate technical conditions.

Product certification (sertifikacija proizvoda) includes the processes and tasks of the authorities involved in compliance confirmation; based upon which the certifying body issues a certificate of compliance for a product as a written that the product complies with the requirements of the appropriate technical conditions.

Certification body (sertifikacioni organ) is an approved body that manages the certification procedure and issues a certificate.

Certificate of conformity (sertifikat o usaglašenosti) is a document issued in accordance with the certification system rules confirming that a precisely defined product, process, or service complies with the requirements indicated in the corresponding code or any other appropriate document.

Internal/production control (unutrašnja kontrola) represents the activities of the manufacturer at the production facility and/or the contractor of works on the construction site at the installation of the product on the construction site in order to harmonize the production and/or determine compliance of the product or production.

1.2 CONTROL AND EVALUATION OF QUALITY

1.2.1 TYPES OF TESTING

In the testing program, as part of the internal and external (third party) control of materials and construction products, comprehensive testing of conformity performance must be included.

Testing the quality of materials, technologies and executed works may be conducted only by a legal entity that is completely independent with respect to the Contractor (the legal entity may not be proprietarily related in any way to the Contractor) and accredited as a laboratory for testing according to the standard SRPS ISO/IEC 17025 by the Accrediting body of Serbia for the subject materials and for all required test methods that it conducts, and the basic legal prerequisite of validity and reliability of laboratory testing.

The certification of internal controls of production, certification of products and issuing of conformity certificates may be conducted only by a legal entity that is accredited for conducting the works of certification according to the standard SRPS EN 45011 with the Accreditation body of Serbia.

1.2.1.1 Initial testing

By initial (laboratory) testing of certain materials (such as a bituminous mixture according to standard EN 13108-20), which is performed within the production control certification, the manufacturer must prove that the available materials ensure the realisation of quality products in accordance with the requirements of specific technical conditions. The costs of initial testing shall be borne by the manufacturer.

1.2.1.2 Production control

The conformity assessment of materials intended for manufacturing or production involves the initial type testing and production control (e.g. a bituminous mixture in accordance with the requirements of standard EN 13108-21). Such testing is not required for land and materials intended for similar use.

The production control in machines and devices that determine the quality of works must be carried out prior to the commencement of the routine processing of materials and products, including the testing of machines and equipment required in terms of conformity and product quality as determined by the specific technical conditions and project documentation.

Tests that are required for production control include the determining of conformity and quality of materials and products.

The Contractor shall submit a certificate of production control to the engineer at least three days before the planned start of works.

The contractor of works bears the costs of the demonstrative production.

Confirmation of materials of the same origin, or works of the same type, is submitted to the rule only once.

1.2.1.3 Demonstrative placing

Based on the results of relevant laboratory tests of the initial composition and production control (testing machines and devices), the engineer approves the demonstrative placing.

The control trials at the demonstrative placing include determining the quality of the product during transport, installation and the built-in condition.

The demonstrative placing is supervised by the engineer and an external control (inspection body). The contractor of works covers the costs of the demonstrative placing.

If the required quality of works is reached within the demonstrative placing, the engineer approves the continuing of works.

1.2.1.4 Internal Control

The manufacturer and/or contractor within the internal control must perform any tests necessary to verify the quality of materials, technologies, and performed works. Appropriate proof of competence for the execution of internal control must be provided.

The tasks related to conformity assessment that are the duty of the manufacturer or contractor, as defined in detail in the standard EN 13108, include:

- initial product testing, or initial testing on the test area (demonstrative production and placing), if these are intended by a prescribed system of conformity verification, as a task of the manufacturer or contractor.
- production control in a facility or control of a product installation or control of work execution at the construction site, together with control of devices for production.
- internal control testing according to an adopted program of average frequency of testing.
- conformity assessment according to the prescribed characteristics of individual types of products.

The contractor is required to adequately document the results of internal control and regularly submit the same to the engineer or to the authority for the performance of external control.

In the event that any internal control or contracting laboratory determines a deviation in quality in relation to the quality planned for the project documentation and specific technical conditions, the Contractor shall immediately notify the engineer or take appropriate measures. Necessary measures may also be determined by the engineer.

Costs of testing within the internal control are covered by the contractor.

1.2.1.5 External (third party) control

Tasks related to conformity assessment or approval of internal control for facility production or for taking over of installed construction products that fall under the remit of the authorised body include:
- review and assessment of conformity evaluation as performed by the manufacturer or contractor
- control test of samples, taken randomly, on supervision of the internal control of production at the facility or construction site, if required by the client within the system for verification of conformity
- assessment of product conformity.

During completion of the construction structure or one of its parts, the authorised body must make a final assessment of the suitability of the entire amount of installed construction products for their intended use in the construction structure.

In the event of a larger number of smaller structures being built by the same contractor under the same technical conditions, some external control tasks may be allocated to multiple structures. Thus, the obtained results may be taken into account in determining the conformity of construction products on a single structure.

A representative of the contractor and engineer must be notified on sampling, testing and measuring in laboratories or in the field, as carried out under external control. The results are valid even if the contractor or engineer are not present during the tests and measurements.

The results of the external control, together with a report on a regular review of internal control, are to be included in a written report of the authorities - these forming the basis of the calculation and taking over of any installed material. The report must be submitted promptly to the client and the engineer, and prior to the technical inspection of completed works.

If the contractor believes that the result of the external control is not representative of the overall work undertaken, he may require additional testing in areas commonly defined by the contractor and engineer. Both testing results are applicable (initial and additional) for taking over. The contractor of works bears the cost of additional testing.

In case the contractor and the inspection body do not agree on the results obtained by the additional testing, it is necessary to perform expert testing by an independent laboratory, selected with the consent of the contractor and the inspection body. The costs of expert testing are covered by the party whose results increasingly deviate from the established results.

The costs of external control are covered by the client.

1.2.1.6 Other testing

The costs of testing and preparation of proposals for remediation as required due to unexpected field conditions are to be covered by the client.

Testing, remediation proposals and any amendments that would have to be performed due to technological errors of the contractor and/or failure to comply with the requirements of these technical conditions are borne by the contractor.

1.2.1.7 Laboratory

The contractor is obligated to organise a laboratory that must meet all the requirements of internal control as prescribed by the technical conditions.

The laboratory must perform testing within the internal control in the requested scope and according to the procedures specified in the technical regulations. If deviations from those requirements are found, it is obliged to determine the causes of such deviations and to promptly take the necessary measures.

The contractor is obligated to provide access to the engineer and external control during performance of testing as part of the internal control and laboratory use, together with support staff and material for field-testing of samples under external control. Operating costs are to be borne by the contractor.

The laboratory must have adequate facilities for work and adequate equipment to perform all required testing as part of internal control, and as informatively given in these specifications. In addition to the manager, the laboratory must employ an appropriate number of professional and support staff. According to the technical conditions, before the start of works the contractor is obliged to submit confirmation to the client of the adequacy of the overall laboratory organisation, together with a list of equipment and employees.

All laboratory equipment used in the contractor's laboratory for geomechanics, cement concrete, asphalt and water proofing, metals and steel, must be inspected and calibrated.

1.2.1.7.1 Basic laboratory equipment for geomechanics

- Thermostatic dryer (to 180°C, precision up to 5°C)
- laboratory scales up to 50 kg
- laboratory scales up to 16 kg (precision up to 0.1 g)
- laboratory scales up to 3 kg (precision up to 0.01 g)
- a set of sieves Φ 300 mm or Φ 400 mm
- sieves Φ 0.063 mm (to rinse)
- hydrometer
- mixer for hydrometrics
- stopwatch / chronometer
- measuring cylinder 1000 cm^3
- device for determination of consistency limits – sieve Φ 0.4 or 0.5 mm, Casagrande device or cone penetrometer
- device for determining the optimum amount of water and maximum density - Proctor apparatus (molds Φ 100 mm or Φ 150 mm)
- device for determination of California Bearing Ratio - CBR machine
- device for determination of resistance to grain shattering - Los Angeles machine
- equipment for determination of equivalent of sand
- equipment for determination of resistance of grain during freezing
- equipment for determining the clay content (methylene blue)
- equipment for determination of organic admixtures content
- equipment for determination of grain shape (caliper, trellis sieve)
- device for determining compressibility module and permeability coefficient - oedometer
- isotope gauge - device for determining the density and moisture
- VSS device - a device for determining the module of elasticity
- device for determining the dynamic module of elasticity - a dynamic panel
- gas or electric dryer (in exceptional cases)
- surface for drying and mixing
- hand tools (mason spoon, knife, wire brush, brushes).

1.2.1.7.2 Basic laboratory equipment for cement concrete

- laboratory scale up to 50 kg (precision up to 10 g)
- laboratory scale up to 10 kg (precision up to 5 g)
- analytical scale, precision up to 0.01 g
- cone and equipment for determining the consistency of fresh cement concrete according to the method of settlement and distribution
- device for determining the air pores in fresh cement concrete - porosimeter according to the method with pressure
- molds for making concrete samples 150 x 150 x 150 mm
- molds for making concrete samples 100 x 100 x 400 mm
- vibrating table or internal vibrator for installation of concrete samples (with the lowest frequency of 120 Hz)
- surfaces for drying (with a diameter of 28 to 32 cm)

- gas or electric dryer or microwave oven (power 800 W at least)
- set of square sieves 33 x 33 cm
- set of sieves for wet sieving (0.063-0.09-0.125-0.25 -1.0 mm)
- caliper
- pool for care of concrete samples (temperature 20 ± 2 ° C)
- press for cement-concrete samples (with range from 1000 to 3000 kN)
- laboratory mixer, 50 l
- laboratory mixer for cement
- molds 40 x 40 x 160 mm for testing of cement and mortar
- Michaelis scale for determining the flexural strength of cement and mortar
- Vicat apparatus with accessories
- press for injection mass (with a range of 50 to 500 kN)
- equipment for testing injection mass (funnel, chronometer, caliper, pipettes, measuring cylinders 100 ml and 1000 ml)
- auxiliary equipment for preparation of injection mass samples for testing compressive strength (diamond saw, level for caps)
- tin box with lid for sample storage of cement and mortar
- digital thermometer (accuracy 0.1 ° C)
- wall thermometer for minimum and maximum temperature (accuracy 1 ° C)
- 50 cm metal ruler or 3 m pocket measuring tape (with a division of 1 mm)
- equipment for determination of organic admixtures content
- hand tools (shovel, mason spoon, wire brush, brushes, scraper, spoon)
- laboratory clock
- stopwatch / chronometer
- equipment for testing of water resistance of cement concrete
- equipment for testing of frost resistance OSMO (dryer, sieves, small accessories)
- equipment for testing of frost resistance OMO (ultrasound, according to the method of dynamic modules)
- freezer or air conditioning chamber
- press for testing of cement concrete samples (1 to 100 kN)
- equipment for testing of sprayed cement concrete
  - penetrometer (for determining of early strength)
  - drilling machine with diamond bit
  - press (range from 100 to 1000kN).

1.2.1.7.3 Basic laboratory equipment for asphalt and water proofing

- Set of sieves
- scale up to 5 kg, 1 g accuracy
- dryers
- device for compacting by Marshall
- press for testing by Marshall
- container for testing with thermostat by Marshall
- stopwatch / chronometer
- pycnometers, glass
- centrifugal device for extraction
- device for determination of softening point by R&B
- rod thermometers
- caliper by Schulze
- immersion heater
- automatic penetrometer
- automatic device for determining breaking point - ductilometer by Dou
- device for determining breaking point by Fraass
- distillation column
- ultra thermostat
- device for determining seals
- drilling machine
- diamond bits for drilling machine
- saw for cutting boreholes
- small laboratory inventory and chemicals
- vacuuming equipment
- ductilometer
- a device for breaking strength testing
- device for testing the formation of cart track
- isotope gauge.

1.2.1.7.4 Basic laboratory equipment for metals/steel

- breaking machine for testing steel tension
- equipment for testing steel tension (measurement of stretching)
- equipment for testing steel bars to bending.

1.2.2 MEASUREMENT, TAKING OVER AND CALCULATION OF WORKS

1.2.2.1 Introduction

1.2.2.1.1 General

Prior to installation of construction products, the manufacturer must carry out a certification procedure for production i.e. product control, by the selected certification authority, or receive appropriate technical approval from an authorized body for products for which there are no harmonised standards for products.

An integral part of professional supervision as prescribed by the law on the construction of facilities is supervision over construction and other products, installations, technological devices and equipment.

Professional supervision over construction products used in road construction includes:
- taking over construction products - on delivery to the construction site - which are already suitable for the intended use and the characteristics of which, after installation, do not change
- taking over of construction products during installation, which are suitable for intended use only after installation (e.g. bituminous or cement-concrete mixtures).

Taking over should be carried out for all construction products
- which may affect the fulfilment of essential technical requirements for facilities, i.e. safety, serviceability, durability and safe use of facilities,
- which are, after the construction of facilities, used for the protection of the living environment and
- which protect the facilities from harmful environmental influences.

1.2.2.1.2 Compliance / compliance of construction material quality and product quality

According to valid legislation, the evidence of compliance of materials and products is regulated through the use of standards and by obtaining the proper certification, as well as through previously conducted testing.

After adoption of the regulation “Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9th March 2011 prescribing the harmonised conditions for the marketing of construction products and repealing the Council Directive 89/106/EEC, Official Journal of the European Union, 88/2011” (Regulation (EU) no. *305/2011 of the European Parliament and the Council of 9th March 2011 regulating the harmonised conditions for placing construction products on the market and the revoked Council Directive 89/106/EEC, Official Journal of the European Union 88/2011),* the procedures will be changed.

All construction products and materials in the EU market must comply with the Construction Products Directive (89/106/CPD). This means that they would have all features of the construction structure in which they will be installed, and comply with all prescribed essential features.

Authorities to verify compliance are
- certification body,
- engineer and
- testing laboratories

Conformity of construction materials and other construction products are based on
- harmonised standards
- national technical agreement and
- European technical approval.

The harmonised standard is issued by CEN for a construction product or several related construction products. It presents the technical requirements for products, methods of inspection and testing, and approval conditions. The standard provides requirements, proof of compliance and testing methods of the product as well as its packaging and labelling.

National or European technical approval may be issued by the EOTA members for the entire system or just one part of the system or individual products. Products for which the appropriate national or European technical approval are issued will be installed only as indicated in the approval. Appropriate evidence as prescribed by the law on construction products depends on the system of conformity certification. For each construction material or product the requirements are specified according to a verification system as stated in the issued harmonised standard or with national or European technical compliance.

Verifying conformity systems are: 1+, 1, 2+, 2, 3 and 4 (table 1.2.2.1). Verifying conformity systems differ in the type of evidence and requests for the following:
- For verifying conformity systems 1+ and 1, a statement of conformity must be issued by the manufacturer as well as a product conformity certificate as issued by the registered certification body. The certificate must specify the designation of the certification body.
- For verifying conformity systems 2 + and 2, a statement of compliance is required as issued by the manufacturer on the basis of certificates for production control. On the declaration of conformity, in addition to the technical specifications and data on the product and the manufacturer, the number of certificates and label must also be indicated, as well as the number of the registered certification body issuing the certificate.
- For verifying conformity system 3, a statement of conformity must be issued by the manufacturer on the basis of the initial

type tests performed by the registered laboratory. On the declaration of conformity, in addition to the technical specifications and data on the product and the manufacturer, the number and label of the registered laboratory that performed the initial type tests must also be indicated.

- For verifying conformity system 4, a statement of conformity must be issued by the manufacturer without any involvement by the reported authorities.

Table 1.2.2.1: Review of conformity control systems

Task	Conformity control systems					
	1+	1	2+	2	3	4
- Manufacturer:						
- Production control	+	+	+	+	+	+
- Sample testing	+	+	+	-	-	-
- Initial type testing	-	-	+	+	-	-
- Certification body						
- Initial testing	+	+	-	-	+	-
- Certification	+	+	+	+	-	-
- Supervision of production	+	+	+	-	-	-
- Control of samples testing	+	-	-	-	-	-

Statement of conformity (issued by the manufacturer or the legal representative of the EU) must contain the following statements:
- name and address of manufacturer (representative) and place of production
- product description and copy of technical information located next to the CE label
- reference on standard and legislation on construction products
- requirements to which the product is in conformity
- special conditions related to the use of the product
- name and address of laboratory where relevant
- name and position of the signatories of the statement.

The CE label must contain the following:
- CE mark
- name and address of manufacturer
- first year of setting the CE label
- specifying of standard
- product description
- listing all required features.

Placement of CE mark
- on the product
- on the label
- on the packaging,
- on the supporting documentation.

To verify conformity with appropriate technical conditions
- manufacturer with his system of internal control of production must ensure conformity of production and perform tasks related to conformity assessment,
- for certain construction products along with the evaluation and monitoring of production control or product, an external control must be included that (at the request of the client) must verify the production control certificate and manufacturer's declaration of conformity.

The provisions relating to determining conformity of construction products are thoroughly specified by technical conditions. If they, for whatever reason, are not prescribed, the established principles of the construction product’s traceability should be applied.

Traceability of construction products means that the engineer has the right to account for each construction product:
- the type of standards by which it was manufactured
- the data on mandatory or optional application of standards
- the conformity system according to which the standard as harmonised
- whether technical approval (national, European) exists for a specific construction product
- the required certificates, manufacturer's declarations of conformity
- labelling of construction products
- access control on construction site
- visual surveillance
- predicted external control of professional organization (independent audit contractor for the client).

As evidence of the construction product's conformity, the manufacturer's statement of conformity will also be taken, issued in accordance with the relevant regulations of the ministry responsible for construction works. The manufacturer's statement on conformity of construction products - depending on the system for verifying the conformity prescribed for the particular product - must be based on the certificate of product control, technical compliance, testing, etc. The certificate of conformity with technical regulatory requirements must be issued by the institution appointed by the Minister based on the assessment of the inspection body.

The Contractor is required to, prior to the use of any material (construction products) for carrying out contract works, submit a technological study to the engineer including all required evidence of construction product conformity with requirements in the project documentation and special technical conditions, as well as with assumed European and national standards.

The contractor may begin to use a particular product for contractual works only after the engineer approves its use.

Determining conformity as a rule consists of the following tasks:
- internal control, performed by the manufacturer or contractor and
- independent audit, performed by the professional organization authorised by the client, that has acquired the right to carry out works based on a tender.

1.2.2.1.3 Control of works

The volume of control of works is completely determined by special technical conditions.

Places for sampling and measurement are randomly determined by a control expert (chapter 1.4.1) if the engineer does not do so, and at the same time the engineer is the sampling coordinator.

The contractor is obligated to offer assistance in taking samples or in determining the quality of all work done. This assistance includes labor force, auxiliary materials and transport of materials from the sampling site to the laboratory or place on the construction site as designated by the engineer. The contractor covers all expenses. All works as a rule are professionally led by the engineer.

The engineer may determine additional control tests even in cases where he already has proof of conformity.

The contractor is obliged to provide access to the engineer for all tests within the internal control, while results of the internal control must be properly processed and submitted to the engineer with the agreed format and timescale.

Complete documentation on the verification of materials, construction products and construction work quality must be processed by the authorized professional organisation/inspection body in the form of a final report.

1.2.2.2 Measuring of works

Quantities of individual works should be measured based on uniform measures, as determined in the project documentation, tender or contractual preliminary calculation and regulations of these technical conditions.

If these technical conditions do not state otherwise, the amounts should be determined based on actual works done and materials installed in the framework of the project documentation for individual works. When a designer subsequently requires a change of quantity or type of work, he must provide an appropriate supplement to the project documentation with a list of works. All amounts must be specified rounded to a maximum of two decimal places, unless the engineer and contractor representative do not agree otherwise for legitimate reasons.

If for any reason and without additional expenses the quantity or quality of works may not be subsequently determined, the contractor is obliged to request provisional taking over from the engineer on time, which should be documented together with drawings in written form and entered in the construction book. Measuring and taking over of such an amount of works are final and only to be confirmed during the ultimate taking over process. In such cases, the contractor may not proceed with the works before the provisional taking over and measurements. If the contractor in this case does not require a provisional taking over, he assumes all consequences arising from any subsequent works to determine the actual quantity and quality of work done, i.e. costs of subsequent removal of all overbuilt layers and, after appropriate control, costs of replacement with appropriate materials and proper installation thereof.

The works, as calculated according to quantities purchased and installed, must be concurrently documented by order forms and recorded appropriately.

If the contractor fails to provide the quality required in the project documentation and special technical conditions, all obligations under the contract shall remain valid, although deductibles are calculated to him.

1.2.2.3 Taking over of works

Taking over of works includes the quantitative and qualitative taking over of individual contracted works. According to the state of construction (building) there are three types of taking over of works as follows:

- provisional taking over of works (for temporary calculation of works)
- final taking over of works
- ultimate taking over of works.

1.2.2.3.1 Provisional taking over of works

During construction of a structure, the engineer temporarily takes over the works performed by the contractor representatives. In this respect the amount of individual works performed are determined in units of measure according to the preliminary contract calculation (the contract between the client and the contractor) and the quality in accordance with the technical conditions. This taking over of works is only a lay-out for preparation of temporary plans and recognition of temporary periodic calculations for payments of value of completed works between the client and the contractor.

Increased quantities, i.e. works that exceed the amount that was planned for in the preliminary contractual calculation may be performed only with the prior written consent of the engineer. In cases where increased quantities were the result or would have resulted with a change of project documentation, the designer must also be in consent.

Also, for each additional job i.e. job that was not foreseen in the project and preliminary contractual calculation, and was formed, for example, due to a process change, the contractor must obtain the prior written consent of the engineer and designer.

If during the provisional taking over of works there exist disputable cases in terms of quantity and quality of work, the engineer does not have to admit the disputed amount and quality until a commission determines the actual plan in accordance with the provisions of the contract.

All temporarily works taken over must be documented and recorded in a book of accounting measurements. The contractor prepares documentation on a monthly basis and submits it with confirmation to the engineer.

For all provisionally taken over works, the final quantity and quality are determined during the final taking over of works, and the quality partly even in the ultimate taking over of the works after the guarantee period.

1.2.2.3.2 Final taking over of works

Final taking over of works on the structure must be executed on completion of work under the contract provisions between the client and the contractor.

The final taking over of works is used as a lay-out for the final calculation of works as proposed by the contractor, who reserves the right to propose a guarantee period extension rather than individual or total deductions. The client may take into account such a proposal in accordance with established professional practices from the standpoint of durability required for certain works performed, as well as based on identified irregularities.

During the final taking over of works, the client evaluates the quality of completed works and calculates any financial deductions for works of insufficient quality.

Final taking over is definite from the standpoint of quantities and price, as well as deductions and premiums, but it does not include warranties and damage repairs during the guarantee period.

1.2.2.3.3 Ultimate taking over of works

Ultimate taking over of the quality of works should be performed after the issuance of certificates for executed works or the execution of all obligations according to the contract.

1.2.2.4 Calculation of works

1.2.2.4.1 General

The contractor must prepare a calculation of the quantities for executed works. The contractor must present executed works separately according to each item of the preliminary contractual calculation, with visible measurement, and planned and executed quantities in total.

The contracted works will be calculated and paid based on temporary plans and the final accounting plan in accordance with the terms of the contract. The lay-out for calculation of works are the unit prices for individual works by the preliminary contractual calculation and the actual amount of works, as determined in accordance with paragraph 1.2.2.2. During calculation, financial evaluation of the quality and quantity of executed works should be taken into account, in the given lay-out.

1.2.2.4.2 Unit prices

The term “unit price” refers to the preliminary contractual calculation price for each job. If the offered price does not include all costs for the performing of planned work, this must be specifically and visibly marked. If the contract, construction regulations or these technical conditions do not provide otherwise, the unit price must cover all costs for the execution of individual work.

If the material or product is the property of the client (e.g., curbstone, traffic sign, etc.), the unit prices must take into account the work of removal, relocation and its re-installation.

1.2.2.4.3 Increased quantities and additional works

The lay-out for calculating increased quantities shall be the unit prices for particular works according to the preliminary contractual calculation and that which is established and confirmed, the amounts of executed increased quantities.

Additional works are calculated based on the provisions of the contract. If the contract contains no such provisions, any additional works are calculated on the basis of a mutual agreement of certain unit prices. In such a case, the engineer is entitled to request from the contractor a detailed calculation of costs, which must be in accordance with the calculation basis price list.

1.2.2.4.4 Interim penalties

An interim penalty is introduced by the client in accordance with the contract for all works that are unreasonably not executed and were anticipated under the work progress plan, or time limits, as confirmed by the client.

The calculated interim penalty - to the extent envisioned within the contract – may be returned to the contractor by the client if he completes all work within the agreed period, without additional costs for the client due to delays regarding deadlines.

For works that are late, the contractor cannot take into account the positive difference in price incurred due to delays.

1.2.2.4.5 Revised conditions

The calculation, according to the contract, may affect the following:
- increase or decrease of volume for executed works and
- shortening or extension of deadline for execution of contracted works, if it is outside the responsibility of the contractor.

1.2.2.4.6 Calculation of poorly executed works

All repair costs for poorly executed works covered by the contractor, including costs for all measurements and tests that revealed the poor quality of executed works, which is why it was necessary, after the completion of appropriate repair, to determine the quality of work by re-measurements and tests.

For any works that do not meet the requirements for quality (exceeding the limit or ultimate limits) set forth by these technical conditions, and the contractor failed to repair these under the direction of the engineer, the contractor shall not receive any compensation. The client, in this case, has the right to extend the guarantee period for all works that depend on un-repaired executed works by at least 5 years.

If the contractor fails to repair unsatisfactory work performed in the period determined by the engineer, the client may grant repairs to some other contractor and charge the first contractor for exceeded and/or additional costs.

1.2.3 QUALITY OF EXECUTED WORKS ON EXPIRATION OF THE GUARANTEE PERIOD

1.2.3.1 Introduction

Any potential errors in the performance of responsibilities shall be borne by the contractor. The contractor is obliged to eliminate any errors during the guarantee period in a manner as specified in the contract. If the duration of the guarantee period is not otherwise specified by a contract or technical conditions, the guarantee period shall be considered within
- at least 5 years for earth works
- at least 5 years for pavement structures
- at least 10 years for new build structures (including water proofing, expansion joints and bearings)
- at least 7 years for restoration of structures (including water proofing, expansion joints and bearings)
- at least 5 years for surfacing on structures
- signalling:
    - at least 3 years for markings on the road
    - at least 5 years for traffic signs, safety and protective equipment.

For other equipment structures, the guarantee requirements of the manufacturer or supplier are applicable, unless the provisions of the contract prescribe otherwise.

It is assumed that the contractor met the contract requirements for good performance if the state of completed works after the guarantee period meets the requirements specified in the general and specific technical conditions for qualitative taking over of works when the guarantee period ends, or the corresponding provisions of the contract.

The client is obliged to perform routine maintenance work during the guarantee period, in accordance with maintenance project.

The client, or body authorised by him (the engineer, an independent institution) is entitled to perform appropriate procedures for checking the quality of completed works during the guarantee period, but must issue prior notice to the contractor. In case of any flaws or errors being identified, the client may require the contractor to immediately remove these at his own expense.

A guarantee for removing errors with a guarantee period must be in accordance with the terms of the contract. It is designed to ensure the adequate quality of works as defined by the contract, together with the payment of all performed works, equipment and materials necessary for repair of any damage, error or identified flaw, incorrect performance or inappropriate quality of used materials.

Prior to the expiry of the guarantee period, a review of the performed works must be completed, and a report must be issued with confirmation of the fulfillment of all contractual obligations.

During the expiry of the guarantee period, limited values are applied for the required quality, as specified in the general technical conditions, unless different limited values for the particular type of work are determined in the special technical conditions.

Following the expiry of a guarantee period, the state of performed works may differ from the requirements specified by the general and special technical conditions for quality during the taking over of works following the expiry of the guarantee period, i.e. contractual terms, only to the extent required by normal use.

For all characteristics of the performed works that are not particularly defined by these technical conditions, the quality after the expiry of the guarantee period must not deviate by more than 10% from the state after installation.

1.2.3.2 Pavement surfaces

First of all, deformations (uneven spots), cracks and the abrasion of pavement surfaces may be taken into account as effects of normal use of pavement surfaces. Limited values of the above changes are given in tables 1.2.3.1 to 1.2.3.3.

1.2.3.2.1 Transversal uneven spots and cart tracks

In order to determine the above deformations, the following should be taken into account
- during execution of continuous measurements, homogeneous sections will be 20 m in length,
- during execution of measurements using a measuring rod (length of 4 m) or profilograph, points should be determined by statistical random choice method (taking into account the average distance between measuring points of 10 m).

Table 1.2.3.1: Limited values of transverse deformation of pavement surfaces (according to TSC (Slovenian Technical Road Specification) 06.610)

Classification of traffic	Limited value of uneven spots		Limited depth of retention
	motorway, expressway	Roads I and II category	water in the cart track
- medium or higher volume (AADT > 2000 vehicles), medium or higher traffic load (annual average daily traffic load > 80 nominal axle load 100 kN/day), travel speed > 70 km / h)	8 mm	10 mm	4 mm
- low volume (AADT ≤ 2000 vehicles), lower traffic load (annual average daily traffic load > 80 nominal axle load 100 kN/day), travel speed > 70 km / h)	10 mm	12 mm	8 mm

1.2.3.2.2 Longitudinal uneven spots

To determine the longitudinal uneven spots based on the IRI index, the homogeneous sections should be identified wherever, within length of at least 300 m, the average unevenness value is greater than the specified limited values.

Table 1.2.3.2: Limited values of longitudinal deformations

Classification of traffic	Limited values IRI_{100m} index
- medium or higher volume (AADT > 2000 vehicles), and medium or higher traffic load (average annual daily traffic load > 80 nominal axle load 82 kN/day), and travel speed > 70 km / h)	1.5
- low volume (AADT ≤ 2000 vehicles), and lower traffic load (average annual daily traffic load ≤ 80 nominal axle load 82 kN/day), and travel speed > 70 km / h)	3.5

1.2.3.2.3 Cracks

Cracks on a pavement surface during the guarantee period are generally not permitted.

1.2.3.2.4 Abraded driving surface

In table 1.2.3.3 the specified limited values of friction ability coefficients SN for a given measured driving speed represent the average value on at least 100 m long homogeneous sections.

If the average value of friction coefficient for a particular driving speed is less than specified in the table, the contractor must at his own expense undertake to

- resurface the existing wearing layer with an appropriate new one, or
- remove the existing worn layer and replace it with a new one.

Table 1.2.3.3: Limited values of friction coefficients SN and the depth of roughness h_h

Measured travel speed km/h	Friction coefficient SN	Depth of roughness h_h mm	Depth of profile h_p mm
40	≥ 57	0.22	-
60	≥ 49	0.30	0.13
80	≥ 43	0.40	0.25

All changes in the state of pavement surfaces occurring during the guarantee period must finally be assessed in relation to the requirements related to the quality specified in the special technical conditions.

1.2.3.3 Cement-concrete construction structures

When the guarantee period expires, the client and contractor should review the plan in the following sections of construction structures (bridges, tunnels, galleries) in their environment:

- access to the construction structure and surroundings (river bed)
- supporting and protective structure (shallow and deep foundations - if these are visible, support, pillars, panels, portals),
- connecting structure (together with external cables and steel ropes)
- top of the structure (water proofing, road, curb stones, corridors, curbstone edging)
- structure equipment (drainage system, steel, concrete and wooden fences, covers, mounts for installation cables)
- bearings
- expansion joints
- vibration silencers.

Requirements execution class 3 according to EN 13670 may be issued in the notice for preparation of a technological study for the construction of cement-concrete structures.

On the expiry of the guarantee period, certain deficiencies respecting the cement-concrete structural elements are unacceptable for the client. It is necessary to distinguish damage that occurred due to defective maintenance, vandalism, traffic accidents or other damage resulting from natural aging of materials, or errors in the design and construction. Limited values defined by the technical conditions are taken as permissible execution deficiencies.

Unacceptable deficiencies are:

- for access to the construction structure and surroundings:
  - settlement of stairs and gullies
  - demolition of the protection of the slope beneath the abutment beams due to inadequate drainage
- for riverbed:
  - dislocated rocks on the bottom of the riverbed
  - rocks that have fallen out from the protective structures
- for foundations, piles, caps, bulkheads
  - erosion damage
- for cement-concretes:
  - frost damage – mesh cracks
  - damage due to alkali-silica reaction and sulphate corrosion - mesh cracks
  - damage due to reinforcement corrosion - linear cracks or corrosion products on the surface of cement concrete
  - honeycomb cavities, a covering layer over the reinforcement that is too thin, delamination, soaking
- for reinforced steel:
  - corrosion of rods due to impacts of chlorides and/or stray electrical currents
- for external cables, steel ropes, vibration silencers:
  - wrinkled and/or torn outer PE layer on the edge of the deviation tube, visible grease leakage from the casings
  - wedge fracture
  - strand breaks
  - oil or wax leakage from the protective cap or hydraulic cylinders, screws falling out
- for attachable structures:
  - shearing cracks
  - sawing remains, wire bonding remains, nails
- for bearings:
  - local deterioration of connection between rubber and steel bushing
  - separation of grease from the elastomer
  - bearing plates that are too narrow
  - uneven seating of the bearing
  - sliding cut compressed
  - moving PTFE or MSM board from the sliding bearing housing
  - inadequately executed bearing cushions
  - sliding of bearing plates
  - uneven bearing plate
  - deviation of the bearing plate from the surface
  - sliding of attachable structure over the bearing
  - moving of PTFE plate or elastomer from the housing of the supporting plate of the sliding bearing or pot
  - construction and other remains on the bearing shelf
- for expansion joints:
  - deviation in the level of positioned partition slats and asphalt connections at the level of the curb

profile of the expansion joint i.e. no overshoot
- size of the expansion joint or its individual parts do not fit the dimensions of the expansion joint
- inadequate calibration at time of expansion joint installation
- space below the box is not adequately concreted and/or reinforced
- unregulated drainage of water that penetrates (soaking the back-wall)
- opened connection of asphalt at curb profile
- rubber gaskets do not seal
- loose and collapsed anchoring and tightened bolts
- rubber springs and bearings cracked / cut off or moved away
- inadequate corrosion protection
- coating tin does not have a protective function
- cracks and wrinkles in the asphalt expansion joints, visible cart tracks

- for drainage devices, gullies:
  - delay of water in pipes or leaking at the connections
  - corroded gullies
  - corroded inner side of pipe made from modular cast metal
  - eroded wedges from supposedly stainless steel
- for joints:
  - deviation of the sealing mixture
  - not sealed
  - moved away
- for fences:
  - cracked final epoxy mortar at the foot of the pillar
  - cracked welds
  - inadequate means of connection
- for secondary tunnel coatings:
  - semi-circular - shape of crescent - cracks in the crown area of the arch
  - stratification of cement concrete joints along the individual segments
  - arch crown cracks and other cracks - relative displacement along the edges of cracks
- for support and protective walls:
  - protective caps of anchorage - protective grease leakage
  - anchor heads - corrosion of steel parts, incomplete placement of cement concrete.

The following limited values may apply for permitted deficiencies:

- for access to the construction structure and surroundings:
  - connection or distance on the pavement next to supporting wall, with a width of ≤ 1 cm
  - settlement of the pavement next to the supporting wall, ≤ 120% of the design settlement
  - settlement of verge on the approach to the structure, ≤ 140% of the design settlement
- for cement concrete of supporting walls:
  - cracks, width of ≤ 0.3 mm (at distance > 100 cm)
  - air pores with diameter from 2 to 10 mm on the surface, criteria of observer's distance 10 m, pore area ≤ 3% of the total surface area, pore concentration in groups of up to 10% of the total surface
- for bearings:
  - dotted corrosion on steel parts, ≤ 5% of the total area
  - neoprene cracks, width of ≤ 0.1 mm or 1/10 thickness of layer of neoprene between two steel bushings cracks expands to the depth of the steel bushing
- for expansion joints:
  - deviation in the level of placed partition slats or curb profiles ≤ 3 mm, lateral unevenness on the junction with asphalt up to 5 mm
- for cement concretes of attachable construction and classically reinforced and/or prestressed cement concretes:
  - cracks, width of ≤ 0.2 mm at distance > 30 cm
- for top of construction:
  - cracks, width of ≤ 0.2 mm at distance > 100 cm
  - peeling of cement concrete, depth ≤ 1 mm, the amount of ≤ 40 mg/mm2
- for fencing, communal infrastructure, signalling:
  - peeling of cement concrete, depth ≤ 4 mm, the amount of ≤ 40 mg/mm2
  - external corrosion, ≤ 10% of the total surface
- for devices of drainage, gullies:
  - external corrosion, ≤ 10% of the total surface

If any of the aforementioned limited values are exceeded, the contractor is obligated, at his own expense, to perform repairs so that the condition of the cement-concrete structural element is in accordance with the requirements specified by the project documentation and special technical conditions.

Detailed provisions regarding the taking over of cement-concrete construction structures for bridging, internal lining of tunnels, galleries and protective and supporting walls at the end of the guarantee period may also be provided in the contractual documentation.

1.2.4 MEASUREMENT OF DENSITY AND MOISTURE

1.2.4.1 Introduction

Guidelines for measuring density and moisture determine the lay-out for carrying out a comprehensive procedure that is an integral part of the quality control of performed works. For easy and quick performance it is recommended to perform measurements using a non-destructive indirect method using an isotope gauge. Since failures can occur during indirect measurements, due to objective error in the procedure, typically, isotope gauge measurements should be supplemented by direct measurements of density and moisture with supplementary proceedings.

In these guidelines, the used professional terms have the following meanings:

Density (gustina) is the mass of material including moisture and voids per volume unit (kg/m^3 or t/m^3).

Investigation/examination (ispitivanje) is a technical activity to establish, in compliance with an accurately defined procedure, one or more fundamental characteristics of a product, method, or service in question.

Isotope gauge (izotopska sonda) is an instrument for the non-destructive measurement of density and moisture content of construction materials; basically it is composed of a radiation source (gamma rays, fast neutrons) and a detector.

Measuring cylinder (merni cilindaris a calibrated cylinder for performing a substitute procedure in measuring the density of materials

Substitute procedure (nadoknadni postupak) is a procedure whereby the material density is measured in such a way that the material mass is determined gravimetrically by weighing excavated material, whilst its volume is established by substituting the excavated material with another – substitute material, the density of which is exactly known (auxiliary procedure for determining soil compactness).

Radioactive isotopes (radioaktivni izotopi,) are isotopes with an unstable nucleus; at disintegration they emit internal energy (alpha, beta, gamma rays, fast neutrons).

Sound (isotope) (sonda (izotopska)) is a flexible element of an isotope gauge, with a source of ionizing radiation (gamma rays) at the top of the rod.

Moisture (vlaga is the water mass in the volume unit of material (kg/m^3 or t/m^3).

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

1.2.4.2 Isotope gauge measurements

1.2.4.2.1 General

These guidelines contain only basic information regarding measurement with the isotope gauge. The contractor of measurements must fully comply with instructions conditioned by the equipment manufacturer, while using an isotope gauge.

Please note:
Equipment used in the considered types of measurements contains radioactive materials. Radioactive materials emit ionizing radiation which is harmful to health if the user does not comply with the proper safety measures. It is therefore important that the user of the equipment already knows, prior to measurements, that there are potential hazards and comply with all available regulations relating to safety measures and procedures.

The process of measurement with isotope gauges is suitable for testing most of the materials used in earthen and asphalting works because the surface area of the isotope gauges corresponds to the insurance of the representative volume / sample for testing. However, on the measurement results of density and moisture, in the process of measurement by direct irradiation and in the measurement procedure of backward scattered radiation, there can be a number of influencing factors, primarily:

- heterogeneity in chemical composition of material, e.g. accidental presence of metal ions in the slag and ash;
- unusual chemical composition of materials, some elements, for example

cadmium, boron and chlorine, can affect the result of determination of moisture due to the high probability of absorption of fast neutrons, and if the material contains elements that would influence measurement results taken by an isotope gauge, and if the proportion of these elements is a constant, the calibration curvature should be adjusted accordingly,
- rough surface material, an effect that should be reduced as much as possible to ensure the best possible contact between the isotope gauge and the tested surface of the compacted layer, the influence of the surface is greatly reduced in the process of measurement by direct irradiation,
- unusual mineralogical composition of the material, e.g. minerals containing chemically bound water (gypsum) and soil with a large portion of organic impurities.

There can be influences on the results of density measurements and:
- layers of compacted material with significant vertical gradients of density, because the degree of compactness on the top contributes little to the transverse compactness of the layer; testing by measuring backward scattered radiation, due to the method of action affects to a greater extent the material near the surface, the procedure of direct irradiation is thereby more appropriate, due to an increase of sensitivity with the depth reduces these effects and
- accidental presence of larger components that are completely surrounded by smaller fragments, which may result in unusually high density.

There can be influences on the results of moisture measurements, along with the hydrogen in free water, and hydrogen in chemically bonded water, as well as hydrogen in other ingredients, e.g. in organic materials.

1.2.4.2.2 Physical lay-outs

1.2.4.2.2.1 Radioactive isotopes

Radioactive isotopes housed in an isotope gauge emit radiation that can penetrate a hard substance. Based on the degree of weakening or change in the radiation energy, conclusions can be drawn concerning the properties of irradiated material.

An isotope gauge typically contains a source of gamma radiation and a combined source of radiation of fast neutrons.

1.2.4.2.2.2 Density measurements

A density measurement is based on the change of direction of gamma rays from the source to the detector due to the Compton effect. A density measure represents the intensity of reverse reflected radiation (in accordance with the appropriate calibration) that reaches the detector and is directly related to the density of electrons of the irradiated material.

1.2.4.2.2.3 Moisture measurement

When measuring the moisture, the slowdown of neutrons is used, emitted from a source of fast neutrons caused by collisions with hydrogen nuclei. The intensity of radiation that reaches the detector is directly related to the status of the received modified neutrons and represents a measure of moisture amount that is present in the area of influence. It is assumed that water is the only source of hydrogen, which is present in the irradiated material.

1.2.4.2.3 Measurement equipment

1.2.4.2.3.1 Isotope gauge

An isotope gauge is measurement device that consists of a sound, a detector, devices for readings and sources of electrical power. These components are embedded in the casing, which must be strong and resistant to water and dust.

An isotope gauge that has the shape of a rod is designed for insertion into the soil. The rod must be marked at intervals of 5 cm in length for testing to a depth of 30 cm. A source of ionizing radiation is embedded in the sound which must be sealed and adequately protected to ensure safe use and storage.

Please note:
The isotope gauge must be designed to allow safe hand-insertion to the required depth.

If it is suspected that the source is damaged, or if the source is damaged or appears to be damaged, the isotope gauge must be placed in a storage crate, and the manufacturer or authorized representative should be informed immediately. Handling and repair may only be attempted by properly equipped and properly trained personnel.

A measuring kit should also contain instructions for use, a calibration certificate and a crate for transport.

1.2.4.2.3.2 Auxiliary equipment for measurement preparation

Auxiliary equipment for measurement preparation includes:
- equipment for surface leveling in the testing area, e.g. masonry trowel, ruler, etc.
- equipment for making boreholes: steel rod or drill, a hammer, a guide to preserving the verticality of the inserted rod (a guide can be used as a leveling plate) and a handle for pulling out the inserted rod, an insertion steel rod must be on one end with a sharp point, with the other end spread out (for hammer impacts)
- material for leveling of uneven surfaces: fine grained material is commonly used, which is located in the measurement area, or dry, fine quartz sand.

Please note:
The equipment mentioned above is also appropriate for making a borehole in fresh, stabilized material, while hardened materials can be drilled according to the procedures for drilling cement concrete.

1.2.4.2.3.3 Calibration equipment

The following reference materials are required for calibration:
- material with known density, prepared in the form of a block
- material with known density, compacted in boxes or
- material from the field, with density determined according to a standardized procedure (calibrated cylinders, compensation with sand or water).

A standard measurement block must be made of material suitable for checking the operation of the measuring system, as well as for repeated determination of a standard number of impulses. A standard block must have the same serial number as the isotope gauge and must not be used in combination with other isotope gauges.

A standard unit should be clean and without attached particles, which would cause poor contact with the sound, which consequently might cause incorrect count of the standard number of impulses.

Please note:
The advantage of blocks is reflected in their durability and consequential calibration repeatability.

Blocks and boxes must be in rectangular form with sides at least 310 mm x 360 mm x 560 mm, or such a size that does not allow them to influence the measuring result.

1.2.4.2.4 Calibration, standardisation and verification of measurement system

1.2.4.2.4.1 Calibration

The proper calibration of an isotope gauge provides a sound lay-out for the reliable performance of a density or moisture measurement. Calibration connects the measured value (number of impulses, of impulse ratio) and the status of the irradiated material (density and moisture). Calibration is given in the form of a curvature or table indicating the material on which it was carried out. Isotope gauges generally allow entry of calibration curvatures in the previously embedded microprocessor.

Density

Calibration must be performed on the basis of counting impulses for each of several different materials with a known density. Materials must be used for calibration from the same area of density as materials that will be later examined with the isotope gauge. The end result of calibration is the correlation relationship between the ratio of impulse rate (in relation to the standard rate) and density.

Factory calibration must be performed by the manufacturer in accordance with the provisions of the relevant regulations.

Factory calibration should be checked at least once each year. If the results of the assessment are not in accordance with the prescribed conditions, it is necessary to re-calibrate the isotope gauge.

Verification or recalibration must be performed by the manufacturer or his authorized representative.

Please note:
Calibration should be checked and, if necessary, repeated after any major repairs to the isotope gauge.

The calibration curvature should be checked on a new gauge as well, and also in case of any doubt concerning the reliability of routine checks. For this purpose it is necessary to use one of the prepared reference materials for calibration. The use of blocks or crates for calibration is more reliable than volumetric field procedures.

Calibration curvature adjustment

If the results of density testing on blocks or boxes fall beyond the calibration curvature , it is necessary to replace the calibration curvature with a new curvature that corresponds to the results of testing for a given material.

When checking the calibration curvature using the field volumetric methods, it is necessary to compare the results of both types of density measurements on at least 10 measuring points.

Measures are as follows:

- if an absolute difference in density, as determined on individual measuring points both ways, does not exceed 80 kg/m3 and the differences are first positive, and the second time negative, there is no need to change the calibration curvature
- if each value, as determined by the appropriate alternative treatment, is greater than value determined by the isotope gauge, and the average difference exceeds 30 kg/m3, it is necessary, for any subsequent density determination with the isotope gauge, to add an average difference
- if each value, as determined by the appropriate alternative treatment, is less than the value determined with the isotope gauge, and the average difference exceeds 30 kg/m3, it is necessary, for any subsequent density determination with the isotope gauge, to subtract the average difference

Moisture

Calibration must be performed on the basis of counting the impulses for each of several different materials with known moisture content. Materials must be used for calibration from the same area of moisture as materials that will later be examined with an isotope gauge. The end result of calibration is a correlation relationship between the ratio of impulse number (in relation to the standard number) and moisture.

For calibration it is necessary to use one of the listed reference materials for calibration.

Factory calibration must be performed by the manufacturer in accordance with the provisions of the relevant regulations.
Factory calibration should be checked at least once a year. If the results of the assessment are not in accordance with the prescribed conditions, it is necessary to re-calibrate the isotope gauge.

Verification or recalibration must be performed by the manufacturer or his authorized representative.

Please note
Calibration should be checked and, if necessary, repeated after any major repairs to the isotope gauge.

Calibration should also be checked as a rule for a new isotope gauge. Calibration should be checked in case of the testing of materials which, based on chemical composition, differ significantly from the material on which the calibration was performed. One of the prepared reference materials listed in section 1.2.4.2.3.3 should be used for verification.

Measures to adjust the calibration curvature are as follows:

- if the verification results of moisture in the material in the crates are not randomly distributed above and below the calibration curvature , it is necessary to replace the calibration curvature with a new one, corresponding to the test results for a given material
- if the verification results of moisture in the materials in the crates randomly distributed above and below the calibration curvature and the average difference does not exceed 8 kg of water per m3 of material in relation to the isotope gauge measurements, an adjustment is not necessary
- if any moisture value, determined in the normal manner, exceeds the value specified by the isotope gauge, it is necessary, at each subsequent measurement with the isotope gauge, to add the average difference
- if any moisture value, determined in the normal manner, is smaller than the value specified by the isotope gauge, it is necessary, at each subsequent measurement with the isotope gauge, to subtract the average difference

1.2.4.2.4.2 Standardisation of isotope gauge

The standardisation of the isotope gauge involves the determination of a standard rate of impulses on a standard block.

Long-term aging of the radioactive source, detector and electronic components has a bearing on the measurement results (rate of impulses) not to mention the possible geographical variations caused by background radiation. To exclude the aforementioned impacts, isotope gauges are calibrated on a ratio of measured impulses for each radioactive source, compared to the standard rate of impulses, as listed on the reference block.

Please note
Routine monitoring of the standard number of impulses is necessary and for incidental activity control of measuring part of the isotope gauge.

It is necessary to perform standardisation of the isotope gauge on a reference measurement block for each type of measurement at the beginning and end of each day of use. This process should be completed after more than eight hours of continuous use. The procedure should be completed after each restarting of the gauge.

When turned on, the isotope gauge emits heat, which must be in accordance with the manufacturer's instructions. The warm-up procedure should not usually last less than 15 minutes.

If the continuous use of the isotope gauge is intended, or use in intervals within the same day, the gauge should not be turned off.

During measurements, the gauge must be located at least 7 m from other isotope gauges and at least 1.5 m from any higher structures that can affect the measurement.

When the gauge is used in a narrow trench or at a distance less than 1.5 m from a structure, it is necessary to take into account the impacts of reflected radiation by determination of a standard rate of impulses in a location that would later be used for measurement.

The standard measurement block must always be positioned at least 1.5 m away from any higher obstacle. At least four consecutive one-minute measurements should be performed for each type of measurement (density and moisture) and the average value calculated.

Please note
One measurement for four minutes is also acceptable, if the gauge allows it.

The results of each standardisation should be amended with the date, and the values should be saved for assessment of the isotope gauge's operational regularity.

It should be verified that the average value of readings is within the limits specified by the following equation:

$$N_s = N_0 \pm 2\ (N_0/p_c)^{0.5}$$

where:

- N_s current calibration average on standard
- N_0 four N_s values average before use
- P_c value of calibration factor for impulse detector before display on screen

Please note
The manufacturer is obliged to specify value p_c in its technical documentation If this factor is not incorporated in the gauge, then it is $p_c = 1$.

In cases where the value N_s, evaluated according to the above equation, is within the permissible value, N_s may be used for the daily use of the gauge.

If the value of N_s is outside the prescribed limits, the procedure for determining the average value of impulses must be repeated at least twice: if all three or two of the three values are beyond acceptable limits, the isotope gauge should not be used until the error is rectified.

If during standardisation at the end of the day the N_s value is found to be beyond the prescribed area, all results measured on that day are invalid.

1.2.4.2.4.3 Measurement system stability verification

It is necessary to standardise the isotope gauge as described in Section 1.2.4.2.4.2, provided that for each type of measurement (for density and moisture) at least 16 repeated one-minute measurements are made on a reference block. During the procedure, it is not permissible to move the gauge.

Each measurement should be recorded separately for each type of radiation source, as well as the measurement date.

It is necessary to calculate the standard deviation and arithmetic mean for every sequence of repeated measurements.

It should be verified whether the stability quotient, expressed as a standard deviation divided by the square root of the arithmetic mean, is in the area specified by the manufacturer. At the recording process it is necessary to take into account the calibration factor.

If any of the values fall outside the area specified by the manufacturer, or if this is the trend indicated by consecutive checks, the gauge may not be used until the error is rectified.

Please note
A stability test for each type of measurement should be performed at least once a month, if the gauge is in daily use, otherwise, once every three months. If the trend of consecutive checks indicates an error, the isotope gauge should not be used.

1.2.4.2.5 Methods of determining density and moisture

1.2.4.2.5.1 Measurement

1.2.4.2.5.1.1 *Determination of density by direct irradiation*

The isotope gauge must be standardised in line with the procedures described under Section 1.2.4.2.4.2.

It is necessary to remove other materials from the surface of the selected measuring point. The measuring surface must be completely flat.
Using the guides it is necessary to drill or impress a borehole to the appropriate depth. As a rule, the borehole must be bigger from the depth to which the volumetric mass will be determined. The required depth of the borehole must be - according to the selected depth of measurement - described in the manufacturer's instructions. At the measuring point should be the designated contact surface of the sound.

After placing the sound on the measuring point it should be ascertained whether the contact between the bottom of the isotope gauges and the measuring surface corresponds.

Any unevenness should be filled with fine, dry, quartz sand or smaller parts of the testing material. Additional material may not be embedded in an independent layer.

The isotope gauge should be set to a selected depth and moved in such a way that the side of the detector closely aligns with the borehole surface.

It is necessary to measure the density (if necessary, and moisture) in accordance with the manufacturer's instructions. The measurement time for each type of measurement must be no less than 1 minute.

To achieve greater precision, an isotope gauge should be rotated 180 ° around the vertical axis, with the following measurements being taken and the average of both results determined. Another possibility for assessment is repeating the measuring over a wider area at neighboring sites and calculating the mean value of these results.

After that, the movable isotope gauge should be returned to its casing in the “safe” position.

One must read and record the measured values for a given test point, and based on the calibration curvature , determine the density.

Please note
Isotope gauges are typically equipped with microprocessors that allow storage of the calibration as defined by the user, as well as density and moisture calculation based on calibration, correction of results and storage of measured values.

1.2.4.2.5.1.2 Determination of density and measurement by reverse scattered radiation

The isotope gauge must be standardised in conformity with the procedures described in Section 1.2.4.2.4.2. According to the manufacturer's instructions, one must measure the density and moisture over at least 1 minute. To achieve greater precision, the isotope gauge should be rotated by 180 ° around the vertical axis, with the following measurements being taken and the average of both results determined. Another possibility is repeating the measuring over a wider area at neighboring sites and calculating the mean value of these results.

Movable rod - after that the gauge should be returned to its casing, in the “safe” position.

One must read and record the measured values for a given test point, and based on the calibration curvature, determine the density and moisture.

Please note
Further measurement of moisture, with isotope gauges that enable this, can be performed simultaneously with the density measurement for both methods of determination.

If the data on moisture in the form of water mass per unit volume is specifically required, one must refer to the given instructions for determining this.

1.2.4.2.5.2 Calculation and presentation of results

1.2.4.2.5.2.1 Dry density

Dry density ρ_d (in kg/m^3) should be determined by the following equations:

- based on moisture measurement by isotope gauge:

$$\rho_d = \rho - W$$

where:

ρ material density (in kg/m^3), determined by isotope gauge

W moisture (in kg/m^3), the mass of water on volume unit of material, specified by the isotope gauge

- determination of moisture at laboratory:

$$\rho_d = 100\rho / (100+w)$$

where:

ρ material density (in kg/m^3), determined by the isotope gauge

w proportion of moisture in the material (in m. -%)

1.2.4.2.5.2.2 Proportion of moisture

The proportion of moisture in the material w (in m. -%) can be calculated by the following equation

$$w = 100\ W / (\rho - W)$$

1.2.4.2.5.2.3 The report on measurements

The report on measurements must include a statement that measurements are made in accordance with these guidelines, as well as the following information or results:
- procedure used to obtain results
- “in situ” density and/or dry material density (kg/m^3)
- proportion of moisture (if specified) (m.-%)
- location and serial number of measurements
- time interval between completion of compaction and measurement time.

1.2.4.2.6 Radiation protection

Radiation of radioactive isotopes may, with improper handling of the isotope gauge, negatively impact the health of humans and animals and cause various injuries. For the reliable prevention of injuries it is necessary to respect the legal provisions for handling radioactive materials and the transportation thereof.

1.2.4.3 Methods of measuring gvolumetric weight (procedural substitutes)

1.2.4.3.1 General

In connection with supplementary procedures for density and moisture measurement, these guidelines define the lay-out for performance of measuring and results evaluation of direct gravimetric density measurement.

1.2.4.3.2 Physical lay-out

1.2.4.3.2.1 Density measurements

Measurements of density of the material by compensatory procedures are based on measurements (weighing) of mass of the excavated soil or embedded layer and the volume occupied by the excavated soil.

Volume measurement is done by filling in gaps that emerged during excavation of a known mass of material with material for replacement of a precisely known density. The most commonly used materials for measuring the volume are calibrated sand and water, although oil or other liquids may be used. When oil, mercury, or some other material that is harmful to the environment is used as a supplementary material, appropriate protective measures are required during the work to avoid any flooding or pollution to the environment.

In the procedure with measuring cylinders, the gap volume formed by taking a known mass of material is specified by the volume of the cylinder.

1.2.4.3.2.2 Moisture measurements

With all density measurements by supplementary procedures, gravimetric determination is used for determining the moisture by drying excavated material in an oven at temperatures of 105 ° C to 110 ° C to a constant weight.

When the material contains minerals that feature chemically or electrochemically bound water, evaporating from the crystal lattice of minerals at already lower temperatures, a drying temperature lower than the temperature of the mineral phase transition is used for drying. A characteristic example may be found in the transitions of gypsum in anhydrite and semi-hydrate, already starting at 40°C, a highly organic soil, and others.

1.2.4.3.3 Procedures for measurement performance

Considered methods of measurement are as follows:

- measuring cylinder procedure, suitable for small and medium-grained soils,
- process of compensating with water, suitable for rough-grained materials.

These measurement procedures should be performed in accordance with the SRPS U.B1.016 standard. Useful additions to the procedures are given in these technical conditions.

1.2.4.3.3.1 Procedure with measuring cylinder

1.2.4.3.3.1.1 Usefulness of the procedure

The measuring cylinder procedure may be used for natural soil and an artificial embankment of dense connective layers of (cohesive) fine-grained soil, without rough grains.

The advantage of proceeding with a measuring cylinder is the quick and easy performance.

1.2.4.3.3.1.2 Equipment for measurement performance

To perform measurements, the following basic equipment is required:

- a calibrated cylinder 130 mm long, with an inner diameter of 100 mm and a wall thickness 3 mm; the bottom edge of the cylinder must be sharpened in the shape of a blade and reinforced, and the cylinder must be coated in grease prior to use
- steel cylindrical ring with a length of 25 mm, with an inner diameter of 100 mm and a wall thickness of 5 mm, with an extension that allows positioning at the top of the measuring cylinder
- a steel mallet
- scale with accuracy 1 g
- masonry trowel
- steel ruler, with a division of 0.5 mm
- tool designed for soil excavation and displacement of soil from the cylinder
- steel knife (for sample treatment) with sharpened edge, recommended length 300 mm, 25 mm wide and 3 mm thick
- equipment intended for determination of moisture (dryer).

It is also possible to use a different form of cylinder, provided basic requirements are met.

1.2.4.3.3.1.3 Performing the measurement

Within the measurement of soil density by measuring cylinders it is necessary to

- calculate the (internal) volume of the measuring cylinder V_c in cm^3; the measuring of the cylinder dimensions must be performed with an accuracy of 0.5 mm
- measure the mass of the cylinder m_c with an accuracy of 1 g
- choose a layer surface on which the density measurement will be performed, and then flatten it in the form of a square with a side of approximately 300 mm; remove the soil, which remained after flattening the surface; deposit the cylinder on the surface so that the sharpened edge of the cylinder - the blade - lies on the surface - deposit the cylindrical extension on the upper part of the cylinder and use a mallet to insert the cylinder into the soil until the free height of the cylindrical extension above the surface is approximately 10 mm,
- carefully dig the cylinder so that on the lower edge of the cylinder is part of the soil below the bottom edge of the blade, carefully flatten the sample surface in the cylinder with a steel knife,
- determine the mass of the cylinder with the soil m_z up to 1 g,

- extract the soil from the cylinder and store it in a waterproof container for determining the moisture of representative tests (w), in accordance with the standard procedure for determining moisture.

1.2.4.3.3.1.4 Calculating the results

The density of naturally moist soil ρ should be calculated according to the equation

$$\rho = \frac{m_z - m_c}{V_c}$$

where:
m_z soil and cylinder mass
m_c empty cylinder mass
V_c internal volume of cylinder (cm^3)
The dry density of soil ρ_d should be calculated according to the equation

$$\rho_d = \frac{100 \cdot \rho}{100 + w}$$

where:
w soil moisture (m.-%)

1.2.4.3.3.2 Procedure of compensating with water

1.2.4.3.3.2.1 Usefulness of the procedure

The procedure is useful for determining the density of rough granular materials located in the natural soil or in compacted and filled layers for which other methods are not suitable due to difficulties in maintaining the wall stability of the excavated pit.

The determination of soil density can be performed in two ways:
- as a determination of density for the whole mass of material excavated from the area
- as a determination of the material density selected granularity, as a rule not less than 0/32 mm or 0/63 mm.

1.2.4.3.3.2.2 Equipment for measurement performance

The equipment for measurement performance depends on the type of material, primarily on the size of grains in the material being tested. Basic equipment includes:
- a solid cylindrical ring, approximately 100 mm high for diameters up to approximately 500 mm and 200 mm for larger diameters; the ring must have extensions that allow attachment on the formation , e.g. metal cloves, dowels etc..; the ring diameter must be several times larger than the diameter of the largest grains in the material

Please note
As a rule, the ring diameter must be 5 times larger than the diameter of the largest grains in the layer material to be tested. Ring sizes are usually between 500 and 2,500 mm. Rings that are larger than 500 mm, as a rule, consist of several arches, which are then assembled into a ring on the testing site and attached to the formation .

- a ruler of an appropriate length, which is adapted to the ring diameter
- a spirit level (a level) of appropriate length for levelling the ring
- a measuring frame or other form of measuring device consisting of an appropriate base or frame with a calibrated scale and adjusting pointer that can be fixed to a permanent place, removed and then re-set to exactly the same place on the ring or nearby.

Please note
For small measuring rings the pointer may be adjusted on a bracket that is equipped with special legs facing the ground on the outside of the measuring ring. In this case the pointer remains in the same place throughout the test. For large rings it is preferable for the measuring frame to be slightly longer than the diameter of the ring so that it can be placed on the rim with the exact spot where it fits being marked. In this case the pointer is fixed to the centre of the measuring frame.

- graduated water containers of varying sizes, each container must be equipped with a volume pointer and drain pipe for water with a valve; the volume pointer must be clearly labeled and must provide accurate readings of up to 0.3% of the control excavation volume
- adequate equipment for performance of excavation and extracting excavated soil: a steel bucket, a steel bat with a head for compaction, a compaction hammer, a shovel, a pick, a big ladle
- a scale, accuracy 100 g
- a container or other type of equipment for the storage of excavated material
- a pump, a container and proper pipes for discharge of the test excavations
- an adequate container and equipment for preparing gypsum paste

- equipment intended to determine the density of large stone grains (if necessary)
- equipment intended for determination of moisture (dryer)
- control sieves (if necessary)
- flexible plastic membranes of proper thickness in order to prevent grain penetration and flexible enough to adhere well to the walls of the excavation when filled with water,

Please note
Polyethylene membranes, with a thickness 0.1 mm and square-shaped with an edge length from 2 to 4 m are suitable for rings with a diameter of up to 1.5 m. For rings with a diameter of to 0.5 m previously prepared polyethylene bags with a thickness of 0.1 mm may be used. For large rings with a radius above 1.5 m, square-shaped membranes with a thickness of 0.2 mm and an edge length of up to 6 or 8 m are suitable.

- gypsum or other quick-setting material
- clear water.

1.2.4.3.3.2.3 Calibrating water containers

Each water container, equipped with a graduated scale for measuring the volume, drain pipe and valve, must be calibrated. The container should be placed on a formation and filled with clean water to the upper edge of the graduated scale. Then one needs to open the valve and sequentially discharge water into separate containers so that the water level drops.

By measuring the mass or volume in the corresponding calibrated container, the volume of discharged water should be determined in each secondary container. The actual measured volume should be marked on a graded scale for each water container that is thus calibrated.

1.2.4.3.3.2.4 Performing measurement

To perform density measurements of all the material in the tested layer one must:
- choose the correct ring size, so that the ring's diameter is approximately 5 times greater than the diameter of the largest grain in the soil layer
- prepare a smooth layer on the formation to be tested; remove all pieces of material from the surface
- prepare gypsum or some other quick-setting pasta, experimentally place the ring on the formation and mark the contact spot; remove the ring and cover the marked place with a thin layer of binder paste, place the ring on the layer and attach it to the ground; remove any excess paste, pushed out beneath the ring.
- adjust the equipment in the base so that the base can be removed from the field of measurement and the pointer can be secured in exactly the same place under the edge of the ring after the restoration on the measurement area, remove the base of the equipment
- select an appropriate membrane, be certain it is not damaged, stretch over the measuring ring and carefully adjust it in the ring, reset the measurement frame and set the pointer
- fill up the space in the ring with water from a calibrated water container, while charging take into account that the membrane adheres well and accurately on the wall and be careful of any leakage through the membrane, the water level in the ring should reach the height of the pointer in the measurement frame; record the volume of water Ri in litres.
- remove the measurement frame and attach the pointer, remove the water and plastic membrane and check that the surface of the flat area is dry, in the event of any visible signs of water leakage, the test should be repeated
- start with the excavation of the soil; during the excavation make sure that the ring does not move or that the soil beneath the ring does not cave in; large grains or blocks of stone must not be removed from the walls of the excavated pit; form the walls of the excavated pit to be as smooth as possible; the depth of the excavated pit should be approximately equal to its diameter, except in exceptional cases where the density is checked at exactly the right depth below the formation
- all excavated material must be stored in appropriate containers for subsequent testing for determining the mass and moisture, the mass of the excavated material is m_w
- select an appropriate membrane and check that it is not damaged; place the membrane over the ring and then carefully lower it into the excavated pit; reconfigure the measurement frame
- fill up the pit with water from the calibrated water container; occasionally, while filling, move away the upper edge

of the membrane from the wall of the excavated pit so that the membrane nicely adheres to the walls of the pit

- fill up the water until the level reaches the height of the pointer on the base of the equipment; when the water level reaches the pointer, follow the state of the level for a few minutes to make sure that there is no leakage through the membrane; the measured volume, recorded in litres, must be within the limits of 0.1% of the entire measured volume R_t
- remove the measurement frame, pump out the water, remove the membrane and check whether during the research there has been any leakage through the membrane; if the portion of water used for testing leaked through the membrane, the test should be repeated.

To perform measurement of the material density in tested layer to a certain nominal grain size, it is necessary to:

- select the right size ring, so that the ring's diameter is approximately 5 times greater than the diameter of the largest grain in the soil layer
- prepare a smooth surface layer on the formation to be tested; remove all pieces of material from the surface
- prepare gypsum or some other quick-setting pasta, experimentally place the ring on the formation and mark the contact spot; remove the ring and cover the marked place with a thin layer of binder paste, place the ring on the layer and attach it to the ground; remove any excess paste, pushed out beneath the ring.
- adjust the equipment in the base so that the base can be removed from the field of measurement and the pointer can be secured in exactly the same place beneath the edge of the ring after the restoration on the measurement area, remove the base of equipment
- select an appropriate membrane, be certain it is not damaged, stretch over the measuring ring and carefully adjust it in the ring, reset the measurement frame and set the pointer
- fill up the space in the ring with water from a calibrated container, while it is filling ensure that the membrane adheres firmly and closely to the wall and be careful of any leakage through the membrane, the water level in the ring should reach the height of the pointer in the measurement frame; record the volume of water Ri in litres.
- remove the measurement frame and attach the pointer, remove the water and plastic membrane and check that the surface of the formation is dry, in case of any visible signs of water leakage, the test should be repeated
- start with the excavation of the soil; during excavation ensure that the ring does not move or that soil beneath the ring does not give way; large grains or blocks of stone must not be excavated from the walls of the excavated pit; form the walls of the excavated pit to be as smooth as possible; the depth of the excavated pit should be approximately equal to its diameter, apart from in exceptional cases where the density is checked at exactly the right depth below the formation
- all excavated material must be stored in appropriate containers for subsequent testing for determining the mass and moisture, the mass of excavated material being m_w
- remove all grains larger than the selected limit size from the measured excavated soil; if necessary, use standardised size sieves; record the mass of grain with a size above the selected limit in kg m_s
- determine the moisture w_p in the remaining excavated soil from which the large grains have been removed,
- determine the density of material in one of two ways:
  - in the excavated pit adjust the membrane, and after fixing, return large grains into the excavated pit; be sure not to damage the membrane; adjust the measurement frame, and attach the height pointer and fill up the pit with water from the calibrated water container, record the volume R_p,
  - in general, perform the filling process of the pit with water as described. Determine the volume of large grains in the laboratory by the prescribed procedure, immersing the grains in water or calculating the volume of grains by taking into account their specific density.

1.2.4.3.3.2.5 Calculating the density of the entire mass of material

The volume of the excavated pit V_i (in m^3) should be calculated according to the equation

$$V_i = \frac{R_t - R_i}{1000}$$

where:

R_t the total volume of water in the excavated pit and in the ring (l)
R_i the volume of water in the ring (l)

The density of naturally moist material *ñ* should be calculated according to the equation

$$\rho = \frac{m_v}{V_i}$$

where:
m_w the mass of excavated material (kg)
V_i the volume of the excavated pit (m^3)

The density of dry soil $ñ_d$ should be determined by the equation

$$\rho_d = \frac{100 \cdot \rho}{100 + w}$$

where:
p the density of naturally moist material (kg/m^3)
w soil moisture (m.-%)

1.2.4.3.3.2.6 Calculating the density of the soil without taking into account the grains of larger size

When large grains are returned into the excavated pit, the dry density of the naturally moist material $ñ_{dp}$ should be calculated according to the equation

$$\rho_{dp} = \left(\frac{m_w - m_s}{R_p - R_i}\right)\left(\frac{100}{100 + w_p}\right)$$

where:
m_w the mass of excavated material (kg)
m_s the mass of exceeding grains (kg)
R_p the volume of water in the excavated pit with larger grains
w_p the moisture of material after removal of large grains (m.-%)

In cases where the volume of the larger grains is determined in the laboratory or by calculation, the dry density of the naturally moist material $ñ_{dp}$ should be calculated according to the equation

$$\rho_{dp} = \left(\frac{m_w - m_s}{V_i - V_s}\right)\left(\frac{100}{100 + w_p}\right)$$

where:
V_i the volume of the excavated pit with large grains (l)
V_s the volume of the excavated pit in the ring (l)

1.3 REGULATION OF THE CONSTRUCTION SITE

1.3.1 INTRODUCTION

The guidelines for regulation of the construction site are composed on the basis of

- the directives and decisions of the Council of the EU for ensuring minimum requirements of security, safety and health protection on temporary and mobile construction sites,
- the decisions and conclusions of the Commission for waste treatment
- the European standards EN with amendments (ISO) as well as
- the valid regulations on work safety.

1.3.2 THE COORDINATION OF HEALTH AND SAFETY

When work on construction site is performed or is predicted that it will be performed by two or more contractors, the client (employer) or the engineer must appoint one or more coordinators for health and safety protection at work, separately for each phase of project preparation as well as for the construction works phase of the project.

In the phase of the execution of works, no person who is employed by one of the contractors may be appointed as a coordinator.

1.3.2.1 Coordination in the preparation phase of the project

The health and safety coordinator performs the following tasks in the preparation phase:

- prepares or provides and coordinates a plan for protection with rules relating to the construction site, taking into account the needs and production activities on the construction site; the project must also include specific measures relating to jobs that fall under the category of particularly dangerous tasks
- prepares documentation that matches the characteristics of the project and containing the appropriate information for health and safety, to be taken into account in any job (in phases of use, maintenance, demolition, etc.).

1.3.2.2 Coordination in the phase of execution of works

In the phase of execution of works by the project, the health and safety coordinator particularly fulfils the following specific tasks:

- coordinates the execution of basic principles of health and safety at work
  - on adoption of decisions concerning technical and/or organizational aspects during the planning of individual phases of work and
  - in determining deadlines, which are necessary for the safe completion of certain phases of work to be performed at once or one after the other,
- coordinates implementation of certain decisions so as to allow for employers and self-employed persons
  - consistently respect the fundamental principles of safety and
  - to conduct themselves according to the plan of safety
- prepare or provide necessary protection and harmonisation of the safety draft and documentation with changes on the construction site
- ensures cooperation and mutual exchange of information between contractors, wither working together or one after the other on the construction site, and workers and their representatives in order to prevent injuries or health problems at work,
- checks the safety of working performance and coordinates planned activities and
- ensures that the construction site is accessed only by persons employed on the construction site who are allowed access.

1.3.2.3 Obligations of the client / employer, the engineer and the contractor

The appointment of the coordinator does not dismiss the client or the engineer from their responsibilities to ensure the health and safety of workers on the construction site.

The tasks performed by the coordinators do not affect the obligations of the contractor in connection with the provisions for the health and safety of workers on the construction site in accordance with the regulations governing health and safety at work.

Contractors must follow the instructions of the coordinator.

1.3.3 PROTECTION PLAN FOR CONSTRUCTION OF CIVIL ENGINEERING STRUCTURES

1.3.3.1 Content of the protection plan

The content of the draft plan for protection for construction of engineering structures in this policy, which in part includes description of the measures during construction, is as follows:

- Introduction
- List of regulations
- Arranging the construction site security from the environment
- Arrangement and maintenance of offices, cloakrooms, toilets and facilities for residence on the site:
  - recreational facilities and/or living quarters
  - communal, sanitary and hygienic regulations
  - transportation to work
  - supplying of workers with food and drinking water
  - ventilation and lighting
- Regulation of electrical and telecommunications installations
- Regulation of traffic communication, emergency routes and exits:
  - transport routes on/by the construction site
  - evacuation routes and emergency exits
  - traffic routes in dangerous areas
  - doors and entrances
  - storage spaces and ramps
- Arrangement and storage of construction materials:
  - spaces for storage of dangerous materials
  - list of hazardous and environmentally suspicious material and products
- Equipment for lifting and handling
- Vehicles and machinery for excavation, transportation and material moving
- Devices and facilities for maintenance of machinery on the construction site:
  - manipulation of fuels, lubricants and hazardous materials on the site
  - cleaning and maintaining vehicles on the site
  - parking of vehicles, machinery, as well as maintenance
- Regulation of workplaces:
  - especially dangerous works and protective equipment
  - first aid
  - influences of stability and strength on safety at work
  - ground works, underground structures, as well as jobs in confined spaces (conditions)
  - demolition and removal
  - work by traffic
  - heavy construction, metal or concrete frames, coverings and heavy prefabricated elements
  - working at height
  - maintenance
- Installations, operating units and their equipment
- Working floors, ladders and scaffolding
- Fire protection on the construction site
- Description of selected / used building technologies
- Impact of construction work execution on the capacity of existing road infrastructure with additional traffic
- Timing schedule for harmonisation of health and safety measures with the construction process
- Common measures for ensuring health and safety at work
- Mutual informing among leaders of particular jobs in the working process
- Order at the construction site
- List of jobs with an assessment of costs for construction site organization and for performing joint measures for ensuring health and safety on the construction site
- Environmental impacts and mitigation measures:
  - the impact of noise on the natural and living environment and mitigation measures
  - noise monitoring plan during construction
  - construction impacts on air and measures to mitigate excessive emissions
  - air monitoring plan during construction
  - construction impact on surface water and measures to mitigate negative impacts
  - surface water monitoring plan during construction
  - construction impact on ground water and measures to mitigate negative impacts
  - ground water monitoring plan
  - construction impact on soils, plants and animals
  - soil and plantlife monitoring plan
  - impact of mining and other dynamic impacts of works on people and structures
  - improvement of the construction site area after completion of works

- Treatment of waste generated during construction works:
  - construction waste management plan
  - construction waste management report
  - obligations of the employer and contractor during the construction works
  - waste collection
  - processing and disposal of construction waste
  - treatment of waste containing asbestos
  - surveillance over proceedings with waste
- Graphic enclosures:
  - clear plan (M 1:5000) with the civil engineering structures
  - plan for work and residence, as well as sanitary facilities and cafeterias (1:100)
  - plan for electricity supply
  - telecommunications plan
  - water supply and sewerage plan
  - plan of traffic regulation during the construction for public roads and roads on the site, with traffic signalling (M 1:5000)
  - positioning of cranes with plotted surface manipulation
  - plan for specific areas of planning with communal lines and power supply (M 1:1000)
  - preliminary draft solutions of specific facilities and equipment for environmental protection according to the project:
    - arranging storage for hazardous materials
    - car parks
    - working areas for servicing of machines and vehicles
    - material dump site
- Land Registry with a list of plots and owners, if there is a procedure in land plots beyond the area of exclusive use according to the Regulation on location draft (LD).

1.3.3.2 Instructions for preparation of the protection plan

The protection plan should be developed in accordance with the bylaws of construction law.

The introductory part of the protection plan must describe the characteristics of intervention in the environment (construction of roads or other facilities) relating to the anticipated volume of works and their characteristics. Information about the geological, hydrological, pedological and biological characteristics of the project location must be given in relation to the status before intervention.

In the protection plan it is necessary to determine and assess the risk of ecological accidents as an extraordinary event that could result in endangering the health or life of people, destruction, damage or critical overloading of the environment. In the protection plan must be described

- types, quantities and characteristics of dangerous materials and predicted treatment,
- procedures in their use, storage, transport and removal,
- possible and appropriate measures for reducing the risk of environmental accidents,
- a scenario of ecological disaster that may arise, including specifying the probability and surface of the affected areas and consequences for human health and the affected area,
- necessary intervention measures to reduce or prevent the consequences.

The protection plan must consider all works performed on the construction site. If multiple contractors share the site, then it is necessary to create multiple plans that must correlate effectively or a single plan for all contractors, which must contain all elements and measures that such a protection plan must contain.

Responsibility for the implementation of project measures must be specified in the protection plan with the designated responsible person (or persons). This person cares about the performance of the project's specific procedures and measures as specified in other statutory provisions. The person in charge delegates additional remedial action measures for the environment to a responsible work manager, if required, providing the principle of public law on environmental protection and cooperating with the responsible authorities and local communities in matters concerning environmental protection and human health.

Preparation of a study on waste treatment is required as part of the protection plan, which must include:

- a description of construction waste and its quantity,
- a description of a temporary dump site, if designated, and

- a description of the final procedure for management of construction waste.

The preparation of an ecological landscaping project for the construction site is required primarily for road sections for which the route passes through areas that are protected as natural heritage, as well as areas with ground and surface water, or in other protected areas according to the decisions of local communities or state authorities. Intervention in these areas without adequate preventative measures for their protection could threaten the natural balance.

1.3.3.3 Construction site organisation

A construction site plan, which is usually developed by the contractor selected by the client, must be made in accordance with the project and construction approvals. The plan must contain all necessary information regarding

- construction site roads and approaches to public roads,
- construction site connections to the public infrastructure,
- dump sites, warehouses, workshops, construction site offices, cloakrooms, sanitary facilities as well as
- other data relevant to the safe and reliable operation of the construction site.

Before the commencement of construction, the construction site development plan must be verified by the client / employer.

The construction site plan should enable the safe functioning of the commercial activities of public infrastructure (air transport, passenger transport, railways, aerial lines and underground lines of communal facilities: sewage system, water supply, electricity grids, telecommunications, gas, heat, etc.).

The construction site plan must allow untroubled and safe performance of all works, there must be no risk of injuries or health problems for workers. All passes and access to the site must be free, wide enough and routinely maintained, including cleaning.

Workshops for auxiliary works at the site (carpentry, locksmith, etc.) must generally be outside any dangerous zones.

The coordinator for health and safety at work must record all necessary measures to enable health and safety for workers against circumstances and events not predicted in the protection plan in a book of measures for safe operation. The book of measures for safe operation is kept by the coordinator and it must be available on site for the entire period of construction for work inspectors and all contractors who perform work on the site.

The construction site security plan is an integral part of the protection plan. The plan predicts:

- marking the construction site (table with information about the project, the designer, the contractor and the employer)
- securing the area of the construction site and individual structures (plastic strips, various kinds of fences)
- securing facilities committed to protecting the environment
- description of safety measures during and outside working hours
- a means of informing responsible persons of emergency ecological disaster events
- instructions for procedures in emergency ecological disaster events outside working hours, and
- anything else that depends on the nature of the construction site.

1.3.3.4 Protective equipment

Required personal protective equipment as specified in the protection plan and other regulations must be made available in accordance with the regulations and standards, specifically used, maintained and inspected prior to use. Damaged, used, poorly maintained personal protective equipment and equipment with an expired date is not permitted for use.

A worker who, despite the warnings of the responsible work manager, does not use the required personal protective equipment and by doing so endangers his safety and the safety of other employees will be removed from the workplace.

All persons who, for whatever reason, find themselves on the construction site with a likelihood of falling objects on the head, falling into a depth deeper than 1 m or head injuries from obstacles in the area, or if the protection plan envisions the possibility of head injuries from other causes, must wear safety helmets.

A sign that declares the required wearing of helmets should be placed on all approaches to the construction site and on exits from buildings on the site.

Wherever there is a risk of head injuries only on part of the construction site, the health and safety coordinator may, notwithstanding the provisions, specify that only in this part of the construction site protective helmets must be worn. .

Any space in which the health and safety of workers is threatened should be specially marked at all approaches by setting the appropriate signs for the obligatory wearing of helmets.

When the workers of only one employer perform work in confined spaces of the construction site, for which the health and safety coordinator discovers that there is no risk listed as per the preceding paragraph of this chapter, these need not be wearing helmets during work. Workers must have a helmet with them and must use it while moving about on the rest of the construction site. This circumstance applies only if it is listed in the book of measures for safe operation.

A number of helmets must be available for visitors to the construction site according to the maximum number of allotted visitors at one time, which must be specified in the plan for protection for this construction site.

Wherever the health and safety coordinator discovers that there is no danger of head injuries, the signs for the obligatory use of protective helmets may be removed, and measures must be recorded in the book of measures for safe operation.

1.3.3.5 Working near traffic

During construction works on roads on which traffic is not stopped during work, it is necessary to ensure the security of the construction site in accordance with temporary traffic safety studies, which must be approved by the engineer.

In addition to the standard traffic signalization, non-standard traffic signalization and equipment may be used for the marking and securing of works as defined in details in the study (signal bands, triangles, sheets ...)

Performance of works is not permitted in very reduced visibility (in fog, darkness ...) unless the site is adequately lit with artificial lighting. Lighting must be designed so that it attracts less nocturnal insects.

At night and during low visibility (fog) all traffic signalization must be illuminated. At locations of re-directing traffic, lights must flash in the direction of oncoming vehicles.

Workers who perform any work with oncoming traffic must wear signalling clothing with reflective strips reflecting the light, which is made in accordance with standard EN 471

When pavement closure is not performed, works may be performed only if the safe operation of workers is supervised by the work manager as designated by the employer. Before the start of works the workers must be given clear instructions.

1.3.3.6 Order at the construction site

Order on the construction site is a summary of the measures and rules for the health and safety of workers on the construction site. The minimum content of construction site order is as follows:

- Title: Regulation on the provision of protection and safety for workers on construction sites
- Access to the construction site
- General measures for safe work
- Behaviour in the event of critical danger or harmful impacts
- Behaviour in the case of accident or fire
- Measures on work finishing

1.3.4 IMPACTS OF THE CONSTRUCTION SITE ON THE ENVIRONMENT AND MEASURES FOR MITIGATING THE NEGATIVE IMPACTS

Significant construction site impacts on the living environment and surroundings are as follows:

- noise impact
- impact on air
- impact on surface water
- impact on underground water
- impact on soil, plants and animals
- impact of blasting and other vibrations.

Appropriate measures to reduce construction site impacts on the living environment should be predicted in the project for construction site organisation.

Projects of monitoring harmful impacts on the living environment should determine the basic data for evaluating and reporting impacts.

1.4 APPENDICES

1.4.1 REGULATIONS FOR STATISTICAL AND FINANCIAL ASSESSMENT OF QUALITY

1.4.1.1 Introduction

The bases for statistical work quality assessment according to the requirements of specific technical conditions are generally:
- average values (and standard deviation),
- limited values and
- ultimate limited values.

The average value ($\overline{X}$) is the arithmetic mean value of quality.

Limited value (x_g) indicates the required upper (x_{gg}) and/or lower quality value of (x_{gd}), as a condition for the of the predicted characteristics. If the achieved quality of works is in the required limits, it means that it has a full financial value.

The ultimate limited value (x_{kg}) indicates a value at which the achieved quality of works is without financial value.

A statistically random choice s that for each material, product or place of measurement an equal opportunity is available to be selected.

1.4.1.2 Lay-out for statistical assessment

For the statistical assessment of test results within the internal and external control the following general provisions apply:

1.4.1.2.1 Average value $\overline{X}$

The average value of quality is generally determined by the specific technical conditions. It can be calculated according to the equation

$$\overline{X} = \sum_{i=1}^{n} x_i / n$$

where
n means the number of results.

1.4.1.2.2 Limited value X_g

The limited value (required) is generally conditioned, and may be determined by the equation

$$X_g = \overline{X} \pm a$$

where:
a the deviation of limited value from the average value.

The limited value can be determined as a specific numeric value.

If individual results positively exceed the ultimate upper limited value (x_{kgg}), as a rule, it can be recognized as a statistical assessment of the quality of completed works, but only to a certain percentage above the required value. If individual results do not reach the specified ultimate lower limited values (x_{kdg}), they should be eliminated prior to statistical evaluation.

If initially low-quality performed work improves with additional steps so that the determined value corresponds to the determined quality requirements, this result should be taken into account in the assessment, and the initial (negative) result should be eliminated.

In special cases for the quality control of completed works, 1.96 s may be considered as a limited value , because it includes 95% of the results.

1.4.1.2.3 Ultimate limited value

The ultimate limited value is generally conditioned, i.e. determined by a deviation from the average value or limited value according to the equation:

$$X_{kg} = \overline{X} \pm b \quad \text{or} \quad X_{kg} = \overline{X} \pm c$$

where:
b is the deviation of the ultimate limited value from the average value.
c is the deviation of the ultimate limited value from the limited value .

The ultimate limited value may be, in special cases, determined also by 3s value, which includes approximately 99.8% of the results.

1.4.1.2.4 Locating sites for measuring and sampling

The lay-out for the statistical evaluation of quality, i.e. the lay-out for random selection of sites for measuring and sampling, should be generally defined according to the principle of random choice.

In these specifications, the following lay-out for the location of sampling and measuring sites, are determined (appendix 1 to 12):

- the beginning of chainage should be attached to the cross profiles according to the project documentation. The current chainage means the distance from the starting point ([1])
- the distance from the edge of the formation O should be determined by using a random number R depending on the width of formation "š" according to the following equations ([2]):
  - for a partial cross section of the formation
    $O_d = R \times (š - 0.5) + 0.5$ (m)
  - for the entire width of the formation
    $O_c = R \times (š - 1.0) + 0.5$ (m)
- for a partial cross section of the formation , the distance should be determined from the outer edge of the formation , and for the entire width according to random choice from the left or right edge.

1.4.1.3 Lay-out for financial assessment

Quality requirements for individual characteristics of completed works are prescribed in special technical conditions.

For defectiveness in the quality of completed works, clients may impose financial deductions.

The scope of works the quality of which is between the limited value and the ultimate limited value should generally be financially assessed according to the equation:

$$FO = f \cdot C \cdot PD \cdot p$$

where:

FO is the financial deduction

f is the coefficient of the impact of defective quality of completed work on usability, which is, for individual works, determined by special technical conditions

C is the price for a unit of quantity of work performed (EUR/m^2)

PD is the scope of defectively performed work (m^2)

p is the deviation from the limited value

Financial deductions for individual deficiencies are being added to a hundred percent price for unit of labour.

In case of exceeding the price for a unit of labour (due to adding individual deductions), the engineer decides on the procedure.

The scope of works, covered by the results above or below the ultimate limited value, has no financial value. For such quality of works, the contractor does not receive payment, and in accordance with the instructions of the engineer, the contractor must repair such performed work at his own expense.

Appendix1

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	5	0.815		+
2	28	0.796	+	
3	43	0.644		+
4	60	0.885		+
5	75	0.468	+	
6	102	0.755	+	
7	118	0.287	+	
8	135	0.040	+	
9	155	0.487	+	
10	174	0.173	+	
11	197	0.174		+
12	218	0.459		+
13	234	0.481		+
14	266	0.601		+
15	273	0.340	+	
16	294	0.191	+	
17	327	0.600		+
18	347	0.623	+	
19	363	0.710	+	
20	381	0.555	+	
21	401	0.655	+	
22	423	0.740		+
23	432	0.294		+
24	453	0.060	+	
25	478	0.063		+

Appendix 2

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	13	0.291		+
2	46	0.844	+	
3	66	0.715		+
4	71	0.193	+	
5	103	0.672		+
6	123	0.636	+	
7	146	0.568		+
8	162	0.885	+	
9	179	0.301	+	
10	190	0.316		+
11	224	0.619		+
12	232	0.212		+
13	255	0.108		+
14	287	0.951	+	
15	300	0.420		+
16	330	0.757	+	
17	340	0.487	+	
18	361	0.744		+
19	379	0.022		+
20	404	0.979		+
21	422	0.985		+
22	433	0.053	+	
23	457	0.077		+
24	470	0.444	+	
25	495	0.187		+

Appendix 3

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	24	0.659		+
2	37	0.252		+
3	60	0.971	+	
4	81	0.540		+
5	91	0.434		+
6	117	0.279		+
7	133	0.002	+	
8	156	0.102		+
9	180	0.855		+
10	199	0.270	+	
11	228	0.732		+
12	238	0.449	+	
13	259	0.013	+	
14	277	0.145	+	
15	306	0.794	+	
16	320	0.216	+	
17	338	0.052		+
18	352	0.294	+	
19	383	0.557	+	
20	392	0.028		+
21	411	0.209		+
22	430	0.820		+
23	450	0.325		+
24	475	0.777		+
25	493	0.869		+

Appendix 4

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	27	0.984		+
2	49	0.981		+
3	63	0.500	+	
4	79	0.319		+
5	102	0.696		+
6	121	0.889	+	
7	137	0.341	+	
8	158	0.111		+
9	178	0.188		+
10	200	0.078	+	
11	211	0.316	+	
12	236	0.213	+	
13	257	0.190	+	
14	274	0.028	+	
15	305	0.885		+
16	317	0.370		+
17	339	0.258		+
18	368	0.582	+	
19	390	0.548	+	
20	391	0.340		+
21	411	0.084	+	
22	448	0.804		+
23	463	0.969		+
24	480	0.938		+
25	494	0.916		+

Appendix 5

Ser. No.	Chainage current [1]	Measuring place Sampling spot random number R	edge distance [2] left	right
1	29	0.810		+
2	30	0.337		+
3	60	0.046		+
4	73	0.433	+	
5	104	0.881	+	
6	124	0.974	+	
7	138	0.028		+
8	160	0.696		+
9	176	0.403	+	
10	196	0.408		+
11	217	0.203	+	
12	231	0.029		+
13	251	0.424		+
14	274	0.397	+	
15	298	0.315	+	
16	324	0.938	+	
17	348	0.883		+
18	362	0.647		+
19	372	0.156	+	
20	397	0.431		+
21	420	0.806	+	
22	433	0.203	+	
23	470	0.782		+
24	474	0.349	+	
25	499	0.013	+	

Appendix 6

Ser. No.	Chainage current [1]	Measuring place Sampling spot random number R	edge distance [2] left	right
1	23	0.740	+	
2	49	0.975		+
3	61	0.558	+	
4	70	0.131		+
5	91	0.253		+
6	120	0.886	+	
7	132	0.128	+	
8	166	0.975		+
9	188	0.870	+	
10	200	0.026		+
11	227	0.841	+	
12	244	0.567	+	
13	265	0.778		+
14	271	0.029		+
15	309	0.650		+
16	315	0.366		+
17	331	0.487		+
18	363	0.852	+	
19	387	0.942		+
20	390	0.492		+
21	421	0.930		+
22	436	0.347		+
23	460	0.715	+	
24	485	0.994	+	
25	496	0.128		+

Appendix 7

Ser. No.	Chainage current [1]	Measuring place Sampling spot: random number R	edge distance [2]: left	edge distance [2]: right
1	12	0.364	+	
2	36	0.032		+
3	55	0.455	+	
4	77	0.389		+
5	103	0.811		+
6	114	0.356		+
7	131	0.495	+	
8	160	0.310	+	
9	174	0.349		+
10	202	0.632		+
11	228	0.946		+
12	235	0.028		+
13	263	0.635		+
14	280	0.216		+
15	310	0.765		+
16	313	0.481	+	
17	340	0.289		+
18	355	0.020		+
19	382	0.978	+	
20	400	0.651		+
21	415	0.005	+	
22	438	0.480		+
23	455	0.194	+	
24	472	0.030	+	
25	499	0.487	+	

Appendix 8

Ser. No.	Chainage current [1]	Measuring place Sampling spot: random number R	edge distance [2]: left	edge distance [2]: right
1	16	0.197		+
2	33	0.490	+	
3	64	0.785		+
4	75	0.113	+	
5	96	0.376		+
6	125	0.722		+
7	135	0.368	+	
8	165	0.518	+	
9	178	0.412		+
10	207	0.547	+	
11	221	0.539		+
12	250	0.507	+	
13	257	0.233		+
14	284	0.706		+
15	295	0.061	+	
16	328	0.977		+
17	339	0.261	+	
18	354	0.369		+
19	380	0.521	+	
20	406	0.756		+
21	417	0.105		+
22	442	0.592	+	
23	452	0.038		+
24	484	0.554		+
25	490	0.335		+

Appendix 9

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	16	0.163		+
2	48	0.824	+	
3	56	0.422	+	
4	84	0.958		+
5	92	0.412		+
6	121	0.848	+	
7	137	0.411		+
8	156	0.422		+
9	181	0.765	+	
10	190	0.070		+
11	211	0.345		+
12	236	0.416		+
13	259	0.083		+
14	285	0.993		+
15	302	0.875	+	
16	319	0.382		+
17	335	0.106	+	
18	363	0.515		+
19	376	0.248		+
20	397	0.072	+	
21	425	0.522	+	
22	438	0.309		+
23	454	0.448		+
24	476	0.290	+	
25	494	0.478	+	

Appendix 10

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	16	0.222		+
2	41	0.645		+
3	55	0.362		+
4	86	0.573	+	
5	97	0.423		+
6	119	0.119	+	
7	150	0.542	+	
8	168	0.622	+	
9	177	0.291	+	
10	200	0.069		+
11	222	0.998		+
12	246	0.752	+	
13	258	0.266	+	
14	274	0.002	+	
15	290	0.220		+
16	328	0.620		+
17	334	0.158	+	
18	363	0.603		+
19	381	0.972		+
20	406	0.795		+
21	429	0.645	+	
22	433	0.272	+	
23	459	0.143		+
24	480	0.610	+	
25	499	0.945	+	

Appendix 11

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	24	0.738	+	
2	35	0.108	+	
3	57	0.025		+
4	89	0.887	+	
5	95	0.429		+
6	118	0.456	+	
7	135	0.300		+
8	165	0.887		+
9	189	0.527	+	
10	192	0.193	+	
11	223	0.528		+
12	248	0.538	+	
13	261	0.859		+
14	287	0.787		+
15	299	0.310	+	
16	321	0.813		+
17	333	0.066	+	
18	370	0.656	+	
19	377	0.146	+	
20	393	0.123	+	
21	423	0.717		+
22	448	0.962		+
23	457	0.311		+
24	490	0.688	+	
25	499	0.278		+

Appendix 12

Ser. No.	Chainage current [1]	Measuring place Sampling spot		
		random number R	edge distance [2]	
			left	right
1	12	0.112		+
2	50	0.763		+
3	54	0.243	+	
4	81	0.630	+	
5	103	0.775		+
6	121	0.988		+
7	146	0.576		+
8	157	0.138		+
9	176	0.305	+	
10	198	0.077		+
11	227	0.643		+
12	233	0.272		+
13	259	0.361	+	
14	278	0.177		+
15	303	0.687	+	
16	325	0.683	+	
17	334	0.093	+	
18	358	0.186	+	
19	380	0.335		+
20	397	0.454		+
21	425	0.560		+
22	436	0.204		+
23	453	0.024	+	
24	474	0.251	+	
25	496	0.535	+	

1.4.2 LAY-OUT FOR PREPARATION OF THE TECHNOLOGICAL STUDY

1.4.2.1 Introduction

In these guidelines for the execution of works on roads are the basics and general provisions specified for the preparation of a technological study, i.e. procedures and tasks that the contractor must perform prior to the commencement of works.

A technological study must be prepared for each of the following groups of works:
- earthworks,
- pavement structures,
- waterproofing works,
- sewer installation,
- construction structures and support elements
- relocation of utility lines and devices (gas, electricity, water, etc.) and
- tunnel works

The technological study must state the following:
- general data on planned works,
- used materials and
- manner of execution.

1.4.2.2 General data

The technological study must include the following general information about the planned work at the proposed structure:
- a description of the structure, including location (plan) and field conditions
- description of the type of works
- characteristic data from project documentation (with project of execution of works)
- organization of construction site (plan and safety measures) - item 1.3).

1.4.2.3 Materials

The technological study must state the following:
- basic materials (types and source, required amount)
- designed half-products (types and marks, recipes, required amounts)
- material quality (evidence – certificates, statements, internal control).

1.4.2.4 Manner of Execution

The technological study should describe:
- the technological processes at various phases of work, the procedure and phases must be displayed graphically, including all details for doing any demanding jobs (e.g. joining the embankment on a slope, landscaping excavated slopes, working contacts with pavements and structures)
- preparation and restoration of installation site
- means of protection from damage (e.g. slope, pavement edge, water proofing)
- care (e.g. cement concrete)
- environmental protection (e.g. air, underground water, noise etc.)

and state:
- the coordinating manager, as well as
- the specialist team that must be present for the execution of works (responsible work manager, technician, laboratory representative); at least one member of the specialist team must already cooperate in preparing the technological study.

1.4.2.5 Quality of execution

The quality of work to be performed must be thoroughly determined in the technological study with all requirements for characteristic features.

Test sections for the relevant types of must be defined in the technological study, if the contractor has not yet provided evidence that he is able to perform the same adequately. In agreement with the engineer, a test section must be prepared by the contractor, on which characteristics and procedures will be proven as required for part of the regular production, installation and possibly required treatment. The results on the tested sections, as determined in the limited values area, should be considered as a lay-out for determining the quality in the routine proceedings of works.

In the technological study the following must be indicated for all types or phases of works:
- agreed technical requirements for individual specificity of performed works by established program, including limited values, and
- contractors of internal control with enclosed certificates of their qualifications for certain jobs.

Within the technological study the contractor must propose what will be the lay-out for the quality control of execution according to a client approved program of average frequency of internal control testing.

1.4.2.6 Planning part

The planning part of the technological study should include a timetable and plan of realisation.

Timetables should display:
- the plan of work progress - by phase and types of works
- the plan of mechanisation and work force
- the supply of basic materials
- working hours.

Timetables should be determined in accordance with the volume and duration of works.

In the plan of realisation the contractor must demonstrate and evaluate the major, minor and additional works in accordance with the preliminary calculation in the contract.

1.4.2.7 Verification of technological study

The Contractor must, for the purpose of obtaining consent, submit two extracts from the technological study to the engineer in a cover letter, or as specified in the contract.

The process for approval of the technological study by the engineer is as follows:
- The engineer shall send a copy of the technological study and the received copy of the contractor's letter with an accompanying memo to the professional supervisory service.
- A copy of the letter sent to the engineer contractor shall be sent simultaneously to the contractor.
- Within 8 days of receiving the letter, the professional supervising service requires the opinion of the engineer on the technical part of the technological study.
- The engineer ratifies the technological study in writing (may be conditional) within 12 days of receiving the letter from the contractor. In the event of a conditional ratification of the technological study, the engineer must determine the period during which the contractor must remove the deficiencies.
- If the engineer returns the technological study, providing an explanation, this means that it is necessary, prior to commencement of works, to repeat the confirmation procedure of the technological study until the engineer does not ratify it.

All information in the technological study is permitted for use only with the consent of the contractor.