ЈАВНО ПРЕДУЗЕЋЕ
ПУТЕВИ СРБИЈЕ

REPUBLIKA SRBIJA

PROJEKAT REHABILITACIJE TRANSPORTA

SERBIAN ROAD CONSTRUCTION SPECIFICATIONS

2. SPECIAL TECHNICAL CONDITIONS

2.4 PAVEMENT STRUCTURES

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2.4.1 INTRODUCTORY SECTION

2.4.1.1 General

As a rule, pavements on roads are constructed of a:
- wearing course
- road base(s)
- sub-base.

A characteristic profile of a modern pavement structure is given in Figure 2.4.1.1.

The quality of all materials used for construction, as well as the dimensions of the courses that are should integrated in pavement structures are pursuant to the project documents and requirements in these special technical conditions for road construction.

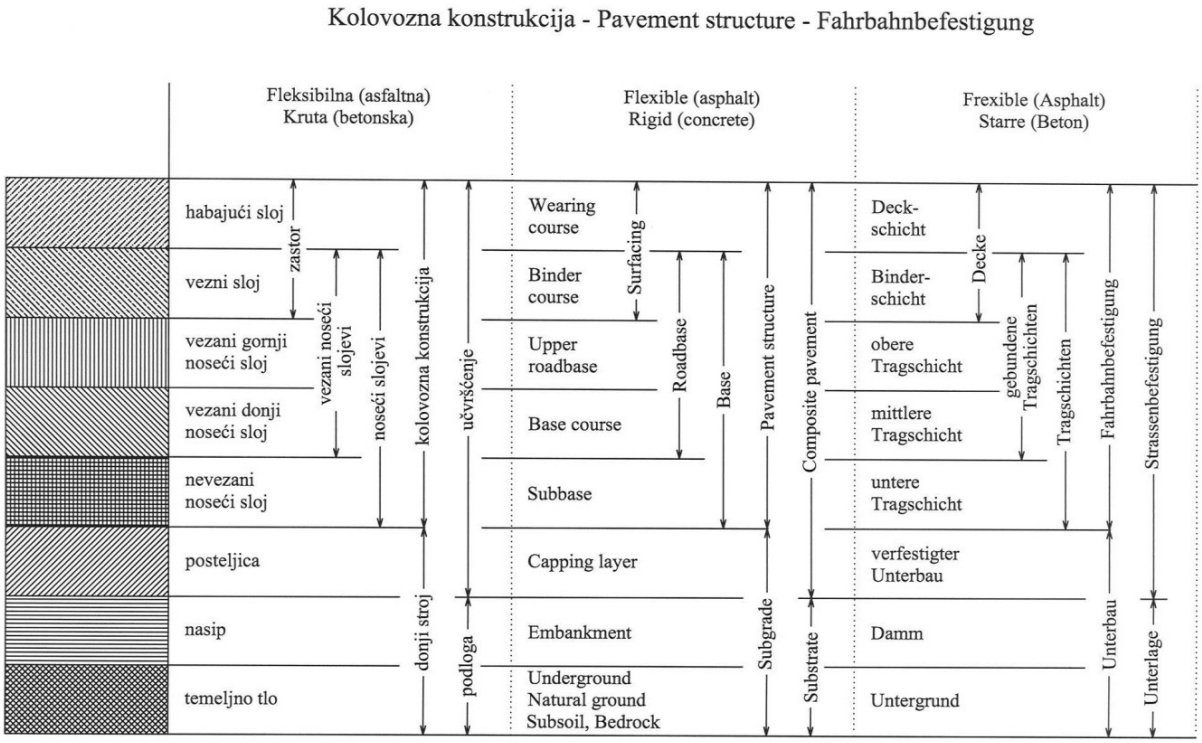


Figure 2.4.1.1: Characteristic profile of new pavement structures

2.4.1.2 Technical regulations

In the special technical conditions for pavement structures only l details of the norms are given for specific European norms. Details of the EN, i.e. the appropriate harmonized documents are, given within the documentation of the individual works, i.e. their particular requirements. Specific requirements for each characteristic property, as a rule, should be defined in the national supplements to the European norms.

When constructing pavement structures the following technical regulations should be applied and observed:

EN 1426	Bitumen i bitumenska veziva – Određivanje penetracije igle	Bitumen and bituminous binders - Determination of needle penetration
EN 1427	Bitumen i bitumenska veziva - Određivanje tačke omekšanja - Metoda prstena i kuglice	Bitumen and bituminous binders - Determination of softening point - Ring and Ball method
EN 1429	Bitumen i bitumenska veziva - Određivanje ostatka bitumenskih emulzija na situ i utvrđivanje stabilnosti pri skladištenju metodom sejanja	Bitumen and bituminous binders - Determination of residue on sieving of bitumen emulsions, and determination of storage stability by sieving
EN 1431	Bitumen i bitumenska veziva – Određivanje veziva i uljnog destilata u bitumenskim emulzijama metodom destilacije	Bitumen and bituminous binders - Determination of recovered binder and oil distillate from bitumen emulsions by distillation
EN 1504	Proizvodi i sistemi za zaštitu i sanaciju betonskih konstrukcija - Definicije, zahtevi, kontrola kvaliteta i vrednovanje usaglašenosti	Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity
EN 1504-1	Proizvodi i sistemi za zaštitu i popravke betonskih konstrukcija - 1. deo: Definicije	Products and systems for the protection and repair of concrete structures - Part 1: Definitions
EN 12591	Bitumen i bitumenska veziva - Specifikacija za bitumene za gradnju puteva	Bitumen and bituminous binders - Specifications for paving grade bitumen's
EN 12593	Bitumen i bitumenska veziva – Određivanje tačke loma po Fraasu	Bitumen and bituminous binders - Determination of the Fraass breaking point
EN13286	Nevezane i hidraulički vezane mešavine	Unbound and hydraulically bound mixtures -
EN 13383	Hidrotehnički kamen	Armourstone
EN 13398	Bitumen i bitumenska veziva – Određivanja elastičnog skraćenja modifikovanih bitumena	Bitumen and bituminous binders - Determination of the elastic recovery of modified bitumen
EN 13808	Bitumen i bitumenska veziva - Katjonska bitumenska emulzija - Uslovi kvaliteta	Bitumen and bituminous binders - Framework for specifying cationic bituminous emulsions
EN 13880	U vrućem stanju ugradljive mase za zaptivanje sastavaka	Hot applied joint sealants
EN 13924	Bitumen i bitumenska veziva - Specifikacije za tvrde bitumene za gradnju puteva	Bitumen and bituminous binders - Specifications for hard paving grade bitumens
EN 14023	Bitumen i bitumenska veziva – Okvirne specifikacije za polimerima modifikovane bitumene	Bitumen and bituminous binders – Framework specification for polymer modified bitumens
EN 15322	Bitumen i bitumenska veziva – Razređeni bitumen za kolovoze - Uslovi kvaliteta	Bitumen and bituminous binders - Framework for specifying cut-back and fluxed bituminous binders
SRPS EN 196	Metode ispitivanja cementa	Methods of testing
SRPS EN 197-1	Cement - 1. dio: Sastav,specifikacija i kriterijumi usklađenosti za obične cemente	Cement - Part 1: Composition, specifications and conformity criteria for common cements
SRPS EN 206-1	Beton - 1.dio: Specifikacija, karakteristike i kriterijumi usklađenosti	Concrete - Part 1: Specification, performance, production and conformity
SRPS EN 450	Leteći pepeo za beton	Fly ash for concrete
SRPS EN 932	Ispitivanja opštih svojstava agregata	Tests for general properties of aggregates
SRPS EN 933	Ispitivanje geometrijskih svojstava agregata	Tests for geometrical properties of aggregates

SRPS EN 934	Dodaci betonu, malteru i injekcionoj masi	Admixtures for concrete, mortar and
SRPS EN 1008	Voda za pripremu betona - Specifikacije za uzimanje uzoraka, ispitivanje i ocenu pogodnosti vode za pripremu betona, uključujući vodu dobijenu iz procesa u industriji betona	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
SRPS EN 1097	Ispitivanje mehaničkih i fizičkih svojstava agregata	Tests for mechanical and physical properties of aggregates
SRPS EN 1107-1	Fleksibilne trake za hidroizolaciju - Deo 1: Bitumenske trake za krovnu hidroizolaciju - Određivanje dimenzionalne stabilnosti	
SRPS EN 1109	Fleksibilne trake za hidroizolaciju - Deo 1: Bitumenske trake za krovnu hidroizolaciju - Određivanje fleksibilnosti pri niskim temperaturama	Flexible sheets for waterproofing - Bitumen sheets for roof waterproofing - Determination of flexibility at low temperature
SRPS EN 1110	Fleksibilne trake za hidroizolaciju - Bitumenske trake za krovnu hidroizolaciju - Određivanje otpornosti prema tečenju pri povišenim temperaturama	Flexible sheets for waterproofing - Bitumen sheets for roof waterproofing - Determination of flow resistance at elevated temperature
SRPS EN 1367	Ispitivanja toplotnih i vremenskih uticaja na svojstva	Tests for thermal and weathering properties of aggregates
SRPS EN 1401	Sistemi cevovoda od plastičnih masa za podzemno odvodnjavanje bez pritiska i kanalizaciju - Neomekšani polivinilhlorid (PVC-U)	Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U) -
SRPS EN 1537	Izvođenje specijalnih geotehničkih radova – Ankeri	Execution of special geotechnical work - Ground anchors
SRPS EN 1744	Ispitivanja hemijskih svojstava agregata	Tests for chemical properties of aggregates
SRPS EN 1849-1	Fleksibilne trake za hidroizolaciju - Određivanje debljine i mase po jedinici površine - Deo 1: Bitumenske trake za krovne hidroizolacije	Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 1: Bitumen sheets for roof waterproofing
SRPS EN 1926	Metode ispitivanja prirodnog kamena - Određivanje čvrstoće pri pritisku	Natural stone test methods - Determination of compressive strength
SRPS EN 1928	Fleksibilne trake za hidroizolaciju - Bitumenske, plastične i gumene trake za krovne hidroizolacije - Određivanje vodonepropusnosti	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of watertightness
SRPS EN 10025	Toplovaljani proizvodi od nelegiranih konstrukcionih čelika - Tehnički zahtevi za isporuku	Hot-rolled products of non-alloy structural steels and their technical delivery conditions
SRPS EN 10080	Betonski čelik - Zavarivi betonski čelik - Opšti deo	Steel for the reinforcement of concrete - Weldable reinforcing steel - General
SRPS EN 12311-1	Fleksibilne trake za hidroizolaciju - Deo 1: Bitumenske trake za krovnu hidroizolaciju - Određivanje svojstava pri istezanju	Flexible sheets for waterproofing - Part 1: Bitumen sheets for roof waterproofing - Determination of tensile properties
SRPS EN 12350	Ispitivanje svežeg betona	Testing fresh concrete
SRPS EN 12390-3	Ispitivanje očvrslog betona - Deo 3: Čvrstoća pri pritisku uzoraka za ispitivanje	Testing hardened concrete - Part 3: Compressive strength of test specimens

SRPS EN 12620	Agregati za beton	Aggregates for concrete
SRPS EN 12697	Asfaltne mešavine – Metode ispitivanja za asfaltne mešavine proizvedene vrućim postupkom	Bituminous mixtures - Test methods for hot mix asphalt
SRPS EN 12390	Ispitivanje očvrslog betona	Testing hardened concrete
SRPS EN 13043	Agregati za bitumenske mešavine i površinsku obradu kolovoza, aerodroma i drugih saobraćajnih površina	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
SRPS EN 13055	Laki agregati	Lightweight aggregates
SRPS EN 13108	Asfaltne mešavine - Specifikacije	Bituminous mixtures - Material specifications
SRPS EN 13179	Ispitivanja kamenog brašna koje se koristi u bitumenskim mešavinama	Tests for rock dust used in bituminous mixtures
SRPS EN 13242	Agregati za nevezane i hidraulički vezane materijale za upotrebu u građevinskim radovima i izgradnji puteva	Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
SRPS EN 13263	Silikatna prašina za beton	Silica fume for concrete
SRPS EN 13990-1	Drveni podovi - Podne daske od masivnog četinarskog drveta	Wood flooring - Solid softwood floor boards
SRPS EN 13969	Fleksibilne trake za hidroizolaciju – Bitumenske trake za podzemne izolacije - Termini i definicije i karakteristike	Flexible sheets for waterproofing - Bitumen damp proof sheets including bitumen basement tanking sheets - Definitions and characteristics
SRPS EN 14695	Fleksibilne trake za hidroizolaciju - Ojačane bitumenske trake za hidroizolaciju betonskih mostova i drugih betonskih saobraćajnih površina - Termini i definicije i karakteristike	Flexible sheets for waterproofing - Reinforced bitumen sheets for waterproofing of concrete bridge decks and other trafficked areas of concrete - Definitions and characteristics
SRPS EN ISO 2431	Boje i lakovi - Određivanje vremena isticanja pomoću posuda za isticanje	Paints and varnishes - Determination of flow time by use of flow cups
SRPS EN ISO 13736	Određivanje tačke paljenja - Metoda u zatvorenom sudu po Abelu	Determination of flash point - Abel closed-cup method
SRPS ISO 10319	Geotekstil - Ispitivanje zatezanjem metodom širokog laboratorijskog uzorka	Geotextiles - Wide-width tensile test
SRPS ISO 11058	Geotekstil i geotekstilu srodni proizvodi - Određivanje svojstva permeabilnosti vode upravno na ravan epruvete, bez opterećenja	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load
SRPS ISO 12236	Geotekstil i geotekstilu srodni proizvodi - Statičko ispitivanje proboja (CBR ispitivanje)	Geotextiles and geotextile-related products - Static puncture test (CBR-Test)
SRPS ISO 12956	Geotekstil i geotekstilu srodni proizvodi - Određivanje karakteristične veličine otvora	Geotextiles and geotextile-related products - Determination of the characteristic opening size
SRPS ISO 12958	Geotekstil i geotekstilu srodni proizvodi - Određivanje kapaciteta protoka vode u ravni	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane

2.4.1.3 Terminology

The terms used in the special technical conditions for pavement structures have the following meaning:

Unbound mixture (aggregate) (agregat/nevezana mešavina kamenih zrna) is a designation for an aggregate, usually of a defined granulometric composition, particularly used for the lower pavement bearing courses.

Mineral aggregate for wedging (agregat za zaptivanje) is a mixture of crushed or naturally crushed mineral grains, of granulometric composition of 0/8 mm as a rule, which should be, upon executing in the unbound wearing courses, spread onto the already built layer of a skeleton base in a quantity required for a complete filling of the voids/cavities on the layer surface and for covering over.

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

Asphalt pavement (asfaltna kolovozna konstrukcija) is a part of the traffic surface stabilisation with asphalt surfacing; the type of other pavement bearing courses is not defined.

Asphalt stabilised base course (asfaltni donji noseći sloj) is a mixture of the homogeneous granulometric composition of aggregate, bounded with bituminous binder, in the pavement.

Milling/crushing residue asphalt (asfaltni granulat) is asphalt consisting of small pieces re-worn by milling or crushing.

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

Asphalt base (asfaltni noseći sloj) is a pavement layer made of asphalt mixture placed as the upper road base (in one or more layers), or as the base course (bituminous stabilization of aggregate).

Asphalt binder course (asfaltni vezni sloj) is a part of the road surfacing made of an asphalt mixture, built-in between the wearing course and the upper road base course.

Asphalt surfacing (asfaltni zastor) is the pavement upper layer consisting of the wearing course and the upper road base course made of a bituminous (asphalt) mixture.

Shoulder (bankina) 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.

Bitumen/asphalt cement (bitumen) is a substantially non-volatile dark mixture of various organic substances obtained during the processing of earthy oils, which changes its elastic viscous behaviour when heated; it is a binder of asphalt mixtures.

Road bitumen (bitumen za kolovoze) is bitumen produced in refineries; it complies with all the requirements to be used in the road construction.

Precoated chippings (bitumenizirana obavijena sitnež) is crushed aggregate thinly coated with liquid bituminous binder, so it can still be spread.

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

Bituminous well graded crushed stone (bitumenizirani drobljeni kameni material) is an asphalt mixture used for bearing courses; it consists of totally crushed stone grains coated with a bituminous binder.

Bituminous gravel (bitumenizirani šljunak) is an asphalt mixture used for bearing courses; it consists particularly of natural rounded particles coated with a bituminous binder.

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

Asphalt concrete (bitumenski beton) consists of a bituminous binder and an

aggregate of a certain grain size intended for execution of the wearing and sealing courses.

Bituminous mortar (bitumenski malter) is a mixture of bituminous binder, aggregate filler, sand (grain size up to 2 mm), and admixtures.

Asphalt mastic (bitumenski mastiks) is a dense mixture of filler aggregate, sand, and bituminous binder, which can be poured and smoothened in hot conditions.

Bituminous slurry seal (bitumenski mulj) 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.

Noise (buka) is strong, mutually mixed up and non-harmonized sounds of different origins.

Cement (cement (hidraulično vezivo)) 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.

Cement concrete (cementni beton) is a material produced by mixing aggregate, cement and water, as needed, with chemical and/or mineral additives; it develops its properties by cement hydration.

Tank sprayer with spray bar (cisterna za vezivo sa rampom) is mobile equipment for a machine spray application of controlled quantity of liquid binder (under pressure) to a substrate.

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

Particle size fraction/class d_i/D_i (čista frakcija/razred zrna d_i/D_i, is a designation for aggregate, which particles pass a sieve of larger openings (D_i) leaving on the sieve the smaller openings (d_i).

Pull-off strength (čvrstoća kidanja) is the tensile strength in the direction perpendicularly from the surface, at which a coating breaks apart or tears off from the substrate.

Dynamic modulus of deformation E_{vd} (dinamički deformacioni modul E_{vd}) is a characteristic value of material deformability at the impact load of the dynamic plate with the light falling weight; it is defined based on the measured settlement amplitude “s”.

Regular-sized aggregate (dobro graduisana zrnasta mešavina) consists of all the appropriate proportions of successive fractions of grains of the stone in the mixture.

Additive (dodatak/aditiv) is a chemical supplement that is added as needed for the improvement of a certain characteristic of a bituminous or any other mixture (e.g. grains coated with bitumen).

Bottom filler (donja ispuna) is an appropriately shaped synthetic material placed in the lower part of the dummy joint that prevents the injection of the pouring mixture into the opening.

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

Asphalt drainage layer (drenažni asfaltni sloj) is a layer of a bitumen mixture with a large content of cavities in which macrocavities are interconnected; intended for drainage, preventing aquaplaning and decreasing the noise of rotating wheels (tires) of vehicles.

Crushed aggregate (drobljeni kameni materijal) is a mix of crushed stone grains of size up to 63 mm.

Crushed/broken particle (drobljeno zrno) is a particle with more than 50% of its surfaces fractured.

Double-layer surface dressing (dvoslojna površinska obrada, zweilagige) is a procedure of pavement 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.

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

Spreader/finisher (finišer) is a mechanical device introduced to spread asphalt mixture

or cement concrete mix uniformly over the entire placing width.

Aggregate size (frakcija kamenih zrna/agregata) is a mixture of aggregate designated on the basis of the lower (d_i) and the upper (D_i) square opening of a sieve, expressed by d_i/D_i; 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).

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

Construction semi product (građevinski poluproizvod) is a construction product, which is not yet suitable for its intended use in a structure, but gets the required properties only after being built-in.

Limiting value (granična vrednost) is a quality value that is just on the limit of compliance with the contractual requirements.

Grading curve limit (granične granulometrijske krive) are curves limiting the range of the admitted oscillation of the grain size distribution.

Crumb rubber (Granulat gume) is ground recycled tire rubber, which is produced from scrap tyres or tyres from production procedure with an appropriate grinding method.

Granulometric composition (Granulometrijski sastav) is the distribution of grain size expressed through the mass percentage after sieving through a sieve of a particular composition.

Rubber asphalt mixture (Gumirana bitumenizirana mešavina) is a mixture containing as a binder rubber bitumen (wet procedure) or the addition of granulated rubber (dry procedure).

Asphalt-rubber (Gumirani bitumen) is paving grade bitumen or polymer bitumen modified with crumb rubber during a wet production process.

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

Noise reduction wearing course (habajući sloj za smanjenje buke) is an asphalt layer of such a surface composition/texture, that the noise caused by vehicle rolling wheels is reduced.

Harmonised European norm (usaglašena (harmonizovana) evropska norma) is the standard introduced by the European Committee for Standardisation (CEN) based on the mandate of the EU Commission, issued pursuant to the prescribed procedure.

Chemical additive (hemijski dodatak) is material added in small quantities with regard to the cement mass during cement concrete mixing, in order to modify the properties of both fresh and hardened cement concrete.

Hydraulic binder (hidraulično vezivo) is a pulverized inorganic material; when mixed with water it hardens in the air and in water; after being hardened, it retains its strength and volume durability under water as well.

Acceptance tests (ispitivanja pri preuzimanju) is testing of certain properties of a built-in product in order to approve or reject the existing conformity assessment of the product with regard to the prescribed properties in the uninstalled state.

Marginal strip (ivična traka) is a clearly marked part of the road, stabilized similarly to the pavement next to it and, as a rule, installed at the height similar to the one of the pavement.

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

Contractor (izvođač) is a legal 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 legal person responsible for a product, method, or service, and who implements the quality assurance conditions.

Single-sized aggregate (jednakozrna mešavina) is composed of stone particles of very similar size (of one class).

Single surface dressing (jednoslojna površinska obrada) is a method of pavement surface finishing by spraying bituminous binder and spreading crushed stone particles.

Mineral capping layer (kamena posteljica) is the top layer of a fill or foundation soil composed of the mechanically stabilised natural, mixed, or crushed aggregate.

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

Rock dust (kameno brašno) is a natural or artificial stone pulverized to a 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.

Drain capacity (kapacitet dreniranja) is a material property enabling draining the water through interconnected voids/cavities.

Characteristic strength (karakteristična čvrstoća) is a value of strength below which maximum 5 % of population of all possible strength tests can be expected.

Category (kategorija) refers to the characteristic level of a specific aggregate property, which is expressed as a range of values or a limiting value for a specific purpose; there is no correlation between categories for different properties.

Pavement surface (kolovozna površina) is a uniformly and continuously consolidated surface of the pavement wearing course, on which the traffic is running.

Quality class (klasa kvaliteta) is a quality and adequacy of a sample in view of the rate of destroying, determined by a laboratory investigation or test.

Carriageway/pavement (kolovoz) is a uniform and continuous stabilized part of the pavement structure suitable for vehicle traffic.

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

Factory production control (kontrola proizvodnje u pogonu) 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 a certain construction product. An integral component is constant control of compliance within the factory in which the product is produced in accordance with the requirements of the corresponding technical conditions.

Conformity control (kontrola usklađenosti) is all the activities, methods, and conformity tests within the scope of the internal control intended for the conformity evaluation.

Control notch (kontrolna spojnica) is a groove (every third or fourth dummy joint), cut as soon as possible after placing the cement concrete surfacing, in order to prevent the uncontrolled cracking of cement concrete.

Control/random tests (kontrolna ispitivanja) are random/spot tests and measurements, verifying the accuracy of conformity of 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.

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

Anchor (kotva/anker) is an inserted piece (bar) of ribbed steel for the reinforcement in longitudinal joints between cement concrete slabs, preventing them to move apart.

Threshold value (Krajnja granična vrednost, Schwellenwert) is a quality level, which is already beyond the requirements of project documents or technical conditions.

Rigid surfacing consists of a wearing course and upper road base made of aggregate and hydraulic binder (predominantly cement).

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

Testing laboratory (laboratorija) is a laboratory involved in the construction product conformity attestation, where the properties or behaviour of materials or products are measured, tested, calibrated, or determined in some different ways.

Mastic Asphalt (liveni asfalt) is a voidless asphalt mixture, in a liquid dense state when hot; compaction of it is not required during installation.

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

Design traffic load (merodavno saobraćajno opterećenje) is a characteristic value of traffic load 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 slope of the carriageway, and eventual dynamical effects; it is a sum of passages of nominal axle load of 100 kN.

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

Artificial aggregate (mešavina veštačkih kamenih zrna) is an aggregate of mineral origin, made by an industrial process under influence of a thermal or some different change.

Micro reinforced shotcrete (mikroarmirani mlazni cementni beton) 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.

Micro pores (mikropore) are microscopic air bubbles purposely made in the cement concrete during its mixing, usually by the use of surface active components; diameter of the bubbles, which are usually spherical or approximately spherical, amounts to 10 to 300 micrometres.

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

Shotcrete (mlazni cementni beton) 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.

Modified bitumen (modifikovani bitumen) is bitumen whose characteristics are improved by adding synthetic materials and/or rubber.

Modified Proctor compaction test (modifikovani postupak po Proktoru) is a test of compacting aggregate under certain conditions, in order to determine the relation between the moisture content and dry mix density.

Wet curing/aftertreatment (mokra naknadna obrada) is a procedure to preserve a damp surface directly after placing cement concrete or similar.

Dowel (Moždanik) 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.

Oversize grains (nadmerena zrna) represent a part of the aggregate that remains on upper sieve.

Supervision (nadzor) means the conformity evaluation after the certificate to verify a permanent conformity of a product with the specified requirements has been acquired from the control body.

Supervisor (nadzorni inženjer) is specialized organization selected by the client responsible for supervising the quality of the works and construction process in accordance with the project documentation.

Client (naručilac) is a competent national body or a special society/organization for national roads.

Embankment/fill (nasip) is a part of the road body between the formation level and foundation soil, artificially constructed of soils

and/or rocks to such a level above the ground surface that both slopes at carriageway edges are inclined downhill.

Unbound wearing course (nevezani habajući sloj) is a wearing course of the pavement for a very light traffic load, or for a temporary arrangement of the pavement surface made of a skeleton and wedged grain mixture to the greatest possible extent.

Sub-base (nevezani noseći sloj) is, as a rule, the lowest bearing course in the pavement; it is mechanically stabilised and composed of natural, crushed, or mixed aggregate.

External / third party control (nezavisna/spoljašnja kontrola) means activities by an institution intended to supervise the internal control, leading to the product conformity attestation, or to the attestation/approval of the production internal control, and/or acceptance of the construction product built-in; it includes activities, procedures, external testing, and measurements during production and/or installing certain construction products.

Bearing course/layer (noseći sloj) 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 load.

Conformity evaluation (ocenjivanje usklađenosti) means a systematic appraisal of the 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.

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

Removed asphalt (odstranjen/uklonjen asfalt) is an asphalt mixture won from existing asphalt by milling (in smaller pieces), digging up, pushing away or similar (in larger pieces).

Strengthened surface dressing (ojačana površinska obrada) is a dressing, where crushed aggregate, preliminarily coated with bituminous binder, has been used for spreading.

Round grain (okruglo zrno) is a natural grain having at least 50% of its surface rounded off.

Primer (osnovni premaz) is a coating penetrating into the substrate and improving adhesion of the subsequent coat.

Impregnating pore filling material/ impregnation (penetracioni premaz) signifies 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.

Sand (pesak) is an aggregate 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.

Testing plan (plan ispitivanja) specifies types and frequencies or number of conformity tests to be carried out during preparation and/or installing the product in view of the requirements indicated in the technical specifications or the contract.

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

Fertile soil (plodno tlo/humus) 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.

Improvement (Poboljšanje) means a procedure in which e the addition of appropriate materials (stone grains or inorganic binder) the workability and compaction capacity of the basic material are improved and the execution of construction works is facilitated.

Preliminary investigation of mixture (početni sastav mešavine) means the careful selection of materials and the percentage of various size grains in the mixture, which is needed for ensuring design characteristics.

Initial type test (početno tipsko ispitivanje) is a testing to verify and approve, prior to the regular production or upon any modification of origin of the 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 should be carried out either by the producer, or by the contractor or institution.

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

Reuse/recycling (ponovna upotreba/reciklaža) indicates the use and/or installation of materials which have already been used, at least once, as construction materials.

Capping layer (posteljica) is the upper (finishing) layer of an embankment or foundation soil, up to 50 cm thick, having special properties (increased bearing capacity, reduced sensitivity to the effects of frost) attained through proper construction-technical measures (improvement, consolidation, stabilization).

Mix-in-place procedure (postupak mešanja) is a procedure to improve, consolidate, and stabilize material: a mixer is driving on the prepared material layer, which is lifted and mixed with both a binder and the required water.

Measuring rod method (postupak sa letvom) is a procedure to determine the rut depth or to measure the deviation from the straight reference line between two points on the pavement surface.

Totally crushed or broken particle (potpuno drobljeno zrno) is a designation for a particle, which more than 90% of the surface is fractured.

Totally rounded particle (potpuno zaobljeno zrno) is a designation for a particle, which more than 90% of the surface is naturally rounded.

Surface dressing (površinska obrada) is construction of a protective layer applied to the surface by spraying bituminous binder and spreading crushed aggregate grains; it also designates a made layer.

Take-over of works (preuzimanje radova) is the activity, performed by the supervising engineer (after being informed by the contractor on completion of works) on the basis of the certificate or statement of compliance for the construction works in accordance with the requirements in the technical specifications and any additional requirements in the project, which is the subject of works.

Compressed/cold joint (pritisnuta/radna spojnica) is a designation for a construction element broken in the entire thickness (daily, longitudinal, transverse), due to the working conditions.

Conformity test (proba usklađenosti) is a random test by which the producer verifies the product conformity with the technical specification requirements on randomly selected samples or locations.

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

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

Working / hardened field (provozna podloga) is a filled up layer of unbound aggregate, embedded in the foundation ground (of poor bearing capacity) in order to facilitate the transportation and all other technological processes needed for the construction of the road.

Filler aggregate (punilo) is an 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 properties.

Joint cut (razrez za pukotinu/spojnicu) is an increased width of the cut (e.g. in cement concrete) to seal the joint with suitable material.

Recycled aggregate (reciklirana mešavina kamenih zrna) is an aggregate, which had already been used as a construction material before, re-won by a suitable recycling method.

Remix (remiks) is a procedure for improvement of the wearing layer composition where a bituminous mixture is heated and scraped, and the scraped material is then mixed with a new material added for the improvement of the existing bituminous mixture, and reinstalled.

Repave (repave) is a method to improve the 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 reinstalled.

Reshape (reshape) is a method to improve the 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 reinstalled, whilst the eventual surplus is pushed away.

Void content (sadržaj šupljina) is the relationship between the volume of voids and the overall volume of solids (V -%).

Traffic load (saobraćajno opterećenje) is a load expressed through the number of vehicles (AADT – average annual daily traffic) or by the number of passages of the nominal axle load of 100 kN (AADL - average annual daily load), which will pass through the selected cross profile of the road within the defined duration period.

All-in aggregate (sastavljeni/prirodni agregat) 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.

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

Certification of factory production control (sertifikacija (unutrašnje) kontrole proizvodnje) 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.

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

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

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

Crushed aggregate (sitnež) is a mixture of totally crushed stone grains of 2 mm to 63 mm in size.

Stone mastic asphalt (skeletni mastiks asfalt) is aggregate bound with road asphalt or a mixture of that asphalt and admixtures (polymers, natural asphalts, crumb rubber, stabilizing admixtures); a high proportion of completely crushed grains support each other, and the cavities among them are filled with bituminous mastic to a large extent.

Soft soil/soil of low bearing capacity (slabo nosivo tlo) is a soil containing a high percentage of water, thus having inadequate physical and/or mechanical properties, and slowly emitting water.

Joint (spojnica) 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.

Skid resistance (sposobnost trenja) 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 pavement.

Protecting agent (sredstvo za zaštitu) is a liquid material sprayed to a surface (e.g. of fresh cement concrete), creating protective film of properties determined in advance.

Stabilisation (stabilizovanje) is a procedure in which, through mixing the binder an water with the existing material, with appropriate compaction of the prepared mixture, the resistance of the installed mixture to traffic load effects and to averse climate and hydrological impacts is permanently increased.

Ageing (starenje) means a change of the properties of construction materials by time due to chemical and/or physical actions; it predominantly means an impairment of the mechanical properties such as strength and viscosity.

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

Compaction degree (koeficijent zbijenosti) 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 %.

Structure (struktura) is a texture in view of size, shape, and proportions of ingredients, as well as their interconnection.

Dry density (suva gustina) 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).

Fresh concrete (sveži cementni beton) is completely mixed cement concrete in such a condition that it still can be recast.

Gravel (šljunak) is a mixture of natural rounded stone grains of a size up to 63 mm.

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

Thin layer decking (tankoslojna obrada) is a mixture of thin bitumen wearing course (typically up to 20 mm) with a mass up to 50 kg/m2.

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

Soil/earth (tlo) 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).

Durability (trajnost) is a period between placing and fatigue (failure) of the material placed, e.g. in the pavement structure.

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

Composite pavement (učvršćenje puta) is a term for all the layers of material embedded in the pavement structure and the capping layer.

Laying/placing (ugrađivanje) is the procedure, which involves spreading out and compaction of the material in the corresponding thickness.

Sealing strip (uložak za zaptivanje) is a suitably shaped synthetic material, placed into the upper part of the cuts in dummy joints or cracks to prevent harmful substances to enter the joint or crack.

Internal/production control (unutrašnja) represents the activities by the producer at the factory production and/or by the contractor at installing the product at site, intended to manage the production and to establish the production conformity.

Base course (vezani donji noseći sloj) is a mixture of aggregate of uniform granulometric composition in the pavement structure, bound with hydraulic or bituminous binder.

Upper road base (vezani gornji noseći sloj) is a hydraulic or bituminous cohesive mixture of aggregate, placed below the wearing layer.

High performance concrete (visokovredni cementni beton) is 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 its high resistance to aggressive actions.

Water-cement ratio (vodocementni faktor) is the ratio of the effective proportion of water and cement in the fresh cement concrete.

Concrete grade (vrsta cementnog betona) means a cement concrete of a specified (same) strength class, resistant to aggressive actions at certain (same) exposure rate.

Bulk density (zapreminska gustina) is the ratio of weight of the compacted material and its volume, including the cavities and pores of the solid material.

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

Backfill wedge (zasipni klin (prelazni)) is the space between the bridge abutment and the surrounding embankment; to ensure a stable crossing between the bridge and the embankment, the wedge should be made pursuant to special requirements.

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

Bleeding (znojenje/isplivavanje) is a common term for the appearance of bitumen/mortar on the pavement surface.

Pavement life time (životni vek kolovozne konstrukcije) is the design time of an adequate serviceability of a pavement surface in view of traffic safety, comfort, and economy.

2.4.1.4 Designations

The following designations are used in the relevant regulations:

- Mixtures of stone grains / aggregates:

Designation type	Designation description	
	Serbian	English
$\Delta_{R\&B}$	delta prsten i kuglica	delta »ring and ball«
AAV	koeficijent otpornosti kamenog materijala na habanje	aggregate abrasion value
A_N	nordijski koeficijent otpornosti na habanje	Nordic abrasion value
BN	bitumenski broj	»bitumen number«
C	drobljena zrna	crushed particles
CC	udeo kalcijum-karbonata	calcium carbonate content
D	prečnik najvećeg zrna u mešavini / veličina najvećeg otvora okaca sita	largest aggregate/upper sieve size
d	prečnik najmanjeg zrna u agregatu / veličina najmanjeg otvora okaca sita	maximum nominal upper aggregate/lower sieve size
E_{CS}	uglastost / sitna zrna agregata	angularity/fine aggregate
f	udeo sitnih zrna (do 0,063 mm)	fines
F	koeficijent otpornosti na mraz i topljenje	freeze-thaw resistance value
FI	indeks pločatosti	flakiness index
G	zrnasti sastav / granulacija	grading
G_A	prirodni zrnasti sastav	grading all-in
G_C	grubi zrnasti sastav	grading coarse
G_F	sitni zrnasti sastav	grading fine
G_{TC}	karakteristični zrnasti sastav	typical grading
HR	otpornost na toplotu	heat resistance
Ka	udeo kalcijum-hidroksida	calcium hydroxide content
LA	koeficijent Los Angeles	Los Angeles coefficient
MB_F	koeficijent metilen plavo	methylene blue fraction
M_{DE}	koeficijent mikro-Deval	micro-Deval coefficient
m_{LPC}	udeo grubih organskih materija	content of coarse matter
MS	koeficijent magnezijum-sulfata	magnesium sulfate value
NR	bez zahteva	no requirement
PSV	koeficijent otpornosti na zaglađivanje	polished stone value
SB	koeficijent Sonnenbrand	Sonnenbrand value
SI	indeks oblika	shape index
SZ	udarna drobljivost	Schlagzertrümmerung
v	šupljine u punilu	voids of filler
V	stabilnost zapremine	volume stability
V_{LA}/V_{SZ}	otpornost na toplotni udar	resistance to thermal shock
WA	koeficijent upijanja vode	water absorption value
WS	koeficijent rastvorljivosti u vodi	water solubility value

- Bituminous mixtures

Designation type	Designation description	
	Serbian	English
A	razred bitumenizirane mešavine	bituminous mixture class
Abr_A	koeficijent habanja	abrasion value
AC	bitumenski beton	asphalt concrete
AC base	bitumenski beton za noseće slojeve	asphalt concrete base
AC bin	bitumenski beton za vezne slojeve	asphalt concrete binder
AC surf	bitumenski beton za habajuće slojeve	asphalt concrete surface
B	bitumen	bitumen
β	sačuvana otpornost	retained strength
BAA	afinitet bitumena i kamenih zrna	bitumen aggregate affinity
B_{min}	najmanji udeo bitumenskog veziva	minimum binder content
D	oticanje veziva	binder drainage
ε_6	otpornost na zamor	resistance to fatigue
F	tečenje po Maršalu	Marshould flow
f_{cmax}	najveći koeficijent puzanja	maximum creep rate
gg	porozan sastav mešavine	gap graded
hg	šupljikav sastav mešavine	hollow graded
I_{dyn}	najveća dinamička dubina utiskivanja	maximum dynamic indentation
I_{max}	najveća dubina utiskivanja	maximum indentation
I_{min}	najmanja dubina utiskivanja	minimum indentation
I_{nc}	najveće povećanje dubine utiskivanja posle 30 min	maximum increase after 30 min
ITSR	koeficijent posredne čvrstoće na zatezanje	indirect tensile strength ratio
K_h	horizontalna propusnost	horizontal permeability
K_v	vertikalna propusnost	vertical permeability
I_n	malo bučan	low noise
MA	liveni asfalt	mastic asphalt
og	otvoren sastav mešavine	open graded
P	permanentno deformisanje / velika sprava	permanent deformation
PA	drenažni asfalt	porous asphalt
PL	gubitak delića	particle loss
PmB	polimerni bitumen	polymer modified bitumen
PRD_{AIR}	permanentno deformisanje / mala sprava	permanent deformation
Q_{min}	najmanji kvocijent po Maršalu	minimum Marshould quotient
RA	asfaltni granulat	reclaimed asphalt
RAM	gumirana bitumenizirana mešavina	rubber asphalt mixture
RmB	gumirani bitumen	rubber modified bitumen
RV	sačuvana adhezija	retained adhesion
SMA	skeletni mastiks asfalt	stone mastic asphalt
S_{max}	najveća stabilnost po Maršalu	maximum Marshould stability
S_{max}	najveća krutost	maximum stiffness
S_{min}	najmanja stabilnost po Maršalu	minimum Marshould stability
S_{min}	najmanja krutost	minimum stiffness
$V10G_{min}$	najmanji sadržaj šupljina posle 10 obrtaja	minimum void content at 10 gyrations
VFB_{max}	najveća ispunjenost šupljina bitumenom	maximum voids filled with bitumen
VFB_{min}	najmanja ispunjenost šupljina bitumenom	minimum voids filled with bitumen
VMA_{min}	najmanji sadržaj šupljina u mešavini kamenih zrna	minimum voids in aggregate
V_{max}	najveći sadržaj šupljina	maximum void content
V_{min}	najmanji sadržaj šupljina	minimum void content
WTS_{AIR}	permanentno deformisanje	permanent deformation
Z	razred mešavine kamenih zrna / agregata	aggregate class

- Cement concrete mixtures

Designation type	Designation description	
	Serbian	English
C…/…	razredi čvrstoće na pritisak za normalno teške i vrlo teške cementen betone	compressive strength classes in case of normal-weight and heavy-weight concrete
CEM …	vrste cementa po EN 197	cement type according to EN 197
Cl …	razredi udela hlorida	chloride classes
CO-C3	koeficijenti gustine	density classes
F1 – F6	koeficijenti tečenja	consistence classes expressed byflow diameter
$f_{c, cnb}$	čvrstoća na pritisak kocke cementnog betona	compressive strenght of concrete determined by testing cubes
$f_{c, cy}$	čvrstoća na pritisak cilindra cementnog betona	compressive strength of concrete determined by testing cylinders
$f_{ck,cub}$	karakteristična (propisana) čvrstoća na pritisak kocke cementnog betona	charakteristic compressive strength of concret determined by testing cubes
$f_{ck, cyl}$	karakteristična (propisana) čvrstoća na pritisak cilindra cementnog betona	charakteristic compressive strength of concret determined by testing cylinders
f_{cm}	prosečna čvrstoća cementnog betona na pritisak	mean compressive strength of concret
f_{tm}	prosečna čvrstoća cementnog betona pri kidanju	mean tensile splitting strength of concrete
LC …/…	razredi čvrstoće na pritisak za lake cementne betone	compressive strength classes in case of lightweight concrete
S1 – S5	koeficijenti sleganja	consistence classes expressed by slump
VI – VIII	koeficijenti otpornosti na prodiranje vode	
XO	koeficijent izloženosti	exposure class
XA1 – XA3	koeficijent otpornosti na hemijsko delovanje	exposure classes for risk of chemical attack
XB1 – XB3	koeficijent otpornosti na habanje i brušenje	
XC1 – XC4	koeficijent otpornosti na karbonizaciju	exposure classes for risk of corrosion induced by carbonation
XD1 – XD3	koeficijent otpornosti na prodiranje hlorida	exposure classes for risk of corrosion induced by chlorides
XF1 i XF3	koeficijent unutrašnje otpornosti cementnog betona na mraz i topljenje	exposure classes for risk of freeze/thaw attack
XS1 – XS3	koeficijent otpornosti na hloride iz morske vode	exposure classes for risk of corrosion induced by chlorides from sea water

2.4.2 UNBOUND COURSES

2.4.2.1 General

Unbound courses are parts of pavement structures placed as
- Sub-base or
- Unbound wearing courses.

Unbound mixtures of mainly stone materials are, as a rule, placed on shoulders as well, except in specific conditions, when an asphalt or cobblestone upper course is installed.

The placement of unbound layers of materials in pavement structures is, as a rule, specified in the project documents and should be in compliance with these technical requirements.

2.4.2.2 Sub-base

2.4.2.2.1 Description

Preparation of the sub-base (mechanically compacted, blanket course) includes the provision and installation of an appropriate mixture of aggregate sized for the sub-base in locations stipulated by the project documents.

The works should be executed when the air temperature is above 2℃ and there is no rainfall.

The sub-base can be installed in pavement structures for all groups of traffic loads; as a rule, it is placed between the formation layer and the upper roadbase.

2.4.2.2.2 Basic materials

The basic materials for the sub-base are mixtures of natural, crushed or mixed grains.

Mixtures of natural grains that contain grains with rounded edges created during the natural decomposition of massive rocks.

Mixtures of crushed grains that contain grains obtained by crushing the rocks, artificial raw materials or coarse natural aggregates.

Combined mixtures contain fractions of natural and crushed grains.

In these special technical conditions the names used for the fractions are given in Table 2.4.2.1. And Figure 2.4.2.1.

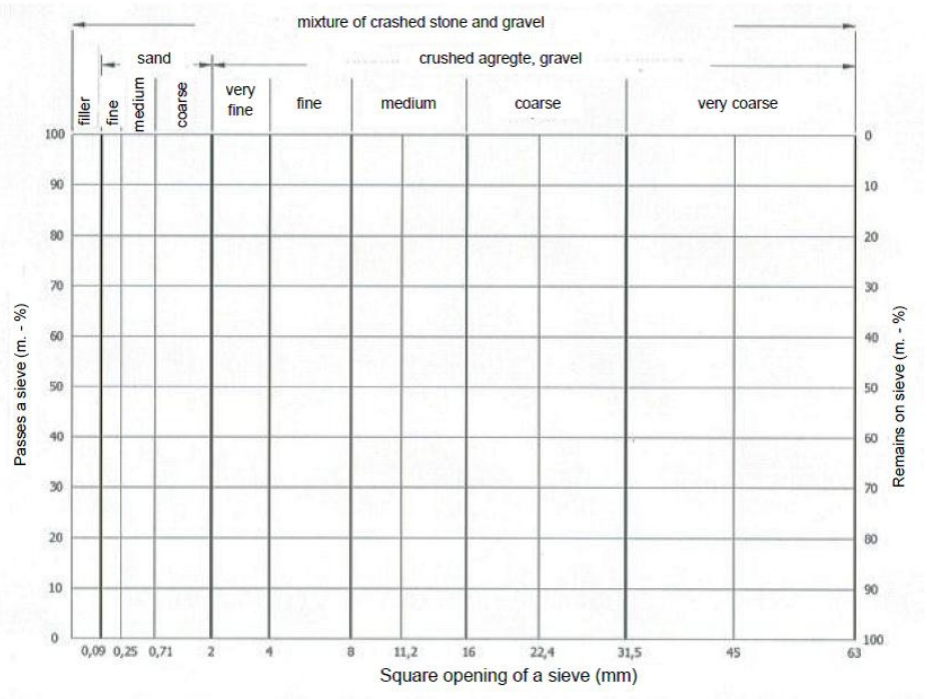


Figure 2.4.2.1: Diagram for defining the granulometric composition of aggregates

Table 2.4.2.1: Aggregate size fractions

Nominal fraction mm	Grain size from mm	Grain size to mm	Name of aggregate
0/1*	0	2	sand
0/2	0	4	
0/4	0	4	
1/4*	0.5	8	
0/8	0	11.2	mixture of crushed grains, gravel
0/11*	0	16	
0/16	0	22.4	
0/22*	0	31.5	
0/32	0	45	
0/45*	0	63	
0/63	0	125	
2/4*	1	8	crushed aggregate, (gravel)
4/8	2	11.2	
8/11*	4	16	
8/16	4	22	
11/16*	8	22	
16/22*	11.2	31.5	
16/32	11.2	45	
22/32*	16	45	
32/45*	22.4	63	
32/63	22.4	125	
45/63*	31.5	125	

* Intermediate aggregate size fraction

2.4.2.2.3 Aggregate quality

The required quality of the aggregates for sub-base is given in detail in EN 13242 – Aggregates for unbound materials and materials bound by hydraulic binders to be used in engineering and road structures.

2.4.2.2.3.1 Composition of aggregates

Natural or crushed aggregates along with mixed aggregates are made of fractions of gravel or crushed grains, i.e. gravel and crushed aggregate, sand and filler, which ensure the required composition of aggregates given in Figures 2.4.2.2, 2.4.2.3 and 2.4.2.4. Definition of aggregate composition is given in EN 933-1.

The proportion of crushed stone grains in the mixture for the sub-base should be determined (pursuant to EN 933-5) within the dimensioning of the pavement structure, taking into account the classifications in EN 13242 (category $C_{90/3}$ or $C_{50/10}$).

The aggregate composition of sub-base should be in compliance with the planned traffic load and the properties of the raw materials stipulated in the project documents. For higher traffic loads larger grains should be used for pavement structures. Here it is necessary to take into account that the layer thickness should be 2.5 times larger than the maximum nominal upper aggregate size in the prepared mixture.

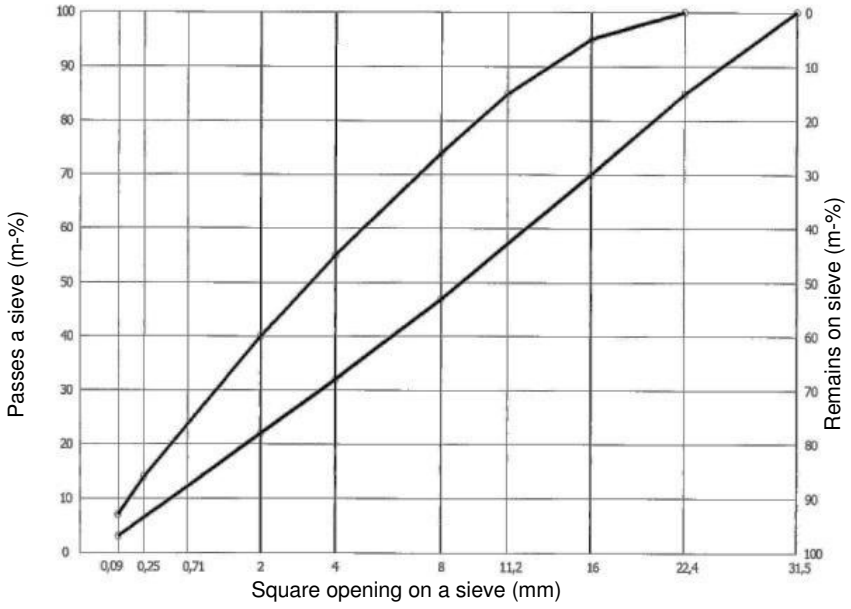


Figure 2.4.2.2: The range of granulometric composition of 0/22 mm aggregate for the sub-base

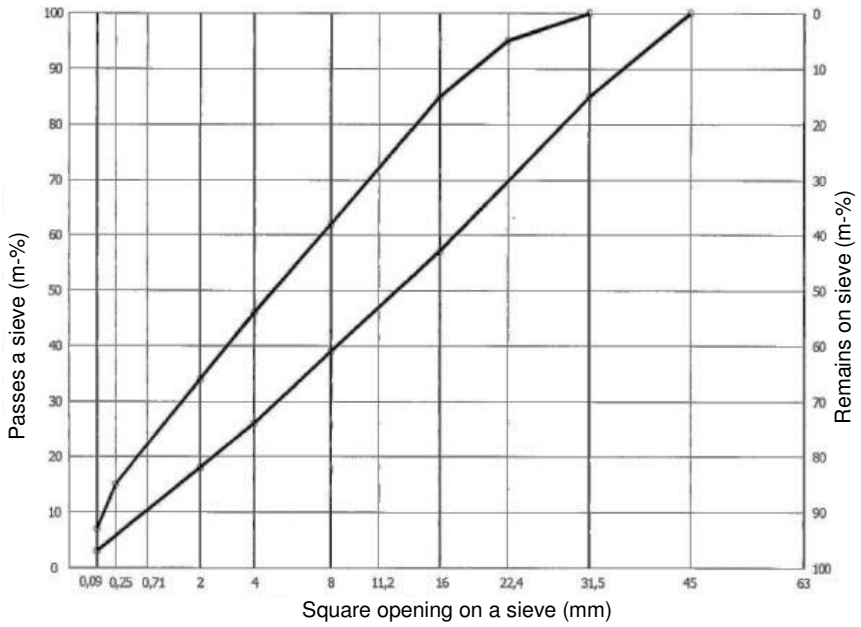


Figure 2.4.2.3: The range of granulometric composition of 0/32 mm aggregate for the sub-base

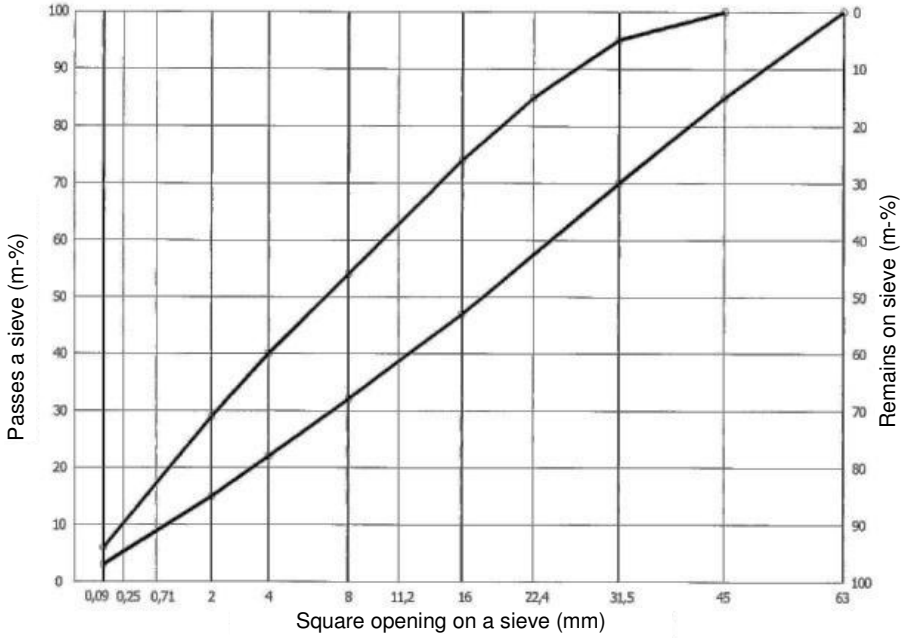


Figure 2.4.2.4: The range of granulometric composition of 0/45 mm aggregate for the sub-base

The contractor may use different aggregate compositions for the sub-base if the conformity of such a mixture is determined by the institution responsible for conformity testing and if it has been approved by the supervisory engineer.

The sub-base aggregate may contain a portion of grains of a size up to 0.063 mm (pursuant to EN 13242), that are:

- at the deposit site – up to 5m.-% (category f_5),
- upon placement – up to 8 m.-% (category f_8).

Individual results (up to 5% of the total number) of testing of the samples taken at the deposit site may exceed this value by up to 10%.

The proportion of stone grains with a size of up to 0.02 mm in the aggregate should not

exceed 3 m-%. Individual results of testing may exceed this value by up to 15%.

The coefficient of irregularity U = d_{60}/d_{10} should have the following values for mixtures of

- natural grains 5 to 100, and
- crushed and mixed grains 8 to 50.

If the supervising engineer, based on the testing results for the placement of aggregates with a coefficient of irregularity U lower than 6, allows the use of the aggregate, it may contain up to 15 m-% as a fraction with a size of up to 0.063 mm. Intermediate values should be determined by linear interpolation.

The sand equivalent, determined (pursuant to EN 933-8) for an aggregate of up to 4 mm in size, for the road sub-base, should have the following values:

- for large traffic loads at least 60 % (category SE_{60}),
- for medium and small traffic loads at least 50 % (category SE_{50}).

2.4.2.2.3.2 Mechanical properties of aggregates

The aggregate's coefficient of resistance to crushing, determined through the Los Angeles procedure (defined in EN 1097-2) for the road sub-base should have the following values:

- for medium or heavy traffic loads – up to 30 % (category LA_{30}),
- for small traffic loads – up to 35 % (category LA_{35}).

The resistance of the aggregates to freezing, determined (pursuant to EN 1367-2) through testing using magnesium sulphate and expressed as the proportion of pealed particles in relation to the previous mixture of samples, may be up to 25 m-% (category MS_{25}), and when testing with sodium sulphate - up to 5 m-%.

Not more than 20 m-% of grains whose shape is not in line with condition l:d ≤ 3:1 (testing pursuant to EN 933-4, category SI_{20}) may be present in the aggregate.

The content of the organic mixtures in the aggregate should not colour the 3% sodium base solution darker than the reference colour (testing pursuant to EN 1744-1).

The sub-base aggregate should not contain any harmful low quality grains or mixtures (testing pursuant to EN 1744-1). The mixture may contain individual brittle or crushable grains only in a quantity that is in compliance with the prescribed requirements.

The aggregate's load bearing capacity coefficient, determined in a laboratory through the Californian procedure CBR, should have the following values:

- for natural and mixed aggregates with less than 50 m-% of crushed grains minimum 40 %,
- for crushed and mixed aggregates with more than 50 m-% of crushed grains minimum 80 %.

2.4.2.2.4 Manner of Execution

2.4.2.2.4.1 Aggregate deposit

The contractor should in a timely manner, prior to the beginning of exploitation, notify the supervising engineer about the location of the aggregate deposit for the sub-base and provide evidence on the conformity of the mixture with the requirements in Article 2.4.2.2.3 of these technical conditions, along with obtaining a permit for its use.

The aggregate should be provided in a way that will ensure its permanent quality and evenness.

Prior to work the borrow pits and quarries should have been well cleaned.

2.4.2.2.4.2 Preliminary tests

Prior to the commencement of works, the following should be tested:

- composition and mechanical properties of the aggregate (pursuant to Article 2.4.2.2.3) and
- the optimal humidity and density through the Proctor's procedure (pursuant to EN 13286-2)

for comparing the conformity of the characteristic aggregate properties with the properties defined at the preliminary testing of samples taken for the internal control of production.

For each characteristic aggregate type, prior to the commencement of works it is necessary to define the technological procedure, the means of compression and their performance at depth. For that reason it is necessary to measure the performance of each means of compression on a pilot

section after completion. After the compression has been completed the following should be measured on the sub-base high plain:
- density and humidity of the installed aggregate courses,
- bearing capacity of the installed course, and
- flatness and height of the high plain of the installed course (all in compliance with Article 2.4.2.2.5).

2.4.2.2.4.3 Preparation of the substrate high plain

Prior to placement of the aggregate in the sub-base, the substrate high plain (capping layer) should be prepared in compliance with Article 2.2.5 of these technical conditions.

The sub-base placement may commence after the take-over of the substrate pursuant to the requirements in Article 2.2.5.6.2 of these technical conditions. Until the commencement of installation, the contractor should maintain the substrate in a valid condition until the time of take-over. The contractor should repair all damage in a timely and appropriate manner and should provide evidence of the repairs performed to the supervising engineer.

2.4.2.2.4.4 Aggregate storage

If the contractor temporarily stores the aggregate prior to its installation in the sub-base, prior to this the storage site should be prepared in an appropriate manner (should be levelled, secured and drained).

The temporary storage site should be as rectangular-shaped as possible (sides of up to 50 m in length). Homogenized and appropriately dampened aggregates should be spread in layers of a height of up to 3.0 m. The slope inclination of the temporary storage site is 1 : 2.

A temporary access road should be constructed to the temporary disposal site.

The temporary disposal site should be marked in an appropriate manner (location, number, size, take-over stage). After the take-over of the temporary storage site, new aggregates should not be brought to the site until the previous are completely used.

2.4.2.2.4.5 Aggregate filling

Aggregate filling of the sub-base may start on the prepared substrate high plain following approval by the supervising engineer.

As a rule, aggregate filling may not be carried out on a prepared and taken over capping layer high plain, but exclusively on an already spread aggregate layer. The vehicles bringing the aggregate should be unloaded by tipping backwards or sideways. If mechanical spreading or placement is required the supply should be partial along the substrate high plain, the manner of the supply should be approved by the supervising engineer.

For the supply of aggregates it is necessary to use vehicles equipped in an appropriate manner, with mechanical equipment that ensures the required even distribution of the aggregate is used for spreading. The thickness of the spread aggregate layer should be in accordance with the required thickness of the compressed aggregate layer pursuant to the project documents.

If the aggregate is placed in several layers, each individual layer should be shaped and compressed in an appropriate way prior to aggregate filling of the subsequent layer.

If the aggregate filling is carried out on an already spread and uncompressed layer, the passage of individual vehicles should be as evenly distributed as possible along the entire width of the spread material.

Vehicles with mud on their wheels should not be driven over an already spread sub-base aggregate.

2.4.2.2.4.6 Aggregate placement

As a rule, placement of the sub-base aggregate is carried out by machines. Manual installation is allowed only in places where machines cannot be used and in places approved by the supervising engineer.

As a rule, the sub-base aggregate should be brought to the construction site by the appropriate means and in the appropriate composition. Each modification of the aggregate's granulometric composition at the construction site or the place of installation should be approved by the supervising engineer based on specific results of preliminary tests.

The water quantity needed for ensuring the optimal aggregate humidity for better improved compression should be evenly added to the aggregate already in the location of procurement.

If water must be added at the location of installation it is dosed by spraying, which prevents the rinsing off of the fine grains. During compression, the aggregate humidity may deviate from the optimal humidity by not more than ± 2 m.-%. Ensuring this humidity is even more important if the aggregate spreading is carried out by graders.

As a rule, spreading of the sub-base aggregate is carried out by the use of pavers, but it may also be performed by graders with the approval of the supervising engineer. Spreading with the use of bulldozers is carried out only in exceptional cases. The spreading should be performed on the same day as the damping.

The aggregate is spread and levelled in the required profile pursuant to the project documents, while compression should be performed by the appropriate machines along the entire layer width. To ensure the appropriate compression along the entire pavement width the layer width of the design layer thickness should be increased by + 10 cm, if this has not planned in the project documents.

Compression is carried out from the lower to the upper edge of the layer. The number of passages of the appropriate means of compression, which were previously defined in the pilot section, should be tested within the internal control of the density of the state of the compaction of the installed aggregate layer.

All irregularities discovered during compression should be repaired as detailed by the supervising engineer.

All places inaccessible to machines should be compressed to the required density by other means that should be approved by the supervising engineer, who also determines the requirements of the use of such means.

Prior to the completion of compression it is necessary to determine the density and bearing capacity of the installed sub-base.

If the values required in the project documents have not been achieved, the contractor should ensure the quality of the installed sub-base by additional measures.

2.4.2.2.5 *Quality of execution*

Prior to the use of the machinery and equipment affecting the quality of the executed works it is necessary to check whether they are suitable and whether they can ensure the uniform quality pursuant to the requirements of these technical conditions.

All equipment and machines should have a certificate, and their capacities should meet the requirements of the project documents.

2.4.2.2.5.1 Compression

The state of compression of the sub-base aggregate, which is defined by the density tested with the Proctor's procedure, should amount to at least 98 % on average. The bottom limit of density should not be lower than the defined average value by more than 3%.

As a rule, the density and humidity of the aggregate installed in the sub-base is determined by measurement with the use of an isotopic gauge (nuclear densitometer, Article 1.2.4).

2.4.2.2.5.2 Bearing capacity

The sub-base bearing capacity, which is defined by the static deformation modulus E_{v2} or dynamic deformation modulus E_{vd} (pursuant to guidelines of SRDM, Article 8.3.3 Bearing Capacity), should be in accordance to the requirements given in Table 2.4.2.2.

Table 2.4.2.2: The required values of deformation modules on the sub-base high plain

Aggregate type (mixtures of stone grains)	Traffic load: very heavy or heavy — required value			Traffic load: medium or light — required value		
	E_{v2} MN/m^2	E_{v2}/E_{v1}	E_{vd} MN/m^2	E_{v2} MN/m^2	E_{v2}/E_{v1}	E_{vd} MN/m^2
- natural	≥ 100	≤ 2.2	≥ 45	≥ 90	≤ 2.4	≥ 40
- crushed or mixed	≥ 120	≤ 2.0	≥ 55	≥ 100	≤ 2.2	≥ 45

The ratio of deformation modules E_{v2}/E_{v1} is not decisive for the assessment of the sub-base bearing capacity if the value of deformation modulus E_{v1} is higher than 50 % of the required E_{v2} value. The bottom limit value of the deformation modulus may be up to 20 % lower than the required value in Table 2.4.2.2 (up to 10% of the total number of measurements).

If the contractor fails to reach the required ratio of deformation modules E_{v2}/E_{v1}, the supervising engineer should decide any further action.

2.4.2.2.5.3 Flatness, height, slope

Unevenness of the sub-base high plain is determined by measuring the deviation below a laid 4-meter long lath, which is placed along any direction in relation to the road centre line (guidelines of SRMG, Article 3.1.3.1). The sub-base high plain may deviate from the lath by no more than 20 mm (upper limit). If such deviations occur continuously one after another, the flatness should be repaired pursuant to the instructions defined by the supervising engineer.

The height of individual measuring points on the sub-base high plain should be determined by levelling. The sub-base high plain at an arbitrary point should not deviate from the design elevation by more than ± 10 mm (upper limiting value).

As a rule, the slope of the sub-base high plain should have equal crossfall and longitudinal slope of the pavement. Permitted deviations are defined by the permitted irregularities and deviations from the height of the sub-base high plain, but they should not exceed ± 0,4 % of the absolute inclination value (ultimate limiting value).

2.4.2.2.6 Quality control

For each significant aggregate type planned for placement in the sub-base it is necessary to determine the conformity with the requirements of the project documents and these technical conditions:

- at the beginning of placement, through preliminary tests
- during installation through testing within the internal and independent control.

2.4.2.2.6.1 Preliminary tests

Preliminary tests for the inspection of conformity of the aggregate properties defined in Article 2.4.2.2.3 are given for the sub-base in Table 2.4.2.3.

The results of preliminary tests should be adjusted to the details of the properties of the supplied aggregates provided by the contractor.

Table 2.4.2.3: Requirements for aggregate properties for preliminary tests intended for the sub-base

Aggregate properties	Unit of measure	Required value	Testing procedure
- aggregate composition	m.-%	Article 2.4.2.2.3	EN 933-1
- proportion of grains with a size of up to 0.063 mm	m.-%	f_5/f_8	EN 933-1
- proportion of crushed grains	m.-%	$C_{90/3}$ / $C_{50/10}$	EN 933-5
- form of coarse particles	m.-%	SI_{20}	EN 933-4
- coefficient of irregularity U	-	Article 2.4.2.2.3	-
- sand equivalent	%	SE_{60}/SE_{50}	EN 933-8
- resistance to crushing – Los Angeles coefficient	%	LA_{30}/LA_{35}	EN 1097-2
- percentage of organic admixtures	-	Article 2.4.2.2.3	EN 1744-1
- bearing capacity – CBR procedure	%	40/80	TP BF-StB, B7.1
- tests pursuant to Proctor's modified procedure			EN 13286-2
- optimal humidity	m.-%	-	
- maximum density	t/m^3	-	
- measurements of the installed aggregate layer:			
- humidity	m.-%	-	SRCS, Article 1.2.4
- state of compaction	%	Article 2.4.2.2.5	SRCS, Article 1.2.4
- bearing capacity:		Article 2.4.2.2.5	SRDM, Article 8.2.3
- dynamic deformation modulus E_{vd}	MN/m^2		
- static deformation modulus E_{v2}	MN/m^2		
- flatness, height, slope	-	Article 2.4.2.2.5	SRMG, Article 3.1.3.1

2.4.2.2.6.2 Internal Control

The contractor's internal control (which should be carried out by an authorized laboratory) should, during the installation of the sub-base aggregate, determine the aggregate's conformity with the requirements of the project documents and these technical conditions.

The type and frequency of testing within the internal control of aggregate placement in the sub-base should be defined in the verified program of the average control frequency. If there is no program, the frequency is defined by the supervising engineer, who also defines the locations of sampling and measuring l through a statistical random selection (Item 1.4.1).

During the placement of aggregate in the sub-base the laboratory should take and inspect the conformity of the properties with the frequency defined in Table 2.4.2.4.

As a rule, aggregate samples should be taken on the temporary storage site (two-thirds of them) and from the installed sub-base (one third of them).

The minimum frequency of testing during the internal control of aggregate placement in the sub-base is defined in Table 2.4.2.5.

Table 2.4.2.4: Minimum frequency of aggregate testing during the internal control of its placement in the sub-base

Properties of installed aggregate	Testing procedure	Minimum frequency of testing
- aggregate composition	EN 933-1	$4000m^2/1000m^3$
- proportion of grains with a size of up to 0.063 mm	EN 933-1	$4000m^2/1000m^3$
- humidity and density by Proctor	EN 13286-2	$4000m^2/1000m^3$
- percentage of organic admixtures	EN 1744-1	$8000m^2/2000m^3$

Table 2.4.2.5: Minimum frequency of testing during the internal control of the aggregate installed in the sub-base

Properties of the installed aggregate	Testing procedure	Minimum frequency Tests
- percentage of water and thickness	SRCS, Article 1.2.4	200 m^2
- bearing capacity:		
- dynamic deformation modulus E_{vd}	SRDM, Article 8.2.3	400 m^2
- static deformation modulus E_{v2}	-	2000 m^2
- layer high plain:		
– evenness	SRMG, Article 3.1.3.1	20 m^1
- height and slope	-	20 m^1

Upon agreement of the supervising engineer the quality of the aggregate installed in the sub-base can also be defined on the basis of other recognized procedures. In these cases the standards for testing the quality of the installed aggregates, as well as the method and frequency of testing should be agreed with the supervising engineer.

2.4.2.2.6.3 Independent control

The scope of works of independent control during the sub-base constructions is, as a rule, in the ratio of 1:4 to those of internal control. The control testing should be carried out by an institution authorized by the client.

The location for aggregate sampling at the temporary storage site and during placement in the sub-base should be determined by the supervising engineer through a statistical random selection (Item 1.4.1).

The sampling for independent control and for testing and measurements at the construction site should be carried out in the presence of the contractor and supervising engineer.

2.4.2.2.7 Measuring and acceptance of works

2.4.2.2.7.1 Measuring of works

As a rule, the executed works are measured pursuant to Item 1.2.2.2 of the general technical conditions and are calculated in cubic metres (m^3).

All quantities should be measured according to the actual scope and type of executed works, which are performed within the remits in the project documents.

2.4.2.2.7.2 Acceptance of works

The installed sub-base should be accepted by the supervising engineer after written notification by the contractor of the completion of works. The acceptance is carried out pursuant to the requirements under these technical conditions and in accordance with Item 1.2.2.3 of the general technical conditions.

The contractor should submit in a timely manner to the supervising engineer all data and reports of the internal control on testing,

as well as the final assessment of conformity, issued by the authorized institution.

The contractor should repair all the discovered deficiencies prior to the continuation of works.

2.4.2.2.8 Calculation of works

2.4.2.2.8.1 General

The executed works are t calculated according to Item 1.2.2.4 of the general technical conditions.

The quantities defined in Item 2.4.2.2.7 should be calculated pursuant to the agreed unit prices.
The agreed unit price should include all the expenses needed for final completion of the works. The contractor may not demand additional payments, unless agreed otherwise in the contract.

2.4.2.2.8.2 Deductions Due to Inadequate Quality

Due to the required quality of the sub-base aggregate, no deductions are applied during calculation.

If the contractor installs in the sub-base an aggregate that does not meet the requirements in Item 2.4.2.2.3 of these technical conditions, the supervising engineer should decide about the calculation.

The bottom limiting value of the execution quality pursuant to Item 2.4.2.2.5 for
- state of compaction,
- bearing capacity and
- flatness and height

is 100 % of the value according to the offered unit price.

Due to the required provision of the bottom limiting value of the execution quality, there are no deductions during calculation.

If the contractor fails to provide the required quality of execution pursuant to Item 2.4.2.2.5, the supervising engineer should decide about the calculation method.

2.4.2.3 Unbound wearing courses

2.4.2.3.1 Description

The execution of the unbound mechanically secured (macadam) wearing course includes procurement and installation of an appropriate aggregate (mixture of stone grains) for the unbound wearing course in locations defined by the project documents.

The works should be executed when during the installation there is no rainfall and when the air temperature is above 2 °C.

As a rule, the unbound wearing courses (UWC) are installed only in pavement structures with very low traffic load or for the temporary definition of a traffic surface.

2.4.2.3.2 Basic materials

As a rule, the basic materials for UWC are mixtures of crushed rock grains or coarse stone grains, and occasionally a mixture of those with crushed secondary raw materials. The basic aggregate size fractions of 0/22 mm, 0/32 mm and 0/45 mm are used and fractions of 0/8 mm are used for the reinforcement and sealing of the UWC surface.

2.4.2.3.3 Quality of materials

2.4.2.3.3.1 Granulometric composition of aggregates

Granulometric composition of the basic fractions of aggregates should ensure the best possible skeleton base, defined by the limiting curves given in Figures 2.4.2.2 to 2.4.2.4. It is useful if the granulometric curve of the mixture lies as close as possible to the limiting curve, i.e. if the mixture has a larger portion of coarse stone grains.

The other requirements of significance for the aggregate quality for the basic skeleton in unbound wearing courses are detailed in Item 2.4.2.2.3.1.

The proper range of the aggregate granulometric composition for securing and reinforcing the UWC surface is defined by the limiting curves given in Figure 2.4.2.5. As a rule, the UWC surface is reinforced and sealed with mixtures of exclusively crushed stone grains. The only requirement that differs from the requirement for the quality of grain mixtures for the base UWC skeleton is the requirement for the sand equivalent, which should be at least 40 % (category SE_{40}).

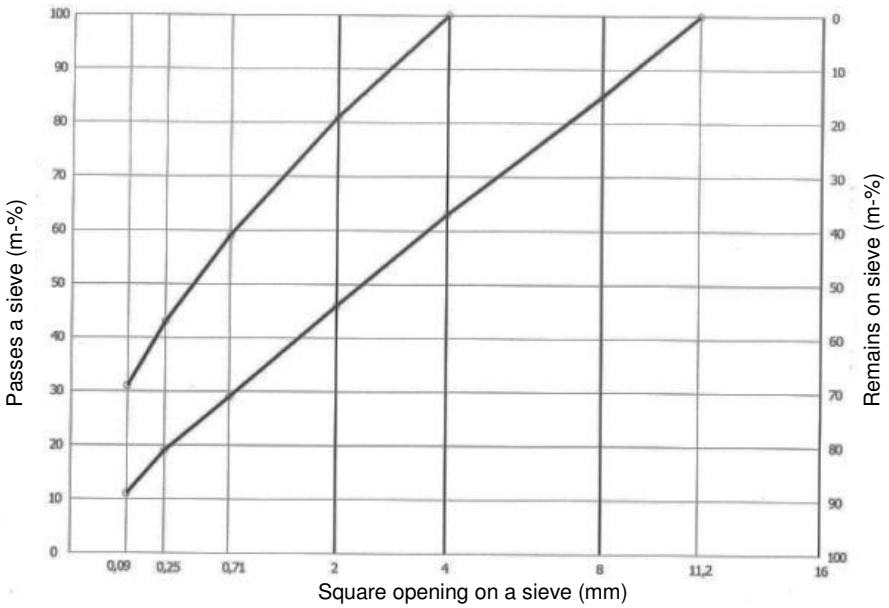


Figure 2.4.2.5: The range of granulometric composition of 0/8 mm aggregate for sealing and securing of unbound wearing courses

2.4.2.3.3.2 Mechanical properties of aggregates

Mechanical properties of aggregates for the base skeleton for UWC are defined in Item 2.4.2.2.3.2.

For aggregates used for sealing and reinforcing the following mechanical properties are required:

- the resistance to freezing, determined (pursuant to EN 1367-2) through testing with magnesium sulphate and expressed as the proportion of pealed particles in relation to the initial mixture of grains, may amount up to 25 m-% (category MS_{25}), and for testing with sodium sulphate - up to 10 m-%.
- the content of organic mixtures in the aggregate should not colour the 3% sodium base solution darker than the reference colour (testing pursuant to EN 1744-1).

2.4.2.3.4 Manner of Execution

2.4.2.3.4.1 Deposit of aggregates

The requirements for the deposit of aggregates for the base skeleton and reinforcement of UWC are defined in Item 2.4.2.2.4.1 of these technical conditions.

2.4.2.3.4.2 Preliminary tests

The requirements for the preliminary technological tests of aggregates for UWC are equivalent to those given in Item 2.4.2.2.4.2.

2.4.2.3.4.3 Preparation of the substrate high plain

The provisions given in Item 2.4.2.2.4.3 are applicable to this stage of works.

2.4.2.3.4.4 Aggregate storage

The provisions given in Item 2.4.2.2.4.4 are applicable to the storage of aggregates for UWC.

2.4.2.3.4.5 Aggregate filling

The skeletal aggregate filling should be separated from the strengthening and sealing aggregate filling. In all other cases the provisions given in Item 2.4.2.2.4.5 should apply.

2.4.2.3.4.6 Aggregate placement

The provisions under Item 2.4.2.2.4.6 should apply for the placement of skeletal aggregates.

The strengthening and sealing aggregate should be spread on an already installed layer of skeletal aggregate in the quantity needed to completely fill the voids on the layer surface as along with partial covering. The water quantity added to improve the penetration of the grains into the skeletal

layer cavities or to strengthen the skeletal layer surface of the UWC aggregate should be added evenly by spraying.

The final density is achieved with the use of lighter static rollers.

The quality of works executed during the UWC installation requires a minimum layer thickness of 15 cm.

2.4.2.3.5 Quality of execution

Prior to the use of the machinery and equipment affecting the quality of the executed works it is necessary to check their capabilities to achieve the appropriate and uniform quality pursuant to the requirements of these technical conditions.

All the equipment and machines should have certificates, and their capacities should meet the requirements of the project documents.

2.4.2.3.5.1 Compression

The requirements given in Item 2.4.2.2.5.1 should apply to the compression of aggregates installed in UWC.

2.4.2.3.5.2 Bearing capacity

The bearing capacity of UWC defined by static deformation modulus E_{v2} or dynamic deformation modulus E_{vd}, should comply with the requirements given in Table 2.4.2.6.

Table 2.4.2.6: The required values of deformation modules on the unbound wearing course high plain

Aggregate	Required value		
	E_{v2} MN/m^2	E_{v2}/E_{v1}	E_{vd} MN/m^2
- crushed, natural crushed	≥ 100	≤ 1.8	≥ 45
- mixed, from secondary raw materials	≥ 90	≤ 2.0	≥ 40

In all other cases the provisions under Item 2.4.2.2.5.2 should apply.

2.4.2.3.5.3 Flatness, height and slope of the high plain

The requirements given in Item 2.4.2.2.5.3 should apply to the given characteristics of the UWC high plain.

2.4.2.3.6 Quality control

2.4.2.3.6.1 Preliminary tests

The provisions from Item 2.4.2.2.6.1 should apply to the preliminary tests of aggregates for UWC.

2.4.2.3.6.2 Internal Control

The provisions under Item 2.4.2.2.6.2 should apply to the internal control of the skeletal aggregates.

The minimum tests within the internal control of the conformity of strengthening and sealing aggregates include:
- aggregate composition on 4,000 m^2
- grain resistance to frost on 8,000 m^2
- proportion of organic admixtures on 8,000 m^2

The minimum internal control during installation should be carried out simultaneously for both aggregates. The requirements in relation to the scope of these tests are given in Item 2.4.2.2.6.2.

2.4.2.3.6.3 Independent control

The provisions under Item 2.4.2.2.6.3 should apply to the independent control of UWC.

2.4.2.3.7 Measuring and acceptance of works

The overall requirements given in Items 2.4.2.2.7.1 and 2.4.2.2.7.2 should apply to the measurement and acceptance of works within UWC.

2.4.2.3.8 Calculation of works

The requirements given in Item 2.4.2.2.8 should apply to the calculation of executed works.

2.4.2.4 Shoulders

2.4.2.4.1 Description

Shoulders are longitudinal strips/elements along the outer edges of the pavement that are not intended for traffic but only ensure the stability of the pavement structure and serve for the installation of traffic signs and road equipment.

Shoulders should be executed in the dimensions defined in the project documentation and in compliance with these Technical Conditions.

The execution of shoulders also includes the placement of all the appropriate materials for the shoulder structure in locations defined by the project documents.

The shoulder structure contains one or several layers of material detailed in the project documents.

The works may be executed when the air temperature exceeds 2 ℃ and when there is no rainfall.

2.4.2.4.2 Basic materials

The basic materials for the execution of shoulders are primarily unbound mixtures of stone grains (aggregates), and also top soil for upper layers, grassing plates (of cement concrete) and bituminous mixtures.

2.4.2.4.3 Quality of materials

The required quality of aggregates for the construction of shoulders is defined in Item 2.4.2.2.3 of these technical conditions.

The top soil material should be active in order to ensure a durable layer.

The specific quality of the grassing plates is given in Item 2.4.5.2.2.

The quality of the bituminous mixtures should comply with the requirements for wearing courses on the neighbouring traffic lane (Item 2.4.3.4.4 or 2.4.3.4.3).

2.4.2.4.4 Manner of Execution

The requirements given in Item 2.4.2.2.4 of these technical conditions should apply to the construction of shoulders, in general.

The substrate for the construction of shoulders may be:

- the capping layer high plain, prepared pursuant to Item 2.2.5.3.8, or
- the sub-base high plain, prepared pursuant to Item 2.4.2.2.5.

The materials placed in the shoulder structure should be connected in such a way so as to ensure minimal erosion.

The thickness of the aggregate layer in the shoulder structure should be at least 30 cm.

For shoulders with top soil, the basic aggregate layer should have a minimum thickness of 20 cm, while the thickness of the upper top soil layer should not exceed 10 cm.

The shoulder structure with grassing plates should have a 20 cm thick basic layer of an appropriate aggregate and at least a 5 cm thick substrate layer of sand. The size of the plates is determined by the supervising engineer.

The shoulders strengthened with crushed stone grains and filled with top soil should be constructed of a basic aggregate layer with a minimum thickness of 20 cm and at least 10 cm thick layer of crushed aggregate (stone chipping), covered with a top soil layer of an average thickness of 5 cm, which should be installed in the layer of crushed aggregate and sown with grass.

Shoulders with an unbound wearing course should be constructed at a distance of at least 10 cm from the steel safety barrier. The shoulder structure should be constructed of the same thickness as the neighbouring traffic lane, where, instead of a bound wearing courses, an unbound aggregate is installed.

A shoulder on an embankment should run at least 50 cm behind the pillar of the steel safety barrier.

2.4.2.4.5 Quality of execution

The quality of execution of shoulder structures of aggregates should comply with the requirements given in Item 2.4.2.2.5 of these technical conditions.

The quality of execution of the shoulder structures with grassing plates should comply with the requirements in Item 2.4.5.4.

The quality of the other shoulder structures should be in compliance with the requirements of these technical conditions, in general terms.

The shoulder high plain should be executed with an outward slope (minimum 4%) and at least 1 cm below the edge of the neighbouring pavement. The latter condition does not apply to shoulders with asphalt wearing layers.

2.4.2.4.6 Quality control

In general, the requirements for the scope of quality control of shoulder structure execution are defined in Items 2.4.2.2.6 and 2.4.5.5 of these technical conditions.

The requirements for the quality control of the execution of shoulders with asphalt wearing layers are defined in Item 2.4.3.5, in general terms.

2.4.2.4.7 Measuring and acceptance of works

The method of measurement and acceptance of the constructed shoulders is defined in Items 2.4.2.2.7 and 2.4.5.6 of these technical conditions.

2.4.2.4.8 Calculation of works

In general, the conditions given in Items 2.4.2.2.8 and 2.4.5.7 should apply to the calculation of executed works on shoulders.

2.4.3 BITUMINOUS BOUND COURSES

2.4.3.1 Description

Bituminous aggregates are used nowadays for asphalt courses in modern pavement structures to the greatest extent.

These technical conditions give the main requirements for:
- aggregates,
- bituminous binders, and
- manufacture, transport and placement of bituminous mixtures

for the asphalt bearing, binder, wearing, sealing and drainage courses of the pavement structures on surfaces intended for public transport.
The bituminous mixtures defined in these technical conditions may be placed only on an appropriately prepared and bearing substrate/course, both during new construction and during the reconstruction and renewal of existing pavement structures.

The thickness and distribution of bituminous mixture courses in the pavement structure should be defined in the pavement structure dimensioning procedure. It is necessary to take into account the increased loads resulting from
- channelled traffic and narrow curves,
- slow traffic,
- frequent braking and acceleration of vehicles,
- traffic in interchanges and on access junctions, and
- standing vehicles.

The loads may also be more pronounced due to climatic impacts such as:
- longer periods of high or low temperature and
- intensive insolation on southern slopes.

The quality requirements in these specifications along with the basic EN requirements use individual types of bituminous mixtures and individual groups of traffic load as the limiting values. The allowed deviations include dissipation during sampling, the confidence interval in the testing procedure as well as irregularities resulting from the execution of the works. The limiting values should be provided, unless a different requirement is provided in writing in individual cases.

2.4.3.2 Basic materials

As the basic materials in the procedure of execution of asphalt courses constructed with bituminous mixtures, these technical conditions envisage the types and quality of:
- aggregates,
- bituminous binders,
- admixtures, and
- asphalt granulate.

2.4.3.2.1 Aggregates

2.4.3.2.1.1 Types of aggregates

The mixtures of crushed and natural (rounded) grains may be used for bituminous mixtures for asphalt courses are:
- mixtures of natural silicate and carbonate rocks,
- mixtures of artificial rocks – produced materials (e.g. slag, clay, ash)
- recycled material – asphalt granulate.

2.4.3.2.1.2 Quality of aggregates

Pursuant to the harmonized European standards EN, the properties of aggregates for bituminous mixtures for asphalt courses are classified into:
- geometrical,
- physical and
- chemical,

and for each characteristic property they are further divided into categories.

The minimum requirements for the characteristic properties of aggregates for bituminous mixtures for asphalt courses are – taken from EN 13043 – defined in categories. The appropriate geometrical, physical and chemical properties of the aggregates are thoroughly divided into the quality classes given in Table 2.4.3.2.1.

For bituminous mixtures of skeletal mastic asphalt SMA 8 and SMA 11 for the protective courses on facilities, the use of aggregates of Class Z4 is allowed in addition to the given mixtures.

For the surface dressing of pavements aggregates with properties defined in Table 2.4.3.2.1 grain mixture class Z1 should be used and for other traffic surfaces - aggregates of Class Z3.

The requirements of the properties of fillers for bituminous mixtures are defined separately.

Table 2.4.3.2.1: The required main properties of aggregates for bituminous mixtures for asphalt courses (EN 13043)

Properties of aggregates	Unit of measure	Testing procedure EN	Classes of grain mixtures and required values					
			Z1	Z2	Z3	Z4	Z5	Z6
Geometrical properties:								
Grading	mm	933-1	aggregate size fractions 0/2, 0/4, 2/4, 4/8, 8/11, 8/16, 11/16, 16/22, 16/32, 22/32				allowed fractions and grain mixtures	
Grading for mixtures of fine grains (D ≤ 8 mm)	m.-%	933-1	$G_{TC}20$				$G_{TC}NR$	
Proportion of fine particles (≤ 0,063 mm)	m.-%	933-1	coarse: f_1 [2)] fine, mixed: f_{10} [3)]				coarse: f_2 fine, mixed: f_{NR}	
Quality of fine particles (D ≤ 0,125 mm)	g/kg	933-9	MB_F10; up to 5					
shape of coarse grains (d > 2 mm)	m.-%	933-3, -4	FI_{20} or SI_{20}					
Proportion of crushed grains in the mixture of coarse grains	m.-%	933-5	$C_{100/0}$	$C90_{/1}$			$C_{50/30}$	C_{NR}
Physical properties:								
Resistance of coarse grains to crushing	-	1097-2, Chapter 5	LA_{20}	LA_{25}	LA_{30}			LA_{40}
Resistance of coarse grains during polishing	-	1097-8	PSV_{50}	PSV_{50} [1)]	PSV_{30}	PSV_{NR}		
Resistance to wear	-	1097-1	M_{DE} NR – state the value				M_{DE} NR	
Water absorption in coarse grains [4)]	m.-%	1097-6, Paragraph 7	$WA_{24}1$					
Resistance of coarse grains (8/16mm) to freezing/melting	m.-%	1367-2	MS_{18}; up to 5			MS_{NR} – state the value		
Coating of coarse grains with bitumen binder	%	12697-11, Procedure A	at least 80					
Testing of “Sonnenbrand” basalt	m.-%	1367-3	SB and SB_{LA} – state the values					
Chemical properties:								
Stability of the slag volume	% by v.	1744-1	$V_{3,5}$					
Proportion of organic admixtures [5)]	m.-%	1744-1	$m_{LPC}0,5$					

1) Applies to mixtures of coarse grains (crushed aggregate); fine grains 0/2 mm (of sand) may be produced from a rock that complies with requirement PSV_{30}
2) For fraction of 2/4 mm category f_4 is required, while for fraction of 4/8 mm category f_2 is required
3) The required category for grain mixtures of an eruptive origin; sieving through a 0.063 sieve may amount to maximum 5m.-%
4) Applies to preliminary testing of the resistance of coarse grains to frost. Water absorption may be even larger if it is proven that the grains are resistant to frost effects.
5) This should be inspected in case of any doubts.

2.4.3.2.1.2.1 Geometrical properties

The requirements referring to the geometrical properties of aggregates for bituminous mixtures for asphalt courses define the requirements for:
- the composition of coarse stone grain mixtures,
- the proportion of particles smaller than 0.063 mm,
- the form of coarse grains, and
- the proportion of crushed grains in the mixture of coarse grains.

Composition of coarse stone grain mixtures

In specific applications, the aggregates may be made of one or several aggregate size fractions of stone grains and rock dust.

The fractions of stone grains should be marked by the lower (d) and upper (D) limiting (nominal) size of the side of the square opening on the sieve.

The limiting values of sieving for the composition of coarse aggregates for bituminous mixtures for asphalt courses are given in Table 2.4.3.2.2.

Table 2.4.3.2.2: Limiting values for the composition of coarse aggregates (D>2mm) for asphalt courses (testing pursuant to EN 933-1)

Size of the sides of the sieve opening (mm)	The size of opening on the upper limiting sieve D (mm) Residue after sieving (m.-%)						
	4	5 (5,6)	8	11 (11,2)	16	22 (22,4)	32 (31,5)
1,4 D	100	100	100	100	100	100	100
D	90 – 100	90 – 100	90 - 100	90 – 100	90 – 100	90 – 100	90 – 100
2	50 – 85	15 – 72	10 – 72	10 – 60	10 – 50	10 – 50	20 - 36
0,063	5 – 17	2 – 15	2 – 13	2 – 12	0 – 12	0 – 11	0 - 8

The basic requirements for the composition of foreign filler aggregate are given in Table 2.4.3.2.3.

Table 2.4.3.2.3: Basic requirements for the composition of foreign filler aggregate (testing pursuant to SIT EN 933-1)

The size of sides of the sieve opening (mm)	Absolute field for individual results Proportion after sieving (m.-%)
2	100
0.125	85 – 100
0.063	70 – 100

The proportion after sieving of the fine stone grain mixture (D ≤ 2 mm – category G_F85) should amount to:
- on 2D sieve 100 % by mass,
- on D sieve 85 to 99 % by mass.

Similar requirements for the composition of aggregates for characteristic types of bituminous mixtures for asphalt courses are defined in these technical conditions.

Proportion of particles smaller than 0.063 mm

The proportion of particles smaller than 0.063 mm should comply with the requirements given in Table 2.4.3.2.1.

If the proportion of fine particles in a natural mixture of sand grains amounts to 3% by mass to 10% by mass, it is necessary to check the proportion of the undesirable grains by fraction 0/012 mm pursuant to the procedure of EN 933-9. The methylene blue value (category MB_F10) should not exceed 4 g/kg.

If the proportion of fine particles in the sand grain mixture is higher than 10% by mass, the fine particles should comply with the requirements for fillers defined in EN 13043.

The proportion of fine particles in the sand grain mixture may exceed the said values if the sand equivalent determined pursuant to the procedure in EN 933-8 amounts to:
- at least SE_{50} in a natural sand grain mixture, and
- at least SE_{60} in crushed sand grain mixture.

Form of coarse grains

The form of coarse grains defined through testing pursuant to EN 933-4 should correspond to category SI_{20} in grain mixtures for asphalt courses.

Proportion of crushed grains in the mixture of coarse grains.

The proportion of crushed grains defined pursuant to EN 933-5 for bituminous mixtures for asphalt courses on roads should be in compliance with the requirements defined in Table 2.4.3.2.1.

If the resistance of the bituminous mixture to the formation of ruts, checked through testing of the initial composition, is suitable for the planned traffic load, the proportion of rounded grains in the aggregate for heavy and medium traffic load may amount to a maximum 5 % by mass.

2.4.3.2.1.2.2 Physical properties

Physical properties of coarse aggregates (d>2mm) for bituminous mixtures for asphalt courses should be in compliance with the common regulations referring to:
- resistance to crushing,
- resistance of bituminous wearing courses to smoothing,
- resistance to wear,
- resistance to frost (water absorption),
- resistance to freezing/melting, and
- coating with bituminous binder.

Resistance of coarse grains to crushing

The requirements referring to the resistance of coarse grains to crushing are defined by various conditions of use as well as by the technical and economic aspects. Primarily the following should be taken into account:
- traffic conditions,
- locally available sources of aggregates, and
- composition of bituminous mixtures.

The values of resistance of coarse grains to crushing (with the value of the Los Angeles coefficient) for asphalt courses are given in Table 2.4.3.2.1.

Resistance of coarse grains for bituminous wearing courses to smoothing

Resistance to the smoothing of coarse grains in bituminous mixtures placed in the bituminous wearing courses should correspond to the categories given in Table 2.4.3.2.1.

If preliminary tests prove the appropriate friction capacity of the bituminous mixture placed in the asphalt course, the value of coefficient PSV for the specific traffic load or the planned traffic density may be even lower than the limiting values given in Table 2.4.3.2.1.

Resistance to wear

The requirement referring to the resistance of coarse grains to wear in bituminous mixtures of asphalt wearing courses is not defined. If there is a requirement for testing the defined value should be stated.

Until a sufficient number of testing results have been acquired, the values of coefficient M_{DE} should remain solely as informative.

Resistance to frost (water absorption)

Water absorption of the coarse grains in bituminous mixtures for asphalt courses - as the preliminary testing of the resistance to frost - should not exceed 1% by mass (category $WA_{24}1$).

The testing procedure for water absorption is defined in EN 1097-6, Items 8 and 9.

Resistance to freezing/melting

Resistance to freezing/melting of the aggregates in bituminous mixtures for asphalt courses should be tested using a procedure with magnesium sulphate, which is defined in EN 1367-2.

Coating of coarse grains with bitumen binder

Coating of coarse stone grains with bitumen B100/150, tested through the procedure defined in EN 12679-11, should amount to at least 80 % of the bituminous mixtures of asphalt courses.

If coarse aggregates are used in a bituminous mixture with polymer bitumen it is necessary to test the coating with bitumen B100/150 using a defined procedure.

Technical regulations occasionally give additional requirements for the following physical properties of coarse aggregates and fillers for bituminous mixtures of asphalt courses:

Resistance to heat

If the mineralogical composition of the aggregates includes flint, it is necessary to test the resistance of the coarse grains to heat; and should be performed pursuant to EN 1367-5, and the results of the tests should be stated (category HR_{NR}).

Proportion of water in the filler

Through the testing defined in EN 1097-5 it is necessary to check the proportion of water in the filler; that should not exceed 1% by mass.

The content of voids in compressed dry filler

The content of voids in the compressed dry filler defined by testing pursuant to Rigden, given in EN 1097-4, should correspond to category $V_{28/38}$ for bituminous mixtures of asphalt courses.

Filler softening point “Delta ring-ball”

The hardening of bitumen, determined by the testing of the increase of the filler softening point by the procedure “Delta ring-ball” pursuant to EN 13179-1, should correspond to category $\Delta_{R\&B}8/25$.

Testing of “Sonnenbrand” basalt

In case that a grain mixture of basalt rock is used, for a hot bituminous mixtures it is necessary to perform the "Sonnenbrand" testing according to the procedure defined in EN 1367-3.

The defined resistance value should be stated (as a rule, the Los Angeles coefficient increased by ≤ 8%).

2.4.3.2.1.2.3 Chemical properties

The requirements referring to the chemical properties of aggregates for bituminous mixtures of asphalt courses define the conditions for:
- proportion of coarse organic mixtures in the natural grain mixtures and
- stability of the volume of slag grains,

and occasionally for:
- sensitivity of the filler to water and
- resistance of slug grains to leaching.

Proportion of organic admixtures

The proportion of coarse particles of organic mixtures in natural mixtures of grains larger than 2 mm should be determined through testing defined in EN 1744-1, Item 14.2. It should correspond to category $m_{LPC0,5}$.

Stability of the volume of slag grains

Stability of the volume of slag grains for bituminous mixtures of asphalt courses should be checked by testing pursuant to EN 1744-1, and should correspond to category $V_{3,5}$.

Sensitivity of the filler to water

If an inspection of the sensitivity of the filler for bituminous mixtures to water is required, it is necessary to perform the testing pursuant to EN 1744-2 and state the result of the tests.

Resistance of slug grains to leaching

The resistance of slug grains to leaching should be in compliance with the requirements stipulated by the applicable legal regulations.

2.4.3.2.2 Bituminous binders

2.4.3.2.2.1 Types of bituminous binders

The following may be used as binders for bituminous mixtures of asphalt layers:
- standardized bitumen for road construction,
- bitumen for road construction modified by polymers (primarily on SBS basis) or crumb rubber (polymer or rubber bitumen)
- bituminous emulsions,
- combined bituminous binders, and
- natural asphalt.

2.4.3.2.2.2 Quality of bituminous binders

The properties of bituminous binders for bituminous mixtures of asphalt courses are defined:
- for standardized bitumen for road construction, with the penetration of 20 to 300 mm/10, in EB 12591,
- for polymer bitumen, in EN 14023,
- for cationic bituminous emulsions, in EN 13808, and
- for natural asphalt, in EN 13108-4:2005, Appendix B.

When selecting the type of bituminous binder it is necessary to take into account primarily the traffic loads, climate and microclimate conditions, the location of the installation of the bituminous mixture (slopes, crawler lanes, interchanges), the resistance of the bituminous binder to thermal loads in the

process of production, transport and installation, as along with the distance between the construction site and the facility for the production of bituminous mixtures.

The requirements that refer to the properties of bituminous binders, including the testing procedures, are defined:
- for standardized bitumen for road construction, in Table 2.4.3.2.4,
- for polymer bitumen, in Tables 2.4.3.2.5 and 2.4.3.2.6,
- for rubber bitumen, in Tables 2.4.3.2.7, and
- for cationic bituminous emulsions, in Table 2.4.3.2.8.

The recommended types of bituminous binders in terms of the characteristics of use are given in Table 2.4.3.2.9.

The properties of bituminous binders should be in compliance with the defined properties for the selected type of bitumen for road construction, polymer or rubber bitumen.

The proportion of the crumb rubber in rubber bitumen should be at least 15 % by mass. Due to the stability of rubber bitumen, the storage (in appropriate conditions) is limited to a maximum of 2 days. It is recommended to store rubber bitumen only within a 24-hour period at a temperature of 175 °C.

Table 2.4.3.2.4: Requirements for the properties of standardized bitumen for road construction (pursuant to EN 12591)

Properties	Testing procedure	Unit of measure	Bitumen type					
			20/30	35/50	50/70	70/100	100/150	160/220
Penetration at 25°C	EN 1426	0.1 mm	20 - 30	35 - 50	50 - 70	70 -100	100 - 150	160 - 220
Softening point	EN 1427	°C	55 - 63	50 - 58	46 - 54	43 - 51	39 - 47	35 - 43
Resistance to hardening at 163°C:	EN 12607- 1							
- preserved penetration value		%	≥ 55	≥ 53	≥ 50	≥ 46	≥ 43	≥ 37
- increase of the softening point, maximum – requirement 1 or - increase of the softening point, maximum – requirement 2		°C °C	≤ 8 ≤ 10	≤ 8 ≤ 11	≤ 9 ≤ 11	≤ 9 ≤ 11	≤ 10 ≤ 12	≤ 11 ≤ 12
Fire point	EN ISO 2592	°C	≥ 240	≥ 240	≥ 230	≥ 230	≥ 230	≥ 220
Solubility	EN 12592	%	≥ 99.0	≥ 99.0	≥ 99.0	≥ 99.0	≥ 99.0	≥ 99.0
Mass change by RTFOT	EN 12607-1	%	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.8	≤ 0.8	≤ 1.0
Special national requirements: - Penetration index	EN 12591 Appendix B		- 1.5 to +.,7	- 1.5 to +0.7	- 1.5 to +0.7	- 1.5 to +0.7	- 1.5 to +0.7	- 1.5 to +0.7
- Kinematic viscosity at 135°C	EN 12595	mm^2/s	≥ 530	≥ 370	≥ 295	≥ 230	≥ 175	≥ 135
- Dynamic viscosity at 60°C	EN 12596	Pa.s	≥ 440	≥ 225	≥ 145	≥ 90	≥ 55	≥ 30
- The Frass breaking point	EN 12593	°C	-	≤ - 5	≤ -8	≤- 10	≤ - 12	≤ - 15

Table 2.4.3.2.5: Basic requirements for properties of bitumen modified by polymers (pursuant to EN 14023)

Basic requirements	Properties	Testing procedure	Unit of measure	Bitumen type					
				PmB 10/40-60	PmB 25/55-65	PmB 45/80-50	PmB 45/80-65	PmB 90/150-45	PmB 10/40-80
Consistency at the medium use temperature	Penetration at 25 °C	EN 1426	0.1 mm	10 – 40	25 – 55	45 – 80	45 – 80	90 - 150	10 - 40
Consistency at the increased use temperature	Softening point	EN 1427	°C	≥ 60	≥ 65	≥ 50	≥ 65	≥ 45	≥ 80
Cohesion	Ductility with	EN 13703	J/cm^2	≥ 2	≥ 3	≥ 3	≥ 3	≥ 2	≥ 2
	force measurement	EN 13589	J/cm^2	at 10 °C	at 5 °C	at 5 °C	at 5 °C	at 5 °C	at 5 °C
	Tensile strength at 25 °C or	EN 13703 EN 13589	J/cm^2	not specified					
	Vialit pendulum	EN 13566	J/cm^2	not specified					
Durability (resistance to hardening pursuant to EN 12607-3)	Mass change	EN 12607-1 or 12607-3	%	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.3
	Preserved penetration value	EN 1426	%	≥ 60	≥ 60	≥ 60	≥ 60	≥ 50	≥ 35
	Increase if the softening point	EN 1427	°C		not specified				
Other properties	Fire point	EN ISO 2592	°C	≥ 250	≥ 250	≥ 250	≥ 250	≥ 235	≥ 250

Table 2.4.3.2.6: Additional requirements for properties of common bitumen modified by polymers (pursuant to EN 14023)

Additional requirements for properties	Testing procedure	Unit of measure	Bitumen type					
			PmB 10/40-60	PmB 25/55-65	PmB 45/80-50	PmB 45/80-65	PmB 90/150-45	PmB 10/40-80
The Frass breaking point	EN 12593	°C	≤ -7	≤ -12	≤ -15	≤ -18	≤ -18	≤ 0
Elastic back deformation at 25 °C	EN 13398	%	≥ 50	≥ 70	≥ 60	≥ 80	≥ 70	≥ 80
Elastic back deformation at 10 °C	EN 13398	%		not specified				
The range of plasticity	-	°C		not specified				
Storage stability - the difference in softening points	EN 13399 EN 1427	°C	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 9
Storage stability – the difference in penetration	EN 13399 EN 1426	0.1 mm	not specified					
Modification of the softening point pursuant to EN 12607-1/-3	EN 1427	°C	not specified					
Elastic back deformation at 25 °C pursuant to EN 12607-1/-3	EN 13398	%	≥ 50	≥ 60	≥ 60	≥ 70	≥ 70	≥ 70
Elastic back deformation at 10 °C pursuant to EN 12607-1/-3	EN 13398	%		not specified				

Table 2.4.3.2.7: Requirements for properties of bitumen modified by crumb rubber (RmB)

Properties	Testing procedure	Unit of measure	Required value
Penetration at 25 °C	EN 1426	mm/10	25 – 100
at 4 °C		mm/10	15 - 25
Softening point	EN 1427	°C	≥ 54
Elasticity at 25 °C	EN 13880-3	%	≥ 20
Dynamic viscosity at 175 °C	EN 12596	mPa.s	1500 - 5000

Table 2.4.3.2.8: Requirements for the properties of cationic bituminous emulsions (pursuant to EN 13808)

Properties	Testing procedure	Unit of measure	Type of bituminous emulsion 3	4	5	6
Stability	EN 13075-1	-	50 -100	70 -130	120 - 180	170 up to 230
Stability with concrete	EN 12848	g	≥ 2	-	-	-
Time of fine particle mixing	EN 13075-2	s	≥ 300	-	-	-
Proportion of binder (with water)	EN 1428	m.-%	48 - 52	53 - 57	58 - 62	63 - 67
Proportion of binder (with distillation)	EN 1431	m.-%	≥ 48	≥ 53	≥ 58	≥ 63
Ratio of oil component	EN 1431	m.-%	≤ 3,0	≤ 5,0	≤ 8,0	≤ 10,0
Flow out time, 2 mm, 40 °C	EN 12846	s	15 - 45	35 - 80	70 - 130	-
Flow out time, 4 mm, 40 °C	EN 12846	s	-	-	-	10 - 45
Residue in sieve: - 0,5 mm - 0.16 mm	EN 1429	 m.-% m.-%	 ≤ 0.2 ≤ 0.5	 ≤ 0.5 -	 - -	 - -
Residue in sieve 0,5 mm (after 7 days of storage)	EN 1429	m.-%	≤ 0.2	≤ 0.5	-	-
Settlement (7 days of storage)	EN 12847	m.-%	≤ 10	-	-	-
Adhesiveness	EN 13614	% of surface	≥ 90	-	-	-

Table 2.4.3.2.9: Recommendation for the use of bituminous binders for bituminous mixtures of asphalt courses

Characteristics of use		Type of bitumen for road construction						Type of polymer bitumen				
		20/30	35/50	50/70	70/100	100/150	160/220	10/40-60	25/55-65	45/80-50	45/80-65	90/150-45
Type of bituminous mixture	AC surf	-	+	+	+	+	+	-	-	+	+	+
	AC bin	-	+	+	+	-	-	-	+	+	+	-
	AC base	+	+	+	+	-	-	+	+	+	+	-
	SMA	-	-	+	+	+	-	-	-	+	+	-
	PA	-	-	-	-	-	-	-	-	-	+	+
Traffic load class (AADL)	IT (extremely heavy)	+	+	+	-	-	-	+	+	+	+	-
	VT (very heavy)	+	+	+	-	-	-	+	+	+	+	-
	T (heavy)	-	+	+	-	-	-	+	+	+	+	+
	S (medium)	-	-	+	+	-	-	+	+	+	+	+
	L (light)	-	-	+	+	+	+	-	-	+	-	+
	VL (very light)	-	-	+	+	+	+	-	-	+	-	+
Traffic volume (AADT)	> 20.000	+	+	+	-	-	-	+	+	-	+	-
	10.000 - 20.000	+	+	+	-	-	-	-	+	+	+	-
	5.000 - 10.000	-	+	+	+	-	-	-	-	+	+	+
Traffic speed	S (slow) [1)]	+	+	-	-	-	-	+	+	-	+	-
	B (fast)	-	-	+	+	+	+	-	-	+	+	+
Climate	M (Mediterranean)	+	+	+	+	-	-	+	+	+	+	-
	C (Continental)	-	-	+	+	+	+	-	-	+	+	+

[1)] ≤ 35 km/h

2.4.3.2.3 Admixtures

The use of the appropriate types and quality of admixtures to bituminous binder by

- the improvement of the adhesiveness between the binder and stone grains,
- increasing the resistance of the bituminous binder to oxidation or ageing,
- reducing the temperature during the manufacture of bituminous mixtures, and
- increasing the thickness of the bituminous binder film on stone grains and consequently increasing the durability of the bituminous mixtures in the asphalt wearing courses, and
- reducing the noise of the asphalt wearing courses,

It is possible to ensure the required properties in special conditions.

The quantity of the stabilizing admixtures for bituminous binders (primarily mineral fibres in granules) and other admixtures in bituminous mixtures for the observed wearing courses should ensure the required properties.

The requirements for the grading of the crumb rubber are dependent on the means of production, i.e. by crushing of old (worn) tyres or by grinding in tyre manufacturing, in Table 2.4.3.2.10.

Table 2.4.3.2.10: Requirements for grading of crumb rubber

Sieves ISO 525		Sieves EN		Sieves ASTM		Sieves EN	
side	residue after sieving	side	residue after sieving	side	residue after sieving	side	residue after sieving
mm	m.-%	mm	m.-%	mm	m.-%	mm	m.-%
0,075	0 – 5	0.063	0 – 5	0.075	0 – 5	0.063	0 – 5
0,250	5 – 25	0.125	2 – 10	0.150	0 – 10	0.125	0 – 10
0,425	45 – 70	0.250	5 – 25	0.300	0 – 45	0.250	0 – 35
0,600	85 – 100	0.500	65 – 85	0.600	25 – 85	0.500	15 – 70
0,850	95 – 100	0.710	90 – 100	1.180	70 – 100	0.710	35 – 90
1,180	100	1.000	100	2.000	100	1.000	55 – 100
-	-	-	-	-	-	2.000	100

Crumb rubber produced from tyres may contain the following impurities:
- up to 0.5 % by mass of fabric and
- up to 0.01 % by mass of stainless metals.

The specific mass of rubber should amount to 1.15 ± 0.10 g/cm^3.

During the use of admixtures the guidelines and informative quantities given by the admixture manufacturer should be observed.

2.4.3.2.4 Asphalt granulate

The various different types and quality of bituminous mixtures installed in the existing asphalt courses require different types and quality of asphalt granulate, which should be known in detail for the reuse in the production of new bituminous mixtures.

The qualities of stone grains in the asphalt granulate planned for reuse should basically be in compliance with the requirements defined in Item 2.4.3.2.1.2.

Grading of the asphalt granulate to be reused in production of bituminous mixtures for asphalt courses should be in compliance with:
- category $DRA_{80/8}$ or $DRA_{110/11}$ for wearing courses and
- category $DRA_{160/16}$, $DRA_{220/22}$ or $DRA_{320/32}$, for road base,

depending on the grading of the planned new bituminous mixture.

The detailed requirements for testing of the asphalt granulate grading and the proportion in the new produced bituminous mixture for asphalt courses are defined in EN 13108-8.

Asphalt granulate may contain only a bituminous binder that meets the requirements defined in Item 2.4.3.2.2.2

The quantity of the bituminous binder in the asphalt granulate obtained with the use of procedure defined in EN 12697-3 or EN 12697-4 should be determined pursuant to the requirements given in EN 12697-1 and classified into the appropriate bitumen type B.

The ratio of impurities in the asphalt granulate determined by testing pursuant to EN 12697-42 should correspond to
- for wearing courses: category F1, and
- for road base: category F5 or F_{dec}.

2.4.3.3 Manner of Execution

The bases for execution of works within bituminous bound courses of the aggregate should be defined:
- in a technological report and
- proven by the installation of bituminous mixtures.

The following types of bituminous mixtures are commonly used for asphalt courses:
- for the asphalt lower base:
  - bituminous aggregate – AC base, stab
- for the asphalt upper base:
  - bituminous crushed stone (gravel) – AC base
- for the asphalt binder course:
  - bituminous crushed stone – AC bin
- for the asphalt wearing course:
  - asphalt concrete - AC surf
  - skeletal mastic asphalt (of standardized and porous composition, or a composition intended for low noise) - SMA
  - drainage asphalt (of standardized and open composition) - PA
  - poured asphalt - MA
  - thin-layer dressing - SS
  - surface dressing – SD.

The area of application of the said bituminous mixtures and the limiting (technologically conditioned) design thickness of the asphalt courses are defined in detail within the dressing of bituminous bound courses.

2.4.3.3.1 Technological information

Not later than 14 days prior to the commencement of the bituminous mixture installation in the asphalt course, the contractor should submit to the supervising engineer for approval its technological information that should be prepared pursuant to the requirements defined in Item 1.4.2 of the general technical conditions.

The technological information should include the following prescribed documents on the product:
- production control certificate with an enclosure
- declaration of conformity with the CE information
- a report on the stability testing of the bituminous mixture for the wearing course during heavy traffic loads at low temperatures
- a report on the preliminary tests (at the request of the supervising engineer).

Depending on the scope of the planned activities, the supervising engineer may allow a deviation from the given requirements.

2.4.3.3.1.1 Technological procedures during the execution of works

The contractor should provide in the technological information a detailed description of individual stages of activities depending on the technological procedure.

2.4.3.3.1.2 Information on machinery

The contractor should provide the basic data on the machines, transportation means and equipment (type, source, capacity) to be used for the execution of asphalt courses of bituminous mixtures.

Prior to the commencement of the operation of the machines and equipment affecting the quality of works, it is necessary to check their suitability to ensure their uniform quality in compliance with the requirements of the applicable technical conditions.

All the equipment and machines to be involved in the technological procedure of placement of bituminous mixtures in the asphalt course should be tested and their capacity should meet the requirements stipulated by the project documents and technical conditions.

2.4.3.3.1.3 Program of average control frequency

The contractor should enclose with the technological information a program of the average frequency of internal controls, which should be prepared on the basis of the defined minimum frequency of testing in accordance with these technical conditions. When the supervising engineer confirms the program, the frequency of testing should be defined.

2.4.3.3.1.4 Information on the staff and responsible workers in the project

For a timely inspection of qualifications the contractor should submit a detailed list of responsible and expert workers at the construction site.

2.4.3.3.2 Proving installation of bituminous mixtures

2.4.3.3.2.1 General

Bituminous mixtures for asphalt courses should be manufactured by a hot procedure. The mixing temperature of bituminous mixtures depends on the type of binder used. The recommended and limiting temperatures of bituminous mixtures in production are given in Table 2.4.3.3.1. In exceptional cases, the highest temperature of the bituminous mixture may be up to 10 °C higher than the given value.

As a rule, in the production of bituminous mixtures it is necessary to use feeding mixing devices, where accurate measurements of the quantity of fractions of rock dust and hot stone grains, bituminous binder and all admixtures used (doping admixtures, stabilizers, etc.), should be ensured by weighing. The bituminous binder may also be measured by volume, where it is necessary to take into account the change of volume (and thus mass by volume) with temperature.

Table 2.4.3.3.1 Temperature of the produced bituminous mixture depending on the type of bituminous binder used

Bitumen type	Temperature of the produced bituminous mixture (°C)	
	recommended	maximum
B 160/220	140 ± 10	165
B100/150	145 ± 10	170
B 70/100	150 ± 10	175
B 50/70	160 ± 10	180
B 35/50	170 ± 10	190
PmB	according to manufacturer's instructions PmB	
RmB	165	175

The mixing time and other impacts on the quality of grain coating with the binder, i.e. on binder distribution in the mixture, should be adjusted so as to ensure a uniform bituminous mixture. If polymer bitumen is used it is necessary to follow consistently the instructions of the binder manufacturer, where special attention should be paid to the maximum allowable temperature (to avoid binder overheating).

During production and storage, the substance for the prevention of the bituminous mixture sticking to metal should be used to the least possible extent.

The production capacities of mixing devices, transportation means and machinery used for installation should be mutually harmonized.

If the contractor fails to submit the appropriate evidence, at the request of the supervising engineer he should prove the suitability of

- transportation to the construction site and
- placement of bituminous mixture.

The proving installation tests should:

- determine the suitability of the installing equipment pursuant to the requirements under these technical conditions,
- take in the location of installation two samples of the hot bituminous mixture for complete testing,
- take two cores in the place of bituminous mixture sampling,
- calibrate the selected density meter for the selected type of bituminous mixture, and
- measure the density of the installed bituminous mixture by the use of a non-destructive procedure.

Control samples of the bituminous mixture should show the conformity with the manufacturer's declaration and:

- that the composition of the extracted aggregate is within the range of allowed tolerance given in Table 2.4.3.3.2,
- that the quantity of extracted bitumen is in the range of ± 0.5 m.-% of t quantity in the initial composition of bituminous mixtures.
- that the minimum quantity of extracted bitumen in bituminous mixtures of skeletal mastic asphalt and drainage asphalt is in compliance with the provisions in EN 13105-5 and 13108-7; due to deviations in determining the proportion of extracted bitumen additional tolerance amounts to ± 0,2 m.-% (limiting value), i.e. - 0,3 m.-% (ultimate limiting value).

Table 2.4.3.3.2: Tolerance of aggregate composition in samples for control testing in relation to the values in the initial composition

Grain size	Individual samples Tolerance of the ratio upon sieving			Average of four samples Tolerance of the ratio upon sieving and initial composition		
	Fine-grained mixtures D < 16 mm	Coarse-grained mixtures D ≥ 16 mm	Poored asphalt D < 16 mm	Fine-grained mixtures D < 16 mm	Coarse-grained mixtures D ≥ 16 mm	Poored asphalt D < 16 mm
	m.-%					
D	-8 +5	-9 +5	-8 +5	±4	±5	±4
D/2 or characteristic coarse sieve	±7	±9	±8	±4	±4	±4
2 mm	±6	±7	±8	±3	±3	±3
0.063 mm	±2	±3	±4	±1	±2	±2

The limiting values of mechanical and spatial properties of the bituminous mixtures in asphalt courses are defined by the technical conditions for individual types of bituminous mixtures.

The properties of the extracted standard bitumen for road construction may change in relation to the type used

- at the softening point by maximum 10 °C and
- in penetration – up to 60 %.

When using bitumen for road construction B 20/30, the softening point of the extracted bitumen pursuant to PK may change by up to 74 °C, and when using polymer bitumen, by a

maximum of 10 °C in relation to the softening point of the delivered polymer bitumen.

Tests of the installation should be repeated upon each change of the basic material and/or composition of the bituminous mixture, as stipulated by EN 13108-20.

Tests of the installation should be executed in the location of the construction site where, pursuant to the project documents, the installation of bituminous mixture is of the same type as planned. If it is not possible, the pilot section should be executed by the same installing machinery at another construction site.

The bituminous mixture should be placed in the planned layer thickness. On the pilot section it is necessary to take at least 5 cores from the installed course and carry out at least 20 measurements of density of the installed bituminous mixture using of a non-destructive procedure (e.g. isotopic gauge). Calibration of the equipment for internal and independent control testing should be carried out by measuring the density on the installed courses in locations where the cores are taken, prior to their taking.

Tests of the installation should be repeated upon each change of the machinery for bituminous mixture installation.

If the contractor has already constructed an asphalt bearing or wearing course in similar conditions with the use of the same bituminous mixture, the test results may be deemed as the initial production and installation. This is decided by the supervising engineer.

For roads with heavy traffic loads, prior to the commencement of works it is necessary to test the bituminous mixtures resistance to the formation of ruts in compliance with the procedure defined in EN 12697-22. Category WTS_{AIR}, i.e. PRD_{AIR}, defined in EN 13108, should be determined depending on the traffic load defined on the basis of traffic data, and planned traffic load in the project documents. For bituminous mixtures for the upper road base, in the given conditions of application it is recommended to inspect its resistance to compaction as well.

The significant features and procedures for the testing of the bituminous mixture composition for asphalt courses are given in Table 2.4.3.3.3.

Table 2.4.3.3.3: Testing of the installed bituminous mixtures

Bituminous mixture type	Quality standard EN	Bituminous mixture property	Testing procedure
AC surf, AC bin, AC base, AC base stab, SMA, MA, PA, SS, SD	13108-1,-5,-6,-7	percentage of binder	EN 12697-1
AC surf, AC bin, AC base, AC base stab, SMA, MA, PA, SS, SD	13108-1,-5,-6,-7	grading	EN 12697-2
AC surf, AC bin, AC base, AC base stab, SMA, PA, SS	13108-1,-5,-7	content of voids content of voids in grain mixture content of binder in voids	EN 12697-8, EN 12697-6, EN 12697-5
AC surf, AC bin, AC base, SMA	13108-1,-5	resistance to permanent deformations (wheel tracking)	EN 12697-22
AC surf, AC bin, AC base, SMA, PA	13108-1,-5,-7	sensitivity to water	EN 12697-12
SMA, PA	13108-5, -7	outflowing of binder	EN 12697-18
AC surf, SMA, PA, SD	13108-1, -5, -7	asphalt sticking to grains	EN 12697-11
PA	13108-7	permeability	EN 12697-19
PA	13108-7	loss of particles	EN 12697-17
MA	13108-6	indentation depth	EN 12697-20

If any changes occur during the manufacture or installation of the bituminous mixtures in asphalt courses, the contractor should submit to the supervising engineer a proposal of

changes in writing. A change may be implemented only upon the approval of the supervising engineer.

2.4.3.3.2.2 Transport of bituminous mixtures

To transport bituminous mixture an appropriate vehicle should be used – tippers, equipped for unloading (onto a paver) and with the appropriate protection of the bituminous mixture from rainfalls, cooling and pollution. The inner surface (sides and bottom) of the metal shipping containers of freight vehicles should prior to loading of the bituminous mixture be sprayed with a substance for the prevention of sticking (based on soap, vegetable oil or other non-solvents) that has no harmful effects on the bituminous mixture.

The number of vehicles for the bituminous mixture transport to the construction site should be – in compliance with the transport route – adjusted to the conditions for the uniform placement.

The transport of hot bituminous mixtures is, as a rule, limited to a maximum distance of 100 km and a maximum travel time of 2 hours, provided that a vehicle with thermal shipping container is used for the transport. Otherwise, the distance for transport of an adequately protected hot bituminous mixture is limited to 70 km with a maximum travel time of 1.5 hours.

Even for shorter transport that takes less time, the bituminous mixture should be protected in an appropriate manner. For the method of transport of a hot bituminous mixture to the construction site the contractor should obtain the consent of the supervising engineer.

2.4.3.3.2.3 Substrate Preparation

The placement of a bituminous mixture for asphalt course onto an appropriately prepared high plain of the bituminous substrate, which should not be dusty or wet, may start only upon the approval of the supervising engineer.

All unbound material should be removed from the pealed substrate surface.

The high plain of the asphalt course substrate should be flat. The tolerance of the substrate high plain below a 4 m long measuring lath may (in an arbitrary direction) have the following values in upgrades:

- with asphalt wearing course up to 10 mm
- with asphalt binder or upper bearing course up to 15 mm
- with asphalt lower bearing course up to 20 mm

The flatness measurement procedure is defined in guidelines SRMG, Item 3.1.3.1, i.e. in EN 13036-7.

If a larger deviation is determined and/or other deficiencies are noticed, such deficiencies should be eliminated prior to the upgrade with the asphalt course.

To ensure the adherence of the layers (except for two-layer drainage asphalt) the substrate should be sprayed with a bituminous emulsion. The quantity of the spraying emulsion depends on the substrate condition and it should be adjusted to each individual condition. TheiInformative quantity of the spraying emulsion amounts to 0.3 to 0.5 kg/m^2. When using polymer bitumen for bituminous mixture, the emulsion of the polymer bitumen should be used for spraying as well. If the substrate for drainage asphalt is a permeable course, to seal the substrate surface it should be sprayed with

- polymer bitumen 1.0 to 1.5 kg/m^2
- polymer bituminous emulsion 1.5 to 2.2 kg/m^2

The sprayed substrate for drainage asphalt should be spread with rock dust or uncoated or minimally coated crushed aggregate grains,

- fractions of 4/8 mm in the quantity of 5 to 8 kg/m^2 or
- fractions of 8/11 mm in the quantity of 7 to 10 kg/m^2

which should be lightly pressed into the substrate by the use of a roller. Prior to installation of the drainage asphalt course it is necessary to remove the surplus crushed aggregate spread.

Substrate spraying should be carried out mechanically and in a timely manner to ensure that the water, i.e. the substance for bitumen dilution has evaporated prior to the commencement of the bituminous mixture installation. - In exceptional cases, manual spraying can be approved by the supervising engineer.

The substrate for the wearing course of poured asphalt may not be sprayed.

Substrate spraying is not necessary if the asphalt course is placed directly on the substrate layer, bound or protected by bituminous binder, on which there has been no traffic. This is to be decided by the supervising engineer.

The height (grade level) of the individual measuring points on the substrate high plain should be determined by levelling. To ensure the conditions for adequate drainage in the area of the pavement distortion, the density of the measuring points should be adequately increased. At an arbitrary point the high plain may not deviate from the design elevation by more than ± 10 mm.

The permitted deviations of slope are defined by the permitted irregularities and deviations from the high plain height, but they should not exceed ± 0.4 % of the absolute inclination value.

The placement of a bituminous mixture for asphalt course onto an appropriately prepared substrate high plain, which should not be dusty or wet, may start only upon the approval of the supervising engineer.

2.4.3.3.2.4 Placement of bituminous mixture

As a rule, the placement of the bituminous mixture should be mechanical with a spreader (paver) that in addition to spreading also partially compresses the bituminous mixture. The coefficient of compaction to be achieved by the bituminous mixture spreader (paver) amounts to at least 85% of the reference density of the laboratory tested sample. Deviations from this requirement should be approved by the supervising engineer.

The spreader (paver) should ensure a uniform composition of the spread bituminous mixture.

Manual bituminous mixture placement is permitted in exceptional cases if the use of machines is not possible due to limited space. Manual placement should be approved by the supervising engineer.

The bituminous mixture may be installed only in adequate weather conditions. The adequate temperature of air and substrate for placement of bituminous mixtures is:
- for wearing courses, at least 3 °C,
- for asphalt bearing courses, at least 0 °C , and
- for wearing courses made of rubber bituminous mixtures, at least 12 °C.

With the consent of the supervising engineer, a bituminous mixture may be placed on a dry and frozen substrate, when there is no wind and at lower temperatures, if the thickness of the asphalt course is in the upper range of the technological thickness for the used mixture grading. The recommended and the minimum temperature of the bituminous mixture in the location of installation in relation to the type of binder used for production are defined in Table 2.4.3.3.4.

The hot bituminous mixture temperature should be measured in accordance with EN 12697-13.

Table 2.4.3.3.4: The recommended and lowest temperature of bituminous mixture during placement

Bitumen type	Recommended temperature of bituminous mixture during placement (°C)	Minimum temperature of bituminous mixture behind the installation machine (°C)
B 160/220 B100/150 B 70/100 B 50/70 B 35/50	135 140 145 155 165	110 115 120 130 140
PmB	according to manufacturer's instructions PmB	
RmB	165	140

The maximum temperature of the bituminous mixture during placement may be up to 20 °C higher than that recommended, except in rubber bitumen application, where it may be

up to 10 °C higher than the recommended temperature.

During manual placement and compression in windy and cold weather, the lowest temperature of bituminous mixture should be 10 °C higher than the required bottom limiting value for the specific binder type.

If permitted by working conditions, the bituminous mixture should be installed in the asphalt course immediately along the entire pavement width. If several overlapping pavers are used for placement, the difference in the quality of the installed bituminous mixture at the point of contact should not be noticeable.

During the installation of bituminous mixtures, at longitudinal joints, as a rule, should overlap with the joints in the substrate layer by 20 cm, and at least 10 cm, while the transverse (cold) joints should overlap by at least 50 cm.

The installed strips of bituminous mixtures should be connected in the longitudinal direction with a hot procedure. If this is not possible, the joint of the previously installed strip should be heated indirectly, or a pouring mixture (also in the form of tape) or bitumen paste should be used for the connection. Otherwise an adhesive mixture is used for connection, during the execution of longitudinal and transverse joints the surfaces of the cooled course should be covered with a bituminous emulsion of at least 0.5 kg/m^2. Additionally, the 15 cm wide belt at the connection point should be coated and spread with sand if needed.

Each interruption of activities should be carried out along the entire width of the pavement or a traffic lane, perpendicularly to the road centre line and vertically, and uniformly coated with the bituminous binder. Deviations from this are possible only with the approval of the supervising engineer.

For compression of layers of different bituminous mixtures appropriate rollers (static, vibrating, rubber-wheeled rollers, combined) of different weights may be used. The rollers should have a system installed for the spraying of wheels with water or other appropriate means to prevent bituminous mixture sticking to the wheels. The use of oil derivatives for spraying of wheels is not allowed.

The selected type and number of rollers, as well as the method of compression, should ensure the most uniform possible density, i.e. compaction of the bituminous mixture along the entire designed pavement width. The width of the substrate courses should thus be increased along the edges by the design layer thickness, unless it is already planned in the project documents (Figure 2.4.3.6.1).

The bituminous mixture should be compressed from the edge towards the centre of the course, and from the lower towards the upper edge, i.e. position of the course. Individual roller passages should always overlap by 15 to 20 cm. Any retention of the vehicle on the installed layer of hot bituminous mixture should be prevented, as along with sudden braking and acceleration of the roller and changing of rolling direction on the still uncompressed layer of hot bituminous mixture.

All places inaccessible for rollers should be compressed to the required density by other means that should be approved by the supervising engineer, who also determines the conditions for the use of such means.

2.4.3.3.2.5 Dressing of the asphalt course surface

On each layer of bituminous mixture, even if such pavement surface is only temporarily (a few days only) exposed to traffic, the contractor should ensure the conditions for safe traffic in all weather conditions.

This may be achieved through dressing the (closed) pavement surface by the mechanical spreading of stone grains of 1/2 mm (1.5 to 2 kg/m^2) or 2/4 mm (2 to 3 kg/m^2) on a partially compressed hot layer of bituminous mixture (with a minimum temperature of 110 °C).

Better adhesion of the spread stone grains on the surface of the installed asphalt course may be achieved by coating the grains for spreading with a bituminous binder (type 160/220, 100/150 or 70/100, approximately 1 m.-%).

While performing the remaining needed passages of the rollers for the conditioned compression of the installed bituminous mixture the spread stone grains should be secured and the appropriate friction capacity of the pavement surface should be ensured. To secure the spread stone grains static rollers with steel bandages should be used.

The supervising engineer should decide about spreading.

The traffic can be released on the installed asphalt course only after the bituminous mixture in the centre of the course cools to approximately 30 °C. The supervising engineer may also determine other conditions for traffic release (e.g. when a low-temperature bituminous mixture is used depending on the admixture).

2.4.3.3.3 Placement conditions

2.4.3.3.3.1 Asphalt concrete-base, stabilized

Table 2.4.3.3.5: The fields of use of bituminous mixtures produced by the hot procedure for asphalt concrete-base (stabilized), depending on average annual daily traffic load (AADL)

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture		
				AC 16 base, stab	AC 22 base, stab	AC 32 base, stab
- extremely heavy	> 3000	A1	Z4	-	+	+
- very heavy - heavy	> 800 to 3000 > 300 to 800	A2				
- medium	> 80 to 300	A3	Z5	+	+	+
- easy	> 30 to 80	A4	Z6	+	+	+
- very easy	≤ 30					

Table 2.4.3.3.6: Limiting design thickness of the bituminous mixture courses produced by the hot procedure for asphalt concrete-base (stabilized) courses

Design layer thickness	Unit of measure	Type of bituminous mixture		
		AC 16 base, stab	AC 22 base, stab	AC 32 base, stab
- minimum	mm	60	80	100
- maximum	mm	100	120	180

2.4.3.3.3.2 Asphalt concrete-base

Table 2.4.3.3.7: Fields of use of bituminous mixtures for asphalt concrete-base depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture		
				AC 16 base	AC 22 base	AC 32 base
- extremely heavy	> 3000	A1	Z4	-	+	+
- very heavy - heavy	> 800 to 3,000 > 300 to 800	A2	Z4	+	+	+
- medium	> 80 to 300	A3	Z5	+	+	+
- light - very light	>30 to 80 ≤ 30	A4	Z6	+	+	-

Table 2.4.3.3.8: Limiting design thickness of the bituminous mixture courses for asphalt concrete-base for new construction

Design layer thickness	Unit of measure	Type of bituminous mixture		
		AC 16 base	AC 22 base	AC 32 base
- minimum	mm	50	60	80
- maximum	mm	70	100	140

Table 2.4.3.3.9: Limiting design thickness of the bituminous mixture courses for asphalt concrete-base for works on existing roads

Design layer thickness	Unit of measure	Type of bituminous mixture		
		AC 16 base	AC 22 base	AC 32 base
- minimum	mm	40	50	70
- maximum	mm	70	100	140

2.4.3.3.3.3 Asphalt concrete-binder

Table 2.4.3.3.10: Fields of use of thebituminous mixtures for asphalt concrete-binders depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of stone grain mixture	Type of bituminous mixture	
				AC 16 bin	AC 22 bin
- extremely heavy	> 3000	A1	Z4	+	+
- very heavy	> 800 to 3000	A2	Z4	+	+
- heavy	> 300 to 800				

Table 2.4.3.3.11: Limiting design thickness of the bituminous mixture courses for asphalt concrete-binders

Design layer thickness	Unit of measure	Type of bituminous mixture	
		AC 16 bin	AC 22 bin
- minimum	mm	50	60
- maximum	mm	80	100

2.4.3.3.3.4 Asphalt wearing courses

2.4.3.3.3.4.1 Asphalt concrete-surface

Table 2.4.3.3.12: Fields of use of the bituminous mixtures of asphalt concrete-surface for asphalt wearing and bearing wearing courses depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture			
				AC 4 surf	AC 8 surf	AC 11 surf	AC 16[4] surf
- extremely heavy	> 3000	A1	Z1[1)2)]	-	-	+	-
- very heavy - heavy	> 800 to 3000 > 300 to 800	A2	Z1[2)]/Z2[1)]	-	+	+	-
- medium	> 80 to 300	A3	Z2[1)]	-	+	+	-
- easy	> 30 to 80	A4	Z2[3)]/Z3[1)]	+	+	+	+
- very easy	≤ 30						

[1)] For bituminous mixtures for protective layers the use of grain mixtures of class Z4 is allowed.
[2)] If a mixture of coarse slug grain is used , the use of a mixture of 0/2 mm grains of class Z2 is allowed.
[3)] A requirement for state roads
[4)] Bituminous mixtures for bearing wearing courses

Table 2.4.3.3.13: Fields of use of the bituminous mixtures of asphalt concrete-surface for asphalt wearing and bearing wearing courses depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture			
				AC 4 surf	AC 8 surf	AC 11 surf	AC 16[4] surf
- extremely heavy	> 20000	A1	Z1[1)2)]	-	-	+	-
- very heavy - heavy	> 1000 to 20000 > 5000 to 10000	A2	Z1[2)]/Z2[1)]	-	+	+	-
- medium	> 2000 to 5000	A3	Z2[1)]	-	+	+	-
- easy - very easy	> 1000 to 2000 ≤ 1000	A4	Z2[3)]/Z3[1)]	+	+	+	+
- walkways, cycling lanes	-	A5	Z3	+	+	+	-

[1)] For bituminous mixtures for protective layers the use of grain mixtures of class Z4 is allowed.
[2)] If a mixture of coarse slug grain is used , the use of a mixture of 0/2 mm grains of class Z2 is allowed.
[3)] A requirement for state roads
[4)] Bituminous mixtures for bearing wearing courses

Table 2.4.3.3.14: Limiting design thickness of the asphalt concrete-surface course for new construction

Design layer thickness	Unit of measure	Type of bituminous mixture			
		AC 4 surf	AC 8 surf	AC 11 surf	AC 16 1) surf
- minimum	mm	15	25	35	50
- maximum	mm	30	40	50	80

[1)] Bituminous mixtures for bearing wearing courses

Table 2.4.3.3.15: Limiting design thickness of asphalt concrete-surface courses for works on existing roads

Design layer thickness	Unit of measure	Type of bituminous mixture			
		AC 4 surf	AC 8 surf	AC 11 surf	AC 16 1) surf
- minimum	mm	20	25	30	40
- maximum	mm	30	40	50	80

[1] Bituminous mixtures for bearing wearing courses

2.4.3.3.3.4.2 Stone mastic asphalt

Table 2.4.3.3.16: Recommended fields of use of the bituminous mixtures of stone mastic asphalt for asphalt wearing courses depending on the average annual daily traffic load (AADL)

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture							
				SMA 8	SMA 8 ln	SMA 8 hg	SMA 8 gg	SMA 11	SMA 11ln	SMA 11 hg	SMA 11 gg
- extremely heavy	> 3000	A1	Z1[1]/Z2	+	+	+	+	+	+	+	+
- very heavy - heavy	> 800 to 3000 > 300 to 800	A2	Z2	+	+	+	+	+	+	+	+
- medium	> 80 to 300	A3	Z2	+	+	+	+	+	+	+	+
- easy - very easy	> 30 to 80 ≤ 30	A4	Z2[2]/Z3	+	+	+	+	+	+	-	-

[1] If a mixture of coarse slug grain is used , the use of a mixture of 0/2 mm grains of class Z2 is allowed.
[2] A requirement for state roads

Table 2.4.3.3.17: Fields of use of the bituminous mixtures of stone mastic asphalt for asphalt wearing coarses depending on the average annual daily traffic load (AADL)

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture							
				SMA 8	SMA 8 ln	SMA 8 hg	SMA 8 gg	SMA 11	SMA 11ln	SMA 11 hg	SMA 11 gg
- extremely heavy	> 20000	A1	Z1[1]/Z2	+	+	+	+	+	+	+	+
- very heavy - heavy	> 1000 to 20000 > 5000 to 10000	A2	Z2	+	+	+	+	+	+	+	+
- medium	> 2000 to 5000	A3	Z2	+	+	+	+	+	+	+	+
- easy - very easy	> 1000 to 2000 ≤ 1000	A4	Z2[2]/Z3	+	+	+	+	+	+	-	-

[1] If a mixture of coarse slug grain is used , the use of a mixture of 0/2 mm grains of class Z2 is allowed.
[2] A requirement for state roads

Table 2.4.3.3.18: Limiting thickness of the stone mastic asphalt layer for asphalt wearing courses

Layer thickness	Unit of measure	Type of bituminous mixture						
		SMA 4	SMA 8	SMA 8 hg	SMA 8 gg	SMA 11 gg	SMA 11 hg	SMA 11 gg
- minimum	mm	15	20[1]	20[1]	15	25[1]	25[1]	25[1]
- maximum	mm	25	40[2]	40[2]	25	50[3]	45[3]	35

[1] For new construction the minimum layer thickness should be larger by 10 mm
[2] For new construction the maximum layer thickness may be 35 mm
[3] For new construction the maximum layer thickness may be 40 mm

2.4.3.3.3.4.3 Porous asphalt

Table 2.4.3.3.19: Fields of use of bituminous mixtures of porous asphalt for the wearing and drainage courses depending on the average annual daily traffic load (AADL)

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture		
				PA 8, PA 8 og	PA 11	PA 11 og
-extremely heavy	> 3000	A1	Z1[1)]	+	+	+
- very heavy - heavy	> 800 to 3000 > 300 to 800	A2	Z1[1)]/Z2	+	+	+
- medium	> 80 to 300	A3	Z2	+	+	+
- light - very light	>30 to 80 ≤ 30	A4	Z2[2)]/Z3	+	+	-

1) In the case of use of a mixture of coarse slug grains, the use of a mixture of 0/2 mm grains of class Z2 is allowed.
2) A requirement for state roads

Table 2.4.3.3.20: Fields of use of bituminous mixtures of porous asphalt for the wearing and drainage courses depending on the average annual daily traffic (AADT)

Group of traffic loadi	PLDP (vehicles)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture			
				PA 8	PA 8 og	PA 11	PA 11 og
- extremely heavy	> 20000	A1	Z1[1)]	+	+	+	+
- very heavy - heavy	> 10000 to 20000 > 5000 do 10000	A2	Z1[1)]/Z2	+	+	+	+
- medium	> 2000 to 5000	A3	Z2	+	+	+	+
- light - very light	>1000 to 2000 ≤ 1000	A4	Z2[2)]/Z3	+	-	+	-
- sports facilities	-	A5	Z3	+	-	+	-

1) If a mixture of coarse slug grains is used, the use of a mixture of 0/2 mm grains of class Z2 is allowed.
2) A requirement for state roads

If the requirements in Tables 2.4.3.3.19 and 2.4.3.3.20 for the selection of bituminous mixture are different, the mixture with the larger and higher quality grains should be taken as the reference.

Table 2.4.3.3.21: Limiting design thickness of porous asphalt layers for wearing and drainage courses

Design layer thickness	Unit of measure	Type of bituminous mixture			
		PA 8	PA 8 og	PA 11	PA 11 og
- minimum	mm	30	20	35	30
- maximum	mm	45	25	50	35

2.4.3.3.3.4.4 Mastic asphalt

Table 2.4.3.3.22: Fields of use of bituminous mixtures of mastic asphalt for the asphalt wearing and protective courses depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture		
				MA 4	MA 8	MA 11
- extremely heavy	> 3000	A1	Z1[1)]	-	-	+
- very heavy - heavy	> 800 to 3000 > 300 to 800	A2	Z2[1)]	-	+	+
- medium	> 80 to 300	A3	Z3[1)]	-	+	+
- light - very light	>30 to 80 ≤ 30	A4	Z3[1)]	+	+	+

[1)] For bituminous mixtures for protective layers the use of grain mixtures of class Z4 is allowed.

Table 2.4.3.3.23: Fields of use of bituminous mixtures of mastic asphalt for the asphalt wearing courses depending on the average annual daily traffic volume

Group of traffic load	AADT (vehicles)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture		
				MA 4	MA 8	MA 11
- extremely heavy	> 20000	A1	Z1[1)]	-	-	+
- very heavy - heavy	> 10000 to 20000 > 5000 to 10000	A2	Z2[1)]	-	+	+
- medium	> 2000 to 5000	A3	Z3[1)]	-	+	+
- light - very light	>1000 to 2000 ≤ 1000	A4	Z3[1)]	+	+	+
- pedestrian corridors cyclist tracks	-	A5	Z4	+	+	-

[1)] For bituminous mixtures for protective layers the use of grain mixtures of class Z4 is allowed.

Table 2.4.3.3.24: Limiting design thickness of the mastic asphalt layers for wearing courses

Design layer thickness	Unit of measure	Type of bituminous mixture		
		MA 4	MA 8	MA 11
- minimum	mm	15	20	30
- maximum	mm	25	35	40

Table 2.4.3.3.25: Types of bituminous mixtures and limiting design thickness of the mastic asphalt layers for protection of the waterproofing membrane on road facilities

Group of traffic load	Type of bituminous mixture	Conditioned limiting design thickness mm
Extremely heavy, very heavy and heavy	MA 11	35 to 40
medium, light and very light	MA 8 MA 11	25 to 35 35 to 40

2.4.3.3.3.4.5 Thin-layer dressing applied by cold procedure (Slurry surfacing)

Table 2.4.3.3.26: Fields of use of bituminous mixtures for slurry surfacing depending on the average annual daily traffic load

Group of traffic load	AADL (NOO 100 kN)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture			
				SS 2	SS 4	SS 6	SS 8
- heavy	> 300 to 800	A2	Z1	-	-	+	+
- medium	> 80 to 300	A3	Z1	-	+	+	+
- light - very light	> 30 to 80 ≤ 30	A4	Z3	+	+	+	+
- corridors, cyclist tracks, parking lots, emergency lanes	-	A5	Z3	+	+	+	-

Table 2.4.3.3.27: Fields of use of bituminous mixtures for slurry surfacing depending on the average annual daily traffic volume

Group of traffic load	AATD (vehicles)	Class of bituminous mixture	Class of aggregate	Type of bituminous mixture			
				SS 2	SS 4	SS 6	SS 8
- extremely heavy	> 20000	A1	Z1	-	-	-	+
- very heavy	> 10000 to 2000	A2	Z1	-	-	+	+
- heavy	> 5000 to 10000			-	+	+	+
- medium	> 2000 to 5000	A3	Z1	-	+	+	+
- light	> 1000 to 2000	A4	Z3	-	+	-	-
- very light	≤ 1000			+	+	-	-

Table 2.4.3.3.28: Limiting design thickness of slurry surfacing courses

Design thickness of dressing	Unit of measure	Type of bituminous mixture			
		SS 2	SS 4	SS 6	SS 8
- minimum	mm	2	4[2)]	6[1)]	8[2)]
- maximum	mm	4[1)]	8[2)]	12[1)]	16[2)]

Legend:
[1)] installation: one-layer or two-layer
[2)] installation: two-layer

Table 2.4.3.3.29: Characteristics of joints of slurry surfacing courses

Characteristics of slurry surfacing joints	Unit of measure
- type of bituminous emulsion	-
- property of bituminous emulsion (pursuant to SIST EN 13614) – coating	-
- type of bituminous emulsion	m.-%
- properties of aggregates	-
- type of admixtures	-
- percentage of admixtures	m.-%
- apparent specific mass	g/cm^3
- micro-texture depth	mm

2.4.3.3.3.4.6 Surface dressing

The basic requirements for the execution of surface dressing are given in EN 12271.

Specific conditions determining the selection of the surface dressing type, are:
- one-layer with single spreading,
- one-layer with double spreading,
- two-layer, and
- reverse two-layer,

and it may also be executed in the form of a sandwich.

Pursuant to traffic load, an appropriate type of bituminous binder should be selected for spraying (Table 2.4.3.3.30), and according to the selected type of surface dressing, the quantity of grains of specific size and the quantity of bituminous binder should be determined (Table 2.4.3.3.31).

Table 2.4.3.3.30: Fields of use of surface dressing on pavements depending on the average annual daily traffic load and on the type of bituminous binder

Group of traffic load	AADT (vehicles)	Type of bituminous binder			
		bitumen for road construction	polymer modified bitumen	bituminous emulsion	
		B 160/220	PmB 90/150-45	BE C69B4	PmBE C69BP4
- extremely heavy - very heavy - heavy	> 20000 > 10000 to 20000 > 5000 to 10000	-	+	-	+
- medium	> 2000 to 5000	-	+	+	+
- light - very light	> 1000 to 2000 ≤ 1000	+	+	+	+

Table 2.4.3.3.31: Types and informative quantities of materials needed for surface dressing on pavements

Type of surface dressing	Aggregate		Bituminous binder	
	fraction (mm)	quantity (kg/m^2)	cold [1] (kg/m^2)	hot [2] (kg/m^2)
one-layer with single spreading	2/4 4/8 8/11	7 to 12 10 to 18 15 to 20	1.2 to 1.6 1.5 to 2.0 1.8 to 2.3	0.8 to 1.1 1.1 to 1.4 1.3 to 1.6
one-layer with double spreading				
1. operational stage 2. operational stage	8/11 2/4	11 up to -20 3 to 8	1.8 to 2.2	1.2 to 1.5
or				
1. operational stage 2. operational stage	11/16 4/8	15 to 20 4 to 8	2.0 to 2.6	1.4 to 1.8
two-layer:				
1. operational stage 2. operational stage	8/11 4/8	up to 18 10 to 15	1.4 to 2.1 1.2 to 1.8	1.0 to 1.5 0.9 to 1.3
	or 2/4	8 to 12	1.0 to 1.4	0.7 to 1.0
or				
1. operational stage 2. operational stage	11/16 4/8	15 to 20 4 to 8	2.0 to 2.4 1.3 to 1.7	1.4 to 1.7 0.9 to 1.2

Type of surface dressing	Aggregate fraction (mm)	Aggregate quantity (kg/m^2)	Bituminous binder cold [1] (kg/m^2)	Bituminous binder hot [2] (kg/m^2)
reverse two-layer:				
1. operational stage	2/4	7 to 12	1.2 to 1.6	0.8 to 1.0
2. operational stage	4/8	10 to 18	1.5 to 2.0	1.0 to 1.3
	or			
	8/11	15 to 20	1.2 to 1.5	0.8 to 1.0
or				
1. operational stage	4/8	10 to 18	1.5 to 2.0	1.0 to 1.3
2. operational stage	11/16	15 to 22	1.2 to 1.5	0.8 to 1.0
sandwich:				
1. operational stage	8/11	11 up to 16	1.7 to 2.1	1.1 to 1.4
2. operational stage	2/4	3 to 8		
or				
1. operational stage	8/11	11 to 16	1.8 to 2.2	1.2 to 2.4
2. operational stage	4/8	4 to 8		
or				
1. operational stage	11/16	15 to 20	1.9 to 2.5	1.2 to 1.6
2. operational stage	4/8	4 to 8		

Legend:
1) values for cold binder refer to bituminous emulsion (BE and PmBE)
2) values for hot binder refer to bitumen for road construction and polymer modified bitumen (B and PmB)

A precondition for quality surface dressing is an adequately flat substrate.

If the aggregates coated with bituminous binder (glazed grains) are used for spreading, the coating should be carried out in the production facility for the bituminous mixtures. The quantity of bituminous binder (0.6 to 0.8 % by mass B 35/50) should ensure the flow of the (temporary stored) grain mixture.

Bituminous binder spraying is carried out with the use of the self-propelled equipment where the heating and repumping of the binder is possible. Appropriate distribution of spraying nozzles should ensure a uniform quantity of the spread bituminous binder; for hot bituminous binder, the tolerance from the conditioned quantity is up to 10 % by mass, while the tolerance for cold bituminous binder amounts to up to 15 % by mass.

The quality of the spread stone grains may deviate from the required by up to 10 % by mass.

As a rule, for rolling of aggregate into the spread bituminous binder heavy rollers with tyres should be used.

The travel speed on the newly constructed surface dressing should be limited to a maximum 30-40 km/h, for at least a period of 2-3 days.

Stone grains that are poorly bound to the substrate should be regularly removed from the pavement (using adequate equipment) to avoid endangering traffic participants.

This is to be decided by the supervising engineer.

2.4.3.4 Quality of execution

The standards for the quality of the executed works within bitumen bound aggregate courses are defined by:

- limiting curves for the recommended point of contact of aggregates,
- limiting values for spatial and mechanical properties of the produced bituminous mixtures, and
- limiting values for spatial characteristics of the installed bituminous mixtures.

2.4.3.4.1 Asphalt concrete-base, stabilized (AC base, stab)

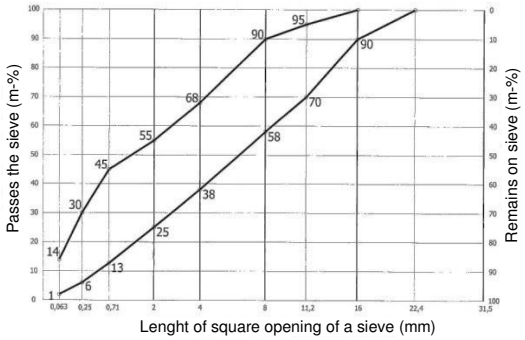


Figure 2.4.3.4.1: Limiting curves of the area for aggregates for AC 16 base, stab

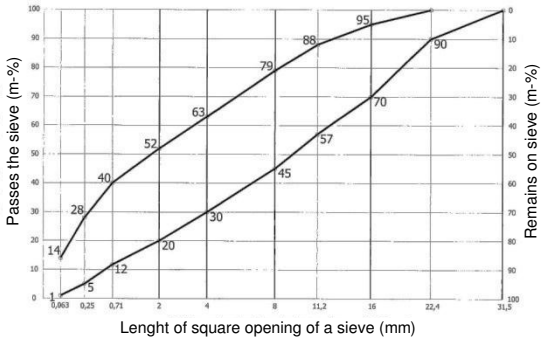


Figure 2.4.3.4.2: Limiting curves of the area for aggregates for AC 22 base, stab

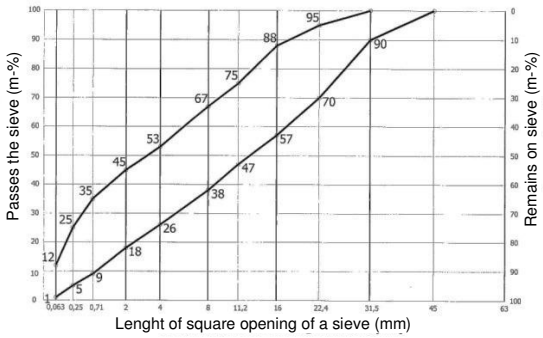


Figure 2.4.3.4.3: Limiting curves of the area for aggregates for AC 32 base, stab

Table 2.4.3.4.1: Limiting values for the spatial and mechanical properties of the bituminous mixtures produced by the hot procedure, for asphalt concrete-base (stabilized) courses

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for AC base, stab**					
				extremely heavy	very heavy	heavy	medium	light	very light
				A1/A2			A3	A4	
				AC 22, 32 base, stab			**AC 16, 22, 32 base, stab**		
				Z4			Z5	Z6	
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1]	minimum	% by v.	V_{min5}			V_{min3}	V_{min3}	
		maximum		V_{max10}					
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2]	minimum	%	VFB_{min40}					
		maximum		VFB_{max64}			VFB_{max68}	VFB_{max72}	
Resistance to permanent deformation	EN 13108-20, Item D.6 [3]	maximum proportionate rut depth	%	PRD_{AIRNR}					
Sensitivity to water	EN 13108-20, Item D.3 [4]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value					
Content of voids in aggregate	EN 13108-20, Item D.2 [5]	minimum	% by v.	$VMA_{min\ NR}$ state the value					

1) *The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B.2.*
2) The void occupancy coefficient should be determined pursuant to EN 12697-8
3) *The resistance to permanent deformation should be determined pursuant to EN 13108-20; the testing conditions are stipulated by EN 13108-20, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of individual mixtures from declared $V_{max} \pm 1.5$ % by V.)*
4) Sensitivity to water should be determined pursuant to EN 12697-12
5) *Voids in aggregate should be determined pursuant to EN-12697-8 (temperature of trial bodies during testing 25 °C)*

Table 2.4.3.4.2: Limiting values for the spatial and mechanical properties of the installed bituminous mixtures produced by the hot procedure, for asphalt concrete-base (stabilized) courses

Properties of the installed bituminous mixture	Unit of measure	Required value	Testing procedure
- layer compactness	%	≥ 97	SRCS, Item 1.2.4
- content of voids in the layer	% by v.	V_{max12}	EN 12697-8

2.4.3.4.2 Asphalt concrete-base (AC base)

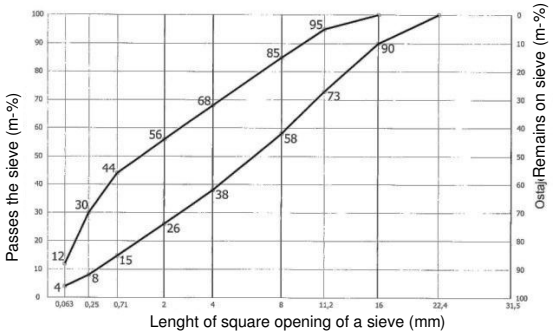


Figure 2.4.3.4.4: Limiting curves of the area for aggregates for AC 16 base

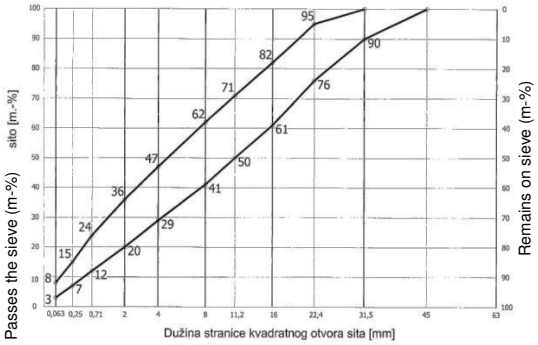


Figure 2.4.3.4.5: Limiting curves of the area for aggregates for AC 32 base

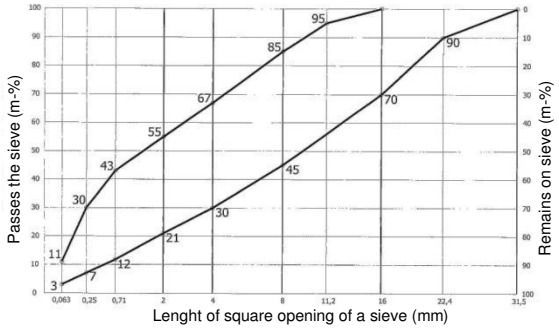


Figure 2.4.3.4.5: Limiting curves of the area for aggregates for AC 22 base

Table 2.4.3.4.3: Limiting values for the spatial and mechanical characteristic of the produced bituminous mixtures for the asphalt concrete-base (pursuant to EN 13108-1)

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for AC base**					
				Extreme-ly heavy	very heavy	heavy	medium	light	very light
				A1	A2		A3	A4	
				AC 22, 32 base	**AC 16,22,32 base**		**AC 16,22,32 base**	**AC 16.22 base**	
				Z4			Z5	Z6	
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1]	minimum	% by v.	V_{min5}			V_{min3}	V_{min3}	
		maximum		V_{max7}			V_{max6}	$V_{max5,5}$	
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2]	minimum	%	VFB_{min50}			VFB_{min55}	VFB_{min55}	
		maximum		VFB_{max68}			VFB_{max74}	VFB_{max77}	
Resistance to permanent deformation	EN 13108-20, Item D.6 [3]	maximum proportionate rut depth	%	$PRD_{AIR7,0}$ [6]			PRD_{AIRNR}		
Sensitivity to water	EN 13108-20, Item D.3 [4]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value					
Content of voids in aggregate	EN 13108-20, Item D.2 [5]	minimum	% by v.	$VMA_{min\ NR}$ state the value					

1) The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B0.1.
2) The void occupancy coefficient should be determined pursuant to EN 12697-8
3) The resistance to permanent deformation should be determined pursuant to SIST EN 13108-20; the testing conditions are stipulated by EN 13108-20, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of an individual mixture from declared $V_{max} \pm 1.5$ % by V.)
4) Sensitivity to water should be determined pursuant to EN 12697-12
5) Voids in aggregate should be determined pursuant to EN-12697-8 (temperature of trial bodies during testing 25 °C)
6) To avoid doubling of requirements, a combination with voids filled with bitumen, stipulated by EN 13108-1, Item 5.3.6, is not permitted. 5.3.6

Table 2.4.3.4.4: Limiting values for spatial characteristics of the installed bituminous mixtures for asphalt concrete-base

Properties of the installed bituminous mixture	Unit of measure	Required traffic load value				Testing procedure
		extremely heavy	very heavy and heavy	medium	light and very light	
- layer compactness	%	≥ 98		≥ 98	≥ 97	SRCS, Item 1.2.4 EN 12697-8
- content of voids in the layer	% by v.	$V_{min4} - V_{max9}$		$V_{min2} - V_{max8}$	$V_{min2} - V_{max8,5}$	

2.4.3.4.3 Asphalt binding layer (AC bin)

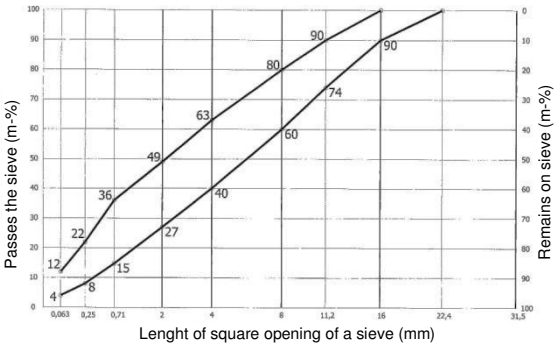


Figure 2.4.3.4.7: Limiting curves of the area for aggregates for AC 16 bin

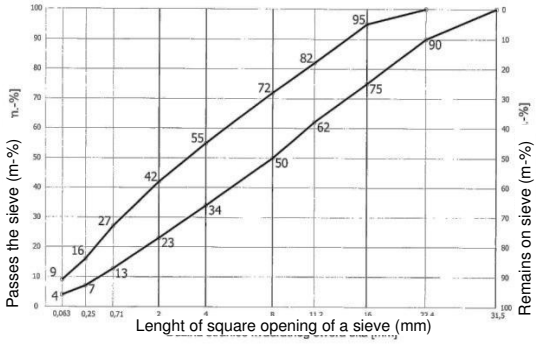


Figure 2.4.3.4.8: Limiting curves of the area for aggregates for AC 22 bin

Table 2.4.3.4.5: Limiting values for the spatial and mechanical characteristics of the produced bituminous mixtures for the asphalt binding layers

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for AC bin**		
				extremely heavy	very heavy	heavy
				A1	A2	
				AC 16 bin and AC 22 bin		
				Z4		
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1)]	minimum	% by v.	V_{min4}		
		maximum		V_{max7}		
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2)]	minimum	%	VFB_{min55}		
		maximum		VFB_{max77}		
Resistance to permanent deformation	EN 13108-20, Item D.6 [3)]	maximum proportionate rut depth	%	$PRD_{AIR3,0}$ [6)]		
Sensitivity to water	EN 13108-20, Item D.3 [4)]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value		
Content of voids in aggregate	EN 13108-20, Item D.2 [5)]	minimum	% by v.	$VMA_{min\ NR}$ state the value		

1) The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B.1.
2) The void occupancy coefficient should be determined pursuant to EN 12697-8
3) The resistance to permanent deformation should be determined pursuant to EN 13108-20; the testing conditions are stipulated by EN 13108-20, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of an individual mixture from declared $V_{max} \pm 1.5$ % by V.)
4) Sensitivity to water should be determined pursuant to EN 12697-12
5) Voids in aggregate should be determined pursuant to EN-12697-8 (temperature of trial bodies during testing 25 °C)
6) To avoid doubling of requirements, a combination with voids filled with bitumen, stipulated by EN 13108-1, Item 5.3.6, is not permitted. 5.3.6

Table 2.4.3.4.6: Limiting values for the spatial properties of the installed bituminous mixtures for asphalt binding layers

Properties of the installed bituminous mixture	Unit of measure	Required value	Testing procedure
- layer compactness	%	≥ 98	SRCS, Item 1.2.4
- content of voids in the layer	% by v.	$V_{min3} – V_{max9}$	EN 12697-8

2.4.3.4.4 *Asphalt wearing course – Asphalt concrete (AC surf)*

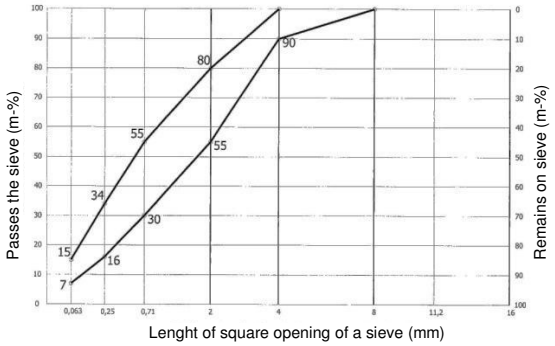


Figure 2.4.3.4.9: Limiting curves of the area for aggregates for asphalt concrete AC 4 surf (Z3)

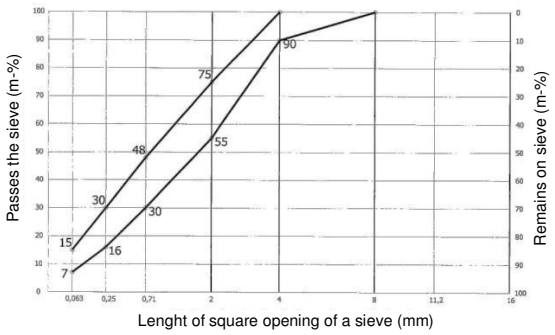


Figure 2.4.3.4.10: Limiting curves of the area for aggregates for asphalt concrete AC 4 surf (Z2)

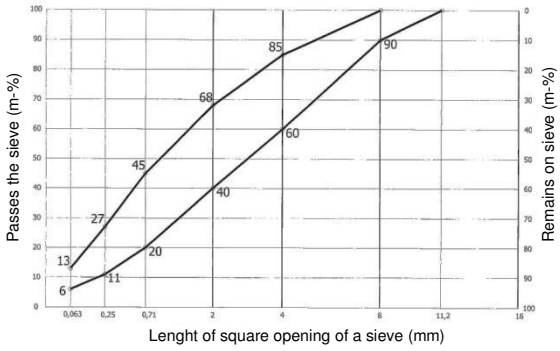


Figure 2.4.3.4.11: Limiting curves of the area for aggregates for asphalt concrete AC 8 surf (Z3)

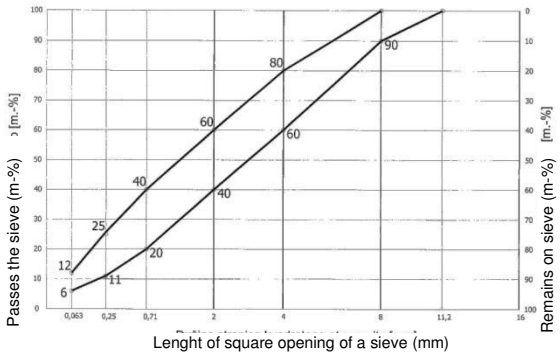


Figure 2.4.3.4.12: Limiting curves of the area for aggregates for asphalt concrete AC 8 surf (Z1/Z2)

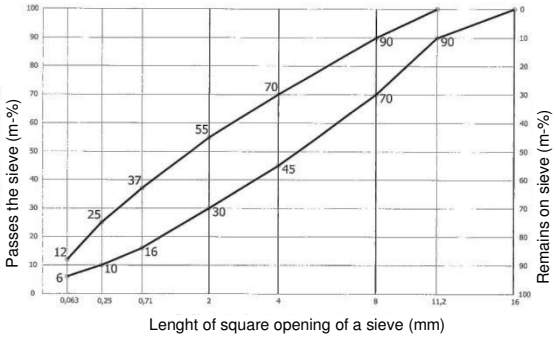


Figure 2.4.3.4.13: Limiting curves of the area for aggregates for asphalt concrete AC 11 surf (Z3)

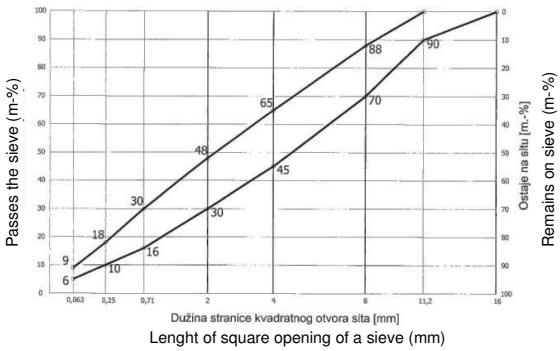


Figure 2.4.3.4.14: Limiting curves of the area for aggregates for asphalt concrete AC 11 surf (Z1/Z2)

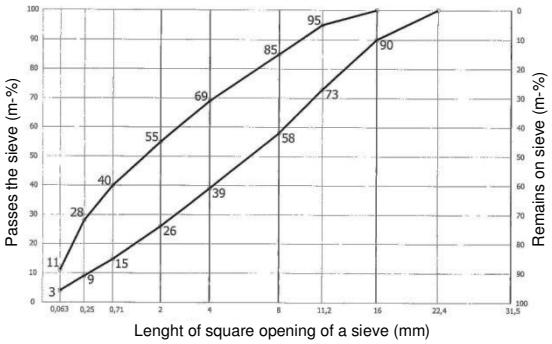


Figure 2.4.3.4.15: Limiting curves of the area for aggregates for ANOP - AC 16 base / surf (Z2/Z3)

Table 2.4.3.4.7: Limiting values for the spatial and mechanical characteristics of the produced bituminous mixtures for asphalt concrete for the asphalt wearing courses and the wearing base-courses (pursuant to EN 13108-1)

Properties of the produced bituminous mixture	**Testing of testing**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for AC surf**						
				extremely heavy	very heavy	heavy	medium	light	very light	pedestrian corridors, cyclist tracks, etc.
				A1	A2		A3	A4		A5
				AC 11 surf	**AC 8.11 surf**		**AC 4,8,11 surf**	**AC 4,8,11 surf AC 16 surf, base**		**AC 4,8,11 surf**
				Z1[7)]	Z2[7)]		Z2[8)]/Z3[7)]			Z4
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1)]	minimum	% by v.	V_{min3}	V_{min3}		V_{min3}	$V_{min1,5}$		$V_{min1,5}$
		maximum		$V_{max6,5}$	$V_{max6,5}$		V_{max6}	V_{max5}		$V_{max2,5}$
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2)]	minimum	%	VFB_{min65}	VFB_{min65}		VFB_{min70}	VFB_{min75}		VFB_{min78}
		maximum		VFB_{max77}	VFB_{max80}		VFB_{max86}	VFB_{max89}		VFB_{max93}
Resistance to permanent deformation	EN 13108-20, Item D.6 [3)]	maximum proportionate rut depth	%	$PRD_{AIR5,0}$ [6)]			PRD_{AIRNR} – state the value			
Sensitivity to water	EN 13108-20, Item D.3 [4)]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value						
Content of voids in aggregate	EN 13108-20, Item D.2 [5)]	minimum	% by v.	$VMA_{min\ NR}$ state the value						

1) The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B0.1.
2) The void occupancy coefficient should be determined pursuant to EN 12697-8
3) The resistance to permanent deformation should be determined pursuant to EN 13108-20; the testing conditions are stipulated by EN 13108-20, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of an individual mixture from declared $V_{max} \pm 1.5$ % by V.)
4) Sensitivity to water should be determined pursuant to EN 12697-12
5) Voids in aggregate should be determined pursuant to EN-12697-8 (temperature of trial bodies during testing 25 °C)
6) To avoid doubling of requirements, a combination with voids filled with bitumen, stipulated by EN 13108-1, Item 5.3.6, is not permitted. 5.3.6
7) For bituminous mixtures for protective and smoothing layers, a grain mixture of class Z4 with the properties given in Table 2.4.3.2.1 may be used.
8) A requirement for state roads

Table 2.4.3.4.8: Limiting values for the spatial characteristics of the installed bituminous mixtures of asphalt concrete

Properties of the installed bituminous mixture	Unit of measure	Groups of traffic loads and types of bituminous mixtures for AC surf							Test method
		extremely heavy	very heavy	heavy	medium	light	very light	pedestrian corridors, cyclist tracks, etc.	
	Lenght of square opening of a sieve (mm)								
		A1	A2		A3	A4		A5	
- layer compactness	%	≥ 98			≥ 97	≥ 96		≥ 96	SRCS, Item 1.2.4
- content of voids in the layer	% by v.	$V_{min2} – V_{max8,5}$			$V_{min2} – V_{max9}$	$V_{min1} – V_{max9}$		$V_{min1} – V_{max6,5}$	EN 12697-8

2.4.3.4.5 *Asphalt wearing course – Stone mastic asphalt (SMA)*

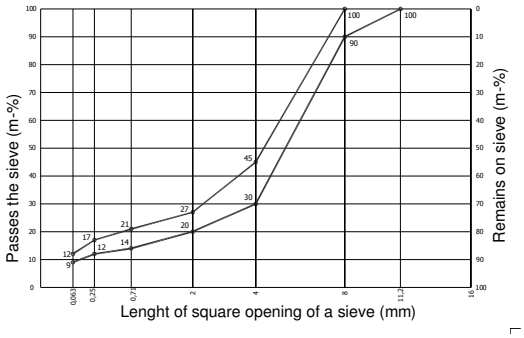


Figure 2.4.3.4.16: Limiting curves for the area of aggregates for stone mastic asphalt of standardized composition SMA 8 and fungous composition SMA 8 hg (hollow graded)

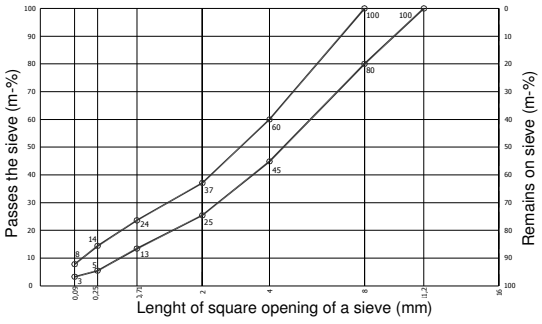
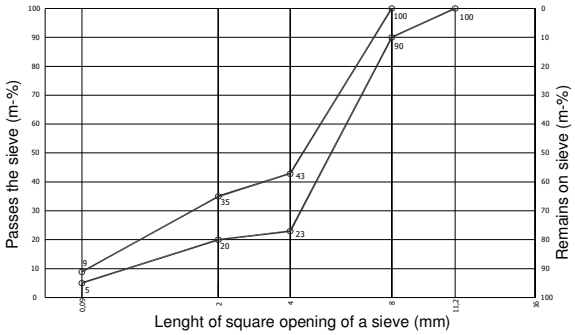


Figure 2.4.3.4.17: Limiting curves for the area of aggregate for stone mastic asphalt of porous composition SMA 8 gg (gap graded)



Slika 2.4.3.4.18: Limiting curves for aggregates for stone mastic asphalt ofa noise reducing composition SMA 8 ln (low noise)

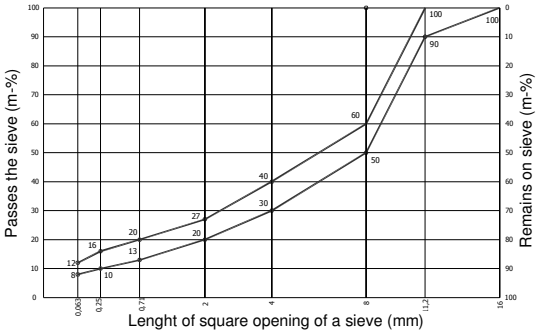


Figure 2.4.3.4.19: Limiting curves for the area of aggregates for stone mastic asphalt of standardized composition SMA 11 and porous composition SMA 11 hg (hollow graded)

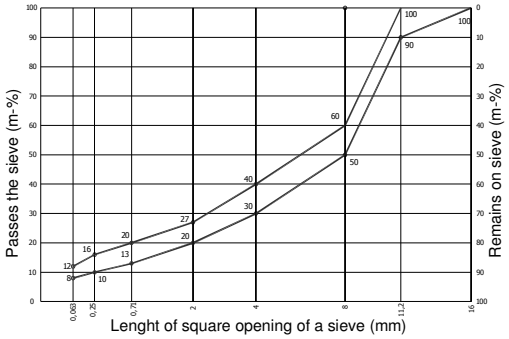


Figure 2.4.3.4.20: Limiting curves for the area of aggregate for stone mastic asphalt of porous composition SMA 11 gg (gap graded)

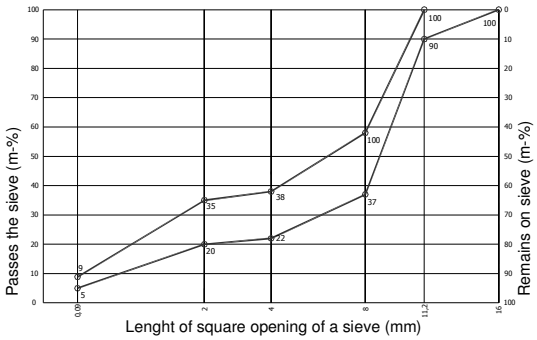


Figure 2.4.3.4.21: Limiting curves for the area of aggregates for stone mastic asphalt of a noise reducing composition SMA 11 ln (low noise)

Table 2.4.3.4.9: Limiting values for the spatial and mechanical characteristics of the produced bituminous mixtures of stone mastic asphalt (pursuant to EN 13108-5)

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for SMA base**						**Groups of traffic loads, classes and types of bituminous mixtures for SMA ln base**						**Groups of traffic loads, classes and types of bituminous mixtures for SMAhg base**						**Groups of traffic loads, classes and types of bituminous mixtures for SMAgg base**					
				extremely heavy	very heavy	heavy	medium	light	very light	extremely heavy	very heavy	heavy	medium	light	very light	extremely heavy	very heavy	heavy	medium	light	very light	extremely heavy	very heavy	heavy	medium	light	very light
				A1	A2		A3	A4		A1	A2		A3	A4		A1	A2		A3	A4		A1	A2		A3	A4	
				SMA 8, SMA 11						**SMA 8ln, SMA 11ln**						**SMA 8hg, SMA 11hg**						**SMA 8gg, SMA 11gg**					
				Z1[6]/Z2	Z2		Z2	Z2[7]/Z3		Z1[6]/Z2	Z2		Z2	Z2[7]/Z3		Z1[6]/Z2	Z2		Z2	Z2[7]/Z3		Z1[6]/Z2	Z2		Z2	Z2[7]/Z3	
Content of binder	EN 13108-20, Item B.5	minimum [9]	m.-%	SMA 8 ≥ B_{min} 6.5 SMA 11 ≥ B_{min} 6.3			SMA 8 ≥ B_{min} 6.8 SMA 11 ≥ B_{min} 6.6			SMA 8 ≥ B_{min} 5.6 SMA 11 ≥ B_{min} 5.4						SMA 8 ≥ B_{min} 6.5 SMA 11 ≥ B_{min} 6.3						B_{min} 7.0					
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1]	minimum	V.-%.	$V_{min2.5}$			V_{min2}			V_{min6}						V_{min10}						V_{min3}					
		maximum	V.-%	$V_{max4.5}$			V_{max4}			V_{max12}						V_{max12}						V_{max9}					
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2]	minimum	%	VFB_{min75}			VFB_{min78}			VFB_{min50}						VFB_{min53}						VFB_{min62}					
		maximum	%	VFB_{max88}			VFB_{max90}			VFB_{max70}						VFB_{max61}						VFB_{max87}					
Bleeding of binder	EN 13108-20, Item D.13 [3]	maximum share	m.-%	$D_{0.6}$						$D_{0.6}$						D_{NR} – state the value						D_{NR} – state the value					
Sensitivity to water	EN 13108-20, Item D.3 [4]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value						$ITSR_{NR}$ state the value						$ITSR_{NR}$ state the value						$ITSR_{NR}$ state the value					
Resistance to permanent deformation	EN 13108-20, Item D.6 [5]	maximum proportionate rut depth	%	SMA 8; $PRD_{AIR}9.0$[8] SMA 11; $PRD_{AIR}7.0$[8]			PRD_{AIRNR}			SMA 8 ln; $PRD_{AIR}9.0$[8] SMA 11 ln; $PRD_{AIR}7.0$[8]			PRD_{AIRNR}			SMA 8 ln; $PRD_{AIR}9.0$[8] SMA 11 ln; $PRD_{AIR}7.0$[8]			PRD_{AIRNR}			PRD_{AIRNR}					

1. *The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B0.1.*
2. *The void occupancy coefficient should be determined pursuant to EN 12697-8*
3. *The resistance to permanent deformation should be determined pursuant to EN 13108-20:2006; the testing conditions are stipulated by EN 13108-20:2006, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of an individual mixture from declared $V_{max} \pm 1.5$ % by V.)*
4. *Sensitivity to water should be determined pursuant to EN 12697-12*
5. *Voids in aggregate should be determined pursuant to EN-12697-8 (temperature of trial bodies during testing 25 °C)*
6. *If a mixture of coarse slug grains is used, the use of a mixture of 0/2 mm grains of class Z2 is allowed.*
7. *A requirement for state roads*
8. *To avoid doubling of requirements, a combination with voids filled with bitumen, stipulated by EN 13108-1, Item 5.3.6, is not permitted. 5.3.6*
9. *The lowest content of binder should be fixed by coefficient α, determined according to equation $\alpha=2.650/\rho_d$ where ρ_d represents average of specific density of agregate mixture*
10. *Fir bituminous mixtures of protective and finishing layer mixture of grain class Z4 is allowed with characteristics described in table 2.1.1*

Table 2.4.3.4.10: Limiting values for the spatial characteristics of the installed bituminous mixtures of stone mastic asphalt

Properties of the placed bituminous mixture	Unit of Measure	Groups of traffic load								Testing procedure
		extremely heavy, very heavy and heavy				medium, light and very light				
		SMA	SMA ln	SMA hb	SMA gg	SMA	SMA ln	SMA hb	SMA gg	
- layer compaction	%	≥ 97				≥ 97				SRCS, it.1.2.4
- content of voids										
- in a layer	V.-%	$V_{MIN1.5} – V_{MAX7}$	$V_{MIN6} – V_{MAX14}$	$V_{MIN10} – V_{MAX14}$	$V_{MIN2.5} – V_{MAX11}$	$V_{MIN1} – V_{MAX7}$	$V_{MIN6} – V_{MAX14}$	$V_{MIN10} – V_{MAX14}$	$V_{MIN2.5} – V_{MAX11}$	EN 12697-8
- in waterproofing and finishing	V.-%	$V_{MIN3} – V_{MAX7.5}$	–	–	–	$V_{MIN2} – V_{MAX7}$	–	–	–	EN 12697-8

2.4.3.4.6 Asphalt wearing course – Porous asphalt (PA)

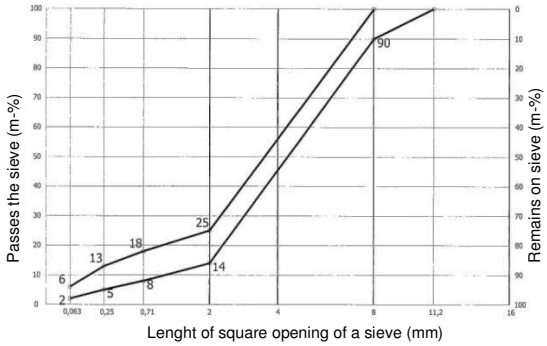


Figure 2.4.3.4.22: Limiting curves for the area of aggregates for porous asphalt PA 8 of standardized composition

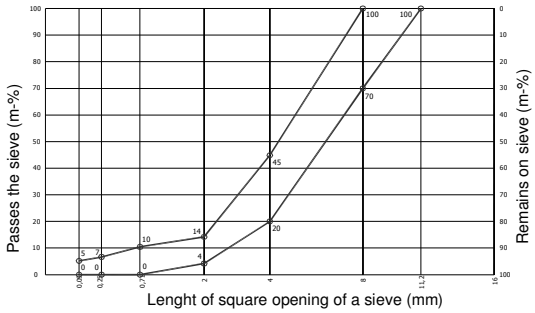


Figure 2.4.3.4.23: Limiting curves for the area of aggregates for porous asphalt of open composition PA 8 og (open graded)

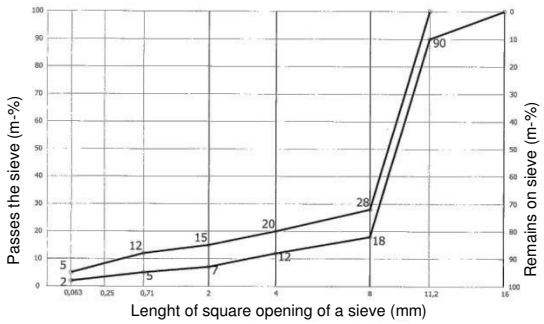


Figure 2.4.3.4.24: Limiting curves for the area of aggregates for porous asphalt PA 11 of standardized composition

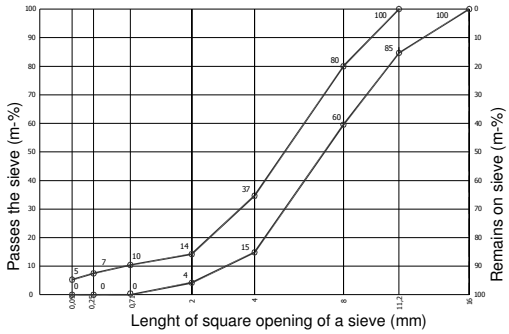


Figure 2.4.3.4.25: Limiting curves for the area of aggregates for porous asphalt of open composition PA 11 og (open graded)

Table 2.4.3.4.11: Limiting values for the spatial and mechanical characteristics of the produced bituminous mixtures of the porous asphalt (pursuant to EN 13108-7)

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures**							**Groups of traffic loads, classes and types of bituminous mixtures**					
				extremely heavy	very heavy	heavy	medium	light	very light	sports facilities	*extremely heavy*	very heavy	heavy	medium	light	very light
				A1	A2		A3	A4		A5	*A1*	A2		A3	A4	
				PA 8, PA 11						PA 8, 11, 16	**PA 8 og, PA 11 og**					
				Z1[7]	Z1[7]/Z2		Z2	Z2[8]/Z3		Z3	Z1[7]	Z1[7]/Z2		Z2	Z3	
Content of binder	EN 13108-20, Item B.7	minimum [9]	m.-%	PA 8 ≥ B_{min} 5.5 PA11 ≥ B_{min} 6.0						$B_{min} \geq 3.0$	B_{min7}					
Content of voids in the bituminous mixture	EN 13108-20, Item D.2 [1]	minimum	V.-%	V_{min16}						V_{min14}	$V_{min3.5}$					
		maximum		V_{max26}						V_{max18}	V_{max9}					
Content of bitumen filled voids in the aggregate	EN 13108-20, Item D.2 [2]	minimum	%								VFB_{min75}					
		maximum									VFB_{max90}					
Sensitivity to water	EN 13108-20, Item D.3 [3]	minimum value of indirect tensile strength	%	$ITSR_{NR}$ state the value												
Resistance to permanent deformation	EN 13108-20, Item D.6 [4]	maximum proportionate rut depth	%	PRD_{AIRNR} state the value												
Bleeding of binder	EN 13108-20, Item D.13 [5]	maximum share	m.-%	D_0						D_{NR}	D_{NR} - state					
Loss of particles	EN 13108-20, Item D.16 [6]	maximum share	m.-%	PL_{30}			PL_{40}	PL_{NR}			-					

1. *The samples for testing should be prepared pursuant to EN 13108-20, Table C.1. The content of voids should be determined pursuant to EN 13108-20, Table B.1.*
2. *The void occupancy coefficient should be determined pursuant to EN 12697-8*
3. *Sensitivity to water should be determined pursuant to EN 12697-12*
4. *Voids in aggregate should be determined pursuant to EN-12697-8*
5. *The resistance to permanent deformation should be determined pursuant to EN 13108-20:2006; the testing conditions are stipulated by EN 13108-20:2006, Table D.1, Item D.1.6 (temperature of samples during testing 60 °C, and deviation of the void content of an individual mixture from declared $V_{max} \pm 1.5$ % by V.)*
6. *Loss of particles must be determined persuant to EN 12697-17*
7. *If a mixture of coarse slug grains is used, the use of a mixture of 0/2 mm grains of class Z2 is allowed.*
8. *A requirement for state roads*
9. *The lowest content of binder should be fixed by coefficient α, determined according to equation $\alpha=2.650/\rho_d$ where ρ_d represents average of specific density of agregate mixture*

Table 2.4.3.4.12: Limiting values for the spatial characteristics of the installed bituminous mixtures of porous asphalt

Properties of the placed bituminous mixture	Unit of Measure	Type of bituminous mixture				Testing procedure
		PA 8	PA 8 og	PA 11	PA 11 og	
- layer compaction	%	≥ 97				SRCS, it.1.2.4
- content of voids	V.-%	V_{MIN15} – V_{MAX28}	$V_{MIN2.5}$ – V_{MAX11}	V_{MIN10} – V_{MAX14}	$V_{MIN2.5}$ – V_{MAX11}	SIST EN 12697-8

2.4.3.4.7 Asphalt wearing course – Mastic asphalt (MA)

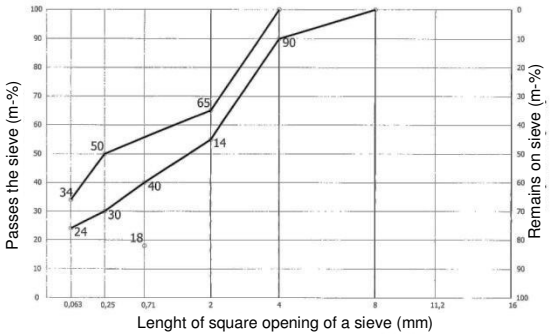


Figure 2.4.3.4.26: Limiting curves for aggregates for mastic asphalt MA 4

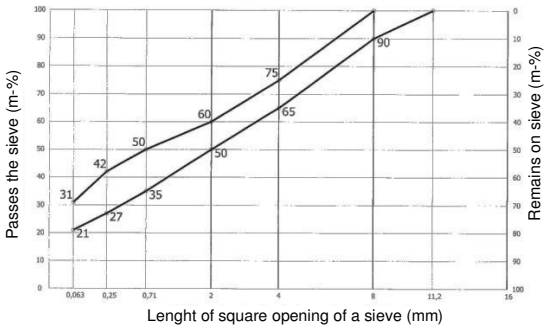


Figure 2.4.3.4.27: Limiting curves for aggregates for mastic asphalt MA 8 (Z2)

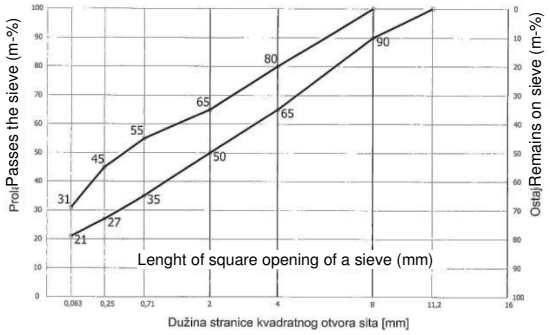


Figure 2.4.3.4.28: Limiting curves for aggregates for mastic asphalt MA 8 (Z3)

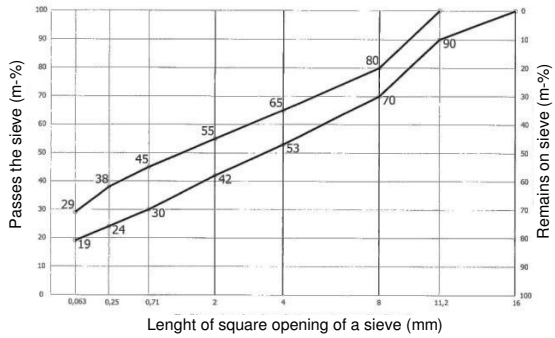


Figure 2.4.3.4.29: Limiting curves for aggregates for mastic asphalt MA 11 (Z1/Z2)

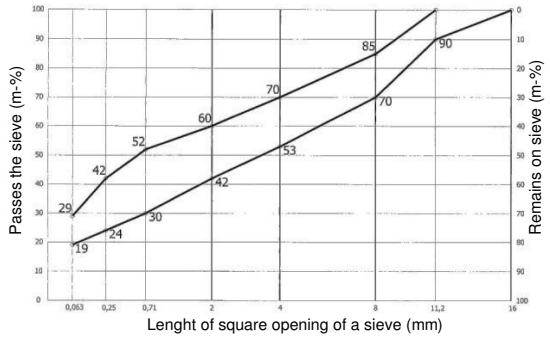


Figure 2.4.3.4.30: Limiting curves for aggregates for mastic asphalt MA 11 (Z3)

Table 2.4.3.4.13: Limiting values for spatial and mechanical characteristics of the produced bituminous mixtures of mastic asphalt (pursuant to EN 13108-6)

Properties of the produced bituminous mixture	**Testing procedure**	**Limiting values**	**Unit of measure**	**Groups of traffic loads, classes and types of bituminous mixtures for MA**						
				extremely heavy	very heavy	heavy	medium	light	very light	pedestrian crossings, cyclist tracks, etc.
				A1	A2		A3	A4		A5
				MA 11	**MA 8, 11**		**MA 8, 11**	**MA 4, 8, 11**		**MA 4, 8, 11**
				Z1 [2)]	Z2 [2)]		Z3 [2)]	Z3 [2)]		Z4
Resistance to permanent deformation	EN 13108-20, Item D.14 Table D.5	minimum depth	mm	$I_{min1,0}$				$I_{min1,0}$		I_{minNR}
		maximum depth	mm	$I_{max3,0}$				$I_{max5,0}$		I_{max10}
		maximum indentation depth, an increase after 30 minutes	mm	$I_{nc0,4}$				$I_{nc0,6}$		I_{ncNR}
		maxium dynamic penetration depth	mm	I_{dynNR} – state the value						

[1)] *Resistance to permanent deformation should be determined pursuant to EN 12697-20.*

2) *For bituminous mixtures for protective and smoothing layers, a grain mixture of class Z4 with the properties given in Table 2.4.3.2.1 may be used.*

Table 2.4.3.4.14: Temperature of the produced bituminous mixtures of mastic asphalt at the beginning of installation depending on the type of the bituminous binder used

Bitumen type	Temperature of the produced bituminous mixture (°C)	
	recommended	maximum
70/100	190	230
50/70	190	230
40/60	200	240
35/50	200	240
30/45	200	240
20/30	210	250
PmB	according to the manufacturer's instructions	

2.4.3.4.8 Asphalt wearing course – Thin layer decking (SS)

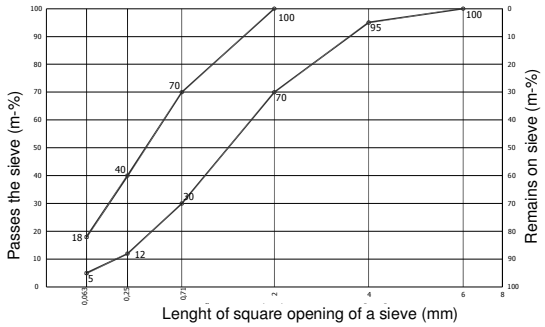


Figure 2.4.3.4.31: Limiting curves of the area for aggregates for thin layer decking SS 2 (Z3)

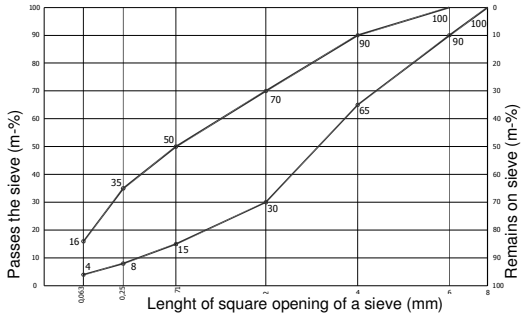


Figure 2.4.3.4.32: Limiting curves of the area for aggregates for thin layer decking SS 4 (Z1/Z3)

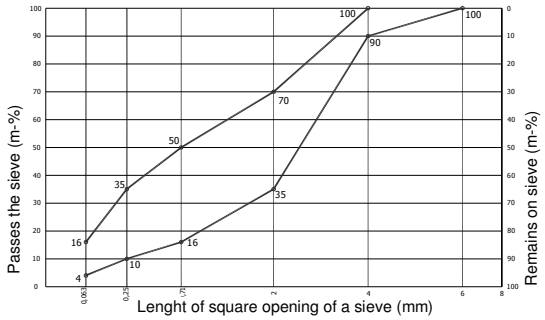


Figure 2.4.3.4.33: Limiting curves of the area for aggregates for thin layer decking SS 6 (Z1)

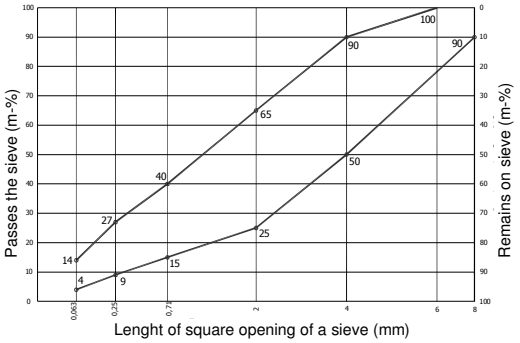


Figure 2.4.3.4.34: Limiting curves of the area for aggregates for thin layer decking SS 8 (Z1)

The micro-texture depth of the thin layer decking of bituminous mixtures of class A1, defined by the procedure required in EN 13036-1, should be in compliance with the requirement in EN 12273 for category 3 (≥ 0.6 mm), and for bituminous mixtures of class A2 – with the requirement for category 1 (≥ 0.2 mm).

2.4.3.4.9 Asphalt wearing course – Surface decking (SD)

The micro-texture depth of the surface decking on the pavement, defined by the procedure stipulated in EN 13036-1, should be in compliance with the requirement for category 3 (≥ 1.0 mm) pursuant to EN 12271.

2.4.3.5 Quality control

The control of the quality and conformity of bituminous mixtures comprises constant internal and independent controls of the production and installation activities, pursuant to the provisions in EN 13108-21 and the requirements stipulated by these technical conditions.

All direct impacts on the quality and requirements for an assessment of the conformity of the produced and installed bituminous mixtures should be stated in the quality rules.

The locations for sampling of the produced bituminous mixtures at the construction site and the installed bituminous mixtures for the asphalt base and wearing courses, as well as the point of measurement of the required properties of the bituminous mixtures, should be defined by a statistic random selection (SRCS, Item 1.4.1).

2.4.3.5.1 Internal Control

Internal control testing during the execution of works should be carried out by a qualified laboratory sourced by the contractor (a separate part of the contractor's organization) or an independent laboratory (third party).

Qualifications of such a laboratory for internal control should be ensured on the basis of recognized professional background for the control system and the declaration of conformity during construction of roads in the Republic of Serbia.

The scope of internal control of the inbound materials and bituminous mixtures for the asphalt base and wearing courses should be specified by a program (pursuant to EN 13108-21) and included in the contract provisions, and it should be finally defined by the supervising engineer on the basis of the test results of the initial production and installation, as well as on the basis of the proposal given by the contractor, who should take into account the minimum frequency of the internal control testing in preparation of the control program proposal.

The contractor should regularly submit the results of the internal control tests and information on the inbound materials to the authority responsible for the execution of the independent control. If the contractor discovers a deviation from the required quality level, he should immediately react in an appropriate way.

If the supervising engineer discovers a considerable deviation of results from the preliminary tests, the defined scope of the minimum internal control tests may be subsequently increased. If the results are uniform, the supervising engineer, in agreement with the independent control contractor, may reduce the scope of the internal control tests.

The minimum scope of internal control tests within the execution of asphalt works is stipulated in Items 2.4.3.5.1.1 to 2.4.3.5.1.3.

2.4.3.5.1.1 Testing of inbound materials

The following internal control tests of the basic inbound material properties, i.e. properties of the aggregate and bituminous binder, should be carried out.

- aggregate	
- rock dust: of the same manufacturer	for every 300 t
- aggregate composition	
- sand: of the same manufacturer - aggregate composition - proportion of fine grains	for every 1,000 t
- crushed aggregate: each aggregate fraction - aggregate composition - proportion of fine grains - form of grains (ratio 1: 3)	for every 2,000 t or at least once a week
- bituminous binder: of the same manufacturer - penetration at 25 °C - softening point pursuant to PK procedure	every tanker or at least once a day for each type

The given conditions of the scope of testing of aggregates should not apply if the aggregate was brought to the facility for the production of bituminous mixtures directly from the facility for the production of the aggregates, with the supplier's declaration of conformity with the requirements defined in the technical conditions.

2.4.3.5.1.2 Testing of bituminous mixture produced

Tests of the bituminous mixture produced are basically defined in EN 13108-21.

Internal control of produced bituminous mixture includes:

- inspection of the temperature of the produced bituminous mixture — for every 1,000 t [1) 2)]
- inspection of the composition and the mechanical and spatial properties of the produced bituminous mixture of the same type — for every 1,000 t [1) 2)] or at least once a day
  - proportion of binder
  - extracted aggregate composition
  - content of overall voids in the bituminous mixture
  - content of voids in the aggregate (calculation)
  - void occupancy in the aggregate with binder (calculation)

[1)] for asphalt base, and for every 500 t in wearing courses

[2)] if small quantities are placed, the appropriate quality should be proven for each bituminous mixture

Samples of the produced bituminous mixture for internal control should be taken from the location of installation. Samples of the bituminous mixture taken from the facility for the production of bituminous mixtures may be used as well.

Within the conformity assessment procedure, the manufacturer of bituminous mixtures should submit evidence that the properties of each bituminous mixture are in compliance with the requirements specified in these technical conditions.

The conformity level of the aggregate composition and the proportion of the soluble bituminous binder with the initial bituminous mixture composition should be determined based on the tolerance of the individual test results or an average value of four test results (Table 2.4.3.3.2).

In case that for the grain size of 1.4 D a 100% percentage in sieving is required, the tolerance is -2 % by mass.

The grain size in the range between D and 2 mm, which is especially important for the definition of composition, may be determined for each bituminous mixture.

The deviation from values in the initial bituminous mixture composition should be determined for each specific property of the composition given in Table 2.4.3.3.2.

Based on the testing results and tolerance (in Table 2.4.3.3.2), the bituminous mixture composition should be classified into conforming and non-conforming. The number of non-conforming results of the last 32 results of individual samples, i.e. of 8 (32 results) for average values of four samples, represents a basis for the definition of the conformity level of the bituminous mixture production (Table 2.4.3.5.1).

Table 2.4.3.5.1: Definition of the conformity level of bituminous mixture production

Number of non-conforming results of the last 32		Conformity level of bituminous mixture production NSP
individual results	average values of four results	
up to 2	0	A
3 to 6	1	B
> 6	≥ 2	C

The minimum frequency of testing of the produced bituminous mixtures in terms of the production conformity level should be determined pursuant to Table 2.4.3.5.2.

Table 2.4.3.5.2: Minimum frequency of testing of the produced bituminous mixtures

Testing frequency level	Production conformity level NSP		
	A	B	C
	Produced bituminous mixture (t/testing)		
X	600	300	150
Y	1000	500	250
Z	2000	100	500

The quantities of the produced bituminous mixture given in Table 2.4.3.5.2 should apply to the test results defined for individual samples or average values of four samples.

The frequency of testing of the produced bituminous mixture should be determined pursuant to the lowest production conformity level in the previous week.

Upon putting into operation a new facility for bituminous mixture production or after displacement of a facility, the frequency of

testing for the production conformity level C should be used until 32 tests have been completed.

If the bituminous mixture production is interrupted for a 3-month period or longer, or a major repair has occurred, the production conformity level should be reduced by one coefficient, until there are 32 results available from the new testing sequence.

Level Z is the minimum testing frequency required for all bituminous mixtures. The provisions of the contract may stipulate higher testing frequency for bituminous mixtures, as defined in Items 2.4.3.5.1.1 and 2.4.3.5.1.2.

2.4.3.5.1.3 Testing of the installed bituminous mixture

The properties of the bituminous mixtures installed in the asphalt concrete-base or wearing course should be checked with the following internal control tests of the installed asphalt surfacing:

- on cores [1)] for every 1,000 t
  - layer thickness
  - layer adherence (if required)
  - layer density
  - content of voids in the layer
- on the layer: for every 200 m^2 [2)]
  - density measured by a non-destructive method
  - smoothness of high plain measured by a 4-meter rod
  - high plain height determined by levelling
  - high plain slope.

[1)] for asphalt base, and for every 500 t in wearing courses

[2)] for asphalt base, and for every 100 m^2 in wearing courses

Cores should be taken in places for sampling of the installed bituminous mixtures.

For bituminous mixtures with a nominal grading of up to 16 mm, cores with a diameter of at least 100 mm should be taken, and for a larger nominal grading – cores with a diameter of at least 150 mm should be taken.

Clean core taking locations coated with bituminous emulsion should be promptly filled with a hot bituminous mixture, which has to be made of similar materials and grading as the mixture installed in the asphalt base or wearing course, and compressed in an appropriate manner.

2.4.3.5.2 Independent control

Independent (external) control may only be carried out by a designated authority (institution).

Independent control
- checks the conformity of the supplied bituminous mixtures for the asphalt base and wearing courses with the manufacturers' declarations of conformity with the CE information
- carries out control of the transport and placement of bituminous mixtures

pursuant to the requirements specified in the technical conditions and/or provisions of the contract.

2.4.3.5.2.1 Control of inbound materials

Independent control tests of properties of the inbound materials should, at the request of the supervising engineer, be implemented in cases of the product non-conformity with the requirements of these technical conditions and enclosed declarations of conformity based on production quality certificates.

2.4.3.5.2.2 Testing of the installed (produced) bituminous mixture

The following independent control tests of properties of the installed (produced) bituminous mixture should be carried out:

- inspection of the temperature of the bituminous mixture during installation — for every 4,000 t 1)
- inspection of the composition and mechanical and spatial properties of the produced bituminous mixture of the same type: — for every 4,000 t 1)
  - proportion of binder
  - extracted aggregate composition
  - extracted binder properties:
    - penetration at 25 °C
    - softening point pursuant to PK procedure
    - penetration index (calculation)
    - breaking point according to Fraas
    - force ductility
- mass per volume of the bituminous mixture (samples according to Marshould at 25 °C)

- content of overall voids in the bituminous mixture
- content of voids in the aggregate (calculation)
- void occupancy in the aggregate with binder (calculation)

[1] for asphalt base, and for every 2,000 t in wearing courses

Samples for independent control tests of the produced bituminous mixture should be taken in the location of installation, and exceptionally in the production facility, if approved by the supervising engineer.

2.4.3.5.2.3 Testing of the installed bituminous mixture

Independent control tests of the installed bituminous mixture should be carried out for the definition of the following characteristics of the executed asphalt base and wearing course:

- on cores (with a diameter of at least 100 mm) — for every 4,000 t [1]
  - layer thickness
  - layer adherence (if required)
  - layer density
  - layer compactness
  - content of voids in the layer
- on the layer: — for every 400 m^2 [2]
  - density measured by a non-destructive method
  - high plain flatness, measured with a 4-meter rod and/or profilometer 4)
  - high plain height determined by levelling
  - high plain slope.
  - friction capacity 3)

[1] for asphalt base, and for every 2,000 t in wearing courses
[2] for asphalt base, and for every 200 m^2 in wearing courses
[3] on sections that are at least 500m long
[4] longitudinal flatness of high plain measured by profilometer and evaluated by IRI index

Cores should be taken in locations for sampling of hot bituminous mixtures. Cores for inspection of thickness and adherence of the layer should be taken by a random selection of the sampling place (SRCS, Item 1.4.1).

2.4.3.5.2.4 Additional tests of the bituminous mixture

Bituminous mixtures for very heavy traffic loads should also be checked in terms of:

- resistance to permanent deformation (occurrence of ruts) at high temperatures and
- resistance to the excess of tensile strength (occurrence of cracks).

Bituminous mixtures for drainage courses should also be checked in terms of the loss of particles.

In bituminous mixtures containing mixtures of silicate and carbon grains (Z2), the proportion of silicate grains should be checked.

2.4.3.5.3 Required properties of installed bituminous mixtures

Based on the testing results within the internal and independent control, the average composition of the bituminous mixture installed in the layer should be evaluated upon the completion of the regular production and installation. The surfacing should also include all the specific characteristics of the installed bituminous mixture and the basic statistical indicators referring to them.

2.4.3.5.3.1 Coefficient of compaction and content of voids

The required limiting values of the coefficient of compaction and content of voids are given for the observed bituminous mixtures installed in asphalt courses, in Item 2.4.3.4.

2.4.3.5.3.2 Layer thickness

The limiting design thickness of bituminous mixture layers installed in asphalt courses are given in Item 2.4.3.3.

An average thickness of the bituminous mixture layer installed in the wearing course may be up to 25% smaller than the designed or contracted layer thickness (ultimate limiting value). The thickness of individual layers evaluated within the average thickness may be smaller by up to 30%.

An average thickness of the bituminous mixture layer installed in the binding, base and base wearing course may be up to 15 % smaller than the designed or contracted layer thickness (ultimate limiting value). Only individually determined thickness may be up

to 25% smaller than the design or contracted thickness.

An average total thickness of the bituminous mixture layer installed in the wearing and base courses may be up to 5 % smaller than the designed or contracted total layer thickness (ultimate limiting value). If, due to the small thickness of the installed wearing, binding and/or base course, an average total layer thickness, determined from the thickness of individual layers, is smaller than the contracted thickness, the client may request deductions.

The thickness of the bituminous mixture layer in the wearing or bound bearing courses may be up to 10% larger than the maximum design thickness.

Excessive average layer thickness should primarily be taken into account for compensation of potential smaller thickness of the substrate layer. For the remaining excessive average layer thickness by up to 5% above the design or contracted thickness, the contractor should be entitled to payment in justified cases. This is to be decided by the supervising engineer.

2.4.3.5.3.3 Adhesion of asphalt courses

Between the installed base and wearing courses of bituminous mixtures, the adhesion force determined by Leutner's procedure (EN B 3639) should be ensured, as given in Table 2.4.3.5.3

It is necessary to inspect the adhesion of the porous asphalt wearing course and substrate layer, and to determine the adhesion force.

Table 2.4.3.5.3: Criteria for adhesion of asphalt courses

Contact of asphalt courses	Traffic load			
	extremely heavy, very heavy, heavy		medium, light, very light	
	shear force kN	adhesion force N/mm^2	shear force kN	adhesion force N/mm^2
- wearing / binding - wearing / upper base	≥ 15	≥ 0.85	≥ 10.5	≥ 0.60
- binding / upper base - wearing / existing - upper base / lower base	≥ 12	≥ 0.68	≥ 8.5	≥ 0.48

The sampling for the inspection of the sheer force or adhesion force of asphalt courses may be carried out when the temperature of the installed bituminous mixtures is ≤ 25 °C.

If immediately upon installation the adhesion of asphalt courses is weaker than the required limiting value, the tests should be repeated after a month.

2.4.3.5.3.4 Evenness, height and slope of the high plain

The evenness of the high plain of the asphalt base and wearing course should be determined – in an arbitrary direction in relation to the road centre line – as a deviation below a laid 4 m long measuring rod, or by another adequate measurement method (SRMG, Item 3.1.3.1, i.e. EN 13036-7).

The limiting deviation values of the high plain of the bituminous mixtures installed in the wearing or base course from the measuring rod are given in Table 2.4.3.5.4.

If the evenness deviations are higher or consecutive, the decision should be made by the supervising engineer.

Since the pavement evenness with surface decking remains similar to the previous substrate evenness, requirements referring to that have not changed.

The height of the individual measuring places on the high plain of the bituminous mixture installed in the asphalt base or wearing course should be determined by levelling. The high plain of the asphalt binding course and/or upper base may, in an arbitrary place,

deviate from the design elevation by up to ± 10 mm (limiting value), and the high plain of the asphalt lower base – by up to ± 15 mm.

The high plain slope of the asphalt base and wearing course should be equal to the crossfall and longitudinal slope of the pavement. Permitted deviations of slope are defined by the permitted irregularities and deviations from the high plain height of that course, but they should not exceed ± 0.4 % total.

On roads where high travel speeds are permitted, and the longitudinal slope is lower than 0.5% and planned crossfall is lower than 1.5%, the crossfall may be 0.2% higher than planned.

Table 2.4.3.5.4: Limiting deviation values of the evenness of asphalt courses high plains

Traffic load / conditions of execution	Limiting deviation value of high plain evenness (mm)		
	wearing courses	binding and/or upper base courses	lower base courses
- extremely heavy, very heavy and heavy traffic loads:			
- mechanical installation:			
- in one layer	≤ 4	≤ 8	≤ 10
- in two layers (on lower layer)	-	≤ 10	≤ 15
- medium, light and very light traffic loads:			
- mechanical installation	≤ 6	≤ 10	≤ 15
- installation on existing pavements with placement in inlets and expansion joints, as well as manual installation	≤10	≤ 15	≤ 20

2.4.3.5.4 Conformance assessment

Upon completion of individual works or stages of works within the execution of asphalt courses, it is necessary to carry out statistical analyses of the results of the internal and independent control of:
- inbound materials,
- the produced bituminous mixture and
- the installed bituminous mixture.

The contractors of both the internal and independent control should prepare a statistical analysis of the control testing results, each of them for their own activities.

The statistical analyses and their comparison represent a basis for the assessment of the quality conformance and for potential claims and measures.

The assessment of conformance of the results of all the control tests with the requirements in the contractual documentation and technical conditions should be prepared by the inspection authority responsible for the independent control and submitted to the supervising engineer.

2.4.3.6 Measuring and acceptance of works

2.4.3.6.1 Measuring of works

All the works executed within the bitumen bound courses should be measured pursuant to provisions specified in the general technical conditions (Item 1.2.2.2).

The measured values of the asphalt courses installed in the pavement structures should be determined based on the widths defined by widenings in Figure 2.4.3.6.1.

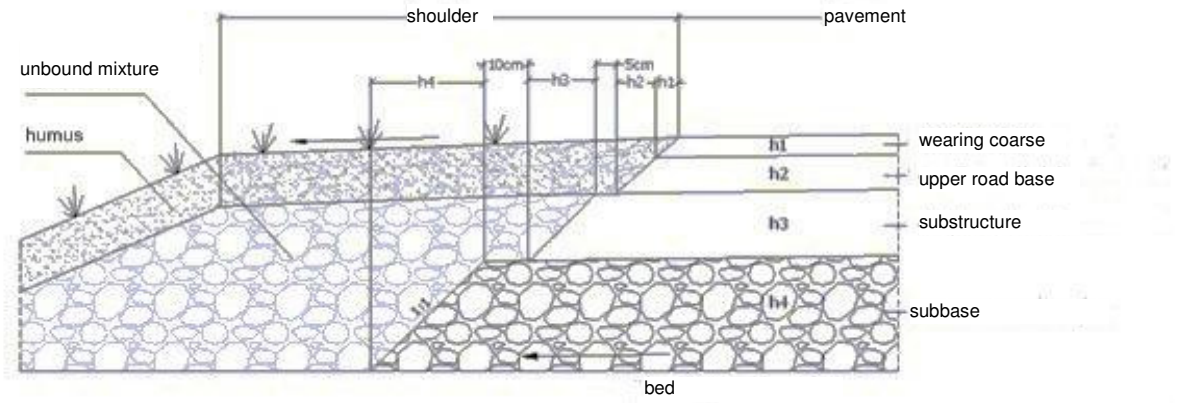


Figure 2.4.3.6.1: Completion of asphalt courses installed in pavement structures

2.4.3.6.2 Acceptance of works

For acceptance of all the works executed within the bitumen bound courses the provisions defined in the general technical conditions should apply (Item 1.2.2.3).

The installed asphalt base and wearing courses should be accepted by the supervising engineer pursuant to the quality requirements given in the technical conditions and in compliance with the requirements of the contractual documents, and upon written notice of the contractor on the completion of works. At the same time, the contractor should submit to the supervising engineer all data and the report of the internal control on conformance of the works executed with the requirements in the technical conditions. The contractor should eliminate all the discovered deficiencies in relation to the requirements prior to further works; otherwise, deductions for improper quality of the works executed should be calculated.

All costs for the elimination of the deficiencies should be borne by the contractor, including the costs of all measurements and tests that have resulted in the inappropriate quality of executed works, and due to which it was necessary to determine the quality of works through repeated tests upon the execution of adequate repairs.

For all works that are not in compliance with the quality requirements specified in these technical conditions (exceeding the defined limiting or ultimate limiting values) and that have not been repaired by the contractor pursuant to the instructions of the supervising engineer, the contractor should not be entitled to any payments. In such a case, the client should be entitled to prolong the warranty period for all works depending on works that have not been repaired, for at least a 5-year period. If upon expiration of such a prolonged warranty period there are no visible errors resulting from the previously discovered deficiencies, the contractor should be entitled to payment for the works executed.

2.4.3.7 Calculation of works

2.4.3.7.1 General

The quantities of executed works determined pursuant to condition in Item 2.4.3.6 should be calculated according to the contracted unit prices.

The unit price should take into account all services needed for the complete execution of the asphalt base and wearing course. The contractor may not demand additional payments, unless agreed otherwise in the contract.

If the contractor fails to ensure the quality within the required values, and if the deductions from his payment have already been calculated, all of his contractual liabilities referring to the warranty should remain in force.

2.4.3.7.2 Deductions Due to Inadequate Quality

Deductions should be determined either on the basis of the inadequate average value for the works executed or on the basis of inadequate individual defined values. The higher deduction value should be relevant.

In the case that:
- the proportion of the bituminous binders in the bituminous mixture is too small, or
- there are too many voids in the installed asphalt course,

the higher deduction value should be relevant.

2.4.3.7.2.1 Basic materials

It is necessary to ensure the quality of the basic materials defined in Items 2.4.3.2.1.2 and 2.4.3.2.2.2.

If the contractor installs in the binding base or wearing course a bituminous mixture whose composition during production or placement deviated from the limiting values defined for the composition, deductions should be calculated for deviations between the limiting composition value and the ultimate limiting value for the produced or installed bituminous mixture.

If the contractor installs in the binding, base or wearing course a bituminous mixture in which the determined values exceed the required ultimate limiting values or in which the basic material is not in compliance with the requirements from Items 2.4.3.2.1.2 and 2.4.3.2.2.2, the supervising engineer, who can also reject all the works executed, should decide about the method of calculation of executed works.

2.4.3.7.2.2 Executed works

Due to:
- a small percentage of bituminous binder in the bituminous mixture, which is defined in the requirements for bituminous mixture composition,
- inadequate content of voids in the installed layer of bituminous mixture,
- small thickness of the executed asphalt course,
- poor adhesion of the installed asphalt courses, and
- inadequate evenness of the high plain of the executed asphalt course,

the client may calculate deductions. The limiting values for the individual characteristic properties of bituminous mixtures installed in asphalt surfacing are defined in Items 2.4.3.3.3 and 2.4.3.4. The ultimate limiting values, i.e. deviations from the limiting value, are given in Table 2.4.3.7.1.

Table 2.4.3.7.1: Ultimate deviations from the limiting values of properties of the installed asphalt surfacing

Characteristic properties	Unit of measure	Deviation from the limiting value
- percentage of bituminous binder	% by m.	- 0,3
- content of voids in the installed bituminous mixture	% by v.	2
- thickness of the installed asphalt course	%	-15 [1)]/ -25[2)]
- adhesion of the installed asphalt courses	%	- 25
- evenness of high plain of the installed asphalt course		
- 4 m rod or	mm	+ 4[3)]/ +6[4)]
- IRI	mm	0.6

[1)] *Progressively above 3% to 15% for bearing courses*
[2)] *Progressively above 3% to 25 % for wearing courses*
[3)] *Above the limiting value for wearing courses*
[4)] *Above the limiting value for bearing courses*

Deductions should be evaluated on the following bases:

- **due to a small percentage of bituminous binder in the bituminous mixture**, pursuant to the formula

$$FO = p^2 \cdot C \cdot PD \cdot f$$

where:
FO - financial deduction (€)
p - deviation from the defined bottom limiting value of the binder percentage, but by up to -0,3% (totally), i.e. up to the ultimate limiting values
C - unit price of the quantity of executed works (€/m^2)
PD - scope of poorly executed works
f - difficulty factor

Example 1:

Stone mastic asphalt SMA 8:

- limiting value:	B_{min} ≥ 6.5 m.-% -0.2 m.-%
- defined value:	B = 6.2 m.-%
- tolerance:	B_{odst} = 0.3 m.-%
- unit price:	C = 11.50 €/m^2
- scope of poorly executed works:	PD = 6,800 m^2
- difficulty factor	f = 3
	p = B_{min} – B = 6,3 – 6,2 = 0,1 m.-%
	$FO = 0.1^2 \cdot 11.50 \cdot 6{,}800 \cdot 3 = 2{,}346$ €

- **due to inadequate content of voids in the installed bituminous mixture,** if the value stipulated in the requirements is exceeded, pursuant to the formula:

$$FO = \frac{p^2}{100} \cdot C \cdot PD \cdot f$$

where:
p - deviation from the defined limiting value of the content of voids, but by up to ± 2 % (totally), i.e. up to the ultimate limiting values

Example 2:

Asphalt concrete for wearing courses AC 11 surf:

- limiting value: V_{max} = 8.5 V.-%
- defined value: V = 9.2 V.-%
- tolerance: V_{odst} = 2 V.-%
- unit price: C = 10.00 €/m^2
- scope of poorly executed works: PD = 11.700 m^2
- difficulty factor f = 6

p = V - V_{max} = 9.2 – 8.5 = 0,7 V.-%

$$FO = \frac{0.7^2}{100} \cdot 10.00 \cdot 11{,}700 \cdot 6 = 3{,}43980 \ €$$

- **due to a small thickness of the executed asphalt courses:**

$$FO = \frac{p^2}{100} \cdot C \cdot PD \cdot f$$

where:

p - % of small thickness of the asphalt course (deviation from the limiting value)

Example 3:

Asphalt concrete AC 11 surf

- contracted thickness 40 mm
- limiting thickness (- 25%) 30 mm
- defined average thickness 32 mm (- 20%)
- unit price: C = 11.80 €/m^2
- scope of poorly executed works: PD = 8,200 m^2
- difficulty factor f:

p (%)	4	6	8	10	12	14	16	18	20	22	24	25
FO'	1.25	1.29	1.33	1.37	1.43	1.49	1.56	1.64	1.73	1.83	1.94	2.00
f	0.313	0.215	0.166	0.137	0.119	0.106	0.098	0.091	0.087	0.083	0.081	0.080

$$FO = \frac{20^2}{100} \cdot 11.80 \cdot 8{,}200 \cdot 0.087 = 33{,}672.48 \ €$$

Example 4:

Asphalt concrete AC 22 base

- contracted thickness 80 mm
- limiting thickness (- 15%) 68 mm
- defined average thickness 72 mm (- 10%)
- unit price: C = 12.60 €/m^2
- scope of poorly executed works: PD = 8,200 m^2
- difficulty factor f:

p (%)	4	5	6	7	8	9	10	11	12	13	14	15
FO'	1.25	1.27	1.30	1.33	1.37	1.42	1.48	1.55	1.64	1.74	1.86	2.00
f	0.313	0.254	0.217	0.190	0.171	0.158	0.148	0.141	0.137	0.134	0.133	0.133

$$FO = \frac{10^2}{100} \cdot 12.60 \cdot 8{,}200 \cdot 0.148 = 15{,}291.36 \ €$$

Example 5:

Asphalt wearing, binding and base course, jointly

- contracted total thickness 40 + 60 + 100 = 200 mm
- limiting total thickness (- 3%) 194 mm
- defined average total thickness 195 mm (- 2.5%)
- price for total thickness: C = 11.80 + 9.60 + 15.80 = 37.20 €/m^2
- scope of poorly executed works: PD = 8,200 m^2
- difficulty factor f=1

$$FO = \frac{2.5}{100} \cdot 37.20 \cdot 8{,}200 = 7{,}626 \text{ €}$$

- **due to weak adhesion of the installed asphalt courses,** if the value stipulated in the requirements is exceeded, pursuant to the formula:

$$FO_2 = \frac{p^2}{100} \cdot C \cdot PD \cdot f$$

where:

p - deviation of the sheer force from the defined value, but by up to 4 kN (totally), i.e. up to the ultimate limiting values

Example 6:

Adhesion of the wearing sealing and upper base course

- limiting value of shear force: ≥ 15 kN
- defined value: 12 kN
- tolerance: 25 %
- unit price: C = 11.50 €/m^2
- scope of poorly executed works: PD = 2,900 m^2
- difficulty factor f = 0.02

p = (15 – 12) : 15 = 20 %

$$FO = \frac{20^2}{100} \cdot 11.50 \cdot 2{,}900 \cdot 0.02 = 2{,}668 \text{ €}$$

- **due to inadequate evenness of high plain of the newly constructed asphalt wearing course,** if the values stipulated in the requirements are exceeded, pursuant to the formula:

  - for measurements with a 4-meter rod

$$FO_{4m} = \sum p^2 \cdot \check{s} \cdot C \cdot f$$

where:

p - deviation of the high plain evenness from the defined limiting value, but by up to 6 mm (totally), i.e. up to the ultimate limiting values

  - for measurements by profilometer ZAG-VP:

$$FO_{IRI} = \sum p^2 \cdot PD \cdot C \cdot f$$

where:

p - deviation of the high plain evenness from the defined limiting value, but by up to 0.6 of the IRI index value (totally), i.e. up to the ultimate limiting values

Example 7:

Measurements with a 4-meter rod:

- limiting value of the high plain unevenness 4 mm
- tolerance: > 4 mm to 10 mm = 6 mm
- traffic lane width: w = 3.50 m
- unit price: C = 10.20 €/m^2
- difficulty factor f = 0.6
- defined values:

Measured unevenness (mm)	Deviation from the limiting value p	p^2	Number of deviations n	p^2 x n
4	-	-	-	-
5	1	1	1	1
6	2	4	3	12
7	3	9	1	9
8	4	16	2	32
9	5	25	-	-
10	6	36	1	36
			Σp^2:	90

$FO_{4m} = 90 \cdot 10.20 \cdot 3.50 \cdot 0.6 = 1{,}927.80$ €

Example 8:

Measurements of the longitudinal profile by profilometer:

- limiting value of the IRI index: $h_m = 2.0$
- tolerance: 0.6 ($h_{sm} = 2.6$)
- traffic lane width: w = 3.50 m
- unit price: C = 10.20 €/m^2
- difficulty factor:

$$f = \frac{h_m}{h_{sm} - h_m} = \frac{2.0}{2.6 - 2.0} = 3.33$$

- defined values of IRI between h_{sm} and h_m:

Measuring section (length 100 m)	Measured value IRI
4	2.17
17	2.34
18	2.50
19	2.44
20	2.36
27	2.27
28	2.23
7 in total	16.31
h_{pros}:	2.33

$$\sum p = \frac{h_{povpr} - h_m}{h_m} = \frac{2.33 - 2.0}{2.0} = 0.165$$

$$\sum p^2 = 0{,}0272$$

PD = 3.50 · 100 · 7 = 2,450 m^2

FO_{IRI} = 0.0272 · 2,450 · 10.20 · 3.33 = 2,263.49 €

An excessive deviation of the high plain evenness of the executed asphalt course should be repaired by the contractor through the implementation of adequate measures, where the planned bearing capacity of the pavement structure may not be reduced. If the condition cannot be repaired in an adequate manner, the supervising engineer or the client may reject to accept the works executed.

2.4.3.7.3 Warranty

During assessment of the current condition of executed works it is necessary to take into account the wear resulting from traffic load within the warranty period.

The contractor should guarantee the adequate condition of the bituminous mixtures installed in asphalt courses within the following warranty periods:

- the warranty period is 5 years (upon the release of traffic) for bituminous mixtures installed in the asphalt base and wearing courses if they are placed within the pavement structure during new construction that was dimensioned pursuant to the defined design requirements (Guidelines SRDM, Item 8.3.6) for the planned traffic load
- for all other methods of construction (on adequately dimensioned substrate bearing capacity), concluding with the adequately dimensioned surface dressing and reinforcement of the existing pavement structures (upon elimination of the cause of changes), the following warranty periods should apply:
  - 2 years
    - for wearing courses that are at least 2 cm thick and installed on the existing substrate layer of bituminous mixture
  - 3 years
    - for bearing courses
  - 5 years:
    - for surfacing installed by a hot procedure with a thickness exceeding 7.5 cm

If, due to the construction site, temporary traffic functioning along the asphalt course for a period longer than one year is required, in the case of partial acceptance of an individual traffic lane the warranty period for such a lane is prolonged by one year.

In case that the asphalt course is executed by a method that is not defined in these technical conditions, the warranty period should be specified in the contract.

2.4.4 CEMENT BOUND COURSES

2.4.4.1 Cement bound base courses

2.4.4.1.1 Description

Execution of the cement bound (stabilized) base course (CSBC) comprises the provision of an appropriate aggregate and cement, the production and installation of an adequate mixture, and the treatment of the installed base course in the locations stipulated by the project documents.

These works should be executed when there is no rainfall and when the air and substrate temperature (with no wind) during installation amounts to 5 °C to 25 °C.

Cement bound base courses are most frequently installed in pavement structures for heavy traffic loads and, as a rule, between the unbound base course and the bound upper base. For lighter traffic loads, the base course is executed in such a way that it may be the only upper roadbase in the pavement structure.

The type of the aggregate bound to the base course with cement is, as a rule, defined in the project documents. If this is not the case, it will be determined by the supervising engineer.

2.4.4.1.2 Basic materials

The basic materials applied in the process of execution of cement bound base courses are:
- stone grain mixtures (aggregates),
- hydraulic binders – cements, and
- water.

2.4.4.1.2.1 Aggregates

For cement bound (stabilised) base courses, natural, crushed and mixed aggregates defined in Item 2.4.2.2.2 of these special technical conditions are used.

The quality of the aggregates for cement bound base courses is given in EN 13242 – Aggregates for unbound materials and materials bound by hydraulic binders to be used in engineering and road structures.

For cement bound (stabilised) base courses that are bound with hydraulic and combined binders, aggregates that are in compliance with the conditions defined for the granulometric composition in Figures 2.4.2.2 to 2.4.2.4 in Item 2.4.2.2.3.1 of these technical conditions may be used. In addition, the stone grains in mixtures for cement bound base courses should have the following mechanical properties:
- resistance of stone grains to crushing, defined by the Los Angeles procedure (stipulated in EN 1097-2), may have the following values:
  - for roads with very heavy and heavy traffic load – up to 30% (category LA_{30}),
  - for roads with medium or light traffic loads – up to 35 % (category LA_{35}),
- resistance of aggregates to frost, defined pursuant to EN 1367-2: the loss based on tests with magnesium sulphate and expressed as a percentage of the separate parts of the preliminary sample mixture, may amount to 25% by mass (category MS_{25}), and based on tests with sodium sulphate – up to 8% by mass.
- maximum 20% by mass of grains may be present in the mixture, whose form (defined pursuant to EN 933-4) is not in compliance with condition $l : d \leq 3 : 1$ (category SI_{20}),
- the content of organic and other harmful admixtures in the mixture should ensure the production of mixtures for CSBC of the required quality (tests pursuant to EN 1744-1).

As a rule, the content and quality of the aggregate should be defined in the project documents. If this is not the case, CSBC coarse stone grains should be used for thicker base courses; their size is limited to 63 mm.

The contractor of the CSBC may also use different aggregates from those defined initially, provided that the use of such a mixture under specific conditions is approved by the authorized (independent) institution and if the use is permitted by the supervising engineer.

Prior to the commencement of works it is necessary to test each aggregate planned for use in CSBC, pursuant to the given requirements.

If the supervising engineer has already approved the use of the same aggregate for the sub-base or in the road base, it is not necessary to repeat the testing of the mixture.

2.4.4.1.2.2 Cements

For stabilisation of the properties of materials and produced mixtures installed in lower base courses the following hydraulic binders may be used:

- Portland cement with puzzolans (CEM II/B-P)
- Portland cement with granulated slag from blast furnaces (CEM II/B-S).

Metallurgical cement and complex binder, i.e. a mixture of Portland cement and flying ashes, may also be used in specific conditions. The contractor may use these and other binders if he proves their usability by submitting the adequate evidence and with the approval of the supervising engineer.

The required basic properties of binders for cement bound (stabilised) base courses are given in Table 2.4.4.1.1.

Table 2.4.4.1.1: The required cement properties for stabilisation of aggregates for cement bound base courses

Cement properties	Unit of measure	Required value	Testing procedure
Grinding fineness (residue on sieve 0.09 mm), maximum	% by m.	10	EN 196-6
Binding time:			EN 196-3
- beginning, not before	h	1	
- end, not later than	h	10	
Water needed for standard consistency, maximum	% by m.	31	EN 196-3

2.4.4.1.2.3 Water

For preparation of mixtures for base courses of aggregates bound by hydraulic binder, only running or standing water may be used, and its properties should be in compliance with the requirements in EN 1008 and the requirements given in Table 2.4.4.1.2.

Table 2.4.4.1.2: The required properties of water for stabilisation of aggregates for cement bound base courses

Water properties	Unit of measure	Required value	Testing level
pH value, minimum	-	6	EN 1008
Sulphite content (SO_4), maximum	mg/l	2700	EN 196-2
Content of chlorine ions, maximum	mg/l	300	EN 196-21
Salt content (dry residue), maximum	mg/l	500	EN 1008

2.4.4.1.3 Manner of Execution

2.4.4.1.3.1 Deposition Sites of Materials

Prior to the beginning of exploitation, the contractor should prepare deposits and/or storage sites of the aggregate and cement for CSBC in a timely and appropriate manner, and he should present evidence to the supervising engineer of the conformity of such materials with the requirements from Item 2.4.4.1.2 of these technical conditions, as well as obtain his consent (approval) for use.

Storage sites of aggregates should, as a rule, be protected from rainfall, and the equipment for cement storage should have the capacity to prevent the impact of moisture from the air.

Aggregates and cement should be stored in a way that will ensure the constant quality and uniformity of production of mixtures for the cement bound (stabilised) base courses.

2.4.4.1.3.2 Preliminary tests

At least 7 days prior to the commencement of installation of the mixture of materials for CSBC, the contractor should submit to the supervising engineer the technological information for approval; the information should include:
- preliminary content of the mixture of materials
- evidence of the conformity of all materials to be used
- a programme of the average frequency of internal and external controls
- a description of the technological procedures, and
- Information on the machinery.

Prior to the commencement of the operation of the machines and equipment affecting the quality of executed works it is necessary to check their condition and capacities to ensure a uniform operation pursuant to the requirements of these technical conditions.

All the equipment and machines should be certified and should have the capacity that will meet the requirements of the project documents and these technical conditions.

Prior to the commencement of the execution of works, the contractor should propose to the supervising engineer the preliminary (laboratory) composition (recipes) for mixtures of materials for CSBC, which should contain:
- the type and quantity of the aggregate,
- type and quantity of cement,
- water quantity and
- mechanical properties of the aggregate.

With the use of the preliminary content of mixtures for CSBC, the contractor should prove that through an applied technological procedure he can achieve the required mixture quality defined in these technical conditions (Table 2.4.4.1.3). As a rule, fulfilment of all the requirements should be proven n a trial field.

Table 2.4.4.1.3: Required aggregate properties for CSBC in the preliminary composition

Water properties	Unit of measure	Required value	Testing level
Percentage of cement (informative)	% by m.	2	-
Compressive strength of hardened mixture after 7 days (trial cylinders D = 15 cm, h = 15 cm):			EN 12390-2
- average	MN/m^2	3.5	-
- maximum/minimum	MN/m^2	4.5/2.5	-
Resistance to frost / ratio	-	0.7	EN 12390-2

The contractor should not start the works prior to obtaining the consent of the supervising engineer for the preliminary composition of the mixture for CSBC.

If in the previous year the contractor executed CSBC with the same materials, the results of the internal controls for the produced mixtures may used. The final decision on this should be made by the supervising engineer.

2.4.4.1.3.3 Production of the mixture of materials for CSBC

Production of the mixture of materials, which comprises aggregate, hydraulic binder and water, should be carried out by concrete mixers with proper proportioning of the individual materials by the feeding method, and in exceptional cases by a continuous method of work.

The measuring devices should ensure the appropriate mass percentage of the individual integral parts of the mixture. The definition of integral parts by volume is permitted only in cases when this is approved by the supervising engineer.

The mixing time and other impacts should be harmonised so as to ensure the uniformity of the mixture of materials.

If any changes occur during the production or installation of CSBC, the contractor should prepare a proposal of changes in written form and submit it to the supervising engineer. The changes should come into force only

upon their confirmation by the supervising engineer.

2.4.4.1.3.4 Preparation of the substrate high plain

The following may be used as a substrate for cement bound (stabilised) base courses:
- the sub-base high plain, which should be executed pursuant to the requirements in Item 2.4.2.2.5 of these technical conditions, or
- the capping layer high plain, which should be executed pursuant to the requirements in Item 2.2.5.3.8 of these technical conditions.

The execution of the cement bound base courses may start only upon the acceptance of the substrate high plain by the supervising engineer, pursuant to the given requirements.

Until the commencement of installation of CSBC, the contractor should maintain the substrate high plain in the condition valid at the time of acceptance. The contractor should repair all damage in a timely manner and should give evidence of the repairs performed to the supervising engineer.

2.4.4.1.3.5 Aggregate filling

The aggregate filling for CSBC on the prepared substrate high plain, which must not be frozen, may start only after the approval of the supervising engineer.

The transport should be carried out with the use of appropriate vehicles equipped for rear unloading (into a paver) and with tarpaulins for protection of the freight from getting dry, and from rainfall and dust.

The inner surfaces (bottom and sides) of the steel cargo container of freight vehicles should be sprayed with water prior to the loading of the aggregate.

The number of vehicles for transport of the aggregate to the construction site should be adjusted to the requirements of continuous installation, pursuant to the capacities of the production facility and the transport distance.

2.4.4.1.3.6 Placement of the mixture of materials

The surface of the substrate on which the aggregate, hydraulic binder and water will be installed in the CSBC should be dampened with water prior to filling.

The placement of the mixture of materials in CSBC should, as a rule, be mechanical, with the use of a paver. Manual placement is allowed in exceptional cases if the use of the machine is not possible due to limited space. Manual placement should be approved by the supervising engineer.

If permitted by the working conditions, the cement bound (stabilised) base course should be installed along the entire width. If two pavers are used during the installation, with overlapping, the difference in quality in the area of contact must not be visible.

When the placement is carried out in several layers, the longitudinal joints of the CSBC should be mutually sheared by at least 20 cm, and the transverse (cold) joints - by at least 50 cm.

Each interruption of activities should be executed along the overall width of the pavement or traffic lane, perpendicularly to the road centre line and vertically to the layer thickness. Deviations from the foregoing are possible only with the approval of the supervising engineer.

The paver performance during spreading of the mixture of materials should ensure a minimum compaction of 85 %.

To ensure the required properties of the installed mixture of materials, the percentage of water may be up to 1.5 % by mass higher than the optimal value pursuant to the modified Proctor's procedure.

The overall process of production, transport, installation and compaction of the mixture of materials may not last longer than 2 hours.

The selected type and number of rollers, as well as the method of compaction, should ensure the most uniform possible density, i.e. compaction of the mixture of materials along the design pavement width. For this reason it is necessary to increase the width of the layer by the design thickness of +5 cm, unless this is planned in the project documents.

The mixture installed in the CSBC should be compressed from the edges towards the centre of the course, and from the lower towards the upper edge of the course. Individual passages of the roller should constantly be covered. Any retention of the roller on the installed course should be prevented.

All places that are inaccessible for machines should be compacted by other means, whose application should be approved by the supervising engineer, along with the conditions in which such means should be used.

If aggregate, hydraulic binder and water is installed in the CSBC, traffic at the construction site may be allowed in that area, and the placement of the subsequent layer of the pavement structure may start immediately upon binding of the surface protection substance.

The supervising engineer may also determine other conditions for traffic release on the CSBC.

The installed course of the mixture of materials should be treated at least 3 days by dampening or another appropriate procedure for protection from drying out (spraying with cationic emulsion, covering, and upgrade).

If aggregate, hydraulic binder and water is installed in the CSBC, the mixture of materials should achieve the required compressive strength and resistance to frost, or it should be protected from frost by appropriate upgrading. The supervising engineer should decide about the need and method of protection.

2.4.4.1.4 Quality of execution

The contractor should inspect and prove the regularity of composition of the mixture of materials installed in CSBC.

The average compaction of the installed mixture of materials should amount to at least 97% of density of the mixture of preliminary composition, and the bottom limiting value is 94% in relation to dry mass per volume defined pursuant to the modified Proctor's procedure.

The percentage of water in the installed mixture of materials may be up to 1.5 % by mass higher than the optimal value, defined for the preliminary mixture composition.

An average compressive strength of tested samples of the installed mixtures of materials after 7 days should amount to at least 3.5 MN/m^2, the minimum individual value may be 2.5 MN/m^2, while the maximum individual value may be 4.5 MN/m^2.

The resistance of the mixture of material to frost should be determined as a ratio of the average values of the compressive strength of the samples tested, which are exposed to alternate freezing and melting (25, i.e. 25 cycles), and samples tested in normal conditions. The minimum value of the coefficient of resistance should amount to 0.7.

The installed mixture layer should be protected from drying out by spraying with a cationic bituminous emulsion (0.8 to 1.0 kg/m^2), which is also used for sticking of the installed layer to the CSBC.

The thickness of the installed mixture layer may deviate from the design thickness by a maximum -10% and, in exceptional cases, individual values of the mixture may deviate by -30 mm.

The height of the high plain installed in CSBC may deviate from that planned by up to +10 / -15 mm, the unevenness (measured with a 4-meter rod) by maximum 15 mm, and the slope by up to +0.4% of the absolute inclination value.

2.4.4.1.5 Quality control

2.4.4.1.5.1 Internal Control

The internal control of the contractor during the CSBC installation should determine the conformance of the properties of the basic materials and produced and installed mixtures of materials with the contractual provisions and requirements given in the project documents and these technical conditions.

The type and frequency of testing within the internal control of the CSBC execution should be defined in the verified program of the average control frequency. If a programme has not been designed, the supervising engineer should prepare it and, based on a statistical random selection, define sampling and measuring points (Item 1.4.1).

During the installation of the mixture of materials in the CSBC, the laboratory responsible for internal control should take samples for testing and check the conformance of the properties in accordance with the frequency given in Table 2.4.4.1.4.

Table 2.4.4.1.4: Minimum frequency of the testing of the mixtures of materials during the internal control of installation in the cement bound base course

Properties	Testing procedure	Minimum frequency of testing
Aggregate:		
- composition	EN 933-1	3,000 t
- properties - Item 2.4.4.1.2.1	EN 13043	15,000 t
Binder:		
- cement – Table 2.4.4.1.1	EN 196	300 t
Water – Table 2.4.4.1.2	EN 1008	as needed
Mixture of materials:		
- optimal moisture and density	EN 13286-2	10,000 m^2
- percentage of binder	-	5,000 m^2
- compressive strength	EN 12390-2	5,000 m^2
- resistance to frost	-	20,000 m^2
- density and moisture	SRCM, Item 1.2.4	150 m^2
- layer thickness	-	200 m^2
- evenness, height, slope	SRMG, Article 3.1.2.1	200 m^2

2.4.4.1.5.2 Independent (external) control

The independent control to be performed by the institution authorized by the client should comprise of:
- definition of the conformity of the mixture of materials produced and installed in the CSBC with the requirements given in the project documents and these technical conditions
- supervision over the internal control.

The scope of inspection by the independent control is, as a rule, in a ratio of 1:4 with the conformity tests undertaken during the internal control.

The properties of the mixture of materials for the CSBC, whose conformity with the requirements given in the project documents or these technical conditions should be inspected, should be stated in the verified program of the average control frequency. If this is not the case, they will be determined by the supervising engineer.

As a rule, the samples for independent control of the mixture of materials should be taken in the location of the installation. The locations for sampling within the independent control should be determined by the supervising engineer.

The sampling for the needs of the independent control and for testing and measurements at the construction site should, as a rule, be carried out in the presence of the contractor and supervising engineer.

A statistical analyses and comparison of the testing results within the internal and independent control represent a basis for the assessment of the conformity of the executed works with the requirements, and for definition of the potential measures for elimination of deficiencies.

The institution performing the independent control of conformity of the mixtures of materials with the requirements should, as a rule, prepare an assessment of conformity in written form and submit it to the supervising engineer.

2.4.4.1.6 Measuring and acceptance of works

2.4.4.1.6.1 Measuring of works

As a rule, the works executed within the CSBC are measured pursuant to the general technical conditions, Item 1.2.2.2, and the quantities are calculated in square metres.

All quantities should be measured according to the actual scope and type of the works executed within the dimensions given in the project documents, which were documented in writing in a timely manner.

2.4.4.1.6.2 Acceptance of works

The installed CSBC should be accepted by the supervising engineer after a written notification by the contractor on the completion of works pursuant to the quality requirements in accordance with the provisions of these and the general technical conditions, Item 1.2.2.3.

The contractor should eliminate all the discovered deficiencies in relation to the requirements prior to further works; otherwise, deductions for improper quality of the works executed should be calculated.

2.4.4.1.7 Calculation of works

2.4.4.1.7.1 General

The executed works are to be calculated according to the general technical conditions (Item 1.2.2.4).

The quantities defined in Item 2.4.4.1.6.1 and accepted pursuant to Item 2.4.4.1.6.2 should be calculated pursuant to the agreed unit prices.

The agreed unit price should include all the expenses needed for the final completion of works. The contractor may not demand additional payments, unless agreed otherwise in the contract.

If the contractor fails to ensure the quality within the required values and if deductions have already been calculated, all of his contractual liabilities should remain in force.

2.4.4.1.7.2 Deductions Due to Inadequate Quality

2.4.4.1.7.2.1 Quality of basic materials

It is necessary to ensure the quality of basic materials defined in Item 2.4.4.1.2.

Due to the required quality of materials for the CSBC, there will be no deductions in calculating the works.

If the contractor installs in the CSBC a material that is not in compliance with the requirements given in these technical conditions, the supervising engineer, who may also reject the entire work executed, should make a decision on the calculation method.

2.4.4.1.7.2.2 Quality of execution

The assessment of the quality of execution and the method of deductions due to improper quality should be determined pursuant to the provisions under Item 2.4.4.1.4.

If the contractor fails to provide the required quality of execution, the supervising engineer should decide about the calculation method. In the case that the supervising engineer discovers during the installation of the mixture of materials:
- improper percentage of the hydraulic binder added,
- improper compaction of the installed mixture of materials,
- improper compressive strength and/or
- improper layer thickness,

during the calculation of works he should apply financial deductions, which should be determined on the following bases:

- **due to inadequate percentage of hydraulic binder** in the mixture, if the optimal quantity determined on the basis of the preliminary composition is (relatively) insufficient by more than 5% (limiting value), pursuant to the equation:

$$FO = \frac{p^2}{100} \times 0.5 \times C \times PD$$

where:

FO - financial deduction
p - excess of the given limiting value (relatively) in %, but only when considering individual values up to the ultimate limiting value of the excess of 15% and insufficient quantities up to 10% (relatively)
C - unit price of the quantity of executed works (KM),
PD - the scope of executed works with deficiencies (m^2)

The deductions are determined based on an average value for the works executed.

Calculation of deductions: $\mathrm{FO}' = p^2 \times 0.5$ (%)

p (%)	1	2	3	4	5	6	7	8	9	10
FO' (%)	0.5	2	4.5	8	12.5	18	24.5	32	40.5	50

- **due to the insufficient compaction** of the installed mixture of materials (below 97%) pursuant to the modified Proctor's procedure, according to the equation:

$$FO = \frac{1}{100} \times (11p - 4.5) \times C \times PD$$

where:

p - % of (total) compaction below the required value (97%)

Calculation of deductions: $FO' = 11p - 4.5$ (%)

p (%)	0.5	1	1.5	2	2.5	3
FO' (%)	1	6.5	12	17.5	23	28.5

- **due to the insufficient compressive strength** of the mixture of materials, pursuant to the equation:

$$FO = \frac{p}{100} \times 2 \times C \times PD$$

where:

$p = \frac{\sigma_z - \sigma_d}{\sigma_z} \times 100(\%)$

σ_z - *the required compressive strength (MN/m^2)*

σ_d - *the achieved compressive strength (MN/m^2)*

The deduction may be determined based on an average value of all the achieved compressive strengths or on the basis of a sum of deductions for individual samples tested. The higher deduction value will be used.

Calculation of deductions: $FO' = p \times 2$ (%)

p (%)	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25
FO' (%)	5	10	15	20	25	30	35	40	45	50

- **due to the insufficient layer thickness** of the installed mixture of materials:

$$FO = \frac{p}{100} \times 3{,}75 \times C \times PD$$

where:

p - % of the insufficient layer thickness above the bottom limiting value – 10% (in relation to the contracted layer thickness)

Calculation of deductions: $FO' = p \times 3.75$ (%)

p (%)	2	4	6	8	10	12	14	16	18	20
FO' (%)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75

The deduction may be determined based on an average value of all the defined layer thickness values or on the basis of a sum of deductions for individually determined layer thickness values. The higher deduction value will be used.

The deduction due to a smaller average thickness than the contracted thickness up to the bottom limiting value is calculated separately by reducing the unit price in relation to the actual average thickness installed and the contracted layer thickness.

Deviations of the height and evenness of the executed CSBC should be repaired by adequate activities, where the planned bearing capacity of the pavement structure

should not be reduced. If the condition cannot be repaired in an appropriate manner, the client may reject the acceptance.

In case that the contractor fails to ensure the quality within the required values, although the deductions have been calculated, all of his contractual warranties should remain in power.

The contractor should ensure other properties of the mixtures of materials for the CSBC that exceed the required limiting values, without reimbursement for costs of the repairs executed.

2.4.4.2 Cement concrete surfacing

2.4.4.2.1 Introduction

Cement concrete surfacing (CCS) may be executed on the cement bound upper road base and wearing course, or only of one layer of cement concrete in the pavement structure.

CCS on roads is mainly used for pavement structures with large traffic and climate loads. The design of CCS is specified in guidelines SRDM, Item 8.3.7.

The installation of cement concrete surfacing should be carried out pursuant to the dimensions and quality defined in the project documents as well as in accordance with these technical conditions, thus ensuring the planned bearing capacity and durability.

The execution of the cement concrete surfacing comprises the procurement and preparation of the appropriate basic materials, i.e. a mixture of stone grains (aggregate), cement binder, water and chemical admixtures, production, filling and installation of the fresh cement concrete mixture in locations stipulated by the project documents. It also includes all works on the execution of joints and protection of the cement concrete surface after its installation in the CCS, and all works referring to the design reinforcement of cement concrete, as needed.

CCS may be executed – when 2 layers are made – of a mixture of cement concrete of the same composition or of mixtures of different composition that must be compatible. The cement concrete mixture exposed to wear on the roads with medium or heavy traffic loads should be of type C 35/45 and should contain stone grains of silicate rocks. In other cases, CCS may be executed of a cement concrete mixture C 30/37, unless stipulated otherwise in the project documents. This is to be decided by the supervising engineer.

The general conditions for works with cement concrete are given in Item 2.5.1.1 of these technical conditions.

2.4.4.2.2 Basic materials

All basic materials for cement concrete surfacing should have properties suitable for use in cement concrete mixtures (EN 13877).

The characteristic required properties of the basic materials for cement concrete mixtures, are:
- aggregates,
- cement,
- water and
- admixtures,

are given in Item 2.5.1.2 of these technical conditions, along with the properties of the protective agents.

The general conditions of the quality of basic materials for CCS are given in Item 2.5.1.2, and for the quality of steel for cement concrete reinforcement – in Item 2.5.2.3 of these technical conditions.

2.4.4.2.2.1 Aggregates

The basic properties of the aggregates for cement concrete mixtures for CCS should be in compliance with the requirements of EN 206-1.

The specific required properties of the aggregates for cement concrete surfacing (ultimate limiting values) are given in Table 2.4.4.2.1.

If the supervising engineer has already approved the use of the same aggregate for CCS by the contractor, it is not necessary to conduct additional conformity tests.

For preparation of the cement concrete mixture for CCS the contractor may also use a different composition of the aggregate if he submits to the supervising engineer the appropriate evidence that the mechanical properties of the proposed composition of the cement concrete mixture are in compliance with the characteristics required in the project documents and these technical conditions.

The aggregates for cement concrete for CCS should also have the required coefficients of resistance for polishing, given in Table 2.4.3.2.1.

The cement concrete mixture for CCS should contain the following in fractions larger than 4 mm:
- at least 90 % by mass of crushed stones on roads with heavy traffic loads, and
- at least 50 % by mass of crushed stones on roads with medium and light traffic loads.

Table 2.4.4.2.1: Required properties of aggregates for cement concrete mixtures for CCS (EN 12620)

Properties of aggregates	Unit of measure	Required value	Testing procedure
Resistance of stone grains to crushing			EN 1097-2
- for wearing courses:			
- for heavy traffic loads	%	LA_{20}	
- for other traffic loads	%	LA_{25}	
- for bearing courses	%	LA_{30}	
Resistance of stone grains to freezing/melting			EN1367-2
- for wearing courses	% by m.	MS_{18}	
- for bearing courses	% by m.	MS_{25}	
Form of coarse stone grains	% by m.	SI_{20}	EN 933-4
Water absorption	% by m.	$WA_{24}1$	EN1097-6

2.4.4.2.2.2 Cement

The basic properties of cement for cement concrete mixtures for CCS are given in EN 197-1. Cement concrete mixtures especially suitable are:

- cements types CEM I, of strength class 32.5,
- in special cases, cement types CEM II/A-S and CEM II/B-S, of strength class 42.5.

For cements used for cement concretes for CCS, the following limiting values are defined:

- the beginning of cement setting at 20 °C is limited to less than 1 hour,
- the beginning of cement setting at 30 °C is limited to less than 45 minutes,
- the final cement setting time is limited to 10 hours.

The required basic cement properties (ultimate limiting values) should be ensured.

For cement concrete mixtures in the same CCS profile it is necessary to use cement with the same properties that is produced of the same raw materials (uniform quality).

The contractor should, in a timely manner and prior to the commencement of works, submit to the supervising engineer the evidence of the quality of cement to be used in the cement concrete mixture for CCS, pursuant to the requirements of these technical conditions.

The supervising engineer may also request or approve the use of cement with other properties, if it is in compliance with the requirements of standards and the project documents.

2.4.4.2.2.3 Water

The properties of water used for preparation of the cement concrete mixture for CCS are defined in EN 1008. The required water properties are given in Table 2.4.4.2.2.

Table 2.4.4.2.2: Required properties of water for cement concrete mixtures for CCS (EN 1008)

Water properties	Unit of measure	Required value	Testing procedure
pH value, minimum	-	6.5	EN 1008
Chloride content (Cl), maximum	mg/l	300	EN 196-21
Sulphite content (SO_4), maximum	mg/l	400	EN 196-2

The required water properties for preparation of the cement concrete mixture (ultimate limiting values) should be ensured.

Water from the public water supply system may be used for preparation of the cement concrete mixture for CCS even without evidence of its quality.

2.4.4.2.2.4 Chemical Additives

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

The chemical additives used should ensure the improvement of properties in the specific condition of cement concrete mixtures (fresh, during setting, hardened). Chemical additives should be previously inspected on the cement concrete mixture to be used for the placement.

The contractor should, in a timely manner and prior to the commencement of works, submit to the supervising engineer the evidence of conformity of the chemical additives to cement concrete mixtures with the requirements for cement concrete mixtures for CCS layers stipulated in the project documents and these technical conditions.

2.4.4.2.2.5 Steel

The properties of steel used for reinforcement of cement concrete in CCS, as well as the properties of dowels and anchors, are specified in EN 10080.

Welded steel nets for reinforcement of the cement concrete in CCS, smooth steel rods for dowels for CCS reinforcement on transverse joints, and ribbed steel rods for anchors for transverse connection of CCS on longitudinal joints, should be in compliance with the quality classes specified in the project documents.

The required steel properties for nets and rods (ultimate limiting values) should be ensured. The contractor should submit to the supervising engineer the evidence on the conformity of steel with the requirements given in these technical conditions and the project documents.

The supervising engineer may approve a deviation from the given requirements for steel for CCS if the contractor submits adequate evidence.

2.4.4.2.2.6 Protective Agents

The properties of the liquid chemical agents for the protection of the surface of the cement concrete mixture installed in CCS are defined in these technical conditions and the manufacturer's instructions for use of the agents.

Protective agents should ensure the conditions for the adequate hydration of cement and protection from adverse weather conditions in the initial stages (7 to 10 days), and they should not have an adverse impact on the surface of the CCS executed.

The evidence of the quality of protective agents for the CCS surface, along with the additional instructions for use, as needed, should be prepared by the authorized institution.

Prior to the use of protective means, the contractor should obtain the consent of the supervising engineer in a timely manner.

2.4.4.2.2.7 Materials for sealing of joints

Materials for the sealing of joints on cement concrete pavements should be in compliance with the requirements for the specific use (EN 14188). These materials include:
- sealing pads,
- strips for the filling of the lower part of joints,
- agents for the previous coating of walls of the upper part of joints,
- bituminous elastic mixtures for sealing of joints (EN 52132).

The quality of the agents for the previous coating of walls of the upper part of joints is defined in relation to the properties of the bituminous elastic mixture for the sealing of joints. The technical conditions and instructions for use of the agents for previous coating should be prescribed by the manufacturer of the sealing mixture.

The use of all sealing materials for joints on CCS should be previously approved by the supervising engineer on the basis of the submitted evidence on conformity with the requirements given in the project documents and these technical conditions.

2.4.4.2.3 Manner of Execution

The general technical requirements for the composition of cement concrete mixtures, their production, properties of fresh and

hardened cement concrete, as well as the method of defining the conformity of the produced cement concrete, are specified in EN 206-1. These requirements should be adjusted to the traffic load and the conditions of the environment and CCS execution.

2.4.4.2.3.1 Deposition Sites of Materials

Prior to the commencement of works, the contractor should inform the supervising engineer in a timely manner about the place of acquisition of the aggregate for preparation of cement concrete mixtures for CCS.

The evidence of conformity of the aggregates with the requirements in Item 2.4.4.2.2.1 should be issued by the authorized institution, and the contractor should submit them to the supervising engineer.

Prior to the commencement of use, the contractor should submit to the supervising engineer, in a timely manner, the evidence for all other materials to be used for the CCS execution (cement, water, admixtures, steel, protective agents and materials for sealing of joints).

2.4.4.2.3.2 Depositing of Materials

If the contractor, during the preparation of the cement concrete mixture for CCS, temporarily stores the aggregate, the space for that should be prepared in an adequate manner and properly protected from rainfall.

Cement should be stored in adequate silos.

If water from the water supply system is not used for preparation of the cement concrete mixture, it should be supplied by cisterns.

Chemical additives for the cement concrete should be stored in compliance with the manufacturer's instructions.

Steel rods and nets for reinforcement should be protected from rainfall at temporary storage sites. Protection of dowels is not necessary if they are pre-insulated.

Protective agents for the treatment and maintenance of the fresh cement concrete, as well as the material for the sealing of joints for CCS should be stored in compliance with the manufacturer's instructions.

The stocks of all materials at storage sites should be such so as to ensure the continuous production and installation of the cement concrete mixture for CCS.

2.4.4.2.3.3 Preparation of the substrate high plain

As a substrate for CCS, it is possible to use the high plain of the asphalt concrete-base of bituminous mixture, which should be prepared pursuant to Item 2.4.3.5.3 of these technical conditions.

As a substrate for CCS, with the consent of the supervising engineer, it is also possible to use the high plain of the lower base course, prepared pursuant to Item 2.4.3.5.3, or the sub-base high plain, prepared pursuant to Item 2.4.2.2.5.

Cement concrete surfacing should not be installed on a frozen substrate or a substrate that is over-saturated with water, nor on a dirty substrate.

If the substrate material absorbs water, prior to the CCS placement it should be:
- covered with an adequate waterproof material (PVC foil),
- sprayed with a bituminous emulsion, or
- dampened with water.

The method of the substrate preparation should be defined by the supervising engineer.

The contractor may start the CCS execution only after the acceptance of the substrate by the supervising engineer, pursuant to the given requirements.

Until the commencement of the CCS installation, the contractor should maintain the substrate high plain in a condition valid at the time of acceptance. The contractor should repair all damage in a timely and appropriate manner and should give adequate evidence of the repairs performed to the supervising engineer.

2.4.4.2.3.4 Production of fresh cement concrete mixture

Production of the fresh cement concrete mixture should be performed mechanically in an adequate concrete mixer for the preparation of mixtures by the feeding method of operation. The production capacities of the concrete mixer for the production of cement concrete mixtures should be certified.

The cement mixer for the production of cement concrete mixtures should be protected from weather impacts. The ability

to constantly visually inspect the quantities of specific materials should be ensured.

The measuring equipment should ensure the prescribed quantities of all the materials by mass.

The mixing time and other quality impacts should be harmonized so as to ensure the uniformity of the cement concrete mixture.

In case that the works are executed at low temperatures, the cement mixer for the production of cement concrete mixtures should have a possibility to heat the aggregates and/or water up to the adequate temperature, so that the fresh cement concrete mixture has a temperature of 5 to 30°C.

The capacity of the cement mixer for production of cement concrete mixtures for CCS should ensure the needed quantity for a uniform and continuous installation with the use of a paver.

The produced cement concrete mixture should be immediately taken to the location of installation in CCS.

2.4.4.2.3.5 Cement concrete mixture filling

The filling of the cement concrete mixture for CCS on the prepared substrate high plain may start only upon the approval of the supervising engineer.

As a rule, adequate vehicles – tippers (as well as mixers in exceptional cases), which directly unload the mixture into the paver – are used for the transport of mixtures. The vehicles – tippers, should be equipped with tarpaulins for protection of the cement concrete mixture from rainfall, drying out or the impacts of dust. During transport, the cement concrete mixture should remain uniform, without any changes of the fresh cement concrete properties.

The number of vehicles for the transport of the fresh cement concrete to the construction site should be adjusted to the conditions of the uniform installation in terms of the facility capacities for the production and transport distance.

Effects on the composition of the cement concrete mixture during transport or prior to its installation in CCS are allowed only if they are already planned in the cement concrete design.

2.4.4.2.3.6 Placement of fresh cement concrete mixture

As a rule, installation of the fresh cement concrete mixture in CCS is performed mechanically, by pavers. In exceptional cases, manual placement of cement concrete in CCS is allowed if the use of machines is not possible due to the limited space. Spreading of the fresh cement concrete mixture by graders or bulldozers is allowed for the bearing course only. Such placement should be approved by the supervising engineer.

The fresh cement concrete mixture may be placed between the fixed formwork or by the use of a paver equipped with sliding formwork. Additionally, the uniformly spread cement concrete mixture for CCS should be uniformly compacted. As a rule, the compaction is carried out by internal vibrators that are evenly distributed along the entire width of the paver, ensuring the uniform and full compaction of the layer along the entire profile. Other mechanical equipment may also be used for the compaction of the cement concrete mixtures on smaller surface areas.

Daily interruptions of the casting works should be dressed as transverse joints pressed perpendicular to the road centre line.

If steel nets are used for the CCS reinforcement, the nets should be placed along the entire surface. The overlap of the nets should be:

- in longitudinal direction – at least 2 openings
- in transverse direction – at least 1 opening.

CCS can be reinforced by micro-reinforcement as well. The conditions of such reinforcement should be defined in the project documents.

In front of bridging facilities CCS at should be at least 15 m before the abutments, and the rear plate reinforced with smooth steel rods with a diameter of at least 16 mm.

The cement concrete mixtures installed in CCS at toll stations should not be reinforced by steel welded nets due to the induction instruments of the automatic toll system and the traffic counting system.

The method and conditions of use of the means for compaction of cement concrete

mixtures in CCS should be defined by the supervising engineer.

Spreading and compaction of the cement concrete mixture in the base and wearing courses of CCS should be time-aligned.

The installation time of CCS should not be:
- at air temperature of up to 30° C – longer than an hour
- at air temperature above 30° C – longer than half an hour.

The supervising engineer may approve a longer installation time if the contractor submits evidence ensuring the required CCS quality.

For the final dressing of the CCS surface mechanical whetstones or sweepers are used. Both methods should ensure the required evenness and sufficient friction of the CCS pavement surface. If this is not the case, an adequate additional layer of the cement concrete mixture should be placed. Adding of cement, water or cement mortar is not allowed.

The cement concrete temperature during installation should not be:
- lower than 10℃ at air temperature of 0° C,
- lower than 20℃ at air temperature of -3° C,
- higher than 30℃ at air temperature higher than 25° C.

If the air temperature falls below -3° C, i.e. below 0° C when the air is wet, or if the temperature of the cement concrete mixture falls below 5° C, the cement concrete installation in CCS should be interrupted, and the installed CCS should be protected.

Placement of the cement concrete mixture in CCS should also be interrupted in cases when the temperature of the fresh cement concrete increases above 30℃.

The interruptions of the cement concrete installation in CCS should be planned on joints in the transverse direction. These joints (cold joints) should be executed as pressed joints.

The surface of the installed CCS should be protected so as to avoid installed cement concrete temperature falling below 5 ℃ until at least 50% of the required compressive strength of the cement concrete is achieved.

Light local traffic may be allowed on CCS for the needs of the construction site when 50 % of the required compressive strength of the cement concrete is achieved, heavier traffic for the needs of the construction site when 70 % of the strength is achieved, while public transport may be allowed only after the required compressive strength of cement concrete is achieved.

2.4.4.2.3.7 Protection of fresh cement concrete

Cement concrete surfacing should be protected from weather impacts. During the installation of the cement concrete mixture between the fixed formwork, portable light tent roofs may be used for 24-hour protection, while chemical protective means (of the lightest colour possible) are used for a more durable protection. During installation of the cement concrete mixture in CCS by the use of a paver with sliding formwork, only chemical protective means are used (sprayed foil).

Protection of the wearing course should be ensured immediately upon cement concrete installation by the adequate means.

When using chemical protective agents it is necessary to take into account the manufacturer's instructions and, as needed, additional instructions for use issued by the authorized institution as well.

The use of water for the dampening of fresh cement concrete surface in CCS by uniform spraying is allowed only as an auxiliary measure to the protection with chemical agents, at high temperatures, and may last up to 3 days, and up to 7 days in exceptional cases.

Excessive and rapid cooling of the cement concrete mixture in CCS during its setting should be prevented by covering the CCS with different covers or with some other adequate manner. This protection should last until the cement concrete reaches 50% of the required compressive strength. The CCS installed in the autumn period should be protected in an adequate manner from the impact of salt used during the maintenance of roads in the winter period.

The duration of the treatment of the cement concrete installed in CCS is defined in informative terms in EN 206-1.

2.4.4.2.3.8 Execution of joints

The procedure of the execution of joints should ensure that the quality of the cement concrete next to joints equals the quality in other places of CCS.

The location and method of execution of joints should be defined in the project documents. If this is not the case, the supervising engineer should make a decision on this.

2.4.4.2.3.8.1 Dummy joints

Cuts for transverse and longitudinal dummy joints should be made in a timely manner to avoid the occurrence of uncontrolled cracks on the cement concrete plates for CCS due to the shrinkage of cement concrete during setting. The depth of cuts should amount to approximately 25 to 30 % of the CCS thickness, and their width should be 3 to 4 mm.

The required depth and width of the subsequently expanded cuts, i.e. incisions of dummy joints, are defined in Table 2.4.4.2.3.

If during the CCS execution a specific longitudinal joint should be executed along the entire pavement width, the incision depth should be 25 mm, and its width should be 8 mm.

Table 2.4.4.2.3: Required depth and width of the incision in dummy joints in CCS

Type of dummy joints	Width of crack below incision (mm)	Incision dimensions	
		depth (mm)	width (mm)
- transverse	up to 1	25	8
	1 to 2	30	12
	more than 2	35	15
- longitudinal	-	15	6

2.4.4.2.3.8.2 Pressed joints

Pressed joints may be executed as cold and structural joints. They separate cement concrete plates along the entire thickness of the CCS. Pressed joints on new cement concrete plates are constructed over the existing ones.

For cold (transverse) pressed joints, prior to the continuation of the CCS placement the vertical surface of the cement concrete should be coated with an adequate bituminous binder (0.8 to 1 kg/m^2). For structural (longitudinal) pressed joints, the vertical surface of cement concrete should first be coated with a pre-coating agent, and after drying with an adequate bituminous binder (1.0 to 1.5 kg/m^2).

The depth of the incisions of pressed joints should be 35 mm, and the width should be 10 mm.

2.4.4.2.3.8.3 Spatial joints

Spatial joints should separate the CCS along the entire thickness. The pads in the spatial joints should be well pressed, and they may be covered with cement concrete to a maximum of 50 mm.

The minimum depth of the incisions in the spatial joints is 30 mm (approximately 1.5 width of the incision), the minimum width is 20 mm and should be at least 2 mm smaller than the pad thickness.

The incision of spatial joints should be made 2 to 3 days after the cement concrete installation.

2.4.4.2.3.8.4 Cutting of joints

Cutting and incision should be performed in a timely manner, by the use of mechanical devices, evenly and with sharp edges.

The incision depth should be adjusted to the type of material for sealing of joints.

2.4.4.2.3.8.5 Sealing of joints

Prior to sealing, the joint should be dried and the incised places should be cleaned well. After drying out of the pre-coating, an adequate material for the sealing of joints is placed on the incision walls. The consent of the supervising engineer should be ensured

for the implementation of the execution of the works.

2.4.4.2.3.8.6 Installation of dowels and anchors

Dowels should be installed in the transverse dummy, pressed and spatial joints, while anchors should be installed in the longitudinal dummy and pressed joints (Figures 2.4.4.2.1 to 2.4.4.2.4).

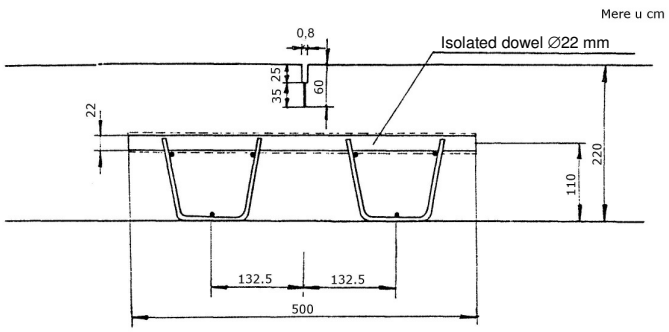


Figure 2.4.4.2.1: Transverse dummy joint in the cement concrete surfacing

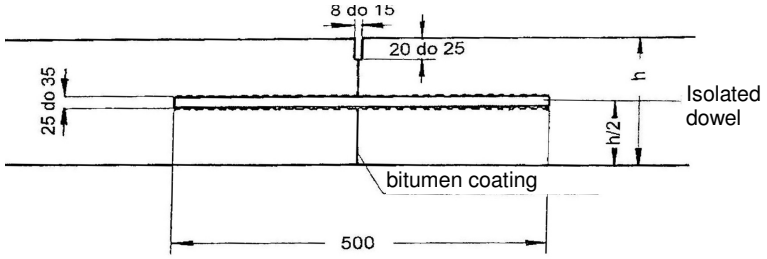


Figure 2.4.4.2.2: Transverse pressed joint with an installed dowel

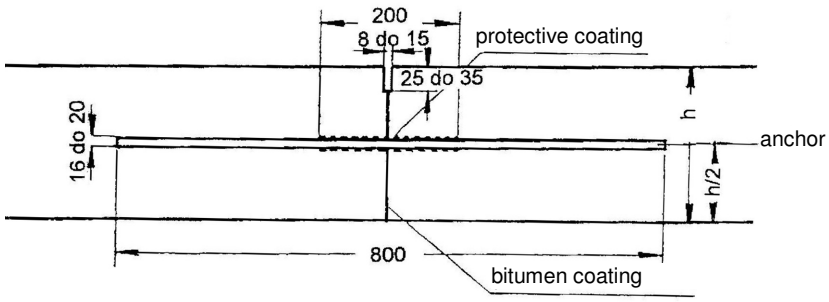


Figure 2.4.4.2.3: Longitudinal pressed joint with an installed anchor

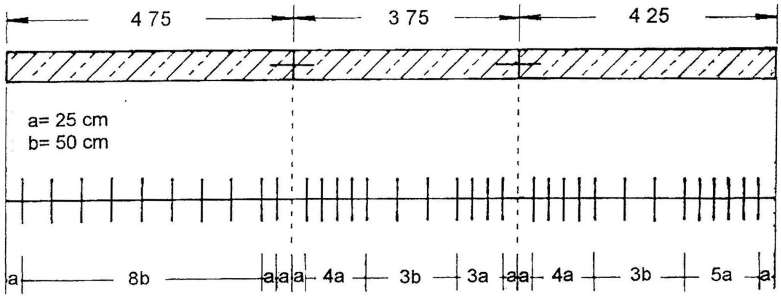


Figure 2.4.4.2.4: Distribution of dowels in a transverse joint

Dowels should be made with steel smooth rods with a diameter of 20 to 25 mm and length of 500 mm, and insulated along the entire length. Anchors should be made of steel ribbed rods with a diameter of 16 to 18 mm and length of 800 mm, and isolated only in the centre, with the length of 200 m.

As a rule, dowels are pressed by vibrations in the centre of the already compacted cement concrete mixture in CCS, so that they are placed in the travel direction. If the dowels are placed prior to the installation of the cement concrete mixture (Figure 2.4.4.2.1), they should be stabilised so that during the installation of the cement concrete in CCS they can remain in the centre of plates and properly directed.

Anchors should be installed perpendicular to the travel direction
- in longitudinal dummy joints up to the height of one third of the CCS thickness (from the bottom edge),
- in longitudinal pressed joints, in the centre of the CCS profile.

The distribution of dowels and anchors in CCS should be detailed in the project documents. If this is not the case, the supervising engineer should decide about the distribution.

2.4.4.2.3.9 Inductive loops of traffic counting and toll systems

Inductive loops of the automatic traffic counting and toll systems should be installed in the grooves that are cut in the cement concrete surfacing after the cement concrete reaches the required compressive strength.

The installation procedure of inductive loops should be detailed in the project documents.

2.4.4.2.4 Quality of execution

Prior to the commencement of works on the execution of CCS, i.e. prior to installation of the cement concrete mixture in CCS, the contractor should, in a timely manner, submit to the supervising engineer for verification the project of CCS execution with all the data required in these technical conditions, which should primarily include:
- results of preliminary (initial laboratory) tests of cement concrete mixtures
- description of the production and installation of cement concrete.

Prior to the commencement of the operation of the machines and equipment affecting the quality of executed works it is necessary to check their capacities in terms of achievement of the constant and uniform quality of CCS pursuant to the requirements of these technical conditions.

All the machines and equipment should have certificates and capacities that will meet the requirements specified in the technical documentation and these technical conditions.

2.4.4.2.4.1 Preliminary tests

2.4.4.2.4.1.1 Composition of the cement concrete mixture

The contractor should submit to the supervising engineer the results of preliminary (initial laboratory) tests of the fresh cement concrete mixture to be installed in CCS.

Composition of the cement concrete mixture should comprise:
- types and quantities of individual fractions in the aggregate (kg/m^3)
- type and quantity of cement (kg/m^3)
- water quantity (l/m^3)
- types and quantities of the chemical additives (in % by mass of cement or in kg/m^3 of cement concrete mixture).

The contractor should not start the installation prior to obtaining the consent of the supervising engineer for the proposed composition of the cement concrete mixture.

If in the previous year the contractor has already executed CCS using similar cement concrete mixtures, the results of the executed mixture composition may be accepted as preliminary tests. This should be decided by the supervising engineer.

2.4.4.2.4.1.2 Cement concrete properties

With the proposed composition of the cement concrete mixture the contractor should prove that the planned composition of the aggregate, cement, water and chemical additives can give as a result the properties of cement concrete that are required in the project documents and these technical conditions (Item 2.5.1.5.2), which are also specified in EN 206-1.

The required properties of the fresh cement concrete mixture for CCS are given in Table 2.4.4.2.4.

Table 2.4.4.2.4: Required limiting values of the cement concrete mixture properties

Cement concrete mixture properties	Unit of measure	Required value	Testing procedure
- content of micropores			EN 12350-7
- for CB 16	% by v.	5 to 7	
- for CB 32	% by v.	3 to 5	
- percentage of cement and stone grains up to 0.25 mm:			-
- if the cement quantity is ≤ 300 kg/m^3	kg/m^3	400	
- if the cement quantity is ≥ 350 kg/m^3	kg/m^3	450+(C-350)	

The tolerance for micropores is – 1 % + 2 % (absolute).

The values indicating the content of pores are limiting values.

The percentage of cement and stone grains of up to 0.25 mm are the upper limiting values.

The required properties of hardened cement concrete for CCS depending on planned traffic loads are given in Table 2.4.4.2.5.

Table 2.4.4.2.5: Required properties of hardened cement concrete (EN 206-1)

Properties of hardened cement concrete	Unit of measure	Required value	Testing procedure
Class of compressive strength			EN 12390-3
- for extremely heavy and very heavy traffic loads			
- for bearing course	class	C 30/37	
- for wearing course	class	C 35/45	
- for heavy and light traffic loads			
- for CCS	class	C 30/37	
Tensile strength at bending			EN 12390-5
- for extremely heavy and very heavy traffic loads	MN/m^2	S 5,5	
- for heavy and light traffic loads	MN/m^2	S 5.0	
Resistance to freezing / melting – coefficient XF4, 50 cycles	mg/mm^2	≤ 0,40	EN 12390-9
Resistance to water penetration	mm	≤ 30	EN 12390-8

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

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

The resistance to water penetration is the lower limiting value.

2.4.4.2.4.2 Initial Production and Placing

The contractor should inspect the preliminary composition of the cement concrete mixture in production in the adequate facility, the transport to the construction site, and placement in CCS, when approved by the supervising engineer.

As a rule, the location of the placement should be approved by the supervising engineer on the contracted facility only upon the inspection of the prepared substrate high plain.

During the initial production and placement, the tests to be approved by the authorized institution hired by the contractor should:

- determine whether the quality of the disposal site and the production facility – cement mixer for production of cement concrete mixtures, the method of

transport and installation equipment, is in compliance with the requirements of these technical conditions,
- take samples of the mixture in the location of installation to test the properties of fresh and hardened cement concrete;
- determine the dressing of the CCS surface,
- determine the execution of joints on CCS,
- determine the protection of the cement concrete surface in CCS,
- determine the thickness, evenness, height, slope and direction of CCS.

If the contractor used similar cement concrete mixtures for works execution during the past year under similar conditions, the results of executed composition may be accepted as initial production and placement. This is to be decided by the supervising engineer.

2.4.4.2.4.3 Regular Production and Placing

The supervising engineer may authorize the contractor to start the regular production of the cement concrete mixture only on the basis of initial production and installation test results. The consent for regular production also includes the requirements regarding the characteristics of cement concrete mixtures and the requirements of internal control, stipulated by these technical conditions and the contractual documentation.

The consent for regular production and placement of the fresh cement concrete mixture in CCS should also include the requirements for the potential additional preparation of the substrate layer surface in terms of the requirements in Item 2.4.3.5.3, i.e. 2.4.2.2.5 of these technical conditions.

If any changes occur during the production or placement of the cement concrete mixture in CCS, the contractor should submit to the supervising engineer a proposal of changes in writing. The contractor may implement the changes only upon the approval of the supervising engineer.

The limiting thickness values of CCS are defined within the design of cement concrete pavement structures (in guidelines SRDM, Item 8.3.7).

The average thickness of CCS may be up to 5% smaller than the given limiting value, and individual measured values may be up to 10% smaller (ultimate limiting value).

Unevenness of the CCS high plain is determined as a deviation below a laid 4-meter rod in an arbitrary direction in relation to the road centre line. The CCS high plain may deviate from the rod (upper limiting value)
- on pavements for extremely heavy, very heavy and heavy traffic loads:
  - during mechanical placement 4 mm
  - during manual placement 6 mm
- on pavements for other traffic loads:
  - during mechanical placement 6 mm
  - during manual placement 10 mm

If such deviations are reoccurring, the supervising engineer should make any necessary decisions.

The height of individual measuring points on the CCS high plain should be determined by levelling. The CCS high plain may deviate from the design height in any place by up to ±10 mm (upper limiting value).

As a rule, the slope of the CCS high plain should equal the design crossfall and longitudinal slope of the pavement. The tolerance is defined by the permitted irregularities and deviations from the height of the CCS high plain, but the deviation should not exceed ± 0.3 % of the absolute inclination value (ultimate limiting value).

The edges of the installed CCS may deviate from the pavement direction (ultimate upper limiting value)
- on pavements for extremely heavy, very heavy and heavy traffic loads, by up to 30 mm
- on pavements for medium and light traffic loads, by up to 50 mm.

2.4.4.2.5 Quality control

2.4.4.2.5.1 Internal Control

The type and frequency of testing of the cement concrete for CCS within the internal control to be performed by the authorized laboratory of the contractor should be determined in the verified program of the average testing frequency. If this is not the case, the locations for sampling and measuring points should be determined by the supervising engineer by a statistical random selection (Item 1.4.1).

During the placement of cement concrete in CCS the laboratory should take samples for testing and inspect the conformity of the

properties with the frequency specified in Table 2.4.4.2.6 and Item 2.5.1.6.1.

Table 2.4.4.2.6: Minimum frequency of the cement concrete testing during the internal control of the placement

Properties of the installed cement concrete	Test method	Minimum testing frequency
Content of micropores in the mixture	EN 12350-7	100 m^3
Compressive strength	EN 12390-3	400 m^3
Tensile strength at bending	EN 12390-5	800 m^3
Resistance to freezing/melting	EN 12390-9	1,600 m^3
Resistance to water penetration	EN 12390-8	1,600 m^3

The contractor should regularly submit the results of the internal control tests to the supervising engineer and the contractor of independent control. If the contractor discovers a deviation of quality from the required values, he should promptly notify the supervising engineer and undertake any adequate measures.

The evenness, height and slope of the CCS high plain should be tested at 200 m^2, and in the direction of the constructed pavement – on 20 m^2.

The conformity of the quality of the constructed CCS with the requirements in the project documents and these technical conditions should be evaluated taking into account the criteria in EN 206-1 and Item 2.4.4.2.4 of these technical conditions.

2.4.4.2.5.2 Independent control

The independent control of the execution of cement concrete surfacing, performed by the institution authorized by the client, should include:

- definition of the conformity of the cement concrete mixture produced and installed in CCS with the requirements given in the project documents and these technical conditions, and
- supervision of the internal control.

The scope of testing of the conformity of the cement concrete mixture produced and installed in CCS by the independent control amounts to 1 : 4 relative to internal control testing. The supervising engineer may also request different frequency of independent control tests.

The testing of the conformity of cement concrete properties should be carried out pursuant to the verified program of the average independent control frequency.

The samples for independent control of the cement concrete conformity should, as a rule, be taken in the location of installation, which should be determined by the supervising engineer (Item 1.4.1).

The sampling for the needs of independent control and the testing and measurements at the construction site should be carried out in the presence of the contractor and supervising engineer.

The authorized institution should prepare a written report on the regular inspection of the internal control, including the assessment of results of all control tests, and send it to the client and supervising engineer.

2.4.4.2.6 Measuring and acceptance of works

2.4.4.2.6.1 Measuring of works

The works executed within CCS should be measured pursuant to Item 1.2.2.2 of the general technical conditions and calculated in square metres.

All quantities should be measured according to the actual scope and type of the works executed within the dimensions given in the project documents, and documented in writing in a timely manner.

2.4.4.2.6.2 Acceptance of works

The placed CCS should be accepted by the supervising engineer pursuant to the requirements referring to quality of these technical conditions and in accordance with Item 1.2.2.3 of the general technical conditions. The contractor should repair all

the discovered deficiencies prior to the continuation of works. If this is not the case, the deductions for inadequate quality of the works executed should be calculated.

2.4.4.2.7 Calculation of works

2.4.4.2.7.1 General

The executed works are to be calculated according to Item 1.2.2.4 of the general technical conditions.

The quantities, defined pursuant to Item 2.4.4.2.6.1 and accepted in accordance with Item 2.4.4.2.6.2, should be calculated pursuant to contracted unit prices.

The contracted unit price includes all services needed for the complete execution of works. The contractor has no right to request later additional payments.

If the contractor fails to ensure the quality within the required values, although the deductions have been calculated, all of his contractual liabilities should remain in force.

2.4.4.2.7.2 Deductions Due to Inadequate Quality

2.4.4.2.7.2.1 Quality of basic materials

Due to the required quality of materials for CCS, there will be no deductions in calculating the works.

If the contractor installs in CCS a material that is not in compliance with the requirements in Item 2.4.4.2.2 of these technical conditions, the supervising engineer, who may also reject the entire work executed, should make a decision on the calculation.

2.4.4.2.7.2.2 Quality of execution

The needed bases for the assessment of quality of execution and the calculation of deductions due to an inadequate cement concrete quality in CCS are given in Tables 2.4.4.2.4 and 2.4.4.2.5.

If the contractor fails to ensure the required quality of the CCS execution pursuant to Items 2.4.4.2.4 and 2.4.4.2.5, the supervising engineer should decide about the calculation. If the supervising engineer discovers:
- inadequate compressive strength,
- inadequate tensile strength at bending,
- inadequate thickness of CCS, and/or
- inadequate evenness of the CCS high plain,

he may apply in the calculation of works the financial deductions FO, which are determined in the following way:

- **due to inadequate compressive strength** of the cement concrete in CCS, pursuant to the equation:

$$FO = \frac{p}{100} \times 3 \times C \times PD$$

where:

p – *deviation from the limiting value (%, determined pursuant to the equation:*

$$p = \frac{f_{ck} - f_{ckd}}{f_{ck}} \times 100$$

f_{ck} *- the prescribed (characteristic) compressive strength (MN/m^2)*
f_{ckd} *- the achieved (discovered) compressive strength (MN/m^2)*
C - the contracted unit price of the quantity of executed works (KM/m^2)
PD - the scope of executed works with deficiencies (m^2)

The definition of the financial deduction for each individual inadequate result of testing of the cement concrete compressive strength should be based on the required limiting values in the project documentation (in Table 2.4.4.2.5), and the determined ultimate limiting values f_{cksm}.

- **due to inadequate tensile strength** at bending of the cement concrete in CCS, pursuant to the equation:

$$FO = \frac{p}{100} \times 5 \times C \times PD$$

where:

p – deviation from the limiting value (%), determined pursuant to the equation $p = \frac{f_{fk} - f_{fkd}}{f_{fk}} \times 100$

f_{fk} *- the prescribed (characteristic) tensile strength at bending (MN/m^2)*

f_{fkd} *- the achieved (discovered) tensile strength at bending (MN/m^2)*

The definition of the financial deduction for each individual inadequate result of testing of the cement concrete tensile strength at bending should be based on the required limiting values in the project documentation (Table 2.4.4.2.5), and the determined adequate ultimate limiting values f_{cksm}.

- **due to inadequate thickness of CCS** pursuant to the equation:

$$FO = p \times C \times PD$$

where:

p – the coefficient of deduction, depending on value f (%) $f = \frac{h_n - h_{dop} - h_u}{h_n} \times 100$

h_n *- design thickness of CCS (cm)*

h_{dop} *- tolerance of the thickness of CCS (cm)*

h_u *- discovered thickness of CCS (cm)*

The value of coefficient *p* should be determined based on value f and pursuant to Table 2.4.4.2.7.

Table 2.4.4.2.7: Definition of the coefficient of deduction p

f (%)	2	4	6	8	10	12	14	16	18	20
0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75

- due to inadequate evenness of the CCS high plain, pursuant to the equation:

$$FO = \sum \left(p_i^2 \times A_i \right) \times 0.6 \times C$$

where:

p_i *– deviation of evenness above the limiting value defined in Item 2.4.4.2.4.3 (mm)*

A_i *- relevant width of the uneven high plain strip (m)*

The contractor should repair the deviation of evenness of the CCS high plain above the limiting value through implementation of adequate measures that should not reduce the design bearing capacity of the pavement structure. If the condition cannot be repaired in an appropriate manner, the client may reject the acceptance.

The contractor should ensure the other CCS properties exceeding the limiting values defined by these technical conditions at his own expense. This is to be decided by the supervising engineer.

2.4.5 MACADAM SURFACING

2.4.5.1 Introduction

Macadam surfacing (MS) refers to the parts of the pavement structure above the bearing courses up to the pavement surface.

The placement is performed in compliance with the method, dimensions and quality stipulated by the project documents and pursuant to these technical conditions, thus ensuring the planned traffic surface and its durability.

The macadam surfacing consists of stone cubes or plates and the substrate layer. It is installed as a wearing course on the sub-base or road base of pavement structures.

MS is primarily intended for pavement structures with light traffic loads, as well as for slow and still traffic.

The MS execution comprises the procurement of needed materials and installation in locations defined in the project documents, including the execution of joints.

The type of MS and the pavement structure is, as a rule, defined in the project documents. If this is not the case, they will be defined by the supervising engineer.

2.4.5.2 Basic materials

2.4.5.2.1 *Stone cubes*

For macadam surfacing for pavement structures small or large cubes are used most frequently. In specific conditions, small cubes may also be used for surfaces intended for pedestrians.

Stone cubes for MS intended for vehicle traffic should be made of viscous, homogeneous rocks of igneous origin, resistant to frost and salt. The cubes for slow traffic and for surfaces intended for pedestrians may be made of rigid and viscous carbonate rocks.

The basic dimensions of cubes of natural rocks are given in Table 2.4.5.1.

Table 2.4.5.1: Basic dimensions of stone cubes

Type of stone cubes	Dimensions of cubes length | width | height mm		
- small stone cubes	80 90 100	80 90 100	80 90 100
- large cubes	120 to 180 140 to 200 160 to 220	120 140 160	130 150 160

The tolerance from the basic dimensions in Table 2.4.5.1 are ± 10 %.

Considering that the cubes in MS are mainly placed in the form of arches, cubes of a trapezoidal or rectangular shape may be used as well. Elongated cubes are needed for mutual binding.

The supervising engineer may also approve the use of cubes of different dimensions.

2.4.5.2.2 *Plates*

Plates that are, as a rule, made of cement concrete differ in the purpose of application on traffic surfaces:

- for grassing of surfaces for still traffic and surfaces for pedestrians
- for surfaces primarily intended for pedestrians, made of scrubbed and washed cement concrete and exceptionally of rocks.

The plates should be made of dense cement concrete, without cracks and with dimensions

that should be in compliance with the requirements from Table 2.4.5.2.

The supervising engineer may also approve the use of plates made of cement concrete with different properties.

If the plates are produced of two types of cement concrete (core and surface layer), their full connectedness should be ensured.

Table 2.4.5.2: Required properties of cubes and plates of cement concrete

Properties of cubes and plates	Unit of measure	Required value
Deviations of dimensions		
- length and width, maximum	mm	± 3
- height, maximum	mm	± 5
convexity of the plate side		
- with the height up to 80 mm, maximum	mm	2
- with the height over 80 mm, maximum	mm	3
Compressive strength of cement concrete:		
- average, minimum	MN/m^2	C 35/45
- individual, minimum	MN/m^2	C 30/37
Resistance to freezing and melting	mg/mm^2	≤ 0.40

2.4.5.2.3 Aggregates

Aggregates for unbound layers of the substrate for stone cubes and plates may contain natural and crushed sand fractions and, in exceptional cases, fine crushed gravel or crushed aggregate. For filling of joints between the plates only mixtures of crushed sand fractions should be used.

Aggregates for unbound substrate layers should be in compliance with the requirements of EN 13242, Item 2.4.2.2.3 of these technical conditions.

It is possible to use mixtures of:
- medium sand of 0/2 mm,
- coarse sand of 0/4 mm, and
- sand and fine crushed aggregates and/or gravel of 0/4 mm.

The aggregate used for filling of joints between stone cubes should be made of crushed or natural sand fractions of 0/2 mm. The percentage of grains of up to 0.063 mm in the mixture may be up to 5% by mass.

2.4.5.2.4 Cement and lime mortar

Cement or lime mortars for the bound substrate layers for MS or for filling of joints between the cubes and plates should consist of a mixture of sand, cement or lime and water.

Sand for cement or lime mortars may consist of natural and/or crushed grains.

For cement mortars for the bound substrate layers for MS or for filling of joints between cubes, the following binders are used:
- Portland cements CEM I and
- Portland cements with granulated slag or puzzolans CEM II/A-S and CEM II/B-S, which are in compliance with the requirements specified in EN 197-1,

while hydrated lime is used for lime mortars.

Water for cement and lime mortars may be naturally or artificially processed, with evidence of its conformity with the requirements from EN 1008.

The requirements referring to the quality of sand for cement mortar for bound substrate layers and for filling of joints between cubes are generally defined in SRCS, Item 2.4.2.2.3.

The requirements for cement are specified in EN 197-1 and Item 2.4.4.1.2.2.

The required properties of hydrated lime for lime mortar for the bound substrate layer are defined in Table 2.4.5.3.

Table 2.4.5.3: Required properties of hydrated lime

Properties of hydrated lime	Unit of measure	Required value
Content of CO_2, maximum	% by m.	7
Content of active CaO + MgO, minimum	% by m.	85
of which MgO, maximum	% by m.	8
Grinding fineness:		
- residue on sieve of 0.5 mm, maximum	% by m.	0.5
- residue on sieve of 0.09 mm, maximum	% by m.	10

Water properties needed for cement and lime mortars are defined in Item 2.4.4.2.2.3.

2.4.5.2.5 Mixtures for filling of joints

Special bitumen based mixtures with additives increasing the elasticity and plasticity may also be used for the filling of the joints between cubes and plates.

The use of all materials for the sealing of joints between cubes should be previously approved by the supervising engineer on the basis of the submitted evidence of the quality for that purpose.

2.4.5.3 Manner of Execution

2.4.5.3.1 Deposition Sites of Materials

Prior to the beginning of the execution of works on MS, the contractor should, in a timely manner, inform the supervising engineer about the types of all materials to be used, and submit adequate evidence on the conformity with the required properties.

All the required properties of materials in Item 2.4.5.2 should be ensured (ultimate limiting values).

2.4.5.3.2 Depositing of Materials

If prior to the placement in MS the contractor temporarily stores the materials, he should ensure an adequate space. During the arrangement of the space it is necessary to take into account the manufacturer's instructions and the requirements of the supervising engineer.

The stocks of all materials at storage sites should be such so as to ensure continuous execution of all the works contracted within MS.

2.4.5.3.3 Preparation of the substrate high plain

The bearing course for MS may be:
- the sub-base high plain, prepared pursuant to Item 2.4.2.2.5,
- the base course high plain, prepared pursuant to Item 2.4.3.5.3.4 or Item 2.4.4.1.4,
- the upper road base high plain, prepared pursuant to Item 2.4.3.5.3.4.

The content of voids in the bearing course below MS and the slope of these courses should ensure good drainage of water that may be sieved through the MS.

In specific conditions, the bituminous mixture for asphalt or cement concrete wearing courses may also be used for the bearing course for MS. This should be approved by the supervising engineer.

The contractor may start the MS execution only after the acceptance of the bearing course by the supervising engineer, pursuant to the given requirements. For the entire period up to the placing of MS, the contractor should maintain the high plain of that course in the same condition as when taken over. The contractor should repair all damage in a timely and appropriate manner and should give adequate evidence of the repairs performed to the supervising engineer.

2.4.5.3.4 Production of cement and lime mortar

The production of cement and lime mortar should be mechanical and should take place in an adequate facility for the preparation of mortar by the feeding method of operation.

The measuring equipment should ensure the adequate mass percentage of binder in the mortar.

The mixing time and other quality impacts should be harmonised so as to ensure a homogeneous mixture of the cement and lime mortar.

The produced mortar should be immediately transported to the place of installation in MS.

2.4.5.3.5 Aggregate and mortar filling

For aggregate filling for the bearing course below the MS, trucks – tippers should be used. The filling may start only upon the approval of the supervising engineer.

The cement or lime mortar filling for the substrate layer below the stone cubes and plates may start only upon preparation of the bearing course high plain and acceptance by the supervising engineer. Adequate vehicles – mixers should be used for transport. The number of vehicles for the transport to the construction site should be adjusted so as to ensure a uniform placement pursuant to the capacity of the production machines, the transport distance and the placement capacity.

2.4.5.3.6 Placing

2.4.5.3.6.1 Substrate layer

A layer of adequate mixture of aggregate, sand or crushed aggregate should be uniformly spread on the bearing course so as to ensure a layer thickness of 3 to 6 cm upon compaction. For small cubes the thickness is smaller, and for large cubes it is larger.

If the MS will be exposed to heavier loads, cement or lime should be added to the aggregate. This addition is carried out in cases when the joints are filled with cement mortar.

If cement mortar is used as the substrate layer, it should be spread in a uniform thickness. In this case the bearing course for MS is made of cement concrete that should not start hardening prior to the beginning of the MS placement.

As the substrate layer for MS it is also possible to place minimum 3 cm thick sand layer that will be covered by a 2 cm thick upper course of the substrate made of lime mortar.

All types of substrate layers should, as a rule, be placed by the use of machines. Manual placement is allowed only when due to the limited space it is not possible to use machines. The method of spreading of the materials for substrate layers should be approved by the supervising engineer.

2.4.5.3.6.2 Cubes and plates

The method of distribution of cubes should be defined in the project documents in the form of segment arches, in rectangular rows or diagonally to the road centre line, mechanically or manually.

The plates may be divided into rows or diagonals and, as a rule, the placement is performed manually.

If the joints are filled with a sand mixture, the distance between the cubes and plates should be 3 to 5 mm. If the joints are filled with the cement mortar of bituminous mixture, the width should be at least 8 mm.

The empty spaces in grassing plates should be filled with top soil and sown with grass (0.5 to 0.8 kg/acre, and 8 kg/acre of artificial fertilizer).

2.4.5.3.6.3 Joints

During the execution of MS with joints to be filled with aggregate it is necessary to cover with a sand mixture and to dampen the entire surface of the installed stone cubes and plates with covered joints. Upon indentation, the remaining sand mixture should be removed from the MS surface.

During the MS execution with joints to be filled with cement mortar or bituminous mixture, the sand from the joints should be removed up to the depth of at least 30 mm.

The filling of joints with cement mortar or bituminous mixture should be performed in places where larger impacts of water, oil or fuels are expected.

When placing cement mortar in joints, the cubes and plates should be dampened, while in the placement of bituminous mixture they should be dry and coated with adequate pre-coating agent (bituminous emulsion or cut bitumen), as needed.

The joints between the cubes and plates should be filled pursuant to the progress of works.

The bituminous mixtures for filling should be placed in joints where there is a need for larger movements of the MS (at a distance of up to 8 mm on the access junctions to facilities).

When using bituminous mixtures to fill the joints between cubes and plates for MS it is necessary to take into account the manufacturer's instructions.

The temperature of the cement mortar during the placement to be performed at temperatures exceeding 10° C should not be lower than 10° C or higher than 30° C.

The MS surface with joints filled with cement mortar should remain wet for at least 7 days. Meanwhile, MS should not be exposed to larger traffic loads.

2.4.5.4 Quality of execution

Prior to the beginning of the MS placement, the contractor should timely submit to the supervising engineer for verification the technological information, which should primarily include:
- evidence of the conformity of all materials to be used
- results of preliminary tests, and
- description of the technological procedures of production and placement of materials in MS.

Prior to the commencement of the operation of the machines and equipment affecting the quality of executed works it is necessary to check their regularity and capacities in terms of achievement of the uniform quality pursuant to the requirements of these technical conditions and project documents. All the machines and equipment should have certificates and capacities that will meet the requirements specified in the project documentation and these technical conditions.

2.4.5.4.1 Preliminary tests of mortar

The preliminary composition of mortar for MS should include:
- types and quantities of individual fractions in the aggregate (kg/m^3)
- type and quantity of the binder (kg/m^3)
- water quantity (l/m^3)
- properties of fresh mortar:
  - analysis of composition (in kg/m^3)
  - consistency / settling of the cone (in cm)
- properties of hardened mortar:
  - compressive strength (MN/m^2)
  - tensile strength at bending (MN/m^2)
  - resistance to frost and salt.

With the preliminary composition the contractor should prove that the planned aggregate and binder can result in the quality of mortar required in the project documents and these technical conditions.

Prior to obtaining the consent of the supervising engineer for the preliminary composition of mortar, the contractor should not start placement.

If in the previous year the contractor already executed MS with a similar mixture of aggregate and binder, the results of the executed composition may be accepted as results of the preliminary composition defined during the internal control. This is to be decided by the supervising engineer.

The required properties of cement mortar for MS are given in Table 2.4.5.4.

Table 2.4.5.4: Required properties of cement mortar

Properties of cement mortar	Unit of measure	Required value		Testing procedure
		for substrate layer	for filling joints	
Percentage of cement, minimum	Kg/m^3	270	500	-
Compressive strength, minimum	MN/m^2	C8/10	C 30/37	EN 12390-3
Tensile strength at bending, minimum	MN/m^2	-	≥ 5.5	EN 12390-5
Resistance to freezing and melting – coefficient XF4, 50 cycles	Mg/mm^2	-	≤ 60	EN 12390-9

The required cement percentage, compressive strength and tensile strength at bending, as well as the resistance to freezing and melting are defined as the bottom limiting values.

2.4.5.4.2 Test Production and Placing

The contractor should inspect the preliminary composition of the cement mortar in production in an adequate facility, the transport to the construction site, and placement in MS, when approved by the supervising engineer.

As a rule, the place of the proving placement should be approved by the supervising engineer on the contracted facility only upon the inspection of the prepared bearing course high plain below the MS.

During the initial production and placement, the tests to be approved by the authorized institution hired by the contractor should:

- determine the regularity of the disposal site and the facility for mortar production, the method of transport and installing equipment, pursuant to the requirements of these technical conditions,
- ensure taking a sample in the location of installation for testing of the hardened cement mortar,
- determine the quality of joints executed between plates,
- determine evenness, height and slope of MS.

If the contractor used the similar mortars for MS execution during the past year under similar conditions, the results of executed composition may be accepted to prove production and placement. This is to be decided by the supervising engineer.

2.4.5.4.3 Regular Production and Placing

The supervising engineer may approve to the contractor the working composition and placement only upon the inspection of results of the report on the proving production and placement. The consent for continuous execution also includes the conditions of the mortar properties and the requirements for internal control, stipulated by these technical conditions and project documents.

If any changes occur during the production or installation of mortar, the contractor should prepare a proposal of changes in written form and submit it to the supervising engineer. The changes are deemed accepted upon the approval by the supervising engineer.

2.4.5.5 Quality control

2.4.5.5.1 Internal Control

The type and frequency of testing within the internal control of MS to be performed by the authorized laboratory of the contractor should be defined and confirmed in the program of the average testing frequency.

If this is not the case, it will be defined by the supervising engineer, who on the basis of a statistical random selection also defines the locations for sampling and measurement points (Item 1.4.1).
During the MS placement, the laboratory should take samples for testing and inspect the conformity of properties with the frequency defined in Table 2.4.5.5.

The scope and type of testing of the lime mortar for MS is defined by the supervising engineer, unless this is specified in the project documents.

Unevenness of the MS high plain is determined as a deviation below a laid 4-meter rod in an arbitrary direction in relation to the road centre line. The MS high plain may deviate from the rod by up to -10 mm (upper limiting value). If such deviations are reoccurring, the supervising engineer should decide about them.

The height of individual measuring points on the MS high plain should be determined by levelling. The MS high plain may deviate from the design height in any place by up to ±10 mm (upper limiting value).

As a rule, the slope of the MS high plain should equal the crossfall and longitudinal slope of the pavement. The tolerance is defined by the permitted deviations from the height of the MS high plain, but they should not exceed ± 0,4 % of the absolute inclination value (ultimate limiting value).

In an agreement with the supervising engineer, the quality of the installed MS may also be defined by other recognized methods. In these cases, the criteria for the installation quality assessment should be stated, along with the method and scope of testing.

2.4.5.5.2 Independent control

The extent of the external control testing, executed by an institution authorized by the client, is usually in the ratio of 1 : 4 relative to the internal control testing. The locations for sampling and the measurement points for the independent control of quality of the MS execution should be defined by the authorized engineer through a statistical random selection (Item 1.4.1).

The authorized institution should prepare a written report on the regular inspection of the internal control, including the assessment of results of all control tests, and submit it to the client and supervising engineer.

Table 2.4.5.5: Minimum frequency of testing within the internal control of the MS placing of cubes and plates

Properties of the installed stone cubes and plates	Test method	Minimum testing frequency
Cubes and plates:		
- dimensions	-	400 m^2
- compressive strength (of cement concrete)	EN 12390-3	800 m^2
Aggregates:		
- composition		
- properties	EN 12620	2,000 m^2
Fresh cement mortar:		
- aggregate composition	EN 933-1	800 m^2
- percentage of cement	-	800 m^2
– Hardened cement mortar:		
- compressive strength	EN 12390-3	800 m^2
- tensile strength at bending	EN 12390-5	2,000 m^2
- resistance to freezing and melting	EN 12390-9	200 m^2
Bituminous mixture for filling of joints	-	800 m^2
Evenness, height and slope of the high plain	-	200 m^2

2.4.5.6 Measuring and acceptance of works

2.4.5.6.1 Measuring of works

The works executed should be measured pursuant to Item 1.2.2.2 of the general technical conditions, and calculated in square metres.

All quantities should be measured according to the actual scope and type of the works executed within the dimensions given in the project documents, and documented in writing in a timely manner.

2.4.5.6.2 Acceptance of works

The placed MS should be accepted by the supervising engineer pursuant to the requirements referring to quality of these technical conditions and in accordance with Item 1.2.2.3 of the general technical conditions. The contractor should repair all the discovered deficiencies prior to the continuation of works. If this is not the case, the deductions for inadequate quality of the works executed should be calculated.

2.4.5.7 Calculation of works

2.4.5.7.1 General

The executed works are to be calculated according to Item 1.2.2.4 of the general technical conditions.

The quantities, defined pursuant to Item 2.4.5.6.1 and accepted in accordance with Item 2.4.5.6.2 of these technical conditions, should be calculated pursuant to the contracted unit prices.

The contracted unit price includes all the costs and services needed for the complete execution of works. The contractor is not entitled to claim any additional payment.

If the contractor fails to ensure the quality within the required values, although the deductions have been calculated, all of his contractual liabilities should remain in force.

2.4.5.7.2 Deductions Due to Inadequate Quality

2.4.5.7.2.1 Quality of materials

Due to the required quality of materials for MS, there will be no deductions in calculating the works.

If the contractor installs in the MS a material that does not meet the requirements from Item 2.4.5.2 of these technical conditions, this will be decided by the supervising engineer. He may completely reject the works executed.

2.4.5.7.2.2 Quality of execution

Due to the required quality of the MS execution, there will be no deductions in calculating the works.

If the contractor fails to provide the required quality of MS execution, the supervising engineer should decide about the calculation method.

2.4.6 CURB ELEMENTS

2.4.6.1 Introduction

The curb elements of the pavement (CEP) are longitudinal elements for limiting and arranging the outer edges of the traffic lanes.

The curb elements of the pavement include:
- marginal strips
- curbs
- gutters
- safety barriers.

Their purpose is to protect the edges of the pavement structures and to increase traffic safety on all types of roads.

Curb elements should be executed in dimensions defined by the project documentation and in compliance with these technical conditions.

The execution of curb elements of the pavement (CEP) includes:
- procurement of all needed basic materials, their dressing and placement in CEP
- procurement of adequate prefabricated elements and their placement

in places defined by the project documents.

The CEP execution also includes all works on the preparation of the foundation for CEP, dressing of joints and the needed protection of surfaces upon placement, as well as all works referring to the reinforcement of the elements.

The works should be executed when there is no rainfall and when the substrate temperature (without wind) is 5 °C to 25 °C. If the current temperature is lower or higher, special measures should be taken.

If the types of curb elements are not specified in the project documents, this will be decided by the supervising engineer.

2.4.6.2 Basic materials

The basic materials used are:
- mixtures of cement concrete for marginal strips and safety barriers
- mixtures of cement concrete and bituminous mixture for curbs, which may be made of igneous (silicate) or sediment (carbonate) rocks
- mixtures of cement concrete, stone cubes (macadam) and bituminous mixture (asphalt concrete) for triangle and segment gutters.

The basic materials used for the production of cement concrete mixtures for CEP execution and their quality are given in Items 2.5.1.2 and 2.5.1.3 of these technical conditions.

The basic materials used for the production of asphalt concrete mixtures for the execution of curbs and their quality are given in Item 2.4.3.2.

The required area for granulometric composition of aggregate for asphalt concrete mixture is given:
- for asphalt concrete for curbs AC 11i in Figure 2.4.6.1
- for asphalt concrete for curbs AC 16i in Figure 2.4.6.2

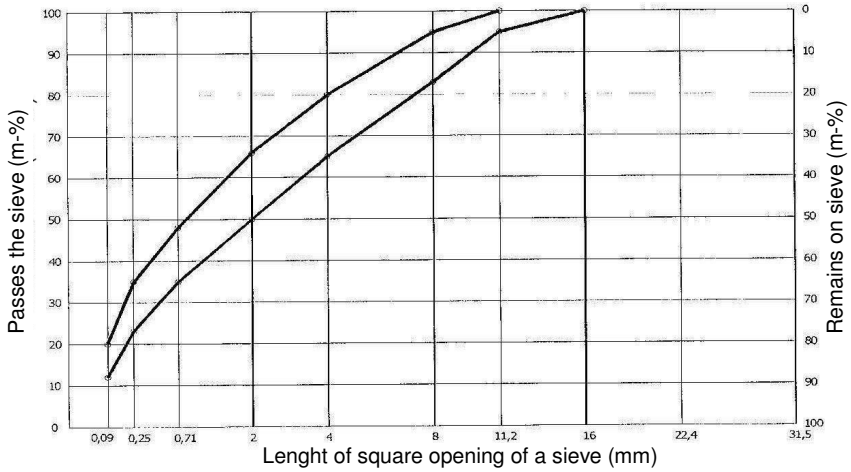


Figure 2.4.6.1: Limiting curves of aggregates for asphalt concrete mixture for curbs AC 11i

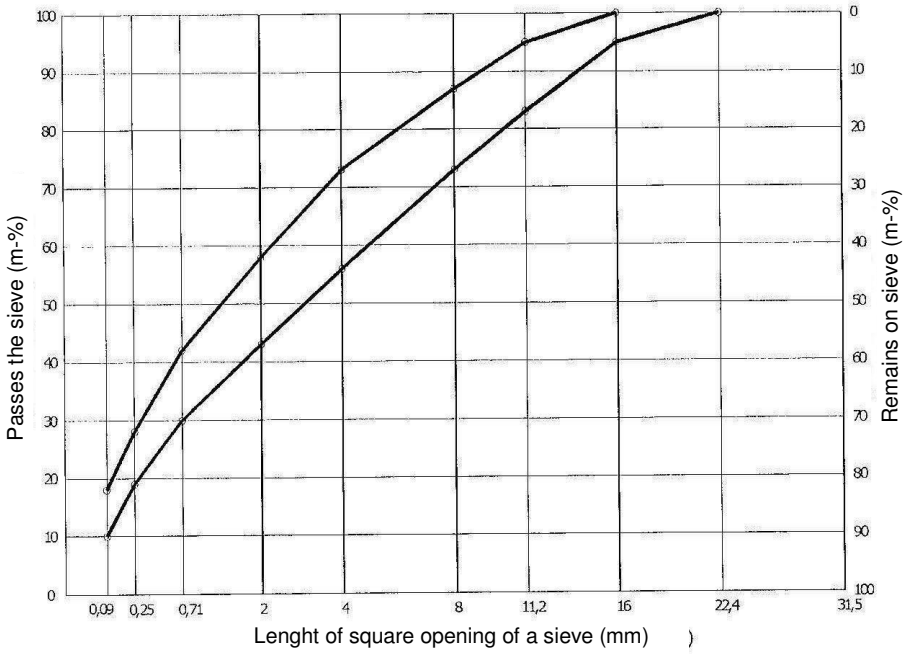


Figure 2.4.6.2: Limiting curves of aggregates for asphalt concrete mixture for curbs AC 16i

During the production, the aggregate granulometric composition may deviate from the range limited by the curves by up to 3% by mass.

All grain stones in the mixture should be exclusively crushed. In exceptional cases, the use of natural sand of 0/2 mm is allowed, but only in the ratio 1:1 with crushed stone.

For preparation of the asphalt concrete mixture for curbs it is necessary to use bitumen type B 50/70.

Stone curbs and cubes should be made of viscous, homogeneous rock that is resistant to the impacts of frost and salt. Visible surfaces may be dressed separately.

The permitted deviation of the dimensions of curbs from the dimensions specified in the project documents may be:

- for the width ± 3 mm,
- for the length ± 10 mm.

The tolerance for the dimension of cubes amounts to ± 10 % from the contractual dimensions (Table 2.4.5.1).

Prefabricated curbs, cubes, prisms and safety barriers of cement concrete should have properties that are in compliance with the requirements in the project documents and in Item 2.5.1.5 of these technical conditions.

The allowed curvature of the curb in the longitudinal direction can be to 5 mm, and 2 mm in the transverse direction. The deviation from evenness in the longitudinal direction can be up to 5 mm for the length of 1,000 mm.

For the execution of safety barriers of cement concrete for sliding formworks it is necessary to use only mixtures of crushed stone grains.

The elements of prefabricated safety barriers of cement concrete may deviate from the required dimensions by up to ± 10 mm.

2.4.6.3 Manner of Execution

2.4.6.3.1 Deposition Sites of Materials

Prior to the beginning of the execution of works on CEP, the contractor should, in a timely manner, inform the supervising engineer about the types of all materials and products to be used, and submit adequate evidence on the conformity with the required installation properties.

All the required properties of basic materials and products should be ensured, pursuant to Item 2.4.6.2 (ultimate limiting values).

2.4.6.3.2 Substrate Preparation

The following may be used as a substrate for marginal strips of cement concrete:

- high plain of the cement bound base course, pursuant to Item 2.4.4.1.4 and
- high plain of the bitumen bound base course, prepared pursuant to Item 2.4.3.5.3.4.

As a substrate for the foundations of curbs and marginal strip it is possible to use the sub-base high plain and, in exceptional cases, the capping layer high plain prepared pursuant to Item 2.2.5.3.8. For curbs of asphalt concrete and safety barriers, the following may be used as the substrate:
- high plain of the cement bound base course, pursuant to Item 2.4.4.1.4 and
- high plain of the bitumen bound wearing course of base course, prepared pursuant to Item 2.4.3.5.3.4.

The contractor may start the CEP execution only after the acceptance of the high plain by the supervising engineer, pursuant to the given requirements. Until the beginning of the CEP construction, the contractor should maintain the substrate high plain in the condition from the time of acceptance. The contractor should repair all damage in a timely manner and should give adequate evidence of the repairs performed to the supervising engineer.

2.4.6.3.3 Storage of basic materials and prefabricated elements

For storage of aggregates, binders and prefabricated elements to be placed in CEP, the requirements from Item 2.5.1.4.2 should apply in general.

2.4.6.3.4 Production of mixtures

For production of all types of cement concrete mixtures for CEP the requirements given in Item 2.5.1.4.4 should apply, and the production of prefabricated elements should be executed pursuant to the requirements in Item 2.5.1.4.5.

For production of cement mortar mixtures for filling of joints on curbs, cubes and safety barriers, the requirements given in Item 2.4.5.3.4 should apply.

For production of bituminous mixture for curbs, the requirements from Item 2.4.3.4.4 should apply.

2.4.6.3.5 Mixture filling

During mixture filling the following should be taken into account:
- for cement concrete mixtures – the requirements in Item 2.5.1.4.6
- for cement mortars – the requirements in Item 2.4.5.3.5, and
- for bituminous mixtures – requirements in Item 2.4.3.3.2.2.

2.4.6.3.6 Placing

Placing of the cement concrete mixture for CEP execution, as well as for foundations and prefabricated elements for CEP, is discussed in detail in Item 2.5.1.4.7.

The needed protection of cement concrete and execution of CEP are described in general in Item 2.5.1.4.7.4.

In addition to the requirements for the placement of bituminous mixtures given in Item 2.4.3.3.2.4, the following should also be taken into account for the placement in curbs:
- for the placement of curbs of bituminous mixtures it is necessary to use machines that will ensure the form of curbs specified in the project documents
- the temperature of the substrate (which should be previously sprayed with bituminous binder) and air should be at least 10° C
- the largest deviation of the bituminous mixture temperature during placement from the optimal temperature, specified during the initial production and placing, may amount to ± 10° C
- the outer edge of the curb of asphalt concrete should be at the distance of at least 5 cm from the outer edge of the substrate layer of bituminous mixture
- the curb may be loaded only upon cooling of the bituminous mixture to the ambient temperature.

Prefabricated curbs and curbs from rocks at that marginal strip are placed on the foundation – a substrate layer of fresh cement concrete (C 15/18) pursuant to the project documents.

The thickness of that substrate layer should be:
- below the curb – at least 15 cm and
- below the marginal strip – at least 10 cm.

The distance between curbs, i.e. cubes for marginal strips should be 10 to 15 mm. These joints should be filled with cement mortar on the front and upper side, up to a depth of at least 30 mm, and adequate sand may be placed on the remaining surface.

The surface of cement mortar in the joints should be adequately shaped.

In exceptional cases, the curbs and cubes for marginal strips may be placed on the unbound substrate layer as well. This is to be decided by the supervising engineer.

2.4.6.4 Quality of execution

At least 7 days prior to the commencement of execution and placement of CEP, the contractor should submit to the supervising engineer the technological information, which should include:
- evidence of the conformity of all basic materials and prefabricated elements, and
- description of the technological procedures of the CEP execution.

2.4.6.4.1 Cement Concrete

The conditions of the quality of cement concrete works for CEP are defined in detail in Item 2.5.1.5. In addition to these requirements it is necessary to take into account that the protective layer of cement concrete above the reinforcement steel in safety barriers should be at least 4 cm.

In case that the requirements for the cement concrete quality for specific CEP are not defined in the project documents, they should be specified by the supervising engineer pursuant to the requirements for similar works from these technical conditions.

2.4.6.4.2 Bituminous mixture

The basic conditions of the quality of execution of curbs from bituminous mixtures are defined in Item 2.4.3.4.4. It is also necessary to take into account the special properties given in Table 2.4.6.1.

2.4.6.4.3 Cement Mortar

The conditions of the cement mortar quality given in Table 2.4.5.4 should also apply in general to cement mortars for filling of joints of all CEP.

2.4.6.5 Quality control

2.4.6.5.1 Internal Control

The scope of the internal control during the CEP placement should be defined by the supervising engineer based on the results of preliminary technological tests.

Table 2.4.6.1: Required properties of e tbituminous mixture for asphalt concrete for curbs

Properties of bituminous mixture	Unit of measure	Required value	Testing procedure
Sample tested according to Marshould:			
- stability at 60 °C, minimum	kN	$S_{min7,5}$	EN 12697-34
- flowing at 60 °C, minimum	mm	Q_{min4}	EN 12697-34
- total percentage of voids	% by v.	V_{min1} to $V_{max2,5}$	EN 12697-8
- occupancy of voids in aggregate by bitumen	%	VFB_{86} to VFB_{93}	EN 12697-8
Core:			
- percentage of all voids, maximum	% by v.	V_{max6}	EN 12697-8
- compaction, minimum	%	96	SRCS, Item 1.2.4

The minimum internal control to be performed by the laboratory of the contractor includes:
- for marginal strips, in an adequate scope, all tests given in Item 2.5.1.6.1,
- for curbs and stone cubes in gutters, in general all tests given in item 2.4.5.5.1, on 100 m^1
- for curbs and gutters placed with the use of sliding formwork, all appropriate tests given in Item 2.5.1.6.1, on 100 m^1,

- for curbs and gutters of asphalt concrete, in principle all tests given in Item 2.4.3.5.1,
- for safety barriers, all adequate tests given in Item 2.5.1.6.1, on 100 m^1.

In agreement with the supervising engineer, the quality of the installed CEP may also be defined in another way with recognized methods. In this case, the supervising engineer should also state the standards for the quality of placement and the method and scope of testing.

2.4.6.5.2 Independent control

The extent of external control testing, executed by an institution authorized by the client, is usually in the ratio of 1 : 4 in relation to the internal control testing. The locations for sampling and the measurement points for the internal and independent control of quality of the CEP execution should be defined by the supervising engineer through a statistical random selection (Item 1.4.1).

The authorized institution should prepare a written report on the regular inspection of the internal control, including the assessment of results of all control tests, and submit it to the client and supervising engineer.

2.4.6.6 Measuring and acceptance of works

2.4.6.6.1 Measuring of works

The works executed should be measured pursuant to Item 1.2.2.2 of the general technical conditions, and calculated in the adequate unit of measure.

All quantities should be measured according to the actual scope and type of the works executed within the dimensions given in the project documents, and documented in writing in a timely manner.

2.4.6.6.2 Acceptance of works

The executed CEP should be accepted by the supervising engineer pursuant to the requirements referring to quality of these technical conditions and in accordance with Item 1.2.2.3 of the general technical conditions. The contractor should repair all the discovered deficiencies in relation to these requirements prior to the continuation of works. If this is not the case, the deductions for inadequate quality of the works executed should be calculated.

2.4.6.7 Calculation of works

2.4.6.7.1 General

The executed works are to be calculated according to Item 1.2.2.4 of the general technical conditions.

The quantities defined pursuant to Item 2.4.6.6.1 and accepted pursuant to Item 2.4.6.6.2 of these technical conditions should be calculated according to the contracted unit prices.

The contracted unit price includes all the services and costs needed for the complete execution of works. The contractor has no right to request later additional payments.

If the contractor fails to ensure the quality within the required values, although the deductions have been calculated, all of his contractual liabilities should remain in force.

2.4.6.7.2 Deductions Due to Inadequate Quality

2.4.6.7.2.1 Quality of materials

Due to the required quality of materials for CEP, there will be no deductions in calculating the works.

If the contractor installs in CEP a material that is not in compliance with the requirements in Item 2.4.6.2 of these technical conditions, the supervising engineer, who may also reject the entire work executed, should make a decision on the calculation.

2.4.6.7.2.2 Quality of execution

For the assessment of the quality of execution and calculation of deductions due to inadequate quality, the needed bases are given:

- for marginal strips, curbs and safety barriers of cement concrete, in Table 2.4.4.2.5 and in Item 2.4.4.2.7.2.2
- for curbs and cubes of rocks, in Table 2.4.5.1 and in Item 2.4.5.2,
- for curbs of asphalt concrete, in Table 2.4.6.1 of these technical conditions.

If the contractor fails to provide the required quality of the CEP execution pursuant to Item 2.4.6.4, the supervising engineer should decide about the calculation method.