Road and Transportation Research Association

Working Group Concrete Pavements

FGSV

Technical delivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements

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TL Beton-StB 07

Edition 2007
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Working Group Concrete Pavements
Committee: Technical Conditions of Contract
Task Group: ZTV/TL/TP Beton

Chairman: Prof. Dr.-Ing. E g e r, München

Members:
BAFr Dipl.-Ing. B i l g e s h a u s e n, Bonn
Dipl.-Ing. B ö h m e, Düsseldorf
Dipl.-Ing. (FH) B u s c h, Bonn
Dr.-Ing. E h r l i c h, Düsseldorf
Dipl.-Ing. E i c k s c h e n, Düsseldorf
Dr.-Ing. E i f e r t, Düsseldorf
Dipl.-Ing. (FH) F r a n k e, Barsinghausen
Ltd. BDir. a.D. Dipl.-Ing. G r ü n i n g, München †
Dr.-Ing. K e r n, Iffezheim
Dipl.-Ing. N o s k e, Bergisch Gladbach
Dipl.-Ing. R i t t e r, Köln
BDir. Dipl.-Ing. R o d e h a c k, München
Dipl.-Ing. S c h ö n h o f e r, München

Preliminary remark

The “Technical delivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements”, issue 2007 (TL Beton-StB 07) were compiled by the Task Group “ZTV/TL/TP Beton” in the Committee “Technical conditions of contract” (chairman: Prof. Dr.-Ing. E g e r).

In combination with the “Technical conditions of contract and directives for the construction of base courses with hydraulic binders and concrete pavements” (ZTV Beton-StB 07) and the “Technical testing regulations for base courses with hydraulic binders and concrete pavements” (TP Beton-StB 07) this issue replaces the “Additional technical conditions of contract and directives for the construction of concrete pavements” (ZTV Beton-StB 01) as well as the parts of the “Additional technical conditions of contract and directives for base courses in road construction” (ZTV T-StB 95/02) which contain regulations for base courses with hydraulic binders.

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1 General

1.1 Scope

The “Technical delivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements”, Edition 2007 (TL Beton-StB 07) contain requirements for building materials, building material mixtures and mixtures for base courses with hydraulic binders and concrete that are produced from these materials for use in road construction and other trafficked areas. These are based on

– ATV DIN 18299 “General rules applying to all types of construction work” and
– ATV DIN 18316 “Road construction - surfacings with hydraulic binders”

Paragraphs in small print refer to sections of ATV DIN 18299 and ATV DIN 18316.

The European standard EN 13877 (DIN EN 13877) “Concrete pavements”

– Part 1: Materials
– Part 2: Functional requirements for concrete pavements
– Part 3: Specifications for dowels to be used in concrete pavements

is implemented with these technical specifications for as-delivered material. Categories from European standards for properties of building materials, base courses with hydraulic binders and concrete – which are required for the application in Germany – are, where available, specified in the “Technical specifications for building materials and building material mixtures for base courses with hydraulic binders and concrete pavements”.

The “Technical delivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements” (TL Beton-StB) contain requirements for the following:

– Aggregates
– Soils
– Hydraulic binders
– Mixing water
– Admixtures
– Additions
– Hydraulically bound building material mixtures for base courses and stabilized layers

The TL Beton-StB also contains requirements for the following materials used for the production of base courses with hydraulic binders and concrete pavements (concrete surfacing) in road construction and for other trafficked areas.

– Concrete
– Steel
– Curing agents
– Bedding materials

Concrete for base courses and pavements is concrete with properties according to DIN EN 206 and DIN 1045-2. It may not be assigned to a group of concretes.

Building materials are defined as suitable according to Article 4, Section 2a of the Construction Products Directive if they are CE-labelled on the basis of proven compliance with a national standard in which a harmonized standard has been implemented.

Products from other member states of the European Community or Turkey and goods originating from the member states of the European Economic Area that do not comply with these technical specifications are considered equivalent – including the tests and inspections carried out in the country of manufacture – provided that the required level of protection for health, safety and usability is achieved in an equal and permanent manner.

The limiting values and tolerances specified below include both the variation due to sampling and the confidence ranges of the test methods (reproducibility) as well as irregularities associated with production, unless another specification is made in a particular case.

The building materials and building material mixtures are to be produced, stored and transported in such a way that their properties are preserved and meet the requirements specified below.

1.2 Definitions

Initial concrete
Ready-mixed concrete delivered to the site before addition of superplasticizer.

Building material mixture
Aggregate mixture with a fixed grading, usually d = 0, without binder and water for use in hydraulically bound layers.

Concrete
Building material mixture produced by mixing cement, coarse and fine aggregates and water, with or without admixtures and additions.

Concrete for pavement
Building material mixture produced by mixing cement, coarse and fine aggregates and water, using air-entraining agents, with or without admixtures or additions.

Concrete with superplasticizer
Concrete with superplasticizer is concrete that can be easily processed. Depending on the type of composition, a distinction is made between the following.

– High early strength pavement concrete with superplasticizer (consistency F2 or C2) and
– Soft consistency pavement concrete with superplasticizer (consistency F3 or C3).

Concrete base course
Base courses of concrete with a specified strength class.

Characteristic strength
Value of strength which is expected to be fallen short of by 5 % of the population of all possible strength measurements for the quantity of concrete or hardened building material mixture considered (5 % fractile).

Mixture for placement
Building material mixture containing binder and water

Initial type test
Test prior to production of a building material mixture to determine the mix design that meets all specified requirements in the fresh and hardened state.

Exposure class
Classification of chemical and physical environmental conditions to which the concrete may be exposed and which may affect concrete, reinforcement or metallic components.

Concrete pavement
Upper part of the superstructure which is supported by the base course or another suitable subgrade. Concrete pavement may be produced in single or double layer form. Each layer may be laid in single or multiple courses.

– **Multilayer concrete pavements**: Multilayer pavement consists of concrete of the same composition, placed in several layers.
– **Dual layer concrete pavement**: Dual layer pavement consists of two layers of concrete of different composition. The upper layer is called the upper concrete layer, the lower layer is called the lower concrete layer.

Joint fillers
Collective term for all materials placed in the joint groove and with which joint fillings or joint filling systems, by the combined effects of different components, are produced.

Joint inserts
Construction elements placed into the groove during production of construction components or slabs and which remain in the joint entirely or partially.

Aggregates
Refer to “Technical delivery terms for aggregates in road construction” (TL Gestein-StB). Granular material for the use in civil engineering. Aggregates may be natural, industrially produced or recycled.

Population
Production quantity, delivered quantity, partial delivered quantity (by rail, truck or ship) or stockpile produced within a particular period of time under assumption of similar conditions.

Note: In a continuous process, the quantity produced within a specified time period should be considered as a population.

Hydraulic binders
Binders which harden with water – in air and under water – and which are water-resistant after hardening. These include cement according to DIN EN 197 or DIN 1164 and hydraulic binders for soil and base courses according to DIN 18506.

Hydraulically bound base courses
Hydraulically bound base courses consist of uncrushed and/or crushed building material mixtures and hydraulic binders. The grading of building material mixtures must be within a specified grading envelope. The mixture must be produced in mixing plants.

Category
Characteristic level for the property of a building material, expressed as range of values or as a limiting value.

Note: There is no inter-relationship between the categories of different properties.

Air voids
Artificially produced, small, spherical and roughly spherical voids evenly distributed in the hardened cement paste microstructure.

Fines / flour
All fine constituents of the concrete less than 0.125 mm (cement, aggregates and, if necessary, concrete additions)

Fines content
Content of fines in concrete

Surface retarders
Component used for the production of exposed aggregate concrete to retard the hardening of concrete in the upper near-surface concrete.

Road construction materials containing tar
Materials produced using carbon-based binders obtained during the removal of layers.

Base courses with hydraulic binders are the following:

– Stabilized layers
– Hydraulically bound layers
– Concrete base courses

Underlay material
Material used as thin intermediate layer between base course and concrete pavement.

Non-woven fabrics
Special textiles for separation, drainage and bedding beneath concrete pavements

Separation membranes
Water-resistant, watertight and separating thin intermediate layer (e.g. thin plastic sheeting) beneath concrete pavements

Stabilization
Construction procedure designed to increase the resistance of unbound granular base courses to the action of traffic and climate. Stabilized layers are produced by adding hydraulic binders and water to the soil and/or building material mixture in mix-in-place or mix-in-plant processes.

– **Mix-in-place process**
  The mixing device operates on the layer prepared for stabilization, scarifying it and mixing in the provided binder and necessary water.
– **Mix-in-plant process**
  Soil or mineral aggregates are mixed with the provided binder and water (mixing water) in stationary mixing plants.

Exposed aggregate concrete
Concrete with surface mortar removed in a wet or dry process.

Water/cement (w/c) ratio
Mass ratio of effective water content and cement content used in fresh concrete.

Soft concrete
Soft concrete is fresh concrete with a slump flow (spread) between 42 cm and 48 cm (consistency F3 or C3).

Factory production control (FPC)
Inspection of the ongoing production with regard to the observance of the properties specified in the initial type test and implementation of corrective measures that may be necessary.

Admixtures
Substances added to concrete during the mixing process in small quantities compared to the cement content to modify the properties of fresh or hardened concrete.

Additions
Finely distributed substances which are used in bases courses with hydraulic binders or in concrete to achieve certain properties. A distinction is made between the following:

– Almost inert type I additions (e.g. stone flour, pigments)
– Pozzolanic or latent hydraulic type II additions (e.g. fly ash, silica fume, trass)

1.3 Initial type test and factory production control

1.3.1 General

The tests are carried out in accordance with the "Technical testing regulations for base courses with hydraulic binders and concrete pavements" (TP Beton-StB).

The tests are distinguished as follows:

– Initial type test
– Factory production control
– Assessment of conformity

The tests are to be carried out by the manufacturer or his authorized representative.

The type and scope of the tests are specified in the individual sections or in the annex.

If concrete is produced by the contractor/user on his own responsibility, the initial type test, the factory production control and the self-monitoring must be carried out by him. The factory production control is to be coordinated with the self-monitoring tests (no double testing) according to the construction contract. In the case of delivered ready-mix concrete, the factory production control is to be carried out in the plant (concrete mixing plant) by the producer. The self-monitoring on site is to be carried out by the contractor/user.

The following tests shall be carried out and verified within the framework of the initial type test and the factory production control of building material mixtures for base courses with hydraulic binders or concrete:

– Stabilized layers
  Annex C
– Hydraulically bound base courses
  Annex D
– Concrete base courses and concrete for pavement
  Proof of conformity according to DIN EN 206 with modifications specified in Annex E

1.3.2 Initial type test

Initial type tests are tests carried out by the contractor.

Initial type tests serve as proof of suitability of building materials and building material mixtures for the intended placement conditions and intended use according to the requirements specified in the construction contract.

The initial type test comprises the entire range of tests of representative samples to determine usability for the intended purpose. The initial type test must be carried out before first use.

In initial type tests of concrete, the minimum values for strengths specified in Table 4 must be exceeded by a safety margin. The safety margin must be sufficiently large in order that the requirements specified in Table 4 are safely met by the factory production control. The bulk density and compressive strength of high early strength pavement concrete with superplasticizer are to be determined at an age of 2 days.

If the properties of building materials used have already been determined by the supplier in accordance with the corresponding technical specifications, these properties do not need to be re-assessed if the usability of the building materials remains the same and no other specifications follow.

The results of the initial type test must be recorded in an initial type test report which contains all information required by these technical specifications. These results form the basis for the data which is part of the contract for the execution of construction work.

The manufacturer shall furnish proof of the suitability of the intended building materials and building material mixtures. Proof shall be furnished in the form of test certificates from a testing laboratory

approved to test the respective building materials and building material mixtures.

The test certificate must contain information about the suitability for the intended purpose of the intended building materials and building material mixtures.

In the case of supply for similar construction projects with similar local and climatic conditions, initial type tests which already exist may be considered if the type and properties (origin) of the building materials or building material mixtures in the preceding initial type test have not changed and the test certificates are no older than two years.

Proof of suitability is to be furnished again if the supplying plant or type and properties of the building materials or installation conditions change.

Samples of all building materials intended for the execution of construction work shall be handed over to the client on request for retention (retained samples) or control tests by the owner. If the specimens are for retention they are to be kept under lock and key. The samples shall be accepted by the contracting parties in a record.

The initial type test report is only valid for one nominal composition and a period of up to 2 years. An initial type test must be carried out again under the following circumstances.

- Change of the supplier of aggregates
- Change of type and properties of the original materials (e.g. binder, petrographic aggregate type)
- Changes in a category defined in the “Technical delivery terms for aggregates in road construction” (TL Gestein-StB).

In any other case the specifications of DIN EN 206-1 and DIN 1045-2 apply.

1.3.3 Factory production control

Factory production control (FPC) is to be carried out.

The scope of the factory production control for stabilized layers and hydraulically bound base courses is specified in Annexes C and D, respectively.

For concrete for concrete base courses and pavement, the factory production control is carried out in accordance with DIN EN 206-1 and DIN 1045-2. Additional tests and deviating test intervals are specified in Annex E.

The factory production control for non-woven fabrics is regulated by DIN EN 13249.

1.3.4 Assessment of conformity

In the case of concrete delivered for concrete base courses and pavement as well as non-woven fabrics, the assessment of conformity shall be carried out in accordance with DIN EN 206-1 and DIN 1045-2 or DIN EN 13249 by an approved monitoring and certification body.

If the concrete is not delivered, but produced by the party responsible for placement, monitoring and certification by an approved inspection and certification body is not required.

2 Requirements for building materials

See DIN 18316, Section 2

2.1 Soils, aggregates and building material mixtures

2.1.1 Soils

The following types of soils are to be used for stabilization:

– Coarse-grained soils according to DIN 18196
– Mixed-grained soils of group GU, SU, GT and ST as far as they can be assigned to frost sensitivity class F 1 according to the “Additional technical conditions of contract and directives for earthworks in road construction” (ZTV E-StB).

2.1.2 Aggregates and building material mixtures

The “Technical delivery terms for aggregates in road construction” (TL Gestein-StB) and the test methods specified therein apply.

Aggregates for concrete and building material mixtures for base courses with hydraulic binders must comply with the categories specified in Annex A for the respective intended use. In case of contradictions, the regulations specified in the “Technical delivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements” (TL Beton-StB) have priority.

The guideline of the German Committee for Reinforced Concrete “Preventative measures against detrimental alkali reaction in concrete” (Alkali Guideline) applies to the use of aggregates in concrete pavement. Concrete pavement of construction classes SV, I to III is to be assigned to moisture classification “moist + external alkali supply + high dynamic load” (WS). Concrete pavement of construction

classes IV to VI is to be assigned to moisture classification “moist + external alkali supply” (WA).

The requirements for testing, monitoring and application specified in the Alkali Guideline, Part 1 and 2 apply to crushed and uncrushed aggregates containing opal sandstone or flint from the region of application or adjacent regions according to the Alkali Guideline, Part 2

The requirements specified in the Alkali Guideline, Part 1 and 3 apply to testing, monitoring and application of the following types of crushed aggregates:

– Greywacke
– Quartz-porphyry (rhyolith)
– Gravel from the Upper Rhine.

These requirements also apply to the following:

– Gravel with a crushed fraction of more than 10 % of the aggregates[1] mentioned above
– Recycled aggregates
– Other crushed aggregates which cannot be classified without objection according to the Alkali Guideline, Part 1, Section 1.1, Paragraph 2.

This also includes the following:

– Crushed aggregates without existing background of experience for use in construction within the scope of the Alkali Guideline.

When using aggregates which are named in the Alkali Guideline, Part 3 and classified as alkali susceptibility class E I-S, the results of the initial type test or routine inspection of the aggregates with regard to the alkali silica reaction shall be presented to the client by the contractor. These results are to be presented in addition to the initial type test of the intended concrete no later than two days before concreting and must not be older than four months.

In the case of the intended use of aggregates classified in alkali susceptibility class E III-S according to the Alkali Guideline, Part 3, the following documents are to be presented to the client by the contractor in addition to the initial type test no later than two days before concreting:

– An expert report regarding damaging alkali silica reactions
– A corresponding statement on the intended concrete.

[1] crushed aggregates according to DIN EN 933-5, Section 3.6

The statement on the concrete must be drawn up by one of the experts who confirmed the suitability of the aggregates.

For the use of industrially produced or recycled aggregates and lava slag for base courses with hydraulic binders, the table in Annex B applies.

If extraction and placement take place on the same construction site, recycled aggregates which comply with the “Fact sheet for recycling of concrete from road pavements” may be used for base courses with hydraulic binders without further proof.

The utilization of reclaimed asphalt and road construction materials containing tar in stabilized layers and base courses with hydraulic binders is regulated in Annex G.

2.1.3 Quality monitoring

The regulations of DIN EN 206-1 and DIN 1045-2 apply to aggregates for use in concrete.

The quality of building material mixtures and soils for stabilization and hydraulically bound base courses must be monitored according to the “Technical delivery terms for material mixtures and soils for the production of unbound granular layers in road construction” (TL G SoB-StB). The requirements for the mix specified in the “Technical delivery terms for material mixtures and soils for the production of unbound granular layers in road construction” (TL SoB-StB) are superseded by the requirements specified in Section 3.1.3 and Section 3.2.3 of the “Technicaldelivery terms for materials and material mixtures for base courses with hydraulic binders and concrete pavements” (TL Beton-StB).

2.2 Hydraulic binders

2.2.1 Base courses with hydraulic binder

Cement according to DIN EN 197 or DIN 1164 in accordance with Table 1 or hydraulic road binders according to DIN 18506 is used as binder.

Table 1: Cement for base courses with hydraulic binders

Main types of cement	Designation of cement type	Main constituents	
CEM I	Portland cement		
CEM II	Portland blast furnace cement	A/B	S Granulated slag
	Portland silica fume cement	A	D Silica fume
	Portland pozzolanic cement	A/B	P/Q Pozzolanic material
	Portland fly ash cement	A	V Fly ash
	Portland shale cement	A/B	T Shale
	Portland limestone cement	A	LL Limestone
CEM II-M	Portland composite cement	A	S-D, S-T
			S-LL
			D-T
			D-LL
			T-LL
			S-P, S-V
			D-P, D-V
			P-V, P-T
			P-LL
			V-T
			V-LL
		B	S-D, S-T
			D-T
			S-P, D-P
			P-T
CEM III	Blast furnace cement	A	S
		B	S
CEM IV	Pozzolanic cement	B	P[1)]
CEM V	Composite cement	A	S-P[2)]
		B	

[1)] applies only to trass according to DIN 51043 as main constituent up to a maximum of 40 wt.%
[2)] applies only to trass according to DIN 51043 as main constituent

2.2.2 Concrete pavements

Portland cement CEM I of strength class 32.5 R or alternatively 42.5 N according to DIN EN 197-1 or DIN 1164-10 is generally to be used for the production of concrete pavements.

Cement CEM I 32.5 R must fulfil the following requirements.

– The water content required to achieve standard stiffness (water demand) must not exceed 28.0 wt.%.
– The compressive strength at an age of 2 days must not exceed 29.0 MPa
– The cement fineness determined as specific surface must not exceed 3500 cm²/g

In agreement with the client, the following types of cement of strength classes 32.5 or 42.5 according to DIN EN 197-1 or DIN 1164-10 may be used:

– Portland blast furnace cement CEM II/A-S or CEM II/B-S
– Portland shale cement CEM II/A-T or CEM II/B-T
– Portland limestone cement CEM II/A-LL
– Blast furnace cement CEM III/A (of at least strength class 42.5 N).

Irrespective of the strength class, cement used for construction of concrete pavement is not permitted to exceed the characteristic values for total alkali content (equivalent sodium oxide content) specified in Table 2 and determined according to DIN EN 196-21.

In tests according to DIN EN 196-3, all types of cement, except cement for high early strength pavement concrete, may not, at 20 °C, start to set earlier than 2 hours after the addition of mixing water.

Table 2: Required characteristic value for alkali content of cement for construction of concrete pavement

Cement	**Granulated blast furnace slag content** (wt.%)	**Alkali content of cement** **Na_2O equivalent** (wt.%)	**Alkali content of cement without granulated blast furnace slag or burnt shale** **Na_2O equivalent** (wt.%)
CEM I		≤ 0.80	–
CEM II/A-S, -T, -LL		< 0.80	–
CEM II/B-T		–	≤ 0.90
CEM II/B-S	21 to 29	–	≤ 0.90
CEM II/B-S	30 to 35	–	≤ 1.00
CEM III	36 to 50	–	≤ 1.05

Verification of all requirements mentioned above must also be furnished for internal monitoring tests and external monitoring to be carried out according to DIN EN 197-1 and DIN 1164-10.

The mixes for the lower und the upper concrete in dual layer pavement must be produced from cement of the same type and strength class.

Before concreting, the results of the following cement tests must be presented.

– Physical properties according to DIN EN 196-1, 196-3 and 196-6, taking into account the additional requirements mentioned above
– Chemical composition according to DIN EN 196-2

When working with cement, the cement temperature shall be below 80 °C.

See Section 4.9 for special regulations for concrete with superplasticizer.

2.3 Mixing water

Mixing water must fulfil the requirements specified in DIN EN 1008.

The use of residual water for concrete pavement is not permitted. Residual water may be used for base courses with hydraulic binder in accordance with the regulations in DIN EN 206-1, DIN EN 1008 and DIN 1045-2.

2.4 Concrete admixtures

Concrete admixtures must fulfil the requirements specified in DIN EN 934-2 or possess a general building test certificate issued by a supervising authority. DIN V 20000-100 is to be observed for the use of concrete admixtures according to DIN EN 934-2.

Admixtures other than air-entraining agents may only be used by agreement.

If an air-entraining agent and either a superplasticizer or a concrete liquefier are used simultaneously, proof of a maximum spacing factor of 0.20 mm and a micro air voids ratio of at least 1.5 vol.% must be furnished in a performance test for this combination of admixtures (refer to the “Fact sheet for the production and processing of air-entrained concrete”).

Only one concrete admixture from any group of the same type may be used in a concrete mix. The simultaneous use of admixtures belonging to the same group of active substances, but produced by different manufacturers, is principally not permitted.

2.5 Concrete additions

Concrete additions must fulfil the requirements specified in DIN EN 206-1 and DIN 1045-2.

Type I or type II concrete additions according to DIN 1045-2 may be added to concrete. It is not permitted to include concrete additions for the determination of cement content and water/cement ratio.

2.6 Steel

2.6.1 Dowels and anchors

Dowels must fulfil the requirements specified in DIN EN 13877-3.

Smooth round bar steel St 37-2 according to DIN EN 10025 with a diameter of 25 mm and a length of 500 mm is required for dowels. When being cut to length, the ends of the dowels must not be deformed such that the movement of the slabs is restricted.

Dowels are to be coated over their entire length and anchors only in the centre over a length of 200 mm with a suitable alkali resistant polymer, at least 0.3 mm thick and with good adhesive properties.

Dowels for expansion joints must be provided with a steel or plastic sleeve at both ends with sufficient space for expansion. The space for expansion in the sleeve must be at least 5 mm longer than the maximum reduction of the joint width.

Reinforcing steel bars BSt 500 S (B) are to be used for anchors.

Anchors with a diameter of 20 mm and a length of 800 mm according to Table 3 of DIN EN 13877-1 are to be used.

The design of screw anchor bolts with regard to joint construction shall ensure a firm and durable connection.

Bonded (chemical) anchors must be at least 650 mm long. They are to be provided with a symmetrical cut face at one end. When using bonded anchors, a bonding cartridge M 24 is to be used as bonding system. Proof of pull-out strength is to be provided by tensile tests with a minimum tensile force of 80 kN. Other bonding systems may be used if verified that that they provide the same durable usability.

2.6.2 Reinforcing steel

If the pavement is reinforced with reinforcing steel, reinforcing steel BSt 500 S (B) or BSt 500 M (B) according to DIN 488 or DIN 1045-1 made of steel bars or reinforcing fabric is to be used. The steel shall be transported and stored such that contamination and bending are avoided.

2.7 Underlay materials

2.7.1 Non-woven fabrics

Non-woven fabrics must comply with DIN EN 13249.

The requirements for non-woven fabrics are regulated in Annex F. Non-woven fabrics consisting of multi-coloured fibres are not permitted.

2.7.2 Separation membranes

Separation sheets shall only be used in exceptional cases where necessary. They must consist of polyethylene and have a thickness of ≥ 0.2 mm.

2.8 Surface retarders

Only surface set retarders with a proven effectiveness according to Annex E, line 4d are to be used.

2.9 Curing agents

Curing agents must comply with the “Technical delivery terms for liquid concrete curing agents” (TL NBM-StB).

2.10 Joint fillers and inserts

Joint fillers and inserts must comply with the “Technical delivery terms for joint fillers in trafficked surfaces” (TL Fug-StB).

3 Requirements for building materials and mixtures for base courses with hydraulic binder

See DIN 18316, Section 2.1.6

3.1 Stabilized layers

3.1.1 Soils and building material mixtures

See Section 2.1.1

If exclusively recycled aggregates according to the “Fact sheet for recycling of concrete from road pavements” are used – provided extraction and placement takes place on the same construction site – external monitoring may be dispensed with.

3.1.2 Hydraulic binders

The following building materials may be used as hydraulic binders.

– Cement according to DIN EN 197 or DIN 1164 in accordance with Table 1
– Hydraulic road binders of strength class HRB 12.5 E or HRB 32.5 E according to DIN 18506

The use of rapidly setting binders is not permitted.

3.1.3 Mixtures for placement

Mixtures for stabilization may be produced in mix-in-site or mix-in-plant processes. In both processes, the mixture must be blended until binder and water are mixed uniformly with the soil and/or the building material mixture. The mixture for placement must be uniform in colour.

Soils or building material mixtures with a maximum particle size of up to 63 mm are suitable. The particle size fraction < 0.063 mm may not exceed 15 wt.%.

If the particle size fraction < 0.063 mm is between 5 and 15 wt.% in the soil or building material mixture, proof of sufficient frost resistance of the hardened mixture must be furnished in the initial type test by means of a frost test.

The appropriate composition of the mixture for placement is to be determined in an initial type test. The quantity of binder may not be less than 3.0 wt.%, with respect to the dry soil or dry building material mixture.

The quantity of binder is to be determined according to the “Technical testing regulations for base courses with hydraulic binders and concrete pavements” (TP Beton-StB).

The requirements specified in Table 3 are to be observed in the initial type test. The following requirements apply additionally for the determination of binder content.

– In the case of stabilized layers beneath asphalt layers, the binder content is determined for an interpolated compressive strength of 7 MPa. If the compressive strength of 7 MPa is exceeded for the minimum quantity of binder of 3.0 wt.%, the minimum quantity of binder is effective.
– The change in length determined in the frost resistance test shall not exceed 1.0 ‰. If a higher quantity of binder results on the basis of the frost resistance test, this quantity becomes effective.

Table 3: Requirements for building material mixtures for stabilized layers and hydraulically bound layers in the initial type test

Line	Soil and/or building material mixture type	Frost resistance (Change in length)	Compressive strength at an age of 28 days	
			beneath asphalt layers	beneath concrete pavements
		(‰)	(MPa)	
(1)	(2)	(3)	(4)	(5)
1	Fines content in soils and/or building material mixtures ≤ wt. 5%	–	7.0	≥ 15.0
2	Fines content in soils and/or building material mixtures > 5 and ≤ 15 wt.%	ΔI ≤ 1.0		

The requirements for the compressive strength are with respect to a test specimen with a height A of 125 mm and a diameter D of 150 mm.

Verification according to Annex C is to be furnished in the initial type test.

The tests are to be performed according to the “Technical testing regulations for base courses with hydraulic binders and concrete pavements” (TP Beton-StB).

The water content shall be specified to ensure that the optimum water content of the mixture for placement is not exceeded and the prescribed degree of compaction is not below the required value.

3.2 Hydraulically bound base courses

3.2.1 Aggregates

See Section 2.1.2

If exclusively recycled aggregates according to the “Fact sheet for recycling of concrete from road pavements” are used – provided extraction and placement takes place on the same construction site – external monitoring may be dispensed with.

3.2.2 Hydraulic binders

The following may be used as hydraulic binders.

– Cement according to DIN EN 197 or DIN 1164 in accordance with Table 1
– Hydraulic soil and base course binders of strength class HRB 12.5 E or HRB 32.5 E.

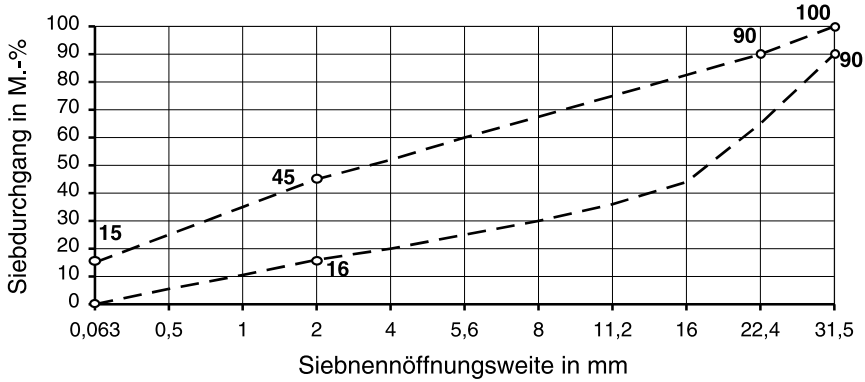
The use of rapidly setting binders is not permitted.

3.2.3 Mixtures for placement

The composition of building material mixtures is to be checked using records of the grading which are compared with the requirements shown in Figures 1 and Figure 2. Where limiting values are specified for the requirements, the appropriate composition is to be determined within these limiting values. The dashed lines between the numbered symbols in the figures have no significance for the building contract.

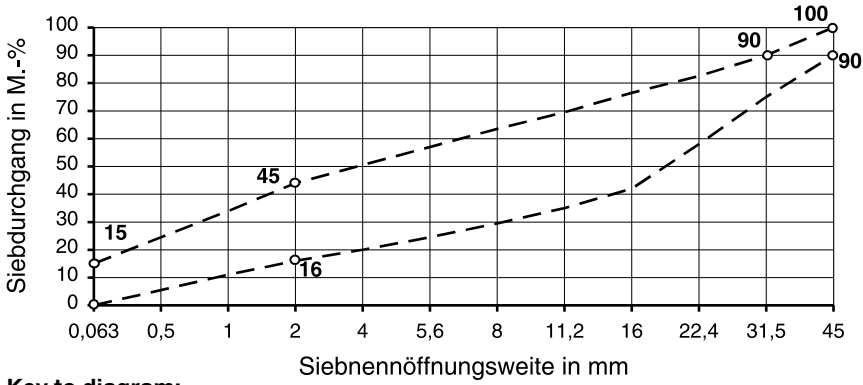
If the particle size fraction < 0.063 mm is between 5 and 15 wt.% in the building material mixture, proof of sufficient frost resistance of the hardened mixture for placement must be furnished in the initial type test by means of a frost test according to the "Technical testing regulations for base courses with hydraulic binders and concrete pavements" (TP Beton-StB).

The suitable composition of the mixture for placement is to be determined in an initial type test. The quantity of binder may not be less than 3.0 wt.%, with respect to the dry soil or the dry building material mixture.



Key to diagram:
M.-% = wt.%
Siebdurchgang in M.-% = passing sieve in wt.%
Sieböffnungsweite in mm = nominal sieve opening in mm

Figure 1: Grading envelope of building material mixtures for hydraulically bound base courses 0/32



Key to diagram:
M.-% = wt.%
Siebdurchgang in M.-% = passing sieve in wt.%
Sieböffnungsweite in mm = nominal sieve opening in mm

Figure 2: Grading envelope of building material mixtures for hydraulically bound base courses 0/45

The quantity of binder is to be determined according to the “Technical testing regulations for base courses with hydraulic binders and concrete pavements” (TP Beton-StB).

The requirements specified in Table 3 must be observed in the initial type test. The following regulations apply additionally for the determination of binder content.

– In the case of a hydraulically bound base course beneath asphalt layers, the binder content is determined for an interpolated compressive strength of 7 MPa. If the compressive strength of 7 MPa is exceeded for the minimum quantity of binder of 3.0 wt.%, the minimum quantity of binder is effective.
– The change in length determined in the frost resistance test may not exceed 1.0 ‰. If a higher quantity of binder results on the basis of the frost resistance test, this quantity becomes effective.

The requirements for the compressive strength are with respect to a test specimen with a height A of 125 mm and a diameter D of 150 mm.

Verification according to Annex D is to be furnished in the initial type test.

The tests are to be carried out according to the “Technical testing regulations for base courses with hydraulic binders and concrete pavements” (TP Beton-StB).

The water content shall be specified to ensure that the optimum water content of the mixture for placement is not exceeded and the prescribed degree of compaction is not below the required value.

The mixture for placement must be produced in mixing plants.

The particle size fractions of the mixture for placement exceeding 2 mm, 8 mm and 16 mm shall not exceed or fall short of the particle fractions of the building material mixture, based on the results of the initial type test and corrected by the binder content in wt.% with respect to the dry mixture for placement, by more than 8 wt.%.

The particle size fraction < 0.063 mm of mixtures for placement shall not exceed the sum of the particle size fraction < 0.063 mm of the building material mixture in wt.% from the results of the initial type test, and the binder content from the results of the initial type test by more than 2.0 wt.%.

3.3 Concrete base courses

3.3.1 Aggregates

See Section 2.1.2

3.3.2 Hydraulic binders

Cement according to Table 1 is to be used.

3.3.3 Mixtures for placement

The concrete must correspond to compressive strength classes C 12/15 or C 20/25.

In the initial test, proof is to be furnished according to DIN EN 206-1 and DIN 1045-2, as well as Annex E.

4 Requirements for concrete used in road pavement

See DIN 18316, Section 2.1.6

4.1 General

Unless other regulations are specified below, the following apply to the properties, production and testing of concrete.

- DIN EN 206-1,
- DIN 1045-2,
- Standards from the series DIN EN 12350, DIN EN 12390 and the DIN 1048.

Beyond the requirements specified in DIN EN 206-1 and DIN 1045-2, additional requirements apply to concrete due to exceptional stress.

4.2 Exposure classes and concrete strength

The requirements for pavement concrete regarding exposure class and concrete strength depend on the construction class of the pavement structure (see Table 4).

Based on the initial type test, the composition of concrete is to be specified such that all requirements for the concrete are durably fulfilled.

Table 4: Requirements for concrete

Construction class		**Exposure class**	**Moisture class**	**Compressive strength class**	**Flexural strength class**	**Minimum required particle size fractions according TL Gestein-StB** (mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
SV, I-III	Upper concrete	XF4, XM2[1)]	WS	C 30/37[4)]	F 4.5[5)]	0/2, 2/8, > 8 0/4, 4/8, > 8 0/2 or 0/4, ≤ 8[2)]
	Lower concrete	XF4[3)]	WS			
IV - VI	Upper concrete	XF4, XM1[1)]	WA		F 3.5[5)]	0/4, > 4
	Lower concrete	XF4[3)]	WA			

1) The upper limit of cement content according to DIN1045-2 does not apply to exposed aggregate concrete.
2) For a maximum particle size of 8 mm (see also Section 4.3.1)
3) See Annex A for requirements for aggregates
4) In the case of dry storage of the test cubes according to DIN EN 12390-2, Annex NA, the test results are to be multiplied by the factor 0.92 for the assessment of the strength class
5) The characteristic strength (ffk) after 28 days, measured on prisms with a cross section of 150 mm x 150 mm, may be used for classification (test in accordance with DIN EN 12390-5 with two point loading).
The mean value of flexural strength determined on 3 beams in the initial type test must be at least 4.5 MPa (F 4.5) or 3.5 MPa (F 3.5).

4.3 Composition of aggregate

4.3.1 Aggregates

Table 4, column 6 contains the particle size fractions that are required as a minimum for the aggregate grading.

In the case of dual or multiple layer placement of concrete, the grading shall be specified to ensure that the triple diameter of the maximum grain size does not exceed the minimum thickness of the respective layer or course.

In the case of dual layer placement of the upper concrete, at least 50 wt.% of the particle size fraction ≥ 8 mm must comply with category $C_{90/1}$ for pavement of construction classes SV and I to III. The fraction of aggregate of category $C_{90/1}$ must be at least 35 wt.%, with respect to the concrete particle mixture.

The grading of the aggregates must correspond to DIN 1045, Figures L 1, L 2 or L 3. Figure L 3 applies analogously to aggregates with D = 22 mm. Figure L 1 applies analogously to aggregate mixtures of D ≤ 8 mm for use in the upper concrete.

The upper concrete for pavement with surface mortar to be removed is to be produced from aggregate mixture 0/8.

Aggregate mixtures D ≤ 8 mm must be composed of at least one particle size fraction 0/2 or 0/4 and a particle size fraction d ≤ 2 mm which complies with category $C_{100/0}$ or $C_{90/1}$ and FI_{15} or SI_{15}.

In the case of concrete for pavement of construction classes SV and I to III and the upper concrete in dual layer placement, the fine particle size fraction (D ≤ 2 mm) is to be limited to ensure that the aggregate passing the 1 mm sieve does not exceed 27 wt.%, passing the 2 mm sieve not above 33 wt.%, for concrete with a maximum aggregate size of 8 mm, not above 35 wt.%.

Aggregates are to be stored on a clean and firm surface or in storage bins sorted separately by type and aggregate size fraction. They are to be protected against contamination.

4.3.2 Content of fine constituents

Concrete must contain a certain quantity of fine material to ensure good workability, a closed microstructure and avoid segregation. The fraction of fine constituents is composed of cement, the fraction of aggregates < 0.25 mm and, where applicable, additions. If the aggregate mixture contains insufficient fine material, filler according to the “Technical delivery terms for aggregates in road construction” (TL Gestein-StB) is to be added as an addition where necessary. The total amount of fine constituents < 0.25 mm must not exceed 450 kg/m³ in compacted fresh concrete and 500 kg/m³ in concrete with a maximum aggregate size of 8 mm.

If the concrete is used in pavement where the surface mortar is removed (see Section 3.3.1.6.1 of the “Additional technical conditions of contract and directives for the construction of base courses

with hydraulic binders and concrete pavements" (ZTV Beton-StB)), this fraction may exceed 500 kg/m³.

4.4 Cement content

The cement content shall be determined in the initial type test.

In the case of concrete for pavement of construction classes SV and I to III, the cement content may not be below a minimum value of 340 kg/m³ in compacted fresh concrete.

In the case of concrete for pavement where surface mortar is removed, the minimum cement content for the upper concrete must be 420 kg/m³ in compacted fresh concrete.

4.5 Consistency

The quantity of added mixing water is to be specified and adjusted taking into account the inherent moisture of the aggregates as well as weather and transport conditions to ensure the necessary consistency and good workability, avoid segregation, achieve a uniform and dense microstructure as well as the required surface height after compaction.

In the case of slip form paving, the consistency of the fresh concrete must be such that the fresh, compacted concrete remains stable after removal of the formwork.

4.6 Water/cement ratio

The water/cement ratio (w/c) for pavement of construction classes SV and I to III may not exceed 0.45. In case of pavement of construction classes IV to VI, a value of 0.50 may not be exceeded.

4.7 Air content and air void content

The "Fact sheet for the production and processing of air-entrained concrete" contains notes on the addition of air-entraining admixtures.

Air-entraining admixtures are to be added to the concrete in at least such a quantity that the air content required in Table 5 is achieved immediately before placement.

Single values may fall below these requirements by at most 0.5 vol.%.

If concrete of consistency classes C2, ≥ F2 or C1 is produced using superplasticizer or concrete liquefier, increased values for air content by 1.0 vol.% apply compared to those in Table 5.

If the air-entraining parameters are determined in the initial type test and the micro air voids content A_{300} is not below 1.8 vol.% and the spacing factor $\overline{L}$ does not exceed 0.20 mm, the requirements specified in Table 5 apply. For verification in the initial type test, the air content of fresh concrete must not exceed 6 vol.% for a maximum grain size of 8 mm, 5 vol.% for a maximum grain size of 16 mm and 4.5 vol.% for a maximum grain size of 32 or 22 mm.

Proof of the micro air voids content and the spacing factor must always be furnished for consistency class F6.

Table 5: Minimum air voids content of fresh concrete

Maximum aggregate size (mm)	**Mean minimum air content for concrete** (vol.%)
8	5.5
16	4.5
32 or 22	4.0

4.8 Production of concrete

4.8.1 Measuring out the mixture constituents

To ensure a uniform grading of the aggregates, the aggregates must at least be measured out separately on the basis of the particle size fractions specified in Sections 4.2 or 4.3, respectively.

Cement and aggregates are always to be added in percentages by mass.

Equipment which enables separated and exact addition of admixtures and additions is to be used.

Conveying and measuring devices are to be kept clean.

4.8.2 Mixing of concrete

The concrete is to be produced in mixing plants. The mixing time must be at least 45 seconds after adding all constituents.

Admixtures shall be added during the mixing process. Superplasticizers are generally added later (see Section 4.10.4).

To ensure uniformity of the concrete, a particular paving device is only permitted to be supplied from a single mixing plant for each layer to be placed.

The equipment and processes for producing and conveying concrete must be suitably chosen and co-ordinated to ensure that concrete can be placed quickly within the workability retention period.

In warm and dry weather conditions, the upper concrete must be processed no later than roughly half an hour after the lower concrete has been laid. In cool and damp weather conditions it must be processed no later than roughly one hour after placement of the lower concrete.

It must be ensured that the paving devices are continuously supplied with concrete. Permanent contact between the mixing plant and the place of paving must be ensured. This is also necessary for continuous fine adjustment of the concrete composition.

4.8.3 Production of concrete at low or high temperatures

The requirements specified in DIN 1045-3 apply.

The dependencies on air temperature T_L and concrete temperature T_B to be observed during production and placement of concrete are shown in Table 6.

Table 6: Temperature limits for placing concrete

Concrete placement	Air temperature	Temperature of concrete
permitted	$5\ °C \le T_L \le 25\ °C$	
only permitted when special measures are taken	$T_L < 5\ °C$ $T_L > 25\ °C$	$5\ °C \le T_B \le 30\ °C$
not permitted	Permafrost $T_L \le -3\ °C$	–
	–	$T_B < 5\ °C$ $T_B > 30\ °C$

4.8.3.1 Specific measures at low temperatures

Appropriate measures must be taken for concreting at air temperatures below +5 °C.

Such measures may include the following.

– Increasing cement content
– Use of cement with higher early strength,
– Increasing the fresh concrete temperature

Mixing water with a temperature exceeding +70 °C is to be mixed with the aggregates before the cement is added.

The use of frozen aggregates is not permitted.

4.8.3.2 Specific measures at high temperatures

If work is carried out at air temperatures above +25 °C, the fresh concrete temperature must be checked directly at the placement location. The temperature may not exceed +30 °C.

Appropriate measures are to be taken against high fresh concrete temperatures.

Such measures may include the following.

– Providing shade for the aggregates
– Spraying the coarse aggregates with water

4.8.4 Transportation of concrete

Fresh concrete must be protected against harmful drying out or absorbing rainwater.

Fresh concrete may not be transported on heated loading platforms or in transport vehicles with aluminium buckets unless special precautions ensure that the fresh concrete will not come into contact with aluminium surfaces.

4.9 Exposed aggregate concrete

The upper concrete is to be produced from fine and coarse aggregates with a maximum particle size of 8 mm. The fine and coarse aggregates must comply with Annex G of the “Technical delivery terms for aggregates in road construction” (TL Gestein-StB 04), column upper concrete 0/8. Coarse aggregates must comply with category $C_{100/0}$. The use of coarse aggregates of category $C_{90/0}$ is permitted if permission is granted by the client in the service specification.

The cement content is to be specified in the initial type test. For exposed aggregate concrete, it may not be below a minimum value of 420 kg/m³ compacted fresh concrete.

4.10 Concrete with superplasticizers

4.10.1 General

An air-entraining agent is to be added to the concrete during the production of the initial concrete in at least a sufficient quantity to ensure that the air content required according to Section 4.7 is fulfilled immediately before placement. Section 2.4 applies for the simultaneous use of superplasticizers and air-entraining agents.

For high early strength concrete, proof of sufficient early strength must also be furnished in addition to fulfilling the 28 day compres-

sive strength and flexural tensile strength (see Table 4). This is to be coordinated with the hardening time up to opening for traffic and specified in the particular project. If not further specified, in the initial type test proof of a minimum compressive strength of 30 MPa for individual values must be furnished, determined on cubes with an edge length of 150 mm after 2 days (storage in water at 20 °C).

4.10.2 Content of fine granular constituents

The total fraction of fine constituents < 0.25 mm may be increased up to a maximum of 500 kg/m³ in compacted fresh concrete if a higher cement content than specified in Section 4.4 is required for high early strength concrete containing superplasticizer.

4.10.3 Cement

CEM I cement of at least strength class 42.5 R is to be used for the production of pavement made of high early strength concrete with superplasticizer.

4.10.4 Concrete admixtures

The superplasticizer must not retard the setting of high early strength concrete with superplasticizer.

The liquefying effect of the superplasticizer may be of limited duration for the production of concrete with superplasticizer.

Superplasticizers are added at the concrete mixing plant or in the transport mixing drum immediately before placement. The mixing time in the transport mixing drum must be at least 1 minute per cubic metre of concrete, but not less than 5 minutes.

The use of concrete liquefiers instead of superplasticizers is permitted for pavement of construction classes IV to VI.

4.10.5 Consistency

By mixing in the superplasticizer, the slump flow of soft concrete with superplasticizer for road construction must be increased by at least 100 mm compared with the slump of the initial concrete.

The consistency to be chosen depends on the installation devices, temperature and the inclination of the pavement. Special measures are to be taken for inclinations exceeding 3 %. Single or multiple measures are to be applied as required.

Such measures may include the following.

- Adjusting the composition of concrete by reducing the dosage of superplasticizer
- Increasing the fraction of coarse aggregates
- Increasing the fraction of crushed aggregates

Annex

Properties and required categories of aggregates for base courses with hydraulic binders and concrete pavement

References to sections, tables and lines relate to the "Technical delivery terms for aggregates in road construction" (TL Gestein-StB)

Para-Section no.	Property \ Layer		Stabilization	Hydraulically bound base course	Concrete base course	Lower concrete	Upper concrete Construction class I, IV–VI	Upper concrete (D > 8) Construction class SV, I – III	Upper concrete (0/8) Construction class SV, I – III
2.1.1	Material identification		to be specified						
2.1.2	Bulk density		to be specified						
2.2.2	Grading								
	Particle size fraction/grading of supplied aggregates according to Table 2		G_F80 (line 9)		G_F85 (lines 20, 21)[d]				
			$G_C80/20$ (line 11, 13, 15, 17, 19)		$G_C90/10$ (line 3), $G_C90/15$ (line 4-7) $G_C85/20$ (line 22-25)				
	Combined particle size fractions according to Table 3		G_A85		$G_C90/15$				
			GT_{NR}, $GT_C20/15$, $GT_C20/17.5$				G_T15, $G_T17.5$		
	Grading tolerance according to Table 4		GT_ANR		line 1 or line 2				
2.2.3	Fines content								
	Particle size fractions according to Table 5	0/2 to 0/5	to be specified [a]		f_3				
		2/4 to 32/63	to be specified [a]		f_1				
2.2.5	Shape of course aggregates		SI_{50} / FI_{50}				SI_{20} / FI_{20}		SI_{15} / FI_{15}
2.2.6	Fraction of crushed surfaces		—				C_{NR}, $C_{90/3}$	C_{NR}, $C_{90/1}$	$C_{90/1}$, $C_{100/0}$
2.2.8	Shell content (coarse aggregate)		—				SC_{10}		

[a] Requirements for the fines content in the entire mixture must not be exceeded.
[b] Exposed aggregate concrete
[c] Climate zone III (Guidelines for the standardization of the superstructures of trafficked surfaces RStO 01)
[d] The use of fine aggregates 0/2 mm from the region of application and the related region of the Alkali Guideline is permitted if the oversized fraction is limited to 10 wt.%.

Annex A continued

Section no.	Property \ Layer	Stabilization	Hydraulically bound base course	Concrete base course	Lower concrete	Upper concrete Construction class I, IV–VI	Upper concrete (D>8) Construction class SV, I – III	Upper concrete (0/8) Construction class SV, I – III
2.2.10	Polishing resistance	—	—	—	—	$PSV_{\text{to be specified}}$(42)	$PSV_{\text{to be specified}}$(48)	$PSV_{\text{to be specified}}$(48), $PSV_{\text{to be specified}}$(53)[b]
2.2.14.1	Water absorption	$W_{cm}0.5$			—	—	—	—
2.2.14.2	Frost resistance	F_4			F_2	—	—	—
2.2.14.3	Freeze-thaw deicing salt resistance	—	—	—	—	Flaking ≤ 8 wt.%, ≤ 5 wt.%[c]		
2.2.17	"Sunburn" of basalt	SB_{SZ} / SB_{LA}						
2.2.18	Organic impurities							
	Fine aggregates	m_{LPC}NR			$m_{LPC}0.25$			
	Coarse aggregates	m_{LPC}NR			$m_{LPC}0.05$			
2.2.19.1	Decomposition of dicalcium silicate in granulated blast furnace slag or foundry-cupola furnace slag	no decomposition			—	—	—	—
2.2.19.2	Iron decomposition in granulated blast furnace slag or foundry-cupola furnace slag	no decomposition			—	—	—	—
2.2.19.3	Volume stability of steelworks slag	$V5$		steelworks slag in concrete is not permitted				
2.2.20	Alkali silica reaction	—	—	see Section 2.1.2 of the TL Beton-StB				
2.2.23	Components detrimental to setting and hardening	proof to be furnished						
2.3.1	Particle size distribution of filler	—	—	—	see Table 26			
2.4	Environmentally relevant properties	see Section 2.4 and Annex D						

Areas of application for industrially produced or recycled aggregates

Building materials	HCFA	GBFS, SS, CUG, CUS, FCFS, SCG, lava slag	SWS	Recycled aggregates[2)]	MSWIA
Construction class	**SV, I to VI**	**SV, I to VI**	**SV, I to VI**	**SV, I to VI**	**IV to VI**
(1)	(2)	(3)	(4)	(5)	(6)
Stabilized layers	as addition to aggregates	as aggregate	as aggregate	as aggregate	limited use[1)]
Hydraulically bound base courses	as addition to aggregates	as aggregate	as aggregate	as aggregate	use not permitted
Concrete base courses	as addition	as aggregate	use not permitted	as aggregate	use not permitted

1) According to the “Fact sheet for use of municipal solid waste incineration ash in road construction”

2) If extraction and placement take place on the same construction site, reclaimed aggregates which comply with the “Fact sheet for recycling of concrete from road pavements” may be used for base courses with hydraulic binders without need of further proofs.

Annex C

Tests for base courses with hydraulic binders – stabilization

Line		Initial type test	Factory production control
	1	2	3
1	**Binders**		
	a) Binder type and grade		Comparison of delivery notes for each delivery
2	**For the soil or building material mixture**		
	a) Grading	in every case	for every 2 500 t delivered, at least once daily
	b) Fines content	in every case	as required
	c) Water content	in every case	as required, at least once daily
	d) Proctor density and optimum water content	in every case	
3	**For the mixture for placement**		
	a) Binder content or quantity	in every case	as required, at least once daily
	b) Proctor density	in every case	
	c) Optimum water content	in every case	at least twice daily
	d) Compressive strength	in every case	as required
	e) Frost resistance	for soils or building material mixtures with fines content < 0.063 mm between 5 and 15 wt.%	

Annex D

Tests for base courses with hydraulic binders – hydraulically bound base courses

Line		Initial type test	Factory production control
	1	2	3
1	**Binders**		
	a) Binder type and grade		Comparison of delivery notes with each delivery
2	**For the building material mixture**		
	a) Grading	in every case	for every 2 500 t delivered, at least once daily
	b) Condition of aggregates	in every case	visual inspection
3	**For the placed mixture**		
	a) Binder content	in every case	as required, at least once daily
	b) Proctor density	in every case	
	c) Compressive strength on test specimen, diameter D = 150 mm, height H = 125 mm	in every case	as required
	d) Frost resistance	only for building material mixtures with fines content < 0.063 mm between 5 and 15 wt.%	
	e) Condition of the placed mixture		visual inspection
	f) Water content	in every case	at least twice daily

Annex E

Tests for concrete

See DIN 18316, Section 2.1.6.4

Line		Initial type test	Factory production control
	1	2	3
	Cement		
1	Compliance between delivery note and initial type test		every delivery
	Aggregates		
	a) Grading	in every case	once daily[1)] for aggregates ≤ 2 mm, once a week for aggregates > 2 mm and always if doubts remain after a visual inspection, occasionally by comparing delivery notes
2	b) Properties of aggregates	visual inspection, in case of doubt in accordance with the TL Gestein-StB	visual inspection of each delivery, in case of doubt in accordance with the TL Gestein-StB, occasionally by comparing delivery notes
	c) Fines content	visual inspection, in case of doubt in accordance with the TL Gestein-StB	visual inspection of each delivery, in case of doubt in accordance with the TL Gestein-StB, occasionally by comparing delivery notes
	d) Inherent moisture	in every case	occasionally

[1)] only for flexural strength class F 4.5

Annex E continued

Line		Initial type test	Factory production control
	1	2	3
3	**Fresh concrete**		
	a) Consistency	in every case	once daily and in case of doubt
	b) Water/cement ratio	to be specified	once daily
	c) Composition	to be specified	once daily
	d) Bulk density	in every case	with each test specimen production[1)]
	e) Air voids content and air temperature	in every case for concrete for pavement when using super-plasticizers and air-entraining agents, refer to Table 5	for pavement concrete, hourly for the upper concrete[2)], daily for the lower concrete
	f) Temperature of concrete	in every case for pavement concrete	every 2 hours for pavement concrete for air temperatures below +5 °C or above +25 °C
4	**Hardened concrete**		
	a) Bulk density and compressive strength	in every case	
	b) Air voids content, micro air voids content and spacing factor (only for the upper concrete for dual-layer pavements)	where applicable when using concrete liquefiers or superplasticizers and air-entraining agents, refer to Table 5	
	c) Flexural strength	in every case	
	d) Exposed aggregate concrete: mean texture depth and effectiveness of the surface retarder used	Determination of the mean texture depth on a specimen slab of at least 900 cm² produced from the intended materials in the intended process	

1) only for flexural strength class F 4.5
2) only for flexural strength class F 4.5, at least once daily for flexural strength class 3.5

Annex F

Requirements for non-woven fabrics

Property	Requirement
Mass per unit area	$450\ g/m^2 \leq M_A \leq 550\ g/m^2$
Thickness under a load of 2/20/200 kN/m²	$d_{2,5\%} \geq 3$ mm $d_{20,5\%} \geq 2.5$ mm $d_{200,5\%} \geq 1$ mm
Maximum tensile force	≥ 10 kN/m
Maximum tensile force strain	≤ 130 %
Water permeability normal to the plane	$k_{V20,\ 5\%} \geq 1 \cdot 10^{-4}$
Water drainage capacity in the plane	$k_{H20,5\%} \geq 5 \cdot 10^{-4}$ $k_{H200,5\%} \geq 2 \cdot 10^{-4}$
Weathering resistance	Residual strength ≥ 60 %
Alkali susceptibility	≥ 96 % PP/PE

Annex G

Recycling of reclaimed asphalt and road construction materials containing tar in base courses with hydraulic binders

1 General

This annex contains additional contractual stipulations regarding the use of building material mixtures containing more than 30 wt.% of reclaimed asphalt as well as the use of road construction materials containing tar for base courses with hydraulic binders.

Road construction materials containing tar may be used for stabilized layers or hydraulically bound base courses due to the fact that the elution of contaminants from the finished layer is substantially reduced as a result of processing and mixing with hydraulic binders during proper placement and compaction. The basis for this is the “Directives fort he environmentally compatible use of reclaimed materials with tar containing components an reclaimed asphalt in road construction with comments” (RuVA-StB).

Materials containing tar should remain on site and be stabilized in a mix-in-place process whenever possible. If materials containing tar have to be extracted, they are to be processed. Processed extracted materials are to be mixed in a mix-in-plant process by adding binder, water and, if necessary, additional aggregate size fractions.

2 Raw materials

2.1 Building material mixture

When using road construction materials containing tar, mixing with material which does not contain any tar is to be avoided as far as possible. Thus, as far as possible, no more than 15 wt.% of additional aggregates according to the “Technical delivery terms for aggregates in road construction” (TL Gestein-StB) and/or additions, with respect to the dry building material mixture, may be added. Proof of adequate frost resistance must be furnished if necessary.

The amount of building material mixture used which passes the 2 mm sieve of must be at least 25 wt.%. The maximum particle size is limited to 45 mm. A fraction of 10 wt.% of oversized particles up to 56 mm is permitted.

Reclaimed asphalt must comply with the “Technical delivery terms for reclaimed asphalt” (TL AG-StB). It shall be extracted and stored according to the “Information sheet for recycling of reclaimed asphalt” (M VAG).

2.2 Additions

Stone flour according to the “Technical delivery terms for aggregates in road construction” (TL Gestein-StB) or hard coal fly ash according to DIN EN 450 may be used as additions (fillers).

3 Storage of road construction materials containing tar

Road construction materials containing tar are to be protected against water during (temporary) storage in order to avoid the release of soluble contaminants. If not stored under cover, the materials may only be stored temporarily on a waterproof surface where seepage water is collected. The materials must be protected against moisture penetration by a waterproof cover. The seepage water is to be disposed according to the respective regulations.

4 Building material mixtures

When road construction materials containing tar are used, the quantity of hydraulic binder and/or the amount of aggregates and additions in the initial type test is to be suitably chosen to achieve a structure of sufficient denseness that meets the requirements of the “Directives for the environmentally compatible use of reclaimed materials with tar containing components an reclaimed asphalt in road construction with comments” (RuVA-StB) regarding the elution of contaminants. This applies in addition to the constructional requirement of the initial type test.

In the case of road construction materials containing tar, the aggregate fraction < 2 mm in the building material mixture may not exceed or fall below the value determined in the initial type test by more than 8 wt.%.

5 Initial type test

If reclaimed asphalt or extracted road construction materials containing tar from a processing test are tested in the initial type test, the size of pieces is to be suitably varied to ensure that the full range of size variation is covered in the recycling process.

In addition to the tests in Annexes 3 and 5, elution tests for the proof of reduction of contaminants according to the “Directives for the environmentally compatible use of reclaimed materials with tar containing components an reclaimed asphalt in road construction with comments” (RuVA-StB) are to be carried out for materials containing tar.

Annex H

Abbreviations and technical regulations

Abbreviations

Abbreviation	Meaning
ATV	General technical specifications in construction contracts (VOB/C)
BASt	Federal Highway Research Institute
BMVBS	Federal Ministry of Transport, Building and Urban Development
DAfStb	German Committee for Reinforced Concrete
DIBt	German Institute for Building Technology
DIN	German Institute for Standardisation
EN	European standard
FGSV	German Road and Transportation Research Association
VOB	German Construction Contract Procedures

Technical regulations

DAfStb[1)]		Preventative measures against detrimental alkali reaction in concrete (Alkali Guideline)
DIBt[2)]		Principles for the approval of concrete admixtures (approval principles) Principles for monitoring of concrete admixtures (monitoring principles) Notes on the approval principles and monitoring principles for concrete admixtures
DIN[3)]	VOB/C	German construction contract procedures – Part C: General technical specifications in construction contracts (ATV) – general rules applying to all types of construction work – DIN 18299
	VOB/C	German construction contract procedures – Part C: General technical specifications in construction contracts (ATV) – road construction – surfacings with hydraulic binders – DIN 18316
	DIN 488	Reinforcing steels

Technical regulations continued

DIN[3)]	DIN 1045-1	Concrete, reinforced and prestressed concrete structures – Part 1: Design and construction
	DIN 1045-2	Concrete, reinforced and prestressed concrete structures – Part 2: concrete – specification, properties, production and conformity – application rules for DIN EN 206-1
	DIN 1045-3	Concrete, reinforced and prestressed concrete structures – Part 3: Execution of structures
	DIN 1048	Testing concrete
	DIN 1164-10	Special cement – Part 10: Composition, requirements and conformity evaluation for special common cement
	DIN 18196	Earthworks and foundations – soil classification for civil engineering purposes
	DIN 18506	Hydraulic road binders – composition, specifications and conformity criteria
	DIN 51043	Trass, requirements, tests
	DIN 52101	Aggregates test methods – sampling
	DIN 53765	Testing of plastics and elastomeres, thermal analysis – DSC method
	DIN EN 196	Methods of testing cement
	DIN EN 197-1	Cement – Part 1: Composition, specifications and conformity criteria for common cements
	DIN EN 459-2	Building lime – Part 2: Test methods
	DIN EN 1008	Mixing water for concrete – specifications for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
	DIN EN 10025-1	Hot-rolled products of structural steels – Part 1: General technical delivery conditions
	DIN EN 10080	Steel for Concrete Reinforcement – Weldable Reinforcing Steel – General Rules
	DIN EN 10221	Surface quality classes for hot-rolled round bars and rods – technical delivery conditions
	DIN EN 12224	Geotextile and Geotextile-Related Products – Determination of Weathering Resistance
	DIN EN 12350	Testing fresh concrete

Technical regulations continued

DIN[3)]	DIN EN 12390	Testing hardened concrete
	DIN EN 12447	Geotextiles and geotextile-related products – screening test method for determining the resistance to hydrolysis in water
	DIN EN 13249	Geotextiles and geotextile-related products – required characteristics for use in the construction of roads and other trafficked areas
	DIN EN 14030	Geotextiles and geotextile-related products – screening test methods for determining the resistance to acid and alkaline liquids
	DIN V 20000-100	Application of building products in structures – Part 100: Concrete admixtures according to DIN EN 934-2:2002-02
	ISO 1035-1	Hot-rolled steel bars; Part 1: Dimensions of round bars
DIN[1)4)]	DIN EN 206-1	Concrete – Part 1: Specification, performance, production and conformity
	DIN EN 450	Fly ash for concrete
	DIN EN 932-1	Test for general properties of aggregates – Part 1: Methods for sampling
	DIN EN 933-1	Tests for geometrical properties of aggregates – Part 1: Determination of particle size distribution – sieving method
	DIN EN 933-5	Tests for geometrical properties of aggregates – Part 5: Determination of percentage of crushed and broken surfaces in coarse Aggregate particles
	DIN EN 934-1	Admixtures for concrete, mortar and grout – Part 1: Common requirements
	DIN EN 934-2	Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – definitions, requirements, conformity, marking and labelling
	DIN EN 1097	Tests for mechanical and physical properties of aggregates
	DIN EN 1367	Tests for thermal and weathering properties of aggregates

Technical regulations continued

DIN[1)4)]	DIN EN 13286-1	Unbound and hydraulically bound mixtures – Part 1: Test methods for laboratory reference density and water content – introduction and general requirements and sampling
	DIN EN 13286-2	Unbound and hydraulically bound mixtures – Part 2: Test methods for laboratory reference density and water content – Proctor compaction
	DIN EN 13286-47	Unbound and hydraulically bound mixtures – Part 47: Test method for the determination of California bearing ratio, immediate bearing index and linear swelling
	DIN EN 13877-1	Concrete pavements – Part 1: Materials
	DIN EN 13877-2	Concrete pavements – Part 2: Functional requirements for concrete pavements
	DIN EN 13877-3	Concrete pavements – Part 3: Specifications for dowels to be used in concrete pavements
FGSV[4)]		Information sheet for the production and processing of air-entrained concrete (FGSV 818)
		Information sheet for recycling of concrete from road pavements (FGSV 828)
	M Geok E-StB	Information sheet for the application of geosynthetics in road construction earthworks with check lists for the use of geogrids in road construction earthworks (C Geok E-StB) (FGSV 535)
	M HMVA	Information sheet for use of municipal solid waste incineration ash in road construction (FGSV 738)
	M OB	Information sheet for the production of surface textures on concrete pavements (FGSV 829)
	M VAG	Information sheet for recycling of reclaimed asphalt (FGSV 754)
	M VuB	Information sheet for use of non-woven fabrics and related products under concrete pavements (FGSV 830)

Technical regulations continued

FGSV[4)]	RAP Stra	Directives for accreditation of test centres for building materials and building material mixtures in road construction (FGSV 916)
	RuVA-StB	Directives for the environmentally compatible use of reclaimed materials with tar containing components and reclaimed asphalt in road construction with comments (FGSV 795)
	TL AG-StB	Technical delivery terms for reclaimed asphalt (FGSV 749)
	TL Fug-StB	Technical delivery terms for joint fillers in trafficked surfaces (FGSV 897/2/3)
	TL Gestein-StB	Technical delivery terms for aggregates in road construction (FGSV 613)
	TL G SoB-StB	Technical delivery terms for material mixtures and soils for the production of unbound granular layers in road construction, Part: Quality monitoring (FGSV 696)
	TL NBM-StB	Technical delivery terms for liquid concrete curing agents (FGSV 814)
	TL SoB-StB	Technical delivery terms for material mixtures and soils for the production of unbound granular layers in road construction (FGSV 697)
	TP Beton-StB	Technical testing regulations for base courses with hydraulic binders and concrete pavements (FGSV 892)

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E-mail: info@beuth.de, Internet: www.beuth.de

2) **Deutsches Institut für Bautechnik**
Address: Kolonnenstrasse 30L, 10829 Berlin
Phone: +49 (0) 30/7 87 30-0, Fax: +49 (0) 30/7 87 30-320,
E-mail: dibt@dibt.de, Internet: www.dibt.de

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Phone: +49 (0) 22 36/38 46 30, Fax: +49 (0) 22 36/38 46 40,
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