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VOLUME II: CONSTRUCTION

SECTION 1: GENERAL TECHNICAL CONDITIONS

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University of Ljubljana
Faculty of Civil Engineering and Geodesy

DDC Consulting & Engineering Ltd.
DDC svetovanje inženiring,
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2.1 GENERAL TECHNICAL CONDITIONS

2.1.1 GENERAL PART

2.1.1.1 General

»General Technical Conditions« (GTC) apply to all types of works in road construction, specified in the bills of quantities and cost estimations of approved design documents, as well as to all other works, which might be necessary for a complete implementation of the particular construction contract.

For individual projects of some particular features the client may direct Special Technical Conditions (STC) for the execution of certain works.

2.1.1.2 Classification of Works

The works in road construction are classified in the following fields:

- road alignment,
- deviations,
- points of access,
- regulations,
- bridges and walls,
- tunnels.

The following groups of works can occur in each of the abovementioned fields:

- preliminary works,
- earth works and foundations,
- pavement structures,
- drainage,
- construction and craftsman's works,
- road furniture,
- services by others.

On principle, the individual works foreseen within the abovementioned groups of works are discussed in the following chapters:

- description,
- basic materials,
- quality of materials,
- construction method,
- construction quality,
- quality verification,
- measurement and taking over of works,
- final settling of account of works.

2.1.1.3 Designation of Works

As a rule, the entire system of work description and special technical conditions are based on the following designation:

(-) field of works
- group of works
- - subgroup of works
- - - type of works
- - - - item

Example

- Description of works
  (1) road alignment

2 earth works and foundation
2.1 excavations
2.1.3 excavations for foundations
2.1.3.1 excavations for foundations of width up to 1 m, and of depth up to 1 m

- Special technical conditions
(1) road alignment
2. earth works and foundations
2.1 excavations
2.1.3 excavations for foundations
2.1.3.1 description

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

A designation of the group of works, subgroup of works, and type of works is the same in both description of works and special technical conditions in order to ensure the required uniformity of the basic classification.

A subsequent, more detailed designation is arranged in accordance with the basic classification: in the bill of quantities for the computer work (verification of offers and accounts, keeping records), whereas in special technical conditions for an appropriate overview.

2.1.1.4 Abbreviations

The following abbreviations are used in these technical conditions:

TR - Technical regulations
GTC - General technical conditions
BQ - Bill of quantities
STC - Special technical conditions
Item - Item
No. - Number

EN - European Norm
EC - Eurocode
DIN - Deutsche Industrie - Normen
SN - Schweizerische Normen
ASTM - American Society for Testing and Materials
TSR - Technical Specification for Roads

2.1.2 TECHNICAL REGULATIONS

The obligatory technical regulations applied to this General technical regulations are (BAS) EN standards and three SIST standards

The Contractor is bound to apply current national regulations with exception of different provisions of the General conditions or Supervisor's additional written instructions.

This technical regulations shall be applied until their complementation and modification or when new technical regulations are adopted. This principle may not be fullfiled only in the case when the provisions of the Technical conditions or Supervisor's additional written instructions gives different directives.

When the provisions of the completed, modificated or new technical regulations are less restrictive as the directives of this technical conditions the contractor shall acquire the supervisor's written accordance to deviate from technical conditions.

EN 196-1	Metode ispitivanja cementa - 1. dio: Odredjivanje čvrstoće cementa	Methods of testing cement - Part 1: Determination of strength
EN 196-2	Metode ispitivanja cementa - 2. dio: Hemijska analiza cementa	Methods of testing cement - Part 2: Chemical analysis of cement
EN 196-3	Metode ispitivanja cementa - 3. dio: Odredjivanje vremena vezivanja i stalnosti zapremine	Methods of testing cement - Part 3: Determination of setting times and soundness
EN 196-6	Metode ispitivanja cementa - 6. dio: Odredjivanje finoće mliva	Methods of testing cement - Part 6: Determination of fineness
EN 197-1	Cement - 1. dio: Sastav,specifikacija i kriteriji uskladjenosti za obične cemente	Cement - Part 1: Composition, specifications and conformity criteria for common cements
EN 206-1	Beton - 1.dio: Specifikacija, karakteristike i kriteriji uskladjenosti	Concrete - Part 1: Specification, performance, production and conformity
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EN 447	Žbuka za prednaprezanje - Specifikacija za obični malter	Grout for prestressing tendons - Specification for common grout
EN 523	Zaštitne cijevi za prednaprezanje iz čeličnih trakova – Terminologija, specifikacija i kontrola kvaliteta	Steel strip sheaths for prestressing tendons - Terminology, requirements, quality control
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EN 771-2	Specifikacija za zidne elemente – 2. dio: Krečnjačko pješčani elementi	Specification for masonry units - Part 2: Calcium silicate masonry units
EN 771-3	Specifikacija za zidne elemente – 3. dio: Betonski elementi (kompaktni i laki agregati)	Specification for masonry units - Part 3: Aggregate concrete masonry units (Dense and light-weight aggregates)
EN 771-6	Specifikacija za zidne elemente - 6.dio Zidni elementi od prirodnog kamena	Specification for masonry units - Part 6: Natural stone masonry units
EN 772-1	Metode ispitivanja zidnih elemenata - 1. del: Odredjivanje tvrdoće na pritisak	Methods of test for masonry units - Part 1: Determination of compressive strength
EN 772-5	Metode ispitivanja zidnih elemenata - 5. dio: Odredjivanje vodotopivih soli u zidnim elementima iz gline	Methods of test for masonry units - Part 5: Determination of the active soluble salts content of clay masonry units

EN 772-11	Metode ispitivanja uzoraka maltera - 11. dio: Odredjivanje upijanja vode agregata betona,dijelova za zidanje obradjenog i umjetnog kamena podesnih za kapilarno penjanje i početno vrijeme upijanja vode dijelova sa glinom	Methods of test for masonry units - Part 11: Determination of water absorption of aggregate concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units
EN 772-16	Metode ispitivanja zidnih elemenata - 16. dio: Odredjivanje mjera	Methods of test for masonry units - Part 16: Determination of dimensions
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EN 921	Plastični cijevni sistemi - Termoplastične cijevi - Odredjivanje otpornosti na unutrašnji pritisak pri konstantnoj temperaturi	Plastics piping systems - Thermoplastics pipes - Determination of resistance to internal pressure at constant temperature
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EN 933-1	Metode ispitivanja geometrijskih karakteristika agregata - 1. dio: Odredjivanje granulometrijskog sastava - Metoda prosijavanja	Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method
EN 933-4	Ispitivanje geometrijskih karakteristika agregata - 4. dio: Odredjivanje oblika zrna - Indeks oblika	Tests for geometrical properties of aggregates - Part 4: Determination of particle shape - Shape index
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EN 998-2	Specifikacije za malter za zidanje – 2. dio: Malter za zidanje	Specification for mortar for masonry - Part 2: Masonry mortar
EN 1008	Voda za pravljenje betona – Specifikacija za uzimanje uzoraka, ispitivanje i procjenu pogodnosti vode, uključujući vodu recikliranu od industrijske proizvodnje betona, kao vodu za pravljenje betona	Mixing water for concrete - Specification for sampling, testing and assessing the suitability
EN 1015-11	Metode ispitivanja maltera za zidanje - 11. dio: Odredjivanje čvrstoće na savijanje i čvrstoće na pritisak stvrdnutog maltera	Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar
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EN 1015-21	Metode ispitivanja maltera za zidanje – 21. dio Odredjivanje kompatibilnosti jednoslojnih maltera s podlogama	Methods of test for mortar for masonry - Part 21: Determination of the compatibility of one-coat rendering mortars with substrates
EN 1097-1	Ispitivanja mehaničkih i fizičkih karakteristika agregata - 1. dio: Odredjivanje otpornosti na trošenje (mikro Deval)	Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval)
EN 1097-2	Ispitivanja mehaničkih i fizičkih karakteristika agregata - 2. dio: Metode odredjivanja otpornosti na drobljenje	Tests for mechanical and physical properties of aggregates - Part 2: Methods for the determination of resistance to fragmentation
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EN ISO 10319	Geotekstil – Test natezanja na širokim uzorcima (ISO 10319:1993)	Geotextiles - Wide-width tensile test (ISO 10319:1993)
EN ISO 11058	Geotekstil i geotekstilu srodni proizvodi – Odredjivanje propusnosti za vodu pravougaono na ravninu bez opterećenja (ISO 11058:1999)	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load (ISO 11058:1999)
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EN ISO 12956	Geotekstil i geotekstilu srodni proizvodi – Odredjivanje karakterističnih veličina otvora (ISO 12956:1999)	Geotextiles and geotextile-related products - Determination of the characteristic opening size (ISO 12956:1999)

EN ISO 12958	Geotekstil i geotekstilu srodni proizvodi – Odredjivanja kapaciteta protoka vode u ravnini (ISO 12958:1999	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane (ISO 12958:1999)
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2.1.3 TERMINOLOGICAL VOCABULARY

The terms in these technical conditions shall be understood as indicated below. The terms in bold face are in local language, whilst the first term in brackets is in English, and the second one in German).

Akvaplaning (aquaplaning, Aquaplaning) is lifting of rolling or sliding wheel of a vehicle from a wet carriageway due to a water wedge, which prevents the contact between wheel and carriage-way.

Analiza prometa (traffic analysis, Verkehrs-analyse) means recording, description, and eva-luation of the existing traffic condition.

Krečnjak (limestone, Kalkstein) is carbonate rock entirely or partly composed of calcite.

Asfalt (asphalt, Asphalt) is a natural or artificial mixture of a bituminous binder and stone grains, as well as eventual admixtures to ensure employability in road construction.

Asfaltna (habajući) krovni sloj (asphalt surfacing, Asphaltdecke) is pavement upper layer consisting of wearing course and bound base-bearing or base-wearing course made of asphalt mixture.

Asfaltni nosivi sloj (asphalt base, Asphalttragschicht) is a pavement layer made of asphalt mixture placed as bound base-bearing upper course (in one or more layers), or as bound base-bearing lower course (bituminous stabili-zation of aggregate).

Asfaltni nosivohabajući sloj (BNOP) (Asphalt base-wearing course, Asphalt-Tragdeckschicht) is an asphalt mixture layer, generally placed as the only bound course onto the lower bearing course; the asphalt mixture contains bituminous binder and totally rounded or totally crushed stone grains.

Asfaltni habajući i zaptivni sloj (asphalt wearing and sealing course, Asphaltverschleiss- und –dichtungsschicht) is a pavement layer made of aggregate and bituminous binder; it is both a wearing and a sealing course at the same time.

Asfaltni habajući sloj (asphalt wearing course, Asphaltverschleissschicht) is the pavement upper layer made of an aggregate of certain particle size distribution (filler, sand, crushed aggregate, coarse gravel), and bituminous binder.

Asfaltna kolovozna konstrukcija (asphalt pave-ment, Asphalt - Fahrbahnbefestigung) is a part of traffic surface stabilization with asphalt surfacing; the type of other pavement bearing courses is not defined.

Asfaltni granulat (milling/crushing residue asphalt, Asphaltgranulat) is asphalt consisting of small pieces re-won by milling or crushing.

Bankina (shoulder, Bankette) is a mechanically stabilized part of the road at the carriageway serving to support the pavement; it is intended neither for motor traffic nor as emergency lane.

Benkelmanova greda (Benkelman-beam, Benkelman-Balken) is a measuring device to determine elastic or total settlement of the traffic surface under a vehicle wheel static load of 50 kN as a rule.

Bitumen (bitumen/asphalt cement, Bitumen) is a viscous liquid, or solid, consisting essentially of hydrocarbons and their derivatives, which is soluble in trichloroethylene and is substantially non-volatile and softens gradually when heated; it is a binder of asphalt mixtures.

Bitumenska emulzija (bitumen emulsion, Bitumenemulsion) is bitumen dispersed in water by means of emulsifiers (road, diluted, or polymer bitumen); in dependence on the emulsifier type, cationic, anionic, and non-ionic emulsions are distinguished.

Bitumenska malta (bituminous mortar, bituminö-ser Mörtel) is a mixture of bituminous binder, aggregate filler, sand (grain size up to 2 mm), and admixtures.

Bitumenska smjesa (asphalt mix/mixture, Asphaltmischgut) is a mixture of filler aggregate stone grains, sand, crushed aggregate, and/or coarse gravel, as well as of bituminous binder and eventually required admixtures. As a rule, asphalt mixtures are produced by hot procedure in an asphalt plant.

Bitumenski beton (asphalt concrete, Asphalt-beton) consists of bituminous binder and aggregate of certain grain size intended for execution of wearing and sealing courses.

Bitumenski mastiks (asphalt mastic, Asphalt-mastix) is a dense mixture of filler aggregate, sand, and bituminous binder, which can be poured and smoothened in hot condition.

Bitumenski mulj (bituminous slurry seal, bitumi-nöse Schlämme) is a mixture of sand and aggregate filler of uniform grain size distribution (exceptionally of fine crushed aggregate), bituminous binder, and water; it is used in cold condition.

Bitumensko vezivo (bituminous binder, bituminö-ses Bindemittel) is a fusible, liquid, or solid com-pound, won from mineral oil or natural asphalt.

Bitumizirana sitnež (precoated chippings, vorbituminierter Splitt) is crushed aggregate thinly coated with liquid bituminous binder, thus it can still be spread.

Bituminizirani drobljenac (bituminous well graded crushed stone, bituminiertes Brechkorn - Mischgut) is an asphalt mixture used for bearing courses; it consists particularly of totally rushed stone grains entirely coated with bituminous binder.

Bituminizirani šljunak (bituminous gravel, bitumi-nierter Kiessand) is an asphalt mixture used for bearing courses; it consists particularly of natural rounded particles entirely coated with bituminous binder.

Bubnjasta mješalica za asfalt (asphalt drum mixer, Trommelmischer) is a mixer containing a cylindrical mixing vessel rotating around an inclined axis. The stone aggregate is dried by means of a burner, and it is moving towards the emptying position; it can operate without any breaks.

Špricani cementni beton (shotcrete, Spritzbeton) is a mixture of cement, aggregate, and water, sprayed by means of compressed air through a nozzle onto a certain surface to form a thickened homogeneous mixture; shotcrete can also include different combinations of chemical and mineral admixtures, as well as fibres.

Potpuni udio vode (total water content, Gesamt-wassergehalt) is the additional water, already present in the aggregate and on its surface, the water in chemical and mineral admixtures, used in a form of slurry, and the water arising from added ice or heating with steam.

Cement (hidraulično vezivo) (cement, Zement) is a pulverized inorganic material; when mixed with water it forms a paste, which, due to reactions and hydration processes, sets and hardens; after being hardened, it retains its strength and volume durability under water as well.

Cementni beton (cement concrete, Beton/Ze-mentbeton) is a material produced by mixing aggregate, cement and, water; as necessary, chemical and/or mineral admixtures can be added; it develops its properties by cement hydration.

Cementni beton visoke tvrdoće (high strength concrete, hochfester Beton) is a concrete, which compressive strength class amounts to more than C55/67 for a normal weight concrete.

Certificiranje (certification, Zertifizierung) is a procedure, where a third party issues a written confirmation that a product, process or service comply with the specified requirements.

Certificiranje (unutrašnje) kontrole proizvodnje (certification of factory production control, Zertifi-zierung der werkseigenen Produktionskontrolle) are procedures and tasks performed by the bodies involved in attestation of conformity; on that basis, a certification body issues a certificate of factory production control as a written confirmation that the production control is

harmonized with the requirements indicated in the corresponding technical specification.

Certificiranje proizvoda (product certification, Produktzertifizierung) are procedures and tasks performed by the bodies involved in attestation of conformity; on that basis, a certification body issues a certificate of the product conformity as a written confirmation that the product complies with the requirements indicated in the corresponding technical specification.

Certifikacijski organ (certification body, Zertifi-zierungsstelle) is a approved institution, that manages the certification procedure and issues a certificate.

Certifikat o uskladjenosti (certificate of conformity, Konformitäts- (Übereinstimmungs-) zertifikat) 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 normative document.

Cestno tijelo (road body, Strassenkörper) is com-posed of all the materials used for fills and pave-ment structure between the subgrade formation and pavement surface, or any other finished surface.

Cestnogradjevinski bitumen (road bitumen, Stras-senbaubitumen) is bitumen produced in refineries; it complies with all the requirements to be used in the road construction.

Cisterna za vezivo s rampom (tank sprayer with spray bar, Tankspritzwagen mit Spritzbalken) is mobile equipment for a machine spray application of controlled quantity of liquid binder (under pressure) to a substrate.

Čas razpada (breaking time, Brechzeit) is the duration of a bitumen emulsion decomposition process.

Čista frakcija/razred zrna d_i/D_i (particle size frac-tion/class d_i/D_i, Kornklasse d_i/D_i) is a designation for a mineral aggregate, which particles pass a sieve of larger openings (D_i) and remain on a sieve of smaller openings (d_i).

Čistoća smjese zrna (aggregate purity, Gesteins-körnungreinheit) means that an aggregate does not contain any harmful admixtures of organic compounds, salts, or other mineral particles, which might affect adversely the quality and life time due to the volume inconstancy.

Crna tačka (black spot, Unfallschwerpunkt) is a spot/location on a carriageway, where the frequency of accidents of the same kind is above average due to particular local conditions (dangerous place).

Debljinski indeks vozne konstrukcije (D) (pavement thickness-index, Dickenindex der Fahrbahnbefestigung) is a sum of products of equivalency factors (= fatigue resistances) of individual materials (a_i), built-in into a pavement, and thicknesses of layers of those materials (d_i).

Deflektograf (deflectograph, Deflektograph) is a measuring device for a continuous automatic determination (measurement and record) of total settlements of pavement surface under certain wheel load during a vehicle drive.

Deflektometar (deflectometer, Deflektometer) is a measuring device for an automatic determination (measurement and record) of pavement surface settlements under certain dynamical loading.

Deformacioni modul (modulus of deformation, Verformungsmodul) is a parameter indicating deformability of the material built-in, and is determined on the basis of the inclination of the curve load/settlement at the load plate test.

Udio kamenih zrna (aggregate content, Gesteins-kornanteil) is a mass portion of stone grains of a certain size in the aggregate (percentage by mass).

Udio veziva (binder content, Bindemittelgehalt) is the quantity of soluble and insoluble bituminous binder in an asphalt mixture (in % by mass) in relation to the entire sample (without water).

Udio vlage (moisture content, Feuchtigkeits-gehalt) is a portion of water in relation to the dry content (% by mass).

Radni kontakt (construction joint, Arbeitsfuge) is a longitudinal or transverse joint in the same material (asphalt mixture, cement concrete mix), required due to particular working conditions.

Destilirani bitumen (straight-run bitumen, Destillationsbitumen) is bitumen, which remains at crude oil distillation (after distillation of volatile compounds).

Dinamičko opterećenje vozne konstrukcije (pavement dynamic loading, dynamische Belas-tung der Fahrbahnbefestigung) is an additional loading resulting from the pavement surface condition and/or motor traffic, or the ratio of the actual traffic loading acting on the pavement structure to the static loading.

Dinamička viskoznost (dynamic viscosity, dynamische Viskosität) is the time of mounting of a liquid substance, e.g. bitumen, in a vacuum in a capillary, established using modified Kopper vacuum viscosimeter (absolute viscosity).

Dinamički deformacioni modul E_{vd} (dynamic modulus of deformation, dynamischer Verfor-mungsmodul) is a characteristic value of material deformability at specified shock loading of a circular plate by a falling light weight, determined on the basis of the measured amplitude "s" of the plate settlement.

Vrijeme trajanja (life time, Lebensdauer) is a period, within which the properties of structural materials remain at the same level, meaning fulfilment of required properties of the structure in its service life (structural performance requirements), on condition that the structure is adequately maintained.

Vrijeme trajanja kolovozne konstrukcije (pavement life time, Lebensdauer der Fahrbahnbefestigung) is the design time of an adequate serviceability of a pavement surface in view of traffic safety, comfort, and economy.

Dop (Dodatak) (additive/admixture, Zusatzmittel) is a chemical compound added/admixed, as necessa-ry, to an asphalt mixture or any other mix to improve its certain properties, e.g. coating of grains with bitumen.

Dodatni rad (additional work, zusätzliche Arbeit) is the work, which has been included neither in the design nor in the bidding/contractual bill of quantities.

Konačno preuzimanje - superkolaudacija (ultimate taking over, endgülltge Übernahme) is an inspec-tion, where the structural condition is established and defects/damages found out; the contractor is obliged to make good those deficiencies within the agreed time; afterwards, the contractor has not further obligation to the client.

Drenažni asfaltni sloj (drainage asphalt layer, Asphaltdränschicht) is a layer of an asphalt mix with a high content of voids where macro-voids are interconnected; it is intended for dewatering, prevention of aquaplaning, and reducing noise of rolling wheels (tyres) of vehicles.

Drenažna sposobnost (drain capacity, Dräin-fähigkeit) is a material property enabling draining the water through interconnected voids/cavities.

Sitnež (crushed aggregate, Splitt) is a mixture of totally crushed stone grains of 2 mm to 63 mm in size.

Sitnež s bitumenskim mastiksom (stone mastic asphalt, Splittmastixasphalt) is an aggregate, which grains are interconnected by means of road bitumen or a mixture of road bitumen and additives (polymers, natural asphalt, stabilizing admixtures); a major portion of grains is crushed aggregate, which particles are internally supported one by another, whilst the voids in-between are filled up with bituminous mastic.

Sitnež za posipanje (spread chipping, Streusplitt) is crushed aggregate of suitable grain size for spreading traffic surfaces, particularly to increase the skid resistance.

Drobljenac (well-graded crushed aggregate, gebrochene Gesteinskörnung) is a mix of totally crushed stone grains of 63 mm size.

Drobljeni pijesak (crushed sand, Brechsand) is a mix of stone grains of size up to 2 mm (fine) or up to 4 mm (coarse), having all the surfaces fractured.

Drobljenje (crushing, Brechen) is an artificial reducing of solid material dimensions (e.g. rock, broken asphalt, cement concrete) to intended grain size.

Drobljeno zrno (crushed/broken particle, gebrochenes Korn / Brechkorn) is a particle with more than 50% of surfaces fractured.

Klizanje (sliding/skidding, Gleiten) is moving of a vehicle with blocked wheels.

Klizeća oplata (slip form, Gleitschalung) is a formwork firmly linked together by means of a paver; when a cement concrete mix is applied to the surfacing, the paver simultaneously pulls the slip form.

Dupla / trostruka osovina (tandem / triple axle, Tandem/ Dreiachsig) are two or three consecutive vehicle axles at spacing up to 1.8 m.

Dvoslojna površinska prevlaka (double-layer surface dressing, zweilagige Oberflächenbehand-lung) is a procedure of carriageway surface finishing, where two single surface dressings are executed consecutively: as a rule, the first one containing coarse crushed aggregate, and the second one with fine crushed aggregate.

Ekstrakcija bitumenskoga veziva (bituminous binder extraction, Extraktion bituminösen Binde-mittels) is a separation of bituminous binder from the asphalt mix using organic solvents.

Ekvivalentno prometno opterećenje (equiva-lent traffic load, äquivalente Verkehrslast) is a loading expressed in terms of an equivalent number of vehicles of a nominal axle load of 82 kN as a rule.

Ekviviskozna temperatura (equiviscous temperature, Äquiviskositäts – Temperatur) is a temperature, at which a bituminous binder has a certain viscosity.

Elastičnost (elasticity, Elastizität) is capability of a body that enables it to regain its original shape or volume after removal of external forces or moments that had temporarily deformed it.

Elastomer (elastomer, Elastomer) is a synthetic material of a non-linked reticular structure of molecules; at normal temperature its elasticity is the same as that of rubber.

Jednakomjerno zrnata smjesa (single-sized aggregate, gleichkörniges Mischgut) is composed of stone particles of very similar size (of one class).

Jednostruka osovina (single axle, Einzelachse) is an individual axle of a vehicle.

Jednoslojna površinska prevlaka (single surface dressing, einfache Oberflächenbehandlung) is a method of carriageway surface finishing by spraying bituminous binder and spreading crushed stone particles.

Jedinična cijena (unit price, Einheitspreis) is the price of an individual item in the contractual bill of quantities, which includes all the costs for a faultless execution of works in view of both quantity and quality.

Evropska tehnička saglasnost (European Technical Approval – ETA, Europäische technische Zulassung) is a positive technical appraisal that a product is suitable to the intended use; it is based on the implementation of essential technical requirements by the structures for which the product is intended; the ETA is issued by a body authorized for issuing technical approvals.

Faktor ekvivalentnosti (equivalency faktor, Äquivalenzfaktor) is an equivalent effect on fatigue in relation to the nominal axle loading.

Filtrska stabilnost (filter stability, Filterstabilität) is a property of the contact of two layers made of different materials, depending on the granulo-metric composition of those layers, so that under influence of permanent or variable water gradient, or under traffic dynamical loading, no solid particles can pass from one layer into another.

Fini djelići (fines, Feinanteile) is an aggregate grain-group, which particles can pass a sieve of an opening of 0.063 mm.

Frakcija kamenih zrna (aggregate grain-group, Korngruppe/Lieferkörnung) is a mixture of grains designated on the basis of the lower (d) and the upper (D) square opening of a sieve, expressed by d/D; such a designation includes a possibility that some particles remain on the upper sieve (over-size particles), and pass the lower sieve (under-size particles).

Glineni naboj (clay/puddle layer, Tondichtungs-schicht) is a sealing layer of cohesive soil in the area of the road body and/or drainage system to protect the ground water from pollution with carriageway swill or from other harmful substan-ces.

Dubina hrapavosti (roughness depth, Rauhtiefe) is the ratio of volume of deepening below the top of the particle peaks on the carriageway surface to the belonging area; it is also a criterion of macrotexture determined by the sand-patch-method or by measuring the water outflow by Moor.

Dubina utisnjenja (pečat) (depth of impres-sion, Eindrucktiefe) is a depth in mm, to which a standard beetle is impressed under certain circumstances into poured asphalt or similar asphalt mix.

Dubina smrzavanja (frost depth, Frosttiefe) is a maximum depth to which the isotherm 0°C reaches at long standing frost.

Gustoća (density, Dichte) is the mass of material including moisture and voids per volume unit (kg/m^3 per t/m^3).

Gradjevinski dnevnik (construction diary, Bautage-buch) is a prescribed document in which both contractor and engineer daily enter all issues relevant to construction works.

Gradjevinski poluproizvod (construction semi pro-duct, Bauhalbprodukt) is a construction product, which is not yet suitable to its intended use in a structure, but gets the required properties only after being built-in.

Gradjevinski proizvod (construction product, Bauprodukt) is any product intended for a permanent building-in into a structure.

Gradilište (construction site, Baustelle) is an area where a construction takes place.

Harmonizirani europski standard (harmonised European standard – hEN, harmonisierte europäische Norm) is a standard prepared by the CEN on the basis of the EU Commission mandate issued in compliance with the procedure prescribed in the CPD.

Hidrauličko vezivo (hydraulic binder, hydrauli-sches Bindemittel) is a pulverized inorganic material; when mixed with water it forms a paste, which, due to reactions and hydration processes, sets and hardens; after being hardened, it retains its strength and volume durability under water as well.

Hidrološki uslovi (hydrological conditions, hydrologische Verhältnisse) are conditions defining water conditions in the ground next to road.

Higroskopnost (water absorption capacity, Wasseraufnahme) is a material property to absorb moisture from the environment.

Hladni radni postupak (cold procedure, Kaltverfahren) means that when an asphalt mix is produced, neither aggregate nor bituminous binder is heated.

Homogeni odsjek (homogenous section, homoge-ner Abschnitt) is defined by the selected variation coefficient. i.e. the ratio of a standard deviation of measured deflection to their mean value.

Hrapavost (roughness, Rauheit) is a texture of the carriageway surface or aggregate surface, which affects the skid resistance essentially; it can be fine and/or rough.

Buka (noise, Lärm) is strong, mutually mixed up and non-harmonized sounds of different origin.

Indeks mraza (frost index, Frostindex) is the sum of mean (negative) daily temperatures from the beginning to the end of the frost

season; it denotes frost duration and intensity at certain location.

Institucija (third party/independent testing institu-tion, unabhängige Prüfstelle) is professional company acting as an independent party in construction works, performing the external control in connection with attestation of conformity and taking over of construction products.

Intaktni uzorak (undestroyed sample, ungestörte Probe) is a sample, which properties have remained unchanged after having been taken.

Inženir (engineer, Ingenieur) is a professional institution appointed by the client; it supervises the quality of construction products and executed works in compliance with the design documents on the basis of which the building permit has been issued.

IRI - mednarodni indeks neravnine (IRI – Inter-national Roughness Index, IRI - Internationaler Unebenheitsindex) is an index describing longitu-dinal evenness of the pavement surface assessed by mathematical simulation of the vehicle response to the carriageway longitudinal profile in a single wheel pass, taking account of a simulation model of one quarter of a vehicle.

Poboljšanje (improvement, Verbesserung) is a procedure where suitable materials (mineral aggregate or inorganic binder) are added to improve capability of the basic material of being placed and compacted, and to facilitate construc-tion works.

Izjava o usklađenosti (declaration of conformity, Konformitätserklärung) is a document issued by the manufacturer to approve conformity of a product with the technical specification; depending on the conformity attestation system such a document can be issued by the producer himself either on the basis of the introduced system of the production control, or on the basis of the certificate of product conformity, or of the certificate of production control.

Potvrda o uskladjenosti (statement of conformity, Konformitätsfeststellung) is a document issued by the supplier to verify in writing that a product, a process, or a service complies with the prescribed requirements.

Izotopi (isotopes, Isotopen) are a group of chemical elements of the same position in the periodical system of elements, i.e. of the same number of protons, but of a different atomic weight.

Izotopski mjerilac (isotope gauge, Isotopen-sonde) is an instrument for a 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.

Masa za izravnavanje (levelling compound, Aus-gleichsgemisch) is a product to fill up bug holes, to level minor unevenness, and to smooth the surface; it is applied in an average thickness of up to 5 mm.

Izvodjač (Concractor, Auftragnehmer) is a corporate body or natural person, who has signed a contract with the client to execute certain service in accordance with the contractual provisions, approved drawings, and other conditions being a constituent part of the contract; it can also be a corporate body responsible for a product, method, or service, and who is able to implement the quality assurance conditions.

Čelična vlakna (steel fibres, Stahlfasern) are pieces of a cold drawn wire, pieces cut out from a steel plate, rolled pieces, or fibres directly produced from melt by extraction method, suitable to a homogeneous adding to cement concrete and spraying mortar.

Kvalitet (quality, Qualität) is a condition of a certain material in view of its suitability to fulfil certain requirements specified in advance.

Kvalitetni razred (quality class, Qualitätsklas-se) is a quality and adequacy of a sample in view of the rate of destroying, determined by a laboratory investigation or test.

Kalcijev hlorid (calcium chloride, Kalziumchlorid) is a chemical compound resulting as by-product in the soda production by Solvay.

Kalibracija (calibration, Kalibrierung) is a perio-dical adjusting of the measurement results with the values of a range known and agreed in advance (by a calibration test within the limits of the known range of expected results).

Kalibrirati (calibrate/adjust, kalibrieren/justieren) means to verify suitability of certain properties of equipment, and/or to calibrate them to the required dimension.

Kameno brašno (stone dust, Gesteinsmehl) is a natural or artificial stone pulverized to particle size up to 0.09 mm, containing maximum 20 or 35% by mass of oversize grains of up to 0.71 mm; it does not include any organic and swelling compounds in harmful quantities.

Kamena posteljica (mineral substructure/capping layer, verfestigter Unterbau) is the top layer of a fill or foundation soil composed of mechanically stabilized natural, mixed, or crushed mineral aggregate.

Kameni material (stone/mineral material, Gesteinmaterial) is a non-cohesive material consisting of mineral particles, which mechanical, chemical, and mineralogical properties do not change in the course of time due to water, air, and/or temperature action, or they change within the limits, where the material is still mechanically sound; stone/mineral material can be of a natural or artificial rock.

Karakteristična tvrdoča (characteristic strength, charakteristische Festigkeit) is a value of strength below which maximum 5 % of population of all possible strength tests can be expected.

Kategorija (category, Kategorie) is a charac-teristic level of certain property of mineral aggre-gate expressed in terms of a range of values or a limiting value for a defined application purpose; there is no correlation between categories of different properties.

Hemijski dodatak (chemical additive, chemi-sches Zusatzmittel) is material added in small quantities with regard to the cement mass during cement concrete mixing, in order to modify properties of both fresh and hardened cement concrete.

Klima (climate, Klima) is a sum of meteorological phenomena determining atmosphere/environment and their changes at certain location.

Klimatski uslovi (climatic conditions, klimatische Verhältnisse) are conditions, defined by the air temperature in certain time period at certain location or in certain area, where a road is situated.

Klin (prelazni) (backfill wedge, Hinterfüllung) is the area between a bridge abutment and adjacent fill; to ensure a stable transition from the bridge to the fill, a backfill wedge shall be executed in compliance with special conditions.

Knjiga obračunskih izmjera (ledger of quantitative measurements, Bau - Abrechnungsbuch) is a pre-scribed document, in which the contractor records measurements and quantities of the works carried out.

Opterećenje točka (wheel load, Radlast) is the normal weight acting via wheels on the pavement structure.

Trag točkova (wheel pass, Radspur) is that area on a carriageway where the traffic frequency is the maximum; there are two wheel passes on one traffic lane.

Kolotrag (rut, Spurrinne) is a longitudinal gutter occurring in the wheel pass area due to strain acting to the pavement structure and/or to the substrate of the material built-in.

Količnik kliznog trenja (coefficient of friction, Gleitreibungsbeiwert) is a coefficient of adhesive-ness between the tyre and pavement surface at a totally blocked wheel.

Količnik odpornosti protiv smrzavanja (frost resistance coefficient, Frostwiderstandkoeffizient) is a ratio of the compressive strength of stone aggregate stabilized with hydraulic binder after prescribed freezing-thawing cycles to that in a dry condition.

Količnik bočnog trenja (sideway-friction coefficient, Reibungsbeiwert am

schräglaufenden Rad) is the ratio of the sideway-friction force activated between a tyre and pavement surface (when a wheel runs oblique with regard to the drive direction), to the normal force.

Završno preuzimanje – kolaudacija (final taking over, Endabnahme) is a taking over upon completion of construction works, i.e. at the beginning of the liability period.

Kontrola istovjetnosti (identity control, Identifi-zierungskontrolle) is all the activities, performed prior to placing/building-in a product, to verify in compliance with the prescribed criteria of a technical specification, whether the results of identity testing of the specified product property belong to the (statistical) population, for which conformity has already been established within the scope of the production control.

Kontrola kvaliteta (quality control, Qualitäts-kontrolle) is checking the quality upon preparation (production), transport, and construction.

Kontrola proizvodnje u toku (factory production control, werkseigene Produktions-kontrolle) is the activity performed by the producer within the scope of the internal control, intended for managing the production, comprising services, procedures, internal testing and measurements during preparation (production) of certain construction product. Its constituent part is a permanent conformity control at the factory where a product is completed, in accordance with the provisions of the relevant technical specification.

Kontrola usklađenosti (conformity control, Konfor-mitätskontrolle) is all the activities, methods, and conformity tests within the scope of internal (production) control intended for conformity evaluation.

Kontrolni urez (control notch, Kontrollkerbe) is a groove (every third or fourth dummy joint), cut as soon as possible after placing cement concrete surfacing, in order to prevent uncontrolled cracking of cement concrete.

Kontrolni organ (inspection body, Überwa-chungsstelle) is a approved body involved in attestation of conformity of construction products; it carries out controlling activities, in compliance with the prescribed criteria, at construction site, at factory, or anywhere, such as assessing and recommendation for taking over, estimation of producer's procedures within the quality management system at the factory, as well as selection and evaluation of product conformity in compliance with the criteria specified.

Kontrolni testi (control/random tests, Stich-probenprüfungen) are random/spot tests and measurements, verifying the accuracy of confor-mity testing results on randomly chosen samples or locations, when the contractor or client are of opinion that the external or internal control results do not indicate the actual condition of the work carried out.

Košarica (dowel-basket, Dübelstuhl) is a support made of steel bars, serving for arrangement of dowels and anchors prior to placing cement concrete into the surfacing.

Gornji sloj (surfacing, Decke) is the pavement upper layer, generally built of a wearing course and bound pavement base-bearing course with a suitable binder.

Laboratorij (laboratory, Laboratorium/Labor) is a professional body performing conformity testing and fulfilling prescribed requirements in the construction works on public roads.

Vlasna razpuklina (hairline crack, Haarriss) is a thin crack in a structural member, which has occurred either due to excessive tensile stresses under load, or due to excessive internal stresses in the material, e.g. due to shrinkage as a result of setting or cooling.

Ledeno sočivo (ice lens, Eislinse) is typical form of pore water, occurring at freezing due to increased water content in the material.

Lunker (bug hole / lunker, Lunker) is a small void/cavity of regular or irregular shape of 25 mm diameter, occurring on concrete surface in contact with formwork due to air entrapped during concrete placing and compacting.

Magnezijev hlorid (magnesium chloride, Magne-siumchlorid) is a chemical compound won by evaporation of waste bases at potassium chloride production.

Malta za popravke (repair mortar, Reparatur-mörtel) is a product for non-destructive repair of major damage to cement concrete surfaces.

Masa (mass, Masse) is a physical quantity being a measure for weight and inertia properties of a body.

Granična vrijednost (limiting value, Grenzwert) is a quality value that is just on the limit of compliance with the contractual requirements.

Granične krivulje zrnatosti (grading curve limit, Grenzsieblinien) are curves limiting the range of admitted oscillation of the grain size distribution.

Odsjek za mjerenje (test section, Versuchsbahn) je del preiskovanega območja, ki praviloma ne vsebuje nepravilnosti, ki bi otežkočale ali onemogočale zanesljivo ugotavljanje preiskovanih parametrov; meritve, ki služijo doseganju ciljev preiskave, so omejene izključno na to območje.

Mjerodavna podajnost (design deflection, mass-gebende Durchbiegung) is a settlement of pavement surface under certain load, taking account of effects on measurement results (corrections).

Mjerodavno saobraćajno opterećenje (design traffic loading, massgebende Verkehrsbelastung) is a characteristic value of traffic loading acting on the pavement structure of one traffic lane in the design life; it is determined on the basis of the average annual daily traffic (number of vehicles) and of its growth, as well as of the additional factors: traffic lane number and width, maximum longitudinal fall of the carriageway, and eventual dynamical effects; it is a sum of passages of nominal axle load of 82 kN.

Mješavina (mixture/mix, Mischgut) is a composition of mineral aggregate, hydraulic binder, and water; after setting it cannot be decomposed in basic materials.

Mikroarmirani špricani cementni beton (micro reinforced shotcrete, mikrobewehrter Spritzbeton) is shot cement concrete containing reinforcing fibres, which enable an improvement of certain properties of cement concrete, e.g. cohesiveness of fresh cement concrete and mechanical properties (compressive and bending/flexural strength, toughness) of hardened cement concrete, as well as limitation of shrinkage, and increase of stiffness of a structural member after the first crack has occurred.

Mikroklima (micro climate, Mikroklima)

is an entirety of equal conditions, such as temperature, sun radiation, precipitations, snow conditions, and wind, characteristic for a limited area.

Mikropore (micro pores / micro voids, Mikro-poren) are microscopically small air bubbles, intentionally added to concrete during mixing, usually by means of surface-active compound; the bubbles are of spherical or approximately spherical shape, and of a diameter from 10 to 300 micrometers.

Mineralni dodatak (mineral admixture, Mineral-zusatzstoff) is fine material added to cement concrete to improve certain properties or to achieve some special properties of the concrete.

Mineralno vezivo (mineral binder, Mineral-bindemittel) is a powdery substance of inorganic origin; when mixed with water it forms a pap or paste, which, after longer or shorter time, hardens to a formation similar to stone; mineral binders serve to agglutinate inactive mineral grains to a solid conglomerate.

Modificirana gustoća prema Proctorju (modified Proctor density, modifizierte Proctordichte) is a maximum achievable density of dry mineral material (test method by Proctor) at approximately 2.65 MNm/m^3.

Modificirani bitumen (modified bitumen, modifi-ziertes Bitumen) is bitumen, which properties are improved by adding synthetic material and/or rubber.

Modificirani postupak prema Proctorju (modified Proctor compaction test, modifiziertes Proctor-Verfahren) is a test of compacting mineral aggregate under certain conditions, in order to determine the relation between the moisture content and dry mix density.

Modul elastičnosti (dinamički) (modulus of ela-sticity (dynamic), Elastizitätsmodul (dynamischer)) is a ratio of normal stress to elastic elongation (under dynamic load).

Modul reakcije tla k_s (modulus of subgrade reaction k_s, Bettungsmodul k_s) is a characteristic value of material deformability at certain loading applied to a circular plate; it is determined on the basis of resulting settlement.

Modul stišljivosti M_E (modulus of compressibility M_E, Zusammendrückungsmodul M_E) is a chracte-ristic value of material deformability at gradual single loading applied to circular plate; it is determined on the basis of inclination of secant of the settlement curve in a certain range of loading.

Mokra naknadna obrada (wet curing/aftertreat-ment, Nassnachbehandlung) is a procedure to preserve a damp surface directly after placing cement concrete or similar.

Mokri postupak (wet procedure, Nassverfahren) is a method of spray application of a wet mix of a specified water-cement value/ratio; cement, mine-ral aggregate, and water, including eventual che-mical and/or mineral additives/admixtures, as well as eventual steel fibres are dosed and mixed at concrete mixing plant.

Moždanik (dowel, Dübel) is an inserted piece (a bar) made of round steel to reinforce cement concrete slabs at transverse joints, enabling their moving apart, and transfer of loads.

Na gradilištu zamiješani cementni beton (in-situ/in-place concrete, Baustellenbeton) is cement concrete produced at construction site by the contractor for his needs.

Na smrzavanje neosjetljiv materijal (frost insen-sible material, frostunempfindliches Material) is material, in which the freezing pore water does not cause any significant increase of the bearing capacity, neither the thawing causes any essential reduction of the bearing capacity of such material.

Nadgradnja (overlay, Hocheinbau) means placing of an additional layer onto (damaged) existing pavement structure; as necessary, the latter can be partly milled off, thus the new surface is higher than the original one.

Nadmjerno zrno (oversize grain, Überkorn) is a designation for the portion of particle mix, which remains on the upper sieve, indicating delivery granulometric composition (D_i).

Nadomjesni postupak (substitute procedure, Ersatzverfahren) is a procedure, where material density is measured in such a way that the material mass is determined gravimetrically by weighing excavated material, whilst it volume is established by substituting the excavated material with another – substitute material, which density is exactly known.

The supervisor is a legal or natural person that provides services of building control as a commercial activity.

The responsible supervisor is the individual responsible to the supervisor for the compliance of works with the conditions specified in the building permit and for the quality of the works carried out in accordance with the building regulations

Nadzor (supervision/superintendence, Überwa-chung) means conformity evaluation after the certificate to verify a permanent conformity of a product with the specified requirements has been acquired.

Nadzorni organ (supervisor, Aufseher) is a legal or natural person that provides services of building control as a commercial activity. The responsible supervisor is the individual responsible to the supervisor for the compliance of works with the conditions specified in the building permit and for the quality of the works carried out in accordance with the building regulations.

Nanos (coating, Beschichtung) is a dense liquid or pasty product, being applied in a greater thickness to cement concrete surface by means of machines of manually.

Prognoza saobraćaja (traffic forecast, Verkehrs-prognose) is an assessment of traffic condition in the future (in an appointed period).

Prirodni asfalt (natural asphalt, Naturasphalt) is a mixture of natural bitumen and small mineral particles, coming into being in the nature, e.g. Trinidad island, Selenica, State of Utah, USA, etc.).

Prirodni bitumen (natural bitumen, Naturbitumen) is a constituent part of natural asphalt mix, suitably purified if necessary (stone particles removed).

Nariv (shoving/swelling, Wulst) is a deviation above a connection of two points on the carriageway or traffic lane vertical alignment.

Naročnik (client, Auftraggeber) is a competent national body or a special society/organization for national roads.

Nasip (embankment/fill, Damm) is a part of a road body between the substructure and foundation ground, artificially constructed of soils and/or rocks to such a level above the ground surface that both slopes at carriageway edges are inclined downhill.

Natrijev hlorid (sodium chloride, Natriumchlorid) is a chemical compound won from the seawater or salt mine.

Prividna gustoća (apparent density, scheinbare Rohdichte) is a dry mass of compacted material to its volume including the pores/voids within it.

Prividna spojnica (contraction/dummy joint, Scheinfuge) is a cut (groove) on the upper part of cement concrete surfacing (in transverse direction as a rule) to allow formation of a controlled crack at that location.

Nazivno (nominalno) osno opterećenje (NOO) (nominal axle load, nominelle Achslast) is a standard/nominal single axle load of 81.6 (82) kN, transferred by double wheels of 4 x 20.4 kN to the pavement surface; it is defined as a base to compare effects of different axle loads.

Neravnost (unevenness, Unebenheit) is a deviation of the actual form of the surface of an individual pavement course from the design form.

Nevezivi nosivi sloj (subbase, untere Tragschicht) is, as a rule, the lowest bearing course in the pavement; it is mechanically stabilized and composed of natural, crushed, or mixed aggre-gate.

Nevezivi habajući sloj (unbound wearing course, ungebundene Deckschicht) is a wearing course of the pavement for a very light traffic loading, or for a temporary arrangement of the pavement surface made of a skeleton and wedged grain mixture to the greatest possible extent.

Neveziva smjesa (kamenih zrna) (unbound mixture (mineral aggregate), ungebundene Mischung (Gesteinskörnung)) is a designation for an aggre-gate, usually of defined granulometric composi-tion, particularly used for the pavement lower bearing courses.

Nevidljiva površina cementnog betona (hidden concrete surface, unsichtbare Betonoberfläche) is a cement concrete surface layer protected with a thicker dressing such as asphalt layer, earth lay-on, etc.

Nosivi sloj (bearing course/layer, Tragschicht) is a pavement unbound or bound course between the wearing course and substructure or substrate formation, placed in particular to ensure a suitable dispersion of traffic loading.

Nosivost (bearing capacity, Tragfähigkeit) is a mechanical resistance of the formation of material built-in to transient loading.

Unutrašnja kontrola (internal/production control, Eigenüberwachung) are the activities by the producer at the factory production and/or by the contractor at building-in/placing/installing the product at site, intended to manage the production and to establish the production conformity.

Unutrašnje probe (production control tests, Eigenüberwachungsprüfungen) are tests and measurements to be performed by the producer/contractor to manage the production and to control the quality both at production plant and at construction site where the particular product is built-in/installed/placed.

Novogradnja (new construction, Neubau) is the first construciton of a road.

Objekt (structure/work, Bauwerk) is everything that is or will be constructed, or that is or will be result of construction works in compliance with the constructional/structural design.

Obogaćenje s maltom (mortar bleeding, Mörtel-anreicherung) is breaking through of bituminous or cement mortar to the carriageway surface.

Obogaćenje s vezivom (binder bleeding, Binde-mittelanreicherung) is breaking through of binder to the carriageway surface.

Obračun (account, Abrechnung) is an interim/provisional or final sum of executed quantities multiplied by corresponding unit prices.

Habajući sloj (wearing course, Deckschicht) is a durable and traffic-safe surfacing of a road pavement or bridge surfacing; its composition depends on both traffic and climatic loading, as well as on the basic purpose.

Habajući sloj koji smanjuje buku (noise reduction wearing course, lärmmindernde Deck-schicht) is an asphalt layer of such a surface composition/texture, that the noise caused by vehicle rolling wheels is reduced.

Habajućezaptivni sloj (wearing and sealing course, Verschleiss- und Sperrschicht) is a durable and traffic-safe pavement surfacing of such a composition, that water seepage is prevented.

Postrojenje za mješanje (mixing plant, Mischan-lage/Mischwerk) is mechanical equipment for dosing (as well as for drying if required) and mixing stone aggregates with bituminous or hydraulic binders.

Obrnuto dvoslojno površinsko prevlačenje (reverse two-layer surface dressing, umgekehrte zweilagige Oberflächenbehandlung) is a method of successive execution of two single surface dressings: the first one containing fine crushed aggregate, and the second one with coarser crushed aggregate.

Postojanost bitumenske smjese (durability of asphalt mixture, Beständigkeit des Asphalt-mischgutes) is resistance of asphalt mixture to harmful changes in the lifetime.

Oglodati (milling, Abfräsen) means digging up the bound material on a layer surface (in different width and thickness), using a machine with turning tools.

Traka za zaustavljanje (emergency lane, Standstreifen) is a marked carriageway surface along the traffic lane, intended for emergency stopping/staying of vehicles.

Odstranjeni asfalt (removed asphalt, beseitigter Asphalt) is an asphalt mixture won from existing asphalt by milling (in smaller pieces), digging up, pushing away or similar (in larger pieces).

Otapanje (thaw, Auftauen) is a whole of physical phenomena occurring in materials, when the temperature rises above 0°C after frost period.

Otpor na trganje (pull-off strength, Abreissfestig-keit) is tensile strength in the direction perpen-dicularly from the surface, at which a coating breaks apart or tears off from the substrate.

Očuvanje (maintenance, Erhaltung) is a common term for measures to preserve the substance and the value in use of a structure.

Ojačani površinski sloj (strengthened surface dressing, verstärkte Oberflächenbehand-lung) is a dressing, where crushed aggregate, preliminarily coated with bituminous binder, has been used for spreading.

Ojačanje (strengthening, Verstärkung) means placing one or more additional material layers to the existing pavement to improve its bearing capacity and/or preserve its serviceability at suitable level.

Okruglo zrno (round grain, Rundkorn) is a natural grain having at least 50% of its surface rounded off.

Odsjek za opažanje (monitoring section, Beobach-tungsbahn) is a part of the road constructed in compliance with current

regulations and guide-lines, where the behaviour of construction materials and/or construction technology are established under common constructional and environmental protection conditions, introducing professional methods.

Prijem (adhesion, Adhesion) is a sum of all the adhesion forces acting between two layers or courses.

Prijemljivost (adhesiveness, Kraftschluss) is a capability of transferring forces in the tyre contact surface from the vehicle to the pavement surface by friction.

Optimalni udio vode (optimum water/moisture content, optimaler Wassergehalt) is a portion of water in the material at the maximum density determined by the Proctor's method.

Osovinsko opterećenje (axle load, Achslast) is a force, which is transferred onto the carriageway over wheels located on a single axle of a vehicle.

Osnovna frakcija zrna (basic aggregate size, Grundkorngruppe) defines grain mix within the basic classification of granulometric composition.

Osnovna mješavina (basic mixture, Grundge-misch) is a dry or wet mixture, or a material mix prepared at plant.

Osnovni premaz (primer, Grundierung) is a coating penetrating into the substrate and improving adhesion of the subsequent coat.

Ocjenjivanje uskladjenosti (conformity evaluation, Konformitätsbewertung) means a systematic assessment of results of conformity testing in view of specified conformity criteria; by the conformity evaluation it can be established to what extent certain type of construction product fulfils the requirements prescribed.

Penetracija bitumenskog veziva (bituminous binder penetration, Bitumenpenetration) is a depth, to which a testing pin, under specified testing conditions, penetrates into the tested bituminous binder (in tenths of mm).

Pijesak (sand, Sand) is a mixture of stone particles/grains in the size range from (at the lower limit) 0 mm, 0.063 mm, or 0.09 mm to (on the upper limit) 2 mm or 4 mm.

Plan probavanja (testing plan, Prüfungsplan) specifies types and frequencies or number of conformity tests to be carried out during preparation and/or building-in/placing/installing the product in view of the requirements indicated in the technical specifications or by the tender conditions.

Planum (formation, Planum) is an area fulfilling certain prescribed quality features (height, evenness, compaction, deflection).

Sloj (course, Schicht) is one or more layers of a material of similar characteristics.

Plodno zemljište /humus/ živica (fertile soil, Oberboden) is a top layer of the ground/soil, resulting from physical, chemical, and biological processes; in addition to inorganic substances it also contains organic compounds required for the vegetation.

Podajnost (deflection, Durchbiegung) is a surface settlement under certain loading; it is a criterion for the structural condition (available bearing capacity) at the time of measurement; the deflection consists of both elastic and plastic component.

Podloga (substrate, Unterlage) is the area below the course or layer being constructed.

Podmjerno zrno (undersize grain, Unterkorn) is a designation for the portion of particle mix, which pass the lower sieve, indicating delivery granu-lometric composition (d_i).

Poissonov količnik (Poisson's ratio, Poissonsche Querdehnungszahl) is the ratio of the material transversal elongation strain to the longitudinal elongation strain.

Polimer (polymer, Polymer) is a synthetic or natural material to improve certain properties of the bituminous binder (e.g. elastomer, thermo-plast, thermoelast, etc.).

Polimerni bitumen (polymer bitumen, Polymer-bitumen) is a binder won by adding polymers (elastomers, thermoplasts, thermoelasts) into road bitumen to improve its characteristic properties.

Punilo (filler aggregate, Füller) is a mineral aggregate, which prevailing portion passes a sieve of 0.063 mm, and which complete amount passes a sieve of 0.09 mm; it can be added to construction material to achieve certain proper-ties.

Ponovna upotreba/recikliranje (recycling, Wie-derverwendung/Recycling) means repeated use / placing / building-in of materials, which have al-ready been used at least once as construction materials.

Popis uzorka (description of sample, Proben-beschreibung) is material main characteristics described by a uniform standard terminology.

Potpuno drobljeno zrno (totally crushed or broken particle, vollständig gebrochenes Korn) is a designation for a particle, which more than 90% of the surface is fractured.

Potpuno zaobljeno zrno (totally rounded particle, vollständig gerundetes Korn) is a designation for a particle, which more than 90% of the surface is rounded.

Popravak (repair, Instandsetzung) is a common term for measures to replace deficient or damaged items/members/places on the structure; such measures are periodically repeated.

Pora (pore / void, Pore) is a confined space in a solid material, filled up with air.

Raspodjela veličine granulata (milling crushing residue size distribution, Granulatgrössen-verteilung) is the composition of milling-crushing residue grains indicated by grain/particle classes (it does not represent the size distribution of stone grains/particles).

Raspodjela veličine kamenih zrna (particle size dispersing, Korngrössenverteilung) means the composition of mineral grain mixture indicated on the basis of grain/particle classes.

Porušeni uzorak (destroyed sample, zerstörte Probe) is a sample, which structure, moisture content, or other properties have changed upon taking or afterwards.

Posteljica (substructure, verfestigter Unterbau) is tje upper (finishing) layer of a fill or subgrade, of thickness up to 50 cm, having special properties (increased bearing capacity, reduced sensitivity to frost effects) attained by adequate constructional-technical measures (improvement, consolidation, stabilization).

Postupak mješanja na mjestu ugradjivanja (mix-in-place procedure, Baumischverfahren) is a proce-dure to improve, consolidate, and stabilize material: a mixer is driving on the prepared material layer, which is lifted and mixed with both binder and required water.

Postupak miješanja u centralnoj napravi za miješanje (mix-in-plant procedure, Zentralmischverfahren) is a procedure of a complete preparation of mixes of aggregate, binder, and other admixtures in a suitable central mixing plant.

Postupak po Proctor-u (Proctor compaction test, Proctor–Versuch) is a test of compaction of soils or aggregates under specified conditions for determination of relation between the moisture content and dry material density.

Postupak "prsten - kruglica" (PK) (procedure "ring and ball" (R&B), "Ring und Kugel" (RuK) – Verfahren) is a laboratory procedure to determine the softening point temperature of bitumen (by means of a steel ball and a ring).

Postupak sa letvom (measuring rod method, Mess-verfahren mit Latte) is a procedure to determine the rut depth or to measure deviation from the straight reference line between two points on the pavement surface.

Oštećenje zbog smrzavanja (frost damage, Frostbeschädigung) is damage to the structure, which is either a direct or indirect consequence of frost action in connection with water; it can lead to structural failure.

Potvrda uskladjenosti (conformity attestation, Konformitätsbescheinigung) is an action, by which, on the basis of a positive evaluation of conformity, it can be approved that a construction product complies with the technical specification requirements; in dependence on the prescribed system of conformity assessment, this can be performed either by the producer by issuing a declaration of conformity, or by an independent testing institution by a conformity attestation.

Potvrđivanje uskladjenosti (attestation of conformity, Bestätigung der Konformität) are the activities and duties of the producer and involved approved bodies for conformity attestation, ensuring, by an acceptable probability, attainment of prescribed product properties or the product conformity with the requirement of an adequate technical specification.

Vozni plato (working/hardened field, befahrbare Unterlage) is a raised layer of an unbound mixture of mineral grains, placed to the subgrade with an intention to enable transportation and all the road construction methods.

Poprečni godišnj dnevni saobraćaj (PLDP) (average annual daily traffic (ADT), durchschnittlicher täglicher Verkehr (DTV)) is the average daily number of motor vehicles having passed the selected road cross section in a specified year, assessed on the basis of traffic counting.

Površinska prevlaka (surface dressing, Ober-flächenbehandlung) is a protective layer applied to the surface by spraying bituminous binder and spreading crushed aggregate grains; it also designates a made layer.

Poprečni nagib (crossfall/cross slope, Querneigung) is the difference between both levels of the traffic lane edges, perpendicularly to the road axis (in %).

Poprečni presjek (profil) (cross section, Querprofil) is a section through the road body, perpendicular to the road longitudinal axis.

Predhodni sestav / istraživanje smjese (prelimi-nary investigation of mixture, Voruntersuchung des Mischgutes) means a thorough selection of materials and their proportion in a mixture (e.g. asphalt mix), required to ensure the design properties.

Traka za preticanje (overtaking/passing lane, Überholspur/-streifen) is an additional traffic lane on the marked carriageway part, intended for faster vehicles and overtaking.

Istraga (investigation/examination, Untersuchung) 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.

Premaz (coating material, Anstrichstoff) is a liquid product applied to the substrate particularly by brush, roller, or spraying, and subsequently forming a continuous dry film of 80 micrometers to 5 mm in thickness.

Premazni sistem (coating system, Anstrichsystem) consists of products applied together or successively in compliance with the specified method to repair or protect the structure.

Preostali period trajanja (residual lifetime, Restlebensdauer) is a period between the measurement carried through (e.g. of pavement surface deflection) and fatigue (failure) of the material placed/built-in.

Proba, ispitivanje, opit, testiranje (test, Prüfung/Versuch) 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.

Test istovjetnosti (identity test, Identifizierungsprüfung) is a test to verify identity of the product supplied.

Test s pločom (plate bearing test, Plattendruckversuch) is a test, where the material is loaded with a circular plate and adequate additional equipment, and unloaded; average loading with the plate "p" and corresponding settlements "s" determine the settlement (deformation) curve.

Proba uskladjenosti (conformity/autocontrol test, Konformitätsprüfung) is a random test performed by the producer on randomly selected samples or locations verifies product

conformity with the technical specification requirements.

Probni odsjek (test section/trial stretch, Erprobungsstrecke/Untersuchungsabschnitt) is a part of the road, where, under usual constructional and environmental conditions, the behaviour of construction materials and/or methods is profes-sionally established; this behaviour can deviate from the current regulations and guidelines.

Probno polje (test area, Versuchsgelände) is a part of the construction site, where, with respect to the set goal, construction materials and methods are professionally tested by varying individual parameters.

Probni uzorak (test specimen/test sample, Prüf-körper) is a sample or part of a sample used for investigation or laboratory testing.

Laboratorij za oglede (testing laboratory, Prüflabor/Prüfstelle) is a laboratory involved in the construction product conformity attestation, where properties or behaviour of materials or products are measured, tested, calibrated, or determined in some different ways.

Protočna mješalica (run-through mixer, Durchlauf-mischer) is a mixer (trough-shaped or drum), being able to carry out continuous mixing.

Provjera propisnosti (certification of confor-mity, Zertifizierung der Übereinstimmung) is a procedure carried out by an independent testing institution to verify whether there is a sufficient probability, that an accurately specified product, method, or service complies with the requirements provided by the relevant standard or other normative document.

Preuzimanje radova (taking over of works, Abnahme der Leistung) is an activity performed by the engineer (upon written notice of the work completion by the contractor) on the basis of certificate or declaration of conformity of the works carried out, as well as in accordance with the requirements provided by the technical specifications and eventual additional design provisions, being a constituent part of the construction contract.

Preuzemna ispitivanja (acceptance tests, Abnahmeprüfungen) is testing of certain property of a built-in/placed/installed product in order to approve or reject the existing conformity asses-sment of the product with regard to the prescribed property prior to building-in/placing/installing the product.

Preporuka (reference, Referenz) is a technical regulation document expressing an advice or instruction for a certain method/procedure.

Pritisnuta (radna) spojnica (compressed/con-struction joint, Pressfuge (Arbeitsfuge)) is a break (due to working conditions) of a structural member in the entire thickness (daily, longitudinal, transverse), with a groove in the upper part as a rule.

Priznati organ (approved body, anerkannte Stelle) is a certification body, control body, and testing laboratory fulfilling required conditions provided by the current legislation.

Šljunak (coarse gravel, Grobkies) is a mixture of natural rounded stone grains of a size of 2 to 63 mm.

Sitni šljunak (gravel, Kiessand) is a mixture of natural rounded stone grains of a size up to 63 mm.

Profil za spojnice (joint sealer, Profil für Fugen-abdichtung) is an elastic construction material, shaped in advance, to seal a joint.

Profilometar (profilometer, Profilmessgerät) is a device to measure the carriageway profile on individual traffic lanes in both transverse and longitudinal direction.

Proizvodjač (producer, Hersteller) is a person or company producing compounds, mixtures, semi-products, products, etc.

Projektant (designer, Konstrukteur) is an authorized legal person/corporate body specia-lized in working out drawings/plans/instructions for construction, operation, and maintenance of roads, bridges, and other structures on roads.

Saobraćajno opterećenje (traffic loading, Verkehrs-belastung) is a loading expressed by vehicle number (ADP - average annual daily traffic), or by the number nominal axle loads of 82 kN passing the selected road cross section in an appointed lifetime.

Saobraćajna traka (traffic lane, Verkehrsstreifen) is a part of the carriageway, of suitable width to allow moving of one vehicle type in one direction, including road marks.

Prostorna gustoća (volume density, Raum-dichte) is a quotient of the mass of compacted material to its volume, including voids/cavities as well as pores in the solid material.

Prostorna spojnica (expansion joint, Raumfuge) is the space between two structural members, which is filled up with suitable material; it allows those members to expand.

Radioaktivni izotopi (radioactive isotopes, radioaktive Isotopen) are isotopes, which nuclei are unstable; at disintegration they emit internal energy (alpha, beta, gamma rays, fast neutrons).

Ravnost (vozne površine) (evenness/smooth-ness, Ebenheit) is a geometrical property (of pavement surface) affecting traffic safety and pavement structure durability; it is also relevant to the driving comfort.

Razdjeljitelj (spreader/finisher, Verteiler/Fertiger) is a mechanical device (trough with a spiral) introduced to spread asphalt mixture or cement concrete mix uniformly over the entire placing width.

Razgradnja (degradation, Abbau) is a damage to wearing course or pavement structure due to exceeded adhesion forces.

Razpad bitumenske emulzije (breaking of bitumen emulsion, Brechen der Bitumenemulsion) is a decomposition of bitumen emulsion into water and bituminous binder.

Razred saobraćajnog opterećenja (traffic loading class, Verkehrsbelastungsklasse) is a classifi-cation with regard to the traffic loading.

Urez raspukline (joint cut, Fugenspalt) is an increased width of the cut (e.g. in cement concrete) to seal the joint with suitable material.

Reciklirana smjesa kamenih zrna (recycled mineral aggregate, Recycling–Gesteinskörnung) is a mineral aggregate, which had already been used as construction material before, re-won by suitable recycling method.

Referentni špricani cementni beton (reference shotcrete, Referenz – Spritzbeton) is a shot cement concrete made of foreseen materials, however without any hardening accelerator, in view of which differences in mechanical proper-ties, e.g. strength reduction, are determined.

Spojnica (joint, Fuge) is a space (groove) at the contact between two structural members, or within a structural member to prevent uncontrolled crack formation, or to level differences in length due to temperature actions.

Remix (remix, Remix) is a method to improve the wearing course composition, where asphalt mix is heated and milled off, and the loosened material is mixed with added new material for an improvement of the existing asphalt mix, and repeatedly placed.

Repave (repave, Repave) is a method to improve evenness and skid resistance of the wearing layer, where the asphalt mix is heated and milled off, and the loosened mixture (with an overlay of uniform thickness – without mixing) is repeatedly placed.

Reshape (reshape, Reshape) is a method to improve evenness of the wearing layer, where the asphalt mix is heated and milled off, and the loosened mixture, without any admixture of a new asphalt mix, is levelled into the profile and repeatedly placed, whilst the eventual surplus is pushed away.

Rezani bitumen (cutback bitumen, Verschnitt-bitumen) is bitumen, which viscosity

has been temporarily reduced by additives of a low volatility.

Glodalica (milling machine, Fräse) is a machine with tools fixed to a turning cylinder, used for milling bound materials.

Oglodani materijal (milling residue material, Fräsgut) is an existing material of suitable grain size won by means of suitable milling machines.

Rezultirajuća smjesa (resulting mixture, resul-tierendes Mischgut) is a mixture of a new and recycled material.

Robni pas (marginal strip, Randstreifen) is a visibly marked part of pavement surface, equally stabilized as the carriageway next to it, and, as a rule, also at the same level as the carriageway.

Rubna traka (particle size distribution, Korngrössenverteilung) means a mixture of mineral aggregate, distributed in classes, and illustrated by a curve in suitable diagram.

Sastav smjese zrna (all-in aggregate, Korngemisch) is a mixture of coarse and fine mineral particles (sand), produced without any separation in grain-groups, or by mixing grain-groups of coarse and fine grains, or of a natural source.

Sastavljeni bitumen (composite bitumen, zusam-mengesetztes Bitumen) is a binder produced from standardized bitumen and natural asphalt or poly-mers, in compliance with the quality requirements for the road bitumen.

Sidro (anchor, Anker) is an inserted piece (bar) of deformed/ribbed steel for reinforcement in longi-tudinal joints between cement concrete slabs, preventing them to move apart.

Silikatna kamenina (silicate rock, Silikatgestein) is a rock consisting of predominantly or exclusively silicate minerals.

Sistem potvrdjivanja uskladjenosti (conformity attestation system, System der Konformitäts-bestätigung) is a combination of methods of conformity control, depending on the product type, on product importance to implement the specified properties, and on the effect of variableness of product properties on its serviceability.

Krajnja granična vrijednost (threshold value, Schwellenwert) is a quality level, which is already beyond the design requirements.

Slabo nosivo zemljište (soft soil/soil of low bearing capacity, schlecht tragfähiger Boden) is a soil, containing a high percentage of water, thus having inadequate physical and/or mechanical properties, and slowly emitting water.

Smjerni kolovoz (one-way carriageway, Rich-tungsfahrbahn) is such a carriageway, on which vehicles may move ahead in a specified direction only.

Sonda (izotopska) (sound (isotope), Sonde (Isotopen)) is a flexible element of an isotope gauge, with a source of gamma rays at the nib of the rod.

Donje ispunjenje (bottom filler, Fugenprofil) is suitably shaped synthetic material, placed into the lower part of a dummy joint; it prevents pressing-in of the filling compound into the notch.

Donji stroj (subgrade, Unterbau) is a constructed part of the road body (fill) between foundation soil and pavement.

Tvrdoća prianjanja (tensile bond strength/ cleavage strength, Spaltfestigkeit) is a tensile strength in the perpendicular direction from the surface, at which a layer breaks or is pulled off from the substrate.

Središnja spojnica (central joint, Mittelfuge) is a joint on the carriageway between traffic lanes.

Srednja vrijednost (mean value, MIttelwert) is the arithmetical mean of results of uniformly distri-buted samples.

Sredstvo za zaštitu (protecting agent, Schutz-mittel) is a liquid material sprayed to a surface (e.g. of fresh cement concrete),

creating protec-tive film of properties determined in advance.

SRT vrijednost (Skid Resistance Tester value, SRT – Wert) is a standard value of skid resistance representing friction between the tested surface and testing device.

Stabilizirajući dodatak (stabilizing additive, stabilisierender Zusatz) is an additive to increase material durability, e.g. to reduce segregation at asphalt mix production, transport, placing, and compacting.

Stabiliziranje (stabilization, Stabilisierung) is a procedure where both binder and water are mixed-in to the existing material, and the prepared mix is then suitably compacted, to increase resistance of the placed mix to traffic loading effects and to adverse climatic and hydrological actions.

Stabilnost bitumenske smjese (stability of asphalt mixture, Stabilität des Asphaltmischgutes) is the resistance of an asphalt mixture to strain.

Stabilnost prema Marshallu (Marshall stability, Stabilität nach Marshall) is the maximum force (in dependence on the sample height), measured upon load testing on a cylindrical sample of asphalt mixture at partially restrained lateral expansion (kN).

Standard (standard, Standard/Norm) is a technical specification (document) introduced on the basis of a common consensus of interested parties; it is based on approved/verified results/achievements of science, technical know-ledge, and experiences; it shall be approved by relevant body; it provides rules for a common and repeated use, guidelines or characteristics for spheres of activity; it is not mandatory to take a standard into consideration.

Standardni postupak prema Proctor-u (standard Proctor compaction test, Proctor – Standard-verfahren) is a test of compacting cohesive soils under certain conditions to determine dependence between moisture content and dry material density.

Staranje (ageing, Alterung/Altern) means a change of properties of construction materials by time due to chemical and/or physical actions; it predominantly means an impairment of mecha-nical properties such as strength and viscosity.

Statički deformacijski modul E_{vs} (static modulus of deformation E_{vs}, statischer Verformungs modul E_{vs}) is a characteristic value of material deformability at gradual multiple loading of circular plate; it is determined on the basis of inclination of secant of the settlement curve in a certain range of the first, second, or third loading.

Stepen ispunjenosti šupljina (rate of void filling, Hohlraumfüllungsgrad) means filling up of apparent voids/cavities in mineral aggregate in a compacted asphalt mixture with a binder (%).

Stepen zgusnutosti (compaction degree, Verdichtunggrad) is a ratio of the measured (dry) material density to the maximum (dry) material density determined in compliance with a suitable method, e.g. by Proctor; the compaction degree is expressed in %.

Stvrdnjavanje (hardening, Erhärtung) means that a stable structure has resulted from reaction components, e.g. cement and water.

Stvrdnuti (cementni) beton (hardened concrete, erhärteter Beton) is a (cement) concrete in solid condition, which cannot be recast/reshaped, and which has developed a measurable strength.

Struktura (structure, Gefüge) is a texture in view of size, shape, and proportions of ingredients, as well as their interconnection.

Suha gustoća (dry density, Trockenraumdichte) is the mass of a dry material per volume unit, including pores in grains, filled up with air and/or water (kg/m^3 or t/m^3).

Suha smjesa (cementnog betona) (dry mix (concrete), Trockengemisch (Beton)) is a mixture of dry constituents of cement concrete, which are used in a dry procedure where the moisture contents does not exceed 1.5% by mass.

Suhi postupak (dry procedure, Trockenverfahren) is a spray procedure using dry mix, where the required water quantity and eventual accelerator are dosed through a nozzle; the constituents are preliminarily dosed and mixed at a concrete plant.

Svježi cementni beton (fresh cement concrete, Frischbeton) is entirely mixed up cement concrete in such a condition that it can still be compacted by an adequate procedure.

Dizna (nozzle, Düse) is a part of spraying equipment through which a cement concrete mixture is sprayed out.

Brojanje saobraćaja (traffic count, Verkehrszählung) is a method of establishing vehicle type and number, or axle loads, passing a selected road cross-section in a specified time.

Tankoslojna prevlaka (thin overlay, Dünnschichtbelag) is a wearing course of an asphalt mix of minor thickness (up to 20 mm as a rule), weighing up to 50 kg/m^2.

Tečenje prema Marshallu (Marshall flow, Fliesswert nach Marshall) is a deformation of the shape of a sample attained at the Marshall test maximum loading (mm).

Tehnička specifikacija (technical specification, Technische Spezifikation) is a valid document prescribing technical requirements for the particular construction product, as well as methods of both internal and external control, and procedures of conformity assessment and attestation; a technical specification can also be a standard or its constituent part, or a document independent of the standard.

Vaganje vozila (vehicle weighing, Fahrzeugwiegung) means measuring of vehicle mass or weight.

Vaganje vozila u toku vožnje (weigh-in-motion/WIM, Wiegen des rollenden Verkehrs) is a measurement of axle loads acting on the pavement structure during driving.

Tekuće sredstvo za njegu svježe ugradjenog cementnog betona (liquid membrane - forming compound for curing concrete, flüssiges Nachbe-handlungsmittel) is a liquid applied to a fresh cement concrete surface, forming a film, which prevents evaporation of water from the cement concrete, on condition that it is applied adequately and uniformly.

Tekstura (texture, Textur) is a property (fine geometrical shape – roughness) of the surface of mineral grains or layers, determined by composition, classification, size, as well as percentage and characteristics of minerals in a grain or grains in a layer.

Temeljno tlo (foundation soil/subgrade, Unter-grund) is soils or rocks, in natural ground as a rule, directly adjacent to the fill, pavement structure, or foundation of a civil engineering structure, or are located immediately below it.

Teoretična dubina zastajanja vode (theoretic water hold-up depth, theoretische Wasserstau-tiefe) is a depth of unevenness between fictitious horizontal line placed over the crest point of the cross-section at the wheel pass, and the lowest point in the wheel pass.

Uložak za tješnjenje (sealing strip, Dichtungsprofil) is suitably shaped synthetic material, placed into the upper part of a dummy joint; it prevents harmful substances to enter the joint.

Tačka loma prema Fraass-u (breaking point (Fraass), Brechpunkt (nach Fraass)) is the temperature, at which the bituminous binder film, at specified testing procedure by Fraass, breaks, or cracks are formed on the film; it is an indication for bituminous binder behaviour at low temperatures.

Kruti gornji sloj (rigid surfacing, starre Decke) consists of a wearing course and upper roadbase made of aggregate mixtures and hydraulic binder, predominantly cement.

Krutost prema Marshall-u (Marshall stiffness, Steifigkeit nach Marshall) is a ratio of stability value to flow value of an asphalt mixture, determined by Marshall test.

Otpor na klizanje (skid resistance, Griffigkeit) signifies an influence of the

material quality and geometrical shape of the pavement surface on the magnitude of driving, braking, and lateral forces, which can be transferred from a wheel tyre onto the carriageway.

Trajnost (durability, Dauerhaftigkeit) is a period between placing and fatigue (failure) of the material placed, e.g. to the pavement structure.

Transporni cementni beton (ready mixed concrete, Transportbeton/Fertigbeton) is a cement concrete produced out of the construction site by either the user, or it is delivered in a fresh condition by another person/company.

Treća stranka (third party/independent testing institution, unabhängige Prüfstelle) is professional company acting as an independent party in construction works, performing the external control in connection with attestation of conformity and taking over of construction products.

Udarna jama (pothole, Schlagloch) is damage to asphalt wearing course or surfacing of local character, causing a hole of sharp edges, of size up to 2 m^2, and of a depth more than 2 cm in the carriageway.

Utvrdjivanje uskladjenosti (conformity assessment, Konformitätsfeststellung) is activities by the produ-cer or contractor, and third party/independent institution, by which it is assessed directly or indirectly, whether the requirements of an adequa-te technical specificetions are implemented.

Korisnik (user, Benutzer) is a person or company using a material (compound, mixture, semi-product, product, etc.) to execute a civil engineering structure, or its constituent member.

Utvrdjenje ceste (pavement structure, Strassenbe-festigung) is a joint term for material layers/cour-ses of both pavement and substructure.

Utvrdjenje zemljišta (ground stabilization, Bodenver-festigung) is a method, where a binder is mixed to the existing ground, and the prepared mixture is suitably compacted, which leads to a permanent increase of resistance of the built-in mixture to harmful effects of the water.

Uvoziti (drive in, Einfahren) means that motor vehicles drive on (press in) the surface to ensure a normal connection of mineral grains with the substrate.

Valjani cementni beton (roller-compacted con-crete, Walzbeton) is suitably cast earth-damp cement concrete compacted by means of rollers.

Povečanje količine rada (change of quantity, vergrösserte Arbeit) is a work, which has been contractually foreseen, however its amount/volume is exceeded.

Vezani donji nosivi sloj (base course, mittlere Tragschicht) is a mixture of mineral aggregate of uniform granulometric composition in the pavement structure, bound with hydraulic or bituminous binder.

Vezani gornji nosivi sloj (upper roadbase, obere Tragschicht) is a mixture of mineral grains bound with hydraulic or natural binder, placed below the wearing course (into the surfacing).

Ugradja po hladnom postupku (cold proce-dure, Kaltverfahren) signifies placing of an asphalt mixture, which can be, due to the type of the bituminous binder used (emulsion, cold or cut bitumen), mixed and processed at air tempe-rature.

Ugradnja po toplom postupku (warm proce-dure, Warmverfahren) signifies placing an asphalt mixture, which requires, in dependence on the binder type, a temperature at placing between 30 °C and 60 °C.

Ugradnja po vrućem postupku (hot procedure, Heissverfahren) means placing an asphalt mixture, produced in hot condition at plant, which requires, depending on the asphalt mix type and binder type, a temperature at placing between 90 °C and 250 °C.

Ugradjivanje (laying/placing, Einbau) is a procedure, where material of suitable thickness is spread and compacted.

Vidljiva površina cementnog betona (exposed concrete surface, Betonoberfläche) is the surface layer of cement concrete exposed to weather conditions.

Viskoelastičnost (viscoelasticity, Viskoelastizität) signifies behaviour of a viscous material of elastic properties.

Viskoznost (viscosity, Viskosität) is a property of a liquid, that due to the internal friction it offers resistance to two adjacent layers to a laminar counter-movement (change of shape); it is also a criterion of bituminous binder flowing capacity, depending on the temperature.

Visokovrijedni cementni beton (high performan-ce concrete, Hochleistungsbeton) is a cement concrete, which compressive strength class is greater than C55/67, and which is due to a low w/c value (ratio) technically impermeable to liquids and gases, thus ensuring it high resistance to aggressive actions.

Vlaga (moisture, Feuchte) is the water mass in the volume unit of a material (kg/m^3 or t/m^3).

Vlažna zmjesa (moist mixture, feuchtes Mischgut) iz a mixture of dry constituents used in a dry procedure, where the moisture content amounts to 1.5 to 5.0 % by mass.

Medjufrakcija (intermediate additive aggregate size, Zwischen-/Ergänzungskorngruppe) is a mineral aggregate in an additional classification of granulometric composition, adjusted to specific execution methods.

Vodocementni faktor (water – cement value/ratio, Wasser – Zement – Wert) is a ratio of the effective water portion to the effective cement portion in fresh concrete.

Vodopropusnost (water permeability, Wasser-durchlässigkeit) is a property of a surface or a layer, that it is water permeable due to interconnected (open) voids/cavities.

Vodozaštiteno područje (water protective area, Wasserschutzgebiet) is an appointed area, which exploitation is limited due to an interest in public water supply or other intentions conditioning protection.

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

Šupljine u smjesi zrna (voids/cavities in mineral aggregate, Hohlräume im Mineralstoffgemisch) is the content of hollows between grains in a mix in proportion to the entire volume (in % by volume).

Kolovoz (carriageway, Fahrbahn) is a uniformly and continuously consolidated part of the pavement, suitable to vehicle traffic.

Kolovozna konstrukcija (pavement structure, Fahrbahnbefestigung) is a part of traffic surface consolidation, consisting of one or more bearing courses and a wearing course.

Vozna površina (pavement surface, Fahrbahn-oberfläche) is a uniformly and continuously consolidated surface of the pavement wearing course, on which the traffic is running.

Vozna traka (traffic lane, Fahrstreifen) is a part of the carriageway, of a suitable width, allowing movement of one vehicle type in a single direction.

Uticajno područje (influence area, Einfluss-bereich) is an area affected by the construction, or an area affecting the particular structure.

Vrijednost CBR (California Bearing Ratio, CBR-Wert) is a characteristic value of material deformability at settlement of a pressed-in beetle, determined on the basis of a loading, which causes a settlement specified in advance.

Ocjenjivanje uskladjenosti (conformity evaluation, Bewertung der Konformität) means a systematic appraisal of conformity test results with regard to the prescribed conformity criteria; by the conformity evaluation it is established to which extent certain type of construction product fulfils the specified requirements.

Vrući radni postoupak (hot procedure, Heiss-verfahren) means that such bituminous binder is used for the preparation of an asphalt mixture, which required a temperature at placing between 90 °C and 250 °C.

Vrsta (tip) proizvoda (product type, Produktart) is a construction product of certain properties and of a specified quality class or quality level.

Vrsta cementnog betona (cement concrete grade, Betonart/-güte) means a cement concrete of a specified (same) strength class, resistant to aggressive actions at certain (same) exposure rate.

Sadržajnost šupljina (void/cavity content, Hohlraumgehalt) is a ratio of the void/cavity volume to the entire material volume (% by volume).

Uzdužni presjek (profil) (longitudinal section, Längsprofil) is a graphical presentation of the entire vertical section in the road longitudinal axis, or parallel to it.

Uzorak (sample, Probe) is a representative amount of material for testing to determine an average quality or to establish deviations from it.

Privremena-konačna situacija (interim/final progress statement, Vorläufige Abrechnung/ Endabrech-nung) is an interim or final settling of account of the works carried out.

Privremeno preuzimanje (provisional taking over, vorläufige Abnahme) is any acceptance/taking over of a quantity and quality of the executed work up to the final taking over.

Početni test prikladnosti (initial standard suitability test, Eignungsnachweis) is a test of the foreseen composition of a mix/mixture, or of a composition proposed by the contractor, to verify prior to commencement of regular production, whether the product fulfils all the specified requirements.

Početni tipski test (initial type test, Eignungs-/Erstprüfung) is a testing to verify and approve, prior to the regular production or upon any modification of origin of constituents and/or their proportions as well as of the production method, the achievement of specified properties and the product suitability for the intended use; in dependence on the prescribed system of conformity assessment, these tests shall be carried out either by the producer/contractor, or by the third party/independent testing institution.

Zagladjivanje (smoothing, Glätten) is a reduction of the skid resistance of grains or pavement surface due to worn out sharpness, edges, and peaks of mineral grains.

Zahtjev (requirement, Anforderung) signifies a provision indicating criteria to be fulfilled.

Zalivni premaz (impregnating pore filling material/ impregnation, Imprägnierung/Versiegelung) signi-fies a coating using a low viscosity compound, which penetrates into the material, e.g., cement concrete, partially fills up the pores, reduces the surface porosity of grains, and forms a discontinuous film of a thickness of 10 to 100 micrometers on the surface.

Zamješana količina (šarža) (charge/batch, Ladung/Charge) is a quantity of mix/mixture produced within one working cycle of a mixer, or a quantity, which can be evacuated from a continuous mixer within one minute.

Zaobljeno zrno (rounded particle, gerundetes Korn) denotes a grain having 50% or less surface broken.

Koeficient zadržavanja vode (water retention coefficient, Wasserhaftungskoeffizient) signifies the effect of the curing/after-treatment agent for newly cast cement concrete on retaining the water in the concrete.

Urez za spojnicu (joint notch, Fugenkerbe) is a foreseen location of rupture in a bound material layer; as a rule, it is made by a narrow cut.

Zasipanje (backfill, Verfüllung) means filling up the installation ditch up to the fill formation, or the voids behind bridge abutments and wing walls.

Otklizavanje točka (wheel slip, Radschlupf) is a slip, which occurs when a rolling wheel drives a different path, as it would correspond to the section on the basis of the wheel circumference.

Tlo (soil/earth, Boden/Erde) is the top part of the earth's crust (sediments and weathering formations) consisting of unbound or weakly bound mineral and/or partly organic particles, which can be decomposed by mechanical means without any force application (e.g. by pouring in water).

Zgusnutost (compaction (degree of), Verdich-tungsgrad) signifies an attained density of placed material after completion of the compaction procedure.

Zgušnjavanje (compaction, Verdichtung) is a procedure, by which material spread into a layer, achieves its required degree of compaction using adequate machines such as rollers, vibration plates, etc.

Smjesa (mix / mixture, Gemisch / Mischgut) is a material composition, which can be decomposed into basic materials after having been placed.

Smjesa drobljenih kamenih zrna (crushed mineral aggregate, gebrochene Gesteinskörnung) is a mixture won by machine crushing of natural mineral grains, artificial stones, or broken materials (asphalt, cement concrete, brick, etc.); it only contains grains of at least 90% of surface broken (crushed aggregate, crushed sand, stone dust).

Smjesa sitnih kamenih zrna/pijesak (fine mineral aggregate/sand, feine Gesteinskörnung/Sand) denotes grain groups of an upper size D, depending on the intended use: for asphalt mixtures the prevailing portion of fine grains in the mix shall pass a sieve of 2 mm, and remain on a sieve of 0.063 mm.

Smjesa grubih kamenih zrna (coarse aggregate, grobe Gesteinskörnung) denotes mixtures of larger natural and/or crushed grain groups; the dimension of the largest grains (D) depends on the intended use; however, the grain size must not be less than 2 mm (a prevailing portion of mineral grains shall remain on a sieve of 2 mm (d)), and not greater than 63 mm.

Smjesa kamenih zrna za zaklinjavanje (mineral aggregate for wedging, Gesteinskörnung für Verkeilung) is a mixture of crushed or naturally crushed mineral grains, of granulometric compo-sition of 0/8 mm as a rule, which shall be, upon executing unbound wearing courses, spread onto the already built layer of a skeleton base in a quantity required for a complete filling up of voids/cavities on the layer surface and for covering over.

Smjesa kamenih zrna/mineralni agregat (mineral aggregate, Gesteinskörnung/Mineralstoffgemisch) is a granular mineral material used in the construction; mineral aggregates can be natural, artificial, or recycled; they are composed of one or more grain or grain group classes.

Smjesa prirodnih kamenih zrna (natural mineral aggregate, natürliche Gesteinskörnung) is a granular material of a mineral origin, which has been subject to natural mechanical actions only.

Smjesa umjetnih kamenih zrna (artificial aggregate, künstliche Gesteinskörnung) is an aggregate of mineral origin, made by an industrial process under influence of a thermal or some different change.

Dizanje tlazbog smrzavanja (frost heave, Frosthebung) is a local lifting of the carriageway due to ice lens formation in an unsuitable material built-in to the frost depth.

Smrzavanje (freeze, Frieren) is a complex of physical phenomena arising in materials when the temperature is below 0°C.

Znojenje (bleeding, Schwitzen) is a common term for a binder or mortar bleeding/enrichment of certain surface.

Zrnatost / granulometrijski sastav (granulometric composition, Kornzu-sammensetzung/Kornaufbau) signifies a grain size distribution expressed in percentage by mass of grains passing a sieve of certain opening dimensions.

Vanjska kontrola (external / third party control, Fremdüberwachung) means activities

by an institution intended to supervise the internal control, leading to product conformity attestation, or to attestation/approval of the production internal control, and/or taking over/acceptance of contrac-tion product built-in; it includes activities, proce-dures, external testing, and measurements during production and/or placing/building-in/installing certain construction product.

Vanjski kontrolni test (external control test, Stichprobenprüfung) is a test, by which, on randomly selected samples or locations, the certification body verifies accuracy of results of conformity tests carried out within the scope of the production control.

2.1.4 TECHNICAL & ECONOMICAL REPORT

Road construction bases are defined by the following documents:

- Instructions for Preparation of Technical & Economical Report indicating general provisions, and
- Instructions for Preparation of Method Statement for Earth Works indicating detailed provisions for a specific works.

2.1.4.1 Instructions for Preparation of Technical & Economical Report

The Instructions for Preparation of Technical & Economical Report (TER) defines procedures and tasks to be carried out by the contractor prior to commencement of the construction works.

The method statement shall be prepared for each of the following works:

- earth works
- pavements
- waterproofing
- drainage
- bridges, walls and other supporting/retaining structures, packed rockfills, piles
- noise barriers
- displacement of public utilities (gas, electric power, water, etc.)
- tunnelling works
- anchoring the structures by means of permanent ground anchors, and
- other works not included in this list.

2.1.4.1.1 General Information

2.1.4.1.1.1 Description

The description shall include the following:

- project description
- description of works to which the TER is relating
- master layout drawing including characteristic details and working stages.

2.1.4.1.1.2 Construction Site Organization

The presentation of the construction site organization shall include the following:

- traffic arrangement (graphical presentation of accesses to the site)
- method of storing basic materials and semi-products
- mechanization inventory including documents on its suitability to the planned construction works.

2.1.4.1.2 Materials

2.1.4.1.2.1 Basic Materials

The list of basic materials shall include the following:

- types and origin
- required quantities
- transportation method.

2.1.4.1.2.2 Semi-Products

The list of semi-products shall include the following:

- types and detailed designation
- certified production methods (cement concrete design, preliminary investigation of asphalt mixtures, method to improve soils and/or mineral aggregates, etc.)
- required quantities
- necessary production equipment and methods
- transportation method.

2.1.4.1.2.3 Quality of Used Materials and Semi-Products

For all the materials and semi-products used, valid conformity documents, i.e. certificates issued by

an authorized third party testing institution shall be submitted, or producers' declarations of conformity for both materials and semi-products, based on the production control certificates.

2.1.4.1.3 Construction Methods

The following shall be described:

- working methods for all the construction stages; the method and stages shall also be presented graphically, including details in particular for more complex works, e.g. connecting fills to slopes, arrangement of excavation slopes, construction joints on pavements and structures, etc.
- preparation and arrangement of locations of placing/laying/casting
- method of protection from damages (e.g. to slopes, roadway edges, waterproofing layers, etc.)
- curing/after-treatment of cement concrete, waterproofing, etc.
- environment protection (air, ground water, from noise, etc.)

and indicated:

- the coordinator of works
- professional crew to be obligatorily present at construction works (responsible director of works, method engineer, laboratory representative); at least one of the aforementioned experts shall already be present at preparation of the TER.

2.1.4.1.4 Construction Quality

The construction quality (performance of works) shall be defined in detail by the preliminary working compositions and property requirements.

2.1.4.1.4.1 Demonstrative Production and Placing

Prior to commencement of an individual working stage, for which the contractor has still not proven that he is capable to perform it adequately, the contractor is obliged to prepare, in agreement with the engineer, a test area where the required properties as well as the methods of regular production, placing, and curing/after-treatment shall be demonstrated and proven.

2.1.4.1.4.2 Construction Quality Verification

Within the scope of the TER the contractor shall submit a programme of the average frequency of both internal and external control/random tests; this programme shall be approved by the client and shall be a basis for the construction quality verification.

2.1.4.1.5 Economical Part

2.1.4.1.5.1 Time Schedules

The following shall be indicated by appropriate time schedules:

- a schedule of work progress – by stages and types of the works,
- a mechanization and labour schedule:
  - by machine types and labour qualifications
  - capacities of machines by stages and types of works
  - manpower by stages and types of works
- deliveries of basic materials, and
- working time.

In view of the work volume and time span, those schedules can be monthly, weekly, or daily.

2.1.4.1.5.2 Realization Plan

In the TER the contractor shall indicate the following:

- a realization plan, and
- an evaluation of works by the bill of quantities or additional/extra works taking account of the contractual provisions.

2.1.4.1.6 Approval of Technical & Economical Report

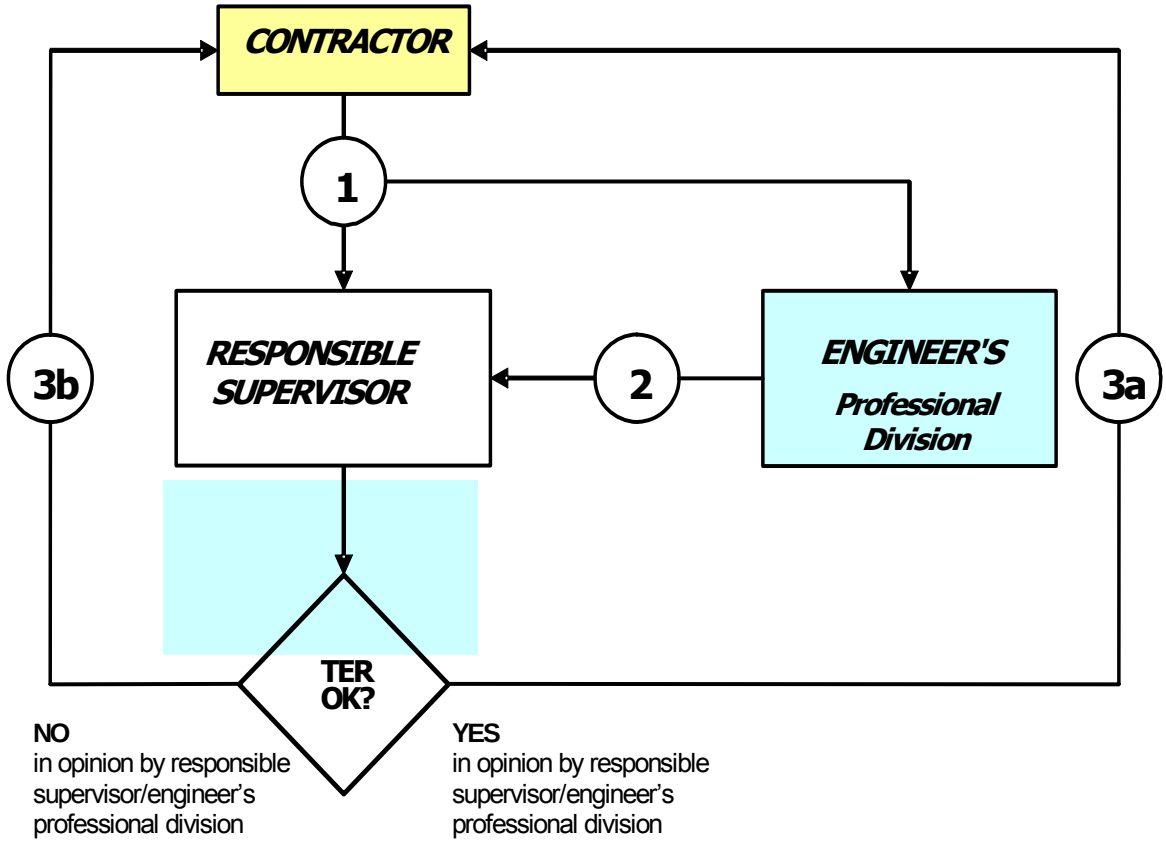
The contractor shall submit by a covering letter to the engineer two (2) copies of the TER not later than fifteen (15) days before the commencement of the works defined in the TER.

One copy of the TER shall be addressed to the site resident engineer, and the other to the engineer's professional division.

Within eight (8) days, the engineer's professional division shall submit to the site resident engineer a written opinion of the technical part of the TER.

Within twelve (12) days after the contractor has submitted the TER, the engineer either approves or rejects the TER. In case of rejection the contractor is obliged to repeat the entire procedure.

The approval of a technical-economical report is presented in the scheme below:



(1) The contractor submits by a covering letter to the site resident engineer a copy of the TER, whilst a copy of the covering letter and another copy of the TER to the engineer's professional division. A copy of the covering letter shall also be submitted to the client.

(2) The engineer's professional division submits within 8 days a written opinion on the technical part of the TER.

(3a) Within twelve (12) days after the contractor has submitted the TER, the engineer approves it (conditionally or definitively). In case of a conditional approval the engineer shall appoint the time within which the contractor is obliged to make good all the deficiencies established.

(3b) Within twelve (12) days after the contractor has submitted the TER, the engineer may reject the latter. Therefore, the contractor shall, prior to commencement of the works, repeat the abovementioned procedure until the engineer approves the TER.

The contractor shall submit to the site resident engineer a copy of the approved TER not later than three (3) days before the commencement of the construction works.

2.1.4.1.7 Ownership Protection

All the information in the TER may only be used upon contractor's written consent.

2.1.5 INSTRUCTIONS FOR PREPARATION OF METHOD STATEMENT FOR EARTH WORKS

The Instructions for Preparation of Method Statement for Earth Works (MSEW) defines in detail methods and tasks to be carried out by the road contractor prior to commencement of and during the earth works.

The Instruction for MSEW defines and analyses in detail the bases indicated in the Instructions for Preparation of TER.

2.1.5.1.1 General information

The MSEW shall provide the following general information on the intended works:

1.1 Descriptions

1.1.1 Project general description:
- location (master layout drawing at scale of 1 : 25,000)
- field conditions:
  - geological – soil mechanical conditions (stability, bearing capacity)
  - hydrogeological and hydrological conditions (ground water, high water)
  - climatic conditions (temperature, precipitations).

1.1.2 Description of works:
- location (road alignment, deviations, transportation roads, etc.)
- type of works (fills, excavations, etc.)
- summary of main quantities of materials for earth works:
  - coverage at the road alignment (longitudinal profile of masses)
  - deficits/surpluses (locations of side cuts/deposits)
- completion deadline (work progress schedule).

1.1.3 Documents:
- design documents (design engineer, characteristic details from the geotechnical report)
- trial pits
- technical regulation dealing with quality.

1.2 Construction site organization

The construction site organization plan shall indicate in detail the following:

1.2.1 Organization of managing the works (responsible employees)

1.2.2 Time schedules of:
- manpower (number and qualifications)
- mechanization (for the particular purpose – types and number of machines and vehicles, as well as their characteristics)

1.2.3 Traffic arrangement:
- access roads and site (internal) roads (layout, maintenance)
- deviations of existing roads (provisional, permanent)
- parking of vehicles and machines.

1.2.4 Methods of storing (areas/rooms, equipment):
- basic materials (including blasting explosives)
- semi-products.

2.1.5.1.2 Materials

2.1 Basic materials

A presentation of condition of basic materials within the scope of the earth works shall include the following:

2.1.1 Types and quantities (categories) of basic materials:
- won by excavation in the road alignment:
  - cohesive: applicable (natural, improved), non-applicable

- non-cohesive: applicable, non-applicable
- won at side cuts (borrow pits), such as quarries, gravel-pits, excavations at road alignment)
  - cohesive: (natural, improved)
  - non-cohesive.

2.1.2 Types and quantities of basic materials required:
- for foundation ground arrangement
- for working field
- for dividing layers
- for fills:
  - cohesive soils
  - granular rock
- for backfills and wedges
- for substructure:
  - improved cohesive soils
  - granular rock
- for clay/puddle layers
- for reinforcing (fills, slopes)
- for vegetation (topsoil).

2.2 Other materials

For other materials within the scope of the earth works the MSEW shall contain adequate information on the following:
- intended use,
- material type and origin, and
- required quantity.

2.2.1 Types of industrial materials:
- limes
- felts
- drainage strips
- drainage pipes.

2.2.2 Types of waste materials:
- fly ashes
- slag
- ….. .

2.3 Material quality

Within the scope of the MSEW for all the materials to be used, including improved and stabilized ones, the following documents shall be submitted:
- appropriate reports including results of preliminary testing, and
- evidence of conformity with the requirements for the intended use, including and of limiting values for the specified properties.

Within the scope of the MSEW the contractor shall:
- submit an approved programme of an average frequency of material tests for both internal and external control, and
- indicate the performer of the internal control, and submit an evidence of his qualification for the specified works.

2.1.5.1.3 Construction method

In the MSEW all the characteristics of each individual construction stage shall be described in detail; as circumstances may require, this shall be done separately for each individual domain considered)road alignment, deviations, regulations, etc.).

For special and more complex constructions, suitable graphical presentations shall be attached as well.

A brief description of each individual procedure the foreseen construction method shall be defined, including the required mechanization; attention shall be drawn to eventual particularities in connection with the execution.

Methods for the following subgroups and types of works shall be particularly defined:

3.1 Excavations:

- fertile soils:
  - temporary depositing the required quantity at road alignment
  - removal of surpluses (location)
- cohesive soils:
  - soil of low bearing capacity (deposit)
  - applicable (location
- granular rock:
  - intended use
  - location and method of winning
  - location of use
- soft rock:
  - excavation method
  - intended use
- solid:
  - excavation method
  - intended use
- slopes:
  - inclination
  - protection: - from erosion
    - from destruction
- berms:
  - details

3.2 Foundation ground stabilization:

- stabilization, levelling
- terracing:
  - details
- low bearing capacity:
  - replacement
  - improvement (with lime)
  - drainage: - vertical
    - horizontal
    - ribs
  - consolidation (monitoring)
- separation:
  - geotextiles
  - filter grain mixture

3.3 Fills

The characteristics of works shall be described and suitably documented by a layout and longitudinal section (at scale of 1 : 5,000 / 1: 500), as well as sketches of details for the following procedures:

- stone toe
- working field
- classical fills:
  - of cohesive soils
  - of stone materials
  - of high-plastic soils:
    - improvement
    - reinforcement
    - sandwich
- fills of artificial materials:
  - very light
  - light
- lateral fills
- fills for noise protection
- reinforced soil
- stone facing
- slopes:
  - inclination
  - protection : - from erosion
    - from destruction

3.4 Substructure:

- of cohesive soils: - improvement
  - stabilization
- of stone materials: - improvement
  - stabilization
  - reinforcement

3.5 Drainage

For all the earth works the MSEW shall include detailed definitions of surface drainage methods during execution of works, as well as after completion of works. In addition, the method of ensuring suitable dampness of materials at placing (moistening, drying) shall be described in detail as well.

3.6 Arrangement of environment

Within the scope of the earth works the environment shall be arranged as well, thus the following procedures shall be defined by the MSEW:

- laying topsoil,
- sowing grass,
- planting shrubbery and trees.

2.1.5.1.4 Construction Quality

The quality of execution of the individual activities related to the earth works shall be defined in detail by the MSEW, including an indication of the requirements for typical properties.

4.1 Test areas

In the MSEW test areas to be prepared for individual types of works shall be specified.

The results of tests performed on test areas, established within the range of limiting values, shall be considered as a quality evaluation base for the works carried out regularly.

4.2 Regular production

For the types or stages of works, the following shall be provided by the MSEW:

- an approved programme of the average frequency of tests to be carried through within the scope of both internal and external control
- technical requirements for individual characteristics of executed works in compliance with the programme, including limiting values
- a list of performers of internal control, and evidences of their qualification for the works specified.

3.1.4.1.1 Approval of MSEW

The contractor shall submit a MSEW to the engineer's professional division not later than fifteen (15) days prior to starting the works defined by the MSEW.

Both the engineer's professional division and the site resident engineer shall either approve or, in case of deviations/deficiencies, reject the MSEW within a period of twelve (12) days after receipt of the latter.

The contractor is obliged to submit the approved MSEW to the site resident engineer not later than three (3) days prior to commencement of the works.

3.1.4.1.2 Ownership protection

All the information in the MSEW may only be used upon contractor's written consent.

2.1.6 QUALITY VERIFICATION AND EVALUATION

2.1.6.1 General

Quality shall be assured by internal control performed by the contractor, and external control carried through by an independent institution (third party) appointed by the client.

The quality control consists of both laboratory and field testing, as well as of all the associated analyses. For the testing, European or adopted national norms apply (EN, SIST).

Before the contractor commences to use certain material or construction product to perform the contractual works, he shall submit to the engineer all the certificates/evidences proving conformity/adequacy of such material or product.

The contractor may start to use certain material or product to implement the contractual obligations only after the engineer has approved such material or product.

Locations to take samples and to perform measurements shall be determined by a random selection. (supplement 1)

In case that the quality is obviously doubtful, the supervising body may direct additional measuring places and/or locations of taking samples for control purposes.

The contractor is entitled to present at taking control samples, performing field measurements, and control investigations.

The contractor shall assist the supervising body/independent control institution at taking samples for external investigations (to verify results of internal investigations on the basis of the sampling method) and in establishing quality of works and structures executed. This assistance comprises manpower, auxiliary material, material transportation from the location of investigation or taking sample to the laboratory or place appointed by the site resident engineer/supervising body, or vice versa. All the associated costs shall be born by the contractor. All the works shall be managed by the engineer/supervising body.

The contractor is obliged to enable the engineer/supervising body a permanent control of all the internal investigations, as well as to process appropriately the results of current investigations, and to submit those results to the engineer/supervising body in an agreed form and within appointed time.

The entire documents of verifying quality of materials and works will be processed by the independent institution (third party) and issued as a final report on the quality of works or the project/structure.

2.1.6.2 Types of Investigations

2.1.6.2.1 Preliminary Laboratory Investigation

By a preliminary laboratory investigation of a certain product the contractor demonstrates that the product quality in compliance with the requirements of the technical conditions can be achieved using available materials. The costs of such preliminary investigation shall be born by the contractor.

2.1.6.2.2 Demonstrative Production

Prior to commencement of a regular processing of materials by machines and apparatus, the use of which affects the quality of works, a demonstrative production shall be carried out, i.e. testing of machines and apparatus in view of the required uniformity and quality of the product, as specified by the technical conditions or drawings.

The contractor shall submit to the engineer/supervising body a programme of the demonstrative production not later than three days prior to intended commencement of the works. The engineer shall approve or supplement such a programme.

The demonstrative production shall be supervised by the engineer and an independent institution authorized by the engineer.

Control investigations required for the demonstrative production comprehend quality assessment for both materials and products.

All the costs in connection with the demonstrative placing shall be born by the contractor.

As a rule, a demonstrative production shall be carried through only once for materials of the same origin or for machines used to execute the same works.

2.1.6.2.3 Demonstrative Placing

On the basis of adequate results of the preliminary laboratory investigation, and of the demonstrative production (testing machines and apparatus), the engineer approves a demonstrative placing.

Control investigations at demonstrative placing include the assessment of quality of a product during transportation, placing, as well as in the placed/built-in condition.

The demonstrative placing is supervised by the engineer and the authorized independent institution. The costs of the demonstrative placing shall be born by the contractor.

In case that the required quality has been achieved by the demonstrative placing, the engineer approves the works to be carried on.

2.1.6.2.4 Current Investigations

The contractor shall perform all the tests within the internal control to verify the quality of materials, technology, and executed works.

The extent of tests is determined by the special technical conditions. In case that the supervisor of testing within internal control finds out great deviations from the results of the previous testing, they may extend the minimum frequency (according to the programme) of tests, and in case of uniformed results as suggested by the contractor also reduces.

The results of the internal control shall be adequately documented by the contractor and the supervisor and the authorised institution for the external control shall regularly be informed.

Measuring points and points for the sample collection for testing shall be defined by the supervisor according to the statistical random choice as a rule.

In case that the contractor establishes deviations of quality from that required in the project documentation and special technical conditions, the contractor shall immediately notify the supervisor and take measures accordingly. The necessary measures may also be defined by the supervisor.

In case that the supervisor of testing within current investigation finds out great deviations of results from the statements in the pieces of evidence or from the previous production process testing, they may additionally extend the minimum extent of the tests. In case of uniformed results the extent of the tests may be reduced.

All the costs associated with the internal control shall be born by the contractor.

2.1.6.2.5 Random Tests

By means of external control the supervision over the internal control and established the accordance of the produced and in-built material.

The programme (type and extent) of the tests for the external control shall be defined by the supervisor if not defined in the special conditions.

Sample collection as well as field tests and measurements within the external control shall be performed in presence of the contractor and supervisor.

The results of the external control, including the report on the regular review of the internal control, shall be defined in the written report of the institution, are a basis for the takeover and statement of the in-built material. The report shall be sent to the client and supervisor on time before the technical inspection of the executed works.

All the costs associated with the external control shall be born by the client.

If the contractor considers that the result of the external control is not representative of the whole executed works, they may demand additional testing on the places, commonly defined by the contractor and the supervisor. For the takeover are decisive the results of both testing (initial and additional). All the costs associated with the additional testing shall be born by the contractor.

In case that with the ascertained result of the additional testing the contractor and the authority do not reach an agreement, an expert testing by the unanimously chosen independent laboratory shall be performed. All the costs associated with the expert testing shall be born by the one, whose results deviate more from the ascertained results.

2.1.6.2.6 Other Testing

The costs of investigations/examinations and preparation of repair proposals, which will be necessary in connection with unforeseen field conditions, shall be born by the client.

All the costs of investigations, repair proposals, and eventual supplements, which will be required due to technological deficiencies brought about by the contractor, and/or due to non-fulfilment of requirements of the technical conditions by the contractor, shall be born by the latter.

2.1.6.3 Laboratory

The contractor shall, according to these technical conditions, organize a laboratory, which must fulfil all the needs of current investigations prescribed by these technical conditions for individual works.

The contractor is obliged to enable the engineer/supervising body to use the laboratory including auxiliary personnel and all the material for the needs of field control investigations to be performed by the engineer/supervising body. All the costs in this connection shall be born by the contractor.

The laboratory shall be situated in adequate rooms and shall be properly equipped. In addition, a sufficient number of professional and auxiliary personnel shall be permanently employed at the laboratory. In the spirit of these technical conditions the contractor shall, prior to commencement of the works, submit to the client for approval a complete laboratory organization including a list of both equipment and personnel.

Equipment to be used at the contractor's laboratory shall be inspected and certified.

2.1.6.4 Bases for Statistical Evaluation

2.1.6.4.1 General

Bases for statistical evaluation of the quality of the works performed as required in the Special Technical Conditions are as a rule:

- average values (and standard deviations)
- limit values and
- absolute limit values

The avarage limit value($\overline{X}$) means the arithmetical mean values calculated by the formula

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

whereby *n* means the number of results.

Limit value (x_m) means the demanded upper value (x_{mz}) and/or lower value of the quality (x_{ms}), conditioned for ensuring expected characteristics. If the quality of works is achieved in the demanded margins it means then their full financial value.

Absolute limit value (x_{sm}) means the value in which the quality of work without financial value is achieved.

Statistical random selection ensures that any material, product, or place of measurement has an equal chance of being selected.

2.1.6.4.2 Evaluation provisions

For evaluating the results of tests within the internal and external control, the following general provisions are in effect.

2.1.6.4.2.1 Average value $\overline{X}$

Average quality value is as a rule conditioned.

2.1.6.4.2.2 Limit value X_m

Limit (demanded) value is as a rule conditioned, but it can be also defined by the formula:

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

whereby:

a – means deviation of the limit value from the average value

Limit value can be but also defined as a specific numerical value.

If individual results, in a positive sense, exceed the extreme upper limit value(x_{smz}), they may be as a rule considered in the statistical evaluation of the quality of the works performed only up to a

determined percentage above the demanded value. If however the individual results do not reach the defined extreme lower limit value(x_{ssm}),they have to be excluded before the statistical evaluation.

If the originally performed work of poor quality is improved by additional measures in such a way that the obtained value corresponds to the specific demands for quality, then this result must be considered in the evaluation and the original (negative) result must be eliminated.

V posebnih primerih je za preveritev kakovosti izvršenih del mogoče upoštevati kot mejno vrednost 1,96 s, ki vključuje 95 % rezultatov.

In special cases, in the quality control of the works performed, the value of 1.96, which includes 95% of the results, may be considered as the limit value.

2.1.6.4.2.3 Absolute limit value

The absolute limit value is as a rule conditioned or defined by deviations from the mean value or limit value with the formula:

$$X_{sm} = \overline{X} \pm b \qquad \text{ali} \qquad X_{sm} = \overline{X} \pm c$$

whereby:

b – means deviation of the absolute limit value from the average value

c – means deviation of the absolute limit value from the limit value.

The absolute limit value can be in special cases, defined by the value 3s which includes approximately 99.8% of the results.

2.1.6.5 Bases for Financial Evaluation of Quality

Quality requirements related to individual characteristics of implemented works are presented in special technical conditions.

In the event of poor quality of implemented works the client can claim financial deduction.

The scope of works with quality between the limit value and the absolute limit value has to be determined in financial terms using the following equation:

$$FO = k \cdot C \cdot PD$$

where:

FO - financial deduction

k - ratio of the impact of poor quality of implemented works on serviceability, which is determined in technical conditions for individual works

C - the price per unit of implemented work (SIT/m^2)

PD - the scope of poorly implemented work (m^2)

Financial deductions for individual deficiencies are summed up to 100% price per unit of work.

If the price per unit of work is exceeded (due to deductions being summed up), the relevant measures are set by the supervisor.

The scope of works bearing results above or below the absolute limit value has no financial value. The contractor will not be paid for works of such quality and has to improve works implemented in such manner at its own expense according to the supervisor's instructions.

2.1.7 MEASUREMENT, TAKING OVER, AND FINAL SETTLING OF ACCOUNT OF WORKS

2.1.7.1 Measurement of Works

2.1.7.1.1 General

The quantities of individual works shall be measured on the basis of unit quantities specified by the design, tender/contract bill of quantities, and in compliance with these technical conditions.

If not specified otherwise by these technical conditions, the quantities shall be determined of actually performed works and materials placed/built-in within the scope of the design for individual works. In case that the designer requires an alteration of the type or quantity of the works subsequently, he is obliged to submit an adequate supplemental of the design including the bill of quantities. All the quantities are determined to maximum two decimal places, unless the engineer and the contractor make a different agreement.

For all the works, for which it is not possible, for whatever reason, to establish the quantities or quality subsequently without special costs, the contractor is obliged, in due time, to request the engineer to carry out a provisional taking over, which shall be documented in writing and by drawings, as well as entered in the construction record book. Both measurement and taking over of such a quantity is ultimate and shall only be approved upon final taking over. In such cases, the works must not be carried on prior to provisional taking over and measurement. Where, in such a case, the contractor gives up the provisional taking over, he shall bear all the consequences that might occur due to subsequent works to establish actual quantities and quality of the executed works, i.e. all the costs of a subsequent removal of all the overlays, and, after control is carried out, all the costs of the required replacement with suitable materials, as well as the costs of placing these materials properly.

The works to be accounted according to delivered and placed/built-in quantities, shall be simultaneously documented by forms of delivery, and clearly identified.

2.1.7.1.2 Ledger of Quantitative Measurements

The quantities and measurements of executed works shall be entered in the ledger of quantitative measurements. All the measures shall be recorded, and the sketches drawn for all such works, which remain hidden after completion, as well as for those works, which deviate from the investment-technical documents.

The contractor is obliged to indicate all the modifications, occurred during construction, in appropriate drawings. Such drawings shall become constituent parts of the ledger of quantitative measurements.

The contractor shall submit the signed ledger of quantitative measurements to the engineer for approval once a month, as a rule prior to preparation of interim monthly progress statements.

The ledger of quantitative measurements shall be managed currently. When the data in the ledger are not mutually confirmed, they cannot be a base for an interim (monthly) account (progress statement) . If some unconfirmed data are included in the provisional/interim account, the engineer is entitled to eliminate such amounts from the provisional account.

The engineer has the right not to approve those quantities and works, for which he can prove that they have not been carried out adequately and that they do not comply with the contractual provisions, current regulations, and standards. In addition, the engineer is entitled not to confirm those quantities and works, for which the contractor has failed to enable the engineer to inspect the working procedure, to review the documents related to the material delivered, or when the contractor has performed certain working operations without engineer's permission, thus jeopardizing technical perfection and safety of the structure.

The contractor is obliged to submit to the engineer all the information he might require to check the ledger of quantitative measurements; moreover, the contractor shall also provide all the required professional manpower and equipment at engineer's disposal free of charge.

The ledger of quantitative measurements shall comprise all the information needed to establish the quantities, i.e. the quantities according to the design, measurements (or estimations) of the works performed, monthly and total quantities, and the final quantity for the individual item in the tender or contract bill of quantities.

2.1.7.2 Taking Over of Works

2.1.7.2.1 General

Under the term "taking over of works" both quantitative and qualitative acceptance of individual contractual works is understood. In view of the construction stage the following three types of taking over shall be distinguished:

- interim/provisional taking over (for a provisional/interim settling of account),
- final taking over
- ultimate taking over

2.1.7.2.2 Provisional/Interim Taking Over of Works

During construction the engineer provisionally takes over the works carried-out. On this occasion, he establishes the quantities of individual works executed, using unit quantities from the contractual bill of quantities, and, as a rule, the quality of the works in compliance with the technical conditions. Such provisional taking over is only a base for preparation of provisional/interim progress statements, and for the confirmation of periodical interim accounts, on the basis of which the client can pay the executed works.

Additional/extra works, i.e. the works, which exceed the quantity foreseen by the tender, can only be carried out by the engineer's precedent written consent. In case that a particular additional work is a consequence of a design modification, or it can cause some design modification, consent by the designer shall be acquired as well.

Moreover, any work that had not been foreseen by the design nor it had been included in the tender, but has occurred e.g. due to some modification of the working method, shall be considered as an additional work, and must not be started until written consent by both engineer and designer is acquired.

In case of a disputable quantity and/or quality, the engineer is not obliged to acknowledge it upon provisional taking over, until the actual state in the spirit of the contractual provisions is determined by an adequate commission.

All the works taken-over provisionally shall be entered in the ledger of quantitative measurements, and shall be suitably documented. Once a month, the contractor shall prepare and submit to the engineer the required documents. The engineer is obliged to approve or reject the entries within seven (7) days.

For all the works that have been taken-over provisionally, the definitive quantity and quality are established upon final taking over of the works; the quality is partly established even upon ultimate taking over, i.e. at expiry of the guarantee/liability period.

2.1.7.2.3 Final Taking Over of Works

A project/structure shall be finally taken over after completion of works taking account of the contractual provisions.

The basis for final taking over is the final account of the works submitted by the contractor in compliance with items 3.1.6.2.2 above and 3.1.6.3 below, on condition that an agreement between the engineer and the contractor has been made with regard to the quantities and quality of the works executed. On the contrary, the contractor has the right to submit to the taking over commission his final account including all the required documents; the commission is obliged to study those documents and to take adequate steps in compliance with the findings.

Upon final taking over of the works where the quality of the executed works is evaluated as well, the client is entitled to out into effect financial deductions for the works, the quality of which has been established as insufficient.

A final taking over can be considered as the ultimate one in view of quantities and prices as well as deductions and bonuses; however, it does not comprise any guarantees and damage repairs in the liability period.

The contractor has the right to propose an extension of the liability period instead of individual or all deductions. The client is entitled to consider such a proposal in accordance with the habitual professional practice in view of the required durability for an individual work, as well as of the deficiencies established.

2.1.7.2.4 Ultimate Taking Over of Works

An ultimate taking over of the work quality shall be carried through upon expiry of the liability/guarantee period; an appropriate commission shall be engaged to perform the ultimate taking over in compliance with the contractual provisions.

In the liability period the contractor is obliged to implement all the contractual obligations.

After the contractor makes good all the deficiencies having been established by the commission at the ultimate taking over, i.e. upon expiry of the liability period, he has no further obligations to the client in view of both quantity and quality of the works carried out.

2.1.7.3 Final Settling of Account of Works

2.1.7.3.1 General

The contractor shall prepare an account of quantities of executed works. Each individual measurement as well as the planned and actually executed quality shall be indicated for each contractual item.

The contractual works shall be accounted on the basis of interim progress statements and final statement in compliance with the contractual provisions. The basis to settle account of the works is contractual unit prices of individual works, and quantities of the works determined in accordance with 2.1.6.2. However, a financial evaluation of both quality and quantity of the performed works (refer to 2.1.5) shall be taken into consideration at final settling of account as well.

2.1.7.3.2 Unit Prices

Unit prices indicated in the tender/contract documents for individual works are in question. When a tender price does not comprise all the costs associated with the planned work, this shall be indicated separately and clearly. Unless provided otherwise by the contract, construction regulations, or these technical conditions, the unit prices shall include all the costs of execution of an individual work, to which the following belongs as well:

- all the services indicated by the descriptions in these technical conditions, and by the design details;
- all the costs of searching for sources and permits to use materials required to execute the works;
- all the costs related to required internal and external transportations of material and manpower, as well as the costs of equipment, etc.;
- all material supplies required to perform individual works;
- all the costs related to salaries/wages including taxes and contributions;
- all the additional costs such as travel costs, daily allowances, field work bonuses, separation allowances, accommodation costs, costs of provisions, etc.;
- all the costs related to site and work organization, contractor's site and direction costs including taxes, different reimbursements for building plots, assembly and dismantling of equipment, devices, and machines including transportation to and from the site, construction of housing for labour, construction of offices and storehouses, communication installations including all the work and material (power and water supply, lighting, and similar), as well as all other services that might be indispensable to an undisturbed work;
- all the costs associated with the use, maintenance, and arrangement of access roads on public areas, as well as displacement of public traffic areas until the works are taken over;
- all the costs of a normal drainage of precipitation, ground, and river water during construction;
- all the remaining auxiliary construction works such as scaffolds, formwork, provisional fences, and any other services/works, for which it is not specially indicated in the contractual bill of quantities, that they have to be accounted for separately/additionally;
- all the costs related to indemnification due to damage caused by construction organization, as well as all the costs of restoring used or affected ground, which shall be brought to the original and faultless condition after completion of the works;
- all the costs in connection with depositing topsoil along the road alignment, as well as arrangement of those deposit areas;

- all the costs of acquiring and arranging suitable deposit areas for materials non-applicable materials;
- all the indemnifications paid to third parties/persons for damage, which might occur during construction, and which are not included in the insurance policy;
- all the costs related to rooms and equipment, as well as to field laboratories performing internal control;
- all the costs of acquiring certificates and of the demonstrative/trial technology;
- all the costs of the internal control and of the assistance to the engineer in field testing, including reimbursements for the following:
  - material costs of testing,
  - salaries of employees including all the taxes, contributions, and allowances,
  - required transportations,
  - data processing,
  - preparation of a report of the works carried through;
- all the costs of necessary measurements of the quantities executed, and control measurements;
- all the costs in connection with the monitoring of structural settlements during construction (in accordance with the current technical legislation);
- all the costs related to the execution of test loading of bridges;
- all the costs of working out the as-built drawings;
- all the costs associated with building, equipping, and maintaining the premises for the engineer to an extent specified by the tender/contract documents;
- all the costs related to heating, lighting, and telephony, that the engineer requires for an undisturbed work;
- all the costs arisen from the requirements indicated in the regulations dealing with safety at work;
- all the works indicated in the bill of quantities, which, taking account of the technical conditions for individual contractual works, can be assigned to the particular tender unit price;
- all the remaining costs foreseen by the tender documents, and are necessary to execute individual works, thus the contractor is not entitled to claim for an additional payment.

In case that some material or product (such as kerb, traffic sign, etc.), which has to be displaced, is property of the client, the unit price shall allow for removal, displacement, and repeated placing.

2.1.7.3.3 Increased Quantities and Additional Works

The basis to settle the account for additional works is unit prices for individual works in compliance with the contract, and the established or approved quantities of the works actually executed.

Any additional work out of the tender/contract shall be balanced on the basis of contractual provisions. When the contract does not include such provisions, the additional work shall be accounted on the basis of unit prices to be agreed preliminarily. In such a case, the engineer is entitled to request the contractor to submit a detailed price calculation, which shall be in compliance with the price list of the calculation bases. When this is not feasible, realistic/current material prices and salaries/wages, including all the taxes and allowances, shall be taken into consideration. In disputable cases, the subject shall be settled on the basis of contractual provisions.

2.1.7.3.4 Interim Penalties

The client is entitled to bring into force an interim penalty for all the works, which have not been carried out due to unjustified reasons, in spite of the fact that they had been foreseen by the work programme approved by the client.

An interim penalty that had been put into force by the client (to an extent as provided by the contract), can be refunded to the contractor, on condition that the latter has carried out all the works within the contractual deadline, and that the interim delays have imposed no additional costs to the client.

For the works, which have not been carried out within the contractual time schedule, the contractor has no right to claim for positive price differences.

2.1.7.3.5 Modified Circumstances

The following can influence settling of account in compliance with the contract:

- Increase or decrease of the scope of works, and
- shortening or extending the deadline to complete the contractual works, if this is out of the contractor's competence.

Price increases or decreases shall be balanced in accordance with the methodology defined by the contract.

2.1.7.3.6 Calculation of Poorly Performed Work

All expenses arising from the improvement of poorly implemented work are borne by the contractor, including all costs of measurements and tests, which revealed inadequate quality of implemented works and resulted in additional measurements and tests aimed at determining the quality of work after suitable repair.

The contractor will not be entitled to any payment for works that do not meet the quality conditions (exceed the limit or absolute limit values) defined in these technical conditions and which the contractor failed to improve according to the supervisor's instructions. In such case the client is entitled to extend the warranty period to at least 5 years for all works that depend on those works which have not been improved.

If the contractor fails to suitably improve the works by the deadline set by the supervisor, the client may hire another contractor for repair and require that the initial contractor covers further and/or additional costs.

2.1.8 MEASUREMENTS OF EVENNESS

2.1.8.1 Subject of Technical Guideline

The present Technical Guidelines for Public Roads, Special Technical Conditions, Measurements of Evenness provide technical bases for measurements and evaluation of pavement surface evenness.

The intention of measuring the pavement surface evenness is to define the safety of traffic running on these surfaces, as well as to determine the influence on the pavement durability, and the travel comfort.

Measurements of evenness in the road construction are required

- to establish conformity of executed works on new pavement surfaces, and
- to monitor the condition of existing pavement surfaces within the scope of the road management.

The executed works meet the requirements when the design vertical and horizontal limitations on the pavement surface are ensured.

By monitoring the condition of existing pavement surfaces the following characteristic forms of unevenness shall be established:

- elevation: crest, embossment, shoving, fold
- deepening: depression, pit, groove, joint
- combination of elevations and deepening: waves, washboard, convexity, concavity
- other forms: step, bend.

For evaluation of unevenness on a pavement surface their impact on vehicles or passengers is relevant. Not only the form and the size of unevenness (height, depth, length), but also their sequence (number and distribution), and orientation (with regard to the road axis) are essential.

2.1.8.2 Basic Methods of Measurements

Basic methods of pavement evenness measurements are the following:

- transversally to the road axis direction,
- longitudinally, i.e. in the road axis direction, and
- in any direction with regard to the road axis.

The pavement surface evenness shall be checked on the basis of

- deviation below a straight edge, or
- survey of actual condition.

For each individual measuring method, suitable equipment is available.

By measuring the evenness transversally and in any direction with regard to the road axis the following shall be assessed:

- differences in fictitious connecting (reference) line between two points on the pavement surface at a selected distance (generally 4 m), and pavement surface (generally in wheel passes, i.e. rut depth),
- heights of crests and depths of grooves, and
- water hold-up depth in ruts.

The following methods are used for these measurements:

- method with straight edge and measuring wedge, and
- method with profilograph.

In certain conditions levelling method can be adopted as well.

By longitudinal measuring, i.e. in the road axis direction, the following shall be assessed:

- actual longitudinal profile of the surface, and
- excessive differences between design and actual surface levels, including their length.

Moreover, the evenness-index shall be evaluated by the measuring in the longitudinal direction.

The following methods are used for these measurements:

- method with straight edge and measuring wedge,
- method using profilograph and levelling the stands, and

- method with profilometer.

2.1.8.2.1 Measuring Equipment

The equipment for measuring both transverse and longitudinal evenness shall ensure, either graphically or digitally, an accuracy of the vertical record of ≤ 1mm, and the horizontal locations of unevenness.

All the equipment to measure evenness shall be suitably calibrated and certified.

2.1.8.2.1.1 Equipment to Measure Transverse Evenness

2.1.8.2.1.1.1 Straight Edge With Measuring Wedge

A straight edge to measure evenness shall be 4 m long. For measuring the water hold-up depth in ruts, the straight edge should be shorter, i.e. approx. 2 m long, and equipped with a spirit level.

The straight edge shall be made of sound wood, light metal, or plastic. As a rule, it shall be of a rectangular cross-section measuring at least 25 mm in width. The straight edge cross-section shall ensure a suitable moment of resistance. The centre of the straight edge shall be adequately marked.

The measuring wedge shall be made of metal. It shall be up to 300 mm long, and 25 – 35 mm wide. The inclination of the measuring plane shall amount to 10 – 15°. The measuring plane shall be marked with a height (depth) scale in mm.

The measuring edge and the wedge measuring plane shall at no place deviate from the calibrated plane by more than ± 0.5 mm.

3.2.8.1.1.1.1 Profilograph

A profilograph is composed of two basic components:

- a straight edge with two stands, and
- equipment for graphical recording.

The straight edge shall be made of sound wood or light metal. The surface of the straight edge shall be perfectly even to allow a proper positioning of the equipment for graphical recording (reference plane). The straight edge shall be so finished as to enable an undisturbed directing of the equipment for graphical recording.

Both metal stands adjusted to fix the straight edge shall ensure a constant height of the straight edge surface onto which the equipment for graphical recording is placed. The stands can be either equipped with wheels or arranged for a fixed placing.

The mobile equipment for graphical recording consists of the following:

- a sliding sensor for pavement surface (generally a measuring wheel) fixed to a movable handle with a writer, and
- a cylinder to record the profile.

The equipment for graphical recording shall ensure a true survey of the actual profile (at suitable scale).

The graphical record of a measured section (profilogram) shall be at scale of 1 : 1 in height, and at suitable scale in length to determine the unevenness accurately.

A profilograph shall ensure accuracy of the graphical record of ± 1 mm in height, and ± 5 mm in length.

3.2.8.1.1.2 Equipment to Measure Longitudinal Evenness

There are numerous types of up-to-date equipment to measure longitudinal evenness, i.e. of profilometers. Only such equipment is acceptable, which fulfils the following requirements:

- suitability to measurements in the traffic flow (e.g. for vehicle speed between 40 and 120 km/h)
- a digital recording
- recording of short, medium, and long waves (e.g. of 0.8 to 30 m in length)
- sampling interval up to 10 cm
- accuracy of distance measurements up to ± 0.3 %.

To a smaller extent, the longitudinal evenness of a pavement surface can also be measured using equipment for measuring the transverse evenness, i.e. a straight edge with a measuring wedge and profilograph.

The characteristics of the profilometer, which meets the aforementioned requirements, are as follows:

- measurements are based on a constancy reference
- a vertical acceleration measuring device is placed on the spring mass of standard motorcar
- the vertical distance to the pavement surface is measured with a contact-free device to measure the angle of the swinging arm of the vehicle (measuring) wheel.

The difference between the analogically calculated double integral of the accelerations and the wheel movement provides an electric signal of a filtered longitudinal profile as a function of the distance in the frequency range of 0.4 to 12 Hz, which represents the length waves (unevenness) of 0.8 to 30 m in the measuring speed range.

On a special panel the driver can observe the passed distance (in metres), and the driving speed (in km/h). To mark the characteristic point on or at the road, three different signals are available, which can be recorded, together with the time for the speed control, on a notebook.

2.1.8.2.2 Execution of Measurements

Prior to commencement of measuring the evenness, the pavement surface shall be perfectly cleaned of all foreign matter.

Each measurement of evenness shall be documented by the following information:

- place of measurement: road number, kilometre marking, traffic lane, layer type
- date of measurement
- used measuring equipment: type, characteristics
- measuring method: transversally, longitudinally, in any direction
- measuring results: evenness maximum deviations.

2.1.8.2.2.1 Measurements of Transverse Evenness

Measurements of the pavement surface transverse evenness shall be carried out

- on a new pavement surface: at joints and edges of executed lanes;
- on an existing pavement surface: in such a way that particularly deviation in both wheel passes is determined.

The latter shall be assessed in view of the following:

- deviation from design cross-section, and
- water hold-up depth in ruts.

On newly constructed pavement surfaces the evenness measurements shall be carried out prior to giving admission to the traffic.

2.1.8.2.2.1.1 Measurement With Straight Edge

2.1.8.2.2.1.1.1 Method

A straight edge shall be so placed onto the selected place as to ensure its perfect resting in at least two points.

In case of some deviation from the design or existing cross-section, the contact points shall be one on each side of the straight edge (Figs. 1 and 2), as to enable reading the h value.

Fig. 1: Placing straight edge to assess deviation of individual unevenness h on pavement surface

Fig. 2: Placing straight edge to assess deviation of individual unevenness h on pavement surface

When the water hold-up depth in ruts is measured, a horizontally placed straight edge shall rest on the surface at one end, whereas the second resting point shall be located on the other half of the straight edge (Fig. 3), as to enable reading the h value.

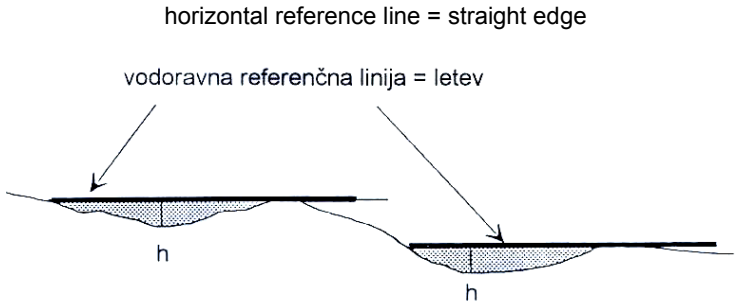


Fig. 3: Placing (shorter) straight edge to assess water hold-up depth in ruts

In case of measuring the crest height, the straight edge shall fit the surface in the middle and in the lower half of the straight edge (measured deviation = twice the crest height, Fig. 4).

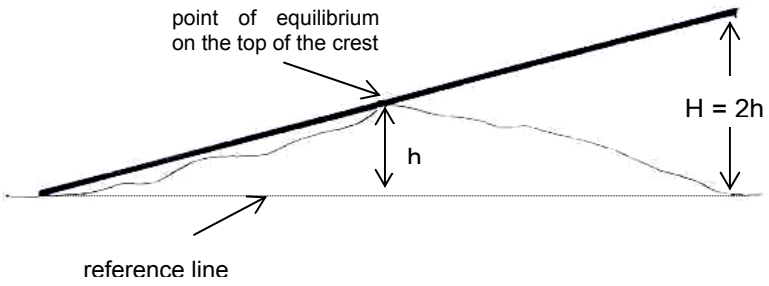


Fig. 4: Placing straight edge to assess crest height h

When settlement of a pavement surface edge is measured, the raised end of the straight edge shall be levelled with the pavement edge.

By inserting a measuring wedge below the straight edge between two adjacent points of resting, or at the end of the straight edge, the maximum deviation of the measuring edge from the measured surface shall be established.

2.1.8.2.2.1.1.2 Evaluation of Results

The measured values of deviation of pavement surface evenness shall be indicated for each individual traffic lane separately, per unit of length, and rounded up to mm.

Bases for accounting shall be determined by taking account the design limiting values of evenness deviation, and the measured values.

2.1.8.2.2.1.2 Measurement With Profilograph

2.1.8.2.2.1.2.1 Method

In dependence on the type of stands, the straight edge of a profilograph is placed on the spot of cross-section measurement, horizontally or vertically to the pavement surface reference plane.

The equipment for graphical recording of the pavement surface cross-section shall be placed onto the straight edge surface, which is arranged for an adequate directing of the equipment, generally to the end of the line.

During a slow moving of the equipment on the straight edge, all major deviations of evenness registered by the measuring wheel (sliding sensor) are directly transferred to the recording cylinder via mobile arm and writer.

2.1.8.2.2.1.2.2 Evaluation of Results

A graphical record of measured pavement surface cross-section enables a direct assessment of all the chracteristic deviations of evenness for each individual traffic lane separately, and per unit of length. On these bases the account of the performed works can be carried out.

An eventually required horizontal reference plane to assess the cross-fall of the pavement surface within the measured cross-section shall be provided by levelling the stands.

2.1.8.2.2.2 Measurements of Longitudinal Evenness

2.1.8.2.2.2.1 Measurement With Straight Edge

The measuring conditions and procedure, as well as the evaluation of measurement results for the pavement surface longitudinal evenness measured with a straight edge and measuring wedge are similar to those indicated in section 3.2.8.1.4.1.

The extent of such measurements of evenness is limited to shorter sections (up to 20 m), generally determined on the basis of assessment of pavement surface condition carried out by a preliminary travel with a vehicle.

During measurements the straight edge shall be so placed as to ensure an overlapping of a half of the length. The maximum deviation of evenness shall be determined (as relevant for assessment) every time on both halves of the straight edge. Only results established with a measuring wedge between two points of resting of the straight edge shall be considered.

2.1.8.2.2.2.2 Measurement With Profilograph

The procedure of measuring pavement surface longitudinal evenness with a profilograph is the same as described in section 3.2.8.1.4.1.2.1.

On the graphical record of the measured pavement surface longitudinal evenness such deviations shall be assessed separately by means of an adequate software, which exceed both limiting and threshold values. In addition, corresponding lengths of those deviations shall be determined as well.

2.1.8.2.2.2.3 Measurement With Profilometer

The fundamental condition to achieve reliable results of measurements carried through with a profilometer is calibration of both measuring device of profile, and measuring device of passed distance. The passed distance shall be suitably verified.

2.1.8.2.2.2.3.1 Method

The method of measuring the longitudinal evenness with a profilometer shall be controlled by means of adequate software. The following activities shall be carried out:

- setting the computer into condition of readiness to load the data;
- ensuring the required speed during performing measurements; the speed depends on road properties;
- ensuring the position of the measuring vehicle in the middle of the traffic lane;
- turning on (at the beginning), and turning off (at the end of the measured section) of loading the measurement data.

2.1.8.2.2.2.3.2 Evaluation of Results

The following results shall be provided by measuring longitudinal evenness on a certain road section with a profilometer:

- number of individual deviations of evenness, and their number within the range between the limiting and the threshold value,
- number of individual deviations of evenness, and their length in the range above the threshold value,
- values of IRI index for a certain length, or per unit of length, as well as an average value for the section under consideration.

The required result of evaluation of longitudinal evenness measurement within the scope of establishing the conformity of the executed works is an appropriate financial evaluation.

The record of measurement results shall be saved in a file.

The calculation of the IRI index (International Roughness Index) shall be carried out according to the World Bank algorithm, derived for the movement of a model of a quarter of a vehicle over the

measured pavement surface. The IRI index value shall be evaluated as an average value of all the falls of the longitudinal section in the individual points *n*, using the equation below:

$$IRI = \frac{1}{n-1}\sum_{i=2}^{n} RS_i$$

The IRI index values shall be evaluated for individual road sub-sections measuring 50 m in length, and for the entire road section considered.

2.1.8.2.3 Criteria for Assessment of Actual Condition

2.1.8.2.3.1 Evenness Deviations on New Pavements

To define the evenness of surfaces of bound layers of new pavements, informative limiting values have been specified. Unless different limiting values are specified in the technical specification or contractual documents, values indicated in Table 1 shall be considered for the evenness assessment.

2.1.8.2.3.2 IRI Index on New Pavements

Informative limiting values of the IRI index are specified in Tables 2, 3, and 4 in view of the traffic density (AADT), and traffic loading (equivalent standard axle load of 82 kN).

2.1.8.2.3.3 Evenness Deviations on Existing Roads

To define a serviceability level of existing pavement surfaces with regard to the evenness, the following shall be specified:

- homogeneous sections, if measurements are performed continuously, or
- at least one (1) measuring place per each 100 m[1] of carriageway, if measurements are carried out with a straight edge; for the evaluation, the average value of the highest read values (at the individual measuring place) on a homogeneous section of at least 300 m of length is relevant.

Informative limiting values of evenness to evaluate pavement serviceability on existing roads with regard to the magnitude of unevenness h are indicated in Table 5.

Table 1: Informative limiting values of unevenness h_m and h_{sm} for surfaces of new pavement bound courses

Type of pavement course	Unit	Unevenness magnitude	
		limiting – h_m	threshold – h_{sm}
- base course	mm	15	20
- upper roadbase	mm	10	15
- bound wearing-bearing	mm	10	15
- bound wearing-sealing - bound wearing - bound sealing	mm	4[1] / 6[2] / 8[3]	6[1] / 8[2] / 10[3]

Legend:

[1] – on motorways, and expressways

[2] – on main roads, and first order regional roads

[3] – on remaining regional roads, and local roads

2.1.8.2.3.4 IRI Index on Existing Roads

To define the serviceability level of existing pavement surfaces with regard to the IRI index value, homogeneous sections shall be determined, on which the average value of unevenness at a length of 300 m is greater than the limiting value h_m indicated in Table 1.

Informative limiting values to assess the pavement surface serviceability on existing roads with regard to the IRI_{100} index are stated in Table 6.

2.1.8.2.3.5 Water Hold-Up Depth

Limiting values of water hold-up depths in ruts on a pavement surface are indicated in Table 7.

Table 2: Informative limiting values of longitudinal evenness index IRI_{20m} and IRI_{20sm} on newly constructed roads – assessment of individual unevenness

Traffic classification	IRI index value	
	limiting IRI_{20m}	threshold IRI_{20sm}
- medium or greater density (AADT > 2,000 vehicles), and medium or heavy traffic loading (> 80 equivalent standard axle loads of 82 kN/day)	2.0	2.6
- low density (AADT up to 2,000 vehicles), and lighter traffic loading (up to 80 equivalent standard axle loads of 82 kN/day)	4.0	4.6

Table 3: Informative limiting values of longitudinal evenness index IRI_{100m} and IRI_{100sm} on newly constructed roads

Traffic classification	IRI index value	
	limiting IRI_{100m}	threshold IRI_{100sm}
- medium or greater density (AADT > 2,000 vehicles), and medium or heavy traffic loading (> 80 equivalent standard axle loads of 82 kN/day)	1.2	1.8
- low density (AADT up to 2,000 vehicles), and lighter traffic loading (up to 80 equivalent standard axle loads of 82 kN/day)	3.8	4.6

Table 4: Informative limiting values of longitudinal evenness index IRI_{100} in IRI_{100sm} after expiry of liability period of 5 years

Traffic classification	IRI index value	
	limiting IRI_{20m}	threshold IRI_{20sm}
- medium or greater density (AADT > 2,000 vehicles), and medium or heavy traffic loading (> 80 equivalent standard axle loads of 82 kN/day)	1.8	2.5
- low density (AADT up to 2,000 vehicles), and lighter traffic loading (up to 80 equivalent standard axle loads of 82 kN/day)	4.5	4.6

Table 5: Informative limiting evenness for assessment of pavement surface serviceability on existing roads with regard to the evenness magnitude h

Traffic classification	Condition assessment				
	very good	good	fair	bad	very bad
	Evenness magnitude h (mm)				
- medium or greater density (AADT > 2,000 vehicles), and medium or heavy traffic loading (> 80 equivalent standard axle loads of 82 kN/day)	< 6	6 to 10	10 to 14	14 to 18	> 18

- low density (AADT up to 2,000 vehicles), and lighter traffic loading (up to 80 equivalent standard axle loads of 82 kN/day)	< 8	8 to 12	12 to 16	16 to 20	> 20

Table 6: Informative limiting values of longitudinal evenness index IRI_{100} for assessment of pavement surface serviceability on existing roads

Traffic classification	Condition assessment				
	very good	good	fair	bad	very bad
	Value of IRI_{100} index				
- medium or greater density (AADT > 2,000 vehicles), and medium or heavy traffic loading (> 80 equivalent standard axle loads of 82 kN/day)	< 1.2	1.2 to 1.5	1.5 to 2.2	2.2 to 3.1	> 3.1
- low density (AADT up to 2,000 vehicles), and lighter traffic loading (up to 80 equivalent standard axle loads of 82 kN/day)	< 2.6	2.6 to 3.5	3.5 to 4.3	4.3 to 4.9	> 4.9

2.1.8.2.3.6 Calculation of Inferior Quality

To evaluate a deficient evenness of a newly constructed pavement surface or to determine an inferior quality, i.e. financial deductions, it shall be considered that

- the quality up to the limiting value h_m signifies a complete fulfilment of all the requirements, i.e. a full financial value, and
- the quality above the threshold value h_{sm} signifies a condition without any financial value.

The quotient of the effect of deficient quality K shall be calculated from the equation below:

$$K = \frac{h_m}{h_{sm} - h_m}$$

The extent of the condition of measured surface of quality between the limiting value and the threshold value shall be financially evaluated using the equation below:

$$FO = \left(\sum O^2 \times PD\right) \times C$$

where:

FO – financial deduction (in SIT)

O – deviation from limiting value, calculated

from the following equation:

$$O = K \frac{h - h_m}{h_m}$$

h – actual (measured) deviation of evenness

PD – extent of deficiently executed pavement surface on individual traffic lane (m^2)

C – unit price (SIT/m^2)

2.1.9 MEASUREMENTS OF SKID RESISTANCE

2.1.9.1 Subject of Technical Guideline

The technical guideline for public roads, Special technical conditions, Measurements of skid resistance, provides technical bases for evaluation of skid resistance of constructed pavement surfaces.

The intention of measurements of skid resistance is to establish the pavement surface condition, and to specify its impact on the traffic safety.

Measurements of skid resistance of pavement surfaces enable:

- to establish the conformity of the newly constructed pavement surface (wearing course) with the designed one,
- to assess the actual skid resistance of the measured pavement surface,
- to control the influence of the traffic loading on materials placed into the upper part of the wearing course, as well as on the skid resistance of pavement surface.

Adequate measures shall be taken on the basis of the ascertained deviation of the skid resistance of a pavement surface from the standard criteria for ensuring conditions for a safe drive.

2.1.9.1.1 Basic Methods of Measurements

Direct and indirect methods of measuring the skid resistance of pavement surfaces exist.

Indirect methods of measurements allow the determination of the roughness depth (texture) of pavement surfaces. The method where the roughness volume is filled with sand up to the top of the peaks, also called a Sand-Patch-Method, is predominantly adopted, or a more up-to-date measurement method by means of laser is introduced.

Direct methods of measurements are basically classified in the following ones:

- stationary (portable and stable) methods to measure the skid resistance of a limited surface on either in situ pavement or at laboratory; the method using a Skid Resistance Tester (SRT pendulum) is mainly used;
- mobile methods for continuous measurements of the pavement surface skid resistance to oblique, blocked, or slipping testing wheel; the method using obliquely led testing wheel and a device called Sideway Force Coefficient Routine Investigation Machine – Texture (SCRIMTEX device) is predominantly used.

For determination of the skid resistance of a pavement surface such measuring devices shall be used, which standardized characteristics are known, and the measurement shall be carried out in compliance with appropriate instructions.

To evaluate the skid resistance of a pavement structure, results of direct and indirect measurements of the actual condition are required as a rule.

2.1.9.1.2 Devices and Accessories to Perform Measurements

The devices to measure pavement surface skid resistance shall ensure:

- the accuracy of recording the skid resistance (in graphical and/or digital record),
- repeatability, and
- durability of record.

The measuring device shall generally be calibrated as specified by the producer. A valid certificate of the calibrated device is mandatory.

The accessories to measure the roughness depth shall ensure repeatability and shall be suitably calibrated.

2.1.9.1.2.1 SRT Pendulum

An SRT pendulum is composed of the following assemblies and components (Fig. 1):

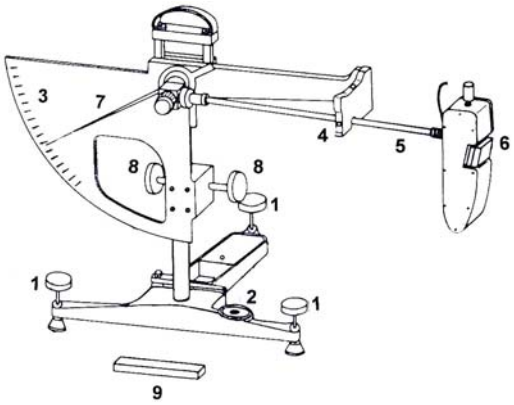


Fig. 1: SRT pendulum

- a framework with
  - fixed bearings for three bolts (1) and spirit level (2) to adjust the horizontality,
  - a plate with measuring scale (in SRT units), and
  - a bracket with a knob (4) to lock and release the swinging arm (5)
  - a swinging arm with a head with flexible measuring rubber (6)
  - a measuring pointer (7)
  - a screw – spiral (8) to adjust the height of the assembly of the swinging arm bearing and the plate with the measuring scale
  - a scale (9) to adjust the skidding length of the measuring rubber.

Preservation of the measuring device in a dry room shall be ensured, unless it is in use for the moment.

The following accessories are required when executing measurements with an SRT pendulum:

- a larger water container
- a plastic water bottle with a squirt
- a soft brush
- a thermometer
- a folding stool.

The SRT pendulum shall ensure an accuracy of perceiving the surface skid resistance within a range of $\pm$ 1 SRT unit.

2.1.9.1.2.2 SCRIMTEX Measuring Device

A SCRIMTEX measuring device (Fig. 2) is composed of the following basic components:

(smer vožnje = direction of driving; stranska sila = sideway force)

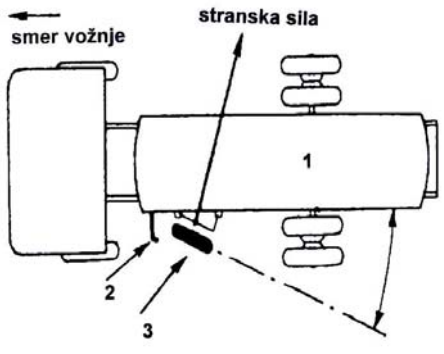


Fig. 2: SCRIMTEX measuring device

- a water tank lorry (1)
- a system for a controlled bringing water in front of the measuring wheel (2)

- a computer with electronic equipment to control the measurement of skid resistance, of roughness depth (texture), and to record the results automatically
- a system of measuring the skid resistance at an angle of 20° between the vehicle axis and the measuring (fifth) wheel (3)
- a system of measuring the roughness depth (profile) of the pavement surface with laser.

A thermometer is required as an accessory when performing measurements with the SCRIMTEX device.

2.1.9.1.2.3 Accessories For Measuring Roughness Depth According to Sand-Patch-Method

The accessories to measure the roughness depth of pavement surfaces according to the Sand-Patch- Method are:

- a cylindrical container of defined volume,
- fine-graded or medium-graded natural sand (of granulometric composition 0.125/0.25 mm or 0.25/0.50 mm),
- a rubber ruler to spread the sand,
- a gauge to determine the diameter of the circular surface of the spread sand, and
- a thermometer.

The Sand-Patch-Method to measure the roughness depth shall enable an accuracy of determining the diameter of the circular surface of the spread sand within a range of ± 5 mm.

2.1.9.1.3 Execution of Measurements

The measurements of skid resistance and roughness depth of pavement surfaces can be carried out on roads of up-to-date asphalt wearing course or cement concrete surfacing.

Each measurement of skid resistance and roughness depth of a pavement surface shall be documented by the following data:

- place of measurement: road designation, kilometre marking, traffic lane and location on it, type of course
- date of measurement
- measuring device/accessories used: type, characteristics
- method of measurement
- weather conditions during measurement
- measurement results: for particular place/section of measurement or for a homogenous section
- characteristics of measured section such as curvatures, slopes, junctions, points of access, etc.

Measurements of both skid resistance and roughness depth shall be performed:

- on newly constructed carriageways to an extent, which, in view of the introduced measuring devices, is relevant to a half of the tested section
- on existing carriageways to an extent enabling a definition of the conditions, and preparation of a proposal of necessary measures, however at least on a half of the tested section
- primarily on the outer rut being the most loaded one as a rule
- within a period after completion of the road construction as specified by the engineer, as well as prior to expiry of the liability period.

Prior to commencement of measurements of skid resistance or roughness depth the actual condition of the pavement surface shall be checked, and all foreign material shall be removed from the carriageway.

On newly constructed carriageways spread with chipping or crushed sand there is, as a rule, no need to carry out measurements of skid resistance and roughness depth, as appropriate values are ensured.

Where a bituminous compound containing a polymer binder is placed to the wearing course, sand or chipping produced from silicate rock of eruptive origin or from suitable artificial rock shall be used for spreading. Measurements of skid resistance to assess the friction capacity of such pavement surfaces shall be carried out not earlier than after the first winter as a rule.

On non-strewn newly constructed pavements suitable conditions to measure the skid resistance or to assess the friction capacity of the carriageway surfaces are only achieved, when the bituminous binder or the cement mortar is removed from mineral grains on the carriageway surface (1 to 2 months after admission has been given to the traffic).

On roads with limited driving speed ($V \leq 50$ km/h), satisfactory assessment of the carriageway surface condition is feasible by measurement with a SRT pendulum. Additional measurements of the roughness depth provide useful information.

On roads with greater driving speed ($V \geq 60$ km/h), measurements with a SCRIMTEX device are required to assess the pavement surface condition, i.e. the skid resistance and roughness depth.

To exclude any differences in the assessment of condition, which might result from the changed properties of the carriageway surface due to specific impacts in different seasons, it is recommended to perform measurements of the skid resistance of the carriageway surface three times a year (in spring, summer, and autumn).

The results of measurements of the carriageway surface roughness depth according to the Sand-Patch-Method enable an informative evaluation of suitability of the carriageway to greater driving speeds.

Adequate safety of the working staff and of the traffic participants shall be ensured all the time during the measurements of both skid resistance and roughness depth of the pavement surface.

2.1.9.1.3.1 Measurements With SRT Pendulum

2.1.9.1.3.1.1 Preparation of Device

After certain number of measurements (1,000 – 1,300 measuring places), however at least once a year, an SRT pendulum shall be thoroughly inspected, calibrated, and tested for perfect operation. All flexible components shall be adequately oiled.

In addition to the conditions indicated in section 3.2.8.2.3, the following shall be done prior to the measurement with an SRT pendulum:

- to check the age of the measuring rubber, as the expiry date for such rubbers is three years after production only, provided that they are suitably maintained and stored;
- to verify wearing of the measuring rubber, as such rubbers are only applicable, if the measuring edge is worn 1 to 3 mm; on a new measuring rubber, an adequate measuring edge can be ensured by 5 skids on a dry and 25 skids on a wet pavement surface;
- to oil the felt bearing of the measuring pointer.

2.1.9.1.3.1.2 Method of Measurement

Measuring places shall be so selected as to achieve representative, undamaged, and homogenous surface for the entire carriageway.

An SRT shall be placed onto the selected measuring place in such a manner that the swinging arm with the measuring rubber is orientated in the traffic direction.

Dust and dirt shall be removed from the measuring place by means of a soft brush, and the surface shall be thoroughly rinsed with water. Onto such surface of the measuring place, the measuring device shall be placed. By means of three bolts and a spirit level, the device shall be brought to a perfectly horizontal position, independently of the carriageway surface slope. The measuring device shall be placed sufficiently high to allow the swinging arm head to swing freely. The measuring pointer, which was originally supported by the swinging arm, shall show a value 0 units SRT on the scale. In opposite case, adequate friction in the measuring pointer bearing shall be ensured by suitable screw and repeating the test.

A length within the range between 124.5 mm and 127 mm shall be ensured by means of a gauge for adjusting the measuring rubber skidding length. This can be achieved by vertical shifting the assembly consisting of the swinging arm and the plate with the measuring scale.

After checking the adequacy of adjustment of the measuring pointer, cleaning the measuring place surface, and adjusting the skidding length of the measuring rubber, the surface of the measuring place shall be once more soaked with water (which shall be taken from the plastic bottle equipped with a squirt) to form a continuous water film on the surface.

In the vicinity of the measuring place, small plash of water shall be created, and a thermometer shall be placed into it.

The measurement of the skid resistance of the pavement surface by the SRT pendulum method

shall commence by releasing the lock on the bracket of the measuring device, so that the swinging arm is free to swing. After the measuring rubber skids, the swinging arm shall be manually retained at the extreme point of swinging. The first test at the measuring place is intended to adjust the rubber measuring edge to the carriageway surface, therefore no reading is required. Then 5 measurements at 5 locations spaced at 5–10 m shall be executed on the tested section. Upon each measurement the swinging arm shall be manually held back at the extreme point of swinging until the SRT value can be read on the measuring scale. The required accuracy of reading amounts to ± 1 SRT unit. After each measurement and locking the swinging arm, the place of measurement shall be repeatedly soaked.

When the results of 5 measurements carried out at the same measuring place differ one from another by more than 3 SRT units, the measurements shall be repeated until the difference is less than 2 SRT units for the last three measurements.

Upon completion of measurements, the length of skidding of the measuring rubber shall be rechecked. If this length deviates from the specified one, it shall be readjusted and the measurements repeated.

After the measurements of the pavement surface skid resistance on the complete section are completed, the temperature of moist pavement surface shall be exactly measured. If the temperature is within the range between 10°C and 30°C (only exceptionally between 5°C and 40°C), its influence shall be adequately corrected. Beyond this temperature range the method of measuring the skid resistance by means of an SRT pendulum is inappropriate.

2.1.9.1.3.1.3 Evaluation of Results

The skid resistance of a pavement surface on the specified section, which is measured according to the SRT pendulum method, shall be assessed:

- by evaluating the mean value of five (or last three) readings of SRT units at the measuring place (SRT_{mm}),
- by evaluating the mean value of SRT units at five measuring places on the section under consideration (SRT_{mo}), and
- by determining the correction value k_T in view of the deviation of the measured temperature of wet carriageway surface from the reference temperature 20°C (according to Table 1).

The pavement surface skid resistance on the measured section corrected due to the temperature effect, and expressed in terms of SRT units, shall be assessed by the following equation:

$$SRT_{mok} = SRT_{mo} + k_T$$

2.1.9.1.3.2 Measurements With SCRIMTEX Device

2.1.9.1.3.2.1 Preparation of Substrate

In addition to the general conditions, which apply to the measuring devices and which are mentioned in section 3.2.8.2.3, several calibrations and tests of the assembly of the SCRIMPED measuring device shall be carried out prior to and during measurements as specified by the producer.

The read resistance force, in terms of SN – skid number, shall be checked by static calibration during loading the measuring wheel with horizontal force not earlier than 24 hours before the anticipated measurement.

The dynamic calibration shall be executed at least once a week or after each repair of the device, and always when there is a doubt of correctness of the measuring results. The function of the entire measuring device at driving speed of 50 km/h on a 2 km section shall be verified. Upon repeated measurement the results must not differ one from another by more than 4 SN units.

The calibration of the rubber tyre pressure shall be carried out at least every three months on a section measuring at least 1 km in length. Individual results of a threefold repetition of the test shall be within the range of ± 2 % compared to the mean value.

The following standard conditions shall apply to the measurements carried out by means of the SCRIMTEX device:

- a pneumatic tyre for the measuring wheel: SCRIM 3 x 20, without profile, narrow
- loading of the measuring wheel: 1,960 N ± 0.5 %
- pneumatic tyre pressure in bar (± 0.05 bar) in accordance with Table 2:

Table 1: Correction values due to the temperature effect of wet pavement surface on skid resistance

Temperature of wet pavement surface (°C)	Correction value k_T (SRT unit)
5	-5.0
6	-4.7
7	-4.3
8	-3.9
9	-3.5
10	-3.0
11	-2.7
12	-2.4
13	-2.0
14	-1.7
15	-1.4
16	-1.1
17	-0.8
18	-0.5
19	-0.3
20	0
21	0.2
22	0.5
23	0.8
24	1.0
25	1.2
26	1.4
27	1.6
28	1.8
29	1.9
30	2.0
31	2.1
32	2.3
33	2.4
34	2.5
35	2.6
36	2.7
37	2.8
38	2.8
39	2.9
40	3.0

Table 2: Temperature effect on the measuring wheel rubber tyre pressure

Pressure (bar)	Air temperature (°C)
3.31	5
3.37	10
3.44	15
3.50	20
3.56	25
3.63	30
3.69	35

- rubber tyre wearing: ≤ 3 mm
  - admitted use of rubber tyre: ≤ 400 km
  - water film thickness (design value): 0.5 mm
- water film width: ≥ 80 mm
  - driving speed upon measurement:
  - on motorways, expressways, and main roads: 80 km/h ± 10 km/h
- on regional roads: 60 km/h ± 10 km/h
- on local roads: 40 km/h ± 10 km/h

Prior to the first measurement or after a standstill of more than 15 minutes, the measuring wheel tyre shall be warmed by driving (according to the prescribed measurement procedure) on a 500 m long section

Pavement surface temperature: 5°C to 50°C

On a wet carriageway, where drizzle occurs due to large water amount, skid resistance measurement with the SCRIMTEX device is inappropriate.

To ensure comparability of the measurement results, rubber tyres shall be handled very attentively:

- tyres shall be stored in plastic bags in a dry, cool, and dark room
- during breaks longer than one month, the tyres must not stay on the vehicle, but shall be stored as appropriate
- no tyres older than 2 year shall be used
- prior to the first measurement, new and unused rubber tyres shall drive on a section of at least 2 km, where the skid number SN amounts to 50 minimum, all in compliance with the calibration procedure.

Prior to each use of the measuring device the following shall be done:

- the tyre felloe on the measuring wheel shall be visually checked: a tyre is no more serviceable as soon as the first layer separated from the rubber occurs
- mechanical parts of steering mechanism shall be visually checked: slide bearing of the measuring wheel, shock-absorbers on the measuring plate, frame
- water supply installations (valves), power supply installations (adjustment controllers), and air supply installations (filters) shall be inspected
- reference voltages on electronic components shall be set, and the software function shall be verified.

Several times a day it is necessary to check the devices to measure the roughness depth:

- the laser optics, i.e. the transmitter and the receiver, shall be cleaned, when the latter is still turned off
- the laser height shall be adjusted; the height changes with regard to the water amount in the tank lorry
- the measuring room shall be well darkened.

When the pavement surface to be measured is significantly polluted, it shall be rinsed with water (from the tank) prior to the measurement.

On the same pavement surface, in a short time interval, and with a probability of 95 %, the SCRIMTEX measuring device shall enable the following:

- repeatability of results of skid resistance measurements carried out with the same SCRIMTEX device, by the same operator, and by means of the same rubber tyre, in the range of: p = 0.03 SN
- repeatability of results of skid resistance measurements carried out with two different SCRIMTEX devices, by two different operators, and by means of two different rubber tyres, in the range of p = 0.07 SN.

2.1.9.1.3.2.2 Method of Measurement

All the data concerning the measured section and the execution of measurement shall be entered in the computer (the length of sub-sections to determine mean values of readings).

In case that more than 15 minutes have elapsed from the last measurement, it is obligatory, during approaching the measured section (approximately 500 m), to lower the measuring wheel onto the pavement surface in order to ensure proper temperature of the rubber tyre at the beginning of measurements.

At the beginning of the measured section the vehicle shall attain adequate driving speed, which shall, as a rule, be constant on the entire measured section; if this is not feasible within the limits of the admissible tolerances, the measurement shall be repeated.

The following shall be thoroughly checked during measurements:

- the position of the measuring wheel (in the middle of the outer rut),
- water outflow in front of the measuring wheel, and
- measurement results, and

all the peculiarities established during the measurement shall be recorded.

On each tested section, two measurements of the pavement surface skid resistance shall be performed one immediately after another.

Measurements of the pavement surface profile depth by means of the SCRIMTEX measuring device shall be executed in accordance with the producer's detailed instructions. The mean profile depths of the pavement shall be read at every 30 cm and expressed in mm. The software shall ensure the calculation of the standard deviation of the profile depth per specified sub-section length.

2.1.9.1.3.2.3 Evaluation of Results

Within the SCRIMTEX device for skid resistance measurements, suitable hardware and software shall fully control the procedure of measurement and the recording of results, as well as evaluate the results in a form that is wished for.

After completion of the particular measurement, the software shall ensure a tabular presentation of mean SN values, as well as of the information on the roughness depth for the selected lengths of tested sub-sections, including both minimum and maximum values, and – in addition to the tabular presentation – a graphic presentation of results of skid resistance and roughness depth measurements.

Where the pavement surface temperature deviates from the basic reference temperature 20°C, the results of measurements shall be corrected as follows:

Measured temperature of pavement surface

- from 5 °C to 10 °C by - 1 SN unit
- from 30 °C to 40 °C by + 1 SN unit
- from 40 °C to 50 °C by + 2 SN units

In case that the driving speed during the measurement deviates from the specified speed by no more than ± 10 km/h, the measurement results shall be modified according to the equation below:

$$SN_i = SN_d + \frac{V_d - V_i}{20} \cdot 0{,}07$$

where:

SN_i - Skid number (SN) for the selected driving speed

SN_d - Skid number (SN), established for the actual driving speed during the measurement

V_d - Actual driving speed during the measurement (km/h)

V_i - Selected driving speed during the measurement (km/h)

20 - Driving speed (km/h)

2.1.9.1.3.3 Measurements With Accessories For Measuring Roughness Depth

2.1.9.1.3.3.1 Method of Measurement

The method of measurement of pavement surface roughness depth is based on the determination of the mean depth of voids below the level of peaks on a surface, where these voids are filled with an amount of fine-graded of medium-graded natural sand as specified in advance.

The following activities belong to the scope of measurement to be carried out:

- pouring out a quantity of sand from the measuring cylindrical container onto the pavement surface
- spreading the sand by means of a rubber ruler in a shape of a circle to fill up all the voids on the pavement surface up to the top of the peaks
- measurement of the sand circle diameter D in four directions.

The measurement shall be repeated at four additional locations spaced at approximately 5 m.

All the testing results shall be entered in a form suitable for roughness depth measurements.

2.1.9.1.3.3.2 Evaluation of Results

The result of a roughness depth measurement at individual tested place is the mean roughness depth h_h, assessed according to the equation below:

$$h_h = {4V}/{\pi \cdot D_p^2} \quad \text{(mm)}$$

where:

V - volume of spread sand (mm^3) (26.317 mm^3 as a rule)

D_p - mean diameter of circle of spread sand (mm)

The mean diameter D_p of the spread sand circle shall be assessed as average value of four measured diameters.

The mean roughness depth h_{hp} for the measured pavement surface shall be assessed as average value of results of measurements of roughness depth h_h at all the five tested locations.

2.1.9.1.4 Criteria For Assessment of Condition

The basic criterion to assess the condition of pavement surfaces in terms of traffic safety is the definition of sections, where the skid resistance is less than the limiting value.

2.1.9.1.4.1 Skid Resistance on New Carriageways

The skid resistance values on newly constructed carriageways with up-to-date asphalt or cement concrete surfacing are - as average values for a 100 m long homogeneous tested section - indicated in Table 3 in dependence on the driving speed of the SCRIMTEX measuring device.

Table 3: Limiting values of skid resistance on new carriageways

Driving speed during measurement (km/h)	Value of skid resistance on tested section ($\overline{SN}$)
30	62
40	57
50	53
60	49
70	46
80	43
90	40

The condition to define a homogeneous section of the traffic surface is the variation coefficient k_v, which shall be assessed by adopting the equation below:

$$k_v = \frac{s}{\overline{SN}} \leq 0{,}35$$

where:

s - standard deviation of SN value calculated from the equation below:

$$s = \sqrt{\frac{SN^2 - \overline{SN}\sum SN}{n-1}}$$

$\overline{SN}$ *- mean SN value calculated from the equation below:*

$$\overline{SN} = \frac{\sum SN}{n}$$

2.1.9.1.4.2 Skid Resistance on Existing Carriageways

The criteria to assess the skid resistance of existing up-to-date pavement surfaces on the basis of measurements by means of a SCRIMTEX device are indicated in Table 4.

A homogeneous tested section shall generally be approximately 300 m long, however it shall not be shorter than 100 m.

The criteria to assess the skid resistance of existing up-to-date pavement surfaces on the basis of measurements by means of an SRT pendulum are indicated in Table 5.

Table 4: Limiting ranges of skid resistance values for assessment of condition of existing pavement, determined by means of a SCRIMTEX device

Speed during measurement (km/h)	Assessment of condition: very poor	poor	satisfactory	good	very good
	Range of mean value of skid resistance on a homogeneous section subjected to measurement (SN)				
30	< 50	50 – 56	57 – 61	62 – 72	> 72
40	< 46	46 – 52	53 – 56	57 – 67	> 67
50	< 42	42 – 48	49 – 52	53 – 63	> 63
60	< 39	39 – 45	46 – 48	49 – 59	> 59
70	< 36	36 – 42	43 – 45	46 – 56	> 56
80	< 33	33 – 39	40 – 42	43 – 53	> 53
90	< 30	30 – 36	37 – 39	40 – 50	> 50
	limiting value		warning value		value for acceptance

Table 5: Limiting values of skid resistance determined by means of an SRT pendulum, for assessment of condition of existing pavement in dependence on traffic loading

Traffic loading		Traffic density		Driving conditions	
Group	NAL 82 kN/day (1)	Group	AADT (2)	Normal	Difficult
				Limiting values	SRT_{mok} (3)
exceptionally light very light light	≤ 300	exceptionally low low medium	≤ 5,000	45 to 55	55 - 65
heavy very heavy exceptionally heavy	> 300	high very high exceptionally high	> 5,000	50 to 60	

Legend:

(1) NAL 82 kN/day – number of passages of nominal axle load 82 kN/day

(2) AADT – average annual daily traffic of vehicles

(3) SRT_{mok} – SRT value on tested section corrected for the temperature effect

Homogeneous sections to be subjected to measurements shall be specified

- on the basis of results of measurements carried out by means of an SRT pendulum at least per every 50 m^1 of carriageway, and
- by evaluating the mean SRT_{mok} value for at least 300 m long section.

The following driving conditions shall be particularly considered as difficult:

- road sections of longitudinal fall greater than 6 % at the length of at least 100 m
- curvatures of radius R < 150 m
- dangerous sections: strong lateral wind, bridges, viaducts, tunnels
- all such road sections where the driving speed must be reduced.

The criteria to assess the roughness depth of existing up-to-date pavement surfaces determined on the basis of the Sand-Patch-Method are informatively indicated in Table 6.

The limiting values of the roughness depth on a pavement surface are specified in dependence on the admitted driving speed on the particular road.

Table 6: Limiting values of mean roughness depth h_{hp} and mean profile depth h_{pp} to assess the conditions of existing carriageway in dependence on the admitted driving speed

Maximum admitted driving speed (km/h)	Limiting value of roughness depth h_{hp} (mm)	Limiting value of profile depth h_{pp} (mm)
40	0.22	-
50	0.26	-
60	0.30	0.13
70	0.35	0.19
80	0.40	0.25
100	0.53	0.42
120	0.70	0.63

The criteria to assess the profile depth of existing pavement surfaces determined by measurements with electro-optical devices – lasers (within the SCRIMTEX device assembly) indicated in Table 6 are evaluated as informative on the basis of the CEN equation:

$h_h = 0{,}2 + 0{,}8 \times h_p$ (mm)

or:

$h_p = 1{,}25\ h_h - 0{,}25$ (mm)

2.1.10 DENSITY AND MOISTURE MEASUREMENTS - ISOTOPE GAUGE METHOD

2.1.10.1 Subject of Technical Guideline

2.1.10.1.1 General

Technical Guidelines for Roads, Special Technical Conditions, Density and Moisture Measurements, Isotope Gauge Method, provide methods of in situ measurements of material density and moisture, as well as of result evaluation methods.

In the present technical guideline, both density and moisture are discussed together as the majority of the isotope gauges are equipped to measure both quantities. The guideline can also be used for isotope gauges to measure the material density only.

The intention of the considered measurements is a quick and non-destructive assessment of both density and moisture of executed earth and asphalt works (comparative tests, conformity tests), as well as research and development in this domain.

The present guideline contains basic information only. The performer of measurements using isotope gauge shall fully consider the instructions provided by the equipment producer.

Note:

Equipment used for such kind of measurements contains radioactive material emitting ionizing radiation, which could be harmful to user's health, if suitable safety precautions are not taken into consideration. Therefore it is essential to be aware of the potential hazard prior to commencement of the measurement, and to pay regard to all the available regulation dealing with safety measures and procedures.

2.1.10.1.1.1 Restrictions

The measurement method introducing isotope gauges is suitable to test most of the materials used in both earth and asphalt works, where the isotope gauge base surface is adequate to ensure a representative volume/test specimen. However, the results of measurements carried out either by direct radiating-through by reflective radiation can be affected by a series of factors, particularly the following ones:

- heterogeneous chemical composition of material, e.g. coincidental presence of metal ions in slag and ash;
- unusual chemical composition of material; certain elements, e.g. cadmium, boron, and chlorine, can affect the moisture measurement results due to a high probability of absorbing fast neutrons; if the material contains elements, that affect isotope gauge measurement results, and the percentage of those elements is constant, the calibration curve shall be suitably adjusted;
- rough surface texture of material, which effect shall be reduced to the smallest possible extent by ensuring the best possible contact between the isotope gauge and the surface of the compacted test layer; the influence of the surface texture is essentially smaller in the direct radiation-through measuring method;
- unusual mineralogical composition of material, e.g. minerals containing chemically bound water (gypsum), as well as soils with a high percentage of organic admixtures.

The following can also affect the density measurements:

- layers of compacted material with substantial vertical density gradients, so that the compaction degree at the top does not contribute very much to the layer average compaction; due to its operation mode, a reflective radiation test embraces the material next to the surface to a greater extent; therefore, a direct radiation method is more appropriate, as the mentioned effects are reduced due to the fact that the sensitivity is increasing with the depth;
- coincidental presence of major inclusions completely surrounded with finer particles, which can result in an unusually high density.

The moisture measurement results can be affected by the hydrogen in the unbound water, the hydrogen in chemically bound water, as well as the hydrogen in other compounds, e.g. organic ones.

2.1.10.1.2 Physical Bases

2.1.10.1.2.1 Radioactive Isotopes

Radioactive isotopes, which an isotope gauge contains, emit radiation that can penetrate through a solid material. Taking into account the degree of radiation energy diminishing or change, one can assess the properties of the material radiated-through.

An isotope gauge usually contains a gamma ray radiation source, and a combined source of fast neutron radiation.

2.1.10.1.2.2 Density Measurement

The density measurement is based on the change of the gamma ray distance from the source to the detector due to the Compton effect. The criterion for the density is the radiation intensity (with regard to a suitable orientation) reaching the detector; it is directly related to the electron density of material radiated-through.

2.1.10.1.2.3 Moisture Measurement

For the moisture measurement, advantage is taken of the speed reduction of neutrons arising from the fast neutron source. The neutron speed is diminished due to the collisions with hydrogen nuclei as a rule. The intensity of radiation reaching the detector is directly related to the condition of arrived modified neutrons, and represents a criterion for the moisture content in the influence area. It may be assumed that the water is the only source of hydrogen, which is present in the radiated-through material.

2.1.10.1.3 Measuring Equipment

2.1.10.1.3.1 Isotope Gauge

An isotope gauge is a measuring device consisting of *a* sound, detectors, a reading device, and electric power source. The mentioned components are mounted in a casing, which shall be firm and resistant to both water and dust.

A sound in a form of a bar is intended to be impressed into the ground. The bar is marked with length intervals of 5 cm for measurements up to a depth of 30 cm. A source of ionizing radiation mounted into the sound shall be sealed and suitably protected for a safe use and storing.

Note:

The sound shall be so executed as to enable a safe manual impression up to the selected depth.

If there is a suspicion of some damage to the source, or if the source is damaged or seems to be damaged, the equipment shall be preserved in a suitable box, and the producer or authorized representative shall be immediately notified. Handling and repair can only be carried out by suitably equipped and qualified personnel.

The measuring set shall comprise instructions for use, a calibration certificate, and a transportation box.

2.1.10.1.3.2 Auxiliary Equipment to Prepare Measurements

The auxiliary equipment to prepare measurements consists of the following:

- equipment for levelling the surface in the test area, e.g. a trowel, a ruler, and similar;
- equipment to carry out a borehole: a steel bar or drill, a hammer, a guide to preserve verticality upon impressing the bar (the guide can also have a function of a levelling plate), and a crank to pull out the rammed bar; the steel bar shall be pointed at one end, whereas it shall be widened at the other end (to enable hammer strokes);
- material for levelling uneven surface: usually, fine-grained mineral material won in the measurement area, or dry fine silica sand is used.

Note:

The abovementioned equipment is also suitable to execute boreholes into new stabilized materials, whilst hardened materials can be bored, as it is usual for cement concrete.

2.1.10.1.3.3 Calibrating Equipment

The following reference materials shall be used to calibrate the measuring equipment:

- material of known density prepared in a form of a block,

- material of known density, compacted in boxed, or
- in-place material, which density is determined by a standard procedure (with calibrating cylinders, by substitution with sand, or with water).

A standard measuring block shall be made of material suitable to verify the measuring system function, as well as to perform repeated assessments of the standard number of impulses. The standard block shall be marked with the same serial number as the isotope gauge, and must not be used in combination with other isotope gauges.

A standard block shall be kept clean and without any stuck-on particles, which might cause bad contact with the sound, thus leading to incorrect counting of the standard number of impulses.

Note:

Blocks are advantageous for their durability, and therefore calibration repeatability.

Blocks and boxes shall have dimensions of minimum 310 mm x 360 mm x 560 mm, or such as not to affect the measurement results.

2.1.10.1.4 Calibrating, Standardizing, and Verifying the Measuring System

2.1.10.1.4.1 Calibration

2.1.10.1.4.1.1 General

A correct calibration of an isotope gauge is a base for a reliable execution of density and moisture measurements. A calibration links the measured value (number of impulses, impulse ratio) with the property of the radiated-through material (density and moisture content), and is given in a form of a curve or table, precisely indicating the materials used to perform the calibration. Isotope gauges generally enable entering the calibration curves into a microprocessor already mounted.

2.1.10.1.4.1.2 Density

2.1.10.1.4.1.2.1 General Conditions

Calibration shall be carried out on the basis of counting impulses for each individual material of a known density. For calibration purposes, materials of the same density range, as materials to be subsequently tested with an isotope gauge shall be used. The final result of a calibration carried out is a correlation between the impulse number ratio (with regard to the standard number), and the density.

2.1.10.1.4.1.2.2 Calibration at Factory

The manufacturer shall execute a factory calibration in compliance with the provisions of the relevant regulation.

The calibration performed at factory shall be verified at least once a year. If the verification results do not comply with the prescribed conditions, the particular isotope gauge shall be recalibrated.

The producer, or his authorized representative is responsible to carry out the verification or the recalibration.

Note:

The calibration shall be checked and, as necessary, repeated after each major repair of the isotope gauge as well.

2.1.10.1.4.1.2.3 Calibration Curve Verification

The calibration curve shall be verified for a new gauge, as well as in any case of suspicious reliability of results of routine tests. For this purpose, one of the prepared reference materials indicated in section 3.2.8.3.3.3 shall be used. It should be noted that calibration blocks or boxes are more reliable than the in-situ volumetric methods.

2.1.10.1.4.1.2.4 Calibration Curve Adjustment

When the results of density measurements on blocks or boxes are out of the calibration curve, the existing calibration curve shall be replaced by a new one, which corresponds to the testing results for the material given.

When a calibration curve is verified by in-place volumetric methods (section 3.2.8.3.3.3), results of both types of density measurements shall be compared at not less than 10 measuring spots.

The following measures shall be taken:

- when the absolute difference in density established in both ways at individual measuring spots does not exceed 80 kg/m^3, and the differences are both positive and negative, the calibration curve needs not be modified;
- when each of the values established by a suitable alternative method exceeds the value measured with an isotope gauge, and the average difference is greater than 30 kg/m^3, the average difference shall be added at each subsequent density measurement carried out by means of an isotope gauge;
- when each of the values established by an adequate alternative method is lower than the value measured with an isotope gauge, and the average difference exceeds 30 kg/m^3, the average difference shall be subtracted at each subsequent density measurement carried out by means of an isotope gauge.

2.1.10.1.4.1.3 Moisture

2.1.10.1.4.1.3.1 General Conditions

Calibration shall be carried through on the basis of impulse counting for each of several different materials with known moisture content. For calibrations such material shall be used, which moisture range is the same as that of the materials to be investigated subsequently by means of an isotope gauge. The final calibration result is a correlation between the impulse number ratio (with regard to the standard number), and the moisture.

For the calibration one of the reference materials mentioned in section 3.2.8.3.3.3 shall be introduced.

2.1.10.1.4.1.3.2 Calibration at Factory

The manufacturer shall execute a factory calibration in compliance with the provisions of the relevant regulation.

The calibration performed at factory shall be verified at least once a year. If the verification results do not comply with the prescribed conditions, the particular isotope gauge shall be recalibrated.

The producer, or his authorized representative is responsible to carry out the verification or the recalibration.

Note:

The calibration shall be checked and, as necessary, repeated after each major repair of the isotope gauge as well.

2.1.10.1.4.1.3.3 Calibration Curve Verification

As a rule, the calibration curve shall be verified for a new isotope gauge. In addition, it shall be verified in case of testing such materials, which chemical composition is essentially different comparing to the materials, on which the calibration has been performed. For the verification, one of the reference materials indicated in section 3.2.8.3.3.3 shall be used.

2.1.10.1.4.1.3.4 Calibration Curve Adjustment

The following measures to adjust a calibration curve are relevant:

- when the results of the moisture measurements carried out on a material in a box are not distributed randomly above and below a calibration curve, the existing calibration curve shall be substituted by a new one, which corresponds the test results for the material given;
- when the results of the moisture measurements carried out on a material in a box are randomly distributed above and below the calibration curve, and the average difference does not exceed 8 kg of water per m^3 of material with regard to the isotope gauge measurements, the calibration curve needs not be adjusted;
- when each moisture content value established in a classic way, exceeds the moisture content measured by means of an isotope gauge, the average difference shall be added at each subsequent isotope gauge measurement;
- when each moisture content value established in a classic way is less than the moisture content measured by means of an isotope gauge, the average difference shall be subtracted at each subsequent isotope gauge measurement.

2.1.10.1.4.2 Isotope Gauge Standardization

2.1.10.1.4.2.1 General

The standardization of an isotope gauge is to determine a standard number of impulses on a standard block.

Measurement results (number of impulses) are affected by a long-term ageing of the radioactive source, electronic components and detectors, as well as geographically dependent variation of the radiation background. To exclude the mentioned impacts, isotope gauges are calibrated to the ratio of measured impulses for each radioactive source to the standard number of impulses established on a reference block.

Note:

A regular verification of the standard number of impulses is also required for a regular control of the isotope gauge proper functioning.

2.1.10.1.4.2.2 Method

The standardization of an isotope gauge shall be performed on a reference measuring block for each measurement type, both at the beginning and the end of each day of the isotope gauge use. Such a procedure shall be carried out after no more than eight hours of a continuous use as well. Moreover, the procedure shall be executed on each repeated turning on of the gauge.

By turning on an isotope gauge, the latter commences to warm up; however, this shall be in compliance with the producer's recommendations. The warming-up shall last at least 15 minutes.

When an isotope gauge is intended to be used continuously, or all the day long at intervals, it needs not be turned off.

During a measurement, the isotope gauge shall be located at least 7 m away from other isotope gauges, and at least 1.5 m away from any higher structure that might affect the measurement.

When an isotope gauge is introduced in a narrow cut, or at a distance of less than 1.5 m from a structure, the reflective radiation effect shall be considered in such a way that the standard number of impulses is assessed at the location where a measurement will be carried out subsequently.

A standard measuring block shall always be placed at least 1.5 m away from any higher obstacle. For each measurement type, either of density or moisture, at least four consecutive one-minute measurements shall be performed, and the mean value shall be calculated.

Note:

A four-minute measurement is also acceptable, provided that this is made feasible by the particular isotope gauge.

2.1.10.1.4.2.3 Verification

The results of each standardizing procedure shall be provided with dates and values, and preserved to verify proper functioning of an isotope gauge.

It shall be checked whether the mean value of readings is within the limits specified by the equation below:

$$N_s = N_0 \pm 2.0(N_0/p_c)^{0.5}$$

where:

N_s *average of calibration carried out on a standard*

N_0 *average of four values N_s prior to use*

p_c *value of calibration factor for impulse detector prior to displaying on a screen*

Note:

The producer shall indicate the value p_c in his technical documents. If this factor is not entered in the isotope gauge, then $p_c = 1$ shall be taken into consideration.

In case that the N_s value calculated from the equation above is within the admissible limits, it can be used for a daily use of the isotope gauge.

When the N_s value is out of the prescribed limits, the procedure to assess an average value of impulses shall be repeated at least twice: if all the three, or two of the three values are out of the acceptable limits, the isotope gauge must not be used until the deficiency is made good.

When, upon standardizing, the N_s values are out of the admissible range at the end of a working day, all the results obtained are invalid.

2.1.10.1.4.3 Verification of Measuring System Stability

A standardization of an isotope gauge shall be carried out as described in section 3.2.8.3.4.2.2, provided that for each measurement type (density and moisture) at least 16 repeated one-minute measurements on a reference block are executed. During the measuring procedure, the isotope gauge must not be moved.

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

Standard deviation (SD), and arithmetic mean for each series of repeated measurements shall be calculated.

It shall be verified whether the stability factor expressed in terms of standard deviation divided by the square root of the arithmetic mean is within the range specified by the gauge producer. The recorded calibration factor shall be considered.

If any of both values is out of the range specified by the producer, or this is indicated by the tendency of consecutive verifications, the particular isotope gauge must not be used until the deficiency is made good.

Note:

A stability test for each type of measurements shall be performed at least once a month, if the gauge is in use daily. If this is not the case, the stability test shall be carried out every three months. When the tendency of successive verifications indicates an error, the isotope gauge must not be used.

2.1.10.1.5 Density and Moisture Assessment Methods

2.1.10.1.5.1 Measurement

2.1.10.1.5.1.1 Density Assessment by Direct Radiating-Through

An isotope gauge shall be standardized according to the methods described in section 2.2.8.3.4.2.2.

All the foreign material shall be removed from the surface of the selected measuring place. The measured surface shall be perfectly even.

By means of a guide a borehole shall be drilled or impressed to a suitable depth. As a rule, the borehole diameter shall be greater than the borehole depth to which the volume mass will be assessed. The required borehole depth shall be – with regard to the selected measurement depth – indicated in the producer's instructions. The resting surface of the measuring device shall be marked at the place of measurement.

After the measuring device is placed onto the measuring spot, it shall be verified whether the contact between the instrument bottom and the measured surface is appropriate.

Eventual unevenness shall be filled up with dry fine silica sand or with fine particles of the investigated material. The added material must not be laid as an independent layer.

The bar, i.e. the isotope gauge, shall be inserted to the selected depth, and the instrument shall be so moved as to achieve its perfect resting on the borehole surface on the detector side.

Density (and also moisture content if necessary) shall be measured in accordance with the maker's instructions. The time of each type of measurement shall not be shorter than 1 minute.

To ensure higher accuracy the isotope gauge shall be turned by 180° around the bar vertical axis, then the subsequent measurement shall be carried out, and the average value of both measurements shall be calculated. Another possibility of evaluation is to repeat the measurements

in an increasingly larger space at adjoining locations, and to calculate the mean value of the results.

The movable bar (the sound) shall then be returned into the casing in position "safe".

The measured values for a given measuring spot shall be read and recorded, and the density shall be determined on the basis of calibration curves.

Note:

Isotope gauges are generally equipped with microprocessors enabling saving the calibrations specified by the user, conversion of both density and moisture on the basis of calibrations, corrections of results, and saving the measured values.

2.1.10.1.5.1.2 Density and Moisture Assessment by Reflective Radiation

An isotope gauge shall be standardized in compliance with the methods described in section 2.2.8.3.4.2.2. Both density and moisture shall be measured in accordance with the producer's instructions. The measurement shall last not less than 1 minute. To achieve higher accuracy the isotope gauge shall be turned by 180° around the bar vertical axis, then the subsequent measurement shall be carried out, and the average value of both measurements shall be calculated. Another possibility of evaluation is to repeat the measurements in an increasingly larger space at adjoining locations, and to calculate the mean value of the results.

The movable bar (the isotope sound) shall then be returned into the casing in position "safe".

The measured values for a given measuring spot shall be read and recorded, and both density and moisture shall be determined on the basis of calibration curves.

Note:

An additional measurement of moisture with isotope gauges, which enable such a mea-surement, can be performed simultaneously with either of both density measurement methods.

Where the information on the moisture is required separately in terms of the mass of water per volume unit, the instructions for determination shall be considered.

Isotope gauges are generally equipped with microprocessors enabling saving the calibrations specified by the user, conversion of both density and moisture on the basis of calibrations, corrections of results, and saving the measured values.

2.1.10.1.5.2 Calculation and Presentation of Results

2.1.10.1.5.2.1 Dry Density

The dry density ρ_d (in kg/m^3) shall be assessed in accordance with the following equations:

- on the basis of moisture measurement with an isotope gauge:

$$\rho_d = \rho - W$$

where:

ρ - *material density (in kg/m^3) established with an isotope gauge*

W - *moisture (in kg/m^3), i.e. mass of water per material volume unit assessed by means of an isotope gauge*

- moisture determination at laboratory:

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

where:

ρ - *material density (in kg/m^3) established with an isotope gauge*

w - *material moisture content*
(in % by mass)

2.1.10.1.5.2.2 Moisture Content

The material moisture content w (in % by mass) can be calculated from the equation below:

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

2.1.10.1.5.2.3 Report on Measurements

A report on measurements carried out with an isotope gauge shall contain a statement that the measurements have been performed in compliance with this technical specification, as well as the following information and results respectively:

- the adopted method to acquire results
- in situ density and/or dry density of material (kg/m^3)
- moisture content (if the latter has been assessed) (% by mass)
- measurement location and serial number
- time interval between completion of compaction and measurement
- description of the material.

2.1.10.1.6 Protection from Radiation

Radiation of radioactive isotopes can have a harmful effect on the health of humans and animals, and can lead to different injuries, if an isotope gauge is handled unprofessionally. For a reliable prevention of damage the relevant legislation dealing with the treatment of radioactive materials and with their transportation shall be considered.

2.1.11 SUBSTITUTION METHODS OF DENSITY MEASUREMENT

2.1.11.1 Subject of Technical Guideline

Technical guidelines for roads, Special technical conditions, Substitution methods of density measurement, provide bases for performing measurements of density of soils by substitution methods, as well as for the evaluation of results.

The present technical guideline describes substitution methods of measuring density of soils, as well as of unbound and hydraulically bound layers. These methods are based on direct, i.e. gravimetrical measurements of density.

In road construction density and moisture measurements are a constituent part of the quality control of executed earth works, as well as of works carried out on both unbound and bound pavement layers. For a simple and quick accomplishment, the majority of density and moisture measurements is carried through indirectly by means of an isotope gauge. As in indirect procedures some errors can occur, which is a consequence of an objective error of the method itself, it is generally required to supplement the isotope gauge measurements with direct substitution measurement methods carried out on all the characteristic pavement layers.

For the evaluation of essential measurement results, as well as in disputable cases, the results acquired by the substitution procedures have precedence over the results of the isotope gauge measurements.

2.1.11.2 Physical Bases

2.1.11.2.1 Density Measurement

Soil density measurements carried out by substitution procedures are based on measuring (weighing) the mass of excavated soil or placed layers, and the volume of the excavated soil.

The volume is measured by filling-up the void, which has taken rise on excavation of the known soil mass. For filling-up, a substitution material of known accurate density is used. Sand and water are used most frequently. In addition, oil, mercury, or some other liquids can be introduced as substitution materials. When oil, mercury, or any other different material hazardous to environment is used, adequate safety precautions are required to prevent outpouring and pollution of surroundings respectively.

In the calibrated cylinder procedure, the volume of void, which occurs due to excavation of a known soil mass, is assessed by means of the cylinder volume.

2.1.11.2.1.1 Moisture Measurement

In all the substitution density measurement procedures, the moisture is determined gravimetrically by drying the excavated material in a dryer at temperature of 105 to 110°C until the mass becomes constant.

When the minerals of the material contain chemically or electrochemically bound water, which leaves the mineral crystal lattice at lower temperatures, such drying temperature shall be foreseen, which is lower than the temperature of the mineral phase transition. Typical examples are a transition of gypsum to poly-hydrate and anhydride already at 40°C, soils of extremely high content of organic compounds, etc.

2.1.11.3 Measurement Methods

2.1.11.3.1 Types of Measurement Methods

In the present technical guideline the following substitution procedures are discussed:

- calibrated cylinder method,
- sand substitution method for fine-grained and medium-grained soils
- sand substitution method for fine-grained, medium-grained, and coarse-grained soils,
- water substitution method suitable to coarse-grained soils.

2.1.11.3.2 Calibrated Cylinder Method

2.1.11.3.2.1 Method Applicability

The calibrated cylinder method is applicable to natural soil, as well as to artificially raised and compacted cohesive fine-grained soils not containing coarse particles.

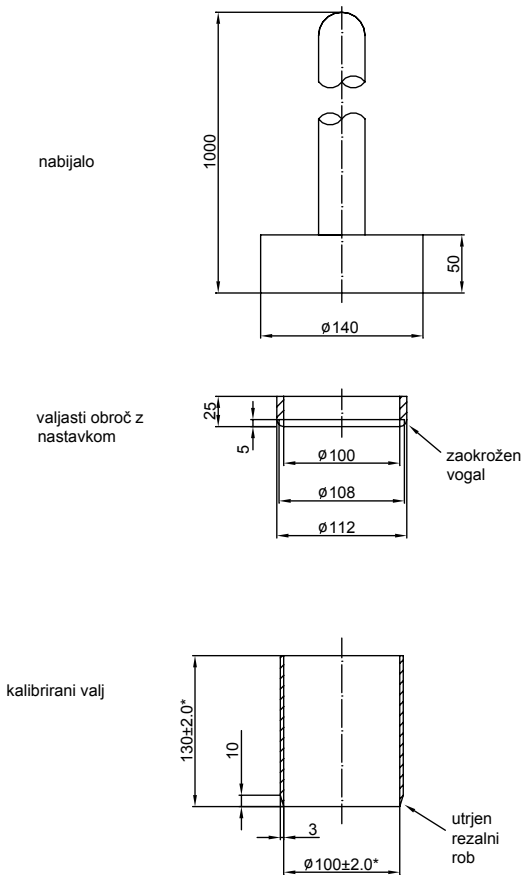
This procedure is advantageous for its fast and simple execution.

This procedure provides less accurate results than other methods.

2.1.11.3.2.2 Measuring Equipment

The following equipment is necessary to perform measurements:

- a steel calibrated cylinder (Fig. 1) measuring 130 mm in length, 100 mm of internal diameter, and 3 mm of wall thickness; the lower strengthened edge of the cylinder shall be ground to a cutting blade shape, and strengthened; prior to use the cylinder shall be greased;
- a steel cylindrical ring measuring 25 mm in length, 100 mm of internal diameter, and 5 mm of wall thickness, including an accessory enabling adjustment to the upper part of the calibrated cylinder;
- a steel rammer;
- scales of accuracy of 1 g;
- a flat blade;
- a steel ruler of 0.5 mm divisibility;
- tools suitable to excavate the soil and to press out the soil from the cylinder;
- steel levelling blade with a ground edge, of recommended length of 300 mm, width of 25 mm, and thickness of 3 mm;
- equipment for moisture determination.



* All dimensions in mm.

The cylinder can also be shaped or conceived differently, however the basic requirements shall always be met.

nabijalo = rammer, kalibrirani valj = calibrated cylinder,

valjasti obroč z nastavkom = cylindrical ring with accessory,

zaokrožen vogal = rounded off corner;

utrjen rezalni rob = strengthened cutting edge

Fig. 1: Calibrated cylinder for soil density assessment

2.1.11.3.2.3 Measurement Execution

The following shall be carried out within the scope of measurements of soil density by means of calibrated cylinders:

- to calculate the (inner) volume of the calibrated cylinder $\mathbf{V_c}$ in cm^3; the cylinder dimension measurements shall be performed to an accuracy of 0.5 mm;
- to weigh the cylinder mass m_c to an accuracy of 1 g;
- to select a layer surface, where density measurements will be carried through, and to confine it within a square of side of approximately 300 mm; soil, which remained after surface levelling, shall be removed; the cylinder shall be so placed onto the surface as to enable the sharpened end of the cylinder, i.e. a blade, to be in a full contact with the surface; the cylindrical accessory shall be placed onto the upper part of the cylinder, and the cylinder shall be rammed into the soil, until the free height of the cylindrical accessory reaching above the layer surface amounts to approximately 10 mm;
- to unearth the cylinder carefully, so that at the lower edge of the cylinder a portion of the soil will be below the blade lower edge; the soil surface in the cylinder shall be thoroughly levelled with the steel blade;
- to determine the mass of the cylinder including the soil m_z to an accuracy of 1 g;
- to press out the soil from the cylinder, and to preserve the soil in a waterproof container for assessment of moisture of a representative specimen (w) in compliance with the standard procedure of moisture content measurement.

2.1.11.3.2.4 Calculation of Results

The density of a naturally moist soil ρ shall be calculated from the equation below:

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

where:

m_z – mass of soil and cylinder (g)

m_c – mass of empty cylinder (g)

V_c – cylinder inner volume (cm^3)

The dry density of the soil ρ_d shall be calculated from the following equation:

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

where:

w - soil moisture content (% by mass)

2.1.11.3.2.5 Investigation Report

A soil investigation report shall include the following:

- the type of applied method;
- soil density and dry soil density to an accuracy of at least 0.01 g/cm^3;
- soil moisture content in % by mass expressed to an accuracy of two decimal places;
- other information or notes important to the result evaluation such as: soil type, source, layer properties, conditions upon measurement, etc.

The investigation report shall also comprise a statement that the investigation has been carried out in accordance with this technical guideline.

2.1.11.3.3 Sand Substitution Method for Fine-Grained and Medium-Grained Soils

2.1.11.3.3.1 Method Applicability

The sand substitution method using a sanding device of 115 mm of diameter is suitable to assess the density of fine-grained and medium-grained soils in layers not thicker than 150 mm.

Note

In case of granular non-cohesive soils, in particular when such soils are very moist, there is a risk of an error, which is a consequence of peeling-off of grains from the excavation walls; it results in a density greater than that realistically occurring in the layer of placed granular soil.

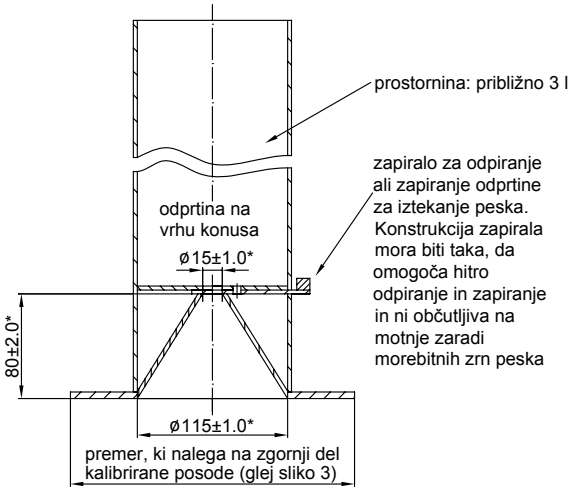
2.1.11.3.3.2 Measurement Equipment

The following basic equipment is required to perform the measurements:

- a sanding device shown in Fig. 2,
- equipment suitable to execute excavation in ground: a steel shovel, a steel bar, a ladle,
- a calibrated cylindrical steel container of internal diameter of 100 mm, and of outer height of 150 mm, including an accessory measuring 50 mm in width and approximately 5 mm in thickness, welded on the upper free edge of the container (Fig. 3),
- scales of accuracy of 1 g,
- a glass plate of suitable size; a square shape with a side of approximately 500 mm, and of a thickness of 10 mm is recommendable,
- a metal container or other equipment for a temporary keeping of excavated soil; a container of square shape with a side of 300 mm, and of a height of 40 mm is recommendable,
- a metal container with a side of 300 mm, and of a height of 40 mm, with a circular opening of 100 mm of diameter in the middle,
- a thin-wall metal cylinder with a ground edge at the lower end, measuring 130 mm in height, 100 mm in inner diameter, and 3 mm in thickness; the cylinder shall always be slightly greased,
- a container suitable to preserving and transporting the soil,
- equipment for moisture assessment (according to the specified procedure),
- calibrated silicate sand for substitution, which shall ensure a constant, repeatable, and controllable density; the sand granulometric composition shall be such, that 100 % by mass of the sand passes a 600 μm, and that 100 % by mass of the sand remains on a 63 μm sieve; the calibrated sand must not contain particles of lamellate shape, silt, clay, and organic admixtures; prior to use the sand shall be dried in a dryer, and then kept in an entirely closed container, so that the sand moisture content is balanced with the air humidity.

Note

For moisture balancing a seven-days keeping is generally sufficient. Prior to use the sand shall be mixed up. The sand, which is, after the performed test, excavated from the control excavation in the controlled layer, shall be, prior to repeated use, sieved out, dried, and re-kept until the moisture is balanced.



* All dimensions in mm.

The cylinder can also be shaped or conceived differently, however the basic requirements shall always be met.

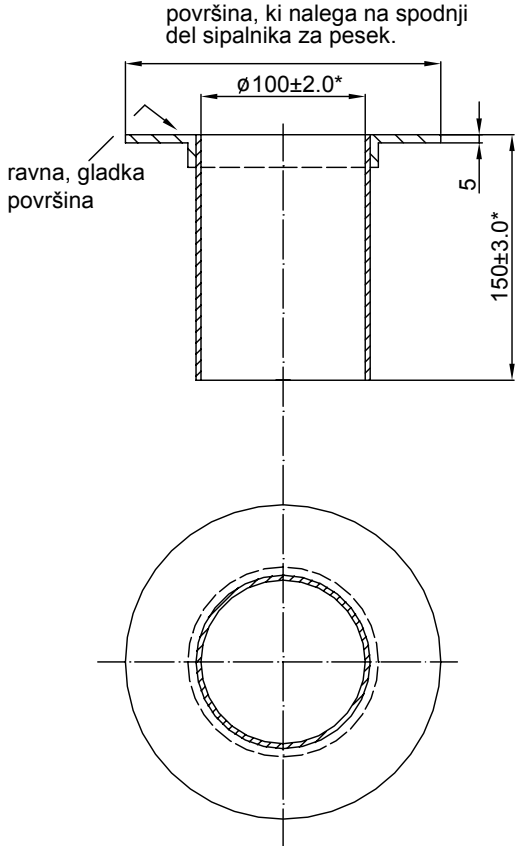
prostornina: približno 3 l = volume: approx. 3 litres

odprtina na vrhu konusa = opening at cone top

zapiralo za odpiranje ... = locking device for opening or closing the sand outflow opening. The locking device structure shall be such as to enable quick opening and closing, and not to be sensitive to disturbances due to eventual sand particles

premer, ki nalega ... = diameter to fit the upper part of calibrated container (refer to Fig. 3)

Fig. 2: Sanding device for assessing density of fine-grained and medium-grained soils



* All dimensions in mm.

The cylinder can also be shaped or conceived differently, however the basic requirements shall always be met.

površina, ki nalega ... = surface that fits the lower part of the sanding device

ravna, gladka površina = even, smooth surface

Fig. 3: Calibrated container used to calibrate a sanding device for fine-grained and medium-grained soils

2.1.11.3.3.3 Calibration

2.1.11.3.3.3.1 Assesment of Sand Mass in Sanding Device Cone

To assess the mass of the sand in a sanding device cone the following shall be executed:

- to fill the sanding device with sand up to a height approximately 15 mm below the cylinder upper edge, and to determine the mass of the cylinder including the sand m_1 to an accuracy of 1 g; for each subsequent calibration the same initial sand mass shall be used;

the locking device shall be opened until the sand volume equal to the excavated void or calibrated container flows out,

- to close the locking device and to place the sanding device including the residual sand onto an even substrate, i.e. glass plate,
- to re-open the locking device and release the sand; during the sand outflow both sanding device and its base must not vibrate; after the sand stops to flow out from the container, the locking device shall be closed and the sanding device carefully removed,
- to collect attentively the sand, which has accumulated in the sanding device cone, and to weigh it to an accuracy of 1 g (m_2),
- to repeat the procedure at least three times, and to calculate the sand mass average value m_2.

2.1.11.3.3.3.2 Assessment of Sand Stratification Density

The following shall be carried out to assess the sand stratification density:

- to place the empty container onto the scales, and to make sure that the container upper edge is horizontal,
- to weigh the empty container to an accuracy of 1 g, and to record the mass (m_5),
- to fill the container with water, so that the water level reaches exactly the container upper edge; to verify the water level accuracy, a ruler shall be placed over the container edge, and the water shall be carefully added droplet by droplet until the level touches the ruler lower edge,
- to remove the ruler and to record the mass of both container and water to an accuracy of 1 g (m_6); the measurement shall be repeated several times to ensure a reliable average value m_6,
- the volume **V** of the container calibrated in such a way amounts to:

$$V = m_6 - m_5 \text{ (ml)},$$

- to place the sanding device filled up with sand (constant mass m_1) centrically to the calibrated container, to open the locking device, and to leave the sand to flow out freely from the sanding device; no vibration or trembling of the container or sanding device is admitted; during the procedure the calibrated vessel shall stand on a larger capturing vessel, where the sand flowing out from the cone after removal of the sanding device will be captured,
- after the sand stops to flow out, the locking device shall be closed, and the sanding device including the residual sand shall be weighed to an accuracy of 1 g (m_3),
- the described procedure shall be repeated at least three times, and the average value m_3 shall be calculated.

2.1.11.3.3.4 Basic Measurement Method

To perform measurement of the stratification density according to the basic method the following shall be carried out:

- to specify the layer surface, on which a density measurement is foreseen; the surface of a square shape with a side of approximately 450 mm shall be thoroughly levelled; the soil, which has remained after the surface levelling, shall be removed,
- to place a steel container with a circular opening onto the surface foreseen for the density measurement; the container opening should serve as a frame to form the excavation, which diameter shall amount to approximately 100 mm, and the depth to approximately 150 mm; the excavated soil shall be attentively collected and preserved in a tightly closed container, as well as weighed to an accuracy of 1 g (m_w); no splinters of excavated soil must remain in the excavation,
- to remove the container with the circular opening,
- to place the sanding device filled up with the sand of constant mass m_1 onto the opening, so that the lower part of the sanding device rests centrically on the upper part of the excavation; the locking device shall be opened, and the sand shall be released to flow out

freely into the excavated pit; after the sand stops to flow out, the locking device shall be closed, and the sanding device including the residual sand shall be weighed to an accuracy of 1 g (m_4),

- to take a representative specimen from the soil sample, and to measure its moisture content in accordance with the approved procedure (w); alternatively it is possible, after the excavated soil mass (m_w) has been determined, to dry up the entire soil mass, and to assess the dry soil mass (m_d).

2.1.11.3.3.5 Alternative Measurement Method

To perform measurement of the stratification density according to the alternative method the following shall be carried out:

- onto a levelled layer surface to be examined, a calibrated cylinder shall be placed and carefully impressed into the ground, so that the cylinder upper edge is levelled with the layer surface,
- to excavate the soil from the cylinder up to a depth of approximately 120 mm, to preserve it into a hermetically closed container, and to weigh it to an accuracy of 1 g (m_w),
- onto the opening the sanding device shall be placed filled up to a constant mass m_1, so that the sanding device lower part rests centrically on the excavation upper part; the locking device shall be opened allowing the sand to flow out freely into the cylinder, from which the soil has been excavated; after the sand ceases to flow out, the locking device shall be closed, and the mass of the sanding device including the residual sand m_4 shall be determined to an accuracy of 1 g,
- to take a representative specimen from the soil sample, and to measure its moisture content in accordance with the approved procedure (w); alternatively it is possible, after the excavated soil mass (m_w) has been determined, to dry up the entire soil mass, and to assess the dry soil mass (m_d).

2.1.11.3.3.6 Calculation of Results

The sand mass m_a required to fill up the calibrated container shall be assessed from the equation below:

$$m_a = m_1 - m_3 - m_2$$

where:

m_1 - *mass of the sanding device including sand prior to filling the calibrated container (g)*

m_2 - *average mass of the sand in the sanding device cone (g)*

m_3 - *average mass of the sanding device and sand after the sand has been released into the calibrated container (g)*

The sand stratification density ρ_a shall be calculated from the following equation:

$$\rho_a = \frac{m_a}{V}$$

where:

m_a - *mass of the sand required to fill up the calibrated container (g)*

V - *volume of calibrated container (cm^3)*

The mass of the sand m_b used for excavation backfilling shall be assessed from the following equation:

$$m_b = m_1 - m_4 - m_2,$$

where:

m_1 - *mass of the sanding device and sand prior to backfilling the excavation (g)*

m_2 - *average mass of the sand in the sanding device cone (g)*

m_4 - *mass of the sanding device and sand after the latter has been released into the excavation (g).*

The density of a naturally moist soil ρ shall be calculated from the equation below:

$$\rho = \frac{m_w}{m_b}\rho_a$$

where:

m_w - *mass of excavated soil (g)*

m_b - *mass of sand to backfill the excavation (g)*

ρ_a - *sand stratification density (g/cm^3)*

The soil dry density ρ_d shall be assessed using the following equation:

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

where:

ρ - *density of naturally moist soil (g/cm^3)*

w - *soil moisture content (% by mass),*

or from the following equation:

$$\rho_d = \frac{m_d}{m_b}\rho_a$$

where:

m_d - *mass of dry soil from excavation (g)*

2.1.11.3.3.7 Investigation Report

A soil investigation report shall include the following:

- the type of applied method;
- natural soil density and dry soil density measured and calculated to an accuracy of at least 0.01 g/cm^3;
- soil moisture content rounded off to an accuracy of 0.01%;
- other information or notes important to the result evaluation such as: soil type, source, layer properties, conditions upon measurement execution, etc.

The investigation report shall also comprise a statement that the investigation has been carried out in accordance with this technical guideline.

2.1.11.3.4 Sand Substitution Method for Fine-Grained, Medium-Grained, and Coarse-Grained Soils

2.1.11.3.4.1 Method Applicability

This method is applicable to assess the soil density, when the procedure described in2.2.8.4.3.5 is not suitable. Therefore, this method is an alternative to the method indicated in 2.2.8.4.3.3, however it is appropriate to investigate layers thicker than 150 mm, and thinner than 250 mm.

Note

In case of granular non-cohesive soils, in particular when such soils are very moist, there is a risk of an error, which is a consequence of peeling-off of grains from the excavation walls; it results in a density greater than that realistically occurring in the layer of placed granular soil. In such a case the investigation shall be carried out in compliance with the method described in 3.2.8.4.3.5.

2.1.11.3.4.2 Measurement Equipment

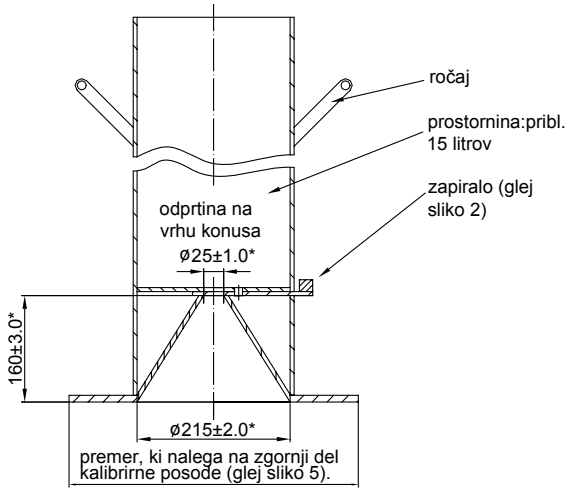
The following basic equipment is required to perform the measurements:

- a sanding device shown in Fig.4,
- equipment suitable to execute excavation in ground: a steel shovel, a steel bar with a ramming head, a rammer, a ladle,

- a calibrated cylindrical steel container of internal diameter of 200 mm, and of outer height of 250 mm, including an accessory measuring 75 mm in width and approximately 5 mm in thickness, welded on the upper edge of the container thus forming a circumference on the opened end of the container (Fig. 5),
- scales of accuracy of 1 g,
- a glass plate of suitable size; a square shape with a side of approximately 500 mm, and of a thickness of 10 mm is recommendable,
- a metal container or other equipment for a temporary keeping of excavated soil;
- a metal container of square shape with a side of 500 mm, and of a height of 50 mm, with a circular opening of 200 mm of diameter in the middle,
- equipment for moisture assessment (according to the specified procedure),
- calibrated silicate sand for substitution, which shall ensure a constant, repeatable, and controllable density; the sand granulometric composition shall be such, that 100 % by mass of the sand passes a 600 μm, and that 100 % by mass of the sand remains on a 63 μm sieve; the calibrated sand must not contain particles of lamellate shape, silt, clay, and organic admixtures; prior to use the sand shall be dried in a dryer, and then kept in an entirely closed container, so that the sand moisture content is balanced with the air humidity.

Note

For moisture balancing a seven-days keeping is generally sufficient. Prior to use the sand shall be mixed up. The sand, which is, after the performed test, excavated from the control excavation in the controlled layer, shall be, prior to repeated use, sieved out, dried, and re-kept until the moisture is balanced.

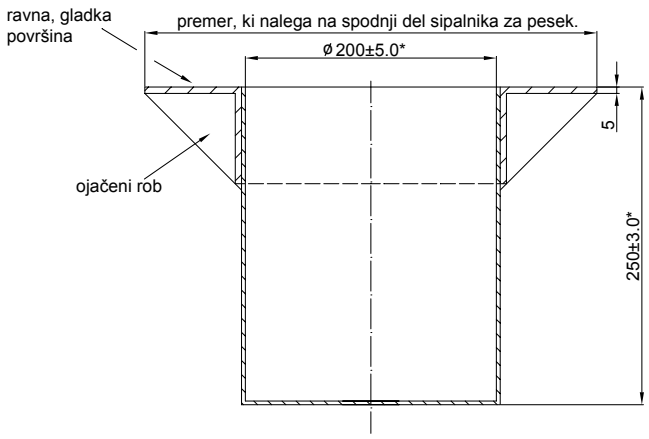


* All dimensions in mm.

The cylinder can also be shaped or conceived differently, however the basic requirements shall always be met.

ročaj = handle, prostornina pribl. 15 litrov = volume approx. 15 litres, zapiralo (glej sliko 2) = locking device (refer to Fig. 2), odprtina na vrhu konusa = opening at the cone top, premer, ki nalega ... = diameter that fits the calibrated container upper part (refer to Fig. 5)

Fig. 4: Large sanding device suitable to assess density of fine-grained, medium-grained, and coarse-grained soils



* All dimensions in mm.

The cylinder can also be shaped or conceived differently, however the basic requirements shall always be met.

ravna, gladka površina =even, smooth surface; ojačeni rob = strengthened edge, premer, ki nalega ...= diameter that fits the sanding device lower part

Fig. 5: Calibrated container used to calibrate the sanding device for fine-grained, medium-grained, and coarse-grained soils

2.1.11.3.4.3 Calibration

2.1.11.3.4.3.1 Assessment of Sand Mass in Sanding Device Cone

To assess the mass of the sand in the sanding device cone the following shall be carried out:

- to fill up the sanding device with sand of known mass weighed to an accuracy of 10 g (m_1); for each subsequent calibration the same initial sand mass shall be used; the locking device shall be opened until the sand volume equal to the excavated void or calibrated container flows out,
- to close the locking device and to place the sanding device including the residual sand onto an even substrate, i.e. glass plate,
- to re-open the locking device and release the sand; during the sand outflow both sanding device and its base must not vibrate; after the sand stops to flow out from the container, the locking device shall be closed and the sanding device carefully removed,
- to collect attentively the sand, which has accumulated in the sanding device cone, and to weigh it to an accuracy of 10 g (m_2),
- to repeat the procedure at least three times, and to calculate the sand mass average value m_2.

2.1.11.3.4.3.2 Assessment of Sand Stratification Density

The following shall be carried out to determine the sand stratification density:

- to determine the calibration container volume as described in 2.2.8.4.3.3.3.2,
- to place the sanding device filled up with sand (constant mass m_1) centrically to the calibrated container, to open the locking device, and to leave the sand to flow out freely from the sanding device; no vibration or trembling of the container or sanding device is admitted; during the procedure the calibrated vessel shall stand on a larger capturing vessel, where the sand flowing out from the cone after removal of the sanding device will be captured,
- after the sand stops to flow out, the locking device shall be closed, and the sanding device including the residual sand shall be weighed to an accuracy of 10 g (m_3),
- the described procedure shall be repeated at least three times, and the average value m_3 shall be calculated.

2.1.11.3.4.4 Measurement Execution

To measure the density the following shall be carried out:

- to select a layer surface, where density measurements will be carried through, and to confine it within a square of side of approximately 600 mm; soil, which remained after surface levelling, shall be removed;
- to place a steel container with the circular opening onto the surface foreseen for the density measurement; the container opening should serve as a frame to form the excavation, which diameter shall amount to approximately 200 mm, and the depth to approximately 250 mm; the excavated soil shall be attentively collected and preserved in a tightly closed container, as well as weighed to an accuracy of 1 g (m_w); no splinters of excavated soil must remain in the excavation,
- to remove the container with the circular opening,
- to place the sanding device filled up with the sand of constant mass m_1 onto the opening, so that the lower part of the sanding device rests centrically on the upper part of the excavation; the locking device shall be opened, and the sand shall be released to flow out freely into the excavated pit; after the sand stops to flow out, the locking device shall be closed, and the sanding device including the residual sand shall be weighed to an accuracy of 10 g (m_4),
- to take a representative specimen from the soil sample, and to measure its moisture content in accordance with the approved procedure (w); alternatively it is possible, after the excavated soil mass (m_w) has been determined, to dry up the entire soil mass, and to assess the dry soil mass (m_d).

2.1.11.3.4.5 Calculation of Results

The sand mass m_a required to fill up the calibrated container shall be assessed from the following equation:

$$m_a = m_1 - m_3 - m_2$$

where:

m_1 - *sanding device and sand mass prior to filling the calibrated container (g)*

m_2 - *average mass of the sand in the sanding device cone (g)*

m_3 - *average mass of sanding device and sand after the sand has been released into the calibrated container (g).*

The sand stratification density ρ_a shall be calculated from the equation below:

$$\rho_a = \frac{m_a}{V}$$

where:

m_a- *mass of sand required to fill up the calibrated container (g)*

V - *calibrated container volume (cm^3)*

The mass of the sand m_b used to backfill the excavation shall be assessed by means of the equation below:

$$m_b = m_1 - m_4 - m_2,$$

where:

m_1 - *mass of sanding device and sand prior to backfilling the excavation (g)*

m_2 - *means mass of the sand in the sanding device cone (g)*

m_4 - *mass of sanding device and sand after the sand has been released into the excavation (g).*

The density of naturally moist soil ρ shall be calculated from the following equation:

$$\rho = \frac{m_w}{m_b}\rho_a$$

where:

m_w - *mass of excavated soil (g),*

m_b - mass of sand to backfill the excavation (g),

ρ_a - sand stratification density (g/cm^3)

The soil dry density ρ_d shall be assessed from the equation below:

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

where:

ρ - density of naturally moist soil (g/cm^3)

w - soil moisture content (% by mass),

or from the following equation:

$$\rho_d = \frac{m_d}{m_b} \rho_a$$

where:

m_d - mass of dry soil from excavation (g)

2.1.11.3.4.6 Investigation Report

A soil investigation report shall include the following:

- the type of applied method;
- natural soil density and dry soil density measured and calculated to an accuracy of at least 0.01 g/cm^3;
- soil moisture content in % by mass expressed to an accuracy of two decimal places;
- other information or notes important to the result evaluation such as: soil type, source, layer properties, conditions upon measurement execution, etc.

The investigation report shall also comprise a statement that the investigation has been carried out in accordance with this technical guideline.

2.1.11.3.5 Water Substitution Method Suitable to Coarse-Grained Soils

2.1.11.3.5.1 Method Applicability

This procedure is applicable to assess density of coarse-grained granular soils located in natural ground, or in artificially raised and compacted layers, where other methods are inadequate for the difficulties in maintaining the stability of excavation walls.

The soil density can be determined in two ways:

- as determination of density for the entire soil mass from the excavated space,
- as determination of density of selected granulometric composition, generally not below 0/32 mm and 0/63 mm respectively.

2.1.11.3.5.2 Measurement Equipment

The equipment to perform measurements depends on the soil type, particularly on the particle size. The basic equipment comprises the following:

- a stiff cylindrical ring measuring approximately 100 mm in height for diameters up to 500 mm, and approximately 200 mm in height for larger diameters; the ring shall be equipped with accessories enabling fixing to the substrate formation (e.g. metal pins, dowels, etc.); the ring diameter shall be several times greater than the diameter of the largest grain in the soil to be investigated.

Note

As a rule, the ring diameter shall be five times greater than the diameter of the largest particle in the soil to be investigated. Ring diameters generally amount to 500 mm – 2,500 mm. Rings greater than 500 mm in diameter, are generally composed of several arcs, which are assembled into a ring and fixed onto the substrate formation at the measuring spot.

- a ruler of suitable length adjusted to the ring diameter,

- a spirit level of suitable length to regulate the ring,
- a measuring frame or an other type of measuring device consisting of an adequate stand or frame with a measuring scale, and with an adjustable indicator, which can be fixed to a permanent place, removed, and fixed again at the same place either on or at the ring.

Note

In case of small measuring rings the indicator can be placed onto a girder equipped with special legs, with which it can be fixed into the ground at the outer side of the measuring ring. In this case the indicator remains on a permanent position in the entire investigation period. On the contrary, for large rings it is wished for that the measuring frame length were slightly greater than the ring diameter, so that it can be put onto the ring, and the exact spot of the contact can be marked. In this case the indicator is placed in the middle of the measuring frame.

- calibrated containers of different dimensions for the water; each container shall be equipped with a volume indicator, and a water outlet pipe including a valve; the volume indicator shall be clearly marked, and shall allow an reading accuracy of 0.3 % of the control excavation volume,
- equipment suitable to execute the excavation, and to take the excavated soil from the ground: a steel shovel, a steel bar with a ramming head, a rammer, a ladle,
- scales of accuracy of 1 g,
- a metal container or other equipment for a temporary keeping of excavated soil;
- a pump, a container, and adequate pipes (hoses) to empty the test excavation,
- a suitable container and accessories to prepare gypsum paste,
- equipment suitable to assess the density of large mineral grains (if necessary),
- equipment suitable to measure moisture content,
- control sieves, if necessary,
- flexible plastic membranes of suitable thickness to prevent soil grain breaking through, and of adequate flexibility to achieve a good adhesion to the excavation walls upon filling with water,

Note

Polyethylene membranes of 0.1 mm of thickness, of square shape measuring 2 – 4 m, are suitable to rings measuring up to 1.5 m in diameter. For rings of diameter up to 0.5 m, prefabricated polyethylene bags of thickness up to 0.1 mm can be used. For large rings measuring more than 1.5 m in diameter, membranes of 0.2 mm of thickness, and of a square shape with a side of 6 to 8 m are appropriate.

- gypsum or some other fast curing material,
- pure water.

2.1.11.3.5.2.1 Water Container Calibration

Each water container equipped with a graduated scale for volume measurement, and with an outlet pipe (hose) including a valve shall be calibrated. The container shall be placed onto an even substrate and filled up with pure water up to the upper edge of the graduated scale. Then the valve shall be opened, and the water shall be poured into individual containers successively, as the water level in the water container is sinking.

Either weighing or measuring volume in the corresponding calibrated container shall assess the volume of released water in each capturing container. On the graduated scale of each container the actually measured volume shall be marked thus completing the calibration.

2.1.11.3.5.3 Measurement Execution

2.1.11.3.5.3.1 Measurement of Density of Entire Material in Tested Layer

The following shall be carried out to accomplish the measurement:

- to select a ring of suitable size, so that the ring diameter is approximately five times greater than the diameter of the largest soil particle in the layer,
- to prepare a smooth and even substrate on the layer formation to be investigated; all soil splinters shall be removed from the surface,
- to prepare a gypsum or some other fast curing paste, to place the ring onto the formation, and to mark the location of the contact; to remove the ring and to cover the marked place

with a thin layer of the binding paste; onto the latter, the ring shall be put and fixed to the ground; to remove all surplus paste pressed out from below the ring,

- to adjust the measuring device in the measuring stand as to allow removal of the stand from the measurement area, and to enable a quick fastening of the indicator exactly onto the same place below the ring edge after repeated return to the measurement area; the measuring stand shall be removed,
- to select an adequate membrane, and to verify whether it is in a perfect condition; then, the membrane shall be spread out over the measuring ring, and carefully placed into the ring; the measuring frame shall be repeatedly placed, and the indicator adjusted,
- to fill up the space in the ring with the water from the calibrated container; during filling attention shall be paid to a proper and tight contact between the membrane and the wall; it shall be verified that no water leaking through the membrane takes place; the water level in the ring shall attain the height of the indicator in the measuring frame; the water quantity R_i shall be recorded in litres,
- to remove the measuring frame, and to fix the indicator; to remove the water and the plastic membrane, and to check, whether the substrate formation is dry; in case that some indications of water leaking are perceived, the test shall be repeated,
- to commence soil excavation; during excavation works attention shall be paid not to move the ring, and not to undermine the soil below the ring; large rock particles or blocks must not be drawn out from the excavation walls; the latter shall be so shaped as to be as smooth as possible; the excavation depth shall be approximately the same as the excavation diameter, except in special cases of assessing the density at an exactly specified depth below the formation,
- to preserve all the excavated soil in suitable watertight containers for a subsequent determination of both mass and moisture; the mass of all the excavated soil is equal to m_w,
- to select a suitable membrane, and to verify whether it is in a perfect condition; the membrane shall be spread out over the ring, and then carefully lowered into the excavated pit; the measuring frame shall be placed again,
- to fill the pit with water from the calibrated container; during filling, the membrane upper edge shall be periodically moved away from the excavation wall to allow a perfect contact between the membrane and the excavation wall during filling the water,
- to add the water until the level reaches the height of the indicator on the measuring stand; after the water level has attained the indicator, the water level condition shall be monitored several minutes to be sure that no water leaking through the membrane takes place; the measured volume shall be within the limits of 0.1 % of the total measured volume R_t recorded in litres,
- to remove the measuring frame, to pump out the water, to remove the membrane, and to verify whether there has been some water leaking through the membrane during the investigation; if a portion of water used for the test has leaked through the membrane, the test shall be repeated.

2.1.11.3.5.3.2 Measurement of Density of Material in Tested Layer up to Specified Nominal Grain Size

The following shall be carried out to accomplish the measurement:

- to select a ring of suitable size, so that the ring diameter is approximately five times greater than the diameter of the largest soil particle in the layer,
- to prepare a smooth and even substrate on the layer formation to be investigated; all soil splinters shall be removed from the surface,
- to prepare a gypsum or some other fast curing paste, to place the ring onto the formation, and to mark the location of the contact; to remove the ring and to cover the marked place with a thin layer of the binding paste; onto the latter, the ring shall be put and fixed to the ground; to remove all surplus paste pressed out from below the ring,
- to adjust the measuring device in the measuring stand as to allow removal of the stand from the measurement area, and to enable a quick fastening of the indicator exactly onto

the same place below the ring edge after repeated return to the measurement area; the measuring stand shall be removed,

- to select an adequate membrane, and to verify whether it is in a perfect condition; then, the membrane shall be spread out over the measuring ring, and carefully placed into the ring; the measuring frame shall be repeatedly placed, and the indicator adjusted,
- to fill up the space in the ring with the water from the calibrated container; during filling attention shall be paid to a proper and tight contact between the membrane and the wall; it shall be verified that no water leaking through the membrane takes place; the water level in the ring shall attain the height of the indicator in the measuring frame; the water quantity R_i shall be recorded in litres,
- to remove the measuring frame, and to fix the indicator; to remove the water and the plastic membrane, and to check, whether the substrate formation is dry; in case that some indications of water leaking are perceived, the test shall be repeated,
- to commence soil excavation; during excavation works attention shall be paid not to move the ring, and not to undermine the soil below the ring; large rock particles or blocks must not be drawn out from the excavation walls; the latter shall be so shaped as to be as smooth as possible; the excavation depth shall be approximately the same as the excavation diameter, except in special cases of assessing the density at an exactly specified depth below the formation,
- to preserve all the excavated soil in suitable watertight containers for a subsequent determination of both mass and moisture; the mass of all the excavated soil is equal to m_w,
- to remove all the grains larger than the specified limiting value from the weighed excavated soil; if necessary sieves of standardized dimensions shall be used; to record the mass of particles of size above the specified limit m_s in kilograms,
- to determine the moisture content w_p on the residual excavated soil from which oversize grains have been removed,
- to determine the soil density by either of the following two methods:
- into the excavation a membrane shall be placed; after the membrane has been placed, all the oversize grains shall be returned into the excavated pit; attention shall be paid not to damage the membrane with these oversize grains; the measuring frame shall be placed, the height indicator fixed, and the excavation filled up with water from the calibrated container; the volume R_p shall be recorded,
- the procedure of filling the excavation with water described in 3.2.8.4.3.5.4.1 shall be entirely carried out; the oversize grain volume shall be assessed at laboratory in compliance with the specified method of immersing the grains into the water, or by calculating the grain volume taking account of their specific density.

2.1.11.3.5.4 Calculation of Results

2.1.11.3.5.4.1 Calculation of Density of Entire Material

The excavation volume V_i (in m^3) shall be calculated from the equation below:

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

where:

R_t *– the total water volume in both excavation and ring (litres)*

R_i *– water volume in the ring (litres)*

The density of naturally moist soil ρ shall be calculated from the following equation:

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

where:

m_w *- mass of excavated soil (kg),*

V_i *- volume of excavation (m^3)*

The dry density of soil ρ_d shall be calculated using the equation below:

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

where:

ρ - *density of naturally moist soil (kg/m^3)*

w - *soil moisture content (% by mass)*

2.1.11.3.5.4.2 Calculation of Soil Density Without Considering Oversize Grains

When oversize grains are returned into the excavation, the dry density of naturally moist soil ρ_{dp} shall be calculated from the following equation:

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

where:

m_w - *mass of excavated soil (kg),*

m_s - *mass of oversize grains (kg)*

R_p - *water volume in the excavation containing oversize grains (litres)*

w_p - *soil moisture content after removal of oversize grains (% by mass).*

Where the volume of oversize grains is assessed at laboratory, or by suitable calculation, the dry density of naturally moist soil ρ_{dp} shall be calculated from the equation below:

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

where:

V_i - *water volume in the excavation containing oversize grains (litres)*

V_s - *water volume in the ring (litres)*

2.1.11.3.5.4.3 Investigation Report

A soil investigation report shall include the following:

- the type of applied method;
- natural soil density and dry soil density measured and calculated to an accuracy of at least 0.01 g/cm^3;
- soil moisture content in % by mass expressed to an accuracy of 0.5%;
- grain size of the soil, which density has been assessed,
- granulometric composition, if necessary,
- dimensions of the excavation,
- method of calculation of volume of oversize grains, if the latter have not been returned into the excavation,

The investigation report shall also comprise a statement that the investigation has been carried out in accordance with this technical guideline.

2.1.12 RANDOM SELECTION OF MEASUREMENT POINTS AND SAMPLING LOCATIONS

According to Item 2.1.5.1 of these technical conditions the sampling locations and measurement points have to be in principle determined randomly.

The following bases are used for determining sampling locations and measurement points:

The basis for survey mark position has to be connected to profiles according to project documentation. Current survey mark position refers to distance from connection location.

The deviation from the edge of pavement structure base (O) has to be determined on the basis of pavement structure base width (š), using the random number (R) in enclosures 1 to 12 according to the following equations:

for partial cross section of the embankment

$$O_d = R \times (š - 0.5) + 0.5 \quad (m)$$

for the entire cross section

$$O_c = R \times (š - 1.0) + 0.5 \quad (m)$$

š = width of pavement structure base

[2] The deviation has to be determined for partial cross section of the embankment from the outer edge of pavement structure base and, in the case of entire cross section, for randomly selected left or right edge - however, the same over the entire embankment.

Enclosure 1

Ref. no.	Survey mark position current [1]	Measurement point sampling location		
		random R number	deviation from the edge [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	+	

Enclosure2

Ref. no.	Survey mark position current [1]	Measurement point sampling location		
		random R number	deviation from the edge [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		+

Enclosure 3

Ref. no.	Survey mark position current [1]	Measurement point sampling location		
		random R number	deviation from the edge [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		+

Enclosur 4

Ref. No.	Survey mark position current [1]	Measurement point Sampling location		
		random R number	deviation from the edge [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		+

Enclosure 5

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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	+	

Enclosure 6

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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		+

Enclosure 7

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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	+	

Enclosure 8

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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		+

Enclosure 9

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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	+	

Enclosure 1/10

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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	+	

Enclosure 11

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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		+

Enclosure 12

Ref. no.	Survey mark position current [1]	Measurement point sampling location random R number	no.	
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	+	

2.1.13 SITE MANAGEMENT

The bases for this guideline are the Directives of EU Council and European standards. As applicable some international and national standards are referenced.

2.1.13.1 EU DIRECTIVES

COUNCIL DIRECTIVE 92/57/EEC of 24 June 1992 on the implementation of minimum safety and health requirements at temporary or mobile constructions sites (8th individual Directive within the meaning of Article (16/1) of Directive 89/391/EEC
COUNCIL DIRECTIVE 92/58/EEC of 24 June 1992 on the minimum requirements for the provision of safety and/or health signs at work (9th individual Directive within the meaning of Article (16/1) of Directive 89/391/EEC
COUNCIL DIRECTIVE of 16 June 1975 on the disposal of waste oils (75/439/EEC)
COUNCIL DIRECTIVE of 22 December 1986 on amendments to the Directive 75/439/EEC on the disposal of waste oils (87/101/EEC)
COUNCIL DIRECTIVE of 15 July 1975 on waste (75/442/EEC)
COMMISSION DECISION of 21 April 1976 setting up a Committee on Waste Management (76/431/EEC)
COUNCIL DIRECTIVE of 20 February 1978 on waste from the titanium dioxide industry (78/176/EEC)
COUNCIL DIRECTIVE of 24 January 1983 on amendments to the Directive 78/176/EEC on waste from the titanium dioxide industry (83/29/EEC)
COUNCIL DIRECTIVE of 8 June 1989 on the prevention of air pollution from new municipal waste incineration plants (89/369/EEC)
COUNCIL DIRECTIVE of 18 March 1991 on amendments to the Directive 75/442/EEC on waste (91/156/EEC)
COUNCIL DIRECTIVE of 12 December 1991 on hazardous waste (91/689/EEC)
COUNCIL DIRECTIVE of 27 June 1994 on amendments to the Directive 91/689/EEC on hazardous waste
COUNCIL DIRECTIVE 94/67/EC of 16 December 1994 on incineration of hazardous waste
COUNCIL DIRECTIVE 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCBs/PCTs)
COMMISSION DECISION of 28 January 1997 establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Text with EEA relevance) (97/129/EC)
COMMISSION DECISION of 3 February 1997 establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Text with EEA relevance) (97/138/EC)
COUNCIL DIRECTIVE 1999/31/EC of 26 April 1999 on the landfill of waste
COMMISSION DECISION of 3 May 2000 replacing Commission Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified by document number K(2000) 1147) (Text with EEA relevance) (2000/532/EC)
DIRECTIVE 2000/76/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 December 2000 on incineration
COMMISSION DECISION of 16 January 2001 amending Decision 2000/532/EC as regards the list of wastes (notified under document number K(2001) 108) (Text with EEA relevance) (2001/118/EC)
COMMISSION DECISION of 22 January 2001 amending Decision 2000/532/EC replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number K(2001) 106) (Text with EEA relevance) (2001/119/EC)
COUNCIL DECISION. of 23 July 2001. amending Commission Decision 2000/532/EC as regards the list of wastes. (2001/573/EC)

2.1.13.2 TECHNICAL SPECIFICATIONS

Health and environment protection

DIN 30787(1 do 6)	Transportbelastungen – Messen und Auswerten von mechanisch -dynamischen Belastungen
E VDI 3840-2002-09	Schwingungstechnische Berechnungen
DIN 45669	Messung von Schwingungsimmissionen

EN ISO 8041:2005	Human reaction on vibrations – measuring instruments (ISO 8041:2005)	
Rules on Equipment and First Aid Procedure, and on Organization of Rescue Service in the Case of Accident at Work		Official Gazette of the SRFY, no. 21/711
Rules Concerning the Provision of Accommodation and Meals or Transportation of Workers from the Lodging Place to the Place of Work And Back		Official Gazette of the SRFY, no. 41/68
Rules on General Industrial Safety Measures and Standards at Work with Regard to Constructions Intended for Workrooms and Auxiliary Rooms		Official Gazette of the SRFY, no. 27/67
Rules on Hygienic Integrity of Drinking Water		Official Gazette of the SRFY, no. 33/87
EN 1263-1:2002	Zaštitne mreže – 1. dio: Zaštitni zahtjevi, probne metode	EN 1263-1: Safety nets – Part 1: Safety requirements, test methods
EN 1263-2:2002	Zaštitne mreže – 2. dio: Zaštitni zahtjevi za namještanje zaštitnih mreža	EN 1263-2: Safety nets – Part 2: Safety requirements for the positioning limits
HD 384.7.704 S1:2001	Električne instalacije građevina – 7. dio: Zahtjevi za posebne instalacije ili lokacije –. odjeljak 704: Gradilišta (IEC 60364-7-704:1989, promijenjen)	Electrical installations of buildings – Part 7: Requirements for special installations or locations – Section 704: Construction and demolition site installations (IEC 60364-7-704:1989, modified)
HD 1000:2000	Radne skele iz prefabriciranih tipskih elemenata (sistemske skele) – Materijali, mjere, opterećenja i zaštitni zahtjevi	Service and working scaffolds made of prefabricated elements – Materials, dimensions, design loads and safety requirements
EN 74:2000	Cijevne spojnice, vezne centrične spojnice i bazne ploče za radne i nosive skele iz čeličnih cijevi - Zahtjevi i postupci ispitivanja	Couplers, loose spigots and base-plates for use in working scaffolds and falsework made of steel tubes - Requirements and test procedures
EN 131-1:1996	Ljestve - Terminologija, tipovi, funkcionalne veličine	Ladders - Terminology, types, functional sizes
EN 131-1: 1996/AC:2001	Ljestve – Terminologija(termini), tipovi, funkcionalne veličine	Ladders - Terms, types, functional sizes
EN 131-2:1996	Ljestve - Zahtjevi, ispitivanje, označavanje	Ladders - Requirements, testing, marking
EN 131-2: 1996/AC:2001	Ljestve - Zahtjevi, ispitivanje, označavanje	Ladders - Requirements, testing, marking
prEN 131-3:2004	Ljestve – 3. dio: Informacija za korisnika	Ladders - Part 3: User information
HD 1004:2000	Pomične radne skele na točkovima iz prefabriciranih tipskih elemenata - Materijali, mjere, opterećenja i zaštitni zahtjevi	Mobile access and working towers made of prefabricated elements - Materials, dimensions, design loads and safety requirements
HD 1039:2000	Čelične cijevi za nosive i radne skele - Zahtjevi, probe	Steel tubes for false work and working scaffolds - Requirements, tests
EN 1065:2000	Čelični teleskopski građevinski potpornici - Specifikacije proizvoda, dimenzioniranje i dokazivanje nosivosti sa proračunom i sa probama	Adjustable telescopic steel props - Product specifications, design and assessment by calculation and tests
EN 1298:2000	Pokretne radne skele na točkovima - Pravila i smjernice za pripremu uputstva za montažu i upotrebu -	Mobile access and working towers - Rules and guidelines for the preparation of an instruction manual

EN 1808:2000	Zaštitni zahtjevi za viseće sprave za dizanje - Konstrukcijski izračuni, kriteriji stabilnosti, izvedbe – Probe	Safety requirements on suspended access equipment - Design calculations, stability criteria, construction - Tests
EN 60439-4:1995.	Sastavi niskonaponskih prekidačkih i sprava za upravljanje – 4. dio: Posebni zahtjevi za gradilišta (ACS)	Low-voltage switchgear and controlgear assemblies - Part 4: Particular requirements for assemblies for construction sites (ACS) (IEC 439-4:1990)
EN 60439-4:1995/A11:2004		Withdrawal of Austrian A-deviation regarding sub clauses 9.1.3d, 9.3.3 and 9.5.2 of EN
EN 60439-4:1995/A1:2000	Sastavi niskonaponskih prekidača i sprava za upravljanje – 4. dio: Posebni zahtjevi za gradilišta (ACS) – Dopuna A1:	Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS) - Amendment A1 (IEC 60439-4:1990/A1:1995)
EN 60439-4:1995/A2:2000	Sastavi niskonaponskih prekidačkih i sprava za upravljanje – 4. dio: Posebni zahtjevi za gradilišta (ACS) – Dopuna A2	Amendment A2:1999 to EN 60439-4:1991
EN 60439-4:2005	Sastavi niskonaponskih prekidačkih i sprava za upravljanje – 4. dio: Posebni zahtjevi za sastave na gradilištima (ACS)	Low-voltage switchgear and control gear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)
HD 22.4 S3:1998		Rubber insulated cables of rated voltages up to and including 450/750 V - Part 4: Cords and flexible cables (IEC 245-4:1994, modified)
HD 22.4 S3:1998/A1:1999		Rubber insulated cables of rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables - Amendment A1
HD 22.4 S3:1998/A2:2003		Cables of rated voltages up to and including 450/750 V and having cross-linked insulation - Part 4: Cords and flexible cables
HD 22.4 S4:2004	Kablovi sa gumenom izolacijom za označene napone do uključeno 450/750 V – 4. dio: Trake(užad) i fleksibilni kablovi	Cables of rated voltages up to and including 450/750 V and having cross linked insulation – Part 4: Cords and flexible cables
EN 60 598-2-8:1998		Luminaries - Part 2: Particular requirements - Section 8: Hand lamps (IEC 60598-2-2:1996, modified)
EN 60598-2-8:1998/A1:2000	Dopuna A1:2000 k EN 60598-2-8:1998	Amendment A1:2000 to EN 60598-2-8:1997
EN 471:2003	Dobro vidljiva upozoravajuća odjeća za profesionalnu upotrebu – Probne metode i zahtjevi	High-visibility warning clothing for professional use - Test methods and requirements
Serija standarda ISO 8421-(1 do 8)	Zaštita od požara– rječnici	ISO 8421-(1 to 8) Fire protection – Vocabularies

Self protective equipment

Equipment for protecting the respiratory system:	EN: 132 to 145; 148, 149; 269 to 271; 371, 372, 402 to 405; 1146, 1827, 1835, 12083, 12419, 12941, 12942, 13274, 13794,
Respiratory equipment	EN: 250, 13949, 13949,
Personal eye-protection	EN: 165 to 172, 174, 175, 208
Protective clothing	EN: 340, 343, 348, 367 to 369; 373, 381, 463 to 471; 530, 531, 533, 702, 863, 943, 1073, 1149, 1999, 1486, 50286, 50321,

	60895; EN ISO 6942; 13997, 13998, 14877, 15025
Personal protective equipment against falls from a height	EN: 341, 353 to 355, 358, 360 to 365; 795, 813, 1868, 1891,
Protective and working footwear for professional use	EN: 344 to 347;
Hearing protection	EN: 352, 458, 13819, 24869, 24869; EN ISO 4869-2,
Safety gloves	EN: 374, 388, 407, 420 to 421; 659, 1082, 12477, 50237, 60903,
Self-darkening filters (welding goggles)	EN: 379,
Lifejackets and personal buoyancy aids	EN: 340, 393 to 396; 399
Industrial safety helmets	EN: 397, 812, 13087, 50365,
Helmets for firefighters	EN: 443,
Eye protectors	EN: 1731,
Mechanical vibration and shock	EN ISO 10819

2.1.13.3 COORDINATION OF SAFETY AND HEALTH AT WORK

When works on the construction site are implemented or are planned to be implemented by two or more contractors, the client or the project supervisor must appoint one or more coordinators for safety and health at work.

The client or project supervisor must appoint coordinator(s) especially for the stage of project preparation and project execution.

Coordinator for safety and health at the project preparations stage shall have at least higher professional education in technical studies, a professional examination as stipulated by law regulating construction of buildings or a professional examination as stipulated by law regulating safety and health at work, training under the programme for coordinators for safety and health at work and at least three years of experience in designing and implementing construction works.

Coordinator for safety and health at the project execution stage shall have at least higher professional education in technical studies, a professional examination as stipulated by law regulating safety and health at work, training under the programme for coordinators for safety and health at work and at least three years of experience in designing and implementing construction works. Coordinator at the execution stage cannot be a person employed with one of the contracting companies.

2.1.13.3.1 Tasks of the coordinator in the design preparation stage

Coordinator for safety and health at the preparations stage shall perform the following tasks:

prepare or make sure/coordinate that the safety plan is prepared in line with the rules referring to the relevant construction site, taking into account, if necessary, also industrial activities on the construction site; this plan must include also special measures for works which belong to one or more categories of works of special danger;

prepare the documentation according to the characteristics of the project, which shall include the suitable safety and health data that need to be considered in all further works (during use, maintenance, demolition, etc.).

2.1.13.3.2 Tasks of the coordinator in the project execution stage

In the project execution stage the coordinator shall have mainly the following tasks:

a) to coordinate the implementation of basic principles of safety and health at work:
   - when making decisions about technical and/or organisational aspects in planning individual phases of work;
   - when setting deadlines necessary for safe completion of individual phases of work carried out at the same time or successively;

b) to coordinate the implementation of relevant provisions to ensure that employers and self-employed persons:
   - consistently follow the basic principles from Article 10 of the above Decree;

- comply with the safety plan;

c) to prepare or provide for the preparation of the necessary adjustment of the safety plan and documentation to the changes on the construction site;

d) to ensure cooperation and mutual informing of contractors, who either at the same time or successively work on the construction site and their workers' representatives with the aim of preventing injuries or health risks at work;

e) to check safe implementation of work procedures and coordinate planned activities;

f) to ensure that the construction site is accessed only by persons employed there and persons authorised for access.

2.1.13.3.3 Obligations of clients, supervisors and contractors

Appointment of a contractor does not relieve the client or supervisor of responsibilities related to ensuring safety and health of workers during works on the construction site.

Tasks implemented by coordinators do not affect the obligations of the contractors as regards the provision of safety and health of workers on the construction site pursuant to the law regulating safety and health at work.

The contractors must follow the instructions of the coordinators.

2.1.13.4 SAFETY PLAN FOR CIVIL ENGINEERING CONSTRUCTION

These guidelines include proposed contents of the SP, which contain also a description of measures in civil engineering construction.

2.1.13.4.1 Contents

1. Introduction
2. List of regulations
3. Organisation of construction site security in view of the surrounding area
4. Organisation and maintenance of offices, changing rooms, sanitary installations and accommodation facilities on the construction site
   - Rest rooms and/or accommodation rooms
   - Utility and sanitary - hygiene installations
   - Transport to work
   - Supplying workers with food and drinking water
   - Ventilation and lighting
5 Organisation of electricity and telecommunication installations
6 Organisation of traffic communications, emergency routes and exits
   - Transport routes on and along the construction site
   - Emergency routes and exits
   - Traffic routes on danger areas
   - Doors and gates
   - Loading bays and ramps
7 Distribution and storing of construction material
   - Premises for storing hazardous materials
   - List of hazardous and ecologically unsafe materials and products
8 Lifting and transporting equipment
9 Vehicles and machines for excavation, relocation and transport of material
10 Devices and facilities for maintaining machinery on the construction site
   - Handling fuel, lubricants and hazardous substances on the construction site
   - Washing and maintaining vehicles on the construction site
   - Parking of vehicles and machinery and maintenance
11 Organisation of work places
   - Works of special danger and protective equipment
   - First aid

- Impacts of stability and strength on safety at work
- Earthworks, underground facilities and works in constricted areas
- Demolition and disassembly
- Work along traffic
- Massive constructions, metal or concrete frames, formwork and heavy prefabricated elements
- Roof work
- Work places at height
- Maintenance works

12 Installations, working devices and equipment

13 Working platforms, ladders and scaffolds

14 Protection against fire on the construction site

15 Description of selected/used construction technologies

16 Impact of construction work on additional traffic volumes on existing roads

17 Timetable for coordinating measures related to safety and health with the construction

18 Joint measures for provision of health and safety at work

19 Mutual informing of individual work managers on work progress

20 Construction rules

21 Works inventory with estimated costs of the construction site arrangement and implementation of joint measures for providing safety and health at work on the construction site

22 Environmental impact and mitigation measures

- Noise impact on natural and living environment and mitigation measures
- Plan of noise monitoring during construction
- Construction's impact on the atmosphere and mitigation measures for excessive emissions
- Plan of monitoring of air during construction
- Construction's impact on underground water and mitigation measures for reducing negative impacts
- Plan of monitoring of air during construction
- Construction's impact on underground water and mitigation measures for reducing negative impacts
- Monitoring plan for underground water
- Impact of construction on the soil, flora and fauna
- Monitoring plan for soil and plants
- Impact of blasting and other dynamic effects of work implementation on people and buildings
- Arrangement of the construction site area after the concluded work

23 Rules on management of construction waste

- Construction waste management plan
- Construction waste management report
- Obligations of the investor and the contractor during work implementation
- Waste collection
- Processing and removal of construction waste
- Handling waste containing asbestos
- Waste management supervision

24 Graphic enclosures

- Overview site plan, RP 1:5000 with construction facilities
- Plan of organisation of living and working premises, sanitary facilities and the cafeteria, RP 1:100

- Electricity supply plan
- Telecommunications plan
- Water supply and sewage
- Traffic arrangement site plan during construction for public and construction roads with traffic signalisation, RP 1:5000
- Lift site plan, including the sketch of handling area
- Site plan of individual areas of utility line organisation and electricity supply, RP 1:1000
- Design sketches of solutions of individual facilities and devices for environmental protection under this project:
- arrangement of warehouses for hazardous substances
- parking area
- working platforms for repairing machines and vehicles
- material depositing
- other.

25 Cadastre with the list of lots and owners, if the activity involves land outside the area of exclusive use according to the Decree on the Detailed Plan.

2.1.13.4.2 Instructions for preparing a safety plan

2.1.13.4.2.1 Introduction

The SP has to be prepared in accordance with implementing regulations of the Construction Act. Within the scope of the SP a waste management study must be carried out. Such study comprises: the description of construction waste and its quantity, the description of temporary depositing and the description of construction waste management. The requirement to prepare a project of ecological organisation of the construction site is for motorway sections included in the Decrees on Detailed Plans, especially for those sections, where the route runs across areas protected as natural heritage, areas with underground and surface waters, and under other measures of local communities or government bodies, if the activities in these areas would without proper preventive protection measures endanger natural balance.

The introductory (or general) part of the SP must describe the characteristics of the intervention in the environment (road construction or other construction) related to the scope of planned works and their characteristics. Moreover, it must include data about the geological, hydrological, pedological and biological characteristics of the intervention location in terms of the status before the intervention. Data are adopted from the Environmental Impact Assessment Report - EIA (if prepared or prescribed), which is produced in the framework of the detailed plan. This report is required for road construction according to the Environmental Protection Act. The Environmental Protection Act stipulates that load on the environment is every intervention or consequence of intervention in the environment resulting or having resulted in environmental pollution, degradation, risk or damage. Every intervention in environment must be planned so as to cause minimum changes in the environment and risk for the environment. A programme for monitoring impacts on the environment must be prepared for monitoring the status. Such programme must be implemented in the work execution phase.

The SP must define and assess the risk of ecological disaster as an extraordinary event arising from uncontrolled event and resulting in danger to health or life of people, destruction, damage or critical load to the environment. In this sense the SP must describe:

- the type, quantity and characteristics of hazardous substances and planned management of these substances;
- measures during their use, warehousing, transport and disposal;
- potential and planned measures for reducing the risk of an ecological disaster;
- potential ecological disaster scenario, including the probability and size of affected area as well as the consequences for the health of people and impairment of the environment;
- the necessary intervention measures for alleviating or preventing consequences.

The SP must deal with all works implemented in the scope defined by the detailed plan and CPP. If there are several contractors on the construction site, more plans have to be prepared. These

plans must be coordinated or a single plan must be produced for all contractors, which has to include all contents and measures prescribed for such SP.

The person(s) responsible for the implementation of measures provided for by the project must be stated in the SP. Such person(s) are in charge of implementing the measures specified in the project and certain measures defined in other legal provisions. Such person proposes to the responsible works manager additional measures, if these are needed for eliminating the consequences of the intervention in the environment, provides the principle of public ness according to the Environmental Protection Act and cooperates with the competent national authorities and local community bodies in matters concerning environmental protection and health of people.

The construction log must include all events related to the contents of the SP and the measures provided in the SP.

2.1.13.4.3 Organisation of construction site

2.1.13.4.3.1 Protection of the construction site

The arrangement of security of the area surrounding the construction site is prescribed by the Construction Act. Organisation plan is a part of Safety Report (plan) (SP)

SP provides for:

- construction site marking (sign containing data on design, designer, Contractor and Employer);
- security of the construction area and individual facilities (plastic tapes, various fences);
- security of facilities intended for environmental protection;
- method of security during and outside working hours;
- method of informing the person in charge about extraordinary ecological events;
- instructions for taking measures in the event of extraordinary ecological events outside working hours;
- other, depending on the nature of the construction site.

2.1.13.4.3.2 Construction site organisation

The plan of construction site organisation is prepared by the contractor selected by the investor. The plan of construction site organisation has to be produced in accordance with the project based on which a building permit has been issued and in line with the safety plan, if prescribed. It has to include all the necessary data about communication paths on the construction site and points of access to the public infrastructure from the construction site, showing also the access to the public road, about warehouses, disposal sites, workshops, office for managing the construction site and engineer/supervision, changing rooms and sanitary premises for workers as well as other information relevant for safe and reliable operation of the construction site.

Prior to the start of construction the plan of construction site organisation has to be approved by the investor.

The plan of construction site organisation need not be prepared for self-managed construction and the construction of less demanding and simple facilities, unless such construction takes place in areas referred to in the previous paragraph or if three or more less demanding facilities are planned to be constructed at a single location or building plot.

If construction is carried out in the area of a public airport, road, railway or port, which is operating and the construction and operation of such public infrastructural facility have to be simultaneous, the plan of construction site organisation has to provide for safe air, road, railway and see transport.

If construction is carried out in an area with overhead lines or underground cables of public infrastructural facilities, such as sewage, water pipeline, electricity network, telecommunications network, gas pipeline, heating installations and other utility facilities, the plan of construction site organisation has to provide for their uninterrupted operation.

Before any works start being implemented in the area of the future construction site, it has to be ensured that during the implementation of works all workers' safety and health hazards are prevented which could arise from the existing installations, devices, facilities and activities (being) carried out on the construction site.

Throughout the construction, the construction site has to be arranged so that it enables unobstructed and safe implementation of all works, preventing danger of injuries and health risk to workers and other persons. All passages and accesses to the construction site have to be clear, wide enough, regularly cleaned and maintained as well as suitably illuminated. Any vertical rods and other obstacles protruding from the ground or ceiling have to be bent or protected and marked so that the workers cannot injure themselves. The construction rules have to be posted at visible places at all entries to the construction site, in the cafeteria and all changing rooms of workers.

Auxiliary construction site facilities, such as carpentry, joiner, locksmith and other workshops as a rule have to be outside dangerous zones. If this is not possible, safety and health of workers have to be ensured in some other suitable way, as specified in the safety plan.

All measures that have to be implemented in order to ensure safety and health of workers due to circumstances and events not projected in the safety plan have to be recorded by the safety and health co-ordinator in the book of measures for safe work. The book of measures for safety work is kept by the co-ordinator and has to be at the construction site at all times, available to the work inspection and all contractors implementing works on the construction site.

In the case of major works the investor may require that the constructor builds and equips working premises for a supervisor or engineer.

Specific equipment required by the investor on their working premises is usually the following:

- telecommunication equipment
- personal computers with software
- off-road vehicles
- rest premises for workers - only for three-shift work (tunnels)

All equipment has to comply with the relevant standards, ensuring safe and healthy work and transport.

2.1.13.4.4 Organisation and maintenance of offices, changing rooms, sanitary installations and accommodation facilities on the construction site

Until the national Decree entered into force, this issue may be regulated by the regulations of former SFRJ:

2.1.13.4.4.1 Rest rooms and/or accommodation rooms

On engineering construction sites, which include the construction of roads and other infrastructural facilities within the scope of road construction, there are several possible approaches to and methods of accommodating all workers working on the construction site occasionally or on a permanent basis. These possibilities depend on:

- the scope of works and the planned number of employees;
- construction site location;
- existing accommodation capacities in the area where works are implemented;
- duration of works;

According to the above stated conditions the following examples of accommodating labour force are possible:

- on the construction site full accommodation is organised for all labour force (temporary prefabricated wooden facilities, living containers);
- accommodation of part of labour force is not organised on the construction site;
- labour force or a part of labour force is accommodated at the existing overnight facilities or leased residential facilities;
- labour force resides at their homes;
- other cases depending on local conditions, working conditions and the scope of work.

SP has to specify:

- the number of workers permanently residing in the construction site facilities;
- the number of workers migrating daily;
- the method of accommodation and solutions;
- the structure of labour force by qualification;

- the method of sanitary water supply.

Rest areas and/or accommodation facilities have to be large enough and equipped with a suitable number of tables and seats with backs accommodating the total number of workers on the construction site.

If no special rest areas are available, other premises have to be provided for workers to spend their time when work is interrupted.

Permanent accommodation facilities have to have sufficient sanitary equipment, rest area and room for spending free time, unless used only in exceptional cases.

They have to be equipped with beds, closets, tables and seats with backs, taking into account the number of workers, and arranged, where appropriate, separately for men and women.

Appropriate measures should be taken for the protection of non-smokers against discomfort caused by tobacco smoke in rest areas and/or accommodation facilities. If necessary, rest areas and/or accommodation facilities of smokers have to be separate.

Pregnant women and nursing mothers must be able to lie down to rest in appropriate conditions.

Work places must be organized to take account of handicapped workers, if necessary.

This provision applies in particular to the doors, passageways, staircases, showers, washbasins and lavatories used directly by handicapped persons and the work sites at which they are employed.

2.1.13.4.4.2 Utility and sanitary - hygiene installations

2.1.13.4.4.2.1 Utility installation

Contractors and supervisors have to be provided:

- electricity;
- cold and hot running water or water reservoir;
- telephone connection and wireless telephones;
- waste water collector, treatment and/or removal to a treatment plant;
- liquid petroleum gas reservoir with distributors (for heating, if planned);
- other resources, depending on the need of the construction site;

The extent of the necessary utility connections depends on the extent of construction works, the number of employees and the accommodation and diet method. This is assessed depending on the technology of work implementation and the needs arising there from.

SP includes:

the method of supplying necessary quantity of drinking and fire extinguishing water as well as technological water, if needed in the working process, and the calculation of quantity and water supply source;

drawing of energy supply and source location;

drawing of waste water collection and drainage from the construction site;

the procedure for handling polluted and waste water, which has to be properly treated before discharged to a water course or underground stream, so that the permitted parameters of hazardous substances are complied with or the water is collected and taken to the sewage treatment plant. The measures depend on the pollution level of the waters and the vulnerability of the environment, surface and underground water;

a map of construction site organisation showing utility and energy lines RP 1,5000 or 1:1000.

2.1.13.4.4.2.2 Sanitary hygiene installation

Sanitary conditions for employees depend on the method of accommodation in residential facilities and organisation of the construction site itself.

Changing rooms have to be provided for workers on the construction site. Changing rooms have to be sufficient for the number of workers needing them, so that each workers is provided at least 0.45 m2 of area. If work is organised in shifts, double area specified above has to be provided.

The following has to be provided on the construction site:

- changing rooms;
- water for showering and washing;
- sanitary facilities (toilets).

The method of implementing the necessary measures to a high degree depends on:

- planned number of employees;
- ecological vulnerability of the area where the construction site is located;
- employee structure by gender;
- nature of work.

If the natural area of a construction site is less vulnerable, toilets with septic tanks may be arranged.

A septic tank may be provided for:

- dry toilets, volume min 50 l/person or 3,000 l, double-cell without outlet;
- toilets with water flushing, volume min 50 l/person or 3,000 l, double-cell;
- septic tank with several divisions, volume 2,000 l/person or min. 6,000 l if pumped, if there are more than 10 but less than 60 persons;
- if more than 60 persons are permanently employed, a (temporary) biological cleaning device has to be provided.

A project has to be prepared for a toilet with septic tank and the rules of procedure drawn up. The rules of procedure have to comply with the Instructions on Septic Tanks and Leaching Cesspools. The latter determine that septic tanks have to be emptied at least on a yearly basis or when 2/3 full. When emptying, 1/6 has to be left inside to enable the metabolism. The rules of procedure have to specify the mud disposal sites resulting from emptying. A disposal site has to be properly selected according to the local situation.

A sanitary container on the construction site provides a combination of a toilet and a shower and is today most frequently used.

In environmentally vulnerable areas (underground water), toilets with septic tanks must not be provided and used. In such cases, chemical toilets have to be used instead of flushing toilets and rules of procedure for handling and maintaining them drawn up.

SP has to include:

- sanitary facilities of accommodation facilities in the facility design (A.1);
- changing room area and the number of lockers (double);
- the number of toilets by the number of employees, taking gender into account;
- the method of organisation according to environmental protection conditions;
- drawing of locations of toilets and washing water RP 1:1000;
- a plan of a toilet with a septic tank;
- rules of procedure and maintenance of sanitary facilities;
- a plan of chemical toilet, rules of procedure and keeping of operation log.

2.1.13.4.4.2.3 Dressing rooms

Appropriate changing rooms must be provided for workers if they have to wear special work clothes and where, for reasons of health or propriety, they cannot be expected to change in another room.

Changing rooms have to be equipped with lockers for personal items.

Every worker has to be provided at least one locker, however, if (s)he carries out work in extremely dirty, aggressive or hot atmosphere, the employer has to provide him/her separate lockers for dirty and clean clothes.

Changing rooms are not necessary if the implementation of works is of short-term nature or when they are available to workers less than 30 km away from the construction site and the employer provides transportation for the workers to these changing rooms. Workers have to have a place available where they can lock their clothes and personal possessions in such case.

Changing rooms must be easily accessible, roomy and equipped with seats.

If circumstances so require (e.g. dangerous substances, humidity, dirt), lockers for work clothes must be separate from those for ordinary clothes and personal items.

Provision must be made for separate changing rooms or separate use of changing rooms for men and women.

2.1.13.4.4.2.4 Showers and washbasins

A suitable number of showers has to be provided, if so required by the nature of work or health reasons.

Provision must be made for separate showers or separate use of showers for men and women.

The shower rooms must be sufficiently large to permit each worker to wash without reservations in conditions of an appropriate standard of hygiene.

Showers must be equipped with running hot and cold water.

If showers are not necessary, a sufficient number of washbasins with running water (also hot, if necessary) has to be provided in the vicinity of work sites and changing rooms.

Provision must be made for separate washbasins or separate use of washbasins for men and women.

If the premises with showers or washbasins are separate from changing rooms, they have to be directly connected with them.

2.1.13.4.4.2.5 Lavatories

Separate facilities must be provided in the vicinity of work sites, rest rooms, changing rooms and rooms housing showers or washbasins, with an adequate number of lavatories and washbasins.

One toilet has to be provided for every 30 workers. In the approximate vicinity of the toilets workers have to be provided a possibility to wash. One washbasin with soap and paper towels has to be provided for every 10 workers who complete their works at the same time.

Provision must be made for separate lavatories or separate use of lavatories for men and women.

2.1.13.4.4.3 Transport to work

If necessary, the workers have to be provided organised transport to work by means of transport which is in perfect technical condition. Transport of workers has to be provided by the contractor, if the place of residence is more than 5 km away.

On engineering construction sites, which include the construction of roads and other infrastructural facilities within the scope of road construction, there are several possible approaches to transporting labour force, i.e. all workers working on the construction site occasionally or on a permanent basis. These possibilities depend on:

- the number of workers without own means of transport:
- the number of workers;
- the possibility of public transport;
- construction site location;
- existing accommodation capacities in the area where works are implemented.

According to the above stated conditions the following examples of transporting labour force are possible:

- own means of transport are used;
- public means of transport are used (buses, train, etc.);
- transport organised by the company - contractor;
- other cases depending on local conditions, working conditions and the scope of work.

In practice there is often a combination of the above, which should be considered in planning and producing a SP. For this reason this part of the project to a great extent depends on the selected contractor of works and its location.

SP has to specify or state:

- the number of workers permanently residing in the construction site facilities;
- the number of workers migrating daily;
- method of transport;
- means of transport;
- proof of conformity in accordance with the regulations.

2.1.13.4.4.4 Supplying workers with food and drinking water

Workers have to be provided:

- premises where they can consume their meals in suitable circumstances;

- accessories enabling preparation of food in suitable circumstances, whenever necessary.

The method of providing food and water is similar as accommodation conditioned by:

- the scope of works and the planned number of employees;
- construction site location;
- existing catering capacities in the area where works are implemented;
- duration of works;

Depending on the above stated conditions and circumstances, food and water supply can be provided as follows:

- meals prepared by the contractor's kitchen provided on the construction site;
- meals prepared by a facility provided by the lessee are available on the construction site;
- food is delivered to the construction site from an outsourced facility;
- food is supplied in a catering facility (nearby);
- other solutions, depending on the circumstances.

All employees have to be provided one hot meal during working time, regardless of how it is prepared.

If food is delivered from outsourced facilities, premises have to be provided on the construction site for the distribution and consummation - canteen. Washbasins have to be installed in the entrance room leading to the canteen. The premises must have heating installed and be suitably ventilated. The area of the premises depends on the number of workers and on whether the food is distributed in one or two shifts.

Supply of liquids (water or other soft drinks) has to be provided regardless of the previous conditions. A suitable number of locations where drinking water can be obtained and other beverages delivered during daily meal has to be provided on the construction site. Hygienic taps for drinking water have to be distributed so that they are no more than 100 m away from the work place. At least one tap has to be provided for every 60 workers.

SP has to specify:

- description of solutions required by food and drinking water supply;
- the quantities necessary considering the number of employees;
- ensuring drinking water health and hygiene safety and control;
- graphic sketch showing the arrangement of facilities and devices for supplying food and drinking water.

2.1.13.4.4.5 Ventilation and lighting

2.1.13.4.4.5.1 Ventilation

Steps shall be taken to see to it that there is sufficient fresh air, having regard to the working methods used and the physical demands placed on the workers.

If a forced ventilation system is used, it has to be maintained in working order. The workers must not be exposed to harmful draught.

Forced ventilation system has to be fitted with signalisation for reporting breakdowns.

Any deposited objects (things) or dirt which could by polluting the air jeopardise workers' health, have to be removed immediately.

2.1.13.4.4.5.2 Temperature

During working hours, the temperature of working environment must be adequate for human organism, having regard to the working methods being used and the physical demands placed on the workers.

The temperature in rest areas, rooms for staff on duty, sanitary facilities, canteens and first aid rooms must be appropriate to the particular purpose of such areas.

Windows or skylights and glass barriers must prevent excessive sun radiation, taking into account the type of work and the purpose of areas.

2.1.13.4.4.5.3 Natural and artificial lighting of work sites, rooms and traffic routes on the construction site

Work sites, rooms and traffic routes must receive as much natural light as possible. At night and when natural daily light is insufficient, suitable and sufficient artificial lighting has to be provided. If necessary, movable light sources have to be used, protected from negative impacts.

The colour of used artificial lighting must not influence the recognition of safety notices and signs.

The installations for lighting the rooms, work sites and traffic routes have to be provided so as not to represent danger.

Rooms, work sites and traffic routes lit by artificial lighting, where workers carry out dangerous works, have to be equipped with emergency lighting of adequate intensity.

2.1.13.4.4.5.4 Floors, walls, ceilings and roofs of rooms

The floors of work places must have no dangerous bumps, holes or slopes and must be fixed, stable and not slippery.

The surfaces of floors, walls and ceilings in rooms must be such that they can be easily cleaned or refurbished to an appropriate standard of hygiene.

Transparent or translucent walls, in particular all-glass partitions, in rooms or in the vicinity of work sites and traffic routes must be clearly indicated and made of safety material or be shielded from such places or traffic routes to prevent workers from being injured should the walls shatter.

It must be possible for workers to safely open, close, adjust or secure windows.

When open, they must not be positioned so as to constitute a hazard to workers.

Windows and skylights must be designed in conjunction with equipment or otherwise fitted with devices allowing them to be cleaned without risk to the workers carrying out this work or to workers present in the area.

2.1.13.4.4.5.5 Impacts of weather conditions

Workers have to be protected against weather conditions which could jeopardise their health and safety.

2.1.13.4.5 Electricity and telecommunication installations

Installations have to be designed, installed and used so as not to present a fire or explosion hazard. All persons must be protected against the risk of electric current caused by direct or indirect contact.

The design, installation and choice of equipment and protection devices must be appropriate to the type of energy and voltage, external conditions and the competence of persons with access to parts of the installations.

Electrical installations and equipment on the construction site have to comply with the applicable regulations and requirements of the standard SIST HD 384.7.704 S1:200.

Electrical installations and equipment have to be protected against weather impacts (at least IP 43 protection). Fixed devices and installation of the construction site as well as tools, equipment, switches and control devices have to be protected against dust particles and water at least according to IP 44.

Distribution devices bought after 1 January 2003 have to be designed in line with the requirements of the standard EN 60439-4.

They have to be fixed, accessible and closed. They have to be equipped with a protective device with differential current (FI - switch), which does not exceed the nominal value of 30 mA.

Free electricity lines on the construction site have to be installed so that there is no danger of mechanic injury. Freely placed on the floor can be only cables of HO 7 RN - F type, which have to be mechanically protected or installed at prescribed height at all passages for vehicles and in the areas where heavy construction machinery is used.

Extension cables for power supply to electrical movable and portable tools and devices on the construction site have to be flexible. Cables bought after 1 January 2003 have to be produced according to the requirements of the standard HD 22.4, at least in HO 5 RN - F version and with suitable mechanic protection or installed at adequate height as stipulated in special regulations. On construction sites only such cable drums can be used which are equipped with covered sockets protected against water sprays, thermic protection against overheating and heavy rubber cable type HO 7 RN - F.

Before cable extensions are used, they have to be visually inspected. When there is visible damage on isolation, inlet, plug, socket, thermic protection or when the cable is pulled from the socket or plug, the extension must not be used. The isolation must not be patched with the isolation tape.

Electrical devices can be connected to the network only through electrical distributors, additionally protected by protective device with differential current with nominal value up to 30 mA. Electrical devices must not be directly connected with the house installation sockets.

On the construction site only plugs and sockets with a protective pole or industrial sockets can be used. The use of distribution sockets is prohibited. Industrial three-phase sockets have to be five-pole with rightward connection.

General illumination of the construction site (when works are implemented at night and in areas where there is no natural light) has to be at least 50 luxes, while local illumination on work places next to machines and where load is attached and released has to be at least 150 luxes. Lighting bought after 1 January 2003 has to be designed in accordance with the requirements of the standard EN 60 598-2-8 of at least IP 23 type and protected against damage by a protective net or installed at least 2.5 metres above ground and always clean.

In wet and moist areas only such devices may be used which are permitted to be used in constricted areas and are well guidable.

Electrical installations, devices and equipment on the construction site can be used only after the measurements have shown that they are impeccable. Periodical tests of installations have to be performed at least twice a year (in the summer and in the winter). Visual inspections have to be carried out regularly by qualified construction workers and monthly by qualified electro-technical engineers. The measurements and monthly inspections have to be minuted and relevant records kept until the construction is completed.

2.1.13.4.6 Traffic communications, emergency routes and exits

The issue depends on the following factors:

- the spread of the existing road network, whether national or local;
- the quality of the existing road network;
- the scope of cargo to be transported to the construction site from various external locations;
- the type of cargo;
- means of transport and their characteristics (the number of axes and axle load);
- traffic density on these roads;
- road route (outside urban area or/and in urban area);
- bearing capacity of bridging structures and other.

The contractor implementing the works or the client have to prepare a study to establish the possible increased load of a public road used for transport and implement construction measures to mitigate the impact on such roads and accompanying facilities as well as the negative impacts on the health and safety of the inhabitants, if such transport routes lead through urban areas.

Transport routes, stairs and passage ramps have to be designed, located and installed in such a way that they ensure safe passage or transport and so that traffic streaming over them does not endanger the workers working on work sites in the approximate vicinity. The area designated for vehicles and the area designated for pedestrian passage have to be apart and separated by a fence. The doors must not open towards the area designated for passage.

Accesses to work places at height (or depth) can be provided only in the form of ramps or stairs.

SP has to:

- establish the number of vehicles with load bearing capacity of 10 tons or more on the existing road based on at least 4 traffic counts at the target-source location;
- calculate road loading by construction site traffic, taking into account the schedule and transport routes, using the vehicles with load bearing capacity of 10 tons or more;
- specify the percentage by which the road load will increase;
- provide for consolidation and expansion of the exiting roads in line with the increased load, based on the methods for dimensioning carriageway structure;-

- provide for the implementation of measures ensuring the safety of pedestrians and cyclists;
- provide for the installation of additional traffic and warning traffic signs;
- provide for arrangement of cleaning sites with water at locations where mudded vehicles passing from the construction site to a public road are cleaned; These pools have to be watertight and drained to a discharge duct or ditch after the waste water us treated and passes through an oil trap;
- provide for strengthening of bridging structures.

2.1.13.4.6.1 Transport routes on and along the construction site

Transport routes on and along the construction site have to be designed based on a technological study. The project has to include the necessary data on transport by material type and the scope of internal transport, means of transport and dynamics.

It is important that the routes are organised so as not to have a negative environmental impact. Namely:

they must not endanger water sources and surface water courses;

they must not pollute air by dust particles and emission of other elements;

they must not cause excessive noise;

they must not cause vibrations affecting facilities and other;

they must, as much as possible, be routed over the construction site.

SF provides for:

transport routes over the construction site;

consolidation of construction routes and their width;

maintenance of the above routes;

traffic regime (speed, priority directions, etc.);

warnings about secured areas;

frequency of vehicles (traffic);

working hours;

marking of the work site or access to it on a public road.

Traffic over the construction site has to follow the same rules as apply to public roads. If traffic frequency is high, traffic signalisation has to be introduced to arrange a traffic regime. In this case the Road Traffic Safety Act, stipulating traffic on non-categorised roads, applies. Crossings of construction road and categorised public road have to be marked using the prescribed traffic signs.

The transport project also specifies the speed of the means of transport, which must not exceed 40 km/hour on open route or 5 km/hour in the vicinity of work places where workers and construction facilities are located.

A constituent part of a SP is a design showing all transport routes RP 1:5000.

2.1.13.4.6.2 Emergency routes and exits

Emergency routes and exits must remain clear and lead as directly as possible to a safe area.

In the event of danger, it must be possible for workers to evacuate all work sites quickly and as safely as possible.

The number, distribution and dimensions of the emergency routes and exits depend on the use, equipment and dimensions of the construction site and the maximum number of persons that may be present.

Special emergency routes and exits have to be indicated by safety signs in accordance with the Rules Governing Safety and Health Signs. (Official Gazette of the RS, no. 89/1999)

The signs must be sufficiently resistant and installed in appropriate places.

The emergency routes and exits, and the traffic routes and doors giving access to them, must be easily accessible and free from obstruction so that they can be used at any time without hindrance.

Emergency routes and exits requiring illumination must be provided with emergency lighting of adequate intensity in case the lighting fails.

Access to area where materials of insufficient solidity are located is prohibited, unless equipment and means enabling safe access are provided.

Emergency doors must open outwards. Emergency doors should not be so locked or fastened that they cannot be easily and immediately opened by any person.

Sliding or revolving doors are not permitted to be used as emergency exits.

2.1.13.4.6.3 Traffic routes on danger areas

Danger areas on the construction site (passages over water courses, construction sites of bridging structures, ditches, etc.) must be secured and fitted with signalisation so as to be protected also in the event of ecological disasters.

Traffic routes, including stairs, fixed ladders and loading bays and ramps, must be located and dimensioned (with the possibility of relocation) to ensure easy, safe and appropriate access for workers employed in the vicinity of these traffic routes in such a way as not to endanger them.

Routes used for pedestrian traffic and/or goods traffic, including loading and unloading routes, must be dimensioned in accordance with the number of potential users and the type of undertaking.

If means of transport are used on traffic routes, a sufficient safety clearance must be provided for pedestrians or a barrier installed.

Routes have to be clearly marked, regularly checked and properly maintained.

Sufficient clearance must be allowed between vehicle traffic routes and doors, gates, passages for pedestrians, corridors and staircases.

If the construction site contains areas with restricted access such areas must be equipped with devices preventing unauthorized persons from entering them.

Appropriate measures must be taken to protect workers authorized to enter danger areas.

Danger areas must be clearly indicated.

2.1.13.4.6.4 Doors and gates

Sliding doors must be protected against being derailed and falling over.

Doors and gates opening upwards must be fitted with a mechanism to prevent unintentional closing.

Doors and gates along emergency routes must be appropriately marked.

Doors for pedestrians must be provided in the immediate vicinity of any gates intended essentially for vehicle traffic, unless it is safe for pedestrians to pass through. Such doors must be clearly marked and left permanently accessible.

Mechanical doors must function in such a way that there is no risk of injury to workers.

They must be fitted with easily identifiable and accessible emergency shut-down devices and, unless they open automatically in the event of a power failure, it must also be possible to open them manually.

2.1.13.4.6.5 Loading bays and ramps

The inclination of the ramps must not exceed 40%, unless there is insufficient space for a passage with the required inclination. When the sloping floor of the ramp is more than 100 cm above ground, a solid safety fence has to be installed at passages and ramps on both sides, at least 100 cm high.

Ramps and passages have to be constructed of solid and healthy wood or other supporting material. Formwork panels must not be used for ramps and passages. It is prohibited for the ramps and passages to be open towards unstable elements of the facility under construction or to piles of material. Wooden ramps and sloping passages with an inclination greater than 10% must have on the upper surface laths 2.4 cm x 4.8 cm equally - maximally 35 cm - apart. The surfaces of ramps made of other materials have to be designed so as to prevent workers from skidding. Ramps and passages comprised of several elements have to function as a whole and be supported so that they do not bend or swing excessively. The floor elements are considered not to bend excessively, when the bend under projected load is less than 1/100 of the distance between supporting elements.

Before use and during the implementation of works the ramps and passages have to be regularly inspected and maintained in good condition as well as cleared of any scattered material. The use

of damaged and incomplete staircases and ramps is prohibited, and has to be prevented by the employer by a physical barrier or marking using a suitable sign.

Conditions:

Loading bays and ramps must be suitable for the dimensions of the loads to be transported.

Loading bays must have at least one exit point.

Loading ramps must secured to prevent workers from falling off.

Ramps and other oblique accesses and passages for transporting material have to be at least 60 cm wide.

2.1.13.4.7 Distribution and storing of construction material

Material warehousing has to be organised so that the workers' safety and health are not endangered. Material has to be arranged according to its characteristics and in such a way that it cannot be accidentally moved. Maximum permissible height of manually arranged stacks is 2 m with the exception of lighter material. Warehoused materials have to be protected from external influences (traffic on the construction site, work implementation, etc.).

2.1.13.4.7.1 Premises for storing hazardous materials

Hazardous substances on the construction site have to be kept on premises separate from other, marked and arranged for such purpose according to the characteristics of the substances and in line with the instructions contained in safety documents. Decanting of hazardous substances into vessels designated for storing food or drink and other vessels intended purposes other than storing of hazardous substances is prohibited.

In the approximate vicinity of hazardous substances the copies of safety documents have to be available at all times in addition to suitable means and equipment for first aid and, in case of flammable or explosive substances, also fire extinguishing equipment. Hazardous substances can be kept directly at work places on the construction site only in the quantity necessary for one-day work.

2.1.13.4.7.2 List of hazardous and ecologically unsafe materials and products

All materials installed in a road body and other facilities and devices have to be ecologically safe. All materials have to be equipped with suitable attestations proving their safeness and the dangerous consequences of construction on the environment.

Special attention has to be paid to use of materials for embankments where hazardous substances may be washed into the soil and subsoil. Particularly so, if materials used are produced by chemical or metallurgy processes.

The project has to state the materials which could be ecologically inadequate and whose composition should be analysed.

Monitoring programme, if necessary according to the type of materials, has to state the type of product, quantity of the material as well as the type and frequency of tests.

SF has to:

- specify the means of transport and the site for depositing hazardous materials;
- provide for checking of the content of hazardous substances in materials intended for construction, their composition and possible environmental consequences;
- based on the findings of environmental hazard, provide for technological procedures that will during the use of environmentally hazardous substances not endanger the environment, neither during the implementation of works nor during exploitation;
- if occasional monitoring is needed, provide for a monitoring programme and the method for monitoring warehousing and installation of material as well as specify the institution which will implement monitoring;
- provide for other measures depending on the materials and technological procedures used.

2.1.13.4.8 Lifting and transporting equipment

All lifting and transporting devices and accessories, including composite parts, additions, anchors and supporters, have to be:

suitably designed and composed as well as sufficiently solid in view of their intended purpose;

properly installed and used;

maintained in good working condition;

inspected and regularly tested and controlled in accordance with applicable regulations;

operated only by suitably qualified staff.

Maximum permitted load bearing capacity must be clearly indicated on all lifting and transporting devices and accessories.

Lifting equipment and accessories must not be used for purposes other than their intended use.

2.1.13.4.9 Vehicles and machines for excavation, relocation and transport of material

All vehicles and machines for excavation, relocation and transport of material have to be:

- suitably designed and produced, taking into account ergonomic principles;
- maintained in good working and driving condition;
- properly used.

Drivers and operators of such vehicles for excavation and relocation of material have to be specifically qualified for these tasks.

Safety measures have to ensure that the vehicles and machines for excavation and relocation of material do not fall into construction pits or water.

Machines for excavation and relocation of material must be equipped with safety constructions protecting the driver from being squashed if a machine tips over and against falling objects, whenever necessary.

2.1.13.4.10 Devices and facilities for maintaining machinery on the construction site

All devices and facilities on the construction site have to be designed, implemented and used in a manner ensuring that they operate in line with environmental protection regulations. The type and quantity of machinery on the construction site depends on the type of works and their scope.

The maintenance method and environmental protection measures depend on the vulnerability level of the environment and potential consequences of omission of protective measures or poor maintenance of facilities and machinery.

Environmental hazards are the following:

- seepage of oil derivatives into soil and underground waters;
- pollution by lubricants and other waste resulting from maintenance;
- pouring fuel into tanks of machines and vehicles;
- improper warehousing of oil derivatives and other hazardous substances as well as environmental consequences.

This issue is regulated by numerous regulations issued based on:

regulations governing the protection of waters;

regulations governing the protection of soil;

regulations governing waste management;

regulations related to hazardous substances;

regulations related to air protection.

For this reason the SP has to provide for all the measures necessary to ensure - according to the vulnerability of the environment - protection of underground and surface waters as well as other natural resources against pollution by waste oils, oil derivatives and waste resulting from maintenance of vehicles and machines.

The project has to provide for a suitably large area (indoor or outdoor) for repair and maintenance works on vehicles and machinery, the size depending on the number of vehicles and machines on the construction site. The area for one unit must be 4.00 x 10.00 m minimum. The area has to be concrete paved with slopes towards the intake shaft with oil trap.

SP and rules of procedure or internal rules have to specify a person in charge of monitoring, in addition to which instructions have to be drafted and all operators of vehicles, machines and devices informed thereof.

2.1.13.4.10.1 Handling fuel, lubricants and hazardous substances on the construction site

Construction machinery, vehicles and other devices on the construction site require regular maintenance using oil derivatives and lubricants for drive and maintenance. In addition to these

substances there is a possibility of other environmentally hazardous substances used for technological operations in work implementation (chemical products for concrete and rehabilitation works, panel oils, etc.). These substances are to a certain extent hazardous for the environment and health of people, if not used, handled and warehoused according to the instructions.

In the current conditions, the most common supply is delivery in a tank used for transport of oil derivatives from the warehouse to users. Moreover, if the demand is smaller, a substance may be provided from tanks on the construction site or vehicles filled at nearby public gas stations. The method of supply depends on the location of the construction site regarding the pubic gas station, the necessary quantity and the ownership of machinery and vehicles. In ecologically sensitive areas a uniform and controlled method of supply has to be provided regardless of the above.

As regards the use of hazardous substances the SP has to provide for:

- Method of warehousing hazardous substances used in technological process.
- These facilities and transport devices have to be, with regard to the type of material, production, corrosion protection and equipment, constructed and set up so as not to cause the pollution of water, air or soil or deteriorate their properties. More detailed instructions and requirements are given in the regulations on the construction and equipment of warehouses and transport devices for hazardous and harmful substances.

If liquefied oil gas is used on the construction site, the Rules on Liquefied Oil Gas apply. The above stipulate technical regulations on tanks, storing of cylinders (outdoor or indoor), use of gas, decanting of gas, safety distance, regulation, pipelines, users, user connections, flue gas outlet and other technical details to be considered in the SP.

If an own fuel pump is set up on major construction sites, the Rules on Construction of Facilities for Flammable Fluids and Warehousing and Decanting of Flammable Fluids have to be complied with. The latter define technical regulations applying to the construction of a station, preparation for supplying motor vehicles with fuel, pipelines, fuel decanting, fire safety.

A transport route must be set for fuel transport and other provisions of the Transport of Dangerous Goods Act considered, applying to vehicles, transport and handling of hazardous substances. In addition, the Rules on Records of Inspection of Transport of Dangerous Substances have to be complied with.

The SP must for every case define the method of supply and measures for environmental protection against pollution due to leaking fuel and other hazardous substances.

Method of controlling the implementation of preventive measures has to be provided and a person responsible for the implementation of SP provisions specified.

Mitigation and rehabilitation measures in the event of an ecological catastrophe have to be laid down.

2.1.13.4.10.2 Washing and maintaining vehicles on the construction site

Vehicles operating on the construction site and construction roads are due to the nature of work often muddy and otherwise dirty. So that such vehicles would not dirty public roads onto which they pass from the construction site, the vehicles have to be cleaned of mud and other environmentally hazardous substances. Road Traffic Safety Act stipulates that traffic participants must not, on the road or next to it, release, place, deposit or throw nothing that could jeopardise the safety of traffic or be harmful to the health of people, animals, plants or pollute the environment.

The condition of public roads is supervised by the company for public roads.

SF provides for:

- the method of ensuring that vehicles do not pollute public roads;
- plan of measures related to vehicles passing onto a public road;
- plan of platform for washing vehicles and draining waste water;
- depositing mud from platforms;
- instructions for drivers and the name of the person in charge.

The platform for washing vehicles has to comply with the following conditions:

- the ground has to be impervious, the platform has to be edged by kerbs;
- vehicles access it over a small-inclination ramp;

- water is drained into the sewage system and an oil trap with coalescent filter is provided;
- equipment for water supply and a hose for water spraying have to be provided.

2.1.13.4.10.3 Parking of vehicles and machinery and maintenance

Parking of vehicles and other machinery and devices can, if not organised properly, cause environmental pollution, especially contamination of soil and the underground water as well as of surface waters in the event of a major oil derivative spill. For this reason - depending on the vulnerability of the environment - suitable technical measures have to be provided aimed at preventing the possibility of environmental pollution. Moreover, instructions to drivers and operators of machines have to provide that parking instructions are implemented. Potential environmental hazards are the following:

- fuel leakage from vehicle or machine as a result of defect;
- pollution by oil from engine, transmission, differential gear, etc.;
- oil change and storing.

Rules on minimum technical and other requirements for parking and maintenance facilities of motor vehicles stipulate that:

- parking lots and other parking areas have to be impervious to water and oil derivatives;
- areas have to be kerbed;
- rain water has to be led from the parking lot over the sewage to the oil trap;
- parking lots for vehicles transporting hazardous liquids have to be separate from other parking lots;
- parking lots have to be marked with vertical signing and ground marking;
- no washing, maintenance or repair is permitted on parking lots; only daily check-ups of vehicles are allowed;
- a separate work station has to be assigned for repairs and washing, such where environmental protection is ensured;
- the floor of workshops used for repair of vehicles and machines have to be impervious to water and oil derivatives and sewage has to be drained through a properly dimensioned oil trap with a coalescent filter.

SF has to:

- provide that a suitable number or parking spaces is prepared in view of the number of vehicles parking on the construction site or other locations, in accordance with the above requirements;
- provide for the drawing up of a construction plan regarding the parking lot organisation;
- provide for the drawing up of a plan for an oil trap with coalescent filter as well as maintenance rules of procedure;
- provide for the drawing up of instructions for users of the parking lot and machine maintenance engineer;
- state the person in charge of maintenance of the parking lot, working platform for repair and oil trap.

2.1.13.4.11 Organisation of work places

Work places have to be at all times orderly and accessible according to:

- type of construction
- changing status on the construction site
- weather impacts
- type of works

and have to ensure safe implementation of works.

Work places have to be of suitable area and height for the workers to perform their work without their safety, health of well-being being endangered.

The area of the ground of a work site has to be such to enable workers free movement while performing work. The area for free movement has to be determined with regard to the presence of equipment or devices.

2.1.13.4.11.1 Works of special danger and protective equipment

2.1.13.4.11.1.1 Draft list of works of special danger

Draft list of works of special danger was included in Attachment II to the Decree on Safety and Health Protection at Work at Temporary and Mobile Construction Sites:

- works in excavations deeper than 5 m or on unstable or marshy terrain, more than 10 m above the ground;
- works with chemical or biological substances representing particular hazard to
- safety and health of workers or which according to regulations require medical supervision;
- works in the area of ionising radiation;
- works in the vicinity of high-voltage electricity lines;
- works where there is danger of drowning;
- works involving digging, cleaning or repair of wells, under ground and in tunnels;
- works involving diving, using air under pressure;
- works in the caisson with compressed air atmosphere;
- works involving explosive and easily flammable substances;
- works during assembly or disassembly of heavy components and/or sets;
- works along traffic on roads or railway;
- works involving tensioning of tendons in prestressed concrete and other constructions;
- works during concreting, cutting and processing of surfaces with devices under high pressure.

2.1.13.4.11.1.2 Basic requirements for safe work

Workers must not be exposed to harmful levels of noise, gases, vapours or dust.

If workers must enter a closed area where the atmosphere may contain a toxic or harmful substance or if the atmosphere does not contain sufficient oxygen or is flammable, the atmosphere has to be controlled and adequate measures preventing danger have to be introduced.

If in closed area hazardous gases arise in working process, forced ventilation has to be provided, gases controlled and an alarm system set up.

The dust and gases resulting from the work process have to be sucked out at a location nearest to the place of their origin.

Under no circumstances may a worker be exposed to high risk in closed atmosphere, if they are not all the time under external supervision so that they may be assisted in any moment, if necessary.

Work places in closed, tight (pipelines, silos, etc.) and underground areas (tunnels, wells, shafts, etc.) have to be ventilated so that the oxygen concentration in the air is at least 19%; maximum permitted concentrations of hazardous gases and dust in the air must not be exceeded; possibility of explosion has to be non-existent.

When on the construction site workers implement works in very dusty atmosphere, under the influence of poisons, caustic substances or substances that may cause an infection or when they work in a hot room, one shower with hot and cold running water, soap, protection cream and means of disinfection have to be provided for every 10 workers. If under such conditions more than 10 workers carry out works on the construction site for more than 14 days, bathrooms have to be provided. The temperature of these premises in the period between 15 October and 30 April must not be less than 21°C.

When works are planned to be implemented on the construction site outdoors or on open premises, an area has to be provided where workers can rest, dry their clothes and warm up. The clear surface of such area has to be at least 0.75 m2 per worker, but not less than 4 m2, while the height has to be at least 205 cm. The temperature of these premises in the period between 15 October and 30 April must not be less than 21°C. Changing rooms or accommodation facilities can be used as the area for staying or warming up, provided that they meet the above stated requirements. These premises need not be provided on construction sites, where up to five workers work for less than seven days, however it has to be made sure that the workers can dry their clothes and warm up.

The construction site has to include a clean room with tables, which the workers can use as a dining room. There have to be chairs at tables. The room has to be equipped with hangers for over clothes, while close by the workers have to be able to wash their hands and be provided cold drinking water or other chilled alcohol-free beverages. In the winter, the room has to be suitably heated. Dining rooms are not necessary, if the employer provides workers meals in some other suitable way (at public restaurants or bistros near the construction site).

2.1.13.4.11.1.3 Protective equipment

The personal protective equipment specified in the safety plan and other regulations has to be manufactured in accordance with regulations and standards, used for specific purposes as well as maintained and checked before use. It shall be prohibited to use damaged, worn out, and poorly maintained personal protective equipment and equipment past the expiration date.

Any person being present, for any reason whatsoever, at the construction site where the possibility of objects falling on the head, falling for more than 1 m or a blow to the head from impact with a hindrance in space exists or the safety plan has determined the possibility for injury of the head due to other causes, shall wear a protective helmet.

Signs specifying obligatory wearing of a helmet shall be placed on all accesses to the construction site and on exits from facilities to the construction site.

When the danger of head injuries exists only on a part of the construction site, the co-ordinator in charge of safety and health may, notwithstanding the provisions of the first paragraph hereunder, specify that a safety helmet be worn only on the part of the construction site in question.

The danger area shall be specifically marked and signs indicating obligatory wearing of a helmet shall be placed on all accesses to the area.

In case workers of a single employer perform work in closed spaces of the construction site, for which the co-ordinator in charge of safety and health has established that there is no danger specified in the first paragraph hereunder, they do not have to wear helmets. However, they should be in possession of helmets and use them on other parts of the construction site. Such measure shall only apply if entered in the book of measures for safe work.

The number of helmets available on the construction site has to equal the maximum number of visitors allowed at any time, which must be defined in the safety plan for the construction site in question.

When the co-ordinator in charge of safety and health establishes that no danger for head injuries exists anymore, the signs indicating obligatory wearing of helmets shall be removed and the measure entered in the book of measures for safe work.

2.1.13.4.11.2 First aid

First aid service organisation in the event of an occupational accident or injury has to be provided by the contractor implementing works on the construction site: The method and scope of the necessary measures depend on:

- the location of the construction site in view of the location of a health station;
- the number of employees;
- the danger involved in work operations and the scope of work.

In the case of large construction sites with many workers, an outpatient clinic has to be provided on the ground floor, with an entrance allowing unhindered access by a medical vehicle. The doors have to be wide enough for a patient to be carried or transported through. The clinic may also be set up in a container, if the latter complies with the stated provisions.

SF has to provide for:

- first aid organisation in accordance with the law and rules;
- premises for offering first aid in line with special regulations;
- staff in charge of organisation and offering first aid;
- number of qualified staff for offering first aid;
- first aid equipment (lockers);
- preventive medical examinations in a health care organisation and management of employee records;
- managing records of occupational injuries.

The procedures and equipment for offering first aid in the event of occupational accidents are stipulated by relevant regulations and standards. With SIST these standards applying to first aid are Technical Committee - Health Protection (TC VAZ).

International classification of standards regulating this issue is as follows: 11.xxx.yy and in addition to others classifies standards applying to:

11.020 - Medical sciences and health care facilities in general

11.040 - Medical equipment

11.080 - Sterilization and disinfection

11.160 – First aid (medical vehicles and equipment)

11.180 - Aids for disabled or handicapped persons

2.1.13.4.11.3 Impacts of stability and strength on safety at work

Materials, equipment and every part which could during any movement influence safety and health of workers have to be fixed suitably and securely.

The construction and stability of facilities have to correspond to their intended use. For load-bearing parts of facilities, scaffolds and construction equipment suitable stability, strength and safety estimate has to be provided, especially after each change of height or depth on the work site.

Access to area where materials of insufficient solidity are located is prohibited, unless equipment and means enabling safe implementation of work are provided.

Movable or fixed work sites at height or on the ground have to be solid and stable, taking into account the following:

- the number or workers on work sites,
- maximum load-bearing capacity and distribution of weight,
- external impacts to which they can be exposed.

If the supporting construction and other parts of work site construction are not stable as such, their stability has to be provided by suitable and secure methods of attachment so as to avoid any unintentional or automatic movement of the entire work site or its individual parts.

2.1.13.4.11.4 Earthworks, underground construction sites and works in constricted areas

When working in construction pits, wells, underground construction sites, pipelines or tunnels, the following safety measures have to be complied with:

suitable supporting constructions or embankment have to be provided,

danger of workers, material or objects falling as well as flooding have to be prevented,

sufficient ventilation has to be provided on all work sites to ensure breathing air which is not hazardous or harmful to health,

workers have to be able to evacuate to a secure area in the event of fire, or water or material intrusion.

2.1.13.4.11.4.1 Earth works

Before excavations start, measures have to be taken to determine and to the highest degree possible reduce any danger arising from underground cables and other installations.

Secure access from/to construction pit has to be provided.

Heaps of soil, material and moving vehicles have to be at a suitable distance from construction pits. If necessary, adequate barriers must be set up.

Prior to commencement of earthworks, the existing installations and facilities shall be marked out and if possible dangers arising there from excluded (by transfer or temporary shutting down of power supply, closing and emptying of pipelines and reservoirs and the like).

In case of excavations in areas where gas, electricity, water supply, sewage or other installations, facilities or buildings are located, the work shall be carried out in accordance with the instructions and under supervision of an expert, to be appointed in agreement between the facility's owner, or the maintenance entity appointed by them, and the contractor.

Such agreement shall be entered in the book of measures for safe work.

Should workers during the excavations unexpectedly come across such facilities, they shall stop work until the supervision specified in the first paragraph hereunder is provided.

Prior to excavations or cleaning of caves, wells, channels and such filled with earth, any presence of carbon monoxide and other harmful, inflammable or explosive gases shall be established.

Excavations in depths exceeding 100 cm shall be carried out with obligatory implementation of safety measures preventing collapse of soil from the sides and mucking out of excavated material (using sheet piles, slurry trench techniques or arrangement of slopes below the angle of inner friction of earth). At least 100 cm wide free area (clearance) shall be provided on the upper edge of the excavation, where no material deposit or use for transport are allowed. Excavations as well as slurry trench techniques for slopes shall be performed professionally, in line with appropriate norms and static calculations and under direct supervision of the manager of individual works. The possibility of flood or increased pressure in excavated walls or sheet piles shall also be taken into account.

In traffic areas, the protection and stability of slopes shall be previously proven by taking into account the expected load.

Building pits and excavations deeper than 2 meters and having slopes under an angle of more than 45° (steeper) shall have a safety fence erected at least 100 cm from the upper edge or arranged protection of the danger area of the excavation.

Earth excavations have to be made from top down. Sapping is not permitted.

In machine excavations, no presence in the machine's work area shall be permitted. Manual work may be performed only when the machine is not operating.

Trenches and other excavations must be made in adequate width enabling unhindered work in them, meaning that after slurry trenching and placement of pipelines or other facilities (panelling, walls…) the excavation still has at least 60 cm available for movement of workers.

The stability of the machine shall be provided in machine excavations. The excavated earth shall be deposited so that stability of lateral sides of the excavation is not endangered. The edges of excavation (and the 100 cm area along them) may be loaded with machinery or other heavy equipment only if appropriate measures preventing collapsing, which would result from the additional load, have been taken.

The formwork for slurry trenching of lateral sides of the excavation shall be at least 20 cm above the terrain. Wood or other material and equipment of appropriate strength and size shall be used for slurry trenching of lateral sides of the excavation.

The means for joining and strengthening of parts of support members (wedges, hardware, screws, nails, wire and such) shall comply with the relevant SIST standards. The empty space between the formwork and the lateral side of excavation shall be filled and strengthened. The formwork shall fit to the bottom of excavation over the entire length.

Removing formwork upon filling of the excavation shall be made in accordance with the instructions and under supervision of the manager of individual works. In case removing of the formwork would endanger workers, it shall be left in the excavation.

For stepping down of workers in the excavation deeper than 100 cm or return therefrom, a ladder of appropriate length shall be provided, so that the hand handle shall be at least 100 cm above the edges of the excavation.

The ladder can be replaced by adequate stairs or ramps, if such a method provides for safe movement of workers during precipitations.

Prior to commencement of work related to excavations of earth and in any case after adverse weather conditions, frost or melting of snow and ice, the manager of individual works (earthwork) shall examine the excavation and, if need be, take appropriate action (in order to protect against collapse of lateral sides of the excavation).

Ways and ramps used for hauling material from the excavation shall be appropriate with regard to strength of the terrain and characteristics of transport vehicles. Their inclination must not exceed 40%.

Loading of material by way of loader or other mechanical means to the freight vehicle over the vehicle's cabin shall not be permitted, unless the cabin is protected against mechanical damage.

The material required for construction or assembly work in excavations (foundations, channels, installation ducts, shafts and the floor) shall not be deposited on edges of the excavation or in areas where it might collapse or pose danger to workers in the excavation.

Devices (channels, hoppers) or transport means used for lowering the material in excavations shall be appropriate with regard to the type, shape and weight of the material. Lowering of heavy construction elements shall only be made by using appropriate work equipment and by workers familiar with such work, under the supervision of the manager of individual works (assembly, carpentry).

2.1.13.4.11.4.2 Underground facilities

The appropriate technical documentation shall be prepared for all work related to construction of underground facilities. The used material and constructions shall be made in line with the regulations and in accordance with the montageological conditions on the construction site.

As regards planning of work on underground facilities through hills, where methane may be expected with regard to performed geological studies, the safety plan shall specify special measures for removal of any dangerous gases.

These measures shall also include:

- the system for determining and controlling methane;
- measures for safety of personnel.

In case methane concentration exceeds 0.5%, all machinery and devices must be immediately turned off.

Work under ground may only be performed by qualified workers under constant and direct supervision of the manager of individual works. Workers shall be informed on dangers to which they are exposed and measures to be taken with that regard.

Regulations applying to mining work shall be complied with in excavations, implementation of support and the basic construction.

The contractor building under ground shall keep accurate records on entering and leaving of all persons to/from the underground facility.

The basic construction shall be regularly monitored and appropriate action taken in case of any detected irregularities.

Transport routes shall be appropriately protected on spots of openings, slopes and spaces on lower levels. In case strewers leading to the lower underexcavation are implemented for transport of material from the underexcavation, their openings shall be adequately protected.

Work places in underground facilities shall be well ventilated by using forced ventilation. The ventilation system shall be appropriate for the location and length of the area and the type of harmful substances appearing during work (gases, dust and other). Vacuuming of dust shall be provided directly on the spot of its appearance.

Smoking and bringing igniters shall be prohibited in tunnels, galleries and under excavations where methane may be present.

At the first instance when methane concentration exceeds 0.5%, the contractor shall immediately inform the Labour Inspectorate of the RS thereof.

Installations for power supply, technological water, compressed air and other shall be placed so that they are not exposed to mechanical damage.

Power installations and equipment shall be implemented as prescribed for narrow and guidable spaces and shall be checked regularly at least once a month and after any reallocation, flooding or other change.

Any machinery used in construction under ground shall be in perfect working condition, and machine operators shall be specially trained to operate such machinery.

Machines with internal combustion engines may only be used if they have diesel engines equipped with devices for cleaning exhaust gases.

Vehicles for transporting material shall be equipped with appropriate light and sound signals, which are automatically turned on when driving in reverse. The work place of the machine operator shall be protected by a protective construction.

Machinery and vehicles shall in addition to the prescribed equipment also have a handy fire extinguisher. Examination of the work equipment shall be made prior to each reallocation to a new construction site and at least once a year.

As regards the use of chemicals added to concrete for faster setting, regulations and instructions for working with dangerous substances shall be taken into account and appropriate protective equipment used.

2.1.13.4.11.4.3 Constricted work sites, shafts and pipelines

Work in constricted areas may only be performed by adult, capable in terms of health and qualified workers, previously informed on dangers and measures for safe work in narrow areas.

Prior to commencement of work, the manager of individual works shall check the condition of the pipeline (inspection for presence of any gases, visual check…) and implement the required preventive measures for providing safety and health of workers. Any work in pipelines may only be carried out under direct supervision of the manager of individual works.

Protection of workers in pipelines shall be provided from the surface in all open accesses. Reliable means of communication shall be used for communication between workers in the pipeline and the responsible person outside. The manager shall have a telephone on their person to be able to call the rescue service.

Outside, near entries to the pipeline, the number of qualified workers and appropriate equipment shall be such that rescuing of workers from the pipeline may begin instantaneously.

Each worker in the pipeline shall be equipped with a battery or electric flashlight.

Lowering and lifting of workers by means of a ladder in a vertical pipeline (or shaft) of more than 5 m in height shall only be permitted by using the personal protective equipment against falling. The exit ladder shall be placed in the pipeline at all times during work.

Workers may only perform work in pipelines with the diameter of more than 1000 mm. Work in pipelines with diameter between 600 mm and 1000 mm may be performed in exceptional cases only, provided that:

- It is previously established that such work can be performed without any danger for collapse of pipes, explosion, drowning, suffocation or poisoning of workers;
- It is ensured that workers move in the pipeline using only devices which are interlinked and guided by ropes or bars from the entry opening to the pipeline or from outside.
- the worker is under constant visual supervision.

It shall be prohibited for any worker to enter a pipeline with diameter of less than 600 mm.

In exceptional cases, work may be performed in pipelines with free surface (without increased pressure) with diameter of more than 1000 mm also in cases when the pipeline cannot be fully emptied. In such cases, the employer shall provide special instructions for carrying out work and implementation of measures for protecting workers against drowning and other dangers.

Power supply installations, machinery and devices used for work in pipelines shall comply with regulations regarding narrow and guidable spaces.

Appropriate regulations regarding work in constricted spaces shall be taken into account when welding, sawing and carrying out similar procedures in pipelines.

The use of liquid gases and work machinery with internal combustion engine shall be prohibited in pipelines.

Forced ventilation shall be provided, if harmful gases or dust result from the work process. The dust resulting from the work process in the pipeline has to be removed or sucked out at a location nearest to the place of its origin.

Workers shall immediately leave the pipeline in case of flooding, occurrence of harmful gases, power failure or shutting down of the ventilation system. Work may be resumed only after the manager of works has verified that the danger no longer exists.

2.1.13.4.11.4.4 Wells and caissons

All diving bells and underwater caissons have to be made of suitable material of appropriate strength, adequately equipped, so that in the event of water or material intrusion workers can recourse to a safe area.

Construction, assembly, modifications or disassembly of diving bell or caisson can be carried out only under expert supervision.

All diving bells and caissons must be checked by an expert at suitable intervals.

2.1.13.4.11.4.5 Danger of drowning

In case the danger of drowning exists, the following shall be provided for:

- appropriate arrangement of the site and adequate equipment ensuring work safety;
- the prescribed rescue equipment and means of rescue (as applicable for bathing sites);
- at least one qualified water rescuer;
- training of workers for self-rescue from water (swimming);
- unhindered access for rescuers and rescue equipment;
- other prescribed measures.

During work above/near rivers and water barriers with a large flow, workers shall in addition to implementation of other measures for safety and health at work also wear lifejackets.

As regards inflows to power plants and other sites where water has a sucking effect, gates shall be closed prior to commencement of work or other appropriate measures taken to prevent sweeping off or drowning of workers.

As regards work sites where the danger of drowning exists due to fast rising of water level, measures shall be envisaged (supervision, signals, methods and routes for escape…) and equipment for quick rescue or escape of workers from the danger area provided.

As regards waters with traffic, measures for protecting the work site against dangers arising from water transport shall also be provided.

As regards work sites on floating objects (platforms, ships, boats, pontoons…), lifejackets for all workers and any visitors of the facility shall be provided.

Vessels shall have a sailing permit in accordance with special regulations and shall be (when work is carried out from them) firmly fastened or anchored and have safe access from land and water.

The areas on vessels where the possibility of falling into water exists shall be protected by a solid and stable protective fence. Openings in the floor of the vessel shall be permanently closed or protected by a safety fence unless being used.

2.1.13.4.11.5 Demolition works and disassembly

In case of demolition or disassembly of a facility or a part thereof, a work programme and safety plan shall be previously prepared regardless of the demolition method (manual, machine or by blasting).

The safety plan shall specifically include the method for detecting the presence of any residual dangerous gases, liquids or other dangerous substances in spaces, recesses, installations, equipment and construction of the facility and measures for preventing dangers resulting there from.

Power supply shall be turned off and any installations, reservoirs and other areas shall be emptied in the facility to be demolished prior to commencement of work.

Prior to the demolition, probing on characteristic spots shall be used for checking whether any asbestos is present in the material. In case the contractor establishes the presence of asbestos or the possibility for occurrence of dangerous dust, they shall implement all measures prescribed for handling of such substances.

Work involving asbestos is regulated by the Rules on Conditions for Disposal of Materials Containing Asbestos in Demolition, Reconstruction or Maintenance of Buildings and in Maintenance and Decommissioning of Plants (Official Gazette of the RS, no. 71/01).

The demolition may be carried out exclusively by workers receiving written instructions on safe work and being qualified to perform it. The work may only be implemented under direct and constant supervision of the responsible manager of individual (demolition) works.

The use of personal protective equipment for protecting the respiratory system and other appropriate personal protective equipment shall be obligatory.

Prior to commencement of the demolition, the danger area shall be fenced by a protective fence or protected by another appropriate method of protection. Protection of the danger area shall be in place until the demolition is completed.

Manual demolition shall be carried out gradually from the top down. Demolition of the construction between floors or of the ceiling may begin only when all parts above its level have been demolished and removed. Manual demolition of freestanding walls (partition walls, fences, columns and similar) shall only be permitted by using the appropriate scaffolding. In disassembly work, at

least two workers shall work on the same spot or in the same room. When this is not possible, the other person shall be within visual or hearing range of the worker.

Demolition of walls by sapping shall not be permitted. Accumulating demolished material on individual floors shall not be permitted in demolition of multi-storey buildings.

All elements to be disassembled shall be prior to loosening of joints by unscrewing, sawing, autogenously cutting or by using another method firmly supported or hanged so that they cannot endanger the safety of workers after loosening of joints.

Disassembled beams, supporters or other heavy or large construction parts may be removed from the facility only by using the appropriate work equipment. Free lowering i.e. dropping of elements and material from the facility shall be prohibited. Bulk and dusty material may be removed from the facility only by using completely covered channels or pipes or by using another method preventing spreading of dust.

In case of machine demolition (by using caterpillar tractor and similar), the machine's distance from the facility or the part to be demolished shall be at least 1.5 the height of the facility or the part in question. Tear up strength of the steel rope used for transmission of the traction force required for the demolition shall be at least three times the traction force of the machine. The machine's traction force shall be transmitted to the surface of the facility or the part to be demolished (wall, column and other) evenly by using placed under planks, beams and such.

Buried concrete columns, steel supporters and other parts of the facility shall not be pulled from ruins by using machinery without removing the ruins first. Demolition or pulling of heavy objects from the construction facility shall not be carried out by using tractors with wheels.

When individual parts or the entire construction facility is demolished by blasting, regulations regarding handling of explosives and blasting shall be complied with.

2.1.13.4.11.6 Work along traffic

When work is performed on roads on which traffic has not been stopped, protection of the work site in accordance with special regulations and the provisions of these rules shall be provided. Works shall not be carried out in conditions of strongly reduced visibility (fog, darkness…) unless the work site has appropriate artificial lighting.

Workers performing any kind of work near traffic flows, shall wear signal clothing with reflective strips manufactured in accordance with the SIST EN 471 standard. Equally applies to workers carrying out daily work in utility services (waste removal, road and pavement sweeping, measuring of the terrain…).

In case the carriage lane is not closed, work may only be performed under supervision of the manager of individual works appointed by the employer providing for work safety. Workers shall be provided with clear work instructions prior to commencement of the work.

The work site has to be marked by the employer with traffic signs in accordance with the Rules on Traffic Signs and Equipment on Public Roads (Official Gazette of the RS, no. 46/2000).

2.1.13.4.11.7 Massive constructions, metal or concrete frames, formwork and heavy prefabricated elements

Metal or concrete frames and their elements, formwork, prefabricated elements or temporary support constructions and struts may be installed or removed only under expert supervision.

To secure workers from dangers arising from temporarily insufficient strength or instability of construction, special safety measures have to be introduced.

Formwork, temporary support constructions and struts have to be planned, designed, installed and maintained so that without any danger they sustain any load or tension that may be applied.

Concreting, construction of arches and other work on the supporting scaffold may only commence when the person performing expert supervision of the construction verifies that the supporting scaffold has been made in accordance with the project, that it is secured by a safety fence and that all required preliminary work has been carried out and make a note thereof in the book of measures for safe work. The work may only be implemented under direct supervision of the manager of individual works.

Prior to commencement of work on the scaffold, any sharp tops and edges of means joining individual parts (nails, clamps, wires and other) protruding from the formwork and other parts of the wooden construction of the supporting scaffold must be bended or covered.

Large-scale concreting on heights and depths (tall buildings, hydro power plants, dams and other) may only be carried out in line with previously prepared programme, by qualified and healthy workers, being informed on dangers related to such work.

In concreting with the use of a pump, the transport pipe for concrete shall be at the point of flowing out of concrete held by two workers.

Forced taking down of the formwork by using lifting or other equipment shall not be permitted. During sliding or taking down of the formwork by using winches (or manually), it is not permitted to stand on the equipment gripping the formwork (sledges and such).

Concreting and concrete treatment with equipment under high pressure may only be performed by qualified workers. The area where such work is carried out shall be secured at the appropriate distance and marked by a warning tape, no access sign and the general danger sign. Workers performing such work shall use personal protective equipment during the work for protection of the face, respiratory system and the entire body.

Prefabricated construction shall only be permitted in accordance with the assembly programme, which shall include the following:

- plans of prefabricated elements including data on their weight, marking, support points for transport and storage and details on anchors for moving;
- description of the required lifting devices and the plan of auxiliary devices for moving;
- plan for storage on the construction site;
- description of the assembly procedure (order of production and transport of individual prefabricated parts, the method and order of lifting, placement and strengthening of prefabricated elements…);
- safety measures for all work related to prefabricated construction.

Joining and fastening of prefabricated elements and other assembly work on the facility shall only be preformed by adults capable in terms of health to work at heights and trained for safe assembly under direct supervision of the manager of individual (assembly) works.

Each prefabricated element shall be adequately visually and otherwise appropriately marked in accordance with the prefabricated construction programme. The production date and weight of the element in kilograms shall be marked on the element in addition to the marking referred to above. In addition to parts needed for assembly and fastening of the element on the facility, each element shall also have auxiliary metal anchors enabling reliable moving and placement of the element on the assembly spot.

Prefabricated construction shall only be permitted with the use of appropriate transport and lifting work equipment and auxiliary devices prepared for such work.

Work at heights related to prefabricated construction shall only be permitted with the use of specified-purpose equipment for work at heights (scaffolds, equipment for lifting people…). Walking and work on elements not being stably placed shall not be permitted.

Prefabricated elements on the construction site shall be properly and in line with the assembly plan placed on a particular spot so that they may be without any delay and safely moved and installed in the facility.

Fastening of prefabricated elements on a hook and their unfastening from a lifting device in loading to motor and other vehicles and unloading therefrom shall generally be carried out without the workers mounting on the vehicle or the elements.

The driver shall not be in the cabin of the vehicle during lowering and lifting of prefabricated elements to/from the motor vehicle by a lifting device.

Assembly of elements on a higher floor of the facility shall not commence until reliable access to this floor has been provided.

Assembly of heavy prefabricated elements (slabs, beams and other) shall only be permitted after previous preparation of auxiliary devices for moving, placing and fastening of elements on the facility (yokes, moving frames and other).

Auxiliary devices shall be prior their use examined and tested with regard to the planned load.

During moving, placement and fastening of each individual prefabricated element on the facility, the signaller and the lift operator shall carefully monitor the path of the prefabricated element to the assembly spot and the work of assembly workers placing and fastening the element.

The assembly worker shall use a special signal to inform the signaller and the lift operator that the operation of moving and assembly of the element on the facility has been concluded.

Parts of the reinforcement protruding from the element after the assembly, which may cause a worker to get stuck or injured, shall be appropriately removed or protected (cut off, bended and similar).

2.1.13.4.11.7.1 Works during the tensioning of tendons in prestressed constructions

Works during prestressing may be carried out only by expert professionals acquainted with dangers and safety measures which need to be considered during work. In the approximate vicinity of the work sites there have to be instructions for safe work and safety measures as well as the documents about work equipment.

The works are carried out in three phases:

Tendon composition and assembly

The anchor head has to be installed precisely in the tendon axis. Protective rib pipes have to be assembled and installed according to the manufacturer's instructions. Only undamaged pipes, clips and injection pipes may be installed. Before tendons are installed, the functioning of the equipment for pushing strands and pulling rope has to be checked. The workers must avoid strand exit locations. All manual interventions in driving or measuring wheels are prohibited.

Tensioning

Tensioning is carried out by means of a tensioning device. During tensioning, none of the workers can stand behind or below the tensioning device. The tensioning device has to be mechanically secured to mitigate the blow if a tendon breaks. The strand or rope gripping mechanism has to be in perfect condition. It is strictly forbidden to remove protective devices on work equipment. The pipes of the hydraulic mechanism have to be laid without sharp turns, transparently and not over sharp objects. Manual interventions in moving elements or parts of machinery are prohibited.

Injection

Injection pipes have to be firmly attached to injection caps. Before injection, the passability of the pipe has to be checked by inserted tendons. The injection mass mixer and pump can be lifted to a suitable position only by the specified lifting device. Injection must be supervised by the injection manager.

2.1.13.4.11.8 Works during concreting, involving devices under pressure

Devices operating under pressure, used for concreting or gunning can be operated only by expert qualified staff, capable in terms of health and acquainted about safety measures applying to work. The work site has to be secured and suitably marked.

If the concrete pouring site is not managed by machinery, the concrete pipe has to be held by two workers standing on stable and solid basis.

Protective equipment for the face, respiratory system and the entire body is obligatory.

2.1.13.4.11.9 Work places at height

2.1.13.4.11.9.1 Roof work

If the height exceeds 2 m or the slope is greater than 30°, the employer has to adopt collective safety measures to prevent workers, tools or other objects or material from falling.

If workers work on a roof, near it or on any other area made of breakable material, through which they might fall, the employer must adopt safety measures to ensure that workers do not walk over such area carelessly or fall off.

Work on surfaces with the inclination exceeding 45^0 and on roofs may only be carried out by workers capable in terms of health to perform work at heights. Such work may only be performed in favourable weather conditions and with implemented measures for preventing of sliding and falling of workers.

Measures for preventing of sliding and falling shall be implemented with regard to:

- height of the work place;
- inclination of the surface (steepness);
- type and bearing capacity of the roofing (or other surface);
- duration and type of work (and dangers arising therefrom).

As regards height and inclination of the surface, the following measures shall be deemed appropriate: on areas with inclination up to 20^0 the installation of safety fences on overhangs of roofs (or scaffolds along the roof) or placement of warning signs about the danger area at least 2 m from the overhang – only when there is no danger of sliding on the surface (the surface is not made from smooth sheet metal or material with similar characteristics);

As regards surfaces with inclination between 20^0 and 45^0, placement of safety fences or safety scaffolds or nets on overhangs of roofs on such distances that the height of sliding is less than 5 m;

As regards surfaces with inclination between 45^0 and 60^0, protection (fastening) of the worker by using personal protective equipment against falling shall be used in addition to placement of safety fences or safety scaffolds or nets specified in the previous indent hereunder;

As regards surfaces with inclination exceeding 60^0 in addition to measures specified in the previous indent hereunder, safe access (stably placed ladder…) for climbing the surface shall be provided and horizontal working platforms placed at every 2 m to be used by workers for performing work (fitted with safety fences).

Safety fences shall have at least the height providing that the upper edge measured right-angled to the inclined surface is not less than 100 cm above such surface. In case the inclination of surface is more than 45^0, the lower (solid) protective edge of the fence shall have the height of at least 50 cm or the fence shall be protected by a net preventing the material from falling.

Prior to commencement of work on existing roofs the responsible person appointed by the employer shall check the condition of the roof structure and the roof itself (laths, roofing) and, if need be, take all measures required for preventing injury of workers or other persons.

No one shall be allowed in the area directly under the roof construction during work on the roof. The danger area shall be protected and marked by placement of appropriate danger signs.

As regards roofs covered with fibre cement plates, thin sheet metal or similar roofing (industrial roofs) unable to sustain large loads (weight of workers, material and tools), reliable passages and working platforms shall be prepared prior to commencing the work. Areas safe for movement of workers shall be clearly marked.

In cleaning of snow and maintenance of the roof near light shafts, windows and other breakable surfaces, the employer shall provide for appropriate protection of such surfaces (covering with safety nets…).

Light shafts and windows with glass cover shall be raised above the roof level. All industrial roofs regardless of their shape and roofing type shall have reliable access to such spots.

Accesses, passages and working platforms shall be at least 60 cm wide and, if need be, have solid protective fence.

In case of short periods of work on the roof requiring plenty of movement, workers may be protected against sliding and falling only by personal protective equipment against falling. The danger area around the facility shall be protected against falling material.

2.1.13.4.11.9.2 Falling objects

Workers have to be protected against falling objects by collective measures whenever this is technically feasible.

Materials and working equipment must be placed or distributed so that they cannot fall down or tip over.

If necessary, roofed passages have to be provided on the construction site or access to dangerous areas prevented.

Work places which involve the danger of falling have to be fall-protected, namely: independently of the height, work places at passages and paths as well as above and next to water and substances where there is danger of drowning; more than 1 metre above ground at staircases, ramps, passages and work places next to machines; more than 2 metres above ground at all other work places; all openings and deepening in ground, mezzanine constructions, on roofs.

Regardless of the first paragraph of this item, protection need not be provided when workers are in terms of health capable of implementing works at height and carry out the following works:

- at the height of 5 metres, when preparing supporting scaffold of mezzanine plates with maximum 20° inclination;

- on the external (or opposite) side when constructing or concreting a wall up to 7 metres high above the terrain or ground. However, such work place where a worker stands and works has to have fall-protection behind the worker's back.

Implementation of works above work places is permitted only if adequate protection measures for all workers are provided.

2.1.13.4.11.10 Protection of work places at height

Falls from height have to be physically prevented by fencing all work places at height with a fence of sufficient height and strength having a border board on the lower part and a knee-high crossbar. The handrail has to be sufficiently strong. Fences can also be provided in some other suitable way.

Work at height may be carried out only with suitable equipment or by using safety devices, such as fences, platforms or safety nets.

If the use of this equipment or devices is not possible because of the nature of work, adequate safety has to be provided by other methods and means.

Fall-protection of work places at height can be provided by a safety fence, described as:

The safety fence has to be 100 cm high with ±5 cm tolerance, measured from the ground of work area. It has to be made of healthy and undamaged wood or other suitable material. The distance between the posts and the size of the posts and other elements of the fence must on the upper edge (rail) be suitable for horizontal load of at least 300 N/m. The distance between the horizontal elements of the safety fence (inside material) must not exceed 47 cm. At the bottom of the safety fence a full protection edge (board) has to be installed on the inner side of vertical posts at least 15 cm high. The lower protection edge is not needed in the fence on staircases, ramps and oblique passages.

Instead of the longitudinal filling of boards (knee protection) a grid may be used with maximum 2 cm x 2 cm openings on the entire height of the fence. In the case of longer safety fences and greater load (traffic, etc.) and fences at great heights, suitable plans and static calculations have to be made in advance.

Safety fence is considered safe even if it is produced differently, in accordance with Slovene, European or international standards, provided that this can be proved by suitable documentation.

If due to the nature of the works the safety fence needs to be removed from exposed edge, the workers at such work places have to be protected by safety belts and the work has to be carried out under the supervision of a qualified professional on the construction site. Such area has to be protected by a substitute parallel fence 1 to 3 m from the exposed edge. If the surface inclination is below 20, a signalling rope or chain with well visible flags 1 metre apart can be placed at least 2 m from the overhang edge. The signalling rope has to be 1.0 to 1.3 m high from the ground and attached to posts or other support so that the load from one field cannot be transferred onto another. The posts must not turn over or move across the surface at the load of 70 N at 1.0 m in height.

At all accesses and other places next to the rope warning signs have to be placed maximally 20 metres apart, prohibiting access, warning against fall and denoting obligatory use of safety belt.

If safety fence cannot be provided for technological reasons, the unprotected work place at height which requires protection according to item 6 should be protected by safety nets, safety scaffolds or the safety of workers has to be ensured in some other way (by personal protective equipment, etc.) in line with the provisions of the relevant standard. Safety nets have to be designed and installed in accordance with the SIST EN 1263 standard. Workers have to be prohibited from walking under the net or allowed to do so only in restricted scope, if there is danger of the falling material breaking through the net (protection of dangerous area under the net, installation of safety signs).

Before the commencement of works the manager of individual works has to check if the safety nets are suitably installed and the protection of the dangerous area adequate.

Openings in walls more than 2 m above the terrain with the parapet lower than 85 cm, have to be up to 100 cm above ground protected by safety fence.

Openings and passages in the ground, mezzanine constructions or roofs have to be, regardless of the dimensions of the opening or the depth of potential fall, protected by hard covers, consolidated in such manner than they cannot be moved.

Instead by a cover, an opening can be protected also by a safety fence.

When works are implemented on openings in walls which are more than 2 metres above the terrain, the workers have to be protected against fall by being attached by personal protective equipment.

2.1.13.4.11.11 Works with carcinogenic and mutagenic substances

The European Parliament and Council Directive 2004/37/EC of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (Official Journal, no. 229 dated 29 June 2004, p. 23), codified version, lays down the minimum requirements for ensuring safety and health of workers protecting them against risks arising from the exposure to carcinogens or mutagens and specifies minimum binding values for occupational exposure.

Work involving carcinogens and mutagenic substances is all activities during which workers are exposed or may be exposed to carcinogens and mutagenic substances while using, producing, warehousing, processing, modifying, decanting, mixing, disposing, destroying these substances and during similar activities. These works include also activities where, due to the conditions during procedures, carcinogens and mutagenic substances are released or created.

Carcinogens and mutagenic substances, preparations and processes are those which meet the criteria for classifying substances, preparations and processes on the classification, packaging and labelling of dangerous substances:

- Auramine production.
- Work involving exposure to polycyclic aromatic hydrocarbons present in coal soot, tar or pitch.
- Work involving exposure to dust, smoke, vapours or aerosols arising from roasting and electrolytic refining of copper-nickel compounds.
- Strong acid procedure for producing isopropyl alcohol.
- Work involving exposure to hard wood dust.

In road construction research is carried out about the workers' exposure to carcinogens and mutagenic substances in production and installation of asphalt mixtures. (European Asphalt Pavement Association; Health, Safety & Environment Committee).

During the implementation of works where there is the risk of exposure to particles of carcinogens and mutagenic substances, the employer has to establish the nature, level and duration of exposure in order to assess the risk for safety and health of workers and based thereon specify all the necessary safety measures.

When risk is estimated, all exposure paths have to be considered, and particular attention has to be devoted to carcinogens and mutagenic substances which more easily penetrate through skin and can lead to absorption of carcinogens and mutagenic substances into and/or through skin.

The employer has to pay special care to the assessment of risk of young, pregnant and nursing workers who may come into contact with carcinogens and mutagenic substances, taking into account the possibility of assigning these workers to such work places where they will not come into contact with carcinogens and mutagenic substances.

The employer has to provide for health supervision of workers who come into contact with carcinogens and mutagenic substances.

The employer has to inform the competent body thereof in writing 15 days before the carcinogenic or mutagenic substance starts being used.

The employer must provide for lower exposure of workers, namely:

1) The employer has to, if this is technically possible, replace and substitute the carcinogenic or mutagenic substance at work place with a substance, preparation or process which is under the conditions of use not dangerous or is less dangerous to safety and health of workers.
2) If a carcinogen or mutagenic substance cannot be technically replaced by a substance, preparation or process which is under the conditions of use not dangerous or is less dangerous to safety and health of workers, the employer must make sure that these substances are produced or used in a closed system.
3) The employer must ensure that at work place workers are not exposed to concentrations of carcinogenic or mutagenic substances in the air exceeding the maximum values specified in

the regulations (Attachment III of the Rules on the Protection of Workers from the Risk Related to Exposure to Carcinogens and Mutagenic Substances).

For all works during which the use of carcinogenic or mutagenic substances cannot be avoided, the employer has to adopt and implement the following measures:

a) reduce the quantity of carcinogenic or mutagenic substances at work place to a minimum;

(b) reduce the number of workers exposed or potentially exposed to carcinogenic or mutagenic substances to a minimum;

(c) plan work procedures and technical control measures so that the release of carcinogenic or mutagenic substances into air at work place is prevented or reduced to a minimum;

d)* eliminate carcinogenic or mutagenic substances at source by introducing the local or general ventilation system, with all methods of elimination being suitable and compatible with the principles of protecting human health and the environment;

(e) use suitable established procedures for measuring concentrations of carcinogenic or mutagenic substances in the air at work place, especially for early detection of unusual exposure on account of unforeseen event or accident;

(f) use suitable work procedures and methods;

g implement collective safety measures and/or personal protective measures;

h) implement hygienic measures, such as regular cleaning of floors, walls and other surfaces;

(i) inform the workers;

j) mark dangerous areas by suitable warning and safety signs, including "no smoking" and "No consumption of food and drink is allowed" signs in the areas where workers may be exposed to carcinogenic or mutagenic substances;

k) prepare plans for taking measures in extreme cases, which are the consequence of unusually high exposure level;

l) ensure suitable equipment for safe storage, handling and transport of carcinogenic or mutagenic substances, especially the use of sealed, clearly and visibly marked containers of carcinogenic or mutagenic substances;

m) provide means enabling the workers to safely collect, store and dispose of waste as well as to provide sealed, clearly and visibly marked containers of carcinogenic or mutagenic substances, which have to be used at work.

If during work an unforeseen event or an accident occurs which could cause unusual exposure of workers to carcinogenic or mutagenic substances, the employer has to immediately inform the workers thereof. Until normal condition is fully reinstated and the causes of unusual exposure eliminated, the employer has to:

- ensure that only the workers truly necessary for repairs and other required tasks work in the affected area;
- provide workers working in the affected area protective clothes and personal protective equipment for the respiratory system as well as ensure that the workers also use it;
- ensure for every individual worker that their exposure to carcinogenic or mutagenic substances is not permanent and is of minimum duration;
- prohibit unprotected workers to work in the affected area.

During the implementation of certain works, e.g. maintenance, rehabilitation, demolition, control, repairs on machines, devices, instruments and facilities, during which workers' exposure is expected to be significantly higher and for which all technical preventive measures to reduce the exposure have already been implemented, the employer has to, after consulting with the workers or their representatives, set safety measures to reduce the duration of workers' exposure to a minimum and ensure safety and health of workers during the implementation of such works.

In accordance with the above paragraph the employer has to provide all exposed workers protective clothes and personal protective equipment for the respiratory system, which the workers must use throughout the exposure.

The duration of each worker's exposure must be restricted to a minimum.

The employer has to ensure that the access to the areas where the above stated works are implemented is provided only to suitably qualified and authorised personnel. These areas have to be clearly separated from other areas and suitably marked.

2.1.13.4.11.12 Works in the area of ionising radiation

Council Directive 2003/122/EURATOM of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources (Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (Sixth individual Directive within the meaning of Article 16(1) of Council Directive 89/391/EEC) (codified version) (Text with EEA relevance); Corrected by..304L0037R(01) define the minimum requirements on safety and health protection.

In addition to radioactivity in the environment, the workers are exposed to the danger of radiation during earthworks and mining works as well as measurements of density and moisture of the carriageway structure.

2.1.13.4.11.12.1 Radioactivity in the environment

We are exposed to natural radiation due to radioactive stone materials on Earth and due to radiation from space (cosmic rays). The existing data about external radiation and the concentration of radon in apartments and outdoors show that the bulk of radiation, approximately 50%, is accounted for by internal radiation caused by inhalation of radon and its progenies (1.2–1.5 mSv annually) in residential buildings. The intake of radioactivity by food and water represents about 0.4 mSv of the annual dose. Annual effective dose of outdoor radiation originating from radioactive soil, construction material in buildings and cosmic radiation in Slovenia totals 0.8-1.1 mSv.

2.1.13.4.11.12.2 Earthworks and mining works

Radioactivity exposure measurements in addition to radon emissions and liquid radioactive discharge include also measurements of specific activities of radionuclides of uranium-radium decay chain in the environment, including the measurements of radon and its short-lived progenies in the atmosphere as well as outdoor radiation measurement. When radionuclides of natural origin are measured, the impact of former mining (estimate of radioactivity increase in the environment) is based also on reference measurements at locations that are not influenced by mining emissions.

2.1.13.4.11.12.3 Facilities and devices

All operation of facilities and devices releasing radioactive substances into the environment is supervised. Radioactivity measurements in the environment are carried out even before regular operation, during it and for a certain time after the operation stops. It is established if the release activities were within the permitted limits and the radioactivity concentrations in the environment below the set maximum.

2.1.13.4.11.12.4 Density measurements

Measurements of density and moisture of carriageway construction are carried out by isotopic measuring devices of density and moisture, with integrated closed radiation sources. Measuring devices are used for controlling the implementation of the final carriageway layers (asphalting) and need to be relocated between individual measuring points.

The environment in the approximate vicinity of the measuring device is exposed to radiation. The danger zone is a circle around the measuring device with a 5 m radius. During the measurement, the access to the danger zone is strictly prohibited.

If the measuring device is damaged or breaks down, a detector has to be used to check for uncontrolled increase in radiation. If uncontrolled radiation appears, the radiation beam has to be directed towards the ground, the site physically fenced and the authorised service called for an intervention.

2.1.13.4.11.13 Maintenance works

When workers are performing minor maintenance work or cleaning on the outer side of a tall building by hanging on ropes, such work is considered particularly dangerous hence only qualified workers capable in terms of health for work at heights shall perform such work. Such work shall not be carried out in adverse weather conditions. During work it is compulsory to use the combined protective-positioning work belt made in accordance with the regulations, and workers shall be fastened with a positioning rope and protected with a protective rope. Each rope shall be fastened to its own solid anchorage.

If the works are performed directly above or next to the traffic communication or the area where other activities are carried out, safety and health of passers-by have to be ensured. The area below the work site needs to be marked by a warning tape and suitable signs.

2.1.13.4.12 Installations, working devices and equipment

Installations, machines and equipment, including manual tools, mechanically driven or not have to be:

- suitably designed and produced, taking into account ergonomic principles;
- maintained in good working condition;
- used exclusively for the work for which they are intended;
- operated only by suitably qualified staff.

Devices and equipment under pressure must be regularly checked and tested in accordance with the applicable regulations.

Installations for the distribution of energy on the construction site, especially those affected by external impacts, have to be regularly examined and maintained.

Electrical installations have to be made, repaired, maintained and removed only by qualified professional electro-technical engineers.

Prior to the start of work on the construction site the existing installations have to be identified, examined and clearly marked.

If possible, overhead electrical conductors have to be relocated outside the construction site or electrical current interrupted.

If this is not possible, safety barriers have to be installed, ensuring that vehicles and installations do not come into contact with overhead electrical conductors.

When vehicles have to drive under electrical lines, suitable warning signs and hanging protection boards must be installed.

All work equipment shall be examined, tested and be in perfect working condition prior to its allocation to the work site (construction site). Machinery may be operated only by workers being qualified in accordance with the regulations and which were previously informed and passed tests in relation to safe work.

The employer shall appoint the person in charge or the manager of individual works responsible for correct and professional placement and maintenance of work equipment at the construction site.

The devices for lifting and moving freely suspended loads (cable crane, building tower crane, tackles and other) and any auxiliary suspension devices shall comply with the prescribed requirements.

Building tower crane and crane lines must be set up according to the manufacturer's instructions for assembly and disassembly and under the supervision of a geomechanic.

The documentation of devices for lifting and carrying load has to be available on the construction site and needs to be kept until a device is disassembled.

The devices must be inspected by the manager of individual works

- before they start being used,
- later at regular intervals, at least once monthly,
- after any modification, after a longer period of non-use, after being exposed to poor weather or earthquakes or any other circumstances which could influence the stability and strength of the device.

All findings are entered in the device control list, signed by the responsible manager of works, geomechanic and safety and health at work coordinator.

Scaffolds may be set up, reshaped, upgraded and disassembled only under direct supervision of the managers of individual works (responsible person), who are in terms of health capable of implementing works at height.

As regards construction sites where movable lifting devices with hooks and other handling devices suspended on a steel rope are used for lifting and moving loads, the employer shall provide for safety of loads and workers in the danger area.

Transport devices in the form of containers may only be filled up to two thirds of their volume or up to the height marked on the container.

The danger area on the spot where loads are being lifted shall be fenced or marked by suspended loads and no access warning signs. Access to the danger area under the loading platform of the lift shall only be permitted to workers loading or unloading material.

The area of loading and unloading of loads for lifts on individual floors shall be appropriately protected to prevent workers falling from the floor.

In case of lifting of loads, protruding parts shall be removed throughout the length of the construction facility or guides preventing the load from getting stuck shall be placed.

Transport of persons with lifting devices for transporting loads shall only be permitted in extraordinary situations, namely:

- in case the placement, use or disassembly of means for access to the work site, such as stairs, elevators, ladders, lifting platforms or similar devices is impossible due to configuration of the work site or when ascending/descending by using such devices poses greater danger to workers;
- in case of work carried out over short time periods.

The following shall be provided with that regard:

- that persons shall be lifted and lowered only in specially manufactured equipment for personal transport (baskets);
- that safe entry and exit are provided for. The basket shall be stably placed on a bearing surface sufficiently large and protected to prevent any danger from workers falling.
- that the speed of the basket's movement is less than 0.5 m/s and the movement is without thrusts in any direction. No sharp or pointed objects shall be present in the basket during lifting/lowering of workers.
- that written instructions are prepared for safe transport of persons and that the lift's operator and users have been informed thereof.

No more than 4 persons shall be lifted/lowered in the basket simultaneously. Only 1 person may be in the basket mounted on a device for transporting concrete. Work from the basket may only be performed, if the worker is fastened to the stable part of the basket by a safety belt.

In stronger wind (gusts of wind exceeding 5 m/s), lifting/lowering shall not be carried out, the lifting in progress shall be stopped and the basket with workers shall be lowered to the ground at reduced speed.

Communication must be established between the lift operator and persons in the basket.

Prior to any transport of persons with lifting devices for transporting loads, the employer shall inform the Labour Inspectorate thereof.

The lift, which can be used for lifting/lowering workers in a basket, shall fulfil the following conditions:

It shall be placed on a solid and flat surface with inclination of less than 1%.

The lift shall be tested and examined prior to any transport of persons. The employer shall provide for periodical checkups to be carried out daily by the lift operator and regularly each month by authorised personnel of the employer in charge of checkups.

In case of any established defects or deficiencies the employer shall immediately stop transporting persons and re-examine the device after deficiencies have been eliminated.

Loading of the lift with the basket having the maximum number of persons shall not exceed one half of permitted loading in the entire area of the planned manoeuvre.

In case two lifts are placed so close together that their areas of operations overlap, one of both lifts shall be still during lifting/lowering of workers in the basket, with the handle turned away from the joint area of operations and both operators being present in the lift the whole time.

Lowering of the loading hook shall be carried out by a motorised drive. Lowering by means of gravity and regulating speed by using brakes only shall be prohibited.

The basket shall be manufactured in accordance with the regulations and previously tested as well as examined monthly and the employer shall keep the related documentation on the construction site.

The basket shall have a rope used for lifting of a ladder or rescue rope in case of unforeseen stopping of the lift. The rope's length shall be such that it reaches the ground when the basket is lifted to the highest possible position and shall have a weight at the end. Tear up strength of the rope shall be at least 10 kN.

Until no regulation exists with regard to baskets for transporting persons, the following conditions shall be fulfilled:

- The basket shall be designed and manufactured for five times the planned load and examined before use.
- It shall have the following clearly indicated:
  - name of the manufacturer
  - year of production
  - type
  - factory number
  - own weight
  - permitted load and the number of persons.

Fence of the basket shall be solid and at least 110 cm high, measured from the floor. Solid protective edge of height not less than 15 cm shall be placed above the floor, the basket shall be closed by a steel net or similar, where openings shall not be more than 2 cm x 2 cm. A round handle shall be placed 1 m above the floor. The cabin shall be free of any sharp edges and pointed parts of the construction.

Entry to the basket/platform/cabin must not open to the outside during lifting/lowering. Appropriate measures shall prevent unintentional opening of the door during lifting and lowering.

The basket's top shall be solid enough to protect workers from falling objects. There must be enough room under the top for the workers to be standing up.

The top over the basket is not required on the basket for transport of concrete with a worker present.

In one-sided loading of the basket with 1.5 useful load at 1/4 of the basket's length, the inclination shall not exceed 20^{o}.

An anchorage shall be provided in the basket where a rope is fastened in case workers need to be evacuated (in case of breakdown of the lifting device).

2.1.13.4.13 Working platforms, ladders and scaffolds

2.1.13.4.13.1 Working platform

Working platform where work at height is carried out has to be stable and firm. It has to be made of elements that comply with the planned load and apply to scaffold floor as stipulated in SIST HD 1000 standard.

If boards are used for working platform, they have to be at least 4.8 cm think (planks) and no less than 20 cm wide, supported at less than every 250 cm. They have to be made of healthy and undamaged wood, without nails and other obstacles. The planks have to fit each other and be placed horizontally on solid supporting elements. If the planks are not placed on the same level, but rather one on top of the other, a triangular lath has to be attached to the joint, which enables carts to be pushed across and prevents workers tripping over. The planks must not extend over the final supporting element by less than 20 cm and more than 30 cm. In addition, they have to be secured so that they cannot move. Formwork panels must not be used for working platform.

The width of the working platform has to be adjusted to the nature of the work carried out on it, but must not be less than 60 cm, if the work does not involve stacking or preparing of material. If material is laid or prepared on the working platform or auxiliary elements are laid on it, it has to be so wide that a worker has at least 30 cm of free space for movement.

If the working platform next to the wall of the facility is more than 100 cm above the ground or the floor of the premises, its edge can be no more than 30 cm away from the wall. If it is farther from the wall or if the wall of the facility has large openings, the safety of workers has to be provided according to the measures applying to protection of work places at height or otherwise.

Platform elements on the scaffold (boards, sheet metal plates and other) have to be carefully inspected before use.

Damaged or worn out elements must not be installed.

Special care is required when construction material and heavy construction elements are moved, transported and stacked on the working platforms. The material has to be properly stacked on the working platform and arranged so that it does not exceed the planned load. Working platform has to be regularly inspected and maintained, and the waste material promptly removed.

2.1.13.4.13.2 Ladders

Ladders have to be strong enough and suitably maintained.

They have to be used carefully, at suitable locations and in accordance with their intended use.

Ladders can be used for accessing a work place at height only if the height difference between bridged levels is less than 5 m;

- access is needed only for implementing short-term works;
- for access to the facade scaffold and under the condition that the ladders are installed within scaffold construction;
- if a ramp or staircase cannot be provided for access to excavations and shafts due to technical reasons.

Portable ladders have to be made in accordance with the requirements of the standard SIST EN 131. Before used, they have to be checked and in perfect condition.

When used, ladders have to be placed firmly, so that they cannot skid, break or turn over.

Portable single ladders used by workers to access wall edges, scaffolds, openings in the ground, pits, shafts and similar, have to be of suitable length, so that they extend at least 1 m over the structure against which they are leaned. The lean angel has to be between 65° and 75°.

Ladders must not be leaned against wedges (at the corners of buildings or poles).

Ladders can be used only for short-term works that do not require great press force of the worker and when only light hand tools and a small quantity of material are used, which cannot additionally endanger the safety and health of workers. The worker has to be standing with both legs on one step. If there is no fall-protection (without the worker being fastened) works can be implemented only up to 3 metres high. Maximum permitted length of portable single ladders used for works is 8 m, and that of double (A) ladders 3 metres.

2.1.13.4.13.3 Scaffolds

Scaffolds are auxiliary constructions intended for construction works at height.

Scaffolds have to be produced and set up according to the plans, which define:

- the size of the scaffold and all its elements,
- the means for joining the elements of the scaffold,
- the method of attaching the scaffold to a facility or ground,
- maximum permitted load,
- types of material and its quality,
- statistical calculation of bearing elements and
- assembly and disassembly instructions.

When a scaffold is designed, the requirements of the SIST HD 1000 standard have to be considered.

For standard scaffolds with a statement on scaffold compliance with the requirements of the SIST HD 1000 standard suitable documentation has to be provided as required by the standard. This documentation has to present the set up of elements, anchorage or support so as to prevent turning over as well as state the permitted loan and the method of assembly and disassembly.

The documentation about the scaffolds has to be available on the construction site and kept until the scaffold is disassembled.

The scaffolds must be inspected by the manager of individual works

- before they start being used,
- later at regular intervals, at least once monthly,
- after any modification, after a longer period of non-use, after being exposed to poor weather or earthquakes or any other circumstances which could influence the stability and strength of the scaffold.

All findings are entered in the scaffold control list, signed by the responsible manager of works and safety and health at work coordinator.

Scaffolds may be set up, reshaped, upgraded and disassembled only under direct supervision of the managers of individual works (responsible person), who are in terms of health capable of implementing works at height.

If the setting up of the scaffold is hindered by unisolated electrical lines or other obstacles, it has to be postponed, until the danger of electrical current is eliminated and other obstacles removed.

The working platform (floor) of the scaffold has to be produced according to the requirements applying to working platforms. The working platform must not be more than 30 cm away from the wall of the facility, unless when this cannot be avoided due to work technology and other form of fall-protection is provided for workers between the facility and the scaffold (by safety fence, by no more than 3 metres lower safety scaffold reaching to the wall, by fastening workers or in some other manner).

The platform elements have to completely fill in the space between the supporting posts of the scaffold.

Safety fences on scaffolds have to be made in accordance with the requirements applying to fences.

A reliable access (or descent) has to lead to every level of the scaffold. If on the scaffold ladders are used for access, their upper pats have to be attached.

The height of the work place in the scaffold that is less than 100 cm wide must not be raised by means of trestle or ladder scaffold or some other auxiliary construction being placed on the working platform of the scaffold.

If the scaffold is placed next to connection or adjoining facility, protection has to be provided in accordance with the requirements applying to scaffolds being set up next to connection or adjoining facility. If scaffold is protected by a safety net placed on it, the material used must not cause any danger for the scaffold turning over or falling down and has to be self-extinguishing. Impervious sheeting may be used for protecting the scaffold only when this is necessary due to the nature of work (removal of asbestos material, etc.), while the stability of such a scaffold (and sheeting) has to be proved by means of a computer.

The sheeting has to be made of self-extinguishing material as well.

2.1.13.4.13.3.1 Trestle scaffold

Works may be implemented also on trestle scaffolds up to 2 m high. The working platform of such scaffolds has to be at least 80 cm wide and made in accordance with the requirements applying to working platforms. The safety fence need not be installed nor the documentation provided, with the exception of manufacturing instructions. Before the trestle scaffold is used, the adequacy of scaffold implementation has to be checked by the manager of individual works or some other responsible person of the employer.

The trestle on which the working platform is placed, has to be produced in such a way that it resist the planned horizontal and longitudinal load. The trestles must not be extended, not even by inserting construction material under them. The distance between the trestles must not exceed 200 cm.

Trestles can be placed only on solid and flat surface. Improperly produced or damaged trestles must not be used. Trestle scaffolds must not be placed on the working platform of other scaffolds.

No digital devices or other heavy devices may be placed on the working platform of a trestle scaffold, unless the statistical calculation and project prove that this is possible.

2.1.13.4.13.3.2 Metal scaffolds

In terms of shape, size and quality of material the pipes of metal scaffolds have to comply with the SIST EN 1039 standard requirements, and the connecting and supporting elements with the SIST EN 74 standard.

Metal scaffolds can be constructed only of flat and undamaged steel pipes, rods and other elements.

The components of the metal scaffolds (steel rods, pipes, joints and other) have to be firmly fastened into a stable and uniform construction unit.

Horizontal supporting rods of the metal scaffold have to be placed vertically to special elements (supports, drags), and these onto a flat surface (main supporting element, concrete plates and other).

When clamps with screws are assembled, the screws have to be attached by torque wrenches according to the instructions of the manufacturer.

Self-standing metal scaffolds and metal scaffolds higher than the facility under construction or some other facility in the approximate vicinity have to be grounded according to the applicable regulations.

2.1.13.4.13.3.3 Timber scaffolds

Timber scaffolds are permitted only for the implementation of easier works at the height up to 10 metres measured from the ground.

The diameter of the round wooden pole on the thinner part must not be less than 8 cm. The poles have to be placed on such surface that they cannot move horizontally nor vertically. The poles must not be extended. When to scaffolds are assembled on the corner of a facility under construction, the corner pole on the outer side of the scaffold has to be doubled and, if necessary, dug into the ground. All vertical poles have to be connected also by diagonal attachments.

The distance between vertical poles of the scaffold must not be greater than 250 cm and it has to correspond to the size of the poles and the planned scaffold load. Longitudinal beams have to be installed horizontally next to the poles and well attached to them. The joints of extensions and the connections with the longitudinal beams can be installed only above the poles or on supports placed over the poles. The transversal scaffold supports must have equal cross-section and have to be installed on longitudinal supports equally distanced. Transversal supports must not be replaced by boards.

2.1.13.4.13.3.4 Safety (fall arrest) scaffolds

Safety scaffolds can be used for fall protection of workers only when the safety fence cannot be installed at work places. They have to be erected as close to the work place or overhang as possible, but not lower than 3 metres.

The width of the safety scaffold depends on the vertical distance between the overhang and the scaffold and should, when the distance is up to 200 cm or up to 300 cm, equal at least 130 cm or 150 cm respectively. The lower protective edge of the safety fence of the scaffold has to be full and at least 50 cm high.

2.1.13.4.13.3.5 Bracket scaffolds

Bracket scaffolds can be installed only for less demanding construction works, if they can be safely attached to the facility or its construction and if this is proved by sketches and calculations.

The maximum overhang of the bracket scaffold used as a working scaffold can be 150 cm. Bracket scaffolds with an overhang up to 3 m can be used only as protective constructions for intercepting material above the facility entrances and passages.

Bracket scaffolds may be anchored only into supporting reinforced concrete elements (plate, wall, pillar). Anchorage may be carried out only by means of standardised steel anchoring elements. Only in exceptional cases anchorage is permitted by double loops made of steel reinforcement bars at least 8 mm in cross-section.

Boards (planks) must not be used for supports of the bracket scaffold.

2.1.13.4.13.3.6 Movable scaffolds

Movable (transportable) scaffolds can be used only on supporting and flat horizontal surface. They have to be manufactured in accordance with the SIST HD 1004 standard. The instructions for assembling and using the scaffolds have to be prepared in line with the SIST EN 1298 standard requirements and available on the construction site throughout the period during which the scaffolds are used. The scaffold has to be assembled and used completely in accordance with the instructions, so that undesirable movements, falling down or turning over cannot occur.

Workers may ascend and implements works on the movable scaffold only when the scaffold is protected against movement. If the scaffold is accessed by ladders installed in the side element of the scaffold, the workers may ascend it only on the inner side of the scaffold. The use of movable single ladders for accessing the scaffold is prohibited.

When the scaffold is moved, it has to be free of persons, material or working equipment.

2.1.13.4.13.3.7 Overhead protection

Entrances, passages and paths around the facility under construction have to be protected against the material which could fall from height by overhead protection. They have to be manufactured in such a way that they can hold the fallen material and prevent the material from bouncing off and spreading over the surrounding area.

Overhead protection at construction site must not be less than 220 cm and more than 600 cm above the ground. Wooden construction of overhead protection which is not standard has to be made of two perpendicular layers of boards with a full vertical protection on the edges at least 50 cm high.

The material that falls on the safety scaffold has to be promptly removed.

2.1.13.4.13.3.8 Supporting scaffolds and panelling

Supporting scaffolds are used for concrete, reinforced concrete and similar massive constructions (scaffolds supporting panelling). The support structures of these scaffolds have to be made of metal. The quality of material used for producing supporting scaffolds has to comply with the standards and the provisions contained herein. Telescopic support members with adjustable length and safety elements for fixing the set element length have to be manufactured according to the SIST EN 1065 standard.

Notwithstanding the previous item, wooden support members may be exceptionally used up to the height of 3 metres. They have to be made of a single piece of healthy wood, with the smallest cross-section equalling 8 cm x 8 cm. They have to be inspected before use. Moreover, they have to be firmly attached on both sides so that any movement is prevented. The support members can be installed no more than up to the height of 10 cm, using wooden or steel elements.

Before the supporting scaffolds start being erected, the ground load capacity has to be checked.

Before use, the installed scaffolds have to be inspected by a person in charge of professional supervision over construction, while during use and work implementation they have to be examined by the manager in charge of individual works appointed by the employer.

The panelling must not be removed and the supporting scaffold disassembled without a written instruction of a person in charge of professional supervision over construction. The supporting scaffold has to be disassembled according to the manufacturer's instructions. When the wooden support members of the panelling are disassembled, safety support members have to be installed for protection against potential falldown as stipulated in the scaffold project.

2.1.13.4.13.3.9 Hanging scaffolds

Hanging scaffolds can be used in accordance with the regulations and instructions of the manufacturer, provided they are manufactured, assembled, tested and inspected according to the requirements of the SIST EN 1808 standard. When working on hanging scaffolds the workers have to be attached to the scaffold by special personal fall arrest equipment.

2.1.13.4.14 Protection against fire on the construction site

2.1.13.4.14.1 Introduction

Fire safety on the construction site is directly or indirectly regulated by Council Directive 92/57/EEC (the eighth specific Directive pursuant to Article 16(1) of the Directive 89/391(EEC) and the standards published by the European and international technical committees: CEN/TC 72 (O), CEN/TC 191 (O), ISO/TC 21 (O), ISO/TC 21/SC 8 (O), CEN/TC 127 (O), CEN/TC 166, ISO/TC 92 (O), ISO/TC 92/SC 1 (O), ISO/TC 92/SC 2 (O), ISO/TC 92/SC 3 (O), ISO/TC 92/SC 4 (O)

International classification:

13.220 Protection against fire

13.220.01 Protection against fire in general

13.220.10 Fire-fighting

13.220.20 Fire protection

13.220.40 Ignitability and burning behaviour of materials and products

13.220.50 Fire-resistance of building materials and elements

13.220.99 Other standards related to fire protection

2.1.13.4.14.2 Fire Safety Study for construction site

2.1.13.4.14.2.1 Fire Risk Evaluation

The basis for specifying the required fire safety measures on construction sites is the fire risk evaluation.

The factors increasing fire risk are the following:

- Properties and quantity of combustible construction material;

- Properties and quantity of other combustible substances (inflammable liquids, gases and highly flammable solid substances);
- Improvised storing of inflammable liquids, gases and highly flammable solid substances
- Improvised installations;
- Improvised temporary facilities and premises;
- Improvised executed work and work procedures;
- "Implemented and unimplemented" fire safety measures, such as evacuation routes, fire separations, fire detectors and alarm devices, devices for initial fire extinguishing (fire extinguishers, indoor hydrants), automatic fire-fighting equipment, water supply, outdoor hydrants and access routes for fire-fighting vehicles, etc.;
- Permanent presence of a large number of workers and visitors on the site, which are not familiar enough with the construction site or the planned safety measures.

2.1.13.4.14.2.2 Fire Hazardous Material and Fire Hazardous Work

There are usually large or small quantities of fire hazardous material on the construction site, e.g.:

- Highly flammable solid substances (construction material: shavings, wood, plastic, foamed insulation material (Styrofoam, PU foam), packaging material: cardboard, foil, wood pallets and internal decoration elements, etc.);
- Inflammable liquids (automotive fuels, paints, diluents, solvents, cleaning agents, etc.);
- Inflammable gases (acetylene for welding, UNP, heating gas, etc.).

Fire hazardous work includes:

- Hot works such as welding, soldering, cutting and buffing of metal and other elements;
- Storage and decanting of inflammable gases, inflammable liquids and highly flammable solid substances;
- Cleaning with organic diluents;
- Painting and lacquering;
- Placement of combustible heat insulation and roof coverings;
- Use of electrical and gas devices in temporary facilities and in improvised conditions;
- Other fire hazardous work.

2.1.13.4.14.2.3 Potential Ignition Sources

The following potential ignition sources exist as a result of:

- Hot works such as welding, soldering, cutting and buffing of metal and other elements;
- Defects on electrical installations and devices;
- Incompliance with the Fire Code;
- Smoking and cigarette butts;
- Wilful fire-raising.

The possibility of ignition due to the following reasons should also be taken into account:

- Fire on adjacent buildings – emission, flying particles;
- Fire in natural environment.

2.1.13.4.14.3 Fire Protection Measures

2.1.13.4.14.3.1 Construction-technical fire protection measures

Construction-technical fire protection measures on construction sites include:

1) Evacuation routes;
2) Division of the construction site to fire sectors;
3) Protection of steel structural elements;
4) Devices for protection against lightning;
5) Automatic fire detectors;
6) Water supply – connection to the public water supply system or pools;
7) Indoor hydrants;
8) Outdoor hydrant network and outdoor hydrants;

9) Automatic fire-fighting equipment;

10) Unhindered and safe access for fire fighting and rescue, access routes for fire-fighting vehicles.

2.1.13.4.14.3.2 Fire extinguishing equipment

Depending on characteristics of the construction site, dimensions and use of premises, the equipment on the construction site, the physical and chemical properties of the substances present and the maximum potential number of people present, the construction site must be equipped with appropriate fire-fighting equipment and, as necessary, with fire detectors systems.

Fire-fighting equipment, fire detectors and alarm systems should be regularly checked and maintained.

Checkups and testing of the devices referred to in the first paragraph hereunder should be carried out in the prescribed periods.

Non-installed fire-fighting equipment must be easily accessible and simple to use.

The equipment referred to in the first paragraph hereunder shall be marked in line with the Rules Governing Safety and Health Signs at Work.

Signs/markings shall be sufficiently resistant and placed on appropriate positions.

The equipment and its placement shall be in line with the fire risk evaluation and provisions of the applicable rules, standards and guidelines for placement of fire extinguishers.

2.1.13.4.14.3.3 Protection against wilful fire-raising

Measures preventing wilful fire-raising shall be in place in all construction sites. The measures used for prevention of wilful fire-raising include:

Lighting of the construction site;

Use of video surveillance with cameras;

Permanent 24-hour control by a security guard.

The requirements should always take into account the fire risk evaluation with regard to the possibility of wilful fire-raising and provisions of guidelines for preventing wilful fire-raising.

2.1.13.4.14.3.4 Placement and construction of temporary facilities

Placement and construction of temporary facilities with devices for heating, cooking and other actions with fire risk shall be specified for the construction site. Particular attention should be given to the following:

Distance from the construction site;

Fire resistance of external walls and ceilings of these temporary facilities;

Installations;

Electrical and gas devices in these temporary facilities;

24-hour security supervision of temporary facilities.

The requirements should take into account results of the fire risk evaluation and provisions of applicable rules ,standards and guidelines related to protection against fire.

2.1.13.4.14.3.5 Storing of inflammable liquids and gases

The method and implementation of temporary storage should be specified as regards construction sites:

Inflammable liquids: diesel fuel, heating oil, paints, lacquers, diluents, solvents, cleaning agents;

Inflammable gases: UNP, acetylene, etc.;

Highly flammable solid substances: cardboard, foil, foam insulation materials, etc.

The requirements should take into account the type, quantity, and properties of fire and explosion hazardous material and provisions of applicable rules, standards, and guidelines for storing, decanting and use of inflammable liquids, gases and solid substances.

2.1.13.4.14.3.6 Implementation of power supply, and electrical and gas installations

Implementation of the following shall be specified for construction sites:

Electrical installations and devices;

Gas installations and devices.

The requirements should take into account results of the fire risk evaluation with regard to the risk of ignition and explosion hazard zones, and provisions of applicable rules ,standards and guidelines related to protection against fire with regard to electrical and gas installations.

2.1.13.4.14.3.7 Execution of hot works

The method and procedure of hot works should be specified as regards construction sites. These hot works include:

Welding;

Soldering;

Cutting and buffing of metal material;

Heating of and heating by solid, liquid and gaseous fuels;

Hearths and burning;

Other hot works.

The requirements should take into account the planned implementation work, envisaged construction materials, results of the fire risk evaluation and provisions of applicable rules, standards and guidelines related to execution of hot works.

2.1.13.4.14.3.8 Inflammable waste handling

The method of collection, disposal and removal of waste resulting from construction should be specified for construction sites.

The requirements should take into account the type, quantity and properties of expected waste, results of the fire risk evaluation and provisions of applicable rules, standards and guidelines related to fire safety and protection of the environment.

2.1.13.4.14.3.9 Procedures in case of fire

The following shall be specified for construction sites:

The person responsible for fire safety on the construction site;

Activities and procedures regarding fire prevention on the construction site;

Activities and procedures in case of fire on the construction site;

Fire-fighting plan in case of fire on the construction site;

Control of the fire's impact on surroundings.

Implementation of aforementioned tasks should take into account the following: results of the fire and explosion risk evaluation, the envisaged fire scenario and provisions of applicable rules, standards and guidelines.

2.1.13.4.14.3.10 Fire safety rules

The local decree on fire safety rules shall be adopted. The minimal content of rule is submitted in local language issue of this guideline.

2.1.13.4.15 Description of used construction technologies

The designer shall in all stages of project planning and preparation take into account the basic principles of safety and health at work as specified in the Occupational Health and Safety Act, and notably as regards the following:

- Deciding on architectural, technical, technological and/or organisational aspects, in order to be able to plan various items or work stages, to be implemented simultaneously or consecutively;
- Determining the time required for finishing such work or work stages.

2.1.13.4.16 Additional Traffic Volumes on Existing Roads and interaction with other industry

Construction of new roads and service facilities results in additional traffic volumes on the existing road network. This network is in accordance with the Public Roads Act either state or municipal. The Roads Directorate manages main (major) and regional roads, while lower-level roads are managed by municipalities (local roads, public paths and urban roads) or other entities, depending on the road's purpose. Increased traffic results in negative impact on the environment and human health as well as safety of road users.

The Public Roads Act specifies that an additional duty, beside the annual road-use fee, is paid for extraordinary road transports and excessive use of public roads. The excessive use of a public road occurs when the temporary or permanent volume resulting from implementation of the investment,

exceeds 50% of all transport on the road in question. The proportion of the transport is determined in the average annual daily traffic of freight vehicles with capacity of more than 10 tonnes. The excessive road user is a natural person or legal entity carrying out the investment causing the excessive volumes. In order to determine the impact on the road/roads with excessive volumes, a special study is required to determine and then implement the physical measures.

In order to establish negative impacts on the environment, resulting from increased traffic, the safety plan should determine the following:

- Volume of increased traffic and its time dynamics;
- Noise impact, notably in urban areas;
- Impact on surface and underground water;
- Impact on air quality, notably in urban areas;
- Impact on flora and fauna;
- Impact on safety of people.

In accordance with the study on negative impacts on the environment and human health due to increased traffic on the existing road network, active or passive protective measures for reducing negative impacts should be envisaged. Provisions of the Environmental Protection Act, allowing temporary excessive pollution of the environment with consent of the Ministry of the Environment and Spatial Planning and by informing the local community, can be used. If the case in question involves an area of protected natural heritage or endangerment of human health, the permit can only be issued with the consent of the competent ministry. Such permit cannot be obtained if pollution of the environment causes critical pollution of the environment.

The following measures are possible for reducing the negative impact on health and lives of people due to increased traffic:

- Active or passive noise protection;
- Putting new asphalt coating on the roadway;
- Arrangement of pavements and cyclist ways in urban areas;
- Using vehicles with reduced emissions of exhaust gases in the air;
- Placing appropriate traffic signs.

2.1.13.4.17 Coordinating the time table of construction and measures related to safety and health

The timetable of construction work with specified work/measures for protection of health is used by the designer, supervisor and coordinator for the following purposes:

- Coordination and control of implementation of basic principles of safety and health at work between the employer, sole proprietors and companies in the area of or adjacent to the construction site;
- Adopting decisions on technical and organisational aspects in planning of individual work stages;
- when setting deadlines necessary for safe completion of individual phases of work carried out at the same time or successively;
- Prompt adapting of the actual time of construction work, used for various types of work or work stages;
- Consultation and cooperation with workers.

2.1.13.4.18 Joint provisions for measures of health and safety at work

Prior to commencement of work, the selected and appointed contractors conclude an agreement in writing on joint measures related to safety at work.

In case of simultaneous work, the joint measures are possible as regards the following tasks:

- Supplements to the safety plan;
- Organisation of construction site security in view of the surrounding area
- Arrangement of entry to the construction site;
- Construction, equipment and maintenance of public utility, dwelling and sanitary facilities on the construction site;
- Arrangement of transport routes;

- Work scaffolds and devices;
- Installation and maintenance of protective gear of machines;
- Power supply installations and lighting of the construction site;
- Warning signs on the construction site (work on heights, obligatory wearing of protective helmet);
- Premises and equipment for first aid;
- Purchase and installation of fire extinguishers and organisation of fire guard;
- Performing checkups and tests of work equipment and electromeasurements prior to commencing work;
- Special refuse treatment;
- Organising food and water supply;
- Arranging premises for the engineer and supervisor.

The joint safety measures are entered in the Construction Site Code.

2.1.13.4.19 Mutual informing

Employers (contractors and subcontractors) shall review the safety plan prior to commencement of work. Any proposals on changes prior and during work shall be coordinated with the work coordinator.

The responsible site manager shall introduce subcontractors and outsourced contractors into work prior to its commencement.

Workers shall also be informed on all measures for providing safety and health.

Competent persons of contractors on the construction site shall daily or as need be agree on the method of work implementation and safety measures and enter them in the control logbook of measures.

The control logbook of measures shall be set up by the competent coordinator of the Client in charge of coordination and implementation of safe work and protection against fire on the construction site. The logbook of measures is also the register of all agreements between employers on the construction site.

Contractors for individual work/technological stages shall comply with the overall timetable for works.

Contractors shall comply with the instructions provided by coordinators. The site manager and the coordinator may:

- Require reports from responsible persons of contractors with regard to implemented safety and fire safety measures.
- Require from responsible persons of contractors to enter the agreed safety measures in the logbook of measures and to sign the logbook.
- Stop the work if workers of a particular contractor fail to implement the measures and if such conduct could endanger health and lives of workers or material damage could be the result.
- Review safety plans of employers on the construction site.
- Supervise the implementation of measures and instructions.

The prescribed documentation to be had by each employer on the construction site is the following:

- Data on workers:
- Decision on employment including data on professional qualifications;
- Medical certificate on the ability to perform the work in question;
- Certificate on passed exam from safety at work and protection against fire.
- Data on employers (contractors):
- Outsourcing contract;
- Signed agreement on joint safety and fire safety measures;
- Crafts licence or the document of company registration;
- Contracts of employment;

- Certificate of medical and disability insurance;
- Work and residence permit for foreign nationals.
- Data on machinery:
- Reports on tests and checkups of machinery;
- Safety certificate or statement of the supplier for imported machinery.

2.1.13.4.20 Construction rules

2.1.13.4.20.1 Red na gradilištu

The construction rules are an abstract of measures and rules related to safety and health protection on the construction site. It is primarily intended for employed staff. The minimum contents of the construction rules consist of the following:

1. Each employee shall perform the work with due care so that his work poses no threat to his own or his fellow co-worker's health and life.
2. The employee shall be physically and mentally capable of performing his work. The employee shall come to work rested and sober, and shall not consume alcohol or other narcotic substances during working hours.
3. The employee shall use the prescribed protective equipment.
4. The employee shall undergo a medical examination upon beginning of the job or upon transfer to another work area. The employee may only perform the work if his health condition, notably his senses, has been deemed adequate for performing the job in question.
5. Work can be performed only by the employee with the appropriate vocational education and passed exam on knowledge of measures for health protection as well as the general and fire safety.
6. The employee can only perform the job he has been assigned to and use only the machinery and tools prescribed for the job in question.
7. The work shall be performed in line with the prescribed regime by using machinery and tools in perfect technical condition.
8. Hazardous work shall be performed only under direct supervision of the work manager.
9. All work shall be coordinated.
10. Fire guard shall be provided during performing work with fire risk. Call the Information Centre on **XXX** in case of an initial fire.
11. The employee shall prior to commencement of the work check whether the work and protective equipment is in perfect condition.
12. The employee shall forthwith report any defect on machinery or tools to the work manager and the coordinator.
13. The employee shall be prohibited from repairing by himself any machinery for which properly trained employees are responsible.
14. In case not all measures related to safety and health at work are implemented, the employee shall have the right and duty to refuse to work on such work post.
15. During operation of machinery it is prohibited to remove the protective equipment, perform any measurements, cleaning except lubrication, if the machine is designed in such a way that the lubrication procedure excludes any danger.
16. The engine of the machine shall be turned off after sudden interruption in power supply, each time the worker distances from the work post and at the end of working hours.
17. Leaning on and bending over the machine or distancing of the worker from the machine while the machine is operating, shall be prohibited.
18. Manual transfer of loads shall only be allowed to workers informed on the instructions on health-friendly handling
19. The worker shall report any injury or sick leave to his supervisor, who shall carry out the prescribed first aid measures and fill the appropriate forms.

20. Until the accident has been investigated, the scene of the accident shall be left as it is unless this could result in further accidents or material damage.
21. The work post shall be clean and tidy. Non-hazardous waste shall be deposited to waste baskets and containers.
22. Construction waste shall be managed in accordance with instructions prepared in line with the Rules on the Management of Waste Generated by Construction Activities.
23. Laying off clothes and footwear on the work post shall be prohibited. Dressing rooms are used for that purpose.
24. The safety fence around the construction site and arrangement of blockade of the entry shall be undamaged and impassable.
25. Only employees may enter the construction site. Other visitors can only move around the construction site under supervision of the work manager and the safety and health at work coordinator.

2.1.13.4.21 Works inventory

The Works Inventory with estimated costs of the construction site arrangement and implementation of joint measures for providing safety and health at work on the construction site is used by the contractor – bidder for the purpose of accurately and correctly taking into account the costs in the bid pro-forma invoice. Usually the Client specifies in the instructions to bidders where and how these costs should be taken into account.

In case there are several contractors on the construction site, they can use the cost estimate to equitably divide the costs of construction site arrangement and implementation of joint measures for providing safety and health at work on the construction site.

2.1.13.5 ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

2.1.13.5.1 Noise Impact on Natural and Living Environment and Mitigation Measures

SF has to provide for:

Characteristics of machines and the noise emitted at full loading of the engine, when working separately or as a group;

Use of machinery with minimum noise pollution of the environment;

Work only during daytime, if noise levels are exceeded at night;

Use of communications for supply and removal notably outside populated areas;

Required passive measures for affected facilities;

Required active protective measures (if possible in combination with the final measures for traffic, if any).

2.1.13.5.1.1 Plan of Noise Monitoring During Construction

Open or covered construction site is deemed as the source of noise.

The plan of monitoring of noise during the construction includes in addition to the general part of the project also the following data and annexes:

- Level(s) of the area's sensitivity;
- Limit values of noise with regard to underlying areas;
- Data on zero state measurements carried out as a part of the EIA. If such measurements do not exist, they should be included in the monitoring project; Selection of measurement points shall be made with regard to the assessment of the entity preparing the project on dangers to the environment;
- Locations and description of buildings to be subject to monitoring, and their purpose as well as distance;
- Timetable of measurements, depending on the timetable of work implementation; Measurements during the maximum intensity of work shall be provided for.
- Implementation method of measurements;
- Preparing of reports and list of institutions to which reports are sent and addresses of these institutions;

- Graphic enclosure – plan in 1:5000 scale showing isophonic lines of the zero state, buildings subject to monitoring and the road's layout / road body;
- The report shall include all the required data and results as specified in the *Rules*
- Name of the competent person of the investor (or the contractor, depending on the contractual obligation) responsible for implementing the monitoring plan;
- Other data and provisions relevant for the correct monitoring implementation.

The monitoring plan shall be prepared by a company or individual qualified in that respect and having the licence from the Ministry of the Environment.

The SF on noise measurements during construction shall include the following data:

- Entity implementing measurements;
- Responsible entity and its activities;
- Main technical characteristics of the noise source;
- Operational condition of the noise source during measurements;
- Used criteria for noise;
- Meteorological conditions at the time of measurements;
- Immission point and the time of measurements;
- Measurement and calculation of the equivalent noise level method;
- Measurement of the peak, daytime and night time noise levels, and the background level;
- Values of noise measurements with regard to the prescribed limit values.

The person responsible for monitoring during construction in accordance with the project shall on the basis of findings specified in the report on implemented measurements adopt measures for reducing noise emissions on the construction site.

The monitoring plan and the report containing measurement results shall be submitted to:

- Ministry of the Environment and Spatial Planning;
- Environmental Protection Inspectorate;
- Health Inspectorate.

2.1.13.5.2 Construction's Impact on the Atmosphere and Mitigation Measures for Excessive Emissions

The SF shall envisage the required measures for reducing negative impacts of construction on the environment. These are related to the used machinery and transport vehicles and to devices installed in temporary facilities on the construction site. The possible measures are specified in the general part hereunder, but they depend on the conditions during the construction and on the nature of work. A textual description of measures and condition for implementation thereof with the name of the responsible person and individuals will suffice.

2.1.13.5.2.1 Plan of Monitoring of Air During Construction

The plan of monitoring of air pollution during the construction includes in addition to the general part of the project also the following data and annexes:

- Data on zero state measurements carried out as a part of the EIA. If such measurements do not exist, they should be included in the monitoring project; Selection of measurement points shall be made with regard to the assessment of the entity preparing the project on dangers to the environment;
- Locations and description of buildings to be subject to monitoring, and their purpose as well as distance;
- Timetable of measurements, depending on the timetable of work implementation; Measurements during the maximum intensity of work shall be provided for.
- Measurements method, the methodology is not prescribed by Slovene regulations;
- Preparing of reports and list of institutions to which reports are sent and addresses of these institutions;
- Graphic enclosure – plan in 1:5000 scale showing locations of the buildings where the zero state is to be measured, buildings subject to monitoring and the road's layout / road body.

The monitoring plan shall be prepared by a company or individual qualified in that respect and having the licence from the Ministry of the Environment.

The report shall include all necessary data and results as specified in:

- Name of the competent person of the investor (or the contractor, depending on the contractual obligation) responsible for implementing the Monitoring Project;
- Other data and provisions relevant for the correct monitoring implementation.

The monitoring plan and the measurements report shall be submitted to the Ministry of the Environment and Spatial Planning within 3 months following the conclusion of the measurements.

2.1.13.5.3 Construction's Impact on Surface Water

The SF shall analyse risks, which could have a negative impact on the quality of the watercourse and its erosion stability, which are mentioned in the general part and envisage the measures required to reduce such negative impacts. These include primarily technical measures reducing the risk of mechanical, chemical and bacteriological pollution of water.

Special attention shall be given to those activities, which are potential sources of pollution (transport and pouring of fuel, storage of dangerous substances and mineral oils, parking spaces for machinery and vehicles, work above water on bridging structures, etc.).

In case the wastewater is polluted in excess of the limit values of parameters for wastewater to be released directly in watercourses or sewage system, such water shall be by technical or chemical measures cleaned to the required level prior to its release in the watercourse (sumps).

Limits for individual areas resulting from local (municipal) ordinances on protection areas for drinking water shall also be taken into account.

2.1.13.5.3.1 Monitoring Plan for Surface Waters

The plan of monitoring of surface water pollution during the construction includes in addition to the general part of the project also the following data and annexes:

Data on zero state measurements carried out as a part of the EIA. If such measurements do not exist, they should be included in the monitoring project; Selection of measurement points shall be made with regard to the assessment of the entity preparing the project on dangers to the watercourse;

Specifying locations of individual watercourses subject to monitoring and their quality class;

Sampling points for water samples on watercourses;

Timetable of measurements, depending on the timetable of work implementation; Measurements during the maximum intensity of work shall be provided for.

Measurement methods – sampling and specification of standards;

Preparing of reports and list of institutions to which reports are sent and addresses of these institutions;

Graphic enclosure – plan in 1:5000 scale showing locations of watercourses and measurements of the zero state, watercourses subject to monitoring and the road's layout / road body;

Hydraulic characteristics of the watercourse (data on high water, medium water and low water);

Name of the competent person of the investor (or the contractor, depending on the contractual obligation) responsible for implementing the monitoring plan;

Other data and provisions relevant for the correct monitoring implementation.

The monitoring plan shall be prepared by a company or individual qualified in that respect and having the licence from the Ministry of the Environment of the RS.

Water from the watercourse is sampled downstream from the location where construction work is carried out. Water is sampled from a homogenous part of the water course. Sampling and testing shall be carried out by an institution authorised by the Ministry of the Environment and Spatial Planning.

Sampling shall take into account provisions of the following standards:

EN 25667-1:1996 Water Quality – Sampling – Part 1: Instruction for Planning Sampling Programmes (ISO 5667-1:1980)

EN 25667-2 – Water Quality – Sampling – Part 2: Instruction on Sampling Techniques (ISO 5667-2:1991)

EN 25667-3 – Instruction for Storing and Handling Samples

EN 25667-6 – Instruction for Sampling Rivers and Water Courses

EN 25667-12 – Instruction for Sediment Sampling

The monitoring plan includes parameters, which are determined with regard to the type of work and possible pollutions.

The monitoring plan and reports shall be submitted to:

- Ministry of the Environment and Spatial Planning;
- Environmental Protection Inspectorate;
- Health Inspectorate.

2.1.13.5.4 Construction's Impact on Underground Water and Mitigation Measures for Reducing Negative Impacts

The SF shall specify the required measures for protection of water sources on the basis of preliminary hydro geological studies. Hence no single method of protection can be given as the protection depends on numerous factors and the underlying water source. Mostly it involves facilities for retaining harmful substances in wastewater.

In case of an extraordinary event (spillage of dangerous substance in the ground or in a watercourse, or in other cases), which could endanger water sources or underground water itself, the SF shall include the "Instructions on Procedures in Case of an Extraordinary Event". These Instructions shall include the following:

- Method of informing and the institutions to be informed as well as the order in which to do so;
- Method of informing about extraordinary events within the construction site;
- Competent persons of the contractor; and
- Measures for prevention / mitigation of consequences of the extraordinary event.

In case of major accidents, the measures shall be specified by the competent inspectorate.

2.1.13.5.4.1 Monitoring plan for underground water

The plan of monitoring of underground water pollution during the construction includes in addition to the general part of the project also the following data and annexes:

- Data on zero state measurements carried out as a part of the EIA. If such measurements do not exist, they should be included in the monitoring project; Selection of measurement points shall be made with regard to the assessment of the entity preparing the project on dangers to the watercourse;
- Specified locations of individual piezometers or wells subject to monitoring and sampling points for water samples;
- Timetable of measurements, depending on the timetable of work implementation;
- Implementation method of measurements and regulations complied with;
- Listing of parameters being controlled and their limit values;
- Preparing of reports and list of institutions to which reports are sent and addresses of these institutions;
- Graphic enclosure – plan in 1:5000 scale showing locations of watercourses and measurements of the zero state, watercourses subject to monitoring and the road's layout / road body;
- Name of the competent person of the investor (or the contractor, depending on the contractual obligation) responsible for implementing the Monitoring Project;
- Other data and provisions relevant for the correct monitoring implementation.

Monitoring of underground water includes the following:

- Measurements of underground water level and depth of the monitored borehole;
- Preliminary pumping of water from the monitored borehole;
- Measurement of air and water temperature, electric conductivity, pH value, oxygen content, turbidity, and redox potential on the location of the monitored borehole;
- Sampling of underground water and sample preparation;

- Analysis of the underground water sample;
- Calculation and evaluation of changes of indicative parameters;
- Preparing the report on performed measurements and analyses.

The report shall include all necessary data and results as specified in the Rules on Monitoring, namely:

Entity performing the monitoring;

- Responsible entity for performing the monitoring;
- Type of measurements and the scope of basic and indicative parameters of underground water;
- Location, time and method of sampling;
- Method of preliminary pumping and the measured values of basic parameters;
- Used measurement methods and measurement equipment;
- Results of each individual measurement and calculation of changes of indicative parameters;
- Evaluation of changes of indicative parameters with regard to warning changes thereof.

The monitoring project and the resulting report shall be submitted to:

- Ministry of the Environment and Spatial Planning;
- Inspectorate for the Environment;
- Health Inspectorate.

2.1.13.5.5 Impact of construction on the soil, flora and fauna

The SF can include analysis of potential consequences of construction to the soil, flora and fauna and envisage the measures required to mitigate negative consequences. Concrete measures shall depend on the level of endangerment and the condition of the environment related to the soil, flora and fauna. Special measures are usually not required except in cases where the route crosses protected areas of natural and animal world. If the route crosses protected areas, the required measures shall usually be specified in the Decree on the Detailed Plan on the basis of studies prepared for such cases, in case these are absent, provisions of the Nature Conservation Act shall apply.

On the basis of requirements provided in the Decree on the Detailed Plan, the plan shall envisage concrete measures for reducing negative impacts. These measures shall completely comply with the requirements specified in the Decree on the Detailed Plan. Any damage to ecosystems and natural value shall be rehabilitated by using the method envisaged in the plan for such a scenario.

2.1.13.5.5.1 Monitoring plan for soil and plants

The monitoring plan shall include the following:

- Sampling of soil and mud from wastewater treatment plants, and sample preparation;
- Measurement of parameters;
- Evaluation of emissions and annual quantity of dangerous substances;
- Preparing the report on performed measurements.

The Rules specify the method of sampling, and methods for sampling and preparation of samples are to be specified in the monitoring project. Locations of sampling shall also be specified. Limit values are specified in proper decree.

The Report on monitoring shall include the following:

- Entity implementing monitoring;
- Responsible entity for monitoring;
- Main characteristics of the area;
- Main characteristics of the development in a river bed, in case of measuring parameters of silt;
- Purpose and type of measurements and the scope of basic and additional parameters;
- Locations (lot nos.) and time of sampling and measurements of soil or slime from sedimentation reservoirs;
- Used measurement methods and measurement techniques;

- Measurement results for each parameter;
- Evaluation of results with regard to the prescribed limit values.

The responsible entity shall submit the report to:

- Ministry of the Environment and Spatial Planning;
- Ministry of Agriculture.

2.1.13.5.6 Impact of blasting and other dynamic effects of work implementation on people and buildings

In addition to local regulations legislating protection and conservation of the environment, the area is also legislated by regulations related to safety and health at work and by: Nature Conservation Act (Official Gazette of the RS, no. 96/04) and regulations on protected areas issued on the basis thereof

- Directive of European Parliament and Council 2002/49/ES dated on 25. Jun 2002 about assessment and ruling the noise
- DIN 30787 - (1 to 6) Transportbelastungen – Messen und Auswerten von mechanisch - dynamischen Belastungen
- E VDI 3840-2002-09 Schwingungstechnische Berechnungen
- DIN 45669 Messung von Schwingungsimmissionen
- EN ISO 8041:2005 Human response to vibration - Measuring instrumentation (ISO 8041:2005)
- CR 12349:2000 - Mechanical vibration - Guide to the health effects of vibration on the human body

The SF has to establish the following:

- Dynamic effects of traffic and construction work on residential and other buildings and potential consequences;
- Health effects of vibrations on the population.

The SF shall in relation to the characteristics specified above provide the following:

- Establish the expected dynamic effects;
- Determine the location and time of these effects on the environment;
- Envisage measures for reducing dynamic effects;
- Provide for examination of condition of buildings, which could be damaged as the result of dynamic effects of construction and document the condition by description, photograph or video;
- Select such technological procedures for work implementation, which cause minimum dynamic effects;
- Transport routes should be distanced from buildings;
- Work should only be carried out during the daytime;
- Measurement of dynamic effects of construction shall be performed by a competent institution in line with the programme specified in the plan.

The constituent parts of the SF are:

- Plan in 1:5000 scale showing buildings and facilities being in the area of influence of the construction site;
- Documentation on condition of buildings in the area of influence (photographs, examination reports);
- Technological procedures and measures for reducing dynamic effects;
- Programme of monitoring of buildings and measurement / monitoring points.

2.1.13.6 WASTE MANAGEMENT

2.1.13.6.1 Guideline content

These instructions specify obligatory management procedures for waste resulting from construction work due to construction, reconstruction, adaptation, rehabilitation or demolition of buildings (hereinafter referred to as: construction waste).

The guidelines apply to waste from waste group with classification number 17 in the classification list of waste. The guidelines do not apply to earth excavations, if the earth excavation is in line with the regulation governing soil pollution by waste deposits. If construction waste contains asbestos, the regulation governing management of waste containing asbestos and the regulation on conditions for disposal of materials containing asbestos in demolition, reconstruction or maintenance of buildings and in maintenance and decommissioning of plants shall also be taken into account.

2.1.13.6.2 Construction Waste Management Plan

The investor planning to demolish a building shall enclose to the Construction Permit Project (CPP) the construction waste management plan, if it is evident from the project documentation for building demolition that the area of ground plan of the perimeter of the building exceeds 100 m^2.

The construction waste management plan referred to in the previous paragraph hereunder shall with regard to the type and quantity of construction waste include all information on the following:

- Removal of hazardous construction waste prior to demolition;
- Separate collection of construction waste, notably hazardous one, on the construction site itself;
- Processing of construction waste on the point of its production;
- Handling earth excavations, notably pollutes ones;
- Quantity and types of construction waste to be handed for processing or removal;
- Envisaged methods for processing and removal of construction waste.

The construction waste management plan shall with regard to envisaged methods and quantity of processing or removal of construction waste take into account the guidelines specified in the operational programme of protection of the environment regarding construction waste handling.

The investor shall provide for the order for accepting construction waste or their transport for processing or removal and their processing or removal prior to commencement of construction work.

If mixing of construction waste cannot be prevented in reconstruction or demolition of a building, the investor shall ensure that prior to demolition all hazardous construction waste classified in the waste group having classification number 17 is removed.

The investor shall for the entire construction site authorise a contractor, who shall in the investor's name hand over construction waste for processing or removal and fulfil upon each handing over of a waste shipment the record statement specified in the regulation governing waste management.

The investor may by themselves provide for processing or removal of construction waste by ensuring handing over of construction waste directly to the entity processing or removing waste.

In case of removal of construction waste, the order for removal of construction waste shall include the address and name of the assessor of waste to be provided by the investor in line with the regulation governing depositing or incineration of waste.

The investor shall not be under obligation to order acceptance from the entity collecting construction waste or handing over of construction waste directly for processing or removal prior to commencement of work, if construction waste on the site is the result of work for which permit is not required in line with the regulations on building, and if the quantity of construction waste in the entire period of construction work does not exceed the minimum quantity specified in the table below:

Waste type	**Min. quantity**	
Concrete, bricks, tiles, ceramics and material based on gypsum	5	m^3
Construction material based on asbestos	0.5	m^3
Wood, glass, plastic	5	m^3
Asphalt, tar and tar products	0.5	m^3
Metals	20	dm^3

Earth excavation	500	m^3
Insulation materials	1	m^3

The investor shall provide by themselves transport and handing over to the collection centre for the specified construction waste.

The investor may reuse or remove construction waste by themselves subject to possessing a licence for processing or removal of such waste in accordance with the regulation governing waste management.

The investor may use construction waste by themselves without obtaining the permit for processing or removal of construction waste, if construction waste is used on the point of its production and within the construction site and if it includes concrete, bricks, tiles, ceramics or construction material based on gypsum or a mixture of such waste with earth excavation and if the quantity does not exceed the maximum quantity specified in the table above.

2.1.13.6.3 Construction Waste Management Report

The investor wishing to obtain the permit of use shall include in the project of implemented work submitted to the administrative authority the *construction waste management report*, which presents the following information:

- Quantity of construction waste handed over to collectors of construction waste;
- Quantity of construction waste handed over directly to processing or removal;
- Quantity of hazardous waste handed over to collectors or directly to processing or removal;
- Quantity of processed construction waste on the point of its production;
- Quantity of construction waste processed by the investor on the construction site;
- Quantity of earth excavation, notably polluted one, removed from the construction site;
- Firms and registered offices of collectors, entities processing or removing construction waste, to which construction and hazardous waste was handed;
- Overview of prescribed record statements, approved by collectors of construction and hazardous waste upon acceptance, whereby the handing over of waste to waste collectors is guaranteed;
- Overview of prescribed record statements, approved by entities processing and removing construction and hazardous waste upon acceptance, whereby the handing over of waste directly to entities processing and removing waste is guaranteed;

The construction waste management report referred to in the previous paragraph hereunder shall not be required if the quantities of individual types of construction waste resulting from construction do not exceed minimum quantities specified in the table above.

As regards constructions where the quantity of produced construction waste exceeds minimum quantities specified in the table above, it shall be deemed that the application for issuing the permit of use is incomplete if the project of implemented work does not include the construction waste management report.

If demolition of a building was carried out as a part of construction for which application for issuing the permit of use has been submitted, data on types and quantities of waste resulting from such demolition specified in the construction waste management report referred to in the first paragraph hereunder shall correspond to data on types and quantities of waste specified in the construction waste management plan.

If the construction, the part of which was the demolition of a building, does not require obtaining the permit of use, the investor shall submit the construction waste management report referred to in the first paragraph hereunder together with a copy of the construction waste management plan not later than within thirty days following completion of the construction to the competent inspector for protection of the environment.

2.1.13.6.4 Obligations of the Investor and the Contractor During Work Implementation

The investor ordering construction of a facility or performing such construction by themselves, shall ensure that contractors keep or temporary store waste, resulting from construction work, on the construction site, separately by type of construction waste as specified in the classification list of waste.

If due to the nature of construction work mutual mixing of individual types of hazardous construction waste or mixing with other construction waste cannot be prevented, the investor shall ensure that contractors keep or store hazardous construction waste separately from other waste, and if this is not feasible, to hand it over separately by individual type directly to the collector, or entity processing or removing construction waste.

The investor shall ensure that the contractors keep or temporarily store construction waste on the construction site in such a way so as not to pollute the environment and that the collector of construction waste has access for their acceptance or the entity transporting it for their shipment to the entity processing or removing construction waste.

If safekeeping or temporary storage of construction waste is not possible on the construction site, the investor shall ensure that contractors deposit construction waste directly after its production in containers, placed on the construction site or adjacent to it, which are adapted for transport of construction waste without any reloading.

The investor shall ensure that contractors hand over construction waste to the collector of construction waste.

The documentation on the order for acceptance of construction waste shall show the type of construction waste, the envisaged quantity of production of construction waste and the address of the construction site with reference to the appertaining building permit to which the acceptance of construction waste relates.

The documentation on the order for processing or removal of construction waste shall show the type of waste, the envisaged quantity of processing or removal of construction waste, point of processing or removal, and the address of the construction site with reference to the appertaining building permit to which the processing or removal of construction waste relates.

2.1.13.6.5 Waste Collection

Collector of construction waste may commence with the collection after obtaining the licence from the ministry competent for protection of the environment (hereinafter referred to as: The Ministry) in accordance with the regulation governing waste management.

The Ministry shall issue the licence referred to in the previous paragraph hereunder to the entity, which is:

- A company or sole proprietor, registered for performing the activity of collection and transport of waste in accordance with the regulation on classification of activities;
- Having means and equipment, and facilities and devices required for collection of construction waste, which comply with technical and other prescribed conditions; and
- Having the possibility for reuse or removal of collected construction waste.

The application for the licence submitted to the Ministry shall include the plan for construction waste collection and providing for their reuse or removal.

The plan for construction waste collection referred to in the previous paragraph hereunder shall include information on the following:

- Area of construction waste collection;
- Types of construction waste for which collection is provided;
- Number and locations of collection centres;
- The estimated total annual quantity of construction waste and annually accepted quantities separately by method of reuse or removal the entity provides;
- Type and capacity of means and equipment for collection and transport;
- Capacity of collection centres and the method of temporary storage and classification or other activities related to construction waste; and
- Measures for protection of the environment aimed at prevention of uncontrolled impacts on the environment during handling of construction waste.

The waste collection plan shall with regard to envisaged methods of reuse or removal of construction waste take into account the guidelines specified in the operational programme of protection of the environment regarding construction waste handling.

The Ministry may in the licence issued to the collector of construction waste specify the areas where a collection centre is to be placed or the areas where provision of acceptance of construction waste is mandatory.

The collector of construction waste shall have at least one collection centre for at least one type of construction waste from the group of waste having the classification number 17 from the classification list of waste specified in the regulation on waste management.

The collection centre shall be arranged so that no pollution of the environment occurs in acceptance, temporary storage or sorting of collected construction waste or in its handing over for processing or removal.

The collector of construction waste shall provide for reuse or removal of the collected construction waste.

The collector of construction waste shall keep records of the following:

- Collected quantity of construction waste by investor and collection centre;
- Total collected quantity of construction waste by type of construction waste and by method of reuse or removal;
- Quantity of construction waste handed over for reuse of removal by contractor of construction work; and
- Total quantity of construction waste handed over.

A constituent part of the records specified in the previous paragraph hereunder shall be the prescribed record statements, which the collector of construction waste receives upon acceptance of construction waste, and the prescribed record statements, returned to the collector of construction waste by entities responsible for reuse or removal of construction waste.

The collector of construction waste shall in accordance with the regulation governing waste management submit to the Ministry a report on collected construction waste and its handling not later than by 31 March for the previous calendar year.

2.1.13.6.6 Processing and Removal of Construction Waste

Processing or removal of construction waste may only be performed by entities having the prescribed licence for processing or removal of construction waste in accordance with the regulations governing waste management.

If the entity processing or removing construction waste is also a collector of construction waste, the licence referred to in the previous paragraph hereunder shall also include statement on fulfilment of conditions for collection of construction waste.

The waste management plan to be enclosed to the application for obtaining the licence for processing construction waste and for licence for removal of construction waste shall in addition to conditions specified in the regulation governing waste management also include the following:

- Types and quantities of construction waste for which recycling is provided;
- The envisaged method of use of construction material obtained by recycling of construction waste;
- Reasons for removal of construction waste in case they are removed directly without any processing;
- Method and location of removal of remaining construction waste; and
- Guidelines from the operational programme for protection of the environment with regard to handling of construction waste in relation to the envisaged methods and quantities of processing.

The Ministry shall approve direct removal of construction waste without previous processing, if the waste management plan shows that no technical possibilities exist for processing of this type of construction waste or that costs of reuse are disproportionate when compared to costs of its removal.

2.1.13.6.7 Handling Waste Containing Asbestos

2.1.13.6.7.1 General

Asbestos is a generic name for a number of mineral fibres. It is resistant to acid, bases and high temperature. Because of these characteristics it was extensively used in industry and construction.

Roughly 3000 products containing asbestos are known. The industry used pure asbestos and materials where asbestos was mixed with other substances acting as the binder for asbestos fibres.

There are two types of asbestos materials:

The first group includes pure asbestos and materials, which are due to their structure easy to crumb and divide into fibres, hence we call them materials with weakly bound asbestos.

The most common products containing weakly bound asbestos are the following:

Product	*Possible location of placement*
Shingles from roof pasteboard	Roof
Sprayed plasters	Ceilings, walls, steel building frameworks
Manually applied plasters	Ceilings, walls
Insulation panels	Walls
Building chemical products containing asbestos Jointing mixtures, resins, adhesives	Floor, walls
Jointing and insulation mixtures	Boilers, heaters, pressure vessels
Asbestos linen	Pipes
Corrugated cardboard from asbestos	Hot water pipes
Paper and rolled paper tapes	Hearths, steam valves, power supply installation
Cardboard	Valves
Putties and polishes	Coatings on joints of water supply and hot water pipes
Sprayed and manually applied insulation	Fuel reservoirs, reservoirs in oil and gas industry
Fabric	Clothes and blankets, felt, tilts, ropes, tapes, yarn, curtains, material for coating of pipes, etc.

The second group includes materials in which asbestos is mixed with substances, which act as a binder for asbestos fibres. The most commonly used binders were cement, vinyl chloride or asphalt. This group includes products made from asbestos-cement (asbestos is not released from these products unless they are damaged or treated, i.e. drilled, cut, saw, whet) and other asbestos products.

Construction products from asbestos cement	*Other asbestos products*
Large format panels (flat or corrugated)	Vinyl asbestos flooring
Small format roofing	Asphalt asbestos flooring
Façade panels, walls and ceilings	Binders, fillers, putties, polishes, paints and coatings
Water supply and sewage piping and elbows	Washers
Building chemical products containing asbestos Jointing mixtures, resins, adhesives	Floor, walls
Water collectors	Brake linings and clutches, etc.
	Flower boxes, etc.

2.1.13.6.7.2 Dangers in use of asbestos

Asbestos is composed of fibres. Fibres tend to easily break longitudinally which results in thinner, needle-like fibres. As they are small enough to be invisible and have no smell, a person can easily inhale them without being aware of it. When inhaled, the fibres can penetrate deep into lungs and cause diseases such as asbestosis and lung cancer (mezzothelium – a rare form of cancer of lungs or stomach is in almost all cases caused by asbestos) As much as 40 years can pass from the initial exposure and occurrence of signs of the disease.

Asbestos in buildings becomes dangerous when the material becomes worn out, is damaged or when asbestos fibres are released in the air because of improper handling of material thereby presenting health risk. Dangerous are thus primarily those products which crumble or turn into dust when used. Crumbly asbestos can be crumbled by hand while non-crumbly asbestos is too hard for manual crumbling. Hence it is best if asbestos products not yet worn out are left alone and if possible protected on the surface.

Their useful life is between thirty and forty years.

Certain products containing weakly bound asbestos are permanently built in buildings.

Namely: sprayed plasters, insulation products, adhesives or insulation mixtures.

A person generally comes into contact with asbestos only when removing materials containing asbestos.

2.1.13.6.7.3 Rehabilitation of roofing and façade panels from asbestos-cement

The hard bound asbestos waste includes construction materials from asbestos cement, e.g. large format panels, flat or corrugated, small format façade and roof panels, usable products, such as plant boxes, ashtrays, flower boxes and similar objects, and piping for buildings and civil engineering works made from asbestos cement.

In order to prevent or reduce emission of asbestos fibres in the environment, obligatory conduct in disposal of materials containing asbestos in demolition, reconstruction or maintenance of buildings and in maintenance and decommissioning of plants is prescribed.

The obligatory conduct in reconstruction or demolition of buildings and in maintenance of buildings, installations or facilities, when disposing of materials containing asbestos is specified in the Rules on the Conditions for the Disposal of Materials Containing Asbestos in the Demolition, Reconstruction or Maintenance of Buildings and in the Maintenance and Decommissioning of Plants (Official Gazette of the RS, nos. 72/01 and 41/01; hereinafter referred to as: the Rules).

Obligations specified in the Rules depend on whether the work performed is of large or small scale.

Small-scale work is that performed by a maximum of two workers and not lasting more than four hours until the completion of the work procedure including any additional work required in the area of demolition, in:

- Removal of asbestos cement products; or
- Removal of small quantities of material containing weakly bound asbestos, e.g. removal of asbestos cardboards under window sills;
- Removal of sealants on burners or doors; or
- Maintenance of asbestos products, e.g. surfacing of blockages in ventilation or smoke channels or cables or surfacing of weakly bound asbestos panels in good condition, except façade panels by using a cylinder; or
- Removal of façade coatings, roofing and piping made from asbestos cement, if the work is carried out outdoors and the total surface of cement panels does not exceed 1,000 m^2 and the total length of asbestos cement piping does not exceed 300 m.

Whereby it is specified what is the meaning of the term "all work", i.e. all work until the completion of the work procedure.

- Entering on premises polluted with asbestos;
- Sampling of air for measuring concentrations of asbestos fibres in the air;
- Vacation of premises polluted with asbestos;
- Cleaning of premises and objects polluted with asbestos;
- Transport on the construction site; and
- Temporary storage of removed material containing asbestos.

Small-scale work can be performed by anyone without requiring the permit for removing asbestos from buildings and facilities issued on the basis of Article 6 of the Rules.

2.1.13.6.7.4 Obligations of the investor prior to commencement of removal of roofing

The investor shall ensure that it is established prior to commencement of planning of the reconstruction or removal of a building and maintenance work whether workers will be exposed to asbestos dust or dust from materials containing asbestos when performing their work.

In case of any doubt whether the building or installation or device has any materials built-in, which contain asbestos, a sample of the material shall be given for testing to an expert organisation competent to perform such tests.

2.1.13.6.7.5 Procedures for removal of asbestos cement roofing

1. Prior to commencement of removal of asbestos cement panels, panels shall be wetted before any work is performed on them or before they are moved. Wetting shall be performed by spraying or sprinkling with sprays under low pressure, water under high pressure shall not be

used under any circumstances. Asbestos fibres deposited in water sinks shall be wetted by water the result of which is a thick mixture, which is removed by a trowel in a PE bag. The bag shall be tightly sealed or glued.

2. In removal, the panels shall be lifted and not pulled or broken. Hooks, screws or nails used for fastening the panels shall be removed in a way not damaging the panels. When fastening elements are removed, the panels shall be protected against sliding. No drills, saws or tools for high-speed scraping shall be used in disassembly. If panels cannot be removed without the use of tools, it is important that manual tools or mechanical instruments for treatment of asbestos cement with installed cleaners having HEPA filters are used exclusively. Panels shall not be pulled over edges or over other products.
3. The removed panels shall not be thrown from the roof. They shall be lowered to the ground by using an appropriate lifting device. 4. When on the ground, panels shall be again wetted on both sides and then piled in a stack on a wood pallet. The pallet shall then be wrapped by a polyethylene foil, which is tightly sealed by adhesive tape.

   The material shall not be crumbled after removal for the purpose of reducing the volume of waste.
5. The area of removal of panels shall be closely inspected for any waste lying around. The roof structure, laths, rafters, and panelling shall be after removal of panels thoroughly cleaned by vacuuming with a cleaner having the HEPA filter. In case the contractor is not in possession of such cleaner, the roof covering shall be wiped by wet cloth. Used cloths shall be placed in a PE bag after completed work. Water in containers used for rinsing cloths shall be poured in the sink after cleaning by placing a wet cloth over the sink to act as a filter. The cloth shall be then placed in a PE bag.
6. On the ground, each bag with waste is placed in another PE bag, which is then tightly sealed and marked by label "Asbestos waste".

2.1.13.6.7.6 Storage and transport of asbestos cement products

Strongly bound asbestos waste shall be packaged in tightly sealed bags so that joints of the fabric or foil are welded or glued.

Transport of strongly bound asbestos waste to the disposal site is permitted in closed containers or bags or in covered freight vehicles so that emission of asbestos fibres in the atmosphere is prevented to the greatest possible extent.

Loading and unloading of asbestos waste to or from loading areas of freight vehicles shall be carried out with due care by not throwing or shaking it.

Containers and bags used for storage of asbestos waste in temporary storage sites shall be marked on visible spots by the label "Asbestos waste".

2.1.13.6.7.7 Disposal sites

Strongly bound asbestos waste shall be deposited on the disposal site for inert (non-hazardous) waste.

The investor shall for accepted asbestos waste obtain from the managing entity of the disposal site an approved record statement on waste handling, which serves as the proof of handing over of asbestos waste to the disposal site.

If the contractor of construction work handed over asbestos waste to the disposal site, then the approved record statement shall be in the name of the investor. The investor may obtain the approved record statement on handing over of asbestos waste to depositing also from the contractor of construction work if the contractor has the licence for collecting construction waste.

2.1.13.6.7.8 Obligations of the disposal site's managing entity

The disposal site's managing entity shall ensure that asbestos waste is deposited on predetermined deposit site for asbestos, which shall be visibly marked and intended solely for depositing of asbestos waste.

Access route to the depositing site for asbestos waste shall be arranged so that the waste may be deposited directly from the freight vehicle in a pit or ditch used for depositing of asbestos waste. If asbestos waste is deposited in the pit or ditch from its edge, it shall be ensured that asbestos waste is not scattered. The waste shall be covered immediately after it was deposited. No freight

vehicle or work machinery shall be allowed to drive over deposited asbestos waste not being covered by soil or similar inert material.

The disposal site's managing entity shall in keeping of the prescribed operational logbook ensure that quantity, type and method of treatment of asbestos waste as well as the location of the deposit site are regularly entered.

2.1.13.6.7.9 Handing over and collection of construction waste

The investor may give asbestos cement waste for further handling to the collector of construction waste entered in the records of collectors of construction waste.

The investor shall for accepted asbestos waste obtain from the collector of construction waste an approved record statement on waste handling, which serves as the proof of handing over of asbestos waste to the collector.

If the contractor of construction work handed over asbestos cement waste to the collector, then the approved record statement shall be in the name of the investor. The investor may obtain the approved record statement on handing over of asbestos cement waste to collection also from the contractor of construction work if the contractor has the licence for collecting construction waste.

When removing asbestos cement products it is recommended that personal protective equipment, at least for protection of the respiratory system, is used. (semi-face/quarter masks with P2 filter or semi-face masks FFP2 with filtration of particles or masks with vetrile and the filter for particles TM1P)

2.1.13.6.8 List of disposal sites having environmental licences for waste disposal (BiH)

2.1.13.6.8.1 General

Waste is classified by using a six-digit numerical code. The first four digits are used for marking the list of waste type.

Hazardous waste is classified by a six-digit code additionally marked by an asterisk, indicating "hazardous waste".

2.1.13.6.8.2 Waste groups classification

01 Waste resulting from exploration, mining, dressing and further treatment of minerals and quarry

02 Waste from agricultural, horticultural, hunting, fishing and aquaculture primary production, food preparation and processing

03 Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture

04 Wastes from the leather and textile industries

05 Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal

06 Wastes from inorganic chemical processes

07 Wastes from organic chemical processes

08 Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesive, sealants and printing inks

09 Wastes from photographic industry

10 Wastes from thermal processes

11 Inorganic wastes containing metals from metal treatment and coating of metals and hydrometallurgy of non-ferrous metals

12 Wastes from shaping and surface treatment of metals and plastics

13 Oil wastes (except edible oils, and those included in 05, 12 and 19)

14 Wastes from organic substances employed as solvents, coolers and pushing gases (except 07, and 08)

15 Packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified

16 Waste not otherwise specified in the catalogue

17 Construction and demolition waste (including excavated earth from polluted areas)

18 Wastes from human or animal health care and/or related research (excluding kitchen and restaurant wastes which do not arise from immediate health care)

19 Wastes from waste treatment facilities, off-site waste water treatment plants and the water industry

20 Municipal wastes and similar commercial, industrial and institutional wastes including separately collected fractions

2.1.13.6.8.3 Wastes resulting from construction of civil engineering facilities and production of building products

01 Waste resulting from exploration, mining, dressing and further treatment of minerals and quarry

01 01 02 Waste from mineral non-metaliferous excavation

01 04 Waste from further physical and chemical processing of non metaliferous minerals

01 04 07* Waste from further physical and chemical processing of non metaliferous minerals containing hazardous substances

01 04 08 Waste gravel not included in 01 04 07

01 04 09 Waste sand and clay

01 04 10 Dust and powder waste not included in 01 04 07

01 04 11 Waste from processing of potassium and rock salt not included in 01 04 07

01 04 12 Tailings and other waste from washing and selection of minerals not included in 01 04 07 and 01 04 11

01 04 13 Waste from cutting and sawing of stone not included in 01 04 07

01 04 99 Wastes not otherwise specified

01 05 Drilling muds and other drilling wastes

01 05 04 Fresh-water drilling muds and wastes

01 05 05* Drilling muds and wastes containing oils

01 05 06* Drilling muds and wastes containing hazardous substances

01 05 07 Drilling muds and wastes containing barite not included in 01 05 05 and 01 05 06

01 05 08 Drilling muds and wastes containing chlorides not included in 01 05 05 and 01 05 06

01 05 99 Wastes not otherwise specified

03 Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture

03 01 Wastes from wood processing and the production of panels and furniture

03 01 01 Waste bark and cork

03 01 04* Sawdust, shavings, wood chips, cuttings, waste wood, parts of panels and plywood containing hazardous substances

03 01 05 Sawdust, shavings, wood chips, cuttings, waste wood, parts of panels and plywood not included in 03 01 04

03 01 99 Wastes not otherwise specified

03 02 Wood preservation waste

03 02 01* Non-halogenated organic wood preservatives

03 02 02* Organochlorinated wood preservatives

03 02 03* Organometallic wood preservatives

03 02 04* Inorganic wood preservatives

03 02 05* Other wood preservatives containing hazardous substances

03 02 99 Other wood preservatives

05 Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal

05 01 Oily sludges and solid wastes

05 01 17 Asphalt

06 Wastes from inorganic chemical processes

06 05 Sludges from on-site effluent treatment

06 05 02*	Sludges from on-site effluent treatment containing hazardous substances
06 05 03	Sludges from on-site effluent treatment not included in 06 05 02
06 13	*Wastes from other inorganic chemical processes*
06 13 01*	Inorganic pesticides, biocides and wood preserving agents
06 13 02*	Spent activated carbon (except 06 07 02)
06 13 03	Carbon black
06 13 04*	Waste from asbestos processing
06 13 05*	Soot
06 13 99	Wastes not otherwise specified

07 Wastes from organic chemical processes

07 02	*Waste from the MFSU of plastics, synthetic rubber and man-made fibres*
07 02 13	Waste plastic
07 02 14*	Waste additives containing hazardous substances
07 02 15	Waste additives not included in 07 02 14
07 02 16	Waste containing silicones
07 02 99	Wastes not otherwise specified
07 03	*Waste from the MFSU of organic dyes and pigments (excluding 06 11)*
07 03 03*	Organic halogenated solvents, washing liquids and mother liquors
07 03 04*	Other organic solvents, washing liquids and mother liquors
07 04	*Waste from the MFSU of organic pesticides (except 02 01 08 and 02 01 09), wood preservatives (except 03 02) and other biocides*
07 04 03*	Organic halogenated solvents, washing liquids and mother liquors
07 04 04*	Other organic solvents, washing liquids and mother liquors
07 04 13*	Solid waste containing hazardous substances

08 Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesive, sealants and printing inks

08 01	*Wastes from MFSU of paint and varnish*
08 01 11*	Waste paint and varnish containing organic solvents or other hazardous substances
08 01 12	Waste paint and varnish not included in 08 01 11
08 01 17*	Waste resulting from removal of paint and varnish containing organic solvents or hazardous substances
08 01 18	Waste resulting from removal of paint and varnish not included in 08 01 17
08 01 19*	Water suspensions of paint and varnish containing organic solvents or other dangerous substances
08 01 20	Water suspensions of paint and varnish not included in 08 01 19
08 01 21*	Waste removers for paint and varnish
08 01 99	Wastes not otherwise specified
08 04	*Wastes from MFSU of adhesives and sealants*
08 04 09*	Waste adhesives and sealants containing organic solvents or other hazardous substances
08 04 10	Waste adhesives and sealants not included in 08 04 09
08 04 15*	Water solutions of adhesives and sealants containing organic solvents or other hazardous substances
08 04 16	Water solutions of adhesives and sealants not included in 08 04 15
08 04 17*	Resin oils (colophony)
08 04 99	Wastes not otherwise specified

10 Wastes from thermal processes

10 01	*Wastes from power station and other combustion plants (except 19)*

10 01 01	Bottom ash (except bottom ash included in 10 01 04)
10 01 02	Coal fly ash
10 01 03	Peat fly ash
10 01 04*	Oil fly ash
10 01 09*	Sulphuric acid
10 01 13*	Fly ash from combustion of carbohydrate emulsions
10 01 20*	Sludges from on-site effluent treatment containing hazardous substances
10 01 21	Sludges from on-site effluent treatment not included in 10 01 20
10 12	*Wastes from manufacture of ceramic goods, bricks, tiles and constructions products*
10 12 01	Waste preparation mixture before thermal processing
10 12 03	Other particulates and dust
10 12 05	Sludges from gas treatment
10 12 06	Discarded moulds
10 12 07	Spent linings and refractories
10 12 08	Waste ceramics, bricks, tiles and construction products (after heat treatment)
10 12 09*	Solid waste resulting from cleaning of waste gases containing hazardous substances
10 12 10	Solid waste resulting from cleaning of waste gases not included in 10 12 10
10 12 11*	Waste from glazing containing heavy metals
10 12 12	Waste from glazing not included in 10 12 11
10 12 13	Sludges from on-site effluent treatment
10 12 99	Wastes not otherwise specified
10 13	*Wastes from manufacture of cement, lime and plaster and articles and products made from them*
10 13 01	Waste preparation mixture before thermal processing
10 13 04	Waste from calcination and hydration of lime
10 13 06	Other particulates and dust
10 13 07	Sludges from gas treatment
10 13 09*	Waste resulting from asbestos cement production containing asbestos
10 13 10	Waste from asbestos cement production not included in 10 13 09
10 13 11	Waste from production of composite materials based on cement not included in 10 13 09 and 10 13 10
10 13 12*	Solid waste resulting from cleaning of waste gases containing hazardous substances
10 13 13	Solid waste resulting from cleaning of waste gases not included in 10 13 12
10 13 14	Waste concrete and waste sludge from concrete
10 13 99	Wastes not otherwise specified
11	**Inorganic wastes containing metals from metal treatment and coating of metals and hydrometallurgy of non-ferrous metals**
11 05	*Wastes from galvanisation processes*
11 05 01	Raw zinc
11 05 02	Zinc ashes
11 05 03*	Solid waste from cleaning of waste gases
11 05 04*	Spent liquids
11 05 99	Wastes not otherwise specified
12	**Wastes from shaping and surface treatment of metals and plastics**
12 01	*Wastes from shaping and surface treatment of metals and plastics*
12 01 01	Ferrous metal filings and turnings

12 01 02	Other ferrous metals particles
12 01 03	Non-ferrous metal filings and turnings
12 01 04	Other non-ferrous metal particles
12 01 05	Plastics particles
12 01 06*	Waste machining oils containing halogens (not emulsioned)
12 01 07*	Waste machining oils free of halogens (not emulsioned)
12 01 08*	Waste machining emulsions containing halogens
12 01 09*	Waste machining emulsions free of halogens
12 01 10*	Synthetic machining oils
12 01 11*	Machining sludges
12 01 12*	Spent waxes and fats
12 01 13	Welding wastes
12 01 14*	Machining sludges containing hazardous substances
12 01 15	Machining sludges not included in 12 01 14
12 01 16*	Waste resulting from sandblasting containing hazardous substances
12 01 17	Waste resulting from sandblasting not included in 12 01 16
12 01 18*	Machining sludges resulting from buffing and honing containing oils
12 01 19*	Easily biodegradable machining oils
12 01 20*	Spent buffing objects and buffing materials containing hazardous substances
12 01 21	Spent buffing objects and buffing materials not included in 12 01 20
12 01 99	Wastes not otherwise specified

13 Oil wastes (except edible oils, and those included in 05, 12 and 19)

13 01	*Waste hydraulic oils*
13 01 01*	Hydraulic oils, containing PCB
13 01 04*	Chlorinated emulsions
13 01 05*	Non chlorinated emulsions
13 01 09*	Chlorinated hydraulic oils based on mineral oils
13 01 10*	Non-chlorinated hydraulic oils based on mineral oils
13 01 11*	Synthetic hydraulic oils
13 01 12*	Easily biodegradable hydraulic oils
13 01 13*	Other hydraulic oils
13 02	*Waste engine, gear & lubricating oils*
13 02 04*	Chlorinated engine, gear & lubricating based oils on mineral oils
13 02 05*	Non-chlorinated engine, gear & lubricating based oils on mineral oils
13 02 06*	Synthetic engine, gear & lubricating oils
13 02 07*	Easily biodegradable engine, gear & lubricating oils
13 02 08*	Other engine, gear & lubricating oils
13 03	*Waste insulating and heat transmission oils and other liquids*
13 03 01*	Insulating and heat transmission oils containing PCB
13 03 06*	Insulating and heat transmission oils based on mineral oils not included in 13 03 01
13 03 07*	Non-chlorinated insulating and heat transmission oils based on mineral oils
13 03 08*	Synthetic insulating and heat transmission oils
13 03 09*	Easily biodegradable insulating and heat transmission oils
13 03 10*	Other insulating and heat transmission oils
13 04	*Bilge oils*
13 04 01*	Bilge oils from inland navigation
13 04 02*	Bilge oils from jetty sewers

13 04 03*	Bilge oils from other navigation
13 05	***Oil/water separator contents***
13 05 01*	Oil/water separator solids
13 05 02*	Oil/water separator sludges
13 05 03*	Interceptor sludges
13 05 06*	Oil/water separator oils
13 05 07*	Water polluted with oil from oil/water separator
13 05 08*	Waste mixture from oil/water separator
13 07	*Liquid fuels waste*
13 07 01*	Heating oil and diesel fuel
13 07 02*	Petrol
13 07 03*	Other fuels including mixtures
15	**Packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified**
15 01	*Packaging including separately collected packaging, which is municipal waste*
15 01 01	Paper and cardboard
15 01 02	Plastic
15 01 03	Wooden
15 01 04	Metallic
15 01 05	Composite packaging
15 01 06	Mixed
15 01 07	Glass
15 01 09	Textile
15 01 10*	Packaging containing remainders of hazardous substances or being polluted with hazardous substances
15 01 11*	Metallic packaging containing hazardous hard coating (e.g. made from asbestos) including empty pressure vessels
15 02	*Absorbents, filter materials, wiping cloths and protective clothing*
15 02 02*	Absorbents, filter materials, wiping cloths and protective clothing polluted with hazardous substances
15 02 03	Absorbents, filter materials, wiping cloths and protective clothing not included in 15 02 02
16	**Waste not otherwise specified in the catalogue**
16 01	*End of life vehicles including non-road transport vehicles and waste resulting from disassembly of end of life vehicles and vehicle maintenance (except waste included in 13, 14, 16 06 and 16 08*
16 01 03	Used tyres
16 01 04*	Discarded vehicles
16 01 06	Discarded vehicles from which liquids and other hazardous components have been removed
16 01 07*	Oil filters
16 01 08*	Components containing mercury
16 01 09*	Components containing PCB
16 01 10*	Explosive components (e.g. from airbags)
16 01 11*	Brake linings containing asbestos
16 01 12	Brake linings not included in 16 01 11
16 01 13*	Brake liquids
16 01 14*	Antifreeze liquids containing hazardous substances
16 01 15	Antifreeze liquids not included in 16 01 14

16 01 16	Liquefied gas reservoirs
16 01 17	Ferrous metals
16 01 18	Non-ferrous metals
16 01 19	Plastic
16 01 20	Glass
16 01 21*	Hazardous components not included in 16 01 07 to 16 01 11 and 16 01 13 and 16 01 14
16 01 22	Other similar components
16 01 99	Wastes not otherwise specified
16 02	*Waste resulting from electrical and electronic equipment*
16 02 09*	Transformers and capacitors containing PCB
16 02 10*	Discarded equipment containing or being polluted with PCB and not included in 16 02 09
16 02 11*	Discarded equipment containing chlorofluorocarbons, HCFC and HFC
16 02 12*	Discarded equipment containing free asbestos
16 02 13*	Discarded equipment containing hazardous components ([2]) and not included in 16 02 09 to 16 02 12
16 02 14	Discarded equipment not included in 16 02 09 to 16 02 13
16 02 15*	Hazardous components removed from discarded equipment
16 02 16	Components removed from discarded equipment not included in 16 02 15
16 03	*Off-specification batches*
16 03 03*	Inorganic waste containing hazardous substances
16 03 04	Inorganic waste not included in 16 03 03
16 03 05*	Organic waste containing hazardous substances
16 03 06	Organic waste not included in 16 03 05
16 04	*Waste explosives*
16 04 01*	Waste ammunition
16 04 02*	Fireworks waste
16 04 03*	Other waste explosives
16 05	*Chemicals and gases in containers*
16 05 04*	Gases in pressure vessels (including halons) containing hazardous substances
16 05 05	Gases in pressure vessels not included in 16 05 04
16 05 06*	Laboratory chemicals consisting of or containing hazardous substances, including mixtures of laboratory chemicals
16 05 07*	Discarded inorganic chemicals consisting of or containing hazardous substances
16 05 08*	Discarded organic chemicals consisting of or containing hazardous substances
16 05 09	Discarded chemicals not included in 16 05 06, 16 05 07 or 16 05 08
16 06	*Batteries and accumulators*
16 06 01*	Lead batteries
16 06 02*	Ni-Cd batteries
16 06 03*	Mercury dry cells
16 06 04	Alkaline batteries (except 16 06 03)
16 06 05	Other batteries and accumulators
16 06 06*	Electrolyte from batteries and accumulators
16 07	*Waste from transport and storage tank cleaning (except 05 and 13)*
16 07 08*	Waste containing oils
16 07 09*	Waste containing hazardous substances
16 07 99	Wastes not otherwise specified

16 09	*Oxidative substances*
16 09 01*	Permanganates e.g. potassium permanganate
16 09 02*	Chromates e.g. potassium chromate or sodium dichromate
16 09 03*	Peroxides e.g. hydrogen peroxide
16 09 04*	Other similar oxidative substances

17 Construction and demolition waste (including excavated earth from polluted areas)

17 01	*Concrete, bricks, tiles and ceramics*
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 06*	Mixtures or separated fractions of concrete, bricks, tiles and ceramics containing hazardous substances
17 01 07	Mixtures of concrete, bricks, tiles and ceramics not included in 17 01 06
17 02	*Wood, glass and plastic*
17 02 01	Wood
17 02 02	Glass
17 02 03	Plastic
17 02 04*	Glass, plastic and wood polluted with hazardous substances or containing hazardous substances
17 03	*Asphalt, tar and tarred products*
17 03 01*	Asphalt containing tar
17 03 02	Asphalt not included in 17 03 01
17 03 03*	Tar and tar products
17 04	*Metals (including their alloys)*
17 04 01	Copper, bronze, brass
17 04 02	Aluminium
17 04 03	Lead
17 04 04	Zinc
17 04 05	Iron and steel
17 04 06	Tin
17 04 07	Mixed metals
17 04 09*	Metallic waste polluted with hazardous substances
17 04 10*	Cables containing oils, tar and other hazardous substances
17 04 11	Cables not included in 17 04 10
17 05	Earth (including excavated earth from polluted areas), rock, and earth excavations
17 05 03*	Soil and rock containing hazardous substances
17 05 04	Soil and rock not included in 17 05 03
17 05 05*	Earth excavations containing hazardous substances
17 05 06	Earth excavations not included in 17 05 05
17 05 07*	Stone chippings from underneath rail tracks and sleepers containing hazardous substances
17 05 08	Stone chippings from underneath rail tracks and sleepers not included in 17 05 07
17 06	*Insulation materials and construction material containing asbestos*
17 06 01*	Insulation materials containing asbestos
17 06 03*	Other insulation materials consisting of or containing hazardous substances
17 06 04	Insulation materials not included in 17 06 01 and 17 06 03
17 06 05	Construction materials containing asbestos

17 08	*Construction material based on gypsum*
17 08 01*	Construction material based on gypsum polluted with hazardous substances
17 08 02	Construction material based on gypsum not included in 17 08 01
17 09	*Other construction waste and waste resulting from demolition of buildings*
17 09 01*	Construction waste and waste resulting from demolition of buildings containing mercury
17 09 02*	Construction waste and waste resulting from demolition of buildings containing PCB (e.g. washers containing PCB, pavements based on resins containing PCB, capacitors containing PCB)
17 09 03*	Other construction waste and waste resulting from demolition of buildings (including mixed waste containing hazardous substances)
17 09 04	Mixed construction waste and waste resulting from demolition of buildings not included in 17 09 01, 17 09 02 and 17 09 03

19 Wastes from waste treatment facilities, off-site waste water treatment plants and the water industry

19 07	*Landfill leachate*
19 07 02*	Landfill leachate containing hazardous substances
19 07 03	Landfill leachate not included in 19 07 02
19 08	*Wastes from waste water treatment plants not otherwise specified*
19 08 02	Wastes from desanding
19 08 05	Sludges from treatment of urban waste water
19 08 06*	Saturated or spent ion exchange resins
19 08 07*	Solutions and sludges from regeneration of ion exchangers
19 08 08*	Waste from membrane cleaning systems containing hazardous substances
19 08 09*	Greases and oil mixtures from oil/water separators containing edible oils and greases
19 08 10*	Greases and oil mixtures from oil/water separators not included in 19 08 09
19 08 11*	Sludges from biological technological wastewater treatment plants containing hazardous substances
19 08 12	Sludges from biological technological wastewater treatment plants not included in 10 08 11
19 08 13*	Sludges from other technological wastewater treatment plants containing hazardous substances
19 08 14	Sludges from other technological wastewater treatment plants not included in 10 08 13
19 08 99	Wastes not otherwise specified
19 12	*Waste resulting from mechanical treatment of waste (e.g. sorting, crushing, compacting, pelleting) not otherwise specified*
19 12 01	Paper and cardboard
19 12 02	Ferrous metals
19 12 03	Non-ferrous metals
19 12 04	Plastic and rubber
19 12 05	Glass
19 12 06*	Wood containing hazardous substances
19 12 07	Wood not included in 19 12 06
19 12 08	Textile
19 12 09	Minerals such as rock
19 12 10	Combustible waste (fuel obtained from waste)
19 12 11*	Other waste (including mixtures of material) resulting from mechanical treatment of waste containing hazardous substances

19 12 12 Other waste (including mixtures of material) resulting from mechanical treatment of waste not included in 19 12 11

19 13 Waste resulting from rehabilitation of polluted soil and underground water

19 13 01* Solid waste resulting from rehabilitation of polluted soil containing hazardous substances

19 13 02 Solid waste resulting from rehabilitation of polluted soil not included in 19 13 01

19 13 03* Sludges resulting from rehabilitation of polluted soil containing hazardous substances

19 13 04 Sludges resulting from rehabilitation of polluted soil not included in 19 13 03

19 13 05* Sludges resulting from rehabilitation of polluted underground water containing hazardous substances

19 13 06 Sludges resulting from rehabilitation of polluted underground water not included in 19 13 05

19 13 07* Waste water solutions and water concentrates resulting from rehabilitation of polluted underground water containing hazardous substances

19 13 08 Waste water solutions and water concentrates resulting from rehabilitation of polluted underground water not included in 19 13 07

20 Municipal wastes and similar commercial, industrial and institutional wastes including separately collected fractions

20 03 Other municipal waste

20 03 03 Waste resulting from road cleaning

20 03 04 Septic tank sludge

20 03 06 Waste resulting from cleaning of urban waste water

20 03 07 Bulky waste

20 03 99 Wastes not otherwise specified

2.1.13.6.8.4 Construction waste for which depositing on disposal sites for inert waste is permitted

The following construction waste may be deposited to disposal sites for inert waste:

– Concrete and reinforced cement concrete	– Fibre cement
– Silicate concrete	– Asbestos cement
– Porous concrete	– Clinker
– Clay bricks and other bricks	– Ceramic tiles
– Grout and plasters	– Sandstone
– Gravel	– Natural stone
– Sand	– Broken natural materials
– Asphalt, asphalt concrete, sand asphalt	– Clay bricks based on gypsum
– Bitumen gravel	– Plastering materials
– Bitumen concrete	– Faience
– Glass	– Fireplace stones and household fireclay
– Brick, concrete and other mineral roof coverings	

Construction waste specified in the Table shall not be polluted with hazardous substances and may contain a maximum of 10% of the following elements:

- Wood
- Products containing wooden particles and/ore particles such as splinters, fillings, planes, abrasives, wood fibres, wood flour or cellulose fibres, e.g.:
    - Plywood
    - Strongly bound plywood
    - Easily installed slabs from wood wool
    - Wood wool
    - Slabs based on cellulose bound by cement

  - Stone coatings, noise protection coatings with mineral bound wood fibres
  - Noise protection material produced from waste paper
- Plaster – cardboard slabs or gypsum slabs
- Wallpaper
- Cork
- Bark
- Straw
- Window frames made from PVC
- Slabs, foils and strips made from plastic
- Flooring
- Pipes, reinforcements or roofing gutters
- Insulation for wires and cables
- Reinforced fissure mixtures or
- Insulation panels