GENERAL TECHNICAL REQUIREMENTS FOR ROAD WORKS

VOLUME III
PAVEMENT STRUCTURE

CLIENTS:
HRVATSKLE CESTE
HRVATSKLE AUTOCESTE

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Foreword

0-00 INTRODUCTION

General Technical Requirements for Road Works (GTR) contain requirements for the realization of individual works necessary for the completion of road construction projects, and they form an integral part of the corresponding contracts. If the technical documentation calls for realization of works not comprised in these GTR, the Designer will prepare Special Technical Requirements (STR) for these works, and the STR will constitute an addendum to these General Technical Requirements.

This is the third revised edition of the General Technical Requirements (GTR). The first edition was published in 1976, and the second in 1989. Experience gained in practical work has been incorporated as appropriate in these General Technical Requirements for Road Works.

These GTR 2001 are composed of the following volumes:
Volume I General Provisions and Preliminary Work
Volume II Earthwork, Drainage, Retaining and Facing Walls,
Volume III Pavement Structure,
Volume IV Concrete Work,
Volume V Road Tunnels, and
Volume VI Road Furniture.

This 2001 edition of GTR consists of six Volumes which together form a single entity. When it is specified in a contract, technical document or cost estimate that a work is to be carried out in accordance with any provision contained in any one of these Volumes, the Contractor will be required to perform such work in accordance with all relevant provisions of these GTR.

These General Technical Requirements were prepared by Institut građevinarstva Hrvatske (Civil Engineering Institute of Croatia).

0-00.1 ABBREVIATIONS

Appropriate abbreviations of terms used in these GTR are explained as follows:

GTR General Technical Requirements for Road Works
CMD Construction Management Design
STR Special Technical Requirements
GRCC General Requirements for Construction Contracts
SRCC Special Requirements for Construction Contracts
QCQAP Quality Control and Quality Assurance Program
SOS-NCS State Office for Standardization – National Certification Service
BL Building Law of the Republic of Croatia
SL Standardization Law of the Republic of Croatia
HRN Croatian standard
ISO International Organization of Standardization
EN European Standard
DIN German standard (Deutsches Institut für Normung)
0-00.2 GENERAL NOTES

These GTR set minimum quality requirements for materials, products and works. The GTR are written in such a way that they can form a part of a contract while requirements relating to special works will be included in the contract as Special Technical Requirements (STR). The GTR take into account all applicable Croatian regulations and technical standards (HRN).

0-00.3 USE OF THESE GENERAL TECHNICAL REQUIREMENTS

These GTR contain technical requirements for the performance of works, methods for quality assurance and quality assessment, and methods for calculation of completed work. The GTR are applicable to works contained in cost estimates of projects, but also to works subsequently defined on the site to ensure full completion of the work specified in the contract. On some projects, special requirements may also be specified to take into account various additional requirements, i.e. particular features of the project. The use of GTR is mandatory when they form an integral part of technical documents of the contract.
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5-0  GENERAL INFORMATION

This chapter deals with the minimum quality requirements for materials, products and works used in placing of base course. The GTR are written in a manner to constitute an integral part of a contract, having the conditions relevant to special works included in the contract as Special technical conditions (STC).

Materials, products, equipment and works shall be in accordance with standards and technical requirements stated in the design documentation. If no standard is stated, the application of respective EU standard is compulsory. If, in the meantime, a standard or regulation becomes non valid, the replacing standard or regulation shall be applicable.

The Contractor may propose the application of accepted technical regulations (standards) of an international standardizing body (ISO, ES, DIN, ASTM,…) with a written explanation and approval of the Supervising Engineer. This change shall be approved by the Supervising Engineer with the consent of the designer. The Contractor shall enter the change into the implementation design.

5-00.1 DEFINITIONS

General terms and expressions and their meaning in these General Technical Requirements are given in chapter 0. Only definitions which are not given in chapter 0 are given below, and these are relevant only for this chapter.

5-00.1.1 General terms

Asphalt by hot procedure is asphalt obtained by mixing of hot bitumen and hot stone material.

Asphalt by cold procedure is asphalt obtained by mixing of bitumen emulsion or cut-back bitumen into stone material.

BBBC is a bituminous base course made of asphalt mixture with the largest nominal grain size 16,22 or 32 mm, made according to the principle of the most dense grain packing, used for execution of pavement structure asphalt base courses.

BBWC is a bituminous base – wearing course made of asphalt mixture with the largest nominal grain size 16 or 22 mm, made according to the principle of the most dense grain packing, used for execution of single-layer asphalt structures.

Stabilizing mixture consistency is a quality parameter determined on testing samples as a mono-axial consistency after 7 and 28 days.

Modulus of compressibility expresses the amount of compressibility of the tested material under determined pressure and determined conditions. It is defined by the use of a circular plate diameter 300 mm according to the HRN U.B1.046 standard.

Base course of granular stone material without binder as part of the pavement structure is, as a rule, placed between the sub-grade and the binding base course (cement stabilization, BBC). This layer is incorporated into the
pavement structure of roads of all traffic load groups. It is made of loose granular stone material, mechanically stabilized by compaction. Types of material are specified, requirements on their quality and placeability, as well as quality requirements of the placed base course.

Placed base course of mechanically compacted granular stone material, according to the grain composition, thickness and position shall be in accordance with the design, i.e. the General Technical Requirements (GTR). Base course without binder is made of a mixture of uncrushed and/or crushed granular stone material. Main quality characteristic of this layer is the compaction (bearing capacity) expressed by the degree of compaction and the modulus of compressibility.

**Base course of granular stone material stabilized (bonded) with hydraulic binder**, as part of a pavement structure is, as a rule, incorporated between the base course of granular stone material without binder and bitumen treated base course of highways and roads with very heavy and heavy traffic load.

Bonded base course is made of material described in item 5-00.1.2 and following items. Types of material are specified as well as their quality and placeability requirements, and the quality requirements of placed base course. The placed base course of granular stone material stabilized by hydraulic binder, in a mixture of basic granular stone material, a mixture of basic binding material and water, according to thickness and position shall be in accordance with the design, i.e. the GTR. Base course stabilized by hydraulic binder is a mixture of stone material of a determined granular size, hydraulic binder and water. The main characteristic of quality of this layer is the consistency (bearing capacity), expressed by the compressive strength and the degree of compaction.

**Trial section** is a part of the road under construction where the capability of the contractors is tested to execute each asphalt course of the pavement structure according to the quality requirements specified by these GTR.

**Initial job mix formula** of asphalt mixture is a laboratory proof that it is possible to reach the required quality of asphalt mixture with specific chosen materials and chosen composition.

**Confirmed job mix formula** of asphalt mixture is proof that it is possible to produce on certain asphalt production plants an asphalt mixture of quality reached by initial job mix formula.

**Stabilizing mixture** is composed of granular stone material of determined grain size, hydraulic binder of determined class, in exactly proportioned quantity and an optimal amount of water necessary for the hydration of hydraulic binder and coating of grains, and is determined by initial job mix formula.

**Rate of compaction** is the ratio between dry mass of placed layer defined according to standard HRN U.B1.016 and the maximum dry mass defined by the modified Proctor procedure according to standard HRN U B1.048, expressed as percentage.

**Compressive strength** is the ratio between single-axial load and the testing sample surface area influenced by the load, with free lateral expansion, according to the standard HRN U.B1.030.
Rolled asphalt is asphalt made by hot procedure, compacted by rolling during placing.

5-00.1.2 Materials

Bitumen is a black, sticky, at normal temperature semisolid or solid mass, composed of hydrocarbons and their non-metallic derivatives, soluble in toluen, found in nature or obtained by petroleum processing. Bitumen has the role of binder in asphalt mixtures.

Bitumen emulsion is a dispersive bitumen agent, dispersed in water, containing an emulsifying agent.

Road construction bitumen is used in production of asphalt mixture, obtained from the surplus of vacuum distilled oil.

Crushed gravel contains more than 90% of crushed grains, i.e. grains with more than 50% of crushed surface area. It can be in the form of non-separated crushed gravel or partially separated crushed gravel.

Crushed stone material is a partially separated mixture of crushed stone grains, grain size ranging from 0 mm to largest grain size diameter, i.e. to the nominal grade size.

Partially separated granular stone material is a non-crushed (gravel, scree) or crushed stone material obtained by crushing of stone, gravel or scree, of nominal grain size between 0 and 32 mm, separated and declared according to the highest nominal grain size.

Crushed stone grit is a granular material, grain size ranging from 2 to 32 mm, obtained by crushing of stone, gravel or scree and separated in accordance with the standard HRN B.B3.100. Stone grit obtained by crushing of gravel shall contain at least 90% (m/m) of crushed gravel grains (crushed grains are those grains having at least 50% of surface crushed), and it can contain at the most 2% of completely non-crushed grains.

Crushed sand is a granular stone material, grain size ranging from 0 to 2 mm or from 0 to 4 mm, obtained by crushing of stone, gravel or scree.

Industrial by-products, e.g. blast furnace slag or similar, are non-separated granular materials. Their volume and grain size distribution shall be stable under the influence of atmospheric agents. Physical and mechanical properties shall be in accordance with requirements for stone materials.

Stone is a part of a rock, separated by natural forces or by means of planned efficient mechanical influence. Rock (rock mass) is a component part of the Earth’s crust, of specific texture, structure, mineral composition and means of geologic occurrence. Genetically, rocks are classified as igneous rocks, sedimentary rocks and metamorphic rocks.

Stone grit (stone aggregate) is a granular material, grain size composition ranging from 2 to 32 mm and separated according to basic fractions or inter-fractions, according to the requirements of standard HRN B.B3.100.
**Rock flour** is a crushed or ground granular stone material, grain size up to 0.71 mm. It shall contain at least 80% (m/m), i.e. 65% (m/m) of filler, depending on the quality of rock flour, according to the HRN B.B3.045 standard.

**Non-crushed stone grit** is a naturally pulverized granular stone material, gravel or scree, grain size composition ranging from 2 to 32 mm, separated according to the HRN B.B3.100.

**Non-separated crushed stone material** is a mixture of crushed stone, with grading ranging from 0 to the maximum nominal grain size (expressed in mm).

**Natural gravel** is a non-separated, loose sediment mostly consisting of rounded conglomerate, size ranging from 2 mm to 63 mm, i.e. particles from 0 mm to the largest grain diameter – nominal grain size. If natural gravel contains grains larger than 63 mm, it is necessary to screen the material.

**Natural scree** is a naturally pulverized, non-separated and loose stone material, originating on the site or after a very short shifting, (mainly gravitational), with not rounded grains larger than 2 mm, i.e. particles ranging from 0 mm to the largest grain diameter. If the scree contains grains larger than 63 mm, it is necessary to screen it.

**Natural sand** is a loose, clastic sediment, grain size composition ranging from 0.02 mm to 2 mm.

**Polymer modified bitumen emulsion** is a dispersive type of polymer modified bitumen or latex dispersed in water, containing an emulsifying agent.

**Polymer modified bitumen (PmB)** is a mixture of road construction bitumen and different types of polymer (elastomers, duromers, tarpolymers).

**Filler** is a part of stone flour, grain size composition up to 0.09 mm.

**Cut-back bitumen** is bitumen subsequently diluted by appropriate oils.

**Separated crushed stone material** is a crushed stone material, separated on at least three fractions or separated according to the HRN B.B3.100 standard.

**Separated granular stone material** is a non-crushed stone material (gravel, scree) or granular material obtained by crushing of stone, gravel or scree, smallest grain size 2 mm to the largest grain size 32 mm, not separated according to the HRN B.B3.100 standard, but separated on some other fractions declared according to the smallest and largest nominal grain size.

**Scree** is a pulverized, non-rounded, loose stone material obtained by natural wear of rocks (in situ) or after a very short “shift” mainly gravitational, with grain size composition larger than 2 mm.

**Gravel** is a loose clastic sediment mostly consisting of rounded conglomerate, size ranging from 2 mm to 63 mm. It can be separated, partially separated or separated according to the HRN B.B3.100 standard.

**Granular stone material** is a granulated stone material, grain size composition ranging from 0 to the largest nominal size (expressed in mm), not ground (gravel, sand) or obtained by grinding of rock, gravel or scree.
5-01 GRANULAR STONE MATERIAL BASE COURSE WITHOUT BINDER

5-01.1 QUALITY CONTROL

Type of material

In order to execute this base course, materials given in sub-item 5-00.1.1 shall be used.

Material sampling

Materials are sampled in accordance with the HRN U.B1.010 standard.

Laboratory testing

The following properties of granular stone material shall be tested in the laboratory.

- grain size distribution according to the HRN U.B1.018 standard
- density according to the HRN B.B1.014 standard
- moisture content according to the HRN B.B8.035 standard
- volume mass and water absorption according to the HRN B.B8.031 standard
- grain shape of stone aggregates according to the HRN B.B8.048 standard
- determining the weak grains according to the HRN B.B8.037 standard
- frost stability by means of sodium sulfate, according to the HRN B.B8.044 standard
- Natural and ground aggregate resistance to grinding and wearing by means of the “Los Angeles” method according to the HRN B.B8.045 standard
- approximate determination of organic substances pollution according to the HRN B.B8.039
- Determination of combustible and organic matter according to the HRN U.B1.024 standard
- Determination of light-weight particles according to the HRN B.B8.034 standard
- Optimal water content according to the HRN U.B1.038 standard
- The California bearing capacity index according to the HRN U.B1.042 standard
- mineral-petrographic composition according to the HRN B.B8.003 standard

5-01.1.1 Quality requirements for granular stone materials

Quality control of granular stone material shall be done in an authorized laboratory.

Grain size distribution

The grain size distribution curve (grading curve) of stone material shall be within the limits defined in the table 5-01.1.1-1.

Apart from the requirement given in table 5-01.1.1-1., granular stone material shall also satisfy the following grain size distribution requirements:

- content of grains smaller than 0,02 mm shall not be greater than 13%
- **the largest grain diameter** shall not be greater than half of the layer thickness, i.e. 63 mm at the most, and
- **degree of unevenness**, as a measure of good material placeability, shall be:

\[
U = \frac{d_{60}}{d_{10}} \quad \text{from 15 to 100 for gravel, and}
\]

\[
U = \frac{d_{60}}{d_{10}} \quad \text{from 15 to 50 for granular stone material,}
\]

with:

\[
d_{60} - \text{grain diameter with 60% mass},
\]

\[
d_{10} - \text{grain diameter with 10% mass}.
\]

**Note:** In some instances granular material with somewhat different composition shall be allowed, if other tests prove their placeability, and with the approval of the Supervising Engineer.

**TABLE 5-01.1.1-1.** Grain size distribution limit values of granular stone material for base course without binder

<table>
<thead>
<tr>
<th>Screen opening (square shaped) [mm]</th>
<th>Percent passing [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1</td>
<td>2-15</td>
</tr>
<tr>
<td>0,2</td>
<td>3-20</td>
</tr>
<tr>
<td>0,5</td>
<td>7-28</td>
</tr>
<tr>
<td>1</td>
<td>13-38</td>
</tr>
<tr>
<td>2</td>
<td>20-48</td>
</tr>
<tr>
<td>4</td>
<td>29-60</td>
</tr>
<tr>
<td>8</td>
<td>40-75</td>
</tr>
<tr>
<td>16</td>
<td>54-90</td>
</tr>
<tr>
<td>31,5</td>
<td>73-100</td>
</tr>
<tr>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>63</td>
<td>100</td>
</tr>
</tbody>
</table>

Percentage of grains smaller than 0.02 mm can be greater than 3% (not greater than 5%), if they are particles of rock origin, in areas of less freezing depths (moderate climatic conditions).

Quality of material shall guarantee the requested pavement bearing capacity during the complete designed operating life.

**Determination of organic substances**

A sample is immersed in a solution containing reagent, where, after a certain time period, the solution color above the sample is compared with the standard solution color. If the solution color above the sample is darker than the standard
one, percentage of organic matter and light-weight particles in the sample is gravimetrically determined.

**Percentage of organic matter and light-weight particles**

Granular material shall not contain more than 2% of organic matter and light-weight particles, e.g. wooden particles, roots, coal particles etc.

**Optimal moisture and maximum dry volume mass**

A sample of granular stone material is compacted by modified Proctor’s procedure \((2,66 \text{ MN m}^3)\). Test result is the optimal moisture, i.e. the amount of water in the sample that enables maximum compactness of material with the applied energy, thus obtaining maximum dry volume mass. Incorporation of granular material into the base course is best under optimal moisture.

Maximum dry volume mass according to the modified Proctor’s procedure depends on the mineral-petrographic composition of material and its grain size distribution, and is used as a parameter while determining the degree of compaction of placed layer.

**California bearing ratio – CBR**

Bearing capacity of a layer is evaluated on the basis of laboratory determined California bearing capacity ratio test – CBR. The CBR is determined on samples compacted with optimal moisture content, according to the HRN U.B1.042 standard.

Bearing capacity requirements for granular stone material, expressed in the form of California bearing ratio - CBR are as follows:

- for natural gravel or gravel mixture with less than 50% of crushed stone material, at least 40%, and
- for crushed granular stone material or natural gravel mixture with more than 50% of granular stone material, at least 80%.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Defined requirement, maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape of grain – percentage of grains of unsuitable shape (3:1), ((\text{HRN B.B8.048}))</td>
<td>[%] 40</td>
</tr>
<tr>
<td>Water absorption ((\text{HRN B.B8.031}))</td>
<td>[%] 1,6</td>
</tr>
<tr>
<td>Friable, low quality grains, ((\text{HRN B.B8.037}))</td>
<td>[%] 7</td>
</tr>
<tr>
<td>Resistance to freezing by Sodium sulfate. Mass loss after 5 cycles ((\text{HRN B.B8.044}))</td>
<td>[%] 12</td>
</tr>
<tr>
<td>Resistance to grinding and wear according to the Los Angeles method ((\text{HRN B.B8.045}))</td>
<td>[%] 45</td>
</tr>
</tbody>
</table>
Physical and mechanical properties

Natural stone material and granular stone material shall conform to the requirements given in table 5-01.1.1-2 regarding the grain shape, water absorption, low quality particles, resistance to freezing and resistance to grinding and wear.

5-01.1.2 Documents on previous material testing

In accordance with Item 5-01.1.1, the contractor or sub-contractor is issued a certificate on the suitability of granular stone material for execution of base course without binder, on the basis of quality control tests performed in an authorized laboratory.

The report on the suitability of material proves the capability of the contractor to produce adequate material for the execution of base course with the plant and equipment available to him.

Such report also proves that the already produced quantity of material satisfies the quality requirements.

If major change in the grain size distribution occurs in the sense of discrepancies from the limit values or the location, the party requesting the report shall obtain new documentation on the quality of the new material.

The report shall contain:

- General part with data on the ordering party, place and date of sampling, origin and type of material, authorized laboratory performing the tests, requirements of the ordering party and standards according to which the tests were performed.
- results of laboratory tests on the material properties given in Item 5-01.1.1 of the GTR.,
- conclusion with opinion on the suitability of granular material for execution of base course without binder.

The suitability tests are performed on a key sample. In the sampling process representatives of the authorized lab and the ordering party shall be present.

If a major change occurs in the properties of granular material due to the change of rock mass in the quarry or due to the production technology of granular stone material, and if a major change occurs in the grain size distribution of the sediment stone material, or a change of the field location, the ordering party shall obtain certificates on quality of new material and submit it to the Supervising Engineer.

The original report on material suitability is submitted to the Supervising Engineer and is valid one year at the most.

5-01.1.3. Quality requirements for placed base course

Completed base course of granular stone material without binder shall satisfy requirements given in the design. If not otherwise stated, the modulus of compressibility requirements, degree of compaction, grain size distribution, evenness of the layer surface, height and thickness as well as the position and the gradient of the layer shall be satisfied according to these GTR.
Modulus of compressibility and the degree of compaction

The following properties are tested on a placed course of granular stone material, after the geodetic approval regarding the height and position:

- Modulus of compressibility by means of the circular plate method, according to the HRN U.B1.046 standard, and
- Degree of compaction by testing the volume mass according to the HRN U.B1.016. standard.

Modulus of compressibility and the degree of compaction of the base course without binder, as defined in Item 5-00.1.1 of the GTR, shall satisfy the requirements given in table 5-01.1.3-1.

Table 5-01.1.3-1. Requirements for granular stone material base course without binder

<table>
<thead>
<tr>
<th>Layers to be placed on the base course of mechanically compacted granular stone material</th>
<th>Requested requirements minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modulus of compressibility Ms [MN/m²]</td>
</tr>
<tr>
<td>Bituminous asphalt surfacing, bituminous base course and base course stabilized by hydraulic binder total thickness &gt; 40 cm</td>
<td>50</td>
</tr>
<tr>
<td>Bituminous asphalt surfacing and bituminous base course total thickness &gt; 15 cm or bituminous asphalt surfacing, bituminous base course and base course stabilized by hydraulic binder thickness from 30 cm to 40 cm</td>
<td>80</td>
</tr>
<tr>
<td>Bituminous asphalt surfacing and bituminous base course total thickness &lt; 15 cm</td>
<td>100</td>
</tr>
</tbody>
</table>

Grain size distribution

The material grain size distribution shall satisfy the requirements given in item 5-01.1.1 of the GTR, sampled at the placing site prior to compacting.

Course surface evenness

The course surface evenness is measured as the course surface deviation from a staff length 4 m. Deviation from the staff can be 20 mm maximum.

Height and position

Elevation position of the placed course is checked by geodetic survey at points under the pavement edges, and the pavement centerline, deviations can be maximum ± 15 mm.
Gradient

As a rule, the gradient shall be equal to the longitudinal and transverse gradient of the designed surface. Deviations shall not be greater than ± 0.4% from the gradient defined by the design.

5-01.1.4. Documents on control testing and audit testing

The necessary documentation for control testing is in accordance with the sub-item 5-01.3.2.
The necessary documentation for audit testing is in accordance with the sub-item 5-01.3.2.

5-01.2 PRODUCTION, TRANSPORT AND PLACING

5-01.2.1 Production of granular stone material

Granular stone material for execution of mechanically compacted base course is produced by grinding of a rock mass obtained by blasting, or by crushing of larger size gravel boulders in the crushing plant.

Natural gravel or natural detritus for base course execution is obtained by sifting out of upper fractions which can be crushed to respective grain size.

If the produced or natural stone material lacks particles of specific size, the grain size distribution can be corrected by adding granular stone material of specific fractions. The stone material mixture shall be well homogenized.

5-01.2.2. Transport of granular stone material

Produced or natural granular stone material is transported to the place of deposition with suitable transport vehicles.

5.01.2.3. Placing of granular stone material

Mechanically compacted granular stone material base course, as part of the pavement structure is, as a rule, placed between the sub-grade and the coherent base course (cement stabilization, BBC). During the rehabilitation of existing roads a base course is sometimes placed on the existing asphalt base serving as a leveling course, on which other courses of the pavement structure are placed.

Requirements for the sub-grade

Granular stone material base course can be placed when the supervising engineer takes over the sub-grade and gives the go-ahead for the start of works. The Supervising Engineer shall check the following: evenness, designed gradient, correctly executed drainage, position and required quality requirements.

The Contractor shall keep the sub-grade in the condition prevailing at the time of taking over from the Supervising Engineer. If the sub-grade is damaged for whatever reason, the Contractor shall repair it to the level of requested requirements and submit proof to the Supervising Engineer.
Weather conditions

The base course shall not be placed on a frozen sub-grade and it shall not be executed with frozen material. Also, after abundant rain or snow melting, the process of compaction shall be delayed until surplus water runs off.

Placing of base course

Granular stone material base course shall be placed on a prepared sub-grade by transporting the granular stone material, spreading it with finishers and compacting.

In both cases a certain amount of material is spread with a banking which, after compaction, gives a layer with designed thickness, which is determined on a trial section.

Care shall be taken during placing to avoid segregation of granular material. If this occurs, places of segregation shall be replaced with homogenous material. Prior and during compaction, moisture of material shall be regulated to reach the optimal moisture defined according to the HRN U.B1.038 standard.

The process of compaction starts after the completed planning and slope staking process.

Compaction shall be done with vibrating machines: plate vibrator, compactors, vibratory rollers or pneumatic-tyred rollers, combined roller with pneumatic or metal tyres, individually or combined.

After spreading of material, compaction shall be done carefully over the complete layer surface. Rollers and / or compacting machinery shall move at a constant speed from 2,5 km/h to 4 km/h. Special attention shall be given to good compaction of the layer. The layer surface shall be well closed, even – of mosaic appearance.

All places not reachable by compacting machinery, shall be compacted by other means in accordance with the requirements. Such places, as well as the means of work execution shall be approved by the Supervising Engineer at the recommendation of the Contractor.

All requirements for the placed course shall be fulfilled before the placing of the next course. Compacting process shall be repeated if freezing, abundant rains, damage due to site traffic or additional works occurred on the existing base course during the period from its placement and the placement of the following pavement structure course.

5-01.3 QUALITY ASSURANCE OF MATERIAL AND WORKS

Quality assurance of the granular stone material base course without binder means several procedures described and defined in the GTR, with the aim of obtaining an adequate pavement structure base course.

Two types of activities are given:

- activities prior to the execution of granular stone material base course without binder, and
• testing during the placing procedure of granular stone material base course without binder.

5-01.3.1. Procedure prior to the placing of granular stone material base course without binder

These are:
• preliminary material testing with appraisal, and
• definition of the placing method on the trial section.

All the mentioned activities are the responsibility of the Contractor, they shall be done on time, prior to the start of work execution, at the Contractor’s expense.

The Contractor shall submit the results of the preliminary tests to the Supervising Engineer for approval.

Preliminary material testing with appraisal

Preliminary testing of material serves as proof of usability of this material for base course execution, and is done in accordance with sub-item 5-01.1 of the GTR.

Preliminary testing results, on the basis of which the suitability appraisal is given, are submitted to the Supervising Engineer in the form of a report on the suitability of material for execution of base course of granular stone material without binder, in original.

The report consists of the following:

➢ General part with the information of the ordering party, place and date of sampling, origin and type of material, authorized laboratory where the testing is performed, requirements of the ordering party and the standards according to which the testing was performed,
➢ results of laboratory tests on the material properties given in Item 5-01.1 of the GTR, and
➢ conclusion with the opinion on suitability of granular stone material for execution of base course without binder.

Definition of the placing method on the trial section

Trial section serves as proof that a pavement base course can be executed with granular stone material and respective placing methods of quality defined in the design or the GTR.

Prior to the transport of material to be used, the Contractor shall submit to the Supervising Engineer the report of granular stone material for execution of base course, on the basis of which the Supervising Engineer approves the execution of the trial section.

Part of the road to be used as trial section shall be defined by the Supervising Engineer on suggestion of the Contractor.

The number of passes of machinery and the type of compacting machinery is determined on the trial section in order to reach the defined quality parameters. Quality of placed course on the trial section is tested according to the following:
• height, position and gradient by geodetic survey
• modulus of compressibility (by means of a circular plate diam. 300 mm) [MN/m²].
• degree of compaction [%],
• surface evenness [mm], and
• course thickness [cm].

The tests shall be done by the Supervising Engineer at the expense of the Contractor.

When the method of work of the vibrating machines are determined on the trial section, by which the required course quality is reached, the Supervising Engineer shall approve the placing of that particular course.

If a positive experience with granular stone material and the efficiency of vibrating machines exists a trial section is not needed.

5-01.3.2 Testing during placing of granular stone material base course without binder.

Tests to be performed during the placing of granular stone material base course without binder are:

• control testing, and
• audit testing

Control testing

Control testing shall be done by the Contractor and its authorized laboratory, or, if he does not have one, by any other authorized laboratory. These tests are used for quality appraisal of the placed course, and on the basis of these, audit testing shall be performed.

Control control includes:

• modulus of compressibility control by means of circular plate diam. 300 mm at every 500 m², or
• degree of compaction by volume-meter in relation to the maximum compactness according to the modified Proctor’s method, at every 500 m² at least, or
• nuclear moisture density meter at every 500 m², or
• modulus of compressibility by means of circular plate diam. 300 mm and the degree of compaction by volume-meter in relation to the maximum compactness according to the modified Proctor’s method, at every 1000 m² at least,
• grade size distribution, at every 3000 m² at least,
• control of the evenness of the course surface by means of a staff length 4 m at every cross section or according to the Supervising Engineer’s requirements, and
• control of the course according to height, position and gradient by geodetic survey.

Immediately upon the completed control control, the Contractor shall submit the control results, in written form, to the Supervising Engineer.
Upon the completion of works, control control results are presented in a written report, including the following:

- general part with information on the Client, Contractor, structure and the used stone material
- information on the scope of control control according to the GTR (control program)
- control control results and the standards according to which the tests were done, and
- conclusion on the quality of executed works.

Audit testing

Audit testing of the base course shall be done by the Client, through an authorized laboratory, all in accordance with the sub-item 0-19, and, together with the control control, shall be proof of the quality of the pavement structure course. Audit testing shall be done upon completed control control and the quality assurance of the course concerning the compactness, evenness, height, position and gradient.

One audit testing shall be done per two control controls.

Upon the completion of works, audit testing results are presented in a written report, including the following:

- general part with information on the Client, Contractor, structure and the used stone material
- information on the scope of audit testing according to the GTR (control program)
- data on the completed scope of audit testing,
- audit testing results and the standards according to which the tests were done,
- Conclusion on the quality of executed works on the basis of control testing and audit testing,
- control of the course according to height and position by geodetic survey.

On the basis of the control testing and audit testing results, the Client, i.e. his Supervising Engineer shall make the final evaluation of the course quality.

5-01.3.3. Taking over of the placed course

The placed base course of granular stone material without binder shall be taken over by the Supervising Engineer on the basis of the fulfilled requirements from these GTR.

All possible faults according to those requirements shall be solved by the Contractor at his expense, including all additional testing and measurements which need to be performed in order to confirm the quality of the betterment.

If the base course is damaged after the taking over as a result of unfavorable weather conditions or any other reason, the course shall be repaired and its quality confirmed prior to the placing of the following pavement structure layer.
5-01.3.4. Documents proving the quality

- Report on material suitability, items 0-17, 0-19 and 5-01.1.1, of the GTR
- Report on control testing, items 0-17, 0-19 and 5-01.3.2 of the GTR
- Report on audit testing, items 0-17, 0-19 and 5-01.3.2 of the GTR
- Report on audit testing of the course by geodetic survey, items 1-02 and 5-01.1.3 of the GTR.
- Report of the Supervising Engineer on the executed works.

5-01.4 CALCULATION OF WORK

This work is measured and calculated in cubic meters of placed material in compacted state.

The designed measurements shall be taken as basis for calculation, if no changes were done by the Supervising Engineer.

The payment shall be done according to the contracted unit price for cubic meter of placed layer in compacted state including all costs of supply, transport, placement of material as well as all other works needed for completion.

5-02 GRANULAR STONE MATERIAL BASE COURSE STABILIZED BY HYDRAULIC BINDER

5-02.1 QUALITY CONTROL

Basic granular stone material

Basic materials as mentioned in item 5-00.2.1 of the GTR shall be used for the execution of granular stone material base course stabilized by hydraulic binder.

Sampling of material

Materials are sampled in accordance with requirements of the HRN U.B1.010 standard.

Laboratory testing

The following properties of granular stone material are tested in the laboratory:
- moisture according to the HRN B.B8.035 standard
- volume mass and water absorption according to the HRN B.B8.031 standard
- grain shape of stone aggregates according to the HRN B.B8.048 standard,
- determining the low quality grains according to the HRN B.B8.037 standard,
- resistance to freezing by means of sodium sulphate according to the HRN B.B8.044 standard,
- resistance of natural and crushed aggregate to crushing and wearing by the "Los Angeles" method, according to the HRN B.B8.045 standard,
- volume mass according to the HR U.B1.016 standard,
- grain size distribution according to the HRN U.B1.018 standard,
- density according to the HRN B.B1.014 standard,
- amount of combustible and organic matter according to the HRN U.B1.024 standard,
• chemical testing of concrete aggregates according to the HRN B.B8.042 standard,
• optimal water content in the cement stabilized soil according to the HRN U.B1.048 standard,
• execution of pavement structure base courses with materials stabilized by cement and similar hydraulic binders according to the HRN U.E9.024 standard.

5-02.1.1. Quality requirements for granular stone materials

Quality control of granular stone material shall be done by testing in an authorized laboratory.

Grain size distribution

The grain size distribution curve (grading curve) of granular stone material for this course shall be within the limits defined in the table 5-02.1.1-1 or 5-02.1.1-2.

For highways and roads of very heavy traffic load, i.e. for pavement structures designed for traffic load exceeding $3 \times 10^6$ equivalent axle loads of 100kN, as well as courses used for strengthening of all roads, grain size distribution of granular stone material shall meet the requirements given in table 5-02.2.2-1 for type A and type B, where:

• type A is; granular stone material with maximum grain size from 8 mm to 31,5 mm,
• type B is; granular stone material with maximum grain size from 31,5 mm to 50 mm.

Table: 5-02.1.1-1 Limit values for granular stone material base course stabilized by hydraulic binder used for highways and roads of very heavy traffic loads

<table>
<thead>
<tr>
<th>Screen opening size (square) [mm]</th>
<th>%</th>
<th>Percent passing [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1</td>
<td></td>
<td>0-12</td>
</tr>
<tr>
<td>0,2</td>
<td></td>
<td>2-18</td>
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<tr>
<td>0,5</td>
<td></td>
<td>5-27</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>8-36</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>14-47</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>21-60</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>33-73</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>49-90</td>
</tr>
<tr>
<td>31,5</td>
<td></td>
<td>75-100</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

For roads of very heavy, medium and light traffic load, i.e. for pavement structures designed for traffic load from $3 \times 10^5$ to $3 \times 10^6$ equivalent axle loads of 100kN, the following materials shall be used with the granular stone materials type A and type B:
• gravel – sand materials with percentage of dust–clay particles from 0% to 10% of particles smaller than 0.02 mm, if they meet the requirements given in table 5-02.1.4-2,
• sand materials of river, glacial or aeolian origin if they meet the requirements set in table 5-02.1.1-2.

Table 5-02.1.1-2 Limit values for granular stone material base course stabilized by hydraulic binder used for roads of heavy and medium traffic loads

<table>
<thead>
<tr>
<th>Screen opening size (square) [mm]</th>
<th>Percent passing [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1</td>
<td>0-55</td>
</tr>
<tr>
<td>0,2</td>
<td>2-70</td>
</tr>
<tr>
<td>0,5</td>
<td>5-100</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>16</td>
<td>50</td>
</tr>
<tr>
<td>31,5</td>
<td>72</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Quality of material shall satisfy the required bearing capacity of the pavement during the total designed road durability period.

Determining the organic impurities

A sample is placed in an agent solution. After some time the solution color above the sample is compared with the standard solution color. If the solution color above the sample is darker than the standard, the content of organic impurities and light particles is gravimetrically determined in the sample.

Content of organic impurities and light-weight particles

Granular material shall not contain more than 25% of organic impurities and light-weight particles such as wood chips, roots, coal particles etc.

Optimum moisture and maximum dry volume mass with addition of binder

A sample of granular stone material with an approximate amount of hydraulic binder shall be compacted by the modified Proctor’s method energy (2,66 MNm/m³). The test result shall be the optimum moisture, i.e. the amount of water in the sample which enables maximum compaction of the stabilizing mixture with the given energy, sufficient also for the hydration of the binder. Granular stone material stabilizing mixture is incorporated into the base course at optimum moisture or optimum moisture increased up to 1%.

The maximum dry volume mass obtained by the modified Proctor’s method shall be used as the parameter in determining the degree of compaction of the incorporated granular stone material stabilized by hydraulic binder into the base course.
Physical and mechanical properties

Natural gravel and crushed stone material shall satisfy requirements given in table 5-02.1.1-3.

**Table 5-02.1.1-3**  Physical and mechanical properties of granular stone material used for base course stabilized by hydraulic binder

<table>
<thead>
<tr>
<th>Properties</th>
<th>Requested, maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape of grains – portion of grains of unfavorable shape (3:1), (HRN B.B8.048) [%]</td>
<td>50</td>
</tr>
<tr>
<td>Water absorption, (HRN B.B8.031) [%]</td>
<td>1.6</td>
</tr>
<tr>
<td>Friable, low quality grains, (HRN B.B8.037) [%]</td>
<td>7</td>
</tr>
<tr>
<td>Sodium sulfate soundness. Mass loss after 5 cycles, (HRN B.B8.044) [%]</td>
<td>12</td>
</tr>
<tr>
<td>Resistance to crushing and wear according to the Log Angeles method, (HRN B.B8.045) [%]</td>
<td>45</td>
</tr>
</tbody>
</table>

**5-02.1.2 Hydraulic binder quality requirements**

Pure Portland cement shall be used as binder; Portland cement with addition of puzzolana or slag and blast furnace cement class 25, 35 and 45.

The cement used shall conform to the requirements of Croatian standards as follows:
- Portland cement: Portland cement with additives. Blast-furnace cement. Puzzolana cement according to the HRN B.C1.001 standard, and
- Cement, means of delivery, package, storage and sampling all according to the HRN B.C1.012 standard.

Other similar hydraulic binders can be used for the base course stabilization according to the HRN U.E9.024 standard, such as fly ash (pulverized fuel ash), slag, puzzolana etc. if the laboratory tests prove their usability and the authorized laboratory defines the conditions of application.

The applied cement shall satisfy the requirements of the HRN B.C1..001 standard.

All binder samples shall be tested for the following properties:
- standard consistency
- setting time
- volume constancy
- residue on screen of 4900 holes / cm²
- compressive strength (for cement class 25 and 35 after 7 and 28 days, and for cement class 45 after 3 and 28 days).
5-02.1.3 Water quality requirements

Water satisfying the following requirements shall be used for the base course stabilized by hydraulic binders:

- pH value greater than 6.0,
- sulfate proportion (SO₃) less than 2700 mg/l of water,
- portion of chloride ions (Cl⁻) is less than 300 mg/l of water,
- organic particles indicator (humus acids, sugars etc.) expressed as potassium permanganate (KmnO₄) according to the oxidation method, less than 200 mg/l of water.

5-02.1.4 Stabilizing mixture quality requirements

The following properties of the stabilizing mixture are tested:

- Determining the compressive strength in mono-axial compression according to the HRN.U.B1.030 standard
- Testing the resistance of cement stabilized layer to freezing according to the HRN U.B1.050 standard.

Stabilizing mixture shall satisfy requirements given in table 5-02.1.4-1.

These requirements are relevant to cement class 25, 35 and 45 (HRN B.C1.011).

If other binders are used such as fly ash (pulverized fuel ash), slag or similar, the same consistency limit values apply, but other (longer) time periods shall be defined for test tube curing. This is done on the basis of laboratory tests and with approval of the Supervising Engineer.

**Table 5-02.1.4-1 The required compressive strength for stabilizing mixtures**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Compressive strength of stabilizing mixture [MN/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>after 7 days</td>
</tr>
<tr>
<td>Pavement structure base course of highways and roads with very heavy traffic loads</td>
<td>from 2,0 to 5,5</td>
</tr>
<tr>
<td>Pavement structure base course of roads with heavy and medium heavy traffic load</td>
<td>from 1,5 to 5,5</td>
</tr>
</tbody>
</table>

Except for given compressive strengths, stabilizing mixtures shall be resistant to freezing.

The compressive strength reduction index according to the HRN U.B1.050 standard shall be minimum 80%.

5-02.1.5 Documents for execution of initial job mix formula

In accordance with Item 5-02.1, on the basis of quality control of basic granular stone material, binder, water and mixture of those components, the Client shall receive the Initial job mix formula for the execution of granular stone material base course stabilized by hydraulic binder.
Initial job mix formula is laboratory proof that it is possible to obtain the quality of mixture as specified by GTR with approved materials and designed composition.

Composition of stabilizing mixture according to the initial job mix formula shall be such that insignificant quality oscillations and proportion of component materials shall not significantly influence the physical and mechanical properties of the mixture.

Initial job mix formula defines the following:
- The grain size distribution of basic granular stone material
- Proportion of basic granular stone material
- Proportion of binder
- Proportion of water
- Optimal moisture and maximum dry volume mass of mixture
- Compressive strength of mixture after 7 and 28 days, and
- Resistance of mixture to freezing and defrosting

All test necessary for execution of initial job mix formula are performed according to the HRN U.E9.024 standard, and the test results shall be presented as a written report (Initial job mix formula for cement stabilized mixture). Except the mentioned test results, the general part of the report shall contain data on the ordering party, place and date of sampling, origin and type of material, authorized laboratory performing the tests, requirements of the ordering party and standards according to which the tests were performed.

If significant changes in the properties of any component material occur, or if there is a change of the basic granular stone material field location or the binder manufacturer, a new initial job mix formula shall be made.

Initial job mix formula is valid for one year, i.e. three years at the most if the confirmed job mix formula each year confirms the properties of material and mixture from the initial job mix formula.

5-02.1.6 Quality requirements for placed base course stabilized by hydraulic binder

Placed base course stabilized by hydraulic binder shall satisfy the quality requirements regarding the rate of compactness, surface evenness, thickness of the layer, homogeneity in compactness as well as height, position and gradient of the layer.

Rate of compactness

The rate of compactness, as defined in Item 5-00.1.2 of the GTR shall be at least 98%.

Surface evenness

Surface evenness is measured as the course surface deviation from a leveling staff 4 m long. The deviation from the staff shall not be greater that 15 mm.
Thickness of course

The course thickness is determined by the design. Base course stabilized by hydraulic binder is placed as single layer, thickness 15 to 30 cm. In case the necessary thickness of that base course is greater than 30 cm, the course is placed in two or more phases, as in the case with racking base courses. Deviation in thickness of the placed course from the designed thickness shall not be greater than 15 mm.

Homogeneity of the course

During the process of compactness, the course shall reach the necessary homogeneity.

Base course stabilized by hydraulic binder is considered as homogenous if the variation coefficient of compaction measurements is less than 3%.

The variation coefficient VC is calculated as follows:

\[ KV = \frac{\sigma}{\bar{x}} \]

\[ \sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2} \]

Where.

\( \sigma \) - standard deviation

\( \bar{x} \) - arithmetic mean value of all compaction measurements on the tested part of placed base course

\( x_i \) - result of unit measurements of course compaction,

\( n \) - number of compaction measurements on the tested stabilization

Height and position

Elevation position of the placed course shall be tested by geodetic survey at places under the pavement kurb and the pavement centerline. The deviation shall be ± 15 mm.

Exceptionally, with approval of the Supervising Engineer, the downward deviation can be –30 mm at most, if the elevation deviation is replaced by the following layer, at the Contractor’s expense.

Gradient

As a rule, the gradient shall be equal to the designed surface transversal and longitudinal gradient. Deviation shall not be greater than (0.4% absolutely from the designed gradient.

5-02.1.7 Documents on control testing and audit testing

The documentation necessary for control testing shall be in accordance with the sub-item 5-02.3.2 of the GTR.
5-02.2 PRODUCTION, TRANSPORT AND PLACING

5-02.2.1 Production of stabilizing mixture

Granular stone material shall be mixed with binder and water into a homogenous mixture. The mixing plant shall enable exact and precise proportioning of granular stone material, binder and water quantities.

Prior to operation, the scales for granular stone material and binder as well as equipment for measuring the water flow shall be attested.

The mixture production plant shall be as near to the construction site as possible since the placing of the mixture is time conditioned.

Special plants for production of stabilizing mixtures are used for mixing, or appropriate cement mixers of bin or continuous type.

Cement stabilizing mixture for execution of base course of highways and roads with very high traffic loads is produced in mixing plants, while the mixture for roads of heavy, medium and light traffic loads can also be produced by mixing in situ, with the approval of the Supervising Engineer.

Mixing time of the stabilizing mixture components shall be adjusted so that the plant produces a mixture with completely coated grains of basic stone material with mortar made of hydraulic binder, small particles of stone material and water. Ready stabilizing mixture shall not contain dry grains of stone material or parts of dry and insufficiently mixed hydraulic binder.

5-02.2.2 Transport of stabilizing mixture

The ready made stabilizing mixture is transported to the site in tipper trucks. It is especially important that the transport be done in a short time period, since the time period from production to placing is limited.

5-02.2.3 Placing of stabilizing mixture

Granular stone material base course stabilized by hydraulic binder, as part of the pavement structure, is usually placed between the base course made of loose granular stone material and the bitumen base course of highways and roads with traffic loads ranging from very heavy to light.

Conditions for bedding

Granular stone material base course stabilized by hydraulic binder shall be placed when the Supervising Engineer takes over the layer on which the base course shall be placed, and approves the beginning of work. Supervising engineer shall check: the evenness, designed gradients, properly executed drainage, position and quality requirements. Prior to placing of stabilizing mixture, the bedding on which it will be placed shall be moist. The stabilizing mixture shall not be placed on a frozen layer.
If the layer on which the stabilizing mixture is to be placed is saturated with water, e.g. after abundant rain or snow melting, the placing should be postponed until the excess water drains out.

The Contractor shall keep the mechanically compacted loose base course in the condition at the time of taking over by the Supervising Engineer. If the base course is damaged for any reason, the Contractor shall repair the damage, bring the layer to the state which satisfies the requirements and inform the Supervising Engineer about it.

Weather conditions

The stabilizing mixture shall not be placed at air temperature lower than 5°C or when the forecast is such that the air temperature will drop below that value within the next 24 hours.

If rain occurs during the execution of the course, the work shall be immediately interrupted and the already spread mixture shall be urgently compacted and covered with protective foil.

During warm and windy weather, special attention shall be given to quick moisture loss from the spread mixture and the placed course.

Work execution

The mixture is spread on the prepared bedding with spreading machines and finishers in order to obtain equal layer thickness and evenness of the surface. Fresh mixture is spread at once along the complete surface.

Immediately after spreading, the course shall be uniformly and carefully compacted along the complete surface by means of plate vibrator, compactors, vibratory rollers and pneumatic-tyred roller, separately or combined.

Places which are not accessible by machines shall be compacted in accordance with the requirements by other means or manner. These places as well as the method of work execution shall be defined by the Supervising Engineer.

Time period from mixing of stabilizing mixture to the finishing and compacting depends on the type of applied binder. In case of Portland cement, this time period shall not be longer than 2 hours.

Surface of the course after the last compacting shall be even, well sealed, without longitudinal marks or cracks.

Special attention shall be given to proper and complete compacting near the longitudinal and transverse joints. In case of flexible pavement structures, longitudinal joints shall be under the centerline, lines that divide the carriage lanes and the border lines.

All areas where the material segregation is obvious, as well as places where damage to the course occurred as a result of insufficient maintenance, site traffic, weather conditions, additional work etc. shall be replaced in full course thickness and additionally compacted.
Since the designed thickness of the stabilized base course is greater than 30 cm, it shall be executed in two or more layers.

In case of roads with heavy and medium traffic loads, granular stone material base course stabilized by hydraulic binder can be executed with adequate machinery at the site, with the approval of the Supervising Engineer.

During execution of the course, at the end of the working day a vertical cross joint is done by cutting the layer at the edge. This is done as the last operation at the end of the working day or as the first operation at the beginning of the next working day.

5-02.3 QUALITY ASSURANCE OF MATERIAL AND WORK

Quality assurance of work on the execution of the cement stabilization means several procedures described and defined in the GTR, with the final aim of obtaining a quality base course stabilized by hydraulic binder in the pavement structure.

There are three types of activities:

- activities prior to execution of base course stabilized by hydraulic binder,
- testing during execution of base course stabilized by hydraulic binder,
- procedure after the execution of base course stabilized by hydraulic binder.

5-02.3.1 Activities prior to execution of base course stabilized by hydraulic binder

These procedures include:
- preliminary testing of all components with appraisal,
- execution of initial job mix formula of stabilizing mixture,
- transfer of initial job mix formula of stabilizing mixture to the mixing plant,
- production of confirmed job mix formula, and
- execution of trial section.

All these procedures shall be done by an authorized laboratory at the Contractor’s expense. On the basis of preliminary testing, the Supervising Engineer shall prior to the beginning of work approve the execution of this base course.

Preliminary testing of material with usability evaluation

Preliminary testing of material shall serve as proof of the usability of material for intended purpose. Preliminary testing of materials, component parts of the stabilizing mixture, shall be done in accordance with sub-item 5-02.1.1, 5-02.1.2 and 5-02.1.3 of these GTR’s.

If preliminary testing proves the usability of component materials in accordance with sub-item 0-17 and 0-19 of these GTR’s, initial job mix formula shall be made.

Execution of initial job mix formula of stabilizing mixture

Execution of initial job mix formula of stabilizing mixture for granular stone material base course stabilized by hydraulic binder shall be in accordance with Item 5-02.1.5 of the GTR.
Transfer of initial job mix formula of stabilizing mixture to the mixing plant

Initial job mix formula shall be transferred to the stabilizing mixture production plant in accordance with provisions given in Item 5-02.2.1 of the GTR. The exact proportioning ratio of granular stone material or mixture of granular stone material fractions, binder and water shall be determined prior to that. The existing moisture level of granular material shall be taken into consideration, so that only the difference in water quantity shall be added in order to reach the optimal moisture of the mixture. Samples of freshly produced stabilizing mixture are taken from the trial production and properties of that mixture are tested to see if it satisfies the set requirements. At least three samples of mixture are tested.

The following properties are tested:
- grain size distribution, and
- compressive strength on the testing samples made of freshly produced stabilizing mixture.

Production of confirmed job mix formula

Compressive strength after 7 days and grain size distribution of granular stone material are tested on at least three samples of freshly produced stabilizing mixture from the trial production.

When adequate compatibility is reached with initial job mix formula, the confirmed job mix formula is presented in written form (Working composition for execution of cement stabilized mixture) to the Supervising Engineer in order to obtain approval for work execution. If the compatibility is not satisfactory, corrections to the mixture shall be made until satisfactory results are obtained. During the production of stabilizing mixture, the Contractor shall at all times keep the working job mix formula as evidence at the plant.

Execution of trial section

If there is no hard evidence that a required quality of stabilized base course can be reached for a particular stabilizing mixture composition and particular technology of spreading and compacting, the working method shall be defined on the trial section. The trial section shall have a surface area of at least 600 m², and if possible, it shall have at least one longitudinal and one transverse joint. Compactness (rate of compactness in relation to compactness according to the modified Proctor's method) shall be tested on a freshly placed course, before binding sets in, on at least four points for each particular phase of work of compacting machinery (certain number of crossings). The grain size distribution shall also be tested at same point.

Compressive strength after 7 days is tested on at least two points of the samples made of freshly made stabilizing mixture.

After the working method and the working regime of the compacting machinery is defined, which give satisfactory results, the documentation is submitted to the Supervising Engineer for approval of work execution.
5-02.3.2 Testing during execution of base course stabilized by hydraulic binder

Tests performed during execution of base course stabilized by hydraulic binder are:

- control testing and
- audit testing.

Control testing

The minimum control testing during work done (enabled) by the Contractor is:

- control of the rate of compactness of freshly placed course at every 500 m² (in relation to the compactness according to the modified Proctor’s method),
- control of the grain size distribution of granular stone material at every 3000 m²,
- control of main parameters determining the binder quality at each 100 tons of binder,
- control of compressive strength on testing units (samples) made of freshly produced stabilizing mixture at every 1000 m²,
- constant control of the evenness, profile exactness and thickness of placed course at every cross section or according to the decision of the Supervising Engineer.

Immediately after the control testing, the Contractor shall submit the results in written form to the Supervising Engineer.

Upon the completion of works, the test results of control testing are presented in a written report containing:

- general part with data on the Client, Contractor, structure and materials used,
- data on the scope of control testing according to the GTR (testing program),
- data on the scope of performed control testing,
- results of control testing and standards according to which the tests were done, and
- conclusion on the quality of performed works.

Audit testing

The minimum audit testing during work done (enabled) by the Client is:

- testing of compressive strength on testing units (samples) made of freshly produced stabilizing mixture at every 3000 m²,
- control of layer thickness, exactness of profile and surface evenness at every 3000 m²,
- control of the rate of compactness in relation to the compactness according to the modified Proctor’s method at every 2500 m²,
- constant control of evenness, profile exactness and thickness of the placed course at every cross section or according to the decision of the Supervising Engineer.

Immediately after the audit testing, the Contractor shall submit the results in written form to the Supervising Engineer.

Upon the completion of works, the test results of audit testing are presented in a written report containing:

- general part with data on the Client, Contractor, structure and materials used,
data on the scope of audit testing according to the GTR (testing program),
data on the scope of performed audit testing,
results of audit testing and standards according to which the tests were done,
testing of the layer according to height, position and gradient by means of
gleodetic survey, and
conclusion on the quality of performed works on the basis of control testing
and audit testing.

On the basis of the control testing and audit testing results, the Client, i.e. his
Supervising Engineer, shall bring a final evaluation of the quality of placed layer.

5-02.3.3 Procedure after placing of base course stabilized by hydraulic binder

After the placing of base course stabilized by hydraulic binder, all procedure shall
be directed to the curing and maintenance of the course.

During warm weather conditions, attention shall be given to the moisture loss
from the course. To continue the process of binder hydration and hardening, it is
necessary to maintain sufficient moisture in the course. This is done by regular
water sprinkling on the surface. The sprinkling shall be done in a manner than
does not damage the course surface, and the course shall be kept moist at least
seven days after placing.

There shall not be any traffic on the placed course at least for seven days and no
following pavement structure layers shall be placed for the same period.

Exceptionally and with the approval of the Supervising Engineer this period can
be shortened, but previous laboratory tests shall prove that the course has
reached the required quality.

During cold weather conditions the placed course shall be protected from freezing
by applying adequate screen, i.e. after seven days the following course shall be
placed.

Prior to the placement of the following layer of the pavement structure, from the
surface of the base course stabilized by hydraulic binder all loose material shall
be removed by compressed air or mechanically, by brushes.

5-02.4 QUALITY EVALUATION

5-02.4.1 Taking over of the placed layer

The placed base course of granular stone material stabilized by hydraulic binder
shall be taken over by the Supervising Engineer on the basis of the fulfilled
requirements from Item 5-02.3 of the GTR.
All possible faults according to those requirements shall be solved by the
Contractor at his expense, including all additional testing and measuring
necessary for determining the quality of rehabilitation.

If after the taking over damage of the layer occurs due to unfavorable weather
conditions or any other reason, the layer shall be remedied and its quality proved
before placing of the next pavement structure layer.
5-02.4.2 Quality assurance documents

Quality assurance documents for materials used and work performed during technical take-over includes the following:

- Initial job mix formula, sub-item 5-02.1.5,
- Confirmed job mix formula as evidence, sub-item 5-02.3.1,
- Report on control testing, sub-item 5-02.3.2,
- Report on audit testing, sub-item 5-02.3.2,
- Report on audit testing of course by geodetic survey according to sub-item 5-02.1.6, and
- Report of Supervising Engineer on works performed.

5-02.5 DEDUCTION FROM THE VALUE OF WORKS

5-02.5.1 Deduction from the value of works due to decreased quality of produced stabilizing mixture

The required composition of stabilizing mixture is defined by the confirmed job mix formula which is produced by an authorized laboratory on the basis of initial job mix formula. Quality of stabilizing mixture is evaluated according to the obtained compressive strength. Other parameters influencing the quality of mixture, such as physical and mechanical properties and grain size distribution of granular stone material as well as type and quantity of binder and water shall be in accordance with the GTR.

Table 5-02.5.1-1 Ranges of compressive strengths for highways and roads with very heavy traffic loads which deviate from the required values but are subject to deduction of certain value of produced layer

<table>
<thead>
<tr>
<th>Compressive strength after 28 days [MN/m²]</th>
<th>Percentage of results for the contracted section, which deviate from the defined requirements, maximum [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,5 to 2,9</td>
<td>5</td>
</tr>
<tr>
<td>6,1 to 10</td>
<td>10</td>
</tr>
</tbody>
</table>

The ruling compressive strength for quality evaluation is the value obtained by testing of the 28 day sample, within the control testing. The required area within which compressive strength shall range is shown in the table of sub-item 5-02.1.4 of the GTR.

The compressive strength results exceeding the required limits which can be accepted, with certain deduction from the value of the course are shown in tables 5-02.5.1-1 and 5-02.5.1-2.

Table 5-02.5.1-2 Ranges of compressive strengths for highways and roads with heavy and medium traffic loads which deviate from the required values but are subject to deduction of certain value of produced course
BASE COURSES

<table>
<thead>
<tr>
<th>Compressive strength after 28 days [MN/m$^2$]</th>
<th>Percentage of results for the contracted section, which deviate from the defined requirements, maximum [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,0 to 2,4</td>
<td>5</td>
</tr>
<tr>
<td>6,1 to 10</td>
<td>10</td>
</tr>
</tbody>
</table>

Values of compressive strength outside the ones given in tables 5-02.5.1-1 and 5-02.5.1-2 are considered as unacceptable.

Deduction from the contracted values of placed stabilized base course, due to decreased quality on the basis of compressive strength according to tables 5-02.5.1-1 and 5-02.5.1-2 is calculated as follows:

$$ O = \frac{p}{100} \cdot C \cdot F $$

where:

- $O$ – deduction from the value of placed stabilized base course (kn),
- $p$ - deduction from the price of placed stabilized base course (%),
- $C$ – unit price (kn/m$^2$),
- $F$ – surface to which the deduction refers (m$^2$).

Percentage of the price of placed stabilized base course being deducted is calculated as follows:

$$ p = \left( \frac{\sigma_{28,i} - 6,0}{6,0} \right)^2 \cdot 100\% $$

where:

- $p$ - deduction from the price (%),
- $\sigma_{28,i}$ – individual value of compressive strength after 28 days (MN/m$^2$)

Quantity of works whose samples give compressive strength outside of these values shall not be taken over, i.e. paid.

5-02.5.2 Deduction from the value of works due to decreased quality of placed stabilized base course

The quality of placed stabilized base course is evaluated according to the obtained density. Other parameters influencing the course quality, such as the quality of stabilizing mixture, thickness and evenness of the course, shall be within the limits defined by the GTR.

Rate of compactness of the placed course according to the GTR shall be at least 98% of the maximum compactness (density) according to the modified Proctor’s procedure. Values of the rate of compactness lower than the defined minimum of 98% show a decreased quality of placed course.
The maximum of 5% of results from the total number of tests would be tolerated within the range of 95% to 98%.

Deduction from the contracted value of placed stabilized base course, due to decreased quality, is calculated as follows:

\[ O = \frac{p}{100} \cdot C \cdot F \]

where:
- \( O \) – deduction from the value of placed stabilized base course (kn),
- \( p \) - deduction from the price of placed stabilized base course (%),
- \( C \) – unit price (kn/m\(^2\)),
- \( F \) – surface to which the deduction refers (m\(^2\)).

Percentage of the price of placed stabilized base course which is being deducted is calculated as follows:

\[ p = \left( \frac{\Delta S Z_i}{5} \right)^2 \cdot 100 \% \]

where:
- \( p \) - deduction from the price of placed layer (%),
- \( \Delta S Z_i \) - deviation of individual value from the defined minimum degree of compaction (%).

Values of the rate of compactness outside the defined limits shall be considered unacceptable. Quantity of works subject to these values shall not be taken over, i.e. paid.

5-02.6. CALCULATION OF WORK

The work shall be calculated according to the actual placed quantities in accordance with the design and the proven quality, if no changes occurred by contract or provision of the Supervising Engineer.

This work shall be calculated in square meters of placed course and shall be paid according to contracted unit prices which include all material, works, transport and everything else needed for completion of the work.

5-03 BITUMEN TACK COAT FOR BINDING THE BITUMEN BASE COURSE WITH THE LAYER MADE ON THE BASIS OF HYDRAULIC BINDERS

5-03.1 DESCRIPTION

Bitumen tack coat for binding the bitumen base course and the layer made on the basis of hydraulic binders is a thin layer of bitumen from bitumen emulsion obtained by sprinkling. It is placed as a part of preparation of bedding for execution of pavement structure bitumen base course.

5-03.2 QUALITY REQUIREMENTS OF BITUMEN EMULSION

Course placed on the basis of hydraulic binders is sprinkled by medium breaking anion and cationic emulsion, depending on the weather conditions.
Quality of bitumen emulsion shall satisfy requirements given in item 6-00.4 of these GTR.

5-03.3 WORK

Course made on the basis of hydraulic binders shall be sprayed by bitumen emulsion in the quantity of 0.5 kg/m² minimum, at least 24 hours prior to the placing of asphalt course.

Spaying by bitumen emulsion shall be done only by power sprayers which enable unified distribution of bitumen emulsion across the surface. Manual spraying shall not be allowed, except on places not accessible by power sprayers and with the approval of the Supervising Engineer.

Prior to spraying by bitumen emulsion, surface of the course made on the basis of hydraulic binders shall be clean, dry and naturally moist.

Spraying of the course made on the basis of hydraulic binders with bitumen emulsion shall not be allowed during rainfall, i.e. during relative air humidity greater than 75% and temperature of air and base lower than 5°C.

5-03.4 QUALITY CONTROL

5-03.4.1 Control testing

During the placing of bitumen course, the Contractor shall perform current control of bitumen emulsion in accordance with item 6-00.4.2.1 in chapter 6 of these GTR.

5-03.4.2 Audit testing

During the placing of bituminous course audit testing of bitumen emulsion shall be performed in accordance with item 6-00.4.2.2 in chapter 6 of these GTR.

5-03.5 CALCULATION OF WORK

Spraying of course made on the basis of hydraulic binders with bitumen emulsion is measured in square meters of actual sprayed surface, in accordance with the design details and is calculated in square meters of sprayed surface area. The price includes all costs of material supply, transport, equipment and all other needed for execution of work.
5-04 BITUMEN BASE COURSE (BBS)

5-04.1 DESCRIPTION

Bitumen base course (BBS) is a base course of the pavement structure made of a mixture of stone flour, stone material largest nominal grain size 32 mm and bitumen as binder, produced and placed according to the hot procedure.

BBC is divided as follows:

- Nominal size of largest stone material grain
- Type of stone material, and
- Grain size distribution of the asphalt mixture stone compound.

BBC is divided according to the nominal size of largest stone material grain as follows:

- BBC 16
- BBC 22 and
- BBC 32.

According to the type of stone material, BBC is divided as follows:

BBC A - made on the basis of crushed stone grit with addition of stone flour,
BBC B - made on the basis of separated or partially separated crushed stone material, with a composition correction by addition of sand and/or stone flour (according to need), or separated natural loose stone material with addition of at least 3% (m/m) of stone compound, crushed grains size larger than 4 mm and/or stone flour (according to need), and
BBC C - made on the basis of separated natural loose stone material, with a composition correction by addition of sand and/or stone flour (according to need).

Table 5 – 04-1 Application and thickness of placed BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Type of BBC</th>
<th>Technological thickness of placed layer, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highways, very heavy, heavy</td>
<td>BBC 22A</td>
<td>60 to 80</td>
</tr>
<tr>
<td></td>
<td>BBC 32A</td>
<td>80 to 120</td>
</tr>
<tr>
<td></td>
<td>BBC 16A</td>
<td>45 to 60</td>
</tr>
<tr>
<td></td>
<td>BBC 16B</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>BBC 22A</td>
<td>60 to 80</td>
</tr>
<tr>
<td></td>
<td>BBC 22B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BBC 32A</td>
<td>80 to 120</td>
</tr>
<tr>
<td></td>
<td>BBC 32B</td>
<td></td>
</tr>
<tr>
<td>Light and very light</td>
<td>BBC 16A</td>
<td>45 to 60</td>
</tr>
<tr>
<td></td>
<td>BBC 16B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BBC 16C</td>
<td></td>
</tr>
</tbody>
</table>

According to the grain size distribution of stone compound, BBC is divided as follows:

BBC 22, - wider limit values of stone compound grain size distribution,
BNS 22s, - narrower limit values of stone compound grain size distribution,
BBC 32, - wider limit values of stone compound grain size distribution, and
BNS 32s, - narrower limit values of stone compound grain size distribution.
5-04.2 QUALITY REQUIREMENTS OF COMPONENT MATERIALS

Stone grit

Stone grit shall satisfy quality requirements set in item 6, sub-item 6-00.2.2 of these GTR.

Table 5-04-2 Application of quality category of stone grit for BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highway and very heavy</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS-S-I</td>
<td>KS-S-I</td>
<td>KS-S-II</td>
<td>KS-S-III</td>
<td>KS-S-V</td>
</tr>
<tr>
<td>KS-S-V</td>
<td>KS-S-II</td>
<td>KS-S-V</td>
<td>KS-S-V</td>
<td>KS-S-VI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KS-S-VIII</td>
<td>KS-S-VII</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>KS-S-VIII</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>KS-S-X</td>
</tr>
</tbody>
</table>

Separated and partially separated granular stone material

Separated and partially separated granular stone material shall satisfy the quality requirements set in item 6, sub-item 6-00.2.3 of these GTR.

Table 5-04-3 Application of quality category of separated and partially separated granular stone material for BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highway and very heavy</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable</td>
<td>KM-I</td>
<td>KM-I</td>
<td>KM-II</td>
<td>KM-III</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>KM-IV</td>
</tr>
</tbody>
</table>

Sand

Natural and crushed sand shall satisfy the quality requirements set in item 6, sub-item 6-00.2.4 of these GTR.

Table 5-04-4 Application of quality category of sand for BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highway and very heavy</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>All categories of crushed sand of sediment origin</td>
<td>All categories of crushed sand of sediment origin</td>
<td>All categories of crushed sand of sediment origin and mixture of crushed and natural sand up to the ratio of at least 1:1</td>
<td>All categories of crushed sand of sediment origin and all categories of natural sand</td>
<td></td>
</tr>
</tbody>
</table>
Stone flour

Stone flour shall satisfy the quality requirements set in item 6, sub-item 6-00.2.5 of these GTR.

Stone flour of category KB-I is only used on highways.

Return stone flour can be returned to the production process under the condition that the filler from that stone flour satisfies the quality requirements set in item 6, sub-item 6-00.2.5 of these GTR.

Bitumen binder

While choosing the type of bitumen, care shall be taken about the climatic zones, according to the HRN U.J.5.600 standard, as well as about the exploitation conditions.

Table 5-04-5  Use of bitumen in relation to the traffic load group

<table>
<thead>
<tr>
<th>Type of bitumen</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>According to HRN U.M3.010</td>
</tr>
<tr>
<td>BIT 45</td>
<td>35/50</td>
</tr>
<tr>
<td>BIT 60</td>
<td>50/70</td>
</tr>
<tr>
<td>BIT 90</td>
<td>70/100</td>
</tr>
</tbody>
</table>

Road construction bitumen shall satisfy the quality requirements set in item 6, sub-item 6-00.2.6 of these GTR.

In special circumstances polymer modified bitumen or road construction bitumen shall be used for BBC, with addition of natural bitumen or polymer additives, applied in the asphalt mixture production process itself, on the asphalt mixing plant.

Polymer modified bitumen (PmB) shall satisfy the quality requirements set in item 6, sub-item 6-00.2.7 of these GTR.

5-04.3 BBC QUALITY REQUIREMENTS

5-04.3.1 Asphalt mixture composition

Table 5-04-6  Scope of stone compound grain size distribution for BBC

<table>
<thead>
<tr>
<th>Screen opening size (mm)</th>
<th>BBC 16</th>
<th>BBC 22</th>
<th>BBC 22s</th>
<th>BBC 32</th>
<th>BBC 32s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,09</td>
<td>5 to 12</td>
<td>4 to 14</td>
<td>5 to 11</td>
<td>3 to 12</td>
<td>4 to 10</td>
</tr>
<tr>
<td>0,25</td>
<td>9 to 30</td>
<td>7 to 37</td>
<td>8 to 17</td>
<td>5 to 18</td>
<td>7 to 15</td>
</tr>
<tr>
<td>0,71</td>
<td>15 to 40</td>
<td>12 to 53</td>
<td>13 to 27</td>
<td>9 to 27</td>
<td>12 to 23</td>
</tr>
<tr>
<td>2,0</td>
<td>26 to 55</td>
<td>21 to 65</td>
<td>24 to 40</td>
<td>17 to 40</td>
<td>20 to 35</td>
</tr>
<tr>
<td>4,0</td>
<td>38 to 70</td>
<td>30 to 74</td>
<td>34 to 53</td>
<td>24 to 52</td>
<td>29 to 46</td>
</tr>
<tr>
<td>8,0</td>
<td>58 to 88</td>
<td>44 to 85</td>
<td>50 to 70</td>
<td>34 to 68</td>
<td>41 to 62</td>
</tr>
<tr>
<td>11,2</td>
<td>74 to 98</td>
<td>54 to 92</td>
<td>61 to 81</td>
<td>42 to 78</td>
<td>50 to 71</td>
</tr>
<tr>
<td>16,0</td>
<td>95 to 100</td>
<td>70 to 100</td>
<td>75 to 94</td>
<td>53 to 90</td>
<td>61 to 82</td>
</tr>
<tr>
<td>22,4</td>
<td>100</td>
<td>97 to 100</td>
<td>70 to 100</td>
<td>76 to 94</td>
<td></td>
</tr>
<tr>
<td>31,5</td>
<td>100</td>
<td>97 to 100</td>
<td>97 to 100</td>
<td>97 to 100</td>
<td></td>
</tr>
<tr>
<td>45,0</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Table 5-04-7  Provisional proportion of bitumen in asphalt mixture for BBC

<table>
<thead>
<tr>
<th>Type of BBC</th>
<th>Provisional proportion of bitumen % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBC 16</td>
<td>4.3 to 5.7</td>
</tr>
<tr>
<td>BBC 22</td>
<td>3.8 to 5.2</td>
</tr>
<tr>
<td>BBC 22s</td>
<td>4.0 to 5.0</td>
</tr>
<tr>
<td>BBC 32</td>
<td>3.3 to 4.7</td>
</tr>
<tr>
<td>BBC 32s</td>
<td>3.5 to 4.5</td>
</tr>
</tbody>
</table>

The exact proportion of bitumen is determined by the production of previous and working composition of asphalt mixture.

5-04.3.2 Properties of asphalt mixture

Table 5-04-8  Physical and mechanical properties of asphalt mixture for BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Highway and very heavy</th>
<th>Heavy and medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability at 60 °C, at least, kN</td>
<td>9</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Relation of stability and deformation at 60 °C, at least, kN/mm</td>
<td>2,5</td>
<td>2</td>
<td>1,5</td>
</tr>
<tr>
<td>Voids, % (V/V)</td>
<td>5 to 8</td>
<td>4 to 8</td>
<td>3 to 8</td>
</tr>
<tr>
<td>Filling of stone compound voids with bitumen, %</td>
<td>51 to 67</td>
<td>52 to 73</td>
<td>to 77</td>
</tr>
</tbody>
</table>

5-04.3.3 Properties of placed course

Table 5-04.9  Percentage of voids, rate of compactness, thickness and bonding of layers executed by BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Properties</th>
<th>Highway and very heavy</th>
<th>Heavy and medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of gravel % (V/V)</td>
<td>4 to 10</td>
<td>3 to 10</td>
<td>2 to 11</td>
</tr>
<tr>
<td>Rate of compactness, minimum, %</td>
<td>98</td>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td>Thickness of course - separately, maximum</td>
<td>- 15 % from designed, but not more than -15 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mean values, maximum, %</td>
<td>- 5 from designed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonding of layers, minimum, N/mm²</td>
<td>1,0**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Thickness greater than 20 % from the designed shall not be considered in the mean thickness calculation.
** Applicable only when the base is sprayed with bitumen binder.
**Table 5-04-10**  Evenness, elevation, cross-fall and horizontal position of the placed BBC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highway</td>
</tr>
<tr>
<td>Evenness</td>
<td></td>
</tr>
<tr>
<td>- IRI(100) , maximum, m/km</td>
<td>1.8</td>
</tr>
<tr>
<td>- measuring staff 3 m, maximum, mm</td>
<td>6</td>
</tr>
<tr>
<td>Elevation:</td>
<td></td>
</tr>
<tr>
<td>allowed elevation deviation from designed elevation position, maximum %</td>
<td>± 10</td>
</tr>
<tr>
<td>cross fall:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation from the designed cross-fall (each profile), maximum, % (aps.)</td>
<td>± 0,4</td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge) from the designed elevation position, maximum, mm</td>
<td>± 25</td>
</tr>
</tbody>
</table>

**5-04.4 EXECUTION OF BBC**

Production, transport and placing of BBC are described in item 6, sub-item 6-00.3 of these GTR.

**5-04.5 QUALITY CONTROL OF BBC**

**5-04.5.1 Preliminary testing**

Activities prior to initiation of asphalt works, with respect to previous material usability tests, production of initial and confirmed job mix formulas and the trial section, shall be done in accordance with item 6, sub-item 6-00.4.1 of these GTR.

**5-04.5.2 Control testing**

*Control testing of component materials*

Control testing of component materials is done in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

*Control testing of produced asphalt mixture*

Samples of asphalt mixture are taken at the production plant or at the placing site.

Asphalt mixture composition is tested by at least one sample at every 500 tons of produced asphalt mixture.

Properties are tested in accordance with item 6, sub-item 6-00.4.2.1.

Physical and mechanical properties of asphalt mixture are tested by at least one sample at every 1000 tons of produced asphalt mixture.
Properties are tested in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

**Control testing of placed asphalt mixture**

Control testing of placed asphalt mixture is done in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

### 5.04.5.3 Audit testing

**Audit testing of component materials**

Samples of component materials for production of asphalt mixtures are taken at asphalt plants and tested in accordance with item 6, sub-item 6-00.4.2.2 of these GTR.

**Audit testing of produced asphalt mixture**

Samples of asphalt mixture for audit testing are usually taken at the site where the asphalt mixture is being placed.

Composition, physical and mechanical properties of asphalt mixture are tested:
- for highways and roads of heavy and very heavy traffic load group at every 2000 tons of produced asphalt mixture, and
- for roads of medium, light and very light traffic load at every 6000 m$^2$ of placed BBC.

Properties, in accordance with item 6, sub-item 6-00.4.2.2 are being tested on asphalt mixture samples.

**Audit testing of placed course**

Rate of compactness, proportion of gravel, thickness of executed course and bonding of the layers are tested on samples taken at every 2000 m$^2$ of surface of placed layer, according to item 6, sub-item 6-00.4.2.2 of these GTR.

Elevation, cross-fall and position of placed course are tested with appropriate equipment which checks at least 20% of data taken by the Contractor during control testing of asphalt mixture placing, according to item 6, sub-item 6-00.4.2.1 of these GTR.

### 5-04.6 QUALITY EVALUATION OF THE PLACED BBC

The placed BBC shall be evaluated and taken over by the Supervising Engineer on the basis of the control test and audit test results.

Percentage of bitumen, defined on asphalt mixture samples during control testing and audit testing shall satisfy the requirements given in item 6, sub-item 6-00.4.1, table 6-00-20.
Grain size distribution of stone compound, defined on asphalt mixture samples during control testing and audit testing shall satisfy the requirements given in table 5-04-6 and in item 6, sub-item 6-00.4.1, table 6-00-19.

Physical and mechanical properties of asphalt mixture shall satisfy the requirements given in sub-item 5-04.3.2, table 5-04-8.

Properties of placed asphalt course shall satisfy the requirements given in sub-item 5-04.3.3, tables 5-04-9 and 5-04-10.

All faults found according to the given requirements shall be solved by the Contractor.

All costs of rehabilitation shall be at the expense of the Contractor, including all additional testing and measuring necessary to prove the validity of the improvement.

All works that do not satisfy the set quality requirements and which are not remedied by the Contractor according to the Supervising engineer’s request, shall not be paid to the Contractor.

5-04.7 CALCULATION OF WORK

The quantity of performed work shall be measured in square meters of upper surface of actually placed and incorporated BBC, in accordance with the design.

The defined quantities shall be paid per contracted unit price for square meter.

The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.

If the works do not completely fulfil the requirements given in these GTR, the quality shall be evaluated according to item 6, sub-item 6-00.5 of the GTR.

Decreased values of works shall be deducted from the Contractor’s contracted price.

5-05 BITUMINOUS BASE-WEARING COURSE (BBWC)

5-05.1 DESCRIPTION

Bituminous base-wearing course (BBWC) is a base bitumen course, which serves as a wearing course, made of a mixture of stone flour, stone material with nominal grain size 22 mm and bitumen as binder, made and placed according to hot procedure. It is placed exclusively on roads intended for light or very light traffic load.

The BBWC is divided as follows:

- Nominal size of largest stone material grain, and
- Type of stone material.

According to the nominal size of largest stone material grain, the BBWC is divides as follows:
BASE COURSES

- BBWC 16 and
- BBWC 22

According to the type of stone material, the BBWC is divided as follows:

BBWC A – made of crushed stone detribus with addition of stone flour,
BBWC B - made on the basis of separated or partially separated crushed stone material, with a correction of composition by addition of sand and/or stone flour (according to need), or separated natural loose stone material with addition of at least 30% (m/m) of stone compound with crushed grains above 4 mm and/or stone flour (according to need), and
BBWC C – made on the basis of separated natural loose stone material, with correction of compound by addition of sand and/or stone flour (according to need).

Table 5-05-1  Application and technological thickness of placed BBWC

<table>
<thead>
<tr>
<th>Type of BBWC</th>
<th>Technological thickness of placed layer, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBWC 16A</td>
<td></td>
</tr>
<tr>
<td>BBWC 16B</td>
<td></td>
</tr>
<tr>
<td>BBWC 16C</td>
<td></td>
</tr>
<tr>
<td>BBWC 22A</td>
<td></td>
</tr>
<tr>
<td>BBWC 22B</td>
<td></td>
</tr>
<tr>
<td>BBWC 22 C</td>
<td></td>
</tr>
</tbody>
</table>

5-05.2 QUALITY REQUIREMENTS FOR COMPONENT MATERIALS

Stone grit

Stone grit shall satisfy the quality requirements given in item 6, sub-item 6-00.2.2 of these GTR.

For BBWC production the following quality categories of stone grit are used:


Separated and partially separated granular stone material

Separated and partially separated granular stone materials shall satisfy the quality requirements given in item 6, sub-item 6-00.2.3 of these GTR, and the following quality categories shall be used:

- KM-I, KM-II and KM-III.

Sand

Natural and crushed sand shall satisfy the quality requirements given in item 6, sub-item 6-00.2.4 of these GTR.

All categories of crushed and natural sand of sedimentary origin are used.
BASE COURSES

Stone flour

Stone flour of categories KB-I and KB-II is used and it shall satisfy the quality requirements given in item 6, sub-item 6-00.2.5 of these GTR.

Return stone flour separated in the asphalt plant shall be returned into the production process under the condition that the filler from that stone flour satisfies the quality requirements given in item 6, sub-item 6-00.2.5 of these GTR.

Bitumen binder

Road construction bitumen BIT 60 or BIT 90 is used for production of BBWC, according to the requirements of the HRN U.M3.010 standard, i.e. road construction bitumen mark 50/70 or 70/100 according to the EN 12591 standard.

The used bitumen shall satisfy the quality requirements given in item 6, sub-item 6-00.2.6 of these GTR.

5-05.3 QUALITY REQUIREMENTS FOR BBWC

5-05.3.1 Asphalt mixture composition

Table 5-05-2 Scope of asphalt mixture stone compound grain size distribution for BBWC

<table>
<thead>
<tr>
<th>Screen opening size (mm)</th>
<th>BBWC 16</th>
<th>BBWC 22</th>
<th>Percent passing, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,09</td>
<td>5 to 12</td>
<td>4 to 14</td>
<td></td>
</tr>
<tr>
<td>0,25</td>
<td>9 to 30</td>
<td>7 to 37</td>
<td></td>
</tr>
<tr>
<td>0,71</td>
<td>15 to 40</td>
<td>12 to 53</td>
<td></td>
</tr>
<tr>
<td>2,0</td>
<td>26 to 55</td>
<td>21 to 65</td>
<td></td>
</tr>
<tr>
<td>4,0</td>
<td>38 to 70</td>
<td>30 to 74</td>
<td></td>
</tr>
<tr>
<td>8,0</td>
<td>58 to 88</td>
<td>44 to 85</td>
<td></td>
</tr>
<tr>
<td>11,2</td>
<td>74 to 98</td>
<td>54 to 92</td>
<td></td>
</tr>
<tr>
<td>16,0</td>
<td>95 to 100</td>
<td>70 to 100</td>
<td></td>
</tr>
<tr>
<td>22,4</td>
<td>100</td>
<td>97 to 100</td>
<td></td>
</tr>
<tr>
<td>31,5</td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-05-3 Provisional percentage of bitumen in asphalt mixture for BBWC

<table>
<thead>
<tr>
<th>Type of BBWC</th>
<th>Provisional percentage of bitumen % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBWC 16</td>
<td>4,5 to 6,5</td>
</tr>
<tr>
<td>BBWC 22</td>
<td>4,0 to 6,0</td>
</tr>
</tbody>
</table>

The exact percentage of bitumen shall be determined by the production of previous composition of asphalt mixture and working composition of asphalt mixture.
5-05.3.2 Properties of asphalt mixture

Table 5-05-4  Physical and mechanical properties of asphalt mixture for BBWC

<table>
<thead>
<tr>
<th>Property</th>
<th>BBWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability at 60 °C, minimum, kN</td>
<td>4</td>
</tr>
<tr>
<td>Ratio of stability and deviation at 0 °C, minimum, kN/mm</td>
<td>1,4</td>
</tr>
<tr>
<td>Percentage of voids, % (V/V)</td>
<td>2 to 5</td>
</tr>
<tr>
<td>Filling of stone compound voids with bitumen, %</td>
<td>70 to 86</td>
</tr>
</tbody>
</table>

5-05.3.3 Properties of placed course

Table 5-05-5  Percentage of voids, rate of compactness and thickness of placed BBWC

<table>
<thead>
<tr>
<th>Property</th>
<th>BBWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of gravel, % (V/V)</td>
<td>2 to 7</td>
</tr>
<tr>
<td>Rate of compactness, minimum, %</td>
<td>97</td>
</tr>
<tr>
<td>Thickness of course *</td>
<td></td>
</tr>
<tr>
<td>- individually, maximum</td>
<td>- 15 % from the designed, but not more than -15 mm</td>
</tr>
<tr>
<td>- mean value, maximum, %</td>
<td>- 5 from the designed</td>
</tr>
<tr>
<td>Evenness of course:</td>
<td></td>
</tr>
<tr>
<td>- IRI (100), maximum, m/km</td>
<td>3.0</td>
</tr>
<tr>
<td>- measuring staff 3 m, maximum, mm</td>
<td>10</td>
</tr>
<tr>
<td>Elevation of course:</td>
<td></td>
</tr>
<tr>
<td>Allowed elevation deviation of course from the designed elevation position, maximum %</td>
<td>± 10</td>
</tr>
<tr>
<td>Cross-fall:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation from the designed cross-fall (each profile), maximum, % (aps.)</td>
<td>± 0.4</td>
</tr>
<tr>
<td>Position</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge) from the designed elevation position, maximum, mm</td>
<td>± 50</td>
</tr>
</tbody>
</table>

* Thickness greater than 20% from the designed thickness shall not be taken into calculation of the mean thickness.

5-05.4 PRODUCTION OF BBWC

Production, transport and placing of the BBWC are described in item 6, sub-item 6-00.3 of these GTR.

5-05.5 QUALITY CONTROL OF BBWC

5-05.5.1 Preliminary testing

Activities prior to the beginning of asphalt works, with respect to previous material suitability testing, production of previous and working compositions and the test section, shall be done in accordance with item 6, sub-item 6-00.4.1 of these GTR.
5-05.5.2 Control testing

Control testing of component materials

Control testing of component materials shall be done in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Samples of asphalt mixture are taken at the asphalt mixture production plant or at the site.

Composition of asphalt mixture is checked by testing at least one sample at every 500 tons of produced asphalt mixture. Properties are tested in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

Physical and mechanical properties of asphalt mixture are checked by testing at least one sample at every 1000 tons of produced asphalt mixture.

Properties are tested in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

Control testing of placed asphalt mixture

Control testing of placed asphalt mixture shall be done in accordance with item 6, sub-item 6-00.4.2.1 of these GTR.

5-05.5.3 Audit testing

Audit testing of component materials

Samples of component materials for asphalt mixture production are taken at the asphalt production plants and tested in accordance with item 6, sub-item 6-00.4.2.2 of these GTR.

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing shall be taken at the site.

Composition, physical and mechanical properties of asphalt mixture shall be tested at every 6000 m² of placed BBWC.

Properties in accordance with item 6, sub-item 6-00.4.2.2 of these GTR shall be tested on asphalt mixture samples.

Audit testing of placed layer

Rate of compactness, percentage of voids, thickness of placed course and bonding of layers are tested on samples taken at every 2000 m² of placed course surface, according to item 6, sub-item 6-00.4.2.2 of these GTR.

Evenness of placed course shall be tested in accordance with item 6, sub-item 6-00.4.2.2 of these GTR.
Elevation, cross-fall and position of placed course shall be checked with appropriate equipment by testing at least 20% of data obtained by the Contractor during control testing of asphalt mixture placing, according to item 6, sub-item 6-00.4.2.1 of these GTR.

5-05.6 QUALITY EVALUATION OF PLACED BBWC

The placed BBWC shall be evaluated and taken over by the Supervising Engineer on the basis of control testing and audit testing results.

Percentage of bitumen defined in the asphalt mixture samples during control testing and audit testing shall satisfy the requirements given in item 6, sub-item 6-00.4.1, table 6-00-20.

Grain size distribution of stone mix defined on asphalt mixture samples during control testing and audit testing shall satisfy the requirements given in table 5-05-2 and item 6, sub-item 6-00.4.1, table 6-00-19.

Physical and mechanical properties of asphalt mixture shall satisfy the requirements given in sub-item 5-05.3.2, table 5-05-4.

Properties of placed asphalt course shall satisfy the requirements given in sub-item 5-05.3.3, table 5-05-5.

All faults found not satisfying the given requirements shall be solved by the Contractor.

All costs of remedy shall be at the expense of the Contractor, including all additional testing and measurements needed to determine the validity of the remedy. Works not satisfying the given requirements and not remedied by the Contractor according to the request of the Supervising Engineer, shall not be paid to the Contractor.

5-05.7 CALCULATION OF WORK

Quantity of performed works is calculated per square meter of BBWC upper surface area placed according to the design. Defined quantities shall be paid per contracted unit price per square meter.

The price includes all costs of supply, production and placing of asphalt mixture, transport, equipment and everything needed for the completion of works.

If the works do not completely satisfy the requirements set in these GTR, the quality is evaluated according to item 6, sub-item 6-00.5 of these GTR.

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<th>Description</th>
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</thead>
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<td>Soil mechanics tests – Sample taking</td>
</tr>
<tr>
<td>HRN U.B1.012:1970</td>
<td>Soil mechanics tests – Determining the soil moisture content</td>
</tr>
<tr>
<td>HRN U.B1.014:1968</td>
<td>Soil mechanics tests – Determining the specific soil mass</td>
</tr>
<tr>
<td>HRN U.B1.018:1980</td>
<td>Soil mechanics tests – Determining the grain size distribution</td>
</tr>
<tr>
<td>HRN U.B1.030:1968</td>
<td>Soil mechanics tests – Determining the soil compressive strength</td>
</tr>
<tr>
<td>Standard Code</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HRN U.B1.038:1968</td>
<td>Soil mechanics tests – Determining the optimum water content</td>
</tr>
<tr>
<td>HRN U.B1.04:1968</td>
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</tr>
<tr>
<td>HRN U.B1.048:1968</td>
<td>Soil mechanics tests – Determining the optimum water content of the cement stabilized soil</td>
</tr>
<tr>
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<td>Stone aggregate – Determining the volume mass and water intake</td>
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</tr>
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<td>Stone aggregate – Determining the weak grains</td>
</tr>
<tr>
<td>HRN B.B8.039:1982</td>
<td>Testing of sand for construction purposes - Approximate determination of organic substances contamination (colorimetric method)</td>
</tr>
<tr>
<td>HRN B.B8.044:1982</td>
<td>Natural and crushed aggregate – Testing the resistance to frost by means of sodium sulfate</td>
</tr>
<tr>
<td>HRN B.B8.048:1984</td>
<td>Stone aggregate – Determining the shape by the nose scale method</td>
</tr>
<tr>
<td>HRN U.E9.024:1980</td>
<td>Execution of pavement structure base course by cement stabilized materials and similar hydraulic binders – technical requirements</td>
</tr>
<tr>
<td>HRN B.B0.001:1984</td>
<td>Natural stone. Sample taking of stone and stone aggregates</td>
</tr>
<tr>
<td>HRN U.J5.600:1987</td>
<td>Thermal technology in civil engineering. Technical requirements for design and construction of buildings</td>
</tr>
<tr>
<td>HRN U.M3.010:1975</td>
<td>Bitumen for pavements. Quality requirements</td>
</tr>
<tr>
<td>HRN U.M3.100:1961</td>
<td>Viscosity tests of liquid hydrocarbon binders for pavements</td>
</tr>
<tr>
<td>HRN U.M8.092:1966</td>
<td>Asphalt pavement structures. Determining the volume mass of samples taken from the suracing and base courses</td>
</tr>
<tr>
<td>EN 12591:1999</td>
<td>Bitumen and bituminous binders – Specifications for paving grade bitumen</td>
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6

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6-08 STANDARDS AND TECHNICAL REGULATIONS
6 – 00  GENERAL INFORMATION

This chapter deals with the minimum quality requirements for materials, products and works used for execution of asphalt road surfacing. The GTR are written in a manner that they constitute an integral part of a contract, having the conditions relevant to special works included in the contract as Special technical requirements. (STR).

Materials, products, equipment and works shall be done in accordance with standards and technical requirements stated in the design documentation. If no standard is stated, the application of respective EU standard is compulsory. If, in the meantime, a standard or regulation becomes non valid, the replacing standard or regulation shall be applicable.

The Contractor may propose the application of accepted technical regulations (standards) of an international standardizing body (ISO, ES, DIN, ASTM,...) with a written explanation and approval of the supervising engineer. This change shall be approved by the supervising engineer with the consent of the designer. The Contractor shall enter the change into the implementation design.

6-00.1  DEFINITIONS

General terms and expressions and their meaning in these General technical requirements are given in chapter 0. Only definitions which are not given in chapter 0. are given below, and which are relevant only for this chapter.

6-00.1.1  General terms

**Asphalt by hot procedure** is asphalt obtained by mixing of hot bitumen into the hot stone material.

**Asphalt by cold procedure** is obtained by mixing of bitumen emulsion or cut-back bitumen into stone material.

**Asphalt road surfacing** is the finishing layer of the pavement structure, consisting of tack coat and wearing course, i.e. only of asphalt wearing course.

**Bitumen tack coat** is a thin bitumen layer intended for bonding of asphalt layers, or for bonding the asphalt layer with a layer made on the basis of hydraulic binders. It is made of bitumen emulsion or hot bitumen by spraying.

**Wearing course** is the finishing course of the asphalt road surfacing.

**WC – AC** is an asphalt-concrete mixture wearing course, made according to the principle of the most dense grain packing.

**WC – SMA** is a wearing course made of “Split-mastic asphalt”

**Poured asphalt (PA)** is asphalt made according to the hot procedure, placed by pouring.

**Micro – asphalt** (MA) is a type of thin layered asphalt coating, made of asphalt according to cold procedure, by mixing of bitumen emulsion into stone material.
Trial section is a part of a road under construction where the Contractor's competence is proven to execute individual pavement structure asphalt courses, in accordance with the quality requirements stated in these GTR.

Surface dressing is a type of thin layered asphalt coating, made by previous bitumen binder spraying and blinding with stone grit fractions.

Initial job mix of asphalt mixture is laboratory proof that it is possible to obtain the required asphalt mixture quality with the chosen materials and composition.

Job mix formula of asphalt mixture is proof that it is possible to produce an asphalt mixture on a chosen asphalt mixing plant of the quality obtained by initial job mix.

Rolled asphalt is asphalt made by hot procedure, compacted by rolling during placing.

Split-mastic asphalt (SMA) (from German Splitmastixasphalt) is a type of asphalt mixture of discontinuous grain size distribution of stone mixture, intended for execution of road surfacing wearing courses of highways and roads of the very heavy and heavy traffic load group.

Bonding layer (BL) is a layer placed between the base course and asphalt wearing course.

6-00.1.2 Materials

Bitumen is a black, sticky, at normal temperature semisolid or solid mass, composed of hydrocarbons and their non-metallic derivatives, soluble in toluen, found in nature or obtained by petroleum processing. Bitumen has the role of binder in asphalt mixtures.

Bitumen emulsion is a dispersible bitumen agent, dispersed in water, containing an emulsifying agent.

Road construction bitumen is used in production of asphalt mixtures, obtained from the surplus of vacuum distilled oil.

Partially separated granular stone material is a non-crushed (gravel, scree) or granular stone material obtained by crushing of stone, gravel or scree, nominal grain size between 0 and 32 mm, separated and declared according to the highest nominal grain size.

Crushed stone grit is a granular material, grain size ranging from 2 to 32 mm, obtained by crushing of stone, gravel or scree and separated in accordance with the standard HRN B.B3.100. Stone grit obtained by crushing of gravel shall contain at least 90% (m/m) of crushed gravel grains (crushed grains are those grains having at least 50% of crushed surface), and it shall contain maximum 2% of completely non-crushed grains.

Crushed sand is a granular stone material, grain size ranging from 0 to 2 mm or from 0 to 4 mm, obtained by crushing of stone, gravel or scree.
Crushed gravel contains a certain percentage of crushed grains, i.e. grains with more than 50% of crushed surface area.

Stone is a part of a rock, separated by natural forces or by means of planned efficient mechanical influence. Rock (rock mass) is a component part of the Earth’s crust, of specific texture, structure, mineral composition and means of geologic occurrence. Genetically, rocks are classified as igneous rocks, sedimentary rocks and metamorphic rocks.

Stone grit (stone aggregate) is a granular stone material, grain size ranging from 2 to 32 mm and separated according to basic fractions or inter-fractions, according to the requirements of standard HRN B.B3.100

Stone flour is a crushed or ground granular stone material, grain size up to 0,71 mm. It shall contain at least 80% (m/m), i.e.65% (m/m) of filler, depending on the quality of stone flour, according to the HRN B.B3.045 standard.

Non-crushed stone grit is a naturally pulverized granular stone material, gravel or scree, grain size ranging from 2 to 32 mm, separated according to the HRN B.B3.100 standard.

Non-separated crushed stone material is a mixture of crushed stone, grain size ranging from 0 to the maximum nominal grain size (expressed in mm).

Polymer modified bitumen emulsion is a dispersible system of polymer modified bitumen or latex dispersed in water, containing an emulsifying agent

Polymer modified bitumen (PmB) is a mixture of road construction bitumen and different types of polymer (elastomers, duromers, tar-polymers).

Natural sand is a loose, clastic sediment, grain size ranging from 0,02 mm to 2 mm.

Filler is a part of stone flour, grain size up to 0,09 mm.

Cut-back bitumen is bitumen subsequently diluted by appropriate oils.

Separated granular stone material is a non-crushed stone material (gravel, scree) or granular material obtained by crushing of stone, gravel or scree, smallest nominal grain size 2 mm to the largest nominal grain size 32 mm, not separated according to the HRN B.B3.100 standard, but separated according to some other fractions declared according to the lowest and highest nominal grain size.

Scree is a pulverized, non-rounded, loose stone material obtained by natural wear of rocks (in situ) or after a very short “shift” mainly gravitational, with grain size larger that 2 mm.

Gravel is a loose clastic sediment mostly consisting of rounded conglomerate, size ranging from 2 mm to 63 mm. It can be separated, partially separated or separated according to the HRN B.B3.100 standard.
Granular stone material is a granulated stone material, grain size ranging from 0 to the largest nominal size (expressed in mm), not ground (gravel, scree) or obtained by grinding of rock, gravel or scree.

6-00.2 MATERIALS FOR ASPHALT MIXTURE PRODUCTION

6-00.2.1 Stone

The use of certain types of stone in the pavement structure asphalt courses depends on the mineralogical and petrographic composition, the physical and mechanical properties and the granular stone materials production technology.

Laboratory testing

Stone is sampled in accordance with the HRN B.B0.001 standard. Following properties are tested on stone samples:

- Mineral–petrographic composition: HRN B.B8.003 or HRN EN 12407
- Compressive strength: HRN B.B8.012 or HRN EN 1926
- Resistance to wear by sanding: HRN B.B8.015
- Water absorption: HRN B.B8.010 or HRN EN 13755
- Stone resistance to freezing: HRN B.B8.001 or HRN EN 12371
- Volume mass: HRN B.B8.032 or HRN EN 1936
- Density: HRN B.B8.032 or HRN EN 1936
- Porosity: HRN B.B8.032 or HRN EN 1936
- Resistance to Na₂SO₄: HRN B.B8.002 or HRN EN 12370.

Quality requirements

Table 6-00-1 Categories of stone quality as raw material for production of granular stone material

<table>
<thead>
<tr>
<th>Property</th>
<th>Tone quality categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K-I</td>
</tr>
<tr>
<td>Mineralogical-petrographic division</td>
<td>igneous group*</td>
</tr>
<tr>
<td>Compressive strength in dry state, minimum MPa</td>
<td>160</td>
</tr>
<tr>
<td>Resistance to wear by sanding, maximum cm³/50 cm²</td>
<td>12</td>
</tr>
<tr>
<td>Water absorption, maximum, % (m/m)</td>
<td>0.75</td>
</tr>
<tr>
<td>Resistance to frost resistant</td>
<td>Resistant</td>
</tr>
<tr>
<td>Resistance to Na₂SO₄, maximum % (m/m)</td>
<td>5 (3)***</td>
</tr>
</tbody>
</table>

* Rock of igneous and/or metamorphic origin but of silicate composition (in further text – silicate composition)
** Rock of igneous and/or metamorphic origin but of carbonate composition (in further text – carbonate composition)
*** For surface treatment
6-00.2.2 Stone grit

Stone grit is a granular stone material, ranging from 2 to 32 mm in size, separated on basic and/or semi-fractions according to the HRN B.B3.100 standard.

**Laboratory testing:**

Stone grit shall be sampled in accordance with the requirements of the HRN B.B0.001 or EN 932-1 standard, and the testing shall be prepared according to the EN 932-1 standard.

The following properties shall be tested on stone grit material:

- Grain size distribution HRN B.B8.029 or EN 933-1
- Percentage of particles < 0.09 mm HRN B.B8.036
- Percentage of clay balls HRN B.B8.038
- Percentage of organic impurities HRN U.B1.024
- Percentage of grains of unfavorable shape HRN B.B8.048 or EN 33-4
- Percentage of weak and friable grains HRN B.B8.037
- Bitumen coated HRN U.M8.096 or EN 12697-11
- Water absorption HRN B.B8.031 or EN 1097-6
- Resistance to Na₂SO₄ HRN B.B8.044 or EN 1367-2
- Resistance to wear and crushing HRN B.B8.045 or EN 1097-2
- Rate of polished stone value HRN B.B8.120 or EN 1097-8
- Mineral-petrographic composition HRN B.B8.004 or EN 932-3
- Percentage of crushed grains
  - EN 933-5
- Density HRN U.M8.082 or EN 1097-6

**Quality requirements for stone grit**

**Table 6-00-2 Requirements for grain size distribution of stone grit**

<table>
<thead>
<tr>
<th>Basic fraction (mm)</th>
<th>Falling through laboratory screens, %(m/m)</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8,0</th>
<th>11,2</th>
<th>16</th>
<th>22,4</th>
<th>31,5</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/8</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15 (10)*</td>
<td>≥ 90:</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/16</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15</td>
<td>≤ 35 (70)</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16/32</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15</td>
<td>≤ 35 (65)</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-fraction (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/4</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15 (10)*</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/11</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15 (10)*</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/16</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15 (10)*</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16/22</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22/32</td>
<td></td>
<td>≤ 5</td>
<td>≤ 15</td>
<td>≥ 90</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For surface treatment

---

1 Tested only in stone grit obtained by crushing of gravel if there is no certificate of validation of gravel as raw material.
2 Tested only in stone grit obtained by crushing of gravel.
Bitumen coating of stone grit intended for wearing courses shall be minimum 100/90, and for other layers minimum 100/85.

Stone grit, depending on the mineral – petrographic division, means of obtainment and production as well as the physical and mechanical properties is divided into:

- three categories of crushed stone grit of igneous and/or metamorphic origin, and
- ten categories of crushed stone grit of sedimentary origin, obtained by crushing of stone and gravel and uncrushed stone grit, gravel and scree.

### Table 6-00-3  Purity requirements for stone grit

<table>
<thead>
<tr>
<th>Property</th>
<th>Fractions and semi-fractions, mm</th>
<th>2/4</th>
<th>4/8 do 16/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of particles smaller than 0,09 mm,</td>
<td></td>
<td>3,0 (1,0)*</td>
<td>1,0 (0,5)*</td>
</tr>
<tr>
<td>maximum, % (m/m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic impurities, maximum, % (m/m)</td>
<td>0,5 (0,2)*</td>
<td></td>
<td>0,25 (0,2)*</td>
</tr>
<tr>
<td>Percentage of clay balls, maximum, % (m/m)</td>
<td>0,25 (0,1)*</td>
<td>0,25 (0,1)*</td>
<td></td>
</tr>
</tbody>
</table>

* For surface dressing

Quality requirements of physical and mechanical properties and stone grit category are given in tables 6-00.2-4, 6-00.2-5 and 6-00.2-5a.

### Table 6-00-4  Quality requirements for physical and mechanical properties of stone grit of igneous and/or metamorphic origin

<table>
<thead>
<tr>
<th>Property</th>
<th>Categories of quality of physical and mechanical properties of crushed stone grit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KS-E-I</td>
</tr>
<tr>
<td>Production procedure</td>
<td>crushed</td>
</tr>
<tr>
<td>Resistance to Na₂SO₄, maximum (m/m)</td>
<td>3,0</td>
</tr>
<tr>
<td>Water absorption, maximum, %(m/m)</td>
<td>1,6 (1,2)*</td>
</tr>
<tr>
<td>Percentage of grains of unfavorable shape, %</td>
<td></td>
</tr>
<tr>
<td>(m/m)</td>
<td>20 (10)*</td>
</tr>
<tr>
<td>Percentage of weak grains maximum, %(m/m)</td>
<td>3,0 (1)*</td>
</tr>
<tr>
<td>Resistance to crushing (Los Angeles), maximum,</td>
<td>16</td>
</tr>
<tr>
<td>(m/m)</td>
<td></td>
</tr>
<tr>
<td>Stone polish values, minimum, (VPK)</td>
<td>56</td>
</tr>
</tbody>
</table>

* For WC-SMA and surface dressing

#### 6-00.2.3  Separated and partially separated granular stone material

Separated granular stone material is non-crushed material, (gravel, scree), or material obtained by crushing of stone, gravel or scree, lowest nominal grain size 2 mm to largest nominal grain size up to 32 mm, which is not separated in accordance to the HRN B.B3.100 standard but separated to some other fractions declared according to the lowest and highest nominal grain size.

Partially separated granular stone material is non-crushed material (gravel, scree), or granular material obtained by crushing of stone, gravel or scree,
nominal grain size from 0 to 32 mm maximum, separated and declared according to the highest nominal grain size.

Table 6-00-5  Quality requirements of physical and mechanical properties of stone grit obtained by crushing stone of igneous origin, gravel and scree and non-crushed stone grit (gravel, scree).

<table>
<thead>
<tr>
<th>Property</th>
<th>KS-S-I</th>
<th>KS-S-II</th>
<th>KS-S-III</th>
<th>KS-S-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material</td>
<td>stone of carb.</td>
<td>stone of carb.</td>
<td>stone of carb.</td>
<td>gravel or</td>
</tr>
<tr>
<td></td>
<td>components or</td>
<td>components or</td>
<td>components or</td>
<td>sprinkling mat.</td>
</tr>
<tr>
<td></td>
<td>gravel</td>
<td>gravel</td>
<td>gravel</td>
<td></td>
</tr>
<tr>
<td>Production procedure</td>
<td>crushed</td>
<td>crushed</td>
<td>crushed</td>
<td>non-crushed</td>
</tr>
<tr>
<td>Resistance to Na$_2$SO$_4$, maximum (m/m)</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Water absorption, maximum, % (m/m)</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Percentage of grains of unfavorable shape, % (m/m)</td>
<td>20 (10)*</td>
<td>20 (10)*</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Percentage of weak grains maximum, % (m/m)</td>
<td>3.0 (2)*</td>
<td>3.0 (2)*</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Resistance to crushing (Los Angeles), % (m/m)</td>
<td>25</td>
<td>28</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Stone polish values, minimum, (VPK)</td>
<td>44**</td>
<td>44**</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Percentage of crushed grains in crushed gravel, % (m/m)</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>--</td>
</tr>
</tbody>
</table>

* For surface dressing only
** For application in wearing courses only

Laboratory testing

Separated and non-separated granular stone material shall be sampled in accordance with the HRN B.B0.001 standard requirements. The following properties shall be tested on separated and partially separated granular stone material:

- grain size distribution
- percentage of particles under 0,09 mm
- percentage of particles under 0,002 mm
- percentage of clay balls
- percentage of impurities of organic origin
- percentage of grains of unfavorable shape
- percentage of weak and friable grains
- bitumen coated
- water absorption
- resistance to Na$_2$SO$_4$
- resistance of grains to crushing and wear

* Tested in case of possible contamination with clay particles
Table 6-00-5a  Quality requirements of physical and mechanical properties of stone grit obtained by crushing stone of igneous origin, gravel and scree and non-crushed stone grit gravel, scree.

<table>
<thead>
<tr>
<th>Property</th>
<th>Quality categories of physical and mechanical properties of crushed and non-crushed stone grit of igneous origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials</td>
<td>stone of carb. comp. or gravel</td>
</tr>
<tr>
<td>Production procedure</td>
<td>crushed</td>
</tr>
<tr>
<td>Resistance to Na$_2$SO$_4$, maximum (m/m)</td>
<td>5,0</td>
</tr>
<tr>
<td>Water absorption, maximum, %(m/m)</td>
<td>1,2</td>
</tr>
<tr>
<td>Percentage of grains of unfavorable shape, %(m/m)</td>
<td>20</td>
</tr>
<tr>
<td>Percentage of weak grains maximum, %(m/m)</td>
<td>5,0</td>
</tr>
<tr>
<td>Resistance to crushing (Los Angeles), maximum, %(m/m)</td>
<td>25</td>
</tr>
<tr>
<td>Percentage of crushed grains in crushed gravel, minimum, %(m/m)</td>
<td>90</td>
</tr>
</tbody>
</table>

**Quality requirements**

Grain size distribution of separated and partially separated granular stone material, nominal grain size from 0 to 32 mm maximum, shall be evaluated according to their declaration and use in particular pavement structure asphalt course.

---

4 Tested only on gravel and crushed gravel without the certificate of consistency
5 Tested only on gravel and/or crushed gravel
### Table 6-00-6  Quality requirements of separated and partially separated granular stone materials

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal size of granular stone material, mm</th>
<th>Separated fractions of granular stone material</th>
<th>Partially separated granular stone material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4/11; 8/22 etc.</td>
<td>0/8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Percentage of particles smaller</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>than 0,09 mm maximum, % (m/m)</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Percentage of particles smaller</td>
<td>--</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>than 0,002 mm, maximum, % (m/m)*</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Percentage of clay balls,</td>
<td></td>
<td></td>
<td>0,25</td>
</tr>
<tr>
<td>maximum, % (m/m)</td>
<td></td>
<td></td>
<td>0,25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0,3</td>
</tr>
<tr>
<td>Percentage of organic impurities,</td>
<td></td>
<td></td>
<td>0,3</td>
</tr>
<tr>
<td>maximum, % (m/m)</td>
<td></td>
<td></td>
<td>0,3</td>
</tr>
</tbody>
</table>

In order that the separated granular stone material fractions, according to their grain size distribution, correspond to their declared composition, they shall satisfy the requirement of maximum 20% (m/m) smaller fractions and maximum 15% (m/m) larger fractions.

In order that the partially separated granular stone material fractions, according to their grain size distribution, correspond to their declared composition, they shall satisfy the requirement of maximum 15% (m/m) of larger grains.

The physical and mechanical properties of separated stone materials are tested on declared fractions. The test results of physical and mechanical properties shall be expressed in mass percentages, % (m/m), given in table 6-00-7 and are relevant for the declared fractions.

For partially separated stone materials of nominal size ranging from 0 to 32 mm maximum, test results of physical and mechanical properties, obtained on laboratory declared fractions, are expressed in mass percentages, % (m/m) and recalculated for the complete sample. Quality requirements for physical and mechanical properties of partially separated stone materials, given in table 6-00-7 are relevant for the complete sample.
Table 6-00-7 Quality requirements for physical and mechanical properties of separated and partially separated granular stone materials.

<table>
<thead>
<tr>
<th>Property</th>
<th>KM-I</th>
<th>KM-II</th>
<th>KM-III</th>
<th>KM-IV</th>
<th>KM-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials</td>
<td>stone of silicate comp.</td>
<td>stone of carbonate origin or gravel</td>
<td>stone of carbonate origin or gravel</td>
<td>gravel or scree</td>
<td>gravel or scree</td>
</tr>
<tr>
<td>Production procedure</td>
<td>crushed</td>
<td>crushed</td>
<td>crushed</td>
<td>non-crushed</td>
<td>non-crushed</td>
</tr>
<tr>
<td>Resistance to Na(_2)SO(_4), maximum (m/m)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Water absorption, maximum, % (m/m)</td>
<td>1.2*</td>
<td>1.2*</td>
<td>1.2*</td>
<td>1.2*</td>
<td>1.2*</td>
</tr>
<tr>
<td>Percentage of grains of unfavorable shape, % (m/m)</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Percentage of weak grains maximum, % (m/m)</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Resistance to crushing (Los Angeles), maximum, % (m/m)</td>
<td>22</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>Percentage of crushed grains in crushed gravel, minimum, % (m/m)</td>
<td>90</td>
<td>90</td>
<td>30</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* Water absorption can be greater if the resistance criterion to freezing is fulfilled.

Bitumen coating of separated and partially separated granular stone material shall be minimum 100/85.

6-00.2.4 Sand

Sand is a granular material, naturally granulated (natural sand) or obtained by crushing of stone, gravel or debris (crushed sand).

According to the largest grain size, it is divided as follows:

- sand 0/2 mm
- sand 0/4 mm

Laboratory testing

The sand shall be sampled in accordance with the HRN B.B0.001 001 or EN 932-1 standard, and prepared for testing according to the EN 932-2 standard. The following properties shall be tested/determined on crushed or natural sand:

- grain size distribution HRN B.B8.029 or EN 933-1
- grain size modulus HRN U.E4.014
- percentage of particles smaller than 0.09 mm HRN B.B8.036
- percentage of clay balls HRN B.B8.038
- percentage of organic impurities HRN U.B1.024
• sand equivalent  HRN U.Bl.040 or EN 933-8
• mineral-petrographic composition  HRN B.B8.004 or EN932-3.

Quality requirements

Table 6-00-8  Grain size distribution requirements for sand

<table>
<thead>
<tr>
<th>Square screen openings (mm)</th>
<th>Type of sand</th>
<th>0/2 mm</th>
<th>0/4 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,09</td>
<td>Fall through screen, % (m/m)</td>
<td>0 to 10 (15)*</td>
<td>0 to 10 (15)*</td>
</tr>
<tr>
<td>0,25</td>
<td>15 to 35</td>
<td>12 to 25</td>
<td></td>
</tr>
<tr>
<td>0,71</td>
<td>40 to 85</td>
<td>33 to 70</td>
<td></td>
</tr>
<tr>
<td>2,0</td>
<td>90 to 100</td>
<td>65 to 100</td>
<td></td>
</tr>
<tr>
<td>4,0</td>
<td>100</td>
<td>90 to 100</td>
<td></td>
</tr>
<tr>
<td>8,0</td>
<td>Granularity modulus</td>
<td>1,70 to 2,55</td>
<td>1,95 to 3,00</td>
</tr>
</tbody>
</table>

* For micro-asphalt only

Table 6-00-9  Quality categories of igneous origin crushed sand

<table>
<thead>
<tr>
<th>Property</th>
<th>Quality categories of igneous origin crushed sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of sand</td>
<td>DP02-E-I</td>
</tr>
<tr>
<td>Percentage of particles smaller than 0,09 mm, maximum, % (m/m)</td>
<td>0/2 mm</td>
</tr>
<tr>
<td>Sand equivalent, minimum, %</td>
<td>70</td>
</tr>
<tr>
<td>Percentage of clay balls, maximum % (m/m)</td>
<td>0,5</td>
</tr>
<tr>
<td>Organic impurities, maximum % (m/m)</td>
<td>0,3</td>
</tr>
</tbody>
</table>

* For micro-asphalt only

Table 6-00-10  Quality categories of sedimentary origin crushed sand

<table>
<thead>
<tr>
<th>Property</th>
<th>Quality categories of sedimentary origin crushed sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of sand</td>
<td>DP02-S</td>
</tr>
<tr>
<td>Percentage of particles smaller than 0,09 mm, maximum, % (m/m)</td>
<td>0/2 mm</td>
</tr>
<tr>
<td>Sand equivalent, minimum, %</td>
<td>60</td>
</tr>
<tr>
<td>Percentage of clay balls, maximum % (m/m)</td>
<td>0,5</td>
</tr>
<tr>
<td>Organic impurities, maximum % (m/m)</td>
<td>0,3</td>
</tr>
</tbody>
</table>

* For micro-asphalt only
Table 6-00-11  Quality categories of natural sand

<table>
<thead>
<tr>
<th>Property</th>
<th>Quality categories of natural sand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP01</td>
</tr>
<tr>
<td>Type of sand</td>
<td>0/1 mm</td>
</tr>
<tr>
<td>Percentage of particles smaller than 0,09 mm, maximum, % (m/m)</td>
<td>5</td>
</tr>
<tr>
<td>Sand equivalent, minimum, %</td>
<td>70</td>
</tr>
<tr>
<td>Percentage of clay balls, maximum % (m/m)</td>
<td>0,5</td>
</tr>
<tr>
<td>Organic impurities, maximum % (m/m)</td>
<td>0,3</td>
</tr>
</tbody>
</table>

6-00.2.5 Stone flour

Stone flour is crushed or pulverized granular stone material, grain size to 0,71 mm. Part of stone flour with grain size to 0,09 mm is called filler. Stone flour used for production of asphalt mixtures shall be produced as follows:

- Base product at the stone flour production plant
- By-product during production of stone debris obtained by dusting at the separation plant.
- Cyclone material or return stone flour at the dusting system, as part of the asphalt production plant.

Laboratory testing

Stone flour shall be sampled at the production plant, in accordance with the HRN B.B0.001 or EN 932-1 standard, and it shall be prepared for testing according to the EN 932-2 standard.

The quality and usability of stone flour is determined by testing of the overall properties:

- External appearance of stone flour  HRN B.B8.103
- Microscopic examination of stone flour  HRN B.B8.103
- Percentage of moisture  HRN U.Bl.012
- Grain size distribution  HRN B.B8.105
  or EN 933-10
- Grain size distribution of particles up to 0,063 mm  HRN U.B1.018
- Purity of filler  HRN U.B1.020
- Percentage of voids in dry compacted state  HRN B.B8.102 or  EN 1097-4
- Filler density  HRN B.B8.101 or  EN 1097-7
- Bitumen hardening index  HRN B.B8.104.
- Insoluble stone flour residue in HCl solvent
- Mineral-petrographic composition of stone flour determined by thermal diffraction and ex-ray analysis

6 If the stone flour is separated during the production process in the air stream (by cyclone).
7 If it does not satisfy the plasticity index and if clay minerals might be present.
Quality requirements

Table 6-00-12. Stone flour quality categories

<table>
<thead>
<tr>
<th>Square screen openings, mm</th>
<th>Quality category of stone flour according to grain size distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KB-I</td>
</tr>
<tr>
<td>Fall through screen(m/m)</td>
<td>minimum</td>
</tr>
<tr>
<td>0,063</td>
<td>60</td>
</tr>
<tr>
<td>0,09</td>
<td>80</td>
</tr>
<tr>
<td>0,25</td>
<td>95</td>
</tr>
<tr>
<td>0,71</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 6-00-13 Purity and quality requirements for physical properties of filler

<table>
<thead>
<tr>
<th>Property</th>
<th>Purity and quality requirements for physical properties of filler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For fillers of carbonate composition</td>
</tr>
<tr>
<td>Plasticity index, maximum, %(m/m)</td>
<td>4</td>
</tr>
<tr>
<td>Effective volume filler concentration (C_{vef}), minimum</td>
<td>0,89</td>
</tr>
<tr>
<td>Voids in dry compacted state, % (V/V)</td>
<td>30 to 40</td>
</tr>
<tr>
<td>Bitumen hardening index</td>
<td>1,8 to 2,4</td>
</tr>
</tbody>
</table>

If the filler does not satisfy some of the set quality requirements, additional testing shall be undertaken to determine its usability in asphalt mixtures.

6-00.2.6 Road construction bitumen

Laboratory testing

Bitumen shall be sampled according to the HRN B.H8.610 or EN 58 standard and it shall be prepared for sampling according to the HRN EN 12594 standard.

The road construction bitumen quality shall be evaluated by testing the following properties:

- penetration (HRN EN 1426)
- softening point (PK) (HRN EN 1427)
- penetration index (HRN B.H8.614 or EN 12591)
- ductility (HRN B.H8.615)
- breaking point according to Fraass (HRN EN 12593)
- density (HRN EN ISO 3838)
- change of properties by heating to 163 °C (HRN EN 12607-1)
- paraffin number (HRN EN 12606-1)
- dynamic viscosity (HRN B.H8.620 or EN 12596)
- cinematic viscosity (HRN B.H8.621 or EN 12595)
- flash point (ISO 2592)
- percentage of soluble components (HRN EN 12592).
**Quality requirements**

Road construction bitumen is divided in groups according to the penetration values and shall satisfy the quality requirements according to the HRN U.M3.010 or EN 12591 standards.

6-00.2.7 **Polymer modified bitumen (PmB)**

Modified bitumen shall be used for production of asphalt mixtures with increased deformation resistance, i.e. increased flexibility at lower exploitation temperatures.

Quality requirements of modified bitumen of asphalt mixture in the production stage at the asphalt production plant are not the subject of these GTR.

**Laboratory testing**

Polymer modified bitumen shall be sampled according to the EN 58 standard and tested according to the HRN EN 12594 standard.

Quality of polymer modified bitumen shall be evaluated by testing the following properties:

- Penetration  
  HRN EN 1426
- Softening point (PK)  
  HRN EN 1427
- Breaking point according to Fraass  
  HRN EN 12593
- Elasticity  
  EN 13398
- Density  
  HRN EN ISO 3838
- Stability during storage  
  EN 13399
- Flash point  
  ISO 2592
- Change of properties after aging  
  HRN EN 12607-1 or HRN EN 12607-3.
**Quality requirements**

Table 6-00-14  Quality requirements of polymer modified bitumen

<table>
<thead>
<tr>
<th>Property</th>
<th>Type of bitumen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PmB 70/100-48</td>
</tr>
<tr>
<td>Penetration at 25 °C, between, mm/10</td>
<td>70 do 100</td>
</tr>
<tr>
<td>Softening point according to PK, minimum, °C</td>
<td>48</td>
</tr>
<tr>
<td>Breaking point according to Frass, maximum, °C</td>
<td>-18</td>
</tr>
<tr>
<td>Elasticity at 25 °C, minimum, %</td>
<td>50</td>
</tr>
<tr>
<td>Stability during storage, difference in softening point according to PK, maximum, °C</td>
<td>5</td>
</tr>
</tbody>
</table>

*Change of properties after ageing*

| Change of mass, maximum, % (m/m) | 0,8 | 0,5 | 0,5 | 0,5 | 0,5 |
| Penetration slow down, maximum, % | 55  | 60  | 60  | 60  | 60  |
| Softening point increase, Maximum, °C | 9   | 9   | 10  | 8   | 8   |
| Softening point decrease, maximum, °C | 2   | 2   | 5   | 2   | 2   |
| Elasticity at 25 °C, minimum, % | 50  | 50  | 50  | 50  | 50  |

All types of polymer modified bitumen shall have good adhesion to stone material (100/95 according to the HRN U.M8.096 standard), and flash point above 235 °C (ISO 2592 standard).

In special circumstances application of other types of polymer modified bitumen shall be allowed with properties according to the EN 14023 standard.

Manufactured or supplier of polymer modified bitumen shall present the Client with the following data:

- Type of PmB,
- Type of polymer used in bitumen modification process,
- Properties given in table 6-00-14,
- density,
- means and period of storage,
- lowest and highest storage temperature,
- equivalent viscosity temperature (0,268 Pa s).

**6-00.2.8 Bitumen binder emulsion**

Bitumen emulsion shall be used for bonding of asphalt layers of for bonding of asphalt layer with any other type of base. It is applied by spraying on a dry surface

---

* Valid for elastomer modified bitumen
in an even layer. Amount of emulsion depends on the state of the base surface with respect to type and texture.

Depending on the type of stone material in the base, a semi stable anion and cationic bitumen emulsion shall be used, with 55% (m/m) minimum bitumen content. For better asphalt layers bonding, a cationic polymer bitumen emulsion shall be used. This type of bitumen emulsion is sprayed on the base where a polymer modified bitumen asphalt mixture shall be placed.

**Laboratory testing**

Means of sampling, quantity and number of samples are defined by the HRN U.M3.020 standard.

The following properties of the bitumen emulsion shall be tested:

- viscosity
- percentage of binder
- degree of stability
- homogeneity
- storage stability
- of bitumen coat under water

The following properties are tested on polymer modified bitumen emulsion:

- percentage of binder
- viscosity
- storage stability
- performance of bitumen emulsion under water
- softening point of extracted binder
- elasticity of extracted binder

**Quality requirements**

Anion bitumen emulsion shall be in accordance with the HRN U.M3.022 standard and the cationic emulsion to the HRN U.M3.024 standard. Bitumen emulsions whose quality requirements comply to the Austrian standard ÖNORM 3503 shall be used for base spraying. The softening point of extracted binder in polymer emulsions shall be minimum 27°C and elasticity greater than 40%.

**6-00.2.9 Bitumen emulsion for micro-asphalt**

For production of micro-asphalt mixtures according to cold procedure, e.g. binder or polymer modified bitumen cationic emulsions shall be used.

**Laboratory testing**

- Type of charge
- Percentage of binder
- Residue on screen
- Storage stability: DIN EN 1429
- Viscosity: DIN 52023-1 or EN 12846
- Stability during breaking: DIN 52047-1
- Adhesion: DIN 52006-1
- Softening point of extracted binder: V DIN 52041-2 and HRN EN 1427
- Breaking point of extracted binder according to Fraass: V DIN 52041-2 and HRN EN 12593
- Elasticity of extracted binder: V DIN 52041-2 and EN 13398.

**Quality requirements**

**Table 6-00-15:** Quality requirements for bitumen emulsion for micro-asphalt mixture production according to cold procedure

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of charge</td>
<td>Cationic</td>
</tr>
<tr>
<td>External appearance</td>
<td>brown, liquid, homogenous</td>
</tr>
<tr>
<td>Percentage of bitumen, minimum, %(m/m)</td>
<td>58</td>
</tr>
<tr>
<td>Residue on screen, maximum, %(m/m)</td>
<td>0.5</td>
</tr>
<tr>
<td>Storage stability after 4 weeks, maximum, %(m/m)</td>
<td>0.5</td>
</tr>
<tr>
<td>Stability, minimum, g</td>
<td>150</td>
</tr>
<tr>
<td>Viscosity, viscosity meter for tar, 4mm, s</td>
<td>spec. prod.</td>
</tr>
<tr>
<td>Adhesion, %</td>
<td>100</td>
</tr>
<tr>
<td><strong>Bitumen extracted from emulsion</strong></td>
<td></td>
</tr>
<tr>
<td>Softening point, minimum, °C</td>
<td>50</td>
</tr>
<tr>
<td>Breaking point accord. to Fraass, maximum, °C</td>
<td>-15</td>
</tr>
<tr>
<td>Elasticity, 30 min., 25 °C, minimum, %</td>
<td>50</td>
</tr>
</tbody>
</table>

**6-00.2.10 Bitumen binders for surface dressing**

Cationic rapid setting emulsions, polymer modified emulsions and polymer modified bitumen shall be used for surface dressing.

60 – 70% emulsions are used, depending on the required thickness of bitumen coating around the stone grit particles, either hot or cold.

Bitumen emulsions used for surface dressing shall satisfy requirements according to the Austrian standard ÖNORM 3501.

Polymer modified bitumen emulsions shall satisfy the requirements of the Austrian standard ÖNORM 3501:1992 or requirements of the German technical requirements (type C) according to TL Pm OB.

Polymer modified bitumen shall satisfy the requirements of the German Technical requirements (type A) according to TL Pm OB.

**6-00.2.11 Bitumen and asphalt admixtures**

Admixtures are added in order to improve binder adhesiveness to the stone material, to improve the rheological properties of bitumen binder and/or asphalt mixture properties. Admixture temperature shall be stable in order to avoid their
breaking during the asphalt mixture production process. It is advisable that the admixtures be added to the binder immediately before or during the asphalt mixture production process. The type and quantity shall be determined by preliminary laboratory testing. During the “Splitmastic” production, “stabilizing” admixtures are added to the asphalt mixture in order to stop the bitumen runoff. For that purpose, admixtures of organic or inorganic origin are used.

6-00.2.12 Synthetic material

Asphalt mixtures can also be produced on the basis of synthetic materials, the usability of which is certified by special testing, depending on the type and use.

6-00.2.13 Proof of quality and material usability

The Contractor shall provide proof on the usability of all component materials for asphalt mixture production.

Laboratory testing and certification according to the special regulation “Order on compulsory certification of fractionated stone aggregate for concrete and asphalt” (Official Gazette no. 55/96) shall prove the quality and usability of:

- Stone grit, and
- Sand

In case that the quality requirements given in these GTR are higher than the ones given in the subject Croatian standards, the material shall not be used without additional quality, irrespective of the valid certificate.

In such cases additional proof on usability of that material shall be obtained.

Usability of synthetic material is proven by technical approvals.

Proof on the usability of all component materials for asphalt works shall be submitted by the Contractor to the supervising engineer for approval.

6-00.3 PRODUCTION, TRANSPORT AND PLACING OF ASPHALT MIXTURE

6-00.3.1 Production of asphalt mixture

The Contractor shall undertake his own asphalt mixture production process control, including maintenance and calibration of measuring instruments on the asphalt plant, in accordance with the EN 13108-10 standard.

Before the start of production a sufficient quantity of material shall be stored at the production plant in order to guarantee uninterrupted production.

Stone materials shall be stored in such manner to avoid mixing or contamination. The surface on which stone materials are stored shall be concrete or asphalt, and the compartments separated. Each compartment shall have the nominal marking of the stored fraction.
Stone flour is stored in silos. Exceptionally, stone flour shall be stored in warehouses, in bags, but shall be protected from moisture, according to the provisions for cement.

All asphalt mixture admixtures, e.g. natural asphalt, fibers, polymer admixtures, hydra lime, shall be appropriately stored.

At the asphalt production plant, bitumen shall be properly stored in reservoirs with installed thermometers for temperature control. The highest temperature for heating of road construction bitumen is shown in table 6-00-16. The heating temperature of polymer modified bitumen depends on the type of polymer and basic bitumen.

The reservoirs shall be marked and set for only one type of bitumen.

Table 6-00-16 Highest storage temperature of road construction bitumen in reservoirs

<table>
<thead>
<tr>
<th>Type of bitumen</th>
<th>Bitumen temperature in reservoirs, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT 90 and 70/100</td>
<td>maximum170</td>
</tr>
<tr>
<td>BIT 60 and 50/70</td>
<td>Maximum180</td>
</tr>
<tr>
<td>BIT 45 and 30/45</td>
<td>maximum190</td>
</tr>
</tbody>
</table>

**Asphalt mixture production plant**

Asphalt mixture production plant shall be technically equipped in a manner the enables production of asphalt mixture of the quality set in these GTR and maintain the constancy of mixture within the allowed deviations.

All measuring instruments at the production plant shall be calibrated at least once a year. The Contractor shall submit documents on calibration to the supervising engineer.

The batching plant shall provide a unified and controlled inflow on stone material from a sufficient number of feeders.

The drying drum shall provide efficient and unified drying and heating of stone material.

Stone material dusting and screening system shall provide efficient screening of stone mass at the full asphalt mixture production capacity. Material obtained by the dusting process shall be stored in separate reservoirs. Uncontrolled return of the dusted material into the production process is not allowed.

Reservoirs for screened stone material shall be so equipped to prevent mixing of already screened material.

Batching plant for bitumen binder shall be daily checked and maintained, especially with the volume dozing of bitumen.

The asphalt production plant shall be equipped with precise equipment for measuring the temperature of component materials and the produced asphalt mixture.

Supervising engineer or authorized person shall at random check the complete production process and management of the asphalt mixture production process.
Temperature of produced asphalt mixture

The highest allowed asphalt mixture temperatures at the exit from the asphalt plant are given in table 6-00-17. These temperatures are relevant for road construction bitumen. Production temperatures of asphalt mixtures made on the basis of polymer modified bitumen depend on the used kind and PmB type.

**Table 6-00-17**     Highest asphalt mixt temperatures at the production plant exit

<table>
<thead>
<tr>
<th>Bitumen type</th>
<th>Asphalt mixture temperatures, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT 90 and 70/100</td>
<td>Maximum 170</td>
</tr>
<tr>
<td>BIT 60 and 50/70</td>
<td>Maximum 180</td>
</tr>
<tr>
<td>BIT 45 and 30/45</td>
<td>Maximum 190</td>
</tr>
</tbody>
</table>

6-00.3.2 Transport of asphalt mixture

Asphalt mixture is transported to the site in tipper trucks. Bottom of the truck shall be made of metal or metal lined, clean and without dust, mud or other materials. In order to prevent sticking of the asphalt mixture, the bottom and sides of the truck box shall be sprayed by appropriate products. Petroleum products shall not be used when spraying.

The asphalt mixture shall be properly protected during transport from cooling, rain and dirt, irrespective of the weather conditions.

6.00.3.3 Placing of asphalt mixture

*Base*

Base, i.e. previously placed course on which the asphalt course shall be placed can be:

- Base course of loose granular stone material
- Base course of granular stone material stabilized by hydraulic binder, and
- Asphalt layer.

*Placing of asphalt course on base course of loose granular stone material*

Asphalt mixture can only be placed on a base that has been tested and taken over by the supervising engineer. Time period between the testing of base course and placing shall not be more than 24 hours and during this time, site transport shall be prohibited on the trial section.

If the base surface is damaged due to unfavorable weather, or for any other reason, it shall be repaired before placing the asphalt mixture.

*Placing of asphalt course on base course stabilized by hydraulic binders*

Placing of asphalt course on the base course stabilized by hydraulic binders shall commence at least seven days after the placing of the base course. With the approval of the supervising engineer and the Client, placing of asphalt course shall commence earlier if laboratory tests prove that damage to the placed courses shall not occur. Stabilized base course shall be dry and clean and all loose material removed from the surface.
Time period between the taking over of the base course and placing of the next shall be 24 hours maximum and during that time site transport shall be prohibited on the trial section.

Base sprayed with bitumen emulsion shall be dry or naturally moist. Surfaces treated with bitumen emulsion or bitumen shall be protected from site traffic.
Placing of asphalt can commence after the bitumen emulsion “breaks”, i.e. after all water evaporates from the emulsion.

Evenness of the surface shall be in accordance with the requirements set in these GTR. Surfaces with inadequate evenness shall be improved. Decision on the means of improvement shall be taken by the supervising engineer.

Height of the placed base shall be in accordance with the designed height.

**Placing of asphalt course on asphalt base**

Placing of asphalt mixture on an asphalt base shall commence when the base is cleaned, dry and sprayed with bitumen emulsion. The spraying shall commence at least three hours before placing of asphalt so that the water can evaporate and the bitumen part binds to the base.

**Weather conditions**

Asphalt mixture is placed only under favorable weather conditions. Placing of asphalt mixture in rainy weather or on a wet base shall not be allowed. When placing the wearing course the base and air temperature shall be above 10°C, and when placing the binding and base course it shall be above +5°C.

In special circumstances (e.g. strong wind) the supervising engineer can stop the works on the base course even if the temperatures are above the minimum allowed, if there is reasonable doubt that the asphalt mixture and works shall not be of adequate quality under these weather conditions.

**Asphalt mixture temperature during the placing procedure**

Asphalt mixture temperature at the placing site depends on the type of bitumen used in the asphalt mixture. Lowest allowed temperatures for asphalt mixture made with road construction bitumen at the placing site are given in table 6-00-18.

<table>
<thead>
<tr>
<th>Type of bitumen</th>
<th>Asphalt mixture temperature at the placing site °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT 90 and 70/100</td>
<td>Minimum 135</td>
</tr>
<tr>
<td>BIT 60 and 50/70</td>
<td>Minimum 140</td>
</tr>
<tr>
<td>BIT 45 and 30/45</td>
<td>minimum 145</td>
</tr>
</tbody>
</table>

Lowest asphalt mixture temperatures made on the basis of polymer modified bitumen depend on the kind and type of use PmB.
Machinery for placing of asphalt courses

- Finisher
- Rollers with:
  - Rubber tyred roller, or combined
  - Vibrating roller and
  - Road roller / three wheel roller
- Truck tanker
- Water truck
- Bitumen sprayer
- Job mix heater
- Motor blower
- Power broom

Generally speaking, a sufficient number of different machinery and equipment, shall be used at the site, to enable optimum efficiency during placing of asphalt mixture. The efficiency of the machinery is seen at the trial section, according the sub-item 6-00.4.1 of these GTR.

Spreading and compacting of asphalt mixture

Asphalt mixture is usually machine placed, my means of asphalt finishers, to enable continuity in work, without stops. Asphalt finishers shall provide an uniform degree of pre-compression, at least 88% in relation to the optimal volume mass of asphalt mixture.

If asphalt mixture is placed with two or more finishers, they shall not be vertically distanced for more than 30 m, to enable hot connection of edges. They shall have equal working characteristics so that the course can be uniformly placed across the complete pavement width, with respect to the rate of compaction and the surface texture.

If gutters or marginal strips are not planned in the design, the pavement asphalt courses shall be placed so that the edge of each layer, in relation to the previous one is under an angle of approximately 45°

If a delay occurs in the placing of asphalt mixture due to a delay in transport or production, and the temperature drops below the lowest allowed temperature (table 6-00-18), the placing procedure shall be stopped. A proper transverse joint shall be executed at that point.

The asphalt mixture is spread at ascents so that the finisher moves from the lover level to the higher level.

On surfaces where the treatment with finishers is not possible, the asphalt mixture can be spread manually, with the approval of the supervising engineer, under the condition that the required quality of placed asphalt mixture is reached.

Except the obligatory control testing, it is necessary to visually check the quality of placed layer and immediately remove possible faults (e.g. marked segregation, marked change in layer thickness or height)
The spread asphalt mixture is rolled with an optimal number of rollers according to number and type. The Contractor shall ask for approval from the supervising engineer on the proposed combination of rollers and the regime of work.

Rubber – tyred rollers shall have all wheels of the same size and diameter. Pressure adjustment in the rubber tyres shall be possible for more efficient adjustment to the type and thickness of asphalt layer.

Standard rollers with vibrating effect have a significant depth effect as opposed to the static rollers. Depending on the layer thickness and the type of asphalt mixture, most efficient frequencies are determined by execution of a trial section, according to the sub-item 6-00.4.1.

For execution of thin asphalt courses, rollers with horizontal oscillations are used.

All three wheel rollers shall have a simple functional device which enables the roller sheeting to be uniformly coated with water. Use of petroleum products is prohibited. All rollers, irrespective of type, shall be of such quality to operate without jerks when changing direction and that they can be correctly driven.

**Execution of joints and edges**

The longitudinal joint is parallel to the carriageway centerline and is executed as hot joint. Transverse joint is perpendicular to the carriageway centerline. Usually these are transverse joints executed at points of interruption.

The number and length of transverse and longitudinal joints shall be minimal, since joints are potentially weak points in the pavement structure. Longitudinal and transverse joints shall be executed according to standards and the asphalt at points of connection shall have nearly the same density and characteristics as the other parts of the surface.

The edges of joints shall be vertically cut, and if they are not, they shall be side cut prior to placing of the second lane (cold longitudinal joints) or during work (transverse joints) at points of full course thickness.

Vertical surface at cold joints shall be well coated by binder in order to secure better bonding of the previous and the newly placed asphalt course. The joints are coated with hot bitumen or appropriate bitumen mass in the quantity of approximately 50 g/m² for one centimeter of asphalt course thickness.

With multi layered asphalt pavements the joints shall not overlap, but shall be distanced at least 150 mm. Longitudinal joint of completed course shall correspond to the carriageway centerline. Traffic lanes shall not have longitudinal joints.

**6-00-4 QUALITY Assurance of asphalt works**

Quality assurance of asphalt works is a number of activities described and explained in this GTR sub-section, with the final aim of reaching the set quality of pavement structure asphalt courses, in accordance with the GTR requirements.

There are two types of activities:
Prior to execution of asphalt works, and
During the execution of asphalt works.

**6-00.4.1 Activities prior to execution of asphalt works**

These works include:

- Preliminary testing of material usability
- Execution of asphalt mixture initial job mix
- Execution of confirmed job mix formula (confirmation of production)
- Execution of trial section (confirmation of placing), and
- Execution of program of quality assurance of material and works.

All the above mentioned activities are the responsibility of the Contractor who shall perform them at his expense prior to work execution. For each of the mentioned activities the Contractor shall give a separate document, in two copies, to the Client or his supervising engineer, who shall validate it by signature on the front page of the document. One copy of the signed document shall be returned to the Contractor and the other copy shall be kept by the Client of the supervising engineer.

**Preliminary testing of material usability**

The Contractor shall provide respective documentation on the usability of all materials to be used in the asphalt mixture production, in accordance with sub-item 6-00.2.13 of these GTR, and submit them to the supervising engineer for validation at least 30 days prior to start of works. The supervising engineer shall approve the preliminary usability testing within 10 days, or return them to the Contractor for additional testing.

**Asphalt mixture initial job mix**

Asphalt mixture initial job mix is made in the laboratory, according to the standard Marshall procedure. In addition to the asphalt mixture with optimal binder content, it is necessary to test at least two more asphalt mixtures for each level of binder content, i.e. with a smaller and a higher content of binder with an increment of 0.3% (8m/m) in relation to the optimal binder content. Trial laboratory samples are prepared at temperature equivalent to the bitumen binder temperature of 0.268 Pa, with the compacting energy of two times 50 hits, in accordance with the HRN U,M8.090 standard, i.e. the EN 12697-30 standard.

During the execution of initial job mix for asphalt mixtures intended for roads and highways of very heavy traffic load group, asphalt mixture shall be tested for resistance to permanent deformations (standard EN 12697-22 and EN 12697-25) and resistance water influence (standard EN 12697-12).

The Contractor shall have an initial job mix for each kind of asphalt mixture defined by the pavement structure design and propose it to the Client or the supervising engineer for approval at least 20 days prior to start of works. The supervising engineer will approve the initial job mix within five days or return it to the Contractor for additional tests.

Report on the asphalt mixture initial job mix shall contain at least:

- General data on materials used,
ASPHALT PAVEMENT SURFACING

- Percentages of particular type and/or fraction of component stone materials in asphalt mixture
- Percentage of binder in asphalt mixture
- Percentages of admixtures in asphalt mixture
- Densities of all component materials
- Grain size distribution of optimal stone mix
- Physical and mechanical properties of trial laboratory asphalt mixtures.

With the initial job mix, copies of the technical documentation on origin and quality of materials shall be submitted. Without the documents on the usability of material, the initial job mix shall not be accepted. Initial job mix is valid maximum 3 years, and shall be renewed after the period. Irrespective of the given time period, in case of change of any component materials regarding the origin and/or type of material, a new asphalt mixture initial job mix shall be made.

Asphalt mixture confirmed job mix formula

The execution of confirmed job mix formula includes the following:
- Checking the composition and properties of material stored on the asphalt production plant which shall be used in production of asphalt mixture in comparison with the composition and properties of material used for execution of initial job mix of asphalt mixture, and
- Checking the exactness and work of the batching plant and other parts of the asphalt plant.

Asphalt mixture production is considered confirmed when the mean value of the composition of at least three samples of asphalt mixture taken from the asphalt plant during a continuous production process (at least 50 tons), corresponds to the initial job mix within the allowed deviations defined for each type of asphalt mixture.

Mean value of asphalt mixture composition obtained in this way represents (is called) confirmed job mix formula. Physical and mechanical properties of all samples shall correspond to the GTR requirements.

When all conditions are satisfied, Contractor shall produce a report on the confirmed job mix formula of asphalt mixture which contains:

- General part with data on the manufacturer and the asphalt production plant,
- Data on the testing of materials stored at the asphalt production plant,
- Basic data on the initial job mix formula of asphalt mixture,
- Individual laboratory test results of asphalt mixtures samples taken during production tests,
- Evaluation of the mean value discrepancy of asphalt mixture composition from the preliminary composition value set on the basis of samples tested during production tests,
- Data on the asphalt mixture production plant and the production elements obtained at the production plant during production tests (opening and the working regime of the batching plant and feeders, separators, individual feeding of screened stone material fractions, proportioning of stone flour and...
bitumen, time of mixing, production capacity, temperatures of asphalt mixture, 
stone material an bitumen binder.

Apart from this data, the Contractor shall submit all notes on the calibration of 
each device at the asphalt mixture production plant, including the batching plant 
and separator of stone material, screen opening, scales and other devices for 
dozing of binders and admixtures as well as devices for measuring the 
temperature of stone material and binder.

Confirmed job mix formula produced in this way shall be submitted by the 
Contractor to the Client or his supervising engineer for approval, at least 15 days 
prior to start of works.

If a trial section is not planned, this confirmed job mix formula shall be considered 
as contracted (confirmed) job mix formula after it is accepted by the Client, i.e. his 
supervising engineer, and shall be used as basis for approval of a continuous 
production and placing of asphalt, as well as evaluation of the quality of placed 
material and works, on the basis of current and audit testing according to GTR.

Initial job mix formula shall be repeated if the existing initial job mix formula can 
not be proven at the asphalt production plant due to major differences in the 
composition and/or properties of materials stored at the production plant and/or 
due to some characteristics of the production plant itself.

Confirmed job mix formula shall be repeated at least once every 12 months, after 
an overhaul of the plant or after repair of any component parts of the production 
plant which caused longer interruption of the production process, and which can 
significantly influence the asphalt mixture composition.

Requirements of the confirmed job mix formula for BBC and BBWC

Confirmed job mix formula of asphalt mixture is valid when:

- The grain size distribution of stone mix of at least three samples of asphalt 
mixture is within the range of allowed deviations from the initial job mix 
formula of asphalt mixture given in table 6-00-19.
- The percentage of bitumen in each sample does not differ more than ± 0,3 % 
(m/m) from the percentage given in the initial composition of asphalt mixture, 
and
- Physical and mechanical properties of all samples satisfy the requirements 
given in item 5-04, table 5-04-8 for BBC and in table 5-05-4 for BBWC.
Table 6-00-19  Allowed deviations of the grain size distribution of stone mix of asphalt mixture samples in relation to the initial job mix formula for BBC and BBWC

<table>
<thead>
<tr>
<th>Square screen openings, mm</th>
<th>Allowed deviations of the grain size distribution of stone mix*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For each sample, ±%(m/m)</td>
</tr>
<tr>
<td></td>
<td>Asphalt mixtures for highways</td>
</tr>
<tr>
<td></td>
<td>Asphalt mixtures for highways</td>
</tr>
<tr>
<td></td>
<td>For highways</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>0,09</td>
<td>2,0</td>
</tr>
<tr>
<td>0,25</td>
<td>2,0</td>
</tr>
<tr>
<td>0,71</td>
<td>3,0</td>
</tr>
<tr>
<td>2,0</td>
<td>4,0</td>
</tr>
<tr>
<td>4,0</td>
<td>5,0</td>
</tr>
<tr>
<td>8,0</td>
<td>5,0</td>
</tr>
<tr>
<td>11,2</td>
<td>6,0</td>
</tr>
<tr>
<td>16,0</td>
<td>6,0</td>
</tr>
<tr>
<td>22,4</td>
<td>6,0</td>
</tr>
<tr>
<td>31,5</td>
<td>6,0</td>
</tr>
</tbody>
</table>

* Total allowed deviation on each screen shall not be greater than the limit values on that screen for particular type of asphalt mixture given for BBC in table 5-04-6, sub-item 5-04 and for BBWC in table 7-05-2, sub-item 5-05.

Table 6-00-20  Allowed deviation of the obtained mean value of bitumen percentage in the asphalt mixture sample from the percentage of bitumen defined in the initial job mix formula of asphalt mixture for BBC, BBWC, TC, WC –AC, depending on the number of tested samples.

<table>
<thead>
<tr>
<th>Number of tested samples</th>
<th>Allowed deviation, %%(m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>± 0,50</td>
</tr>
<tr>
<td>2</td>
<td>± 0,45</td>
</tr>
<tr>
<td>3 do 4</td>
<td>± 0,40</td>
</tr>
<tr>
<td>5 do 8</td>
<td>± 0,35</td>
</tr>
<tr>
<td>9 do 19</td>
<td>± 0,30</td>
</tr>
<tr>
<td>≥ 20</td>
<td>± 0,25</td>
</tr>
</tbody>
</table>

Allowed deviation of the grain size distribution and percentage of binder in tables 6-00-18 and 6-00-19 are valid for the quality evaluation of asphalt mixture for BBC and BBWC on the basis of implemented control testing and audit testing.

Requirements of the confirmed job mix formula for tack coat (TC) and wearing course (WC)

Confirmed job mix formula of asphalt mixture is valid when:

- The grain size distribution of stone mix of at least three samples of asphalt mixture is within the range of allowed deviations from the initial job mix formula of asphalt mixture given in table 6-00-21.
- The percentage of bitumen in each sample does not differ more than ± 0,3 % (m/m) from the percentage given in the initial composition of asphalt mixture, and
Physical and mechanical properties of all samples satisfy the requirements given in sub-item 6-02, table 6-02-3 for TC and sub-item 6-03, table 6-03-7 for WC-AB.

Table 6-00-21  Allowed deviations of the grain size distribution of stone mix of asphalt mixture samples in relation to the initial job mix formula for TC and WC-AC

<table>
<thead>
<tr>
<th>Square screen openings, mm</th>
<th>Asphalt mixtures for highways</th>
<th>Other asphalt mixtures</th>
<th>Asphalt mixtures for highways</th>
<th>Other asphalt mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>± %(m/m)</td>
<td>± %(m/m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0,09</td>
<td>1,5</td>
<td>2,0</td>
<td>1,0</td>
<td>1,0</td>
</tr>
<tr>
<td>0,25</td>
<td>2,0</td>
<td>3,0</td>
<td>1,2</td>
<td>1,2</td>
</tr>
<tr>
<td>0,71</td>
<td>3,0</td>
<td>4,0</td>
<td>1,7</td>
<td>1,7</td>
</tr>
<tr>
<td>2,0</td>
<td>4,0</td>
<td>5,0</td>
<td>2,3</td>
<td>2,3</td>
</tr>
<tr>
<td>4,0</td>
<td>4,0</td>
<td>5,0</td>
<td>3,0</td>
<td>3,0</td>
</tr>
<tr>
<td>8,0</td>
<td>5,0</td>
<td>6,0</td>
<td>3,0</td>
<td>3,5</td>
</tr>
<tr>
<td>11,2</td>
<td>5,0</td>
<td>6,0</td>
<td>3,0</td>
<td>3,5</td>
</tr>
<tr>
<td>16,0</td>
<td>5,0</td>
<td>6,0</td>
<td>3,0</td>
<td>3,5</td>
</tr>
</tbody>
</table>

* total allowed deviation at each screen shall not be greater than the limit values for that screen for each type of asphalt mixture for TC given in sub-item 6-02, in table 6-02-1 and for WC-AC given in sub-item 6-03, table 6-03-5

Allowed deviations of the percentage of binder and the grain size distribution of the mixture given in tables 6-00-20 and 6-00-21 are valid for the quality evaluation of asphalt mixture for tack coat (TC) and asphalt concrete wearing course (AC-WC) on the basis of control testing and audit testing.

Requirements of the confirmed job mix formula for the wearing course made of splitmastic asphalt (WC-SMA)

Confirmed job mix formula of asphalt mixture is valid when:

- The grain size distribution of stone mix of at least three samples of asphalt mixture is within the range of allowed deviations from the initial job mix formula of asphalt mixture given in table 6-00-22.
- The percentage of bitumen in each sample does not differ more than ± 0,2 % (m/m) from the percentage given in the initial composition of asphalt mixture, and
- Physical and mechanical properties of all samples satisfy the requirements given in sub-item 6-04, table 6-04-5 for WC-SMA.

Allowed deviations of the percentage of binder and the grain size distribution of the mixture given in tables 6-00-22 and 6-00-23 are valid for the quality evaluation of asphalt mixture for WC-SMA on the basis of control testing and audit testing.
Table 6-00-22  Allowed deviations of the grain size distribution of stone mix of asphalt mixture samples in relation to the initial job mix formula for WC-SMA

<table>
<thead>
<tr>
<th>Square screen openings, mm</th>
<th>Allowed deviations of the stone mix grain size distribution*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For each sample, ±% (m/m)</td>
</tr>
<tr>
<td></td>
<td>For mean value, ±% (m/m)</td>
</tr>
<tr>
<td>0.09</td>
<td>1.5</td>
</tr>
<tr>
<td>0.25</td>
<td>2.0</td>
</tr>
<tr>
<td>0.71</td>
<td>3.0</td>
</tr>
<tr>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>8.0</td>
<td>3.0</td>
</tr>
<tr>
<td>11.2</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* Total allowed deviation at each screen shall not be greater than the limit values for that screen for each type of asphalt mixture for WC-SMA given in sub-item 6-04, in table 6-04-3

Table 6-00-23  Allowed deviation of the obtained mean value of bitumen percentage in asphalt mixture sample from the percentage of bitumen defined in the initial job mix formula of asphalt mixture for WC-SMA depending on the number of tested samples.

<table>
<thead>
<tr>
<th>Property</th>
<th>Number of tested samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Allowed deviation, % (m/m)</td>
<td>± 0.30</td>
</tr>
</tbody>
</table>

Trial section

Trial section is evidence that an asphalt layer of quality set in the GTR can be executed with an asphalt mixture produced according to the confirmed job mix formula. A trial section is used for highways and roads of very heavy traffic load group, minimum length 300 m.

Place and length of the trial section, machines used for its execution, regime of placing of asphalt mixture and the schedule of asphalt course compaction by rolling is proposed by the Contractor in written form and approved ny the supervising engineer.

The Contractor shall test the following on the trial section:

- Asphalt mixture temperature during loading into the finisher from every delivery,
- Composition and the physical and mechanical properties of asphalt mixture on at least three samples
- Change in the rate of compaction of the asphalt course by non-destructive method during placing and on cooled asphalt course at six points minimum,
- Rate of compaction, percentage of voids, thickness of executed course and the adhesive binder strength with the base, on at least three original samples,
• Evenness of each traffic lane in the full trial section length,
• Adhesion (for wearing courses) on at least three points.

All places of sampling and testing shall be decided by the supervising engineer.

An authorized body, executing audit testing on the subject structure, shall test the following on the trial section:

• Composition and physical and mechanical properties of asphalt mixture on at least on parallel sample,
• Rate of compaction, percentage of voids and thickness of executes asphalt course on original samples previously tested by the Contractor.

On the basis of the laboratory tests and field surveys, the Contractor shall produce a report about the trial section, containing the following information:

Part I – General information
• Structure, Contractor and Client,
• description of trial section,
• list of certificates and other evidence on the usability of materials.

Part II – evidence on the asphalt mixture production (contracted confirmed job mix formula)
• production capacity of asphalt production plant,
• description of the means of transport of asphalt mixture,
• asphalt mixture temperatures at the time of placing,
• laboratory results on the testing of composition and properties of produced asphalt mixture,
• evaluation of the test results of the composition and properties of asphalt mixture in relation to the initial job mix formula, in accordance with item 6-00.4.1.

On the basis of the test results evaluation, the mean value of the composition and the physical and mechanical properties of tested samples of produced and placed asphalt mixture represents the confirmed job mix formula of asphalt mixture.

According to the confirmed job mix formula the quality of produced asphalt mixture is evaluated on the basis of control testing and audit testing:

Part III – evidence on execution of asphalt mixture:
• description of the working regime of the finishers,
• description of the working regime of rollers,
• test results on the rate of compaction, percentage of voids and the thickness of the course,
• test results of the evenness and adhesion of the course.

In case when the results of tests performed by an authorized laboratory are compatible with the results given in the trial section report, the supervising engineer shall sign the Contractor's trial section report and approve the start of continuous production and placing of the mixture.

If the quality parameters of asphalt mixture and the placed asphalt course on the trial section are not in accordance with the quality requirements given in these
GTR, the Contractor shall execute a new trial section and shall repair the previous at his expense.

**Quality control program of materials and works**

Program of quality control of materials and works shall be performed by the Contractor and approved by the Client.

Program of quality control of materials and works includes:

- design name and designation,
- name of structure,
- name of the work stage,
- location of the asphalt production plant with a location sketch,
- description of asphalt production plant with the daily asphalt production and placing capacity,
- list of documents on the implemented test procedures of measuring instruments on the asphalt production plant, including the description of the test procedures during the duration of a specific project,
- description of test procedure of the accuracy of main devices on the asphalt plant (batching plant, drying, dusting screening, dozing of all components),
- planned number and capacity of truck for asphalt mixture transport,
- description of machines for placing of asphalt mixture,
- location and description of laboratory,
- description of equipment for laboratory and field testing,
- description of the way of sampling of component materials and asphalt,
- means of implementation of corrections during the production process and placing of asphalt in case of noncompliance with the GTR.
- Time of completion of laboratory and field testing and the way of documenting the test results,
- Period and way of submission of test results to the supervising engineer,
- List of technical staff in charge of this program, with detailed description of duties and responsibilities,
- Name, surname and signature of person responsible for the implementation of this program.

Program of quality control of materials and works shall be submitted by the Contractor to the supervising engineer for approval at least 10 days prior to start of works.

**6-00.4.2 Activities during the execution of asphalt works**

This sub-section defines the activities of the Client and Contractor during construction works, for the purpose of quality assurance of asphalt works.

These activities are:

- Control testing as the responsibility of the Contractor, and
- Audit testing as the responsibility of the Client.
6-00.4.2.1. Control testing

Control testing is performed by the Contractor, in a manner that assures the possibility of quick and efficient intervention in the production process. In case the Contractor does not have adequate equipment and staff, control testing shall be performed an authorized laboratory at the Contractor's expense.

The Contractor shall keep written record on the test results performed during control testing, which shall be available to the supervising engineer.

Control testing includes the following:
- Control of the quality of component materials for production of asphalt mixtures,
- Control of produced asphalt mixture,
- Control of placed asphalt mixture.

Control testing of component materials for asphalt mixture

When taking over materials from the manufactures of supplier, the Contractor shall check the type and quality of taken over material by appropriate audit tests, and submit the evidence on quality to the supervising engineer.

(a) Stone grit and separated or partially separated stone material

The following is tested at least once a day during delivery:

- Grain size distribution
- percentage of particles smaller than 0,09 mm

HRN B.B8.036 or EN 933-1

At least once for the quantity of material needed for production of 4000 tons of asphalt mixture for base course or tack coat, i.e. 2000 tons for the wearing course, the following is tested on each fraction:

- density
- grain shape
- percentage of weathered –low quality grains
- percentage of organic substances
- percentage of clay balls
- percentage of crushed grains

HRN U.M8.082 or EN 1097-6
HRN B.B8.048 or EN 933-4
HRN B.B8.037
HRN U.B1.024
HRN B.B8.038.
EN 933-5

(b) Crushed and natural sand

At least once a day during delivery the following is tested:

- Grain size distribution
- Grain size modulus
- Percentage of particles smaller than 0,09 mm

HRN B.B8.029 or EN 933-1
HRN U.E4.014
HRN B.B8.036.

(c) Stone flour and return stone flour

At every second delivery of industrial stone flour and at least once a day, if return filler is used, the following is tested:
• Grain size distribution       HRN B.B8.105 or EN 933-10

(d) Bitumen

At least once for the quantity of bitumen needed for production of 4000 tons of asphalt mixture for base course or tack coat, i.e. 2000 tons for the wearing course, the following is tested:

• Softening point       HRN EN 1427
• Penetration          HRN EN 1426
• Density             HRN EN ISO 3838

(e) Polymer modified bitumen (PmB)

At least once for the quantity of polymer modified bitumen needed for production of 4000 tons of asphalt mixture for base course or tack coat, i.e. 2000 tons for the wearing course, the following is tested:

• Softening point       HRN EN 1427
• Penetration          HRN EN 1426
• Density             HRN EN ISO 3838
• Elasticity          EN 13398

(f) Bitumen emulsion for bonding of courses

At every second delivery at least the following is tested:

• Viscosity       HRN U.M3.100 or EN 12846
• percentage of bitumen       HRN U.M3.020 or EN 1428

(g) Polymer emulsion for bonding

At every second delivery, at least the following is tested:

• viscosity (STV-apparatus) EN 12846
• percentage of binder EN 1428

(h) Polymer emulsion for micro-asphalt and surface dressing

At every second delivery at least the following is tested:

• type of charge EN 1430
• viscosity (STV-apparatus) EN 12846
• percentage of binder EN 1428

(i) Polymer modified bitumen for surface dressing

At every second delivery at least the following is tested:

• softening point HRN B.EN 1427
• penetration HRN EN 1426
• elasticity EN 13398
Control testing of produced asphalt mixture

As part of the control testing process the Contractor shall check and record the temperature of produced asphalt mixture in accordance with the EN 12697-13 standard, at least every hour during daily production. The Contractor shall submit reports and notes on control testing which refer to the daily production of asphalt mixture to the supervising engineer within two days after the conducted control.

Asphalt mixture is sampled according to the EN 12697-27 standard, and for testing it is prepared according to the EN 12697-28 standard.

(a) Composition of asphalt mixture

The following is tested:

- Percentage of bitumen HRN U.M8.105 or EN 12697-1
- Grain size distribution of extracted stone component HRN U.M8.102 or EN 12697-2.

(b) Physical and mechanical properties of asphalt mixture for rolled asphalt

The following is tested, i.e. the following properties are determined:

- Stability at 60 °C HRN U.M8.090 or EN 12697-34
- Deformation at 60 °C HRN U.M8.090 or EN 12697-34
- Volume mass of asphalt sample HRN U.M8.092 or EN 12697-6
- Asphalt mixture density HRN U.M8.082 or EN 12697-5
- Percentage of voids EN 12697-8
- Extent of filling of stone mixture voids by bitumen HRN U.E4.014.

(c) Physical and mechanical properties of asphalt mixture for poured asphalt

The following is tested:

- Depth of sinking HRN U.M8.104 or EN 12697-20
- Increase in depth of sinking HRN U.M8.104 or EN 12697-20

(d) Physical and mechanical properties of asphalt mixture for mastic asphalt

The following is tested:

- Softening point according to Wilhelm HRN U.M3.095.

Control testing of asphalt mixture placing

The following is tested during the placing of asphalt course:

- Asphalt mixture temperature,
- Degree of compaction of placed asphalt mixture by non-destructive method⁹,
- Thickness of course,
- Bonding of courses,
- Evenness of course,

⁹ Reference values of volume mass is the mean value of volume mass of asphalt mixture samples within control testing, samples according to Marshall, taken from the complete daily production, i.e. from the complete quantity of asphalt of tested unit surface.
• Height of course,
• Cross fall of course,
• Position of course.

After the course has been placed, the contractor shall make an geodetic survey of the complete course according to position and elevation. Characteristic point are surveyed in the cross section, at every 50 m: centerline, left edge and right course edge.

**Report on control testing**

When the report is placed, all activities as well as results of conducted testing as part of the control testing shall be presented in a written containing the following:

- General part with information on the structure, Contractor and Client,
- Information on the scope of control testing as given in the GTR,
- Information on the performed scope of control testing
- Results of control testing,
- Comment on all activities conducted as part of the control testing of materials used, production process and placing of the asphalt mixture, and
- Comment on the quality of executed works with respect to the GTR requirements,

**6-00-4-2-2 Audit testing**

Audit testing shall be performed by the Client or by an authorized laboratory, at the Client's expense.
Audit testing includes the quality of works implemented and materials used in relation to the quality set in the GTR.

On the basis of control testing and audit testing, the Client, i.e. his supervising engineer shall make the final quality evaluation of executed asphalt courses.

In case the test results show deviations from the set quality level, the Contractor shall, with the approval of the supervising engineer, ask for additional sampling at his expense in order to localize the asphalt surface (quantity) of insufficient quality.

Depending on the degree of deviations, the supervising engineer, with the approval of the designer shall make the decision whether the placed course should be improved, or if the deviations are such that the placed course can be accepted with a deduction from the contracted price, in accordance with the requirements given in sub-item 6-00-5 of these GTR.

In case of doubt in the quality of placed asphalt course, additional samples can be tested at the request of the supervising engineer. If additional tests prove deviations from the required quality, additional testing shall be at the expense of the Contractor.
In case there is no deviations from the required quality, additional testing shall be at the expense of the Client.

Surface of the placed course localized by additional sample taking shall be evaluated according to sub-item 6-00-5 of these GTR (for certain quality parameters), and the quality evaluation shall be given on the basis of individual test result values of samples taken at that surface. The price does not include test results of samples with defined limits of localized surface.
The Contractor shall, at his expense, repair all places on the asphalt course damaged by quality control sample taking.

Audit testing includes the following activities:

- Testing the quality of component materials,
- Testing the quality of produced asphalt mixture, and
- Testing the quality of placed asphalt course.

The supervising engineer, can request additional testing of the quality of component materials for asphalt mixture production which shall be done as part of control testing (sub-item 6-00.4.2.1).

If deviations from the required quality are found, costs of these test shall be at the expense of the Contractor.

**Audit testing of component materials for asphalt mixture production**

(a) Stone grit, separated and partially separated stone material

The following is tested at least once for the quantity needed to produce 15000 tons of asphalt mixture for base course, i.e. tack coat, or 10000 tons for the wearing course, or for the quantity of material needed to produce 50000 m$^2$ of micro-asphalt or surface dressing:

- Grain size distribution HRN B.B8.029 or EN 933-1
- Percentage of particles smaller than 0,09 mm HRN B.B8.036
- Density HRN U.M8.082 or EN 1097-6
- Grain shape HRN B.B8.048 or EN 933-4
- Percentage of weak / friable grains HRN B.B8.037
- Percentage of clay balls HRN B.B8.038.
- Percentage of organic impurities HRN U.B1.024
- Water absorption HRN B.B8.031 or EN 1097-6
- Resistance to Na$_2$SO$_4$\textsuperscript{10} HRN B.B8.044 or EN 1367-2
- Resistance to crushing and wear HRN B.B8.045 EN 1097-2
- Percentage of crushed grains (for crushed gravel and scree only)

(b) Crushed and natural sand

The following is tested at least once for the quantity needed to produce 15000 tons of asphalt mixture for base course i.e. tack coat, or 10000 tons for the wearing course, or for the quantity of material needed to produce 50000 m$^2$ of micro-asphalt:

- Grain size distribution HRN B.B8.029 or EN 933-1
- Grain size modulus HRN U.E4.014
- Percentage of particles smaller than 0,09 mm HRN B.B8.036
- Density HRN U.M8.082 or EN 1097-6
- Sand equivalent HRN U.Bl.040 or EN 933-8.

\textsuperscript{10} Tested only in case of increased value of water absorption
(c) Stone flour and return stone flour

The following is tested at least once for the quantity needed to produce 15000 tons of asphalt mixture for base course or tack coat, or 10000 tons for the wearing course:

- Grain size distribution: HRN B.B8.105 or EN 933-10
- Percentage of moisture: HRN U.BI.012
- Filler purity: HRN U.B1.020
- Percentage of voids in dry compacted state: HRN B.B8.102 or EN 1097-4
- Filler density: HRN B.B8.101 or EN 1097-7

(d) Bitumen

The following is tested at least once for the quantity of bitumen needed to produce 15000 tons of asphalt mixture for base course or tack coat, or 10000 tons for the wearing course:

- Penetration: HRN EN 1426
- Softening point (PK): HRN EN 1427
- Penetration index: HRN B.H8.614 or EN 12591
- Ductility: HRN B.H8.615
- Breaking point according to Fraass: HRN EN 12593
- Density: HRN EN ISO 3838
- Change of properties by heating to 163 °C: HRN EN 12607-1
- Paraffin number: HRN EN 12606-1
- Flash point: ISO 2592
- Percentage of soluble particles: HRN EN 12592.

(e) Polymer modified bitumen (PmB)

The following is tested at least once for the quantity of polymer bitumen needed to produce 15000 tons of asphalt mixture for base course or tack coat, or 10000 tons for the wearing course:

- Penetration: HRN EN 1426
- Softening point (PK): HRN EN 1427
- Breaking point according to Fraass: HRN EN 12593
- Elasticity: EN 13398
- Density: HRN EN ISO 3838
- Storage stability: EN 13399
- Flash point: ISO 2592
- Change of property during aging: HRN EN 12607-1 or HRN EN 12607-3.

(f) Bitumen emulsion for bonding

The following is tested at least once for the surface covered by 15 000 tons of asphalt mixture for base course or tack coat, i.e. 10000 tons for wearing course:

- Viscosity: HRN U.M3.100
- Percentage of binder: HRN U.M3.020 or EN 1428
- Degree of stability: HRN U.M3.020 or EN 13075-1
- Homogeneity: HRN U.M3.020 or EN 1429
• Stability during storage and
  Behavior of bitumen film under water HRN U.M3.020 or EN 13614-2.

(g) Polymer emulsion for bonding

The following is tested at least once for the surface covered by 15 000 tons of
asphalt mixture for base course or tack coat, i.e. 10 000 tons for wearing course:

• Percentage of binder EN 1428
• Viscosity EN 12846
• Storage stability EN 1429
• softening point of extracted binder V DIN 52041-2 and HRN EN 1427
• elasticity of extracted binder V DIN 52041-2 and EN 13398.

(h) Polymer emulsion for micro-asphalt and surface dressing

The following is tested at least once for the quantity of polymer emulsion needed
for execution of 50 000 m² of micro-asphalt or surface dressing:

• Type of charge EN 1430
• Percentage of binder EN 1428
• Residue on screen EN 1429
• Storage stability EN 1429
• Viscosity EN 12846
• Stability during breaking DIN 52047-1
• Adhesiveness DIN 52006-1
• Softening point of extracted binder V DIN 52041-2 and HRN EN 1427
• Breaking point of extracted binder according to Fraass V DIN 52041-2 and HRN EN 12593
• Elasticity of extracted binder V DIN 52041-2 and EN 13398.

(i) Polymer modified bitumen for surface dressing

The following is tested at least once for the quantity of polymer modified bitumen
needed for execution of 50 000 m² of surface dressing:

• Penetration HRN EN 1426
• Softening point (PK) HRN EN 1427
• Breaking point according to Fraass HRN EN 12593
• Elasticity EN 13398
• Density HRN EN ISO 3838
• Storage stability EN 13399
• Flash point ISO 2592
• Change of properties after aging HRN EN 12607-1 or HRN EN 12607-3.

Audit testing of produced asphalt mixture

Asphalt mixture is sampled according to the EN 12697-27 standard, and
preparation for sampling is done according to the EN 12697-28 standard.
(a) **Composition of asphalt mixture**

The following is tested:

- Percentage of bitumen HRN U.M8.105 or EN 12697-1
- Grain size distribution of extracted stone mix HRN U.M8.102 or EN 12697-2.

(b) **Physical and mechanical properties of asphalt mixture for rolled asphalt**

The following is tested:

- Stability at 60 °C, HRN U.M8.090 or EN 12697-34
- Deformations at 60 °C, HRN U.M8.090 or EN 12697-34
- Volume mass of asphalt sample HRN U.M8.092 or EN 12697-6
- Density of asphalt mixture HRN U.M8.082 or EN 12697-5
- Percentage of voids EN 12697-8
- Filling of stone mix voids with bitumen HRN U.E4.014.

Change of properties of asphalt mixture bitumen binder for wearing course shall be checked by testing the softening point and penetration of extracted binder.

(c) **Physical and mechanical properties of asphalt mix for poured asphalt**

The following is tested:

- Depth of sinking HRN U.M8.104 or EN 12697-20
- Increase in depth of sinking HRN U.M8.104 or EN 12697-20
- Softening point of extracted bitumen HRN EN 1427
- Penetration of extracted bitumen HRN EN 1426
- Breaking point of extracted bitumen according to Fraass HRN EN 12593.

(d) **Physical and mechanical properties of asphalt mixture for mastic asphalt**

The following is tested:

- Softening point according to Wilhelm HRN U.M3.095
- Softening point of extracted bitumen HRN EN 1427
- Penetration of extracted bitumen HRN EN 1426
- Breaking point of extracted bitumen according to Fraass HRN EN 12593.

**Audit testing of placed asphalt course**

Within the audit testing, when sampling the asphalt mixture, temperature of asphalt mixture on the site is tested and recorded, in accordance with the standard EN 12697-13.
The following is tested during placing of asphalt course:

**Rate of compaction**\(^{11}\): Determined from the relation of volume mass of placed asphalt and the volume mass of laboratory prepared asphalt sample.

**Percentage of voids**\(^{12}\): Determined from the relation of volume mass of placed asphalt and apparent of asphalt mixture.

**Thickness of the course**: Determined by original samples taken from the pavement.

**Evenness of the course**: Placed course is divided on measuring sections in alternative order at least 0,75 m from the carriageway edge.

Measuring instrument that expresses evenness in an IRI\(_{(100)}\) index is used (length of measuring section is 100 m). A measuring staff can also be used, length 3 m (standard or rolling), in accordance with the EN 13036-7 standard, and in this case the length of one measuring section is 500 m.

**Height of the course, cross fall and position**: measured by respective geodetic equipment.

**Adhesiveness of the course**: Measured with a SCRIM apparatus (blocked and pulled roller) or with a pendulum apparatus, and by measuring the depth of the texture with sand (HRN U.C4.018 or EN 13036-4)

**Bonding of courses**: tested on original samples of asphalt by method according to ALPA – StB, part 4.

**Audit testing report**

Report on conducted audit testing includes the following:
- General part with the information on the Client, Contractor and structure,
- Information on the required scope of audit testing according to the Gtr,
- Information on the scope of conducted audit testing,
- Results of audit testing,
- Explanation of all activities undertaken during control of used materials, production and placing of asphalt mixture, and
- Expert opinion on the quality of placed asphalt course with respect to the quality requirements according to the GTR.

**6-00.4.3 Documentation**

Technical documentation on the activities of quality control of executed structure, necessary for technical inspection, consists of the following:

\(^{11}\)when the original sample was not taken at the sampling place, the reference value of volume mass is the mean value of volume mass of samples according to Marshall, of all asphalt mixture samples during control testing and audit testing, from the complete daily production, i.e. the complete quantity of asphalt of tested unit surface.

\(^{12}\)when the original sample was not taken at the sampling place, reference value of apparent density is the mean value of apparent density from all asphalt mixture samples during control testing and audit testing, from the complete daily production, i.e. from the quantity of asphalt of tested unit surface.
• Certification on conformity and evidence on usability of all materials used in production of asphalt mixture,
• Initial job mix formula for each used type of asphalt mixture,
• Confirmed job mix formula for each type of used asphalt mixture, for every used asphalt production plant,
• Contracted job mix formula with report on trial section results,
• Report on control testing,
• Report on audit testing.

6-00.5 EVALUATION OF ASPHALT QUALITY

The main aim of all activities undertaken to evaluate the quality is to reach the most realistic, objective and reliable picture on the quality of produced and placed asphalt mixture, and to evaluate the executed asphalt works on the basis of results on the reached quality. Namely, it would not be correct from the technical or the economic standpoint to proclaim asphalt which deviates in some properties from the set quality requirements to proclaim unfit. It would be more correct in such cases to evaluate the asphalt works in stages, depending on the degree of deviation from the set quality requirements.

Final quality evaluation shall be done by the Client or the supervising engineer, on the basis of audit testing results. The final quality evaluation depends on the following:

• Quality evaluation of produced asphalt mixture, and
• Quality evaluation of placed asphalt course.

6-00.5.1 Quality evaluation of produced asphalt mixture

Quality evaluation of produced asphalt mixture is made on the basis of audit testing results of percentage of binder in the asphalt mixture.

Quality evaluation is usually made on the basis of mean result values of laboratory tests, except in case of smaller scope of work, when there are less than three individual results. In that case the quality evaluation is made on the basis of individual audit test results, as well as in other exceptions given in the text below.

Mean value of individual audit test results of bitumen content, depending on the number of tested samples, shall not deviate from the value required in table 6-00-20 for BBC, BBWC, TC and WC and in table 6-00-23 for WC-SMA.

If the mean value deviates from the required more than given in the tables 6-00-20 and 6-00-23, the respective quantity of produced asphalt mixture (asphalt course) is evaluated according to formulas (1) and (2).

Note 1: In order to reach the best possible compatibility of the mean value of bitumen content with the quantity required according to the confirmed job mix formula, individual values shall not deviate from the required for more than ± 0,5 % (m/m). Individual results deviating more than ± 0,5% (m/m) shall not be considered in the mean value calculation, and the quality of respective asphalt mixture quantity shall be evaluated according to the formulas (1) and (2).

\[ O = \left( \frac{P}{100} \right) \cdot C \cdot G \]  
(1)
\[ O = \left( \frac{P}{100} \right) \cdot C \cdot F, \quad (2) \]

Where:

\( O \) – deduction from the contracted price (kn),
\( P \) – deduction from the contracted price (%),
\( C \) – contracted unit price (kn/t) or (kn/m²),
\( G \) – relevant quantity for deduction (t),
\( F \) – relevant surface for deduction (m²).

Value \( P \) in formulas (1) i (2) is calculated according to the following:

a) when evaluation is made on the basis of mean value
\[ P = \left[ 5 \cdot \frac{p}{(0.5 - d)} \right]^2; \quad (3) \]

b) when evaluation is made on the basis of individual values
\[ P = p^2 \cdot 100, \quad (4) \]

Where:

\( d \) – limits of allowed deviations,
\( p \) – extent of exceeding the limit of allowed deviations

Asphalt mixture for which the audit testing shows such percentage of binder that the application of formula (3) and (4) gives values \( P \) greater than 25%, shall not be accepted.

6-00.5.2 Quality evaluation of placed asphalt course.

Quality evaluation of placed asphalt course is made on the basis or the audit testing results of the thickness, percentage of voids and evenness\(^{13}\) of the placed course.

**Thickness of the placed asphalt course**

Thickness of the course is determined by the samples taken from the placed asphalt course. Thickness is measured at four places for each sample, turned one toward the other at an angle of 90°. Arithmetic mean value of four individual samples is taken as the test results, rounded to 1 mm. Test result represents the thickness of the course on the executed surface for the relevant sample.

Final evaluation of the quality of placed course, with respect to its thickness, is made on the basis of individual thickness test results and on the basis of mean values of thickness of the course on the executed section.

Calculations for deduction from the contracted price, due to decreased quality is done in two stages.

\(^{13}\) Only for wearing course
In the first stage, on the basis of test results of the course thickness, the so-called thickness for calculation is calculated, which serves for calculation of the corrected unit prices for each type of course. After that, in the second stage the test results are compared with the set quality requirements, deductions are calculated but not on the basis of contracted but on the basis of corrected unit price.

**Determining the corrected unit price**

The corrected unit price is determined separately for each executed course, on the basis of the mean thickness value of each course (Note 3).

**Note 2:** For calculation of the mean value of course thickness, all individual test results are taken, except those which deviate from the designed thickness more than +20%. Such results are taken into the mean value calculation as if they deviate from the designed thickness +20% (e.g. if the designed thickness is 50 mm, and the individual thickness test result is 62 mm, this result is not taken into the mean value, but this one: 50 x 1.20 = 60 mm).

On the basis of calculated mean thickness values of courses, the thickness for calculation is obtained, and after that the corrected unit prices for each course separately.

Thickness for calculation of the wearing course (WC-AB or WC-SMA) i.e. bitumen base-wearing course (BBWC) is equal to the mean value of the individual test results of the wearing course thickness (Note 2).

Thickness for calculation of the bitumen base course (BBC) is calculated so that the sum of the thickness for calculation and the designed thickness of the tack coat is deducted from the sum of mean values of the wearing course thickness, the tack coat and the base course thickness.

**Note 3:** Thickness for calculation of any course shall not be greater than the designed thickness. If calculations produce such results, then the designed thickness is taken as the thickness for calculation for the course.

Corrected unit prices for individual courses are calculated according to the following formula:

\[
C' = C \cdot \frac{D'}{D_p}
\]

where:

- \(C'\) - corrected unit price,
- \(C\) - contracted unit price,
- \(D'\) - thickness for calculation
- \(D_p\) – designed course thickness,
**Deduction due to decreased quality**

Possible deductions due to decreased quality caused by the decreased thickness of placed courses shall not be calculated on the basis of thickness of individual courses but on the basis of the sum of the thickness of individual courses.

The following thicknesses are taken into account when calculating deductions:
- Wearing course thickness \( W \),
- Thickness of wearing + tack coat \( W + T \),
- Thickness of wearing + tack coat + base courses \( W + T + B \).

Quality evaluation of the asphalt part of the pavement structure is made on the basis of individual test results and on the basis of the mean values of determined thickness.

Allowed deviations of individual and mean values from the ones required by the design are given in Table 6-00-24.

<table>
<thead>
<tr>
<th>Course</th>
<th>Allowed deviation of placed course thickness</th>
<th>Individual results</th>
<th>Mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower limit (%)</td>
<td>Highest limit (%)</td>
</tr>
<tr>
<td>Wearing</td>
<td></td>
<td>-15</td>
<td>+20</td>
</tr>
<tr>
<td>Wearing + tack coat</td>
<td></td>
<td>-15</td>
<td>+20</td>
</tr>
<tr>
<td>Wearing + tack + base course</td>
<td></td>
<td>-15</td>
<td>+20</td>
</tr>
</tbody>
</table>

Deductions due to the decreased quality caused by the decreased thickness of placed course are calculated as follows:

\[
O = \frac{p^2}{100} \times 0.3 \times C' \times F \\
p = \frac{D_{\text{min}} - D_{\text{izv}}}{D_p} \times 100
\]

Where:
- \( O \) - deductions (kn),
- \( p \) - deviation (%),
- \( D_{\text{min}} \) - lowest thickness according to table 6-00.5-1,
- \( D_{\text{izv}} \) - actual executed thickness (mm),
- \( D_p \) - designed thickness (mm),
- \( C' \) - corrected unit price (kn/m²),
- \( F \) - surface to which the deduction refers.

When evaluation is made on the basis of individual test results, the values from previous formulas have these values:

- For wearing course \( D_{\text{min}} = D_p \times 0.85 \)
- For wearing course + tack coat \( D_{\text{min}} = D_p \times 0.90 \)
For wearing course + tack coat + base course \( D_{\text{min}} = D_p \cdot 0.90 \)

\( D_{\text{izv}} \) is the individual test result and, \( F \) is the surface represented by the tested sample.

When evaluation is made on the basis of mean values of individual test results, values for \( D_{\text{min}} \) are calculated for all courses in the same manner, i.e., \( D_{\text{min}} = D_p \cdot 0.95 \), and \( F \), the surface to which the deduction refers, is the total executed surface.

\( D_{\text{izv}} \) is in that case equal to the mean value of individual test results (Note 2).

Corrected unit price \( C' \) is calculated, depending on the course, as follows:

- For wearing course \( C'H = C'H \)
- For wearing + BBC \( C'H+V = C'H + C'V \)
- For wearing + BBC + DBBC \( C'H+V+N = C'H + C'V + C'N \)

Where \( C'H \), \( C'V \), and \( C'N \) are the corrected unit prices for the wearing, tack coat, and base course, calculated in the way described in sub-item, 6-00.5.2.

After the deductions have been calculated on the basis of individual test results and their mean values, the amounts of calculated deductions shall be compared and only one of the calculated values deducted, the higher one. If the courses have been executed as defined in this sub-item, in the thickness equal to or greater than the one given in the design, there shall be no deductions.

**Percentage of voids in the placed asphalt course**

Quality evaluation of the placed course with respect to the percentage of voids shall be made for each executed course, on the basis of individual test results and on the basis of mean values of the percentage of voids in the executed course.

Individual results for determining the percentage of voids in the placed course, which exceed the upper limits set by these GTR by more than 10% of their value, shall not be taken into the mean value calculation of the percentage of voids in the executed course. Such results shall be evaluated according to the criteria for evaluation according to the individual test results. Deductions due to decreased quality as a result of the percentage of voids in the executed course are calculated as follows:

\[
O = \frac{p^2}{100} \cdot C' \cdot F
\]

where:
- \( O \) - deductions from the contracted unit price (kn),
- \( C' \) - corrected unit price (according to sub-item 6-00.5.2 (kn/m²),
- \( F \) - surface to which the deductions refer (m²),
- \( p \) - deviation from allowed limits (%(V/V)).

When calculating the deductions on the basis of the mean value of voids in the executed course, the allowed limits are identical to the scope for the percentage of voids set by these GTR.
When calculating the deductions on the basis of individual test results of the percentage of voids in the executed course, the allowed limits shall be obtained in a manner that the upper limit of the scope set by these GTR is increased by 10% of its value.

After the deductions have been calculated on the basis of individual test results and on the basis of their mean value, the amounts of calculated deductions shall be compared and only one calculated value, the higher one, shall be deducted.

**Evenness of the placed course**

Evaluation of the evenness of the placed course shall be made on the basis of the mean IRI<sub>500</sub> index value on the measuring section 500 m long, which consists of 5 IRI<sub>100</sub> indexes, determined in accordance with sub-item 6-00.4.2.2, within the audit testing of the placed asphalt course.

If the mean value of the IRI<sub>500</sub> index on a section 500 m long exceeds the allowed values by more than 0,1 m/km, than the evenness of the subject section is measured in full length of two longitudinal profiles. If the obtained mean value of the IRI<sub>500</sub> index deviates from the set value increased by 0,1 m/km, the contracted price shall be decreased according to the table 6-00-25.

**Table 6-00-25** Deductions due to the unevenness of the wearing course depending on the traffic load

<table>
<thead>
<tr>
<th>Category of evenness</th>
<th>Traffic load group</th>
<th>Deduction from corrected unit price %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highway</td>
<td>Very heavy and heavy</td>
</tr>
<tr>
<td>A-IRI&lt;sub&gt;500&lt;/sub&gt;</td>
<td>1,1 do 1,2</td>
<td>1,6 do 1,7</td>
</tr>
<tr>
<td>B-IRI&lt;sub&gt;500&lt;/sub&gt;</td>
<td>1,2 do 1,3</td>
<td>1,7 do 1,8</td>
</tr>
<tr>
<td>C-IRI&lt;sub&gt;500&lt;/sub&gt;</td>
<td>1,3 do 1,4</td>
<td>1,8 do 1,9</td>
</tr>
<tr>
<td>D-IRI&lt;sub&gt;500&lt;/sub&gt;</td>
<td>1,4 do 1,5</td>
<td>1,9 do 2,0</td>
</tr>
<tr>
<td>E-IRI&lt;sub&gt;500&lt;/sub&gt;</td>
<td>&gt; 1,5</td>
<td>&gt; 2,0</td>
</tr>
</tbody>
</table>

If the mean value of the IRI<sub>500</sub> index corresponds to the categories of evenness from A to D, and the mean IRI<sub>100</sub> index value is in the E category, the subject sub-section shall not be paid to the Contractor 100 m long. Depending on the amount of deviation, the supervising engineer can request a change of the course.
6-01 BITUMEN TACK COAT FOR BONDING OF ASPHALT LAYERS

6.01.1 DESCRIPTION

Bitumen tack coat for intermediate bonding of asphalt layers is a thin layer of bitumen obtained from bitumen emulsion or hot bitumen by spraying. It is a part of preparatory works of road base for execution of pavement structure asphalt courses.

6.01.2 BITUMEN EMULSION QUALITY REQUIREMENTS

Previously executed asphalt layer is sprayed with semi-stable anion or cationic bitumen emulsion, depending on the type of stone material used and the weather conditions prevailing. If the asphalt courses are made of asphalt mixture produced from polymer modified bitumen, asphalt base shall be sprayed with semi-stable or unstable cationic polymer emulsion. Quality of bitumen emulsion shall be in accordance with the requirements given in item 6-00.2.8 of these GTR.

6.01.3 WORKS

Course executed on the basis of bitumen binders shall be sprayed with bitumen emulsion in the quantity ranging from 0.15 to 0.35 kg/m², depending on the contamination and wearing out of the road base. The road base can also be sprayed by hot bitumen in stead of bitumen emulsion, in the quantity from 0.1 to 0.2 kg/m².

Spraying of bitumen emulsion or hot bitumen shall only be done by motor sprayers, which enable an unified distribution of bitumen emulsion across the surface. Manual spraying is not allowed, except at places that are not reachable by motor sprayers, with the approval of the supervising engineer. Before spraying with bitumen emulsion, the surface shall be clean and dry. Spraying of course executed on the basis of bitumen binders shall not be sprayed by bitumen emulsion during rainy weather, i.e. at relative air humidity of 75%, at temperature of air and road base lower than 5°C.

6-01.4 QUALITY CONTROL

6.01.4.1 Control testing

During the execution of pavement structure asphalt courses, the Contractor shall maintain control testing of bitumen emulsion in accordance with sub-item 6-00.4.2 of these GTR.

6.01.4.2 Audit testing

During the execution of pavement structure asphalt courses, audit testing of bitumen emulsion shall be conducted in accordance with sub-item 6-00.4.2.2 of these GTR.
6-01.5 CALCI UATION OF WORK

Spraying of pavement structure asphalt courses with bitumen emulsion is measured in square meters of actually sprayed surface, in accordance with the design details and is calculated in square meters of sprayed surface. The price includes all costs of material supply, transport, equipment and everything needed for execution of work.

6-02 BONDING LAYER

6-02.1 DESCRIPTION

Bonding layer (BL) in the pavement structure is found between the base course and the wearing course, made of a mixture of stone flour, stone grit smallest nominal grain size of 22 mm and bitumen as binder.

Bonding layer is divided according to the nominal grain size of stone material as follows:

- VS 16
- VS 32

Bonding layer is used in execution of pavement structures of highways and roads of very heavy and heavy traffic load group.

Technological thickness of the bonding layer is:

- VS 16, 50 to 60 mm
- VS 22, 60 to 80 mm

6-02.2 QUALITY REQUIREMENTS FOR BONDING LAYER COMPONENT MATERIALS

Stone grit

Stone grit shall be in accordance with quality requirements given in sub-item 6-00.2.2. For execution of bonding layer the following stone grit categories shall be used:

- KS-E-I,
- KS-E-II,
- KS-E-III and
- KS-S-I.

Separated and partially separated granular stone material shall not be used for the execution of bonding layer.

Sand

Natural and crushed sand shall be in accordance with the quality requirements given in sub-item 6-00.2.4. All categories of crushed sand can be used.

Stone flour

Stone flour shall be in accordance with the quality requirements for category KB-I, given in sub-item 6-00.2.5.
Use of return stone flour is allowed in the amount of 50% maximum of the total added quantity of stone flour, if the return stone flour is not of silicate origin.

**Bitumen binder**

When choosing the type of bitumen care shall be taken about the climatic zones, according to the HRN U.15.600 standard.

Rod construction bitumen BIZ 60 and BIT 90 are used as binder, quality according to the HRN U.M3.010 standard, or bitumen mark 50/70 according to the EN 12591 standard.

**Road construction bitumen** shall be in accordance with the quality requirements given in sub-item 6-00.2.6.

Polymer modified bitumen or road construction bitumen with addition of natural bitumen or polymer admixtures, added in the production process itself at the asphalt mixture production plant, shall be used in special cases.

**Polymer modified bitumen (PmB)** shall be in accordance with the quality requirements given in sub-item 6-00.2.7.

### 6-02.3 BONDING LAYER QUALITY REQUIREMENTS

#### 6-02.3.1 Composition of asphalt mixture

<table>
<thead>
<tr>
<th>Square mash openings, screen, mm</th>
<th>Type of bonding layer</th>
<th>Rough estimate of bitumen content in asphalt mixture for BL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,09</td>
<td>VS 16</td>
<td>3 to 9</td>
</tr>
<tr>
<td>0,25</td>
<td>VS 22</td>
<td>3 to 9</td>
</tr>
<tr>
<td>0,71</td>
<td>VS 16</td>
<td>3 to 9</td>
</tr>
<tr>
<td>0,71</td>
<td>VS 22</td>
<td>6 to 20</td>
</tr>
<tr>
<td>2,0</td>
<td>VS 16</td>
<td>11 to 28</td>
</tr>
<tr>
<td>2,0</td>
<td>VS 22</td>
<td>19 to 35</td>
</tr>
<tr>
<td>4,0</td>
<td>VS 16</td>
<td>27 to 44</td>
</tr>
<tr>
<td>4,0</td>
<td>VS 22</td>
<td>36 to 57</td>
</tr>
<tr>
<td>8,0</td>
<td>VS 16</td>
<td>45 to 68</td>
</tr>
<tr>
<td>8,0</td>
<td>VS 22</td>
<td>58 to 82</td>
</tr>
<tr>
<td>11,2</td>
<td>VS 16</td>
<td>58 to 82</td>
</tr>
<tr>
<td>11,2</td>
<td>VS 22</td>
<td>58 to 82</td>
</tr>
<tr>
<td>16,0</td>
<td>VS 16</td>
<td>90 to 100</td>
</tr>
<tr>
<td>16,0</td>
<td>VS 22</td>
<td>90 to 100</td>
</tr>
<tr>
<td>22,4</td>
<td>VS 16</td>
<td>100</td>
</tr>
<tr>
<td>22,4</td>
<td>VS 22</td>
<td>100</td>
</tr>
<tr>
<td>31,5</td>
<td>VS 16</td>
<td>4,7 to 5,7</td>
</tr>
<tr>
<td>31,5</td>
<td>VS 22</td>
<td>4,5 to 5,5</td>
</tr>
</tbody>
</table>
Exact percentage of bitumen is determined by the asphalt mixture initial job mix formula and the confirmed asphalt mixture job mix formula.

6-02.3.2 Properties of asphalt mixture

Table 6-02-3 Physical and mechanical properties of asphalt mixture for VS 16 and VS 22 depending on the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Stability at 60 °C, minimum, kN</td>
<td>8</td>
</tr>
<tr>
<td>Stability and deviation ratio at 60 °C, minimum, kN/mm</td>
<td>2,2</td>
</tr>
<tr>
<td>Percentage of voids, %(V/V)</td>
<td>4 do 7</td>
</tr>
<tr>
<td>Filling of stone mix voids by bitumen, %</td>
<td>57 do 75</td>
</tr>
</tbody>
</table>

6-02.3.3 Properties of placed course

Table 6-02-4 Percentage of voids, rate of compactness, thickness and bonding of placed courses in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Percentage of voids, %(V/V)</td>
<td>5 do 9</td>
</tr>
<tr>
<td>Rate of compactness, %</td>
<td>98</td>
</tr>
<tr>
<td>Thickness *</td>
<td></td>
</tr>
<tr>
<td>- individually, maximum, %</td>
<td>- 15 from designed</td>
</tr>
<tr>
<td>- mean value, maximum, %</td>
<td>- 5 from designed</td>
</tr>
<tr>
<td>Bonding of courses, minimum, N/mm²</td>
<td>1,0 (1,5)**</td>
</tr>
</tbody>
</table>

* Thickness greater than 20% from the designed shall not be taken in the mean thickness calculation.
** In case when the base is sprayed with polymer bitumen emulsion.
Table 6-02-5  Evenness, height, cross fall and horizontal position of the executed bonding layer

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways</td>
</tr>
<tr>
<td>Evenness:</td>
<td></td>
</tr>
<tr>
<td>- IRI(100), maximum, m/km</td>
<td>1.4</td>
</tr>
<tr>
<td>- measuring staff 3 m, maximum, mm</td>
<td>5</td>
</tr>
<tr>
<td>Height:</td>
<td></td>
</tr>
<tr>
<td>Allowed elevation deviation from the designed elevation position, maximum %</td>
<td>± 10</td>
</tr>
<tr>
<td>Cross fall:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation from the designed cross fall (each profile), maximum, % (aps.)</td>
<td>± 0.4</td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge) from the designed elevation position, maximum, mm</td>
<td>± 25</td>
</tr>
</tbody>
</table>

6-02.4 PRODUCTION, TRANSPORT AND PLACING OF BONDING LAYER

Production, transport and placing of asphalt mixture for bonding layer are described in sub-item 6-00.3 of these GTR.

6.02.5 QUALITY CONTROL OF BONDING LAYER

6-02-5-1 Preliminary testing

Activities prior to the start of asphalt works, with respect to preliminary testing of material usability, initial job mix formula, confirmed job mix formula and trial section shall be done in accordance with sub-item 6-00.4.1.

6-02.5.2 Control testing

Control testing of component materials

Control testing of component materials shall be done in accordance with sub-item 6.00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Samples of asphalt mixture shall be taken at the production plant and at the placing site.

Asphalt mixture composition is tested with at least one sample for every 500 tons of produced asphalt mixture.
Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Physical and mechanical properties of asphalt mixture shall be tested by at least one sample for every 750 tons of produced asphalt mixture.
Properties in accordance with sub-item 6-00.4.2.1 shall be tested.
Control testing of placed asphalt mixture

Control testing of the course placing works shall be in accordance with sub-item 6-00.4.2.1.

6-02.5.3 AUDIT TESTING

Audit testing of component materials

Samples of component materials for asphalt mixture production shall be taken at the asphalt mixture production plant and tested in accordance with sub-item 6-00.4.2.2. of these GTR.

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing as usually taken at the asphalt mixture placing site.

Composition and physical and mechanical properties of asphalt mixture shall be tested for every 1500 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.2 shall be tested.

Audit testing of placed course

Rate of compactness, percentage of voids, thickness and bonding of placed course shall be tested on samples taken at least every 2000 m² of placed course according to sub-item 6-00-4-2-2.

Evenness of placed layer shall be tested in accordance with sub-item 6-00.4.2.2.

Height, cross fall and position of placed layer are tested by special measuring device, checking at least 20% data collected by the Contractor during control testing of asphalt mixture placing, according to sub-item 6-00.4.2.1.

6.02.6 QUALITY EVALUATION OF PLACED ASPHALT COURSE

Placed asphalt course shall be evaluated and taken over by the supervising engineer on the basis of results of control testing and audit testing.

Percentage of bitumen determined by samples of asphalt mixture, as part of the audit testing and control testing, shall be in accordance with sub-item 6-00, table 6-00-20.

Grain site distribution of asphalt mix, determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in table 6-01.2 and sub-item 6-00, table 6-00.21.

Physical and mechanical properties of asphalt mixture shall satisfy the requirements given in sub-item 6-02, table 6-02.3.

Properties of placed asphalt course shall satisfy the requirements given in sub-item 6-02, table 6-02.4 and table 6-02.5.

All found faults shall be removed by the Contractor.
All costs of such works shall be at the expense of the Contractor, including all additional tests and measurements needed to be done in order to test the quality of the remedy. All works not in accordance with the quality requirements, not remedied according to the requests of the supervising engineer shall not be paid to the Contractor.

6.02.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed and incorporated binding layer in accordance with the design.

Defined quantities shall be paid per contracted unit price for square meter. The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.

If the works are not completely in accordance with the GTR requirements, the quality shall be evaluated according to the sub-item 6-00.5. Decreased value of works shall be deducted from the Contractor's contracted price of works.

6-0.3 ASPHALT-CONCRETE WEARING COURSE (AC-WC)

6-03.1 DESCRIPTION

Asphalt-concrete wearing course is an asphalt course made of a mixture of stone flour, stone material and bitumen as binder, where the grain size distribution of stone mix is made according to the principle of the most densely made material.

Asphalt mixture for the asphalt-concrete wearing course is divided according to:

- Nominal grain size of stone material,
- Grain size distribution of stone mix and the type of used stone material.

According to the nominal grain size of stone material, asphalt-concrete wearing course is divided as follows:

- asphalt concrete AB 4
- asphalt concrete AB 8
- asphalt concrete AB 11 and
- asphalt concrete AB 16.

According to the grain size distribution of stone mix and the type of stone material used, asphalt mixture for the asphalt concrete wearing course is divided as follows:

<table>
<thead>
<tr>
<th>AB4</th>
<th>standard limit values of the grain size distribution of stone mix of carbonate composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB 8</td>
<td>standard limit values of the grain size distribution of stone mix of carbonate composition</td>
</tr>
<tr>
<td>AB 8E</td>
<td>standard limit values of the grain size distribution of stone mix of silicate composition</td>
</tr>
<tr>
<td>AB 11</td>
<td>standard limit values of the grain size distribution of stone mix of carbonate composition</td>
</tr>
</tbody>
</table>
AB 11E narrower limit values of grain size distribution of stone mix of silicate composition

AB 16 standard limit values of the grain size distribution of stone mix of carbonate composition

AB 16E narrower limit values of grain size distribution of stone mix of silicate composition

**Table 6-03-1** Technological thickness of the placed AC -WC

<table>
<thead>
<tr>
<th>AB 4</th>
<th>AB 8</th>
<th>AB 8E</th>
<th>AB 11</th>
<th>AB 11E</th>
<th>AB 16</th>
<th>AB 16E</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 do 30</td>
<td>30 do 40</td>
<td>30 do 40</td>
<td>35 do 50</td>
<td>35 do 50</td>
<td>45 do 60</td>
<td>45 do 60</td>
</tr>
</tbody>
</table>

**Table 6-03-2** Application of AC-WC depending on the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Type of wearing course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AB 4</td>
</tr>
<tr>
<td>Highways and very heavy</td>
<td>-</td>
</tr>
<tr>
<td>Heavy</td>
<td>-</td>
</tr>
<tr>
<td>Medium</td>
<td>-</td>
</tr>
<tr>
<td>Light</td>
<td>-</td>
</tr>
<tr>
<td>Very light</td>
<td>+</td>
</tr>
</tbody>
</table>

**6-03.2 QUALITY REQUIREMENTS OF WEARING COURSE COMPONENT MATERIALS (AC-WC)**

**Stone grit**

Stone grit shall be in accordance with the quality requirements given in sub-item 6-00.2.2.

**Table 6-03-3** Use of quality category of stone grit for AC-WC depending on the traffic load group.

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway and very heavy</td>
<td>KS-E-I</td>
<td>KS-E-II</td>
<td>KS-E-I</td>
</tr>
<tr>
<td>KS-E-I</td>
<td></td>
<td></td>
<td>KS-E-II</td>
</tr>
<tr>
<td>KS-E-II</td>
<td></td>
<td></td>
<td>KS-E-III</td>
</tr>
<tr>
<td>KS-E-III</td>
<td></td>
<td></td>
<td>KS-S-I</td>
</tr>
<tr>
<td>KS-S-I</td>
<td></td>
<td></td>
<td>KS-S-II</td>
</tr>
</tbody>
</table>

**Sand**

Natural and crushed sand shall be in accordance with the requirements given in sub-item 6-00.2.4.
Table 6-03-4 Use of quality category of sand for AC-WC depending on the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highway and very heavy</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP02-E-I</td>
<td>DP02-E-I</td>
<td>All categories of crushed sand of igneous and sedimentary origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP02-E-II</td>
<td>DP02-E-II</td>
<td>All categories of crushed sand of igneous and sedimentary origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP02-S*</td>
<td>DP02-S</td>
<td>All categories of natural sand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* up to 50 % (m/m) maximum of the total quantity of crushed sand

Stone flour

Stone flour shall be in accordance with the requirements given in sub-item 6-00.2.5.

Stone flour of KB-I category only can be used for highways and roads of very heavy and heavy traffic load.

Return stone flour extracted at the asphalt production plant can be returned into the production process under the condition that the filler from that stone satisfies the quality requirements given in sub-item 6-00-2-5 and that it was not produced by dusting of stone mix containing crushed sand of igneous origin.

Asphalt mixtures for highways and roads with very heavy traffic load use of return filler shall not be allowed.

Bitumen binder

When choosing the type of bitumen attention shall be given to the type and intended use of asphalt mixture as well as the climatic zones according to the HRN U.15.600 standard.

Road construction bitumen BIT 45, BIT 60 and BIT 90 shall be used as binder, quality according to the HRN U.M3.010 standard or bitumen mark 35/50, 50/70 and 70/100, according to the EN 12591 standard.

Road construction bitumen shall be in accordance with the requirements given in sub-item 6-00.2.6

In special circumstances polymer modified bitumen or road construction bitumen with addition of natural bitumen or polymer admixtures used in the mixing process itself at the production plant shall be used.

Polymer modified bitumen (PmB) shall be in accordance with the requirements given in sub-item 6-00.2.2.
6-03.3 WEARING COURSE QUALITY REQUIREMENTS (AC-WC)

6-03.3.1 Composition of asphalt mixture

Table 6-03-5  Limit values of stone mix grain size distribution for AC-WC

<table>
<thead>
<tr>
<th>Square mash opening, screen mm</th>
<th>Type of asphalt concrete</th>
<th>Fall through screen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09</td>
<td>AB 4</td>
<td>8 to 18</td>
</tr>
<tr>
<td>0.25</td>
<td>AB 4</td>
<td>4 to 12</td>
</tr>
<tr>
<td>0.71</td>
<td>AB 8</td>
<td>4 to 12</td>
</tr>
<tr>
<td>2.0</td>
<td>AB 8E</td>
<td>3 to 12</td>
</tr>
<tr>
<td>4.0</td>
<td>AB 11</td>
<td>3 to 11</td>
</tr>
<tr>
<td>8.0</td>
<td>AB 11E</td>
<td>3 to 12</td>
</tr>
<tr>
<td>11.2</td>
<td>AB 16</td>
<td>3 to 12</td>
</tr>
<tr>
<td>22.4</td>
<td>AB 16E</td>
<td>3 to 12</td>
</tr>
</tbody>
</table>

Table 6-03-6  Rough estimate of bitumen content in asphalt mixture for AC-WC

<table>
<thead>
<tr>
<th>Type of asphalt concrete</th>
<th>Percentage of bitumen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB 4</td>
<td>6.8 to 8.0</td>
</tr>
<tr>
<td>AB 8</td>
<td>5.8 to 7.5</td>
</tr>
<tr>
<td>AB 8E</td>
<td>5.8 to 7.5</td>
</tr>
<tr>
<td>AB 11</td>
<td>5.4 to 7.0</td>
</tr>
<tr>
<td>AB 11E</td>
<td>5.4 to 6.5</td>
</tr>
<tr>
<td>AB 16</td>
<td>5.2 to 6.2</td>
</tr>
<tr>
<td>AB 16E</td>
<td>5.2 to 6.0</td>
</tr>
</tbody>
</table>

Exact bitumen percentage shall be determined by the initial job mx formula and the confirmed job mix formula.

6-03.3.2 Asphalt mixture properties

Table 6-03-7  Physical and mechanical properties of asphalt mixture for AC-WC in relation to the traffic load

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability at 60 °C minimum, kN</td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Stability and deviation ratio at 60 °C minimum, kN/mm</td>
<td>2.2</td>
</tr>
<tr>
<td>Percentage of voids, % (V/V)</td>
<td>3.5 to 5.5</td>
</tr>
<tr>
<td>Filling of stone mix voids with bitumen, %</td>
<td>64 do 79</td>
</tr>
</tbody>
</table>
6-03.3.3 Properties of placed course

Table 6-03-8 Percentage of voids, rate of compactness and bonding of placed AC-WC course in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Percentage of voids, % (V/V)</td>
<td>3.5 to 7.5</td>
</tr>
<tr>
<td>Rate of compactness, %</td>
<td>98</td>
</tr>
<tr>
<td>Thickness *</td>
<td>- individually, maximum, %</td>
</tr>
<tr>
<td></td>
<td>- mean value, maximum, %</td>
</tr>
<tr>
<td>Bonding of course, minimum, N/mm²</td>
<td>1.0 (1.5)**</td>
</tr>
</tbody>
</table>

* Thickness greater than 20% from the designed shall not be taken in the mean thickness calculation.

** In case when the base is sprayed with polymer bitumen emulsion

Requirements for evenness, height, cross fall and horizontal position of the placed course are given in table 6-03-9.

Wearing course adhesion

These GTR define the numeric values that have to be satisfied when measuring the adhesion property, i.e. when measuring the resistance to slipperiness of a wet wearing course surface or a concrete carriageway surfacing. Resistance to slipperiness is measured within a time period not longer than 2 weeks after the completion of asphalt works. Resistance to slipperiness is defined by two limit values of the friction coefficient $\mu$ as follows:

- The friction coefficient $\mu$ is the lowest required value of friction of a wet road surfacing when the road is being opened for traffic. During traffic operation the friction coefficient value should not be less than $\mu_a$. If the coefficient value changes below the limit value of $\mu_a$, the state of the surfacing shall be monitored through periodical measurements of the resistance to slipperiness.
- Friction coefficient $\mu_b$ is the lowest allowed value of the resistance to slipperiness of the surface which, because of the danger of sliding shall not be lower, if the changed value to the friction coefficient drops below the limit value of $\mu_b$, adequate measures shall be taken (decrease of the highest allowed driving speed and improvement of the surface course).
Table 6-03-9  Evenness, height, cross fall and horizontal position of the placed AC-WC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways</td>
</tr>
<tr>
<td>Evenness of layer:</td>
<td></td>
</tr>
<tr>
<td>- IRI(100), maximum, m/km</td>
<td>1,0</td>
</tr>
<tr>
<td>- measuring staff 3 m, maximum, mm</td>
<td>3</td>
</tr>
<tr>
<td>Height of layer:</td>
<td></td>
</tr>
<tr>
<td>Allowed elevation deviation from the designed elevation position, maximum%</td>
<td>± 5</td>
</tr>
<tr>
<td>Cross fall:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation from the designed cross fall (each profile), maximum, % (aps.)</td>
<td></td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge) from the designed elevation position, maximum, mm</td>
<td>± 25</td>
</tr>
</tbody>
</table>

Estimate of the changed values of the resistance to slipperiness shall be done on the basis requirements given in these GTR, depending on the highest speed limit on the road, traffic load group and the conditions on the road itself. These conditions are divided on normal and unfavorable (potentially dangerous) conditions.

The potentially dangerous road conditions are:

- Road segments with longitudinal gradients greater than 6% and longer than 100 m,
- Curves with radius less than 150 m at stretched road route,
- Dangerous spots like road segments with strong side winds, bridges, tunnels and segments where the vehicles have to decrease their speed,

Normal road conditions are other circumstances on the road which are not stated. Depth of the pavement surface texture, defined by “sand blasting”, depending on the highest allowed speed is given in table 6-03.10.

Table 6-03-10  Limit values of the texture depths

<table>
<thead>
<tr>
<th>Property</th>
<th>Highest allowed speed, (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Depth of texture, (mm)</td>
<td>0,13 to 0,30</td>
</tr>
</tbody>
</table>

In accordance with the definitions of the friction coefficient limit values, $\mu_b$ and $\mu_A$, table 6-03-11 shows the lowest (SRT$_B$) and highest (SRT$_A$) limit values SRT for normal and unfavorable (dangerous) road conditions, depending on the traffic load group.
Table 6-03-11 Limit values of resistance to slipperiness

<table>
<thead>
<tr>
<th>Traffic load groups</th>
<th>Normal road conditions</th>
<th>Unfavorable (dangerous) road conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SRT&lt;sub&gt;B&lt;/sub&gt;</td>
<td>SRT&lt;sub&gt;A&lt;/sub&gt;</td>
</tr>
<tr>
<td>Highways, very heavy, heavy and medium</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Light and very light</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>All groups</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Procedure for evaluation of the measured values of the depth of pavement surface texture by "sprinkling" and the SRT pendulum values is given in table 6-03-12.

Table 6-03-12 Procedure for evaluation of the resistance to slipperiness by combined method (SRT pendulum and "sand blasting") according to HRN U.C4.018

<table>
<thead>
<tr>
<th>Measured value of texture depth</th>
<th>Measured value of SRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below the limit value</td>
<td>Below the limit value</td>
</tr>
<tr>
<td>Within the limit value</td>
<td>-</td>
</tr>
<tr>
<td>Above the limit value</td>
<td>+</td>
</tr>
</tbody>
</table>

- Resistance to slipperiness of the road surface is insufficient,
+ Additional measurements needed,
+ resistance to slipperiness of the road surface is sufficient.

Limit values of the friction coefficient defined according to the measuring method SCRIM are given in table 6-03-13.

Table 6-03-13 Limit values of the friction coefficient according to SCRIM method

<table>
<thead>
<tr>
<th>Friction coefficient</th>
<th>Speed of measuring apparatus, km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>
| \( \mu_{SCRIM} \)    | 0,60| 0,53| 0,46        

The highest allowed deviation of the friction coefficient for individual measured value of the segment length 100 m, in relation to the limit value is 0,03. This allowed deviation is relevant for the guarantee period.

6-03.4 PRODUCTION, TRANSPORT AND PLACING OF WEARING COURSE (AC-WC)

Production, transport and placing of asphalt mixture for wearing course (AC-WC) are described in sub-item 6-00.3 of these GTR.
6-03.5 WEARING COURSE QUALITY CONTROL (AC-WC)

6-03.5.1 Preliminary testing

Activities prior to the start of asphalt works, with respect to preliminary testing of material usability, initial job mix formula, confirmed job mix formula and trial section shall be done in accordance with sub-item 6-00.4.1.

During the production of initial job mix formula for asphalt mixtures intended for highways and roads of very heavy traffic load, the asphalt mixture shall be tested for resistance to permanent deformations (standard EN 12697-22 or EN 12697 – 25) and to resistance against influence of water (EN 12697-12)

6-03.5.2 Control testing

Control testing of component materials

Control testing of component materials shall be done in accordance with sub-item 6.00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Samples of asphalt mixture shall be taken at the production plant and at the placing site. Asphalt mixture composition is tested with at least one sample for every 500 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Physical and mechanical properties of asphalt mixture shall be tested by at least one sample for every 500 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Control testing of placed asphalt mixture

Control testing of the course placing works shall be in accordance with sub-item 6-00.4.2.1.

6-03.5.3 Audit testing

Audit testing of component materials

Samples of component materials for asphalt mixture production shall be taken at the asphalt mixture production plant and tested in accordance with sub-item 6-00.4.2.2. of these GTR.

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing as usually taken at the asphalt mixture placing site. Composition and physical and mechanical properties of asphalt mixture shall be tested for every 1000 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.2 shall be tested.
Audit testing of placed course

Rate of compactness, percentage of voids, thickness and bonding of placed course shall be tested on samples taken at least every 2000 m$^2$ of placed course surface according to sub-item 6-00-4-2-2.

Evenness of placed layer shall be tested in accordance with sub-item 6-00.4.2.2.

Height, cross fall and position of placed layer are tested by special measuring device, checking at least 20% data collected by the Contractor during control testing of asphalt mixture placing, according to sub-item 6-00.4.2.1.

Adhesiveness of the wearing course surface shall be tested in accordance with the sub-item 6-00.4.2.2 with at least one sample every 10 000 m$^2$ of placed wearing course.

6.03.6 QUALITY EVALUATION OF PLACED WEARING COURSE (AC-WC)

Placed wearing course AC-WC shall be evaluated and taken over by the supervising engineer on the basis of results of control testing and audit testing.

Percentage of bitumen determined by samples of asphalt mixture, as part of the audit testing and control testing, shall be in accordance with sub-item 6-00, table 6-00-20.

Grain size distribution of asphalt mix, determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in table 6-03.5 and sub-item 6-00, table 6-00.21.

Physical and mechanical properties of asphalt mixture determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in sub-item 6-03.3.2, table 6-03-7.

Properties of placed asphalt course determined during control testing and audit testing, shall satisfy the requirements given in sub-item 6-03.3.3, table 6-03-8, table 6-03-9, table 6-03.10, table 6-03.11 and table 6-03.13.

All found faults shall be removed by the Contractor.
All costs of such works shall be at the expense of the Contractor, including all additional tests and measurements needed to be done in order to test the quality of the remedy.
All works not in accordance with the quality requirements, not remedied according to the requests of the supervising engineer shall not be paid to the Contractor.

6.03.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed and incorporated AC-WC in accordance with the design.

Defined quantities shall be paid per contracted unit price for square meter.

The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.
If the works are not completely in accordance with the GTR requirements, the quality shall be evaluated according to the sub-item 6-00.5.

Decreased value of works shall be deducted from the Contractor's contracted price of works.

6-04 WEARING COURSE OF “SPLIT MASTIC ASPHALT” (SMA –WC)

6.04.1 DESCRIPTION

Split mastic asphalt wearing course, SMA –WC ((German – Splitmastixasphalt or Stone mastic asphalt) is an asphalt layer made of a mixture of stone flour, stone grit, bitumen as binder and admixtures which prevent the runoff of binder from the stone grit particles, where the grain size distribution of stone grit is discontinuous and with considerably increased percentage of stone grit in relation to the AC-WC.

SMA – WC is intended for highways and roads of very heavy traffic load group and is divided according to the nominal grain size of stone material as follows:

- SMA 8,
- SMA 11, and
- SMA 16.

The SMA-WC thickness depends on the largest grain size in the asphalt mixture.

<table>
<thead>
<tr>
<th>Table 6-04-1</th>
<th>Technological thickness of placed SMA-WC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technological thickness of SMA-WC (mm)</strong></td>
<td></td>
</tr>
<tr>
<td>SMA 8</td>
<td>SMA 11</td>
</tr>
<tr>
<td>25 to 35</td>
<td>30 to 40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6-04-2</th>
<th>Application of SMA in relation to the traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic load group</td>
<td>Type of SMA-WC</td>
</tr>
<tr>
<td></td>
<td>SMA 8</td>
</tr>
<tr>
<td>Highways and very heavy</td>
<td>-</td>
</tr>
<tr>
<td>Heavy</td>
<td>+</td>
</tr>
</tbody>
</table>

6-04.2 QUALITY REQUIREMENTS FOR WEARING COURSE COMPONENT MATERIALS (SMA-WC)

Stone grit

Stone grit shall satisfy the requirements given in sub-item 6-00.2.2.

The following categories of stone grit, depending on the traffic load group, shall be used for execution of SMA – WC:

- Highways and roads of very heavy traffic load group: KS-E-I
- Roads of heavy traffic load group: KS-E-I and KS-E-II
Sand

Natural and crushed sand shall satisfy the requirements given in sub-item 6-00.2.4. For execution of the SMA-WC, depending on the traffic load group, the following categories of sand are used:

- Highways and roads of very heavy traffic load group: DP02-E-I
- Roads of heavy traffic load group: DP02-E-I, DP02-E-II

Stone flour

Stone flour shall satisfy the requirements given in sub-item 6-00.2.5. Stone flour of KB-I category only shall be used for highways and roads with very heavy and heavy traffic load. Use of return filler shall not be allowed.

Bitumen binder

When choosing the type of bitumen care shall be taken about the type and intended use of asphalt mixture, and on the climatic zones, according to the HRN U.J5.600.

Road construction bitumen BIT 45 and BIT 60 shall be used as binder, quality according to HRN U.M3.010 standard, or bitumen mark 35/50 and 50/70 according to the EN 12591 standard.

Road construction bitumen shall satisfy the quality requirements given in sub-item 6-00.2.6.

Polymer modified bitumen (PmB) shall satisfy the quality requirements given in sub-item 6-00.2.7.

6-04.3 WEARING COURSE QUALITY REQUIREMENTS (SMA-WC)

6-04.3.1 Composition of asphalt mixture

Table 6-04-3 Grain size distribution of asphalt mixture stone mix for SMA-WC

<table>
<thead>
<tr>
<th>Square mash openings, screen, mm</th>
<th>Type of SMA-WC</th>
<th>Fall through screen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMA 8</td>
<td>SMA 11</td>
</tr>
<tr>
<td>0,09</td>
<td>9 to 13</td>
<td>9 to 13</td>
</tr>
<tr>
<td>0,25</td>
<td>10 to 20</td>
<td>11 to 18</td>
</tr>
<tr>
<td>0,71</td>
<td>13 to 25</td>
<td>14 to 22</td>
</tr>
<tr>
<td>2,0</td>
<td>20 to 30</td>
<td>19 to 27</td>
</tr>
<tr>
<td>4,0</td>
<td>30 to 45</td>
<td>25 to 35</td>
</tr>
<tr>
<td>8,0</td>
<td>90 to 100</td>
<td>42 to 57</td>
</tr>
<tr>
<td>11,2</td>
<td>100</td>
<td>90 to 100</td>
</tr>
<tr>
<td>16,0</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>22,4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6-04-4  Rough estimate of bitumen content in asphalt mixture for SMA-WC

<table>
<thead>
<tr>
<th>Type of SMA-WC</th>
<th>Percentage of bitumen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMA 8</td>
<td>6,8</td>
</tr>
<tr>
<td>SMA 11</td>
<td>6,5</td>
</tr>
<tr>
<td>SMA 16</td>
<td>6,0</td>
</tr>
</tbody>
</table>

Exact percentage of bitumen is determined by the initial job mix formula and the confirmed job mix formula.

Quantity of “stabilizing” admixtures to the asphalt mixture which prevent the runoff of binder from the stone grit particles, is roughly 0,3 to 1,5% (m/m) of asphalt mixture.

The exact percentage of admixtures is determined by testing the “runoff” of binder according to the ALPA-StB, Teil 2, and shall satisfy the requirement of maximum 0,3% of “runoff” binder.

6-04.3.2 Asphalt mixture properties

Table 6-04.5  Physico-mechanical properties of asphalt mixture for AMS-WC

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Percentage of voids, % (V/V)</td>
<td>3 to 5</td>
</tr>
<tr>
<td>Filling of stone grit voids by bitumen, %</td>
<td>74 to 84</td>
</tr>
</tbody>
</table>

6-04.3.3 Properties of placed course

Table 6-04-6  Percentage of voids, rate of compactness, thickness and adhesiveness of SMA-WC, tested on samples taken from the placed course

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
</tr>
<tr>
<td>Percentage of voids, % (V/V)</td>
<td>3 to 7</td>
</tr>
<tr>
<td>Rate of compactness, %</td>
<td>98</td>
</tr>
<tr>
<td>Thickness *</td>
<td></td>
</tr>
<tr>
<td>-individually, maximum, %</td>
<td>- 15 from designed</td>
</tr>
<tr>
<td>-mean value, maximum, %</td>
<td>- 5 from designed</td>
</tr>
<tr>
<td>Bonding of coursed, minimum, N/mm²</td>
<td>1,0 (1,5)**</td>
</tr>
</tbody>
</table>

* Thickness greater than 15% from the designed shall not be taken in the mean thickness calculation.
** In case when the base is sprayed with polymer bitumen emulsion
Table 6-04-7  Evenness, height, cross fall and horizontal position of placed SMA-WC in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways and very heavy</td>
<td>Heavy</td>
<td></td>
</tr>
<tr>
<td>Evenness of course:</td>
<td>1</td>
<td>1,5</td>
<td></td>
</tr>
<tr>
<td>IRI(100), maximum, m/km</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Measuring staff 3 m, maximum, mm</td>
<td>± 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of course:</td>
<td>from designed elevation position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowed elevation deviation, maximum %</td>
<td>± 0,4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross fall:</td>
<td>from designed cross fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (each profile), maximum, %% (aps.)</td>
<td>± 25 from designed elevation position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position:</td>
<td>± 25 from designed elevation position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge), maximum, mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adhesiveness of the SMA-WC shall be in accordance with the requirements given in sub-item 6-03.3.3.

6-04.4  PLACING OF THE WEARING COURSE (SMA-WC)

Production of asphalt mixture for SMA-WC is allowed only on discontinuous asphalt mixture production plants with compulsory use of respective size screen.

The production process shall be automatic.

Admixtures in the form of fibers or granules shall be protected from possible contamination and moisture and shall be added to the production process gravimetrically or volumetrically.

The period of mixture shall be so adjusted to allow unified distribution of admixtures and unified coating of stone material by bitumen.

The SMA-WC asphalt mixture is mechanically placed, by finishers with a high degree of pre-compression, uniformly along the complete width of the finisher.

Manual throwing of asphalt on the already placed course is not allowed.

Placement of asphalt mixture at air and road base temperature lower than 10°C shall not be allowed.

Asphalt mixture temperature during spreading by finishers shall not be lower than 150°C.

Speed of placing shall be adjusted to the production capacity and transport of asphalt mixture and the placement shall be uniform without interruptions.

Rolling of asphalt mixture shall be done by three wheel rollers total mass 10 tons. Use of combination rollers or rubber tyred roller shall not be allowed.

In order to achieve the necessary initial degree of pavement adhesion, the asphalt layer is blinded by igneous stone grit during the process, size 2/4 mm, in the
amount of 1 to 2 kg/m². The grit is mechanically sprinkled, with machines that enable a unified distribution of material. The blinding shall be done during the final rolling.

The process of blinding shall be determined on the trial section.

The SMA –WC asphalt course shall not be opened for traffic at least 12 hours after the completion of the process.

Everything else shall be in accordance with the requirements given in sub-item 6-00.3 of these GTR.

6-04.5 QUALITY CONTROL OF SMA-WC

6-04.5.1 Preliminary testing

Activities prior to the start of asphalt works, with respect to preliminary testing of material usability, initial job mix formula, confirmed job mix formula and trial section shall be done in accordance with sub-item 6-00.4.1.1; 6-00.4.1.2; 6-00.4.1.3 and 6-00.4.1.4.

During the production of initial job mix formula for asphalt mixtures intended for highways and roads of very heavy traffic load, the asphalt mixture shall be tested for resistance to permanent deformations (standard EN 12697-22 or EN 12697 – 25) and to resistance against influence of water (EN 12697-12)

6-04.5.2 Control testing

Control testing of component materials

Control testing of component materials shall be done in accordance with sub-item 6.00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Samples of asphalt mixture shall be taken at the production plant and at the placing site. Asphalt mixture composition is tested with at least one sample for every 300 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Physical and mechanical properties of asphalt mixture shall be tested by at least one sample for every 500 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Control testing of placed asphalt mixture

Control testing of the course placing works shall be in accordance with sub-item 6-00.4.2.1.
6-04.5.3 Audit testing

Audit testing of component materials

Samples of component materials for asphalt mixture production shall be taken at the asphalt mixture production plant and tested in accordance with sub-item 6-00.4.2.2. of these GTR.

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing are usually taken at the asphalt mixture placing site.

Composition and physical and mechanical properties of asphalt mixture shall be tested for every 1000 tons of produced asphalt mixture. Properties in accordance with sub-item 6-00.4.2.2 shall be tested.

Change of extracted binder properties shall be tested at every 2000 tons of produced asphalt mixture, in accordance with sub-item 6-00.4.2.2.

Audit testing of placed course

Rate of compactness, percentage of voids, thickness and bonding of placed course shall be tested of samples taken at least every 2000 m² of placed course surface according to sub-item 6-00-4-2-2.

Evenness of placed course shall be tested in accordance with sub-item 6-00.4.2.2.

Height, cross fall and position of placed layer shall be tested by special measuring device, checking at least 20% data collected by the Contractor during control testing of asphalt mixture placing, according to sub-item 6-00.4.2.1.

Adhesiveness of the wearing course surface shall be tested in accordance with the sub-item 6-00.4.2.2 with at least one sample every 10 000 m² of placed wearing course.

6.04.6 QUALITY EVALUATION OF PLACED WEARING COURSE SMA-WC

Placed wearing course SMA-WC shall be evaluated and taken over by the supervising engineer on the basis of results of control testing and audit testing.

Percentage of bitumen determined by samples of asphalt mixture, as part of the audit testing and control testing, shall be in accordance with sub-item 6-00.4.1, table 6-00-23.

Grain site distribution of asphalt mix determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in table 6-04.3 and sub-item 6-00.4.1, table 6-00.22.

Physical and mechanical properties of asphalt mixture determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in sub-item 6-04.3.2, table 6-04-5.
Properties of placed asphalt course determined during control testing and audit testing, shall satisfy the requirements given in sub-item 6-04.3.3, table 6-04-6, table 6-04-7, table 6-03.10, table 6-03-11, 6-03-12 and table 6-03.13 of subsection 6-03.

All found faults shall be removed by the Contractor.

All costs of such works shall be at the expense of the Contractor, including all additional tests and measurements needed to be done in order to test the quality of the remedy.

All works not in accordance with the quality requirements, not remedied according to the requests of the supervising engineer shall not be paid to the Contractor.

6.04.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed and incorporated SMA-WC in accordance with the design.

Defined quantities shall be paid per contracted unit price for square meter.

The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.

If the works are not completely in accordance with the GTR requirements, the quality shall be evaluated according to the sub-item 6-00.5.

Decreased value of works shall be deducted from the Contractor's contracted price of works.

6-05 MICRO – ASPHALT

6-05.1 DESCRIPTION

The micro-asphalt mixture, produced by cold procedure, consists of a stone grit and crushed sand mixture of defined grain size distribution, polymer bitumen emulsion and admixtures regulating the speed of bitumen emulsion “breaking”.

According to the nominal grain size of stone material, the micro-asphalt is divided as follows:

- MA 4,
- MA 8, and
- MA 11.

Micro-asphalt belongs to a group of thin-layered coatings placed on an asphalt or concrete base of roads belonging to all traffic load groups, in order to improve the driving characteristics and protect the penetration of water into the pavement structure.

The thin-layered micro-asphalt coating is placed only on previously prepared homogenized base (remedied cracks, pot holes etc.). The thin-layered micro-asphalt coating is placed in the amount of 10-30 kg/m² (taking into consideration dry mixture).
6-05.2 QUALITY REQUIREMENTS OF COMPONENT MATERIALS FOR MICRO-ASPHALT

Stone grit

Stone grit shall be in accordance with the quality requirements given in sub-item 6-00.2.2.

<table>
<thead>
<tr>
<th>Table 6-05.1 Use of stone grit for micro-asphalt according to quality category and depending on the traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic load groups</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>KS-E-I</td>
</tr>
<tr>
<td>KS-E-II</td>
</tr>
<tr>
<td>KS-E-III</td>
</tr>
<tr>
<td>KS-S-I</td>
</tr>
</tbody>
</table>

Sand

Crushed sand shall satisfy the quality requirements given in sub-item 6-00.2.4. Only crushed sand of 0/2 mm of silicate or carbonate composition shall be used for micro-asphalt on roads intended for very heavy, heavy and medium traffic load. Filler from crushed sand shall not contain organic impurities.

Bitumen binder

Cationic semi-stable polymer bitumen emulsion quality given in sub-item 6-00.2.9 of these GTR shall be used as binder. For micro-asphalt on roads of medium, light and very light traffic load ordinary cationic semi-stable emulsion shall be used of quality according to the HRN U:M3.024 standard.

Admixtures

Water of quality similar to potable water is used for micro-asphalt production.

Cement or hydralime of standard properties shall also be used.

6-05.3 QUALITY REQUIREMENTS FOR MICRO-ASPHALT

6-05.3.1 Asphalt mixture composition

<table>
<thead>
<tr>
<th>Table 6-05.2 Grain size distribution of micro-asphalt mixture stone mix depending on the type of micro-asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square mash opening, screen, (mm)</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0,09</td>
</tr>
<tr>
<td>0,25</td>
</tr>
<tr>
<td>0,71</td>
</tr>
<tr>
<td>2,0</td>
</tr>
<tr>
<td>4,0</td>
</tr>
<tr>
<td>8,0</td>
</tr>
<tr>
<td>11,2</td>
</tr>
<tr>
<td>16,0</td>
</tr>
</tbody>
</table>
Table 6-05-3  Rough estimate of bitumen content in micro-asphalt mixture

<table>
<thead>
<tr>
<th>Type of micro-asphalt</th>
<th>Percentage of bitumen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 4</td>
<td>6.5 to 8.0</td>
</tr>
<tr>
<td>MA 8</td>
<td>5.5 to 0.0</td>
</tr>
<tr>
<td>MA 11</td>
<td>4.5 to</td>
</tr>
</tbody>
</table>

Bitumen content in micro-asphalt mixture (after separation of water and emulsion) shall be proportioned to reach optimum properties of micro-asphalt mixture (voids in the sample according to Marshall from 6 to 9% (V/V)). The exact percentage of bitumen, i.e. bitumen emulsion of defined composition in the micro-asphalt mixture shall be defined by initial job mix formula of micro-asphalt mixture.

6-05.3.2 Properties of placed course

Course thickness

The thickness of the placed micro-asphalt is defined by the type of micro-asphalt used.

Course evenness

Surface of placed micro-asphalt depends on the evenness of the base and shall deviate 6 mm maximum from the reference value of the measuring staff 3 m long.

Resistance to slipperiness

Surface of executed thin wearing course made on the basis of micro-asphalt shall be rough and resistant to slipperiness. Resistance to slipperiness is measured by an apparatus with pendulum according to the procedure described in the HRN C4.018 standard, at earliest 6 and at latest 10 weeks after the road is opened for traffic.

Resistance to slipperiness shall not be less than 60 SRT units.

Bonding of layers

Bonding strength between the micro-asphalt coating and base shall be at least 0.5 N/mm², and is measured at earliest 6 and at latest 10 weeks after the road is opened for traffic.

Strength of binder is determined by samples diameter 100 mm at temperature of 10 ± 0.5°C, using a tension apparatus “class 2” or more, according to the DIN 51 220 standard, at load velocity of 0.025 N/mm²/s.

6-05.4 PLACING OF MICRO-ASPHALT

Production

Stone material mixture of defined grain size distribution is prepared by mixing of fractions in defined proportions according to the initial job mix formula. After mixing, the mixture is transported to the self-propelled machine where stone
material, bitumen emulsion and admixtures are prepared (emulsion stabilizer, cement, hydralime, water).

Road base

The base on which micro-asphalt is placed shall be completely clean of all loose stone material grains and earth. In case of extremely dirty surface, a machine with water pressure of 80 to 150 bars shall be used. Prior to placing of micro-asphalt the existing pavement shall be repaired (profile correction, pot holes, tire marks, cracks etc) in order to reach a good base for micro-asphalt.

Surface on which the micro-asphalt is placed shall be clean and moist but not wet. In case of extremely dry weather and high air and base temperatures, the base shall be slightly moistened.

Spreading

Micro-asphalt mixture is spread by machinery which enables a homogenous micro-asphalt mixture placed into a thin wearing course of defined width and height, as well as of a homogenous surface appearance.

After placing the micro-asphalt as a thin wearing course no additional treatment shall be necessary.

Placement shall not be allowed in case of rainy weather or air temperatures below +10°C.

Road can be opened for traffic one hour after placing the micro-asphalt.

6-05.5 QUALITY CONTROL OF MICRO-ASPHALT

6-05.5.1 Preliminary testing

Activities prior to the start of asphalt works, with respect to preliminary testing of the usability of materials for surfacing are done in accordance with provisions given in sub-item 6-00.4.1.

Micro-asphalt surface on the first working day presents the trial section where three samples of asphalt mixture shall be taken in order to determine the grain size distribution, percentage of binder and percentage of micro-asphalt voids.

Two samples shall be tested as part of the control testing and on as part of audit testing. The medium value of parameters from all three samples represent the characteristics of produced micro-asphalt.

Individual values of percentage of binder shall not deviate for more than ±0,5 % (m/m) from the values proposed by initial job mix formula, and the medium value shall not deviate for more than ±0,2 % (m/m).

Individual values of the percentage of filler shall not deviate for more than +4,0% (m/m) and not more than –2,0% (m/m) from the values proposed by initial job mix formula.
6-05.5.2 Control testing

Control testing of component materials

Control testing of component materials for micro-asphalt is done according to the sub-item 6-00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Sampling of micro-asphalt in order to determine the percentage of binder and the grain size distribution of stone mix shall be done in accordance with the EN 12274-1 standard.

The asphalt mixture composition is checked by testing at least one sample daily, testing the percentage of binder and the grain size distribution of stone mix, according to the sub-item 6-00.4.2.1 of these GTR.

Control testing of placed asphalt mixture

Control testing of placed micro-asphalt includes:

- Control of quantity of placed asphalt,
- Visual evaluation of the homogeneity of asphalt mixture,
- Visual evaluation of the speed of "breaking" of emulsion,
- Visual control of longitudinal and transverse joints.
- Control of the surface evenness.

Control of the quantity of placed micro-asphalt shall be done in accordance with the EN 12274-6 standard.

6-05.5.3 Audit testing

Audit testing of component materials

Samples of component materials for micro-asphalt production shall be taken at the stone mix production plant, i.e at the site, and tested in accordance with sub-item 6-00.4.2.2. of these GTR.

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing as usually taken at the asphalt mixture placing site.

Micro-asphalt is sampled according to the EN 12274-1 standard.

Composition and physical and mechanical properties of asphalt mixture shall be tested for every 6000 m² of placed course surface or for every 200 tons of produced micro-asphalt.

Binder content, grain size distribution of stone mix and percentage of voids in the sample according to Marshall shall be tested, in accordance with sub-item 6-00.4.2.2.
Audit testing of placed course

Evenness of placed course shall be tested in accordance with sub-item 6-00.4.2.2.

Adhesion of micro-asphalt shall be tested with a pendulum apparatus at every 1000 m of placed surface in accordance with the sub-item 6-00.4.2.2.

Binding and adhesion of micro-asphalt shall be tested at every 1000 m of placed surface according to provisions given in sub-item 6-05.3.2.

Points for testing the binding and adhesion are determined by the method of random numbers.

6.05.6 QUALITY EVALUATION OF PLACED MICRO-ASPHALT

Placed micro-asphalt shall be evaluated and taken over by the supervising engineer on the basis of results of control testing and audit testing.

Percentage of bitumen determined by samples of asphalt mixture, as part of the audit testing and control testing, shall be in accordance with sub-item 6-05.4.

Table 6-05-4

<table>
<thead>
<tr>
<th>Number of tested samples</th>
<th>1</th>
<th>2</th>
<th>3 do 4</th>
<th>5 do 8</th>
<th>9 do 19</th>
<th>≥ 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowed deviation, % (m/m)</td>
<td>± 0,50</td>
<td>± 0,45</td>
<td>± 0,40</td>
<td>± 0,35</td>
<td>± 0,30</td>
<td>± 0,25</td>
</tr>
</tbody>
</table>

Grain size distribution of asphalt mix, determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in table 6-05-2.

Properties of placed asphalt mixture shall be in accordance with requirements given in sub-item 6-05.3.2.

All found faults shall be removed by the Contractor.

All costs of such works shall be at the expense of the Contractor, including all additional tests and measurements needed to be done in order to test the quality of the remedy.

All works not in accordance with the quality requirements, not remedied according to the requests of the supervising engineer shall not be paid to the Contractor.

6.05.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed and incorporated micro-asphalt according to the design. Defined quantities shall be paid per contracted unit price for square meter.
ASPHALT PAVEMENT SURFACING

The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.

6-06 SURFACE DRESSING

6-06.1 DESCRIPTION

Surface dressings are thin layered asphalt coatings executed by spraying of base by bitumen binder, blinding by bitumen coated or non-coated stone grit and by rolling. Surface dressing is not a separate pavement surfacing course, a part of the pavement structure but id applied for the following reasons:

- Protection of pavement from water penetration,
- Rehabilitation of worn surface of the wearing course,
- Improvement of driving and safety characteristics of the wearing course (drainage, adhesiveness),
- Execution of temporary wearing course (stage of construction),
- Protection and enrichment of concrete pavement,
- Execution of new roads of light and very light traffic load.

Depending on the means of execution, surface dressing is divided as follows:

- Single seal,
- Single seal with double blinding,
- Double seal,
- Surface dressing with previous blinding ("sandwich" treatment)

Single seal

Single seal consists of a layer of sprayed bitumen binder over which stone grit of smaller grain size is spread. Stone grit fraction 4/8 or 8/11 mm shall be used, depending on the hardness of the base and the traffic intensity.

Single seal with double blinding

Single seal with double blinding consists of a layer of sprayed bitumen binder over which stone grit of larger grain size is spread (8/11 or 11/16) and immediately after that a smaller fraction stone grit (2/4 or 4/8 mm), in the amount sufficient to fill the space between the larger size grains.

Double seal

Double seal consists of a layer of sprayed bitumen binder over which stone grit is spread, granulation 8/11 mm. This layer of stone grit shall be sprayed by bitumen binder and covered with a layer of stone grit, grain size 2/4 mm. The order in which stone grit shall be spread, with respect to the grain size of fraction used, can be reversed.

Surface dressing with previous blinding ("sandwich" treatment)

This surface dressing consists of previously spread layer of stone grit on a base, larger fraction size – 8/11 mm or 11/16 mm, over which the single or double seal is executed.
Table 6-06-1 Application of quality categories of stone grit for surface dressing, depending on the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Very heavy</th>
<th>Heavy and medium</th>
<th>Light and very light</th>
</tr>
</thead>
</table>

6-06.2 QUALITY REQUIREMENTS FOR COMPONENT MATERIALS OF SURFACE DRESSING

Stone grit

Quality category of stone grit used for surface dressing, in relation to the traffic load group is given in table 6-06.1.

Bitumen binder

Cationic unstable emulsions, polymer modified cationic unstable emulsions and polymer modified bitumen shall be used for surface dressing. In order to improve the binder adhesiveness to stone grit, respective admixtures are applied, according to need. In case polymer modified bitumen is used, bitumen coated stone grit shall be also used (0.6 – 0.8% (m/m) BIT 45) in order to improve the adhesion.

Quality requirements of bitumen binder for surface dressing are given in sub-item 6-00.2.10.

6-06.3 QUALITY REQUIREMENTS FOR SURFACE DRESSING

Surface dressing shall have an unified and homogenous texture (mosaic) along its complete surface, and this shall be obtained by unified feeding of bitumen binder and stone grit.

Feeding of component materials

Table 6-06-2 Rough estimates of bitumen binder and stone grit fractions

<table>
<thead>
<tr>
<th>Type of binder</th>
<th>Layer</th>
<th>Feeding of binder (kg/m²)</th>
<th>Feeding of stone grit (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2/4</td>
<td>4/8</td>
</tr>
<tr>
<td>SINGLE SEAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65% polymer modified bitumen emulsion</td>
<td>1. sloj</td>
<td>1.2 – 1.7</td>
<td>7 - 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 – 2.0</td>
<td>10 - 17</td>
</tr>
<tr>
<td>Polymer modified bitumen PmB</td>
<td>1. sloj</td>
<td>0.8 – 1.1</td>
<td>7 - 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0 – 1.3</td>
<td>10 - 17</td>
</tr>
<tr>
<td>65% polymer modified bitumen emulsion</td>
<td>2. sloj</td>
<td>1.2 - 1.6</td>
<td>3 - 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11 - 16</td>
<td>15 - 20</td>
</tr>
</tbody>
</table>

SINGLE SEAL WITH DOUBLE BLINDING

<table>
<thead>
<tr>
<th>Type of binder</th>
<th>Layer</th>
<th>Feeding of binder (kg/m²)</th>
<th>Feeding of stone grit (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2/4</td>
<td>4/8</td>
</tr>
<tr>
<td>65% polymer modified bitumen emulsion</td>
<td>1. sloj</td>
<td>1.8 – 2.2</td>
<td>11 - 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. sloj</td>
<td>3 - 8</td>
</tr>
<tr>
<td>1. sloj</td>
<td>2. sloj</td>
<td>2.0 do 2.6</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Polymer modified bitumen PmB</td>
<td>1. sloj</td>
<td>1.2 – 1.5</td>
<td>11 - 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. sloj</td>
<td>3 - 8</td>
</tr>
<tr>
<td>1. sloj</td>
<td>2. sloj</td>
<td>1.4 – 1.8</td>
<td>4 - 8</td>
</tr>
<tr>
<td>1. sloj</td>
<td>2. sloj</td>
<td>15 - 20</td>
<td></td>
</tr>
</tbody>
</table>

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The exact quantity of bitumen binder and stone grit are specially defined for each road section.

Quantity of bitumen binder and stone grit can deviate from the designed and contracted quantity maximum ± 5%.

The variation coefficient for transversal distribution of bitumen binder and stone grit shall not be greater than 10%.

Properties of placed course

Table 6-06-3  Evenness, height, cross fall and horizontal position of placed surface dressing in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very heavy and heavy</td>
</tr>
<tr>
<td>Evenness of layer: Measuring staff 3 m, maximum, mm</td>
<td>6</td>
</tr>
<tr>
<td>Cross fall: Allowed deviation from the designed cross fall (each profile), maximum, % (aps.)</td>
<td>± 0.4 from the designed cross fall</td>
</tr>
<tr>
<td>Position: Allowed deviation (horizontal position of left and right edge), maximum, mm</td>
<td>± 25 from the designed elevation position</td>
</tr>
</tbody>
</table>

6-06.4 EXECUTION OF SURFACE DRESSING

Machinery

The following machines are used for execution of surface dressing:

- Motor sprinkler
- Gritter
- Rollers
- Power broom
Motor sprinklers shall be constructed in a way that enables uniform distribution of bitumen binder longitudinally and transversally, considering the optimal temperature of chosen binder.

The gritter shall evenly distribute the chosen quantity of stone grit fractions on the surface in the required density.

Rubber tyred rollers and combined rollers are used for execution of surface dressing. The rollers shall be between 10 and 30 tons and pressure in the tyres as high as possible.

Rotational brooms are used for surface cleaning before execution of surface dressing (rough) as well as for removal of loose grains after surface dressing (soft fiber brooms. Rotational brooms – vacuum cleaners shall be used.

Weather conditions

Surface dressing shall be executed only under favorable weather conditions, from mid May to mid September. Surface dressing shall not be placed on wet pavements and air and surface temperatures lower than 15°C, and relative humidity above 75%.

Surface dressing shall be completed at least three hours before sun-down. Surface dressing works shall commence in the period of stable weather. In case of surface damage due to rain during the first 24 hours, the Contractor shall remedy the damaged surface and execute a new surface dressing at his expense.

Surface

Faults on the existing pavement (profile corrections, discharges, cracks, ruts, pot holes etc.) shall be remedied at least one month prior to surface dressing, so that the surface would be uniform under the influence of traffic, and enable an even and effective adhesion of surface dressing.

Spraying of bitumen binder shall commence immediately after cleaning.

The binder shall have optimal viscosity and can, according to need, be heated.

Polymer bitumen emulsions are heated up to 75°C, and polymer bitumen up to 175°C.

Care shall be taken about the weather conditions at the time of start of works <8 cold and moist pavement early in the morning).

Connection joints

Each interruption in work of the motor sprinkler causes an uneven feeding of the binder during start-up, therefore a paper tape shall be used during execution of transverse joint.

In order to enable uniform feeding of binder during execution of longitudinal joints the end nozzles shall be adjusted to that the total quantity of binder at the longitudinal joint is the same as on the rest of the pavement surface. Before spraying the second lane, loose grains from spreading on the first lane shall be removed from the expansion joints.
Surface dressing shall be completed along the complete pavement width until the end of the day.

Longitudinal joints shall overlap only with traffic lane edges.

**Spreading of stone grit**

Spreading of stone grit shall be done immediately after binder spraying. This is especially important when using hot binder, when this distance interval shall not be more than 10 meters.

Distance between spreading of binder and stone grit, when using bitumen emulsion shall not be more than 30 meters.

Second blinding with stone grit shall be done as soon as possible, immediately after the roller on first blinding.

Special attention shall be paid to the transverse and longitudinal joints.

**Rolling**

By passing of the roller, the first composition of the “mosaic” shall appear, and its final shape or appearance shall emerge after several days of traffic. After the first blinding with stone grit, the surface is rolled 1-2 times. The first rolling shall be done as soon as possible after spreading of stone grit. After the second blinding, 3 to 5 runs of a rubber tyre roller are sufficient to obtain a correct position of the stone grit particles. The speed of the roller shall be limited to 8-10 km/h.

**Opening for traffic**

Opening for traffic of a freshly treated surface is a critical moment considering that it is still not stabilized and it could be damaged. Therefore it is necessary to limit the speed to the lowest possible (maximum 30 km/h). This traffic regime shall be in force for several hours. During this time, traffic shall be directed over the complete surface in order to obtain an uniform surface texture. During the second day, driving speed should be limited to 50 km/h. After removal of loose grains, the following day a normal traffic regime shall be maintained on the road. After several days subsequently fallen out grains shall be removed.

6-06.5 **QUALITY CONTROL OF SURFACE DRESSING**

6-06.5.1 Preliminary testing of material

Activities prior to the start of asphalt works, with respect to preliminary resting of material usability, shall be done in accordance with provisions given in sub-item 6-00.4.1.1.

6-06.5.2 Design of surface dressing

Design of surface dressing consists of the choice of quality, size and quantity of stone grit, as well as the quality and quantity of binder, aimed at obtaining a wearing pavement surface that will be resistant to total usability requirements.
Designed composition of surface dressing shall contain the following information:

a) type of surface dressing,
b) binder

- type of binder,
- binder storage temperature,
- binder spraying temperature,
- quantity and order of binder spraying (kg/m²)

c) stone grit

- type of stone grit,
- stone grit fractions (grain size of blinder),
- quantity and order of stone grit spreading (kg/m² or l/m²),

d) admixtures for improvement of adhesion

- type and quantity of admixtures,
- means of application of admixtures,

Surface dressing is designed separately for each section.

6-06.5.3 Trial section

Trial sections confirm the quality of designed surface dressing and the complete technological process of surface dressing execution.

Trial section confirms:

- Binder proportioning,
- Stone grit proportioning,
- Means of rolling,
- Means of cleaning of loose grains,
- Conditions for opening for traffic

6-06.5.4 Control testing

Control testing of component materials

Control testing of component materials for surface dressing are done according to sub-item 6-00.4.2.1 and these GTR.

Control testing of surface dressing execution

The Contractor shall conduct control testing and control of surface dressing execution.

The control includes the following:

- Installation and maintenance of road markings,
- Preparation of surface (cleaning),
- Follow-up of weather conditions,
• Execution of individual phases of work (proportioning and spreading of individual components),
• Rolling (number of passes, regime of rolling, speed),
• Organization of opening for traffic procedure.

The accepted average proportioning values are checked by a quick control of the mass of used binder as well as the mass and volume of stone grit at minimum 1000 m$^2$ of executed surface or two times a day.

Notes on the results of control testing shall be submitted by the Contractor to the supervising engineer.

6-06-5-5 Audit testing

Audit testing of component materials

Samples of component materials for surface dressing are taken at the site and tested in accordance with provisions given in sub-item 6-00.4.2.2. of these GTR.

Control testing of surface dressing execution

Control of bitumen binder and stone grit proportioning is done at least once at every 6000 m$^2$ of executed surface dressing.

Evenness, cross fall and position of joints is tested on executed surface dressing, in accordance with provisions given in sub-item 6-00.4.2.2 of these GTR.

6-06.6 QUALITY EVALUATION OF EXECUTED SURFACE DRESSING

Executed surface dressing shall be evaluated and taken over by the supervising engineer on the basis of the control testing and audit testing results.

Final evaluation of the executed surface dressing shall be given 25 to 35 days after completion of work, in accordance with the EN 12272-2 standard. All found faults according to these standards and the request of the supervising engineer shall be remedied by the Contractor.

All costs of remedy shall be at the expense of the Contractor, including all additional testing and measuring necessary to prove the quality of improvement.

All works not in accordance with the set quality requirements and not improved by the Contractor at the request of the supervising engineer, shall not be paid to the Contractor.

6-06.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed surface dressing in accordance with the design and the GTR.
Defined quantities shall be paid per contracted unit price for square meter.

The price includes all costs of material supply, production and placing of surface dressing, transport, equipment all everything else needed to complete the works.

6-07 Poured Asphalt

6-07.1 Description

Asphalt courses executed according to the hot procedure, by pouring, are made of a mixture of stone flour, stone material and bitumen as binder where the percentage of bitumen mortar is greater than the available space in a maximum compacted stone skeleton.

Asphalt courses made by pouring can be placed on an asphalt or concrete base.

Asphalt mixtures for production of poured asphalt are divided according to the nominal grain size of stone material and the grain size distribution of stone mix as follows:

- Poured asphalt (PA): asphalt mixtures with percentage of stone grit from 30 to 40 % (m/m), and grains of largest nominal size 4 and 8 mm (PA 4 and PA 8) and
- Heavy poured asphalt (HPA); asphalt mixtures with percentage of stone grit above 40% (m/m) and grains of maximum rated size of 11 mm (HPA 11)

Table 6-07-1  Technological thickness of placed wearing and blanket course

<table>
<thead>
<tr>
<th>Type of asphalt mixture</th>
<th>Technological thickness of course, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 4</td>
<td>20 to 25</td>
</tr>
<tr>
<td>PA 8</td>
<td>25 to 35</td>
</tr>
<tr>
<td>HPA 11</td>
<td>35 to 40</td>
</tr>
</tbody>
</table>

Poured asphalt PA8 and heavy poured asphalt HPA 11 are used for wearing courses of traffic and parking areas and for water-proofing blanket courses on bridges and viaducts.

The poured asphalt PA 4 is used for execution of wearing courses on pedestrian lanes.

6-07.2 Quality Requirements of Component Materials for Poured Asphalt

Stone grit

Stone grit shall satisfy the quality requirements given in sub-item 6-00.2.2.
Table 6-07-2  Stone grit quality category used for poured asphalt in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highways and very heavy</th>
<th>Heavy</th>
<th>Medium and wearing course</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS-E-II</td>
<td>KS-E-II</td>
<td>KS-E-II</td>
<td>KS-E-II</td>
<td>KS-E-II</td>
</tr>
<tr>
<td>KS-S-I</td>
<td>KS-S-I</td>
<td>KS-S-II</td>
<td>KS-S-II</td>
<td></td>
</tr>
</tbody>
</table>

Sand

Natural and crushed sand shall satisfy the requirements given in sub-item 6-00.2.4.

Table 6-07-3  Sand quality category used for poured asphalt in relation to the traffic load group

<table>
<thead>
<tr>
<th>Traffic load group</th>
<th>Highways and very heavy</th>
<th>Heavy</th>
<th>Medium and wearing course</th>
<th>Light and very light</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP02-E-I</td>
<td>DP02-E-I</td>
<td>All categories of crushed sand of igneous and sedimentary origin and all categories of natural sand, ratio 1:1 in relation to crushed sand</td>
<td>All categories of crushed sand of igneous and sedimentary origin and all categories of natural sand</td>
<td></td>
</tr>
<tr>
<td>DP02-E-II</td>
<td>DP02-E-II</td>
<td>DP01-S</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DP02-S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stone flour

Stone flour shall be in accordance with the requirements given in sub-item 6-00.2.5.

For roads of very heavy and heavy traffic load, and for the waterproofing protection course, stone flour of category KB-I shall be used.

Bitumen binder

Road construction bitumen BIT 45 or BIT 25 shall be used for production of poured asphalt, according to the HRN U,M3.010 standard, i.e. bitumen 35/50 or 20/30 according to the EN 12591 standard, and shall satisfy the quality requirements given in sub-item 6-00.2.6.

For production of poured asphalt used for surfaces with special traffic load as well as for execution of waterproofing protective course of slabs on bridges and viaducts, polymer modified bitumen shall be used type PmB 30/50-58 or PmB 10/40-63, and shall satisfy the quality requirements given in sub-item 6-00.2.7.

Road construction bitumen can be improved not only by synthetic polymers but also by addition of a certain quantity of natural asphalt, on the basis of preliminary laboratory tests.
6-07.3 QUALITY REQUIREMENTS FOR Poured ASPHALT

6-07.3.1 Composition of asphalt mixture

Percentage of bitumen binder in poured asphalt shall be so proportioned to completely fill the inter-granular voids in stone mix and satisfy the requirement of sinking given in table 6-07-6.

Table 6-07-4 Grain size distribution of stone mix for poured and heavy poured asphalt

<table>
<thead>
<tr>
<th>Square mesh opening, screen, mm</th>
<th>Type of asphalt mixture</th>
<th>Fall through screen, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09</td>
<td>PA 4</td>
<td>32 to 46</td>
</tr>
<tr>
<td>0.25</td>
<td>PA 8</td>
<td>22 to 32</td>
</tr>
<tr>
<td>0.71</td>
<td>HPA 11</td>
<td>19 to 29</td>
</tr>
<tr>
<td>2.0</td>
<td>PA 4</td>
<td>49 to 64</td>
</tr>
<tr>
<td>4.0</td>
<td>PA 8</td>
<td>36 to 46</td>
</tr>
<tr>
<td>8.0</td>
<td>HPA 11</td>
<td>27 to 32</td>
</tr>
<tr>
<td>16.0</td>
<td>PA 8 and HPA 11</td>
<td>24 to 34</td>
</tr>
</tbody>
</table>

Table 6-07-5 Rough estimate of bitumen in poured asphalt

<table>
<thead>
<tr>
<th>Type of asphalt mixture</th>
<th>Rough estimate of binder percentage, % (m/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 4</td>
<td>8.0 to 10.0</td>
</tr>
<tr>
<td>PA 8</td>
<td>7.0 to 9.0</td>
</tr>
<tr>
<td>HPA 11</td>
<td>6.0 to 7.0</td>
</tr>
</tbody>
</table>

Exact percentage of bitumen is determined by initial job mix formula and confirmed job mix formula of asphalt mixture.

6-07.3.2 Properties of asphalt mixture

Table 6-07-6 Physical and mechanical properties of asphalt mixture for poured asphalt

<table>
<thead>
<tr>
<th>Property</th>
<th>Use of asphalt course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wearing course</td>
</tr>
<tr>
<td>Depth of sinking at 40°C, mm</td>
<td>PA 4</td>
</tr>
<tr>
<td>Increase of depth of sinking, maximum, mm</td>
<td>3 to 8</td>
</tr>
<tr>
<td>0.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

6-07.3.3 Properties of placed course

Physical and mechanical properties of asphalt mixture for poured and heavy poured asphalt tested on samples taken from the placed course are shown in table 6-07-7. Evenness, height, cross fall and horizontal position of placed course are given in table 6-07-8.
Adhesiveness of placed poured asphalt wearing course shall be in accordance with requirements given in sub-item 6-03.3.3.

Table 6-07-7  Physico-mechanical properties of asphalt mixture for poured and heavy poured asphalt tested on samples taken from the placed course, thickness and adhesiveness of placed course

<table>
<thead>
<tr>
<th>Property</th>
<th>Wearing course</th>
<th>Waterproofing protective course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of sinking at 40°C, mm</td>
<td>3 to 8</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Increase of depth of sinking, maximum, mm</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Water absorption in vacuum, maximum, % (V/V)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Thickness: *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- individual, maximum, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mean value, maximum, %</td>
<td>- 15 from designed</td>
<td></td>
</tr>
<tr>
<td>Course adhesion, minimum, N/mm²</td>
<td>1,0 (1,5)**</td>
<td></td>
</tr>
</tbody>
</table>

* Thickness greater than 20% from the designed shall not be taken in the mean thickness calculation.

** In case when the base is sprayed with polymer bitumen emulsion

Table 6-07-8  Evenness, elevation, cross fall and horizontal position of placed course of poured asphalt in relation to the traffic load group

<table>
<thead>
<tr>
<th>Property</th>
<th>Traffic load group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highways</td>
</tr>
<tr>
<td>Evenness of course:</td>
<td></td>
</tr>
<tr>
<td>IRI(100), maximum, m/km</td>
<td>1,0</td>
</tr>
<tr>
<td>Measuring staff 3 m, maximum, mm</td>
<td>3</td>
</tr>
<tr>
<td>Height of course:</td>
<td></td>
</tr>
<tr>
<td>Allowed elevation deviation, maximum, %</td>
<td>± 5</td>
</tr>
<tr>
<td>Cross fall:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (each profile), maximum, % (aps.)</td>
<td>± 0,4</td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
<tr>
<td>Allowed deviation (horizontal position of left and right edge), maximum, mm</td>
<td>± 25</td>
</tr>
</tbody>
</table>

6-07.4 PRODUCTION, TRANSPORT AND PLACING OF Poured ASPHALT

Production

The material is stored at the asphalt production plant according to the provisions given in sub-item 6-00.3 of these GTR. Maximum bitumen heating temperatures stored in a reservoir are:

- For bitumen BIT 45 185°C
• For bitumen BIT 25  195 °C

If poured asphalt is produced on a standard asphalt production plant then provisions given in sub-item 6-00.3.1 are valid.
In case asphalt is produced in special boilers for poured asphalt, with a direct feeding of stored material, when proportioning the binder, moisture of stone material shall be considered.

Transport

There shall not be any segregation in the asphalt mixture during transport. Therefore transport shall be done in special boilers with constant mixing and maintenance of temperature within the limits of 200 °C to 250°C.

Placing of poured asphalt

Poured asphalt is placed by finishers or manually
Poured asphalt can be placed in several layers, under the condition that the thickness of each layer does not exceed 40 mm.
The base shall have the necessary bearing, be stable, of correct and designed gradient, of given evenness and during placing it shall be clean and dry.
When the base for poured and heavy poured asphalt is made of asphalt mixture for base and tack coats, then the percentage of voids in the placed base course shall be within the range of 6 to 9% (v/v).

If the concrete base contains expansion joints, they shall also be placed on exactly the same spots in the asphalt course and grouted with grouting mass of quality given in the HRN U.M3.095 standard.

Along the kerbs and dilatation joints a joint shall be made 20 to 25 mm, in the full asphalt course thickness and it shall be grouted with grouting mass according to the HRN U.M3.095 standard.

Asphalt mixture temperature at the site shall be within the range of 200 °C to 250°C.

Poured and heavy poured asphalt shall not be placed during rainy, humid or windy weather since this cools the mixture and the base. Placing of asphalt mixture shall be stopped when the air temperature drops bellow +5°C.
During longer interruptions, edges of the already placed course shall be vertically cut and heated before proceeding with work. The edges can also be heated so that hot asphalt mixture is placed over the already placed cold layer, width 100 to 150 mm. When the lower layer is heated up, connection between the old and the new course is done by removing the placed mixture and ironing the connection manually to the designed height.

In order to achieve the roughness of poured and heavy poured asphalt surface for the wearing course, stone grit produced of stone material of silicate origin shall be used, quality according to sub-item 6-00.2.3(2), grain size 2/4 mm in the quantity of 5 to 8 kg/m², i.e. size 4/8 mm in the quantity of 15 to 18 kg/m². Stone grit shall be coated with thin bitumen coating (~ approx. 1 to 1.5 % (m/m) of bitumen type BIT 60.)
Waterproofing protective course can be blinded with non-coated grit of carbonate composition. Stone grit is spread mechanically or manually on a still hot asphalt surface in even quantities. Stone grit is rolled by wooden or steel rollers immediately upon spreading.

6-07.5 QUALITY CONTROL OF POURED ASPHALT

6-07.5.1 Preliminary testing

Activities prior to the start of asphalt works, with respect to preliminary testing of material usability, initial job mix formula, confirmed job mix formula and trial section shall be done in accordance with sub-item 6-00.4.1.

6-07.5.2 Control testing

Control testing of component materials

Control testing of component materials for poured asphalt shall be done in accordance with sub-item 6.00.4.2.1 of these GTR.

Control testing of produced asphalt mixture

Samples of asphalt mixture shall be taken at the production plant and at the placing site.

Asphalt mixture composition is tested with at least one sample for every 250 tons of produced continuously produced asphalt mixture in the asphalt production plant, or by testing of one sample for every two boilers of produced asphalt mixture at the placing site. Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Physical and mechanical properties of asphalt mixture shall be tested by at least one sample for every 250 tons of continuously produced asphalt mixture, or by testing of one sample for each boiler produced at the placing site.

Properties in accordance with sub-item 6-00.4.2.1 shall be tested.

Control testing of placed asphalt mixture

Control testing of the course placing works shall be in accordance with sub-item 6-00.4.2.1, except the control of the rate of compactness of the course.

6-07.5.3 Audit testing

Audit testing of produced asphalt mixture

Samples of asphalt mixture for audit testing as usually taken at the asphalt mixture placing site.

Composition and physical and mechanical properties of asphalt mixture shall be tested as follows:

- For wearing courses at every 500 tons of produced asphalt mixture, and
- For waterproofing protection courses at every 500 tons of continuously produced asphalt mixture at the production plant or for every fourth boiler of asphalt mixture produced at the site.

Samples of asphalt mixture are tested for percentage of binder, grain size distribution of stone mix, physical and mechanical properties in accordance with sub-item 6-00.4.2.2.

**Audit testing of placed course**

Samples taken at every 2000 m of placed course surface, properties given in sub-item 6-00.4.2.2 are tested, except the rate of compactness. Instead of percentage of voids, absorption of water in vacuum shall be tested.

Adhesiveness of the wearing course surface shall be tested in accordance with the sub-item 6-00.4.2.2 with at least one sample every 10 000 m² of placed course.

### 6.07.6 QUALITY EVALUATION OF Poured ASPHALT

Poured asphalt shall be evaluated and taken over by the supervising engineer on the basis of results of control testing and audit testing.

**Percentage of bitumen** determined by samples of asphalt mixture, as part of the audit testing and control testing, shall be in accordance with table 6-07-9.

**Table 6-07-9**

<table>
<thead>
<tr>
<th>Property</th>
<th>Number of tested samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Allowed deviation, % (m/m)</td>
<td>± 0.50</td>
</tr>
</tbody>
</table>

Grain size distribution of stone mix, determined by sampling of asphalt mixture during control testing and audit testing, shall satisfy the requirements given in table 6-07-4 and table 6-07-10.

**Table 6-07-10**

<table>
<thead>
<tr>
<th>Allowed deviation of grain size distribution of stone mix*</th>
</tr>
</thead>
<tbody>
<tr>
<td>For individual sample, ± % (m/m)</td>
</tr>
<tr>
<td>0.09</td>
</tr>
<tr>
<td>0.25</td>
</tr>
<tr>
<td>0.71</td>
</tr>
<tr>
<td>2.0</td>
</tr>
<tr>
<td>4.0</td>
</tr>
<tr>
<td>8.0</td>
</tr>
</tbody>
</table>

*Total allowed deviation on individual screen shall not be greater than the limit values for that screen for individual type of asphalt mixture for PA and HPA given in table 6-07-4.
Physical and mechanical properties of asphalt mixture, shell satisfy the requirements given in sub-item 6-07.3.2, table 6-07-6.

Properties of placed asphalt course shall satisfy the requirements given in sub-item 6-07.3.3, table 6-07-7 and table 6-07-8.

All found faults shall be removed by the Contractor.

All costs of such works shall be at the expense of the Contractor, including all additional tests and measurements needed to be done in order to test the quality of the remedy.

All works not in accordance with the quality requirements, not remedied according to the requests of the supervising engineer shall not be paid to the Contractor.

6.07.7 CALCULATION OF WORK

Quantity of performed works shall be measured per square meters of upper surface of actually placed and incorporated poured asphalt in accordance with the design.

Defined quantities shall be paid per contracted unit price for square meter.

The price includes all costs of material supply, production and placing of asphalt mixture, transport, equipment all everything else needed to complete the works.
6-08  STANDARDS AND TECHNICAL REGULATIONS

HRN B.B0.001:1984  Natural stone, Sampling of stone and stone aggregates
HRN B.B8.032:1980  Natural stone testing. Determining the volume mass with pores and voids, volume mass without pores and voids and the coefficient of volume mass and porosity.
HRN B.B8.048:1984  Stone aggregate. Determining the grain shape by means of nose measurement
HRN B.B8.102:1982  Stone flour testing. Determining the percentage of voids in dry compacted state.
HRN B.H8.615. 1980  Bitumen testing. Determining the ductility.
HRN U.M8.092: 1966  Asphalt pavement structures Determining the volume mass by samples from the surfacing and base course
HRN U.M8.096:1987  Bituminous mixtures for surfacing. Testing the behavior under water
HRN EN 1426:2002  Bitumen and bituminous binders – Determination of needle penetration
HRN EN 1427:2002  Bitumen and bituminous binders – Determination of softening point – Ring and Ball method
HRN EN 1926:1999  Natural stone test methods – Determination of compressive strength
HRN EN 1936:1999  Natural stone test methods – Determination of real density and apparent density and of total and open porosity
<table>
<thead>
<tr>
<th>Standard Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRN EN 12370:1999</td>
<td>Natural stone test methods – Determination of resistance to salt crystallization</td>
</tr>
<tr>
<td>HRN EN 12407:2000</td>
<td>Natural stone test methods – Petrographic examination</td>
</tr>
<tr>
<td>HRN EN 12592:2002</td>
<td>Bitumen and bituminous binders – Determination of solubility</td>
</tr>
<tr>
<td>HRN EN 12593:2002</td>
<td>Bitumen and bituminous binders – Determination of the Fraass breaking point</td>
</tr>
<tr>
<td>HRN EN 12594:2002</td>
<td>Bitumen and bituminous binders – Preparation of test samples</td>
</tr>
<tr>
<td>HRN EN 12606-1:2002</td>
<td>Bitumen and bituminous binders – Determination of the paraffin wax content – Part 1: Method by distillation</td>
</tr>
<tr>
<td>HRN EN 12607-1:2002</td>
<td>Bitumen and bituminous binders – Determination of resistance to hardening under the influence of heat and air – Part 1: RTFOT Method</td>
</tr>
<tr>
<td>HRN EN 12607-3:1999</td>
<td>Bitumen and bituminous binders – Determination of resistance to hardening under the influence of heat and air – Part 3: RFT method</td>
</tr>
<tr>
<td>HRN EN ISO 3838:1999</td>
<td>Oil and liquid or solid oil products – Determining the density or relative density – Method by means of cylinder with capillary plug and graded bi-capillary cylinder.</td>
</tr>
<tr>
<td>prEN 58:2001</td>
<td>Bitumen and bituminous binders – Sampling of bituminous binders</td>
</tr>
<tr>
<td>EN 932-1:1996</td>
<td>Tests for general properties of aggregates-Part 1: Methods for sampling</td>
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<td>EN 932-2:1999</td>
<td>Tests for general properties of aggregates-Part 2: Methods for reducing laboratory samples</td>
</tr>
<tr>
<td>EN 933-1:1997</td>
<td>Tests for geometrical properties of aggregates-Part 1: Determination of particle size distribution-Sieving method</td>
</tr>
<tr>
<td>EN 933-4:1999</td>
<td>Tests for geometrical properties of aggregates-Part 4: Determination of particle shape-Shape index</td>
</tr>
<tr>
<td>EN 933-5:1998</td>
<td>Tests for geometrical properties of aggregates-Part 5: Determination of percentage of crushed and broken surface in coarse aggregate particles</td>
</tr>
<tr>
<td>EN 933-8:1999</td>
<td>Tests for geometrical properties of aggregates-Part 8: Assessment of fines – Sand equivalent test</td>
</tr>
<tr>
<td>prEN 933-10:1999</td>
<td>Tests for geometrical properties of aggregates-Part 10: Assessment of fines – Grading of fillers (air jet sieving)</td>
</tr>
<tr>
<td>EN 1097-2:1998</td>
<td>Tests for mechanical and physical properties of aggregates-Part 2: Methods for the determination of resistance to fragmentation</td>
</tr>
<tr>
<td>EN 1097-4:1999</td>
<td>Tests for mechanical and physical properties of aggregates-Part 4: Determination of voids of dry compacted filler</td>
</tr>
<tr>
<td>prEN 1097-6:2000</td>
<td>Tests for mechanical and physical properties of aggregates-Part 6: Determination of particle density</td>
</tr>
</tbody>
</table>
and water absorption

EN 1097-7:1999  Tests for mechanical and physical properties of aggregates-Part 7: Determination of particle density of filler; cylinder method

EN 1097-8:1999  Tests for mechanical and physical properties of aggregates-Part 8: Determination of polished stone value

EN 1367-2:1998  Tests for thermal and weathering properties of aggregates – Part 2: Magnesium sulfate test

EN 1428:1999  Bitumen and bituminous binders – Determination of water content in bitumen emulsions – Azeotropic distillation method

EN 1429:1999  Bitumen and bituminous binders – Determination of residue on sieving of bitumen emulsions, and determination of storage stability by sieving

EN 1430:1999  Bitumen and bituminous binders – Determination of particle polarity of bitumen emulsions


EN 12274-1:2001  Slurry surfacing-Test methods-Part 1: Sampling for binder extraction

EN 12274-6:2001  Slurry surfacing-Test methods-Part 6: Rate of application

EN 12371:2001  Natural stone test methods – Determination of frost resistance

EN 12591:1999  Bitumen and bituminous binders – Specifications for paving grade bitumen

EN 12595:1999  Bitumen and bituminous binders – Determination of cinematic viscosity

EN 12596:1999  Bitumen and bituminous binders – Determination of dynamic viscosity by vacuum capillary


prEN 12697-8:1996  Bituminous mixtures – Test methods for hot mix asphalt –Part 8: Determination of the air voids content of bituminous materials

prEN 12697-11:1999  Bituminous mixtures – Test methods for hot mix asphalt – Part 11: Determination of the compatibility between aggregate and bitumen

prEN 12697-12:1999  Bituminous mixtures – Test methods for hot mix asphalt – Part 12: Determination of the water sensitivity of bituminous specimens


prEN 12697-20:1999  Bituminous mixtures – Test methods for hot mix asphalt – Part 20: Indentation using cube or Marshall specimens


asphalt – Part 28: Preparation of samples for 
determination of binder content, water content and 
grading

prEN 12697-30:2000  Bituminous mixtures – Test methods for hot mix 
asphalt – Part 30: Sample preparation, impact 
compactor

prEN 12697-34:1999  Bituminous mixtures – Test methods for hot mix 
asphalt – Part 34: Marshall test

prEN 12697-36:1996  Bituminous mixtures – Test methods for hot mix 
asphalt – Part 36: Method for determining the 
thickness of a bituminous pavement

prEN 13036-4:1997  Pavement surface characteristics – Test methods – 
Part 4: Method for measurement of skid resistance 
of a surface: The pendulum test

prEN 13036-7:1997  Pavement surface characteristics – Test methods – 
Part 7: Measurement of single irregularities – The 
straight edge test

prEN 13075-1:1997  Petroleum products - Bitumen and bituminous 
binders – Determination of breaking behavior – Part 
1: Determination of breaking value of cationic 
biteumen emulsions - Mineral filler method

EN 13108-10:1997  Bituminous mixtures – Quality – Part 10: Production 
plant control

prEN 13398:1998  Bitumen and bituminous binders – Determination of 
the elastic recovery of modified bitumen

prEN 13399:1998  Bitumen and bituminous binders – Determination of 
storage stability of modified bitumen

EN 13614-2:1999  Bitumen and bituminous binders – Determination of 
adesiveness of bitumen emulsions by water 
immersion test – Part 2: Aggregate method

EN 13755:2001  Natural stone test methods – Determination of water 
absorption at atmospheric pressure

prEN 14023:2001  Bitumen and bituminous binders – Specifications for 
polymer modified bitumen

,P A-StB, Teil 2  Arbeitsanleitungen zur Prüfung von Asphalt, ALP A-
StB, Teil 2, Prüfung des Bindemittelablaufs, 
Forschungsgesellschaft für Straßen-und 

,P A-StB, Teil 4  Arbeitsanleitungen zur Prüfung von Asphalt, Prüfung 
des Schichtenverbundes nach Leutner, 
Forschungsgesellschaft für Straßen-und 

N 51 220:1996  Werkstoffprüfmaschinen – Allgemeines zu 
Anforderungen und an Werkstoffprümaschinen und 
zur deren Prüfung und Kalibrierung

DIN 52006-1:1980  Prüfung bituminöser Bindemittel – Wassereinwirkung 
auf Bindemittelüberzüge – Bindemittelüberzug aus 
Bitumenemulsion

V DIN 52041-2:1994  Prüfung von Bitumen – Verfahren für die 
Rückgewinnung des Bindemittels – Rückgewinnung 
aus polymermodifizierten Bitumenemulsionen
<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 2592:1973</td>
<td>Petroleum products – Determination of flash and fire points – Cleveland open cup method</td>
</tr>
<tr>
<td>NORM 3501:1991</td>
<td>Bitumenemulsionen für Straßenbau, Bitumenemulsionen für Oberflächebehandlungen</td>
</tr>
<tr>
<td>NORM 3503:1992</td>
<td>Bitumenemulsionen für Straßenbau, Bitumen-und Polymerbitumenemulsionen für Haftbrücken</td>
</tr>
<tr>
<td>PmOB:1997</td>
<td>Technische Lieferbedingungen für gebrauchsfertige polymermodifizierte Bindemittel für Oberflächebehandlungen</td>
</tr>
</tbody>
</table>