THE REPUBLIC OF SLOVENIA
MINISTRY OF INFRASTRUCTURE

TECHNICAL SPECIFICATION TSG-211-XXX: 2025

On the basis of Article 13 of the *Roads Act* (Official Gazette of the Republic of Slovenia, No 132/2022 and 140/22 – ZSDH-1A, 29/30 and 78/23 – ZUNPEOVE), the Minister of Infrastructure issues a technical specification

UPPER STRUCTURE OF ROADS

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATE

TSPI – P.06.200: 2025

Minister of Infrastructure
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Number:

Ljubljana,

Contents

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATES

1 Subject of the technical specification

Technical specification TSPI – P.06.200: 2025 *Unbound load bearing layers and unbound wearing layers made of natural aggregates* sets out the basic technical requirements for material quality, performance quality and conformity assessment, including quality control, as well as instructions for the implementation of upper unbound load bearing layers, lower unbound load bearing layers (mineral capping layer) and unbound wearing layers made of natural aggregates in roadway structure and lower railway structure.

The quality requirements set out in this specification can also be applied mutatis mutandis to other transport infrastructure and elements of carriageways and walking surfaces – airports, pedestrian corridors, cycle paths, paving surfaces, roadsides, middle dividing lanes, parking areas, etc.

The use of artificial and recycled aggregates in unbound load bearing and wearing layers is not the subject of this TSPI.

The TSPI also does not cover the rideable base, which is dealt with in the TSPI for earthworks.

This TSPI sets out the minimum quality requirements for the materials and built-in layers of the lower and upper unbound load bearing layer and the unbound wearing layer.

If provided for by the project, deviations from the requirements set out in this document are conditionally permissible, e.g. a high distance of the source of quality materials from the construction site may result in disproportionate cost increases, adverse environmental impacts, impact of transport loads on existing transport infrastructure, etc. In such cases, the deficiency of the available local materials must be compensated for by other procedures (e.g. improvement – stabilisation with binders, strengthening of the bound load bearing layers of roadway structures, etc.).

In the evaluation of the quality of the existing layers for the purpose of planning for rehabilitation of roadway structures, in addition to the characteristics listed in this TSPI, it is also taken into account whether said layers are the actual cause of damage to the roadway structure, as well as the economy criterion (evaluation of the costs and benefits of individual alternative measures).

The TSPI is prepared on the basis of technical specifications TSC 06.100 – *Mineral capping layer and rideable base* and TSC 06.200 – *Unbound bearing and wearing layers*, including the older special technical conditions of PTP SCS, Books 3 and 4 and their supplements.

In preparing the TSPI, we took into account the requirements set out in the harmonised product standard SIST EN 13242 – *Aggregates for unbound and hydraulically bound materials for use in civil engineering and road construction*.

In the field of railway infrastructure construction, the main guideline for the preparation were *the Rules on the Lower Structure of Railway Lines*. Some of the guidelines given in this TSPI differ from the requirements given in the *Rules*. Until its revision, we propose that the requirements be taken into account as recommendations based on the experience gained from the construction and upgrading of railway infrastructure in Slovenia and comparable requirements from abroad.

On the basis of a review of domestic and selected foreign regulation, standards and guidelines, the results of research projects carried out in the past, and in particular the experience in building road and railway infrastructure and the natural properties of stone aggregates deposits in Slovenia, revised requirements for the characteristics and quality of natural aggregates and installation requirements are prepared.

The classification is described in the text of the document and shown transparently in Annexes 1 and 2.

Natural aggregates for upper and lower unbound load bearing and unbound wearing layers are classified into classes.

The classes give requirements for the quality characteristics of natural aggregates before and after installation (grain and geometric characteristics, physical characteristics, resistance to freezing and thawing and chemical characteristics), they are formed depending on the traffic loads of road infrastructure and/or type of railway line.

The document defines the quality characteristics of natural aggregates for the following classes:

- NNP1, NNP2, NNP3, NNP4 and NNP5 for the upper unbound load bearing layer – ZNNP,
- PO1, PO2 and PO3 for the lower unbound load bearing layer – SNNP (mineral capping layer); and
- MA1 and MA2 for unbound wearing layer – NOP (macadam).

In this TSPI, the lower unbound load bearing layer (mineral capping layer) represents the lowest layer of the roadway structure and not the foundation of the roadway structure, which must be taken into account when preparing the TSPI dimensioning specification. The previously unbound load bearing layer shall be treated as the upper unbound load bearing layer.

Depending on the traffic loads of the road infrastructure and/or the type of railway line, quality requirements for installation (bearing capacity, density, altitude deviation, straightness) are also given.

The TSPI provides average frequencies of quality control of materials and built-in layers, which take into account the specificity of different types of roads and railways.

The content of this TSPI cannot be interpreted and implemented in such a way as to prevent or condition the proper use of construction products placed on the market in accordance with the requirements of the *Construction Products Act*.

2 Definition of terms

The meanings of technical terms used in this TSPI are described below.

Aggregate is a granular material used in construction. Aggregates can be natural (mineral-derived aggregate that has undergone mechanical processing), artificial (mineral-derived aggregate prepared in an industrial process under the influence of thermal or other changes) and recycled (aggregate resulting from the processing of inorganic material that has previously been incorporated).

Dynamic modulus of deformation (ger. *dynamischer Verformungsmodul*) is a characteristic value for the deformability of a material at a defined shock load of a circular plate with a falling light weight determined on the basis of the measured amplitude of the plate deflection s.

Drain capacity (ger. *Dränfähigkeit*) is the property of the material to discharge water through the interconnected cavities.

Filter stability (ger. *Filterstabilität*) is the contact property of two layers made of different materials and is conditioned by their grain composition, so that under the influence of a constant or variable gradient of water or under the dynamic loads of traffic it is not possible to transfer solid particles from one layer to another.

Fines (ger. *fein*) are grains with a size below 0.063 mm.

Coarse aggregate (ger. *Große gesteinskörnung*) is a size designation for aggregates with d equal to or greater than 1 mm and D greater than 2 mm.

Improvement (ger. *Verbesserung*) means a process in which the incorporation of suitable materials (stone grains or inorganic binders) improves the installation and thickening properties of the base material and facilitates the execution of construction work.

Coefficient of uniformity (C_U) (ger. *Ungleichförmigkeitszahl*) is the ratio of grain size at 60 and 10 % sieve, given as dimensionless parameter.

Coefficient of curvature (C_C) (ger. *Krümmungszahl*) is the ratio of the square grain size at 30 % sieve to the product of the grain size at 10 % and 60 % sieve, given as a dimensionless parameter.

Grading curve limit *(* nem. *Grenzsieblinien*) are curves limiting the range of permissible variations in the granular composition of the aggregate.

All-in aggregate (ger. *all-in Gesteinskörnung*) is an aggregate made of a mixture of coarse and fine aggregates with a D greater than 6.3 mm. It can be produced either without separation into coarse and fine fractions or by assembling coarse and fine aggregates.

Modified Proctor compaction test (nem. *modifiziertes Proctor – Verfahren*) is a laboratory test in which the maximum dry density and optimum humidity of an aggregate are determined using the prescribed thickening energy.

Unbound wearing course or layer – NOP (ger. *ungebundene Deckschicht*) represents the wearing layer of the roadway structure for a light and very light traffic load or temporary arrangement of the road surface from the most skeletal and compact mixture of grains on the traffic surface. Unbound wearing layer is not upgraded with bound layers.

Bearing capacity (ger. *Tragfähigkeit*) means the mechanical resistance of the formation of the embedded material to (short-term) loads.

Formation (ger. *Planum*) means the surface of a layer with certain prescribed quality characteristics of that layer (height, flatness, density, bearing capacity).

Particle size distribution (ger. *Korngrössenverteilung*) means the size distribution of stone grains in the aggregate, illustrated by a curve in the corresponding diagram.

Unbound subbase or lower unbound load bearing layer – SNNP (mineral capping layer) (ger. *ungebundene Untere Tragschicht*) is the lowest layer of the roadway structure consisting of mechanically hardened aggregate of rounded, broken (crushed) stone grains or a mixture of rounded and broken stone grains. It ensures frost security and bearing capacity. If it meets the quality and functional requirements, the top layer of the embankment or the subsoil can be used as SNNP. In practice, the term capping layer, bed is often used to designate the lower unbound load bearing layer.

Stabilization (ger. *Stabilisierung*) is a process in which the resistance of the built-in aggregate to the effects of traffic loads and to adverse climatic and hydrological effects is permanently increased by stirring the binder and, if necessary, the water into the existing aggregate and by suitable condensation.

Modulus of deformation (ger. *Verformungsmodul*) is a parameter which represents the deformability of the embedded material and is determined on the basis of the slope of the load/subsidence curve at a pressure experiment with a load plate.

Aggregate size (ger. *Gesteinskörnung größe*) is the designation of the aggregate according to the lower (d) and upper (D) sieve size, expressed in d/D. In this designation, it is understood that some grains remain on the upper sieve (oversized grains) and some pass through the lower sieve (undersized grains). The size of the lower sieve (d) may be zero.

Laying (ger. *Einbau*) is a process that involves spreading the material in the appropriate layer thickness and thickening.

Initial test type (ger. *Eignungs-/Erstprüfung*) is a test to verify and confirm the achievement of the required characteristics and the suitability of the product for its intended use prior to regular manufacture or when the origin of the ingredients and/or their proportions and the method of manufacture change.

Unbound base or upper unbound load bearing layer – ZNNP (ger. *ungebundene Obere Tragschicht*) is, as a rule, the highest mechanically compacted load bearing layer in a road construction, consisting of a natural aggregate of broken (crushed), a mixture of broken and rounded or rounded stone grains, which forms the basis of the bound layers in the road structure. In the case of railways, the upper unbound load bearing layer is the highest layer of the lower structure and is usually the base for the track ballast of the upper structure. In practice, the term tampon (tampon layer, tampon fragmentation, etc.) is often used to describe the upper unbound load bearing layer.

Compaction (ger. *Verdichtung*) is a process in which a material spread into a layer achieves the required compaction using thickeners (cylinders, vibration plates).

Grading (ger. *Korngrößenverteilung*) is the distribution of grain sizes, expressed as mass percentages of sieve fractions through specified sieves.

Abbreviations and symbols

Abbreviation, symbol	Meaning of the designation, symbol
c_c	Coefficient of curvature of granulation
c_u	Coefficient of uniformity of granulation
C	Percentage of crushed or broken and fully rounded grains in coarse aggregates
G_A	Permissible deviation from the typical grain size declared by the producer for all-in aggregates. The tolerance does not apply to the proportions of fine grains f_3, f_5 and f_7.
d/*D*	Aggregate size in relation to lower (*d*) and upper (*D*) sieve size. In this designation, it is understood that some grains remain on the upper sieve (oversized grains) and some pass through the lower sieve (undersized grains). The size of the lower sieve (*d*) may be zero.
f	Content of fines
FI	Form of coarse aggregate, flakiness index
SI	Shape of coarse aggregate, shape index
SE(10)	Quality of fines, sand equivalent
MB	Quality of fines, methylene blue
LA	Crushing resistance of coarse aggregate, Los Angeles coefficient
M_{DE}	Resistance of the coarse aggregate to wear, micro Deval coefficient
WA_{24}	Water absorption of the aggregate after 24 hours of saturation
F	Frost and thaw resistance
MS	Frost resistance - Magnesium sulphate process
E_{vs1}, E_{vs2}	Static deformation module
E_{vd}	Dynamic deformation module
EH, VH, H, M, L, VL	Traffic load group according to the number of transitions of nominal axle load of 100 kN per day/over 20 years (Table 7: TSC 06.511:2009): extremely heavy: over 3000 / over 2 x 10^7 very heavy: over 800 to 3000 / over 6 x 10^6 to 2 x 10^7 heavy: over 300 to 800 / over 2 x 10^6 to 6 x 10^6 medium: over 80 to 300 / over 6 x 10^5 to 2 x 10^6 light: over 30 to 80 / over 2 x 10^5 to 6 x 10^5 very light: up to 30 / up to 2 x 10^5
Main line, regional line, industrial track	Types of lines according to the *Regulation on the categorisation of lines* and the *Regulation amending the Regulation on the categorisation of lines*
CCC	Continuous dynamic density measurement

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATES

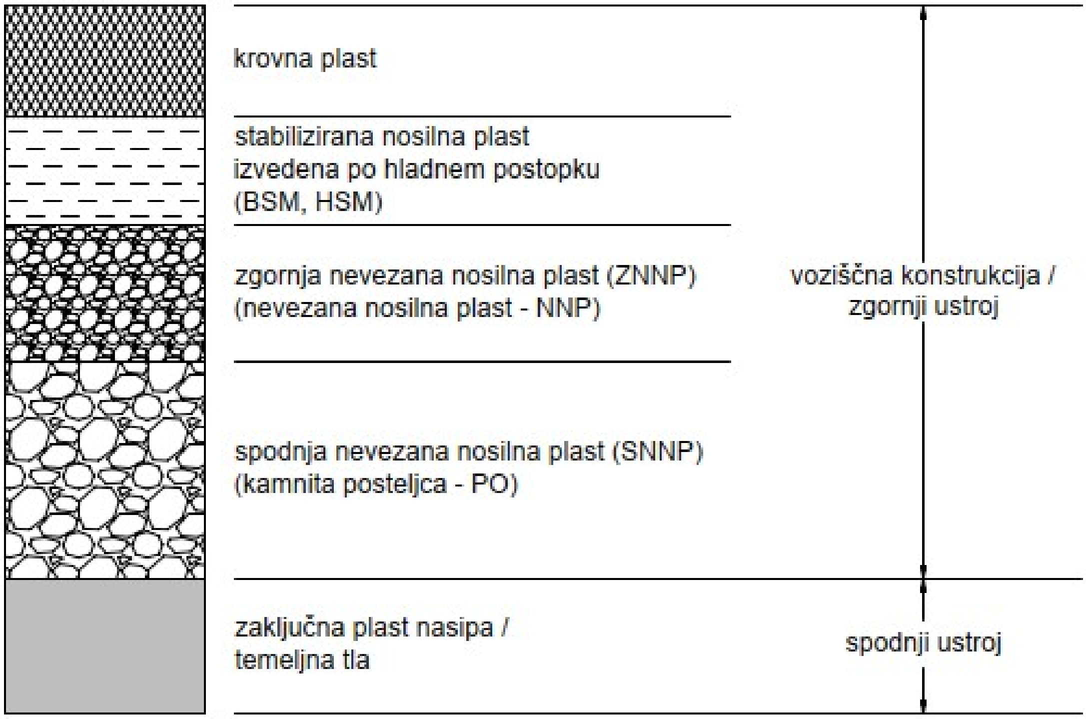

Figure 2.1: *Unbound load bearing layers in a typical cross-section of the roadway structure*

krovna plast	cover layer
stabilizirana nosilna plast izvedena po hladnem postopku (BSM, HSM)	stabilised load bearing layer carried out by cold procedure (BSM, HSM)
zgornja nevezana nosilna plast (ZNNP) (nevezana posteljca – PO)	upper unbound load bearing layer (ZNNP) (unbound base - PO)
spodnja nevezana nosilna plast (SNNP) (kamnita posteljca – PO)	lower unbound load bearing layer (SNNP) (unbound subbase - PO)
zaključna plast nasipa / temeljna tla	final layer of embankment / subsoil
vozišČna konstrukcija / zgornji ustroj	roadway structure / upper structure
spodnji ustroj	lower structure

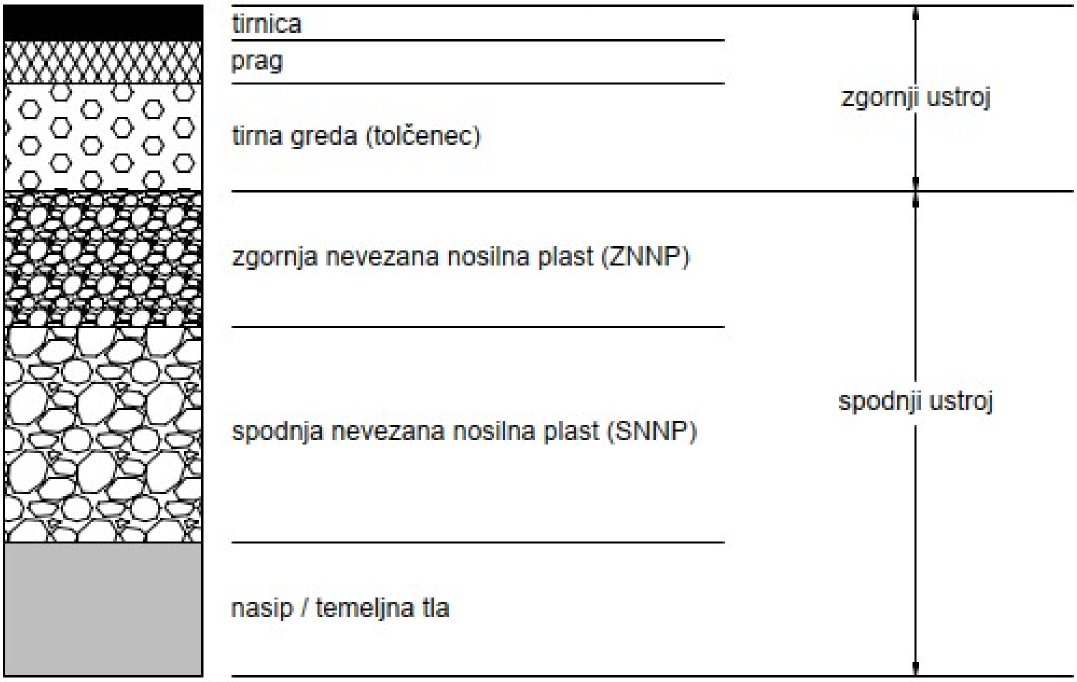

Figure 2.2: *Unbound load bearing layers in a typical cross-section of the railway lower structure*

tirnica	rail
prag	sleeper
tirna greda (tolčenec)	track ballast (crushed stone)
zgornja nevezana nosilna plast (ZNNP)	upper unbound load bearing layer (ZNNP)
spodnja nevezana nosilna plast (SNNP)	lower unbound load bearing layer (SNNP)
nasip / temeljna tla	embankment / subsoil
zgornji ustroj	upper structure
spodnji ustroj	lower structure

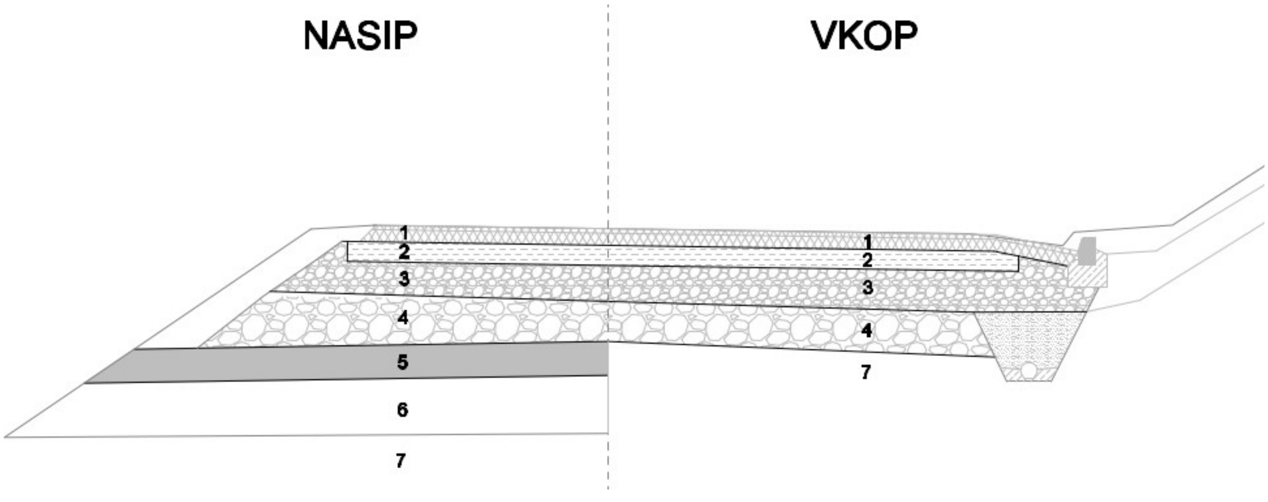

Figure 2.3: *Schematic representation of the road in the embankment and burrow: 1 – cover layer, 2 – stabilised load bearing layer, 3 – ZNNP (unbound base), 4 – SNNP (unbound subbase), 5 – embankment finishing layer, 6 – embankment, 7 – subsoil*

NASIP	EMBANKMENT
VKOP	BURROW

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATES

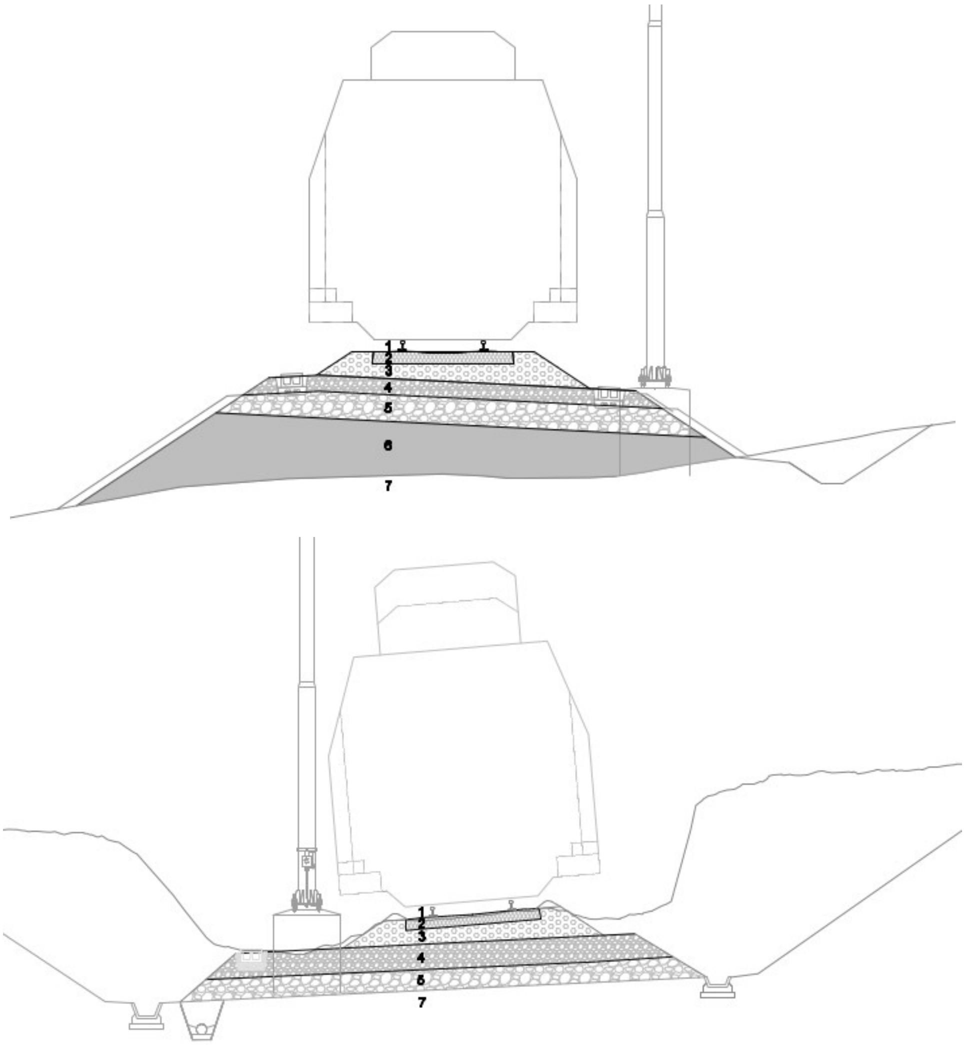

Figure 2.4a and b: *Schematic representation of the the railway in the embankment and burrow; 1 – rail, 2 – sleeper, 3 – track ballast, 4 – upper unbound load bearing layer, 5 – lower unbound load bearing layer, 6 – embankment, 7 – subsoil*

3 Base materials

Aggregates which are natural, artificial or recycled may be incorporated into lower and upper unbound load bearing layers and unbound wearing layers. The use of artificial and recycled aggregates for use in roadway structures of transport infrastructure is not the subject of this TSPI.

Aggregates with a broken grain surface (crushed aggregates) have grains with sharp edges and tips and more or less rough break faces. They are usually produced by over-crushing quarried rock, coarse natural grains, or coarse, previously crushed grains.

Aggregates with rounded grains contain grains with more or less rounded edges and tips. They are formed during the disintegration of solid rocks, due to the action of water, wind and temperature. These mainly consist of sediment from rivers or glaciers (gravel sites, gravel pits). They can be extracted by excavation. As a rule, aggregates with rounded grains must be cut to the appropriate nominal size, taking into account the intended use.

Aggregates with broken and rounded grains are produced by partial crushing of rounded grains or by mixing individual portions of rounded and broken grains.

The TSPI provides generally applicable quality performance requirements for basic materials – natural aggregates for lower and upper unbound load bearing and unbound wearing layers for new constructions. The designer may use the requirements given in this TSPI as part of the dimensioning the structures of the transport infrastructure, but may also prescribe higher/lower requirements.

The conditional permissible deviations from the requirements set out in this document and the evaluation of the quality of the existing layers for the purposes of planning the renovation of road structures are described in point 1.

3.1 Lower unbound load bearing layer – SNNP (unbound subbase or mineral capping layer)

3.1.1 General

The lower unbound load bearing layer (unbound subbase) is usually the lowest mechanically compacted layer of the roadway structure. It consists of mechanically hardened natural aggregate. If it meets the quality requirements, the function of the SNNP may also include the finishing layer of the embankment or the subsoil. The thickness of the SNNP depends on the bearing capacity of the substrate and the depth of frost penetration and ranges from a minimum of 30 to 50 cm, or more if necessary. SNNP is an important structural element of the roadway structure. Throughout its service life, it must ensure and comply with the requirements for:

- frost and weather resistance; if necessary, it must protect the materials incorporated under it from the harmful effects of cold;
- adequate and permanent bearing capacity; it must be dimensioned in such a way that it sufficiently takes over traffic loads over the intended service life, so as to avoid plastic deformation on the SNNP formation and provide bearing capacity to the higher lying layers.

The aggregates installed in the SNNP must ensure adequate water permeability, prevent the occurrence of capillary water rises, water retention, etc. This is ensured by consistently meeting the specified quality requirements for aggregates and by correctly thickening them in layers.

Articles 13 and 14 of *the Rules on the Lower Structure of Railway Lines* define the quality requirements of materials and the installation requirements for the lower part of the unbound load bearing layer and the formation of the frost resistant upper embankment, which are functionally identical. The Rules do not formally define the term mineral capping layer.

3.1.2 Geometric characteristics

The aggregate for SNNP shall comply with the requirements for category G_A85. It may contain up to 15 % of oversized grains, which must not be greater than 1.4 times (or 1.2 times at D = 125 mm) the declared upper nominal grain size D. The maximum grain size must not be greater than 150 mm and/or exceed half of the thickness of the built-in layer. The granular composition shall be determined by the wet sieving procedure SIST EN 933-1 (normative procedure or Appendix A).

The proportion of coarse grains must ensure the skeletal composition of the aggregate incorporated in the SNNP. On thickening, the size of coarse grains may be reduced by a maximum of 1.4 times the upper nominal grain size due to over-crushing.

The effect of crushing on the granular composition due to compaction needs to be further verified with a test field in case of doubt.

An aggregate of nominal sizes of 0/63 mm, 0/90 mm or 0/125 mm shall be used for installation in the SNNP.

Exceptionally and upon the decision of the designer, in areas with limited local resources of coarse-grained materials or on less congested roads, local materials of lower nominal sizes may be used, which must meet the grain requirements for the ZNNP(1).

The grain size shall be well graduated: the coefficient of uniformity of granulation shall be $c_u > 5$ (for class PO1 recommended $8 \leq c_u \leq 50$, for classes PO2 and PO3 recommended $15 \leq c_u \leq 100$). The coefficient of curvature of granulation c_c shall be $1 \leq c_c \leq 5$.

The content of fines shall be determined at the same time as the granular composition test using the wet sieving process SIST EN 933-1. Before installation (on the landfill or on the construction site before hardening), the aggregate must contain from ≥ 3.0 % to ≤ 6.5 % of fines ≤ 0.063 mm (as a rule, category f_5). The layer-integrated aggregate may contain ≤ 8 % of fines ≤ 0.063 mm. The granular composition after installation shall be decisive for the assessment of conformity.

If the aggregate contains less than 3.0 % or more than 6.5 % of fines before installation, the installability or over-crushing size during compaction must be demonstrated by means of a test field.

Fines, if more than 5 %, shall not be plastic. The character of fines shall be determined according to the procedure SIST EN 933-8 sand equivalent, $SE(10) \geq 35$ % or methylene blue according to the procedure SIST EN 933-9, $MB \leq 2.5$ g/kg(2). The requirement must be fulfilled at the landfill and during and after installation.

If the fines content is less than 5 % by weight, such particles shall be considered harmless regardless of their nature. The boundary is defined experientially.

Coarse grains must meet the requirements for fragmentation $C_{90/3}$ for class PO1 and $C_{50/30}$ for class PO2. For class PO3 no fragmentation is required, category C_{NR}.

Note 1: The installation of less coarse-grained materials of ZNNP in the SNNP area (mineral capping layer) is taken into account by the designer in the specification of works, where instead of the SNNP they envisage the incorporation of ZNNP in several layers. If necessary, the designer shall determine whether the absence of a coarse skeleton is compensated by other measures, e.g. chemical stabilisation of the material. Note 2: In borderline cases or in case of dispute, the methylene blue test is decisive for determining the character of fines. The limit values for methylene blue given in this TSPI are typical for materials from Slovenian and petrographically comparable foreign deposits (limestones, dolomites, carbonate gravel, carbonate silicate Drava gravel, silicate Mura gravel), but not for materials from foreign deposits of magmatic or metamorphic rocks. In these cases, it is recommended to evaluate the fines by examining the sand equivalent.

If the SNNP is deposited on a substrate consisting of coherent soils or fine-grained mixed soils and regular or intermittent fluctuations of groundwater are expected in the layer, the filter stability of the contact must be checked. To verify the filter stability, the USBR or Terzaghi equation or a different expert calculation should be used. In the case where due to the granular nature of the aggregate it is not possible to ensure the filter stability of the contact, an additional filter layer made of an appropriate filter-stable grain mixture, or a dedicated geosynthetic, transverse drainage, etc., must be installed under the SNNP. The principles are described in the technical specification for earthworks TSPI PG.05.000 and in the technical specification for the design and use of geosynthetics in the construction of thoroughfares.

3.1.3 Physical properties and frost/thaw resistance

The coarse SNNP grains must be mechanically and in volume stable and resistant to water and cold influences.

The resistance to fragmentation (Los Angeles test, SIST EN 1097-2) must satisfy category LA_{35} ($LA \leq 35$ %).

In the event of doubt or product without demonstrably documented satisfactory use in the past, the frost resistance of the grains must first be determined by simplified macroscopic petrographic examination in accordance with the procedure SIST EN 932-3. Where that procedure does not allow a reliable identification, appropriate additional investigations must be carried out:

- determination of water absorption according to the procedure SIST EN 1097-6 (category $WA_{24}2$, $WA_{24} \leq 2.0$ %) or
- determination of frost and thaw resistance according to procedure SIST EN 1367-1 (category F_1, $F \leq 1$ %)(3) or
- test with magnesium sulphate according to the procedure SIST EN 1367-2 (category MS_{18}, $MS \leq 18$ %)(3).

If the SNNP aggregate is produced from the same rock/gravel and with a comparable technological process as the ZNNP aggregate, the characteristic values of the resistance to fragmentation and the resistance to freezing of the latter may be assumed.

3.1.4 Chemical characteristics

The aggregate must not contain harmful admixtures of humus or organic matter. The humus or organic matter present in the aggregate must show a negative test in a 3 % NaOH solution (the colour of the solution may be equal to or lighter than the standard dark yellow colour). Admixtures of solid, lithified coal particles (e.g. deposits in the lower Sava basin) are not considered humus substances, even if the reaction result is positive (colour darker than standard). The test must be carried out in accordance with SIST EN 1744-1, point 15.1.

Note 3: The determination of resistance to freezing/thawing according to the procedure of SIST EN 1367-1 is not yet fully established in Slovenia. As a rule, the investigation shall be carried out in accordance with the procedure SIST EN 1367-2, which has a highly destructive impact on grains, which may unjustifiably restrict the use of materials with adequate resistance to freezing/thawing determined in accordance with the procedure SIST EN 1367-1.

3.2 Upper unbound load bearing layer – ZNNP

3.2.1 General

In the road construction, the upper unbound load bearing layer is usually the highest mechanically compacted load bearing layer of the roadway structure. It is constructed of, as a rule, crushed, less often from a mixture of crushed and rounded or rounded stone grains, which form the basis of bound layers in the roadway structure. In the roadway, it takes over traffic loads from the higher layers, distributes them and, as a rule, transfers them to the lower unbound load bearing layer – the mineral capping layer.

The upper unbound load bearing layer, like the SNNP, must meet a number of quality requirements for frost and weather stability, mechanical resistance, geometrical properties of stone grains throughout its lifetime, enabling and ensuring its permanent bearing capacity after appropriate compaction.

In roadways with lower traffic loads, where the thickness of the upper and lower unbound load bearing layers are usually lower, the ZNNP plays a significantly larger role than in roadways where traffic loads are high and where the thickness of the bound layers of the upper structure is high, in accordance with the dimensioning rules. Due to the thin bound layers of the upper structure, the ZNNP of less congested roadways is significantly more exposed to the effects of stress of rare but heavy goods vehicles and buses, which must be taken into account in the planning.

In railways, the upper unbound load bearing layer is the uppermost layer of the lower structure. It is constructed of mechanically compacted crushed stone grains and, as a rule, forms the basis of the track ballast of the upper structure.

In practice, the term tampon (tampon layer, tampon fragmentation, etc.) is often used to describe the unbound load bearing layer.

3.2.2 Geometric characteristics

The aggregate for ZNNP shall comply with the requirements for category G_A85. It may contain up to 15 % of oversized grains, which shall not be greater than 1.4 times the declared upper value of granulation *D.* The granular composition shall be determined using the wet sieving process of SIST EN 933-1.

The grain curvature of the aggregate for ZNNP must lie between the limit curves determined depending on the grain size for three grain size characteristic types of aggregates:

- *d/D* = 0/22 mm (grains size 0-32 mm),
- *d/D* = 0/32 mm (grains size 0-45 mm),
- *d/D* = 0/45 mm (grains size 0-63 mm).

The zones are defined in Figures 3.1, 3.2 and 3.3 and in Table 3.1. The grain curvature shall lie as close and as parallel as possible to the corresponding lower limit curvature.

Some aggregates have grain curvatures of unfavourable shapes. Despite the granular location between the two boundary curvatures, such aggregates contain an increased content of fine grains, a low proportion of sand-size grains and a disproportionately high proportion of grains of a narrow grain area of fine or medium gravel, and a low proportion of coarse gravel grains, which may have an adverse effect on the incorporation and bearing capacity of the layer. Such aggregates shall, as far as possible, be grain-corrected by selecting the appropriate production technology.

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Presevek [m.-%]	Sieve fraction [m.-%]
Dolžina stranice kvadratne odprtine sita [mm]	Side length of square sieve opening [mm]
melj	silt
pesek	sand
drobir/prod	rubble/gravel

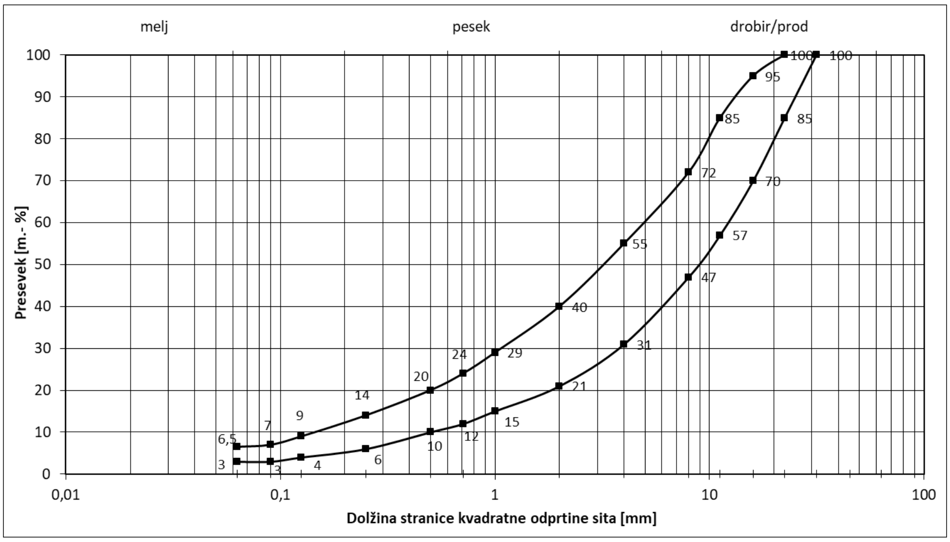

Figure 3.2: *Composition area of aggregate 0/22 mm for ZNNP and NOP for installation*

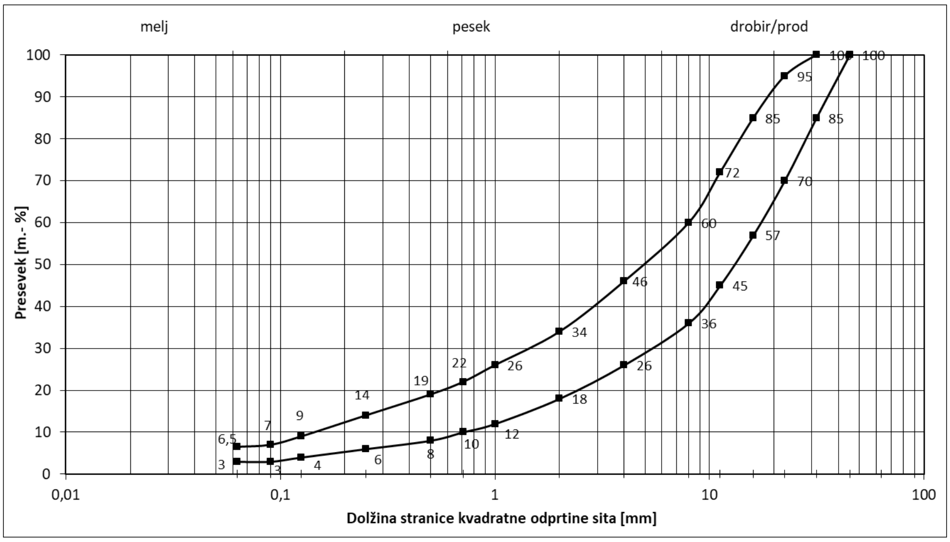

Figure 3.3: *Composition area of aggregate 0/32 mm for ZNNP and NOP for installation*

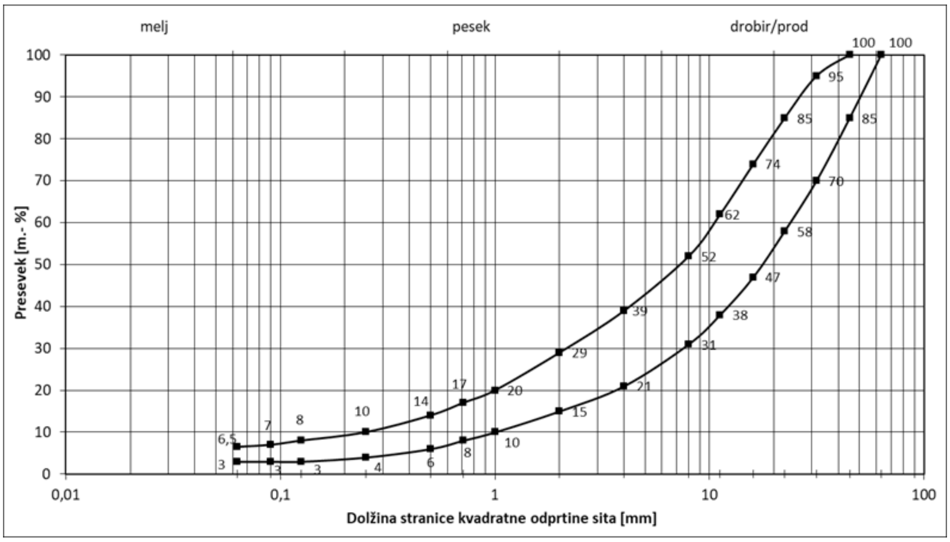

Figure 3.4: *Composition area of aggregate 0/45 mm for ZNNP and NOP for installation*

Table 3.1: *Composition area of aggregates for installation in ZNNP and NOP*

		side length of square sieve opening [mm]															
		0.063	0.09	0.125	0.25	0.5	0.71	1	2	4	8	11.2	16	22.4	31.5	45	63
nominal size d/D	**0/22 mm**	3-6.5	3-7	4-9	6-14	10-20	12-24	15-29	21-40	31-55	47-72	57-85	70-95	85-100	100		
	0/32 mm	3-6.5	3-7	4-9	6-14	8-19	10-22	12-26	18-34	26-46	36-60	45-72	57-85	70-95	85-100	100	
	0/45 mm	3-6.5	3-7	3-8	4-10	6-14	8-17	10-20	15-29	21-39	31-52	38-62	47-74	58-85	70-95	85-100	100

The grain size test shall be carried out using the following sieves:

- 0.063 mm, 0.125 mm, 0.5 mm, 1 mm, 2 mm, 4 mm, 8 mm, 11.2 mm, 16 mm, 22.4 mm, 31.5 mm, 45 mm and 63 mm, or
- 0.063 mm, 0.09 mm, 0.25 mm, 0.71 mm, 2 mm, 4 mm, 8 mm, 11.2 mm, 16 mm, 22.4 mm, 31.5 mm, 45 mm and 63 mm or
- using all the above-mentioned sieves.

The grain site shall be well graduated: the uniformity coefficient c_u of the grain size shall be $8 \le c_u \le 50$ for classes NNP1, NNP2 and NNP3 and $15 \le c_u \le 100$ for classes NNP4 and NNP5. The coefficient of curvature of granulation c_c shall be $1 \le c \le 5$.

The content of fines shall be determined at the same time as the granular composition test using the wet sieving process SIST EN 933-1. Before installation (on the landfill or on the construction site before hardening), the aggregate must contain from ≥ 3.0 % to ≤ 6.5 % of fines ≤ 0.063 mm (as a rule, category f_5). In the integrated layer, the aggregate may contain ≤ 8 % fine particles ≤ 0.063 mm. The grain size composition after installation shall be decisive for the assessment of conformity.

If the aggregate contains less than 3.0 % or more than 6.5 % of fine particles before installation, the installability or over-crushing size during compaction must be demonstrated by means of a test field.

Fine particles should not be plastic. The character of fine particles shall be determined by examination of the sand equivalent *SE*(10) according to the procedure SIST EN 933-8 or methylene blue *MB* according to the procedure SIST EN 933-9 [(4), (5)]. The character of fine particles shall be checked before and during installation, in accordance with the test programme. In case of doubt, it shall also be checked after installation. For classes NNP1 and NNP2, the requirements for *SE(10)* are ≥ 50 % or *MB* ≤ 1.5 g/kg. For classes NNP3, NNP4 and NNP5, the requirements for *SE(10)* are ≥ 40 % or *MB* ≤ 2.0 g/kg. The requirements must be met at the landfill, and during and after installation.

If the content of fine particles in the aggregate is less than 3 % by weight, such particles shall be considered harmless, regardless of their character.

Note 4: In borderline cases or in case of conflict, methylene blue or granular composition test with areometry is decisive (up to 3 % of particles ≤ 0.02 mm allowed). Alternatively, it is also possible to measure the specific surface area – humidity at 1500 kPa < 5 %.

Note 5: The limit values for methylene blue given in this TSPI are typical for materials from Slovenian and petrographically comparable foreign deposits (limestones, dolomites, carbonate gravel, carbonate silicate Drava gravel, silicate Mura gravel), but not for materials from foreign deposits of magmatic or metamorphic rocks. In these cases, it is recommended to evaluate the fines by examining the sand equivalent or granular composition by areometry (up to 3 % of particles ≤ 0,02 mm allowed) or other procedures (Enslin-Neff, suction).

The shape of coarse grains in classes NNP1 and NNP2 shall comply with the flakiness index requirement (SIST EN 933-3) for category FI_{20} (FI ≤ 20 %) or the shape index requirement (SIST EN 933-4) for category SI_{20} (SI ≤ 20 %). For classes NNP3, NNP4 and NNP, the required category is at most FI_{35} or SI_{40}.

The proportion of broken (crushed) and fully rounded coarse grains shall be determined in accordance with the procedure SIST EN 933-5. For classes NNP1 and NNP3, it must meet the requirement for category $C_{90/3}$. For class NNP2, the requirement is category $C_{70/10}$ for road construction and $C_{80/10}$ for railway. If crushed gravels of class NNP2 are installed in pavements with EH, VH and H traffic loads, additional stabilisation with cement binder is recommended. The requirement for class NNP4 is category $C_{50/30}$. Class NNP5 has no requirement for fragmentation of coarse grains – category C_{NR}.

3.2.3 Physical properties

Coarse grains in aggregates for the upper unbound load bearing layer must be mechanically and spatially stable and resistant to the effects of water and cold action. Depending on the traffic load, they must correspond to the following categories *LA* and M_{DE}:

Crushing resistance (Los Angeles test, SIST EN 1097-2) shall meet category LA_{30} (*LA* ≤ 30 %) for classes NNP1 and NNP2 and category LA_{35} (*LA* ≤ 35 %) for classes NNP3, NNP4 and NNP5.

Aggregates produced by crushing coarse grains of silicate Mura gravel typically exhibit Los Angeles crushing resistance values of between 30 and 35 %. At the same time, these aggregates show high wear resistance micro Deval M_{DE} ~ 10 %, so they can also be used in NNP2 class, despite a higher than required value of Los Angeles.

The wear resistance (micro Deval, SIST EN 1097-1) shall meet category $M_{DE}15$ (M_{DE} ≤ 15 %) for classes NNP1 and NNP2 and category $M_{DE}20$ (M_{DE} ≤ 20 %) for classes NNP3, NNP4 and NNP5.

3.2.4 Frost/thaw resistance

The aggregate for the upper unbound load bearing and wearing layers shall meet the requirements for frost and thaw resistance, SIST EN 1367-1 for categoryF_1 (F ≤ 1 %) or magnesium sulphate test, SIST EN 1367-2 for category MS_{18} with a required value of MS ≤ 10 %.

3.2.5 Chemical characteristics

The aggregate for the upper unbound load bearing layer must not contain harmful admixtures of humus or organic matter. The potentially present humus or organic matter must show a negative test in a 3 % NaOH solution (the colour of the solution may be equal to or lighter than the standard). Admixtures of solid, lithified coal particles (e.g. deposits in the lower Sava basin) are not considered humus substances, even if the reaction result is positive (colour darker than standard). The test must be carried out in accordance with SIST EN 1744-1, point 15.1.

3.3 Unbound wearing layer - NOP

The unbound wearing layer aggregate consists of the base skeleton and the wedging grains.

The characteristics of the basic skeletal aggregate of the NOP must reasonably meet the geometrical characteristics, as is the case for the upper unbound load bearing layers, unless otherwise specified by the design.

For a basic skeleton of 0/22 mm, 0/32 mm or 0/45 mm, the required granular category is G_A75. The aggregate of a basic skeleton may contain up to 25 % of oversized grains. In comparison with the requirements of the ZNNP, a higher content of fine particles is permissible.

Wedging grains should be selected depending on the granularity characteristics of the skeletal part of the layer. As a rule, aggregates with crushed grains must be used for wedging.

In cases where the rock grains of the basic skeleton are produced from solid and healthy rocks, crushed grain fractions of 0/8 mm are generally used for wedging, the proportion of fine particles of which after installation is within the range of 8 to 15 %.

In cases where the aggregate of the basic skeleton itself already contains a sufficient amount of fine particles and sand grains (e.g. crushed Drava gravel, less compact crumbly dolomites), it is recommended to use a pure fraction of the obtained grains of 2/4 mm for wedging.

The necessary characteristics of the grains for the wedging may generally be very different for the different materials of the basic skeleton. Therefore, to determine the optimal combination, it is recommended to carry out a test field.

4 Execution instructions

4.1 Extraction of natural aggregates

The natural aggregate must be obtained in a way that ensures constant and traceable quality. The spatial distribution of grains of different nominal sizes must be uniform and homogeneous. It must be prepared in such a way as to ensure an optimal proportion and an even distribution of moisture that allows optimal installation of the aggregate.

The contractor shall communicate the site of preparation of the aggregate for SNNP, ZNNP and NOP to the supervisor prior to the start of the work, and shall provide him with a certificate and declaration of performance/conformity indicating the declared quality of the aggregate. The compliance of the declared characteristics with the design requirements shall be verified by the supervisor, including, where appropriate, external quality control.

Aggregates for SNNP, ZNNP and NOP are construction products whose properties must be determined in accordance with the harmonised European standard SIST EN 13242 – *Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*. Individual construction products – aggregates for the lower and upper unbound load bearing layers and the unbound wearing layer shall have at least the following declared characteristics:

- SNNP (mineral capping layer): grain size, fine particle content, fine particle quality (sand and/or methylene blue equivalent), proportion of broken (crushed) and fully round grains (if required), resistance to fragmentation, resistance to freezing/thawing (category *F* or *MS*);
- ZNNP: grain size, fine particle content, fine particle quality (sand and/or methylene blue equivalent), proportion of broken (crushed) and fully round grains (if required), resistance to fragmentation, resistance to freezing/thawing (category *F* or *MS*);
- NOP: grain size, fine particle content, proportion of broken (crushed) and fully round grains (if required).

Construction products of rock aggregates for ZNNP, as a rule also for SNNP and NOP, must satisfy the 2+ assessment and verification system defined in the standard SIST EN 13242, Appendix ZA. The manufacturer or authorised representative shall demonstrate the conformity of the factory production control by means of a certificate of conformity issued by a designated notified body and a declaration of performance/conformity declaring the quality characteristics of the product.

For aggregates for SNNP and NOP, it is permissible to apply assessment and verification system 4, defined in the SIST EN 13242 standard, Appendix ZA. The same system 4 may also be used for ZNNP aggregates, but only for installation in carriageways with very light and light traffic load. The characteristics of the aggregate shall be declared by the manufacturer or authorised representative on the declaration of performance/conformity. In the case of system 4, the manufacturer must also submit, upon request of the inspection authority, the results of the initial type test and periodic tests, which must be carried out in accordance with standard SIST EN 13242, Annex ZA.

If a construction product is manufactured on a construction site for installation into the construction works in accordance with the applicable national rules, where the persons responsible for the installation are those responsible for the safe execution of the construction works in accordance with the applicable national rules, the manufacturer may choose not to draw up a declaration of performance as defined in Article 5 of *Regulation (EU)* No 305/2011 (CPR) or Article 14 of *Regulation (EU)* No 2024/3110. Despite the possibility of deviation from the drawing up of the declaration of performance/conformity and the certificate, such a product must meet the quality characteristics consistent with the project. For such products, the manufacturer must ensure that laboratory tests are carried out at the frequencies specified in SIST EN 13242, appendix ZA, or in accordance with the requirements of the contracting authority set out in the invitation to tender. He shall provide the results of the tests to the supervisor and the external control on request.

4.2 Disposal of aggregate

As a general rule, the aggregate is deposited at the place of origin with the producer. The Contractor shall communicate the site of preparation and deposit of the aggregate to the Supervisor before the start of the work.

Depending on project requirements, additional sampling and testing of specified aggregate properties (landfill tests) shall be carried out on landfills before delivery to the construction site by the IQC and the EQC. Additional investigations cannot replace the investigations that the manufacturer is required to carry out at the prescribed frequencies in accordance with the factory production control requirements.

Temporary or construction site landfills of materials must meet the following requirements:

- the base of the landfill must be cleaned and level;
- mixing of the deposited material with the substrate materials must be prevented;
- the landfill must be built in layers up to 0.5 m thick and up to 6 m high;
- the landfill must be protected from adverse weather effects or effects from the construction site.

The requirements regarding cleanliness, substrate, and protection also apply to the manufacturer's landfills.

The homogeneity and uniform humidity as well as the granularity and character of the fine particles of the aggregate in the landfill must be checked before removal for installation into the lower and upper unbound load bearing layers.

4.3 Preparation of the base formation

The base of the lower unbound load bearing layer – unbound subbase is/may be:

- subsoil in rock,
- mechanically hardened, improved or stabilised subsoil with binders (subsoil formation),
- embankment constructed from mechanically hardened or binder-stabilised soils, stone, recycled or secondary materials (finishing layer or embankment formation),
- rideable base.

When the subsoil is built on frost and weather-resistant rock, as a rule, SNNP is not installed. Only a levelling layer made of aggregate that meets the quality characteristics of the aggregate for SNNP or ZNNP shall be installed. When the SNNP substrate is constructed by soil with low or variable bearing capacity, this should be taken into account in particular when sizing. The less favourable condition of the soil (CBR2 of the naturally moist sample after saturation with water) shall be taken into account.

Special attention should be paid to soft rocks that decompose upon contact with water (e.g. flysch, marl, siltstone, clayey). Such soft rocks, despite their initial hardness due to the action of water, decay, which leads to a decrease in bearing capacity (e.g. the cut Goli vrh in flysch clasts on the highway between Razdrto and Senožeče). In such cases, adequate drainage should be ensured and floors made of soft rock should be upgraded with SNNP of suitable thickness.

When the composition of the material in the foundation soil or in the finishing layer of the embankment meets the criteria for SNNP (point 3.1) and allows to ensure density and bearing capacity (points 6.1.2 and 6.2.2), the mechanically hardened subsoil or the finishing layer of the embankment may be valued as SNNP. The formation of the subsoil or embankment shall be prepared and accepted by the supervisor in accordance with the requirements of this document.

The base of the upper unbound load bearing layer is the lower unbound load bearing layer (unbound subbase), it can also be a stabilised aggregate with binders or it can be clipped, weather-resistant and frost-resistant rock. The SNNP formation shall be prepared and accepted by the supervisor prior to being upgraded with the ZNNP, in accordance with the requirements of this document.

4.4 Aggregate delivery

The delivery of aggregate for SNNP may only take place on previously spread SNNP aggregate. Under no circumstances may material be delivered over previously compacted and taken over subsoil formation (or embankment) made of cohesive soils.

The delivery of aggregate for ZNNP (and NOP) may only be carried out on aggregate that has already been spread. It is not recommended to deliver material on the prepared and taken over SNNP formation, except in exceptional cases or if specifically permitted by the supervisor. In cases of construction under traffic, where it cannot be guaranteed that no traffic will take place on the spread or even the already taken over layer, the protection of the layer shall be carried out in accordance with point 6.4 of the TSPI.

If the aggregate is to be delivered on an uncompacted layer, the passages of the individual vehicles must be distributed as evenly as possible over the width of the unfolded aggregate.

Vehicles with mudded wheels or undercarriage shall not travel on an already unfolded or compacted layer.

In the case of the installation of aggregate into unbound load bearing (and unbound wearing) layers in a large number of layers, each layer must be properly shaped and compacted before starting the loading of the next one.

The aggregate may segregate during transport and emptying of vehicles, therefore vehicles should be emptied by slowly tilting them backward or sideways while slowly moving the vehicle forward.

In the case of unbound wearing layers, the delivery of the skeletal base of the aggregate must be separated from the wedging aggregate.

5 Method of implementation

5.1 Paving (Installing)

When delivered to the construction site, the requirements for the composition and uniformity of the aggregate must be met. The aggregate must contain an appropriate moisture content for optimal installation.

If the aggregate is found to be insufficiently moist during installation, water may be added before compaction, but only by sprinkling. This prevents the washing out of fine particles and segregation, as well as the softening of cohesive soils in the SNNP base if they form the final layer of the embankment or the subsoil.

During installation, the moisture content of the aggregate may deviate from the optimum moisture content according to Proctor, as a rule, up to ± 2 m.-% or so as to ensure the prescribed compaction.

Spreading should generally be carried out using a grader and/or bulldozer. In the ZNNP, the aggregate can also be installed with a finisher. Manual installation shall be permitted only in places which cannot be reached by the machinery or if specifically authorised by the supervisor.

When selecting the compaction machine and the aggregate installation process, the following shall be taken into account:

- the thickness, surface area and number of layers to be installed;
- the requirements for the installed layer to be fulfilled;
- the conditions on the construction site (e.g. scope of necessary measures for installation, capacity, course of work, possibility of using machinery);
- quality of the substrate (trafficability, evenness);
- the characteristics of the aggregate to be installed (maximum grain size).

The thickness of the layer of the unfolded aggregate shall be such that, after compaction, the thickness prescribed in the project will be reached.

The minimum permissible thickness of the aggregate layer in compacted condition, depending on the largest grain size in the aggregate is shown in Tables 5.1 (SNNP) and 5.2 (ZNNP).

Table 5.2: *Minimum permissible thickness of the lower unbound load bearing layer depending on the largest grain size*

Grain size in SNNP d/D [mm]	Minimum permissible layer thickness [cm]
0/63 0/90 0/125	≥ 20 ≥ 25 ≥ 30

Table 5.3: *Minimum permissible thickness of the upper unbound load bearing layer depending on the largest grain size*

Grain size in ZNNP d/D [mm]	Minimum permissible layer thickness [cm]
0/22 0/32 0/45	≥ 12 ≥ 15 ≥ 20

Proper execution of the unbound wearing layer requires a minimum layer thickness of 15 cm.

The maximum permissible installation thickness in one layer is 50 cm (SNNP) and 30 cm (ZNNP and NOP).

5.2 Compaction

5.2.1 General

The method of compaction of the spread aggregate depends on the quality of the substrate and the method of installation. In order to prevent moisture loss in the aggregate, compaction should be started immediately after spreading.

5.2.2 Test field

The purpose of the test field is to verify the intended installation technology, the suitability of the machinery – in particular the compacting agents. The necessary compaction energy (type and number of transitions of the compaction agent) and the compaction method (depth, surface, oscillation, vibration, static, etc.) must be determined on a test field.

The effect of the compacting agent must be measured after each transition for each type of aggregate. The recommended minimum length of the test field should be 20–40 m to ensure the appropriate length of the measurement section. Machinery start-up and shut-down areas are not suitable for performing measurements.

Before compaction begins, aggregate samples must be taken to determine:

- optimal humidity and maximum dry mass by the modified Proctor method (SIST EN 13286-2 or SIST EN 13286-2, Appendix A),
- granular composition of the aggregate (SIST EN 933-1),
- the character of fine particles (SIST EN 933-8 and/or SIST EN 933-9).

During compaction and after the completion of compaction, the following shall be performed on the SNNP, ZNNP or NOP formations of the measuring section:

- measure the density and moisture with a non-destructive method using an isotope meter (TSC 06.711). If necessary, alternative procedures for the determination of density and moisture (TSC 06.712) shall be used to verify the results; measurements need not be carried out on an unbound wearing layer;
- measure bearing capacity by determining the static and dynamic deformation module (TSC 06.720);
- after compaction has been completed, samples of the installed aggregate are taken from the test field for determining the granular composition and character of fine particles after compaction (SIST EN 933-1, SIST EN 933-8 or SIST EN 933-9).

In the test field, it is recommended to use compaction agents which, by means of built-in measurement equipment, allow continuous control of the achieved compaction (CCC), which is particularly appropriate for large infrastructure projects.

The results of the measurements of the tests in the test field given in the report shall form the basis for the detailed determination of the technological process and the type of compaction agent, which must be defined in the technological study to be carried out before the start of the works. The results are also evidence that the properties of the stone grains, even after compaction, comply with the quality requirements of the TSPI.

5.2.3 Compaction process

The spread aggregate in the planned profile must be compacted with appropriate compaction agents across the entire width of the layer.

In the selection of compaction agents, priority shall be given to those which, with installed measuring equipment, permit continuous control of the achieved compaction (CCC), in accordance with the procedures described in TSC 06.713 *Density measurements – Continuous surface dynamic measurement procedures*. This applies in particular to large infrastructure projects with large areas and lengths of aggregate installation areas (e.g. new construction of motorways, expressways, railways, bypass roads, wide urban access roads, airports, etc.).

The compaction should start from the outer edges of the layer towards the middle and from the lower edge of the layer towards the higher. In order to ensure adequate compaction and bearing capacity throughout the design width of the layer, the layer at each edge should be extended for the designed compaction of the layer + 10 cm.

The first transition of the compaction agent should be static to prevent segregation of the aggregate grains, especially on the surface of the layer. Compaction should continue with vibration until the prescribed compaction and bearing capacity are achieved. Due to vibrations, the loosened surface must be compacted statically at the end of compaction; compaction agents with rubber wheels are particularly suitable for this purpose.

It is recommended to check the appropriate number of transitions of the compaction agent determined on the test field by means of continuous compaction tests of the installed aggregate.

If during compaction it is found that the moisture for optimal compaction is too low, the aggregate should be moistened further by sprinkling, but in no case by pouring with a strong jet.

All areas inaccessible to compaction machines must be compacted to the required degree of compaction using other means approved by the supervisor.

After completion of compaction, the compaction and bearing capacity of the layer should be measured in accordance with the programme of average internal and external control frequencies and the requirements in chapter 7.6.

If the layer measurements reveal individual areas where the specified compaction and/or bearing capacity has not been achieved or where there is significant segregation, these must be corrected by additional measures (e.g., additional compaction, removal and replacement of material, etc.).

When installing SNNP on poor supporting ground, static compaction procedures with lighter machinery should be used to avoid the occurrence of rubber cushion/soil collapse in the substrate.

6 Quality of the work performed

This TSPI provides generally applicable requirements for compaction, bearing capacity, flatness and protection/care of the lower and upper unbound load bearing layer and unbound wearing layer. The designer may use the requirements given in this TSPI, as part of the dimensioning of the roadway structures of the transport infrastructure, but may also prescribe higher/lower requirements.

6.1 Compaction

6.1.1 Compaction measurements

The compaction is determined by a non-destructive rapid compaction and moisture measurement procedure using the isotopic meter specified in TSC 06.711.

Occasionally, but always in case of doubt, the results of the compaction measurements with the isotopic meter should be verified by other appropriate procedures for the determination of compaction and moisture specified in TSC 06.712(6).

The Contractor may also demonstrate the compaction of the installed layers by the process of continuous control of achieved compaction (CCC), in accordance with the procedures described in TSC 06.713, and in combination with established compaction and bearing capacity measurement procedures(7).

6.1.2 Requirements for compaction

The compaction in the SNNP and ZNNP of the installed aggregate must be at least 98 % on average based on the maximum compaction according to the modified Proctor procedure (SIST EN 13286 or SIST EN 13286, Appendix A).

The values given represent the average compaction values of each acceptance.

The lower compaction limit may deviate from the average by no more than 3 %.

Note 6: Due to the safety requirements to be met when using radioactive isotope meters, alternative meters are available on the market for non-destructive measurements of the compaction and moisture of aggregates and soils (e.g. electromagnetic probe, ASTM D7830/D7830M-14:2021). The comparability of the results of compaction and moisture measurements with alternative meters and established measurement procedures during the preparation of this TSPI has not yet been systematically demonstrated in Slovenia. Until the adoption of the regulation, the results of alternative measurements without parallel measurements using an isotope probe and other regulated substitute procedures cannot be recognized as equivalent. When the procedure for compaction and moisture measurements with alternative non-destructive meters will be included in the national regulation (supplement TSC 06.712 or new TSPI for the subject area), the latter shall be taken into account in this TSPI.

Note 7: Measurements of the compaction/bearing capacity of the installed layer are, as a rule, point-based. The CCC equipment shall enable continuous measurements to be made. In cases where CCC-measurement is not available, it is recommended to observe visually the deformations of the installed layer under the tyres of a slow-moving heavy-duty truck or heavy roller at the time of acceptance. The areas with detected deformations should be particularly carefully examined, the causes of the deformations should be established and, if necessary, corrected.

6.1.3 Measurements of bearing capacity

The bearing capacity on the formations of SNNP, ZNNP and NOP shall be measured according to the TSC 06.720 procedures defined as follows:

- with a circular load plate (in practice a German procedure with a static plate or VSS plate) and a static load to determine the values of the deformation modules E_{vs1} and E_{vs2} — static deformation module. Loading in the unbound subbase, as a rule, is carried out at the rates of 0.05 MPa, and in the unbound load bearing and unbound wearing layer, as a rule, at the rates of 0.07 MPa;
- with a circular load plate with a drop light weight (in practice a dynamic plate) or a dynamic load to determine the value of the dynamic deformation module E_{vd}.

The Contractor may also demonstrate the bearing capacity of the installed layers by the process of continuous control of achieved compaction (CCC), in accordance with the procedures described in TSC 06.713, and in combination with classic compaction and bearing capacity measurement procedures.

Verification of bearing capacity exclusively with a dynamic plate with falling weight shall not be permitted unless otherwise specified in the project or in the average frequency programme and in cases where due to limited space it is not possible to ensure the appropriate conditions for the measurements. Combined measurements must always be carried out using the static load procedure.

6.1.4 Requirements for bearing capacity

6.1.4.1 Lower unbound load bearing layer (unbound subbase) of the carriageways

The bearing capacity or value of deformation modules achieved on SNNP of roadways must, depending on the expected traffic loads and unless otherwise specified in the project, be as follows:

– $E_{vs2} \geq 100$ MPa and $E_{vd} \geq 45$ MPa (traffic loads: EH, VH, H),

– $E_{vs2} \geq 80$ MPa and $E_{vd} \geq 40$ MPa (traffic loads: M, L, VL).

The deformation modules ratio E_{vs2}/E_{vs1} shall be ≤ 2.5. The indicated ratio E_{vs2}/E_{vs1} is not decisive for the assessment of the bearing capacity of the layer if the value E_{vs1} is ≥ 50 % of the required value E_{vs2}.

If the base of the SNNP is rocky ground and/or embankments made of crushed stone grains, the required bearing capacity values on the SNNP formation of pavements with extremely heavy and very heavy traffic loads may also be conditionally higher: $E_{vs2} \geq 120$ MPa and $E_{vd} \geq$ 55 MPa.

6.1.4.2 Lower unbound load bearing layer of the lower railway structure

The bearing capacity or value of the deformation modules achieved on the SNNP of the lower structure of the railway must be:

– $E_{vs2} \geq 80$ MPa and $E_{vd} \geq 40$ MPa on main lines (new construction)(8).

– $E_{vs2} \geq 60$ MPa and $E_{vd} \geq 30$ MPa on regional lines and industrial tracks and exceptionally (recommendation) when upgrading main lines with bound soil substrate(8).

The deformation modules ratio E_{vs2}/E_{vs1} shall be ≤ 2.2. The stated ratio E_{vs2}/E_{vs1} is not decisive for the assessment of the bearing capacity of the layer if the value E_{vs1} is ≥ 60 MPa.

Note 8: Experience with upgrades of main railway lines in Slovenia shows that, according to *the Rules on the Lower Structure of Railway Lines,* the requirement for bearing capacity of the SNNP $E_{vs2} \geq 80$ MPa is too strict in relation to the designed thickness of SNNP if it is installed on a base made of bound soils of low bearing capacity. Preliminary estimates of the bearing capacity of the soil/embankments from bound soil on which the dimensioning is based are usually overestimated. Nevertheless, after upgrading the SNNP, which achieves a bearing capacity E_{vs2} ~ 50 to 60 MPa, with a 0.3 m thick layer of ZNNP, it is possible to achieve the bearing capacity of ZNNP E_{vs2} ≥ 100 Mpa required by the *Rules*.

6.1.4.3 Upper unbound load bearing layer of carriageways

The bearing capacity or value of deformation modules achieved on the ZNNP formation of carriageways must, depending on the traffic load, and unless otherwise specified in the project, be:

- E_{vs2} ≥ 150 MPa and E_{vd} ≥ 70 MPa (traffic loads: EH, VH, H)
- E_{vs2} ≥ 120 MPa and E_{vd} ≥ 55 MPa (traffic load: M)
- E_{vs2} ≥ 100 MPa and E_{vd} ≥ 45 MPa (traffic load: L, VL).

The bearing capacity ratio E_{vs2}/E_{vs1} shall be ≤ 2.2. The indicated ratio of the deformation modules E_{vs2}/E_{vs1} is not decisive for the assessment of the bearing capacity of the layer if the value E_{vs1} ≥ 60 % of the required value E_{vs2}.

On municipal and local roads with medium traffic load, lower requirements for the bearing capacity of the ZNNP can also be designed: E_{vs2} ≥ 100 MPa and E_{vd} ≥ 45 MPa. The same applies to cycle paths and pedestrian corridors located outside mixed traffic areas: E_{vs2} ≥ 80 MPa and E_{vd} ≥ 40 MPa.

Where an aggregate of class NNP1 is installed in the ZNNP and the SNNP substrate is a stone foundation soil and/or embankments made of crushed stone grains, the required values of bearing capacity of the ZNNP formation of pavements with an extremely heavy and very heavy traffic load may also be conditionally higher: E_{vs2} ≥ 180 MPa and E_{vd} > 70 Mpa. On motorways as well as on other roads, we often achieve bearing capacity E_{vs2} higher than 200 MPa without much difficulty, where the requirement of bearing capacity E_{vs1} ≥ 108 MPa is mostly unattainable and above all unnecessary. It should be noted that carbonate aggregates from some deposits, despite meeting all quality requirements, do not allow to achieve the rationE_{vs2}/E_{vs1} without adverse consequences of compaction on the structure and functionality of stone grains.

6.1.4.4 Upper unbound load bearing layer of lower railway structure

The bearing capacity or value of the deformation modules achieved on the formation of the upper unbound load bearing layer of the lower railway structure must be:

- E_{vs2} ≥ 100 MPa and E_{vd} ≥ 45 MPa on main lines[(9)],
- E_{vs2} ≥ 80 MPa and E_{vd} ≥ 40 MPa on regional lines,
- E_{vs2} ≥ 60 MPa and E_{vd} ≥ 30 MPa on industrial tracks.

The bearing capacity ratio E_{vs2}/E_{vs1} shall be ≤ 2.2. The indicated ratio of the deformation modules E_{vs2}/E_{vs1} is not decisive for the assessment of the bearing capacity of the layer if the value E_{vs1} ≥ 60 % of the required value E_{vs2}.

6.1.4.5 Unbound wearing layer

The bearing capacity on the unbound wearing layers of the carriageways must be:

- E_{vs2} ≥ 100 MPa and E_{vd} ≥ 45 MPa (traffic load: L)
- E_{vs2} ≥ 80 MPa and E_{vd} ≥ 40 MPa (traffic load: VL)

The bearing capacity ratio E_{vs2}/E_{vs1} shall be ≤ 2.2. The indicated ratio is not decisive for the assessment of the bearing capacity of the layer if the value E_{vs1} is ≥ 60 % of the required value E_{vs2}.

Note 9: The German and Swiss guidelines allow for lower bearing capacity requirements for works on existing lines: E_{vs2} ≥ 80 MPa for lines with speeds higher than 160 km/h and E_{vs2} ≥ 50 MPa for all remaining lines.

6.2 Straightness, height and inclination

6.2.1 Road requirements

The elevation deviation of the formation of the layer at any point may deviate from the designed angle:

– a maximum of ± 30 mm for SNNP, and

– a maximum of ± 15 mm for ZNNP.

The straightness of the formation of the layer may deviate from the 4 m long measuring rail placed in any direction on the axis of the road:

– a maximum of 15 mm for ZNNP.

If such deviations from the straightness are followed successively, the contractor shall draw up a remediation proposal, which shall be approved by the supervisor before implementation.

The inclination of the SNNP, ZNNP and NOP formations of the pavements shall, as a general rule, be equal to the transverse and longitudinal inclination of the pavement, but shall not deviate from the planned inclination by more than ± 0,4 % of the absolute value of inclination.

6.2.2 Railway requirements

In the case of railways, the requirements of *the Rules on the lower structure of railway lines,* which are the same for main and regional lines and industrial tracks, shall apply mutatis mutandis.

The altitude deviation of the formation at any location may deviate from the planned angle:

– a maximum of ± 25 mm for SNNP, and

– a maximum of ± 10 mm for ZNNP.

The straightness of the formation may deviate from the 4 m long measuring rail placed in any direction on the track axis:

– a maximum 30 mm for SNNP, and

– a maximum 20 mm for ZNNP.

The transverse inclination of the formations of the SNNP and the ZNNP must be at least 5 %, the permissible deviation from the design inclination shall be not more than 1 % in the case of SNNP and 0.4 % in the case of ZNNP.

The straightness measurement procedure is detailed in TSC 06.610.

6.3 Surface protection and care

After the lower and upper unbound load bearing layers have been carried out and taken over, transportation of vehicles, machinery or construction site transports are not permitted. The built SNNP and ZNNP must have a homogeneous structure, the grains must be and remain well splined and clamped to each other.

If necessary due to the nature of the further work, the protection of SNNP and ZNNP formations against pollution (muddying) must be ensured and the driving speed must be limited to a maximum of 20 km/h. This is particularly important for work carried out under traffic, in partial closures, etc., where it is difficult to prevent adverse effects of traffic loads. In the event of pollution by fine particles, binding soils (muddying), salts and over-crushing, such a layer shall be removed and replaced by a suitable layer before upgrading with the next layer. In order to avoid this, it is recommended to upgrade the SNNP by 10 cm and the ZNNP by at least 5 cm to protect the surface. Preparing the formation for the planned angle is carried out by removing excess stone grains, leveling the height, additional hardening and taking over before upgrading with the next layer.

If SNNP and ZNNP have been exposed to adverse weather and other natural influences (rain, snow, low temperatures, unwanted foraging, etc.), the contractor must – if necessary – carry out remediation. Before installing the next layer, the exposed layer must be prepared again for qualitative acceptance (as a rule, additional hardening of the layer, if necessary, removal of a part of the layer and replacement with new material...). Qualitative acceptance includes measurements of compaction and bearing capacity and of geometrical characteristics (height, straightness, inclinations).

The upper unbound load bearing layer should be additionally protected from drying (by additional moistening, by sprinkling).

In order to ensure water permeability, the surfaces of the SNNP and the ZNNP must not be sanded. This would change the granular composition and properties of the aggregate.

SNNP and ZNNP must be upgraded with the next layer as soon as possible (ZNNP, recycling with cement or bitumen, asphalt, concrete, track ballast, etc.). In this way, the prescribed properties of the layers are preserved without additional interventions.

7 Verification of the quality of the work carried out

The quality of the installed aggregates and the implementation of SNNP, ZNNP and NOP must meet the requirements set out in points 3 and 6 of this TSPI.

In the light of the envisaged conditions of use, the contracting authority has the right and duty to require a higher level of quality and to lay down additional requirements in the tendering procedure. Similarly, as part of the dimensioning of the pavement structures of the transport infrastructure, the designer may use the requirements given in this TSPI, but may also prescribe higher/lower requirements.

The quality of the basic and installed materials used and the conformity of the works carried out with the requirements of this TSPI and/or the contractual provisions shall be checked:

- with preliminary checks of the manufacturer/supplier’s documentation,
- with internal quality control (IQC),
- with external quality control (EQC),
- if necessary by means of control tests.

The frequency of tests to determine the quality of the work performed is determined by the average frequency of internal and external controls.

7.1 Preliminary checks of the manufacturer’s/supplier’s documentation

In accordance with point 4.1 of this TSPI, the quality characteristics of the aggregates are defined in the declarations of performance[(10)], technological studies, initial type test reports, reports containing the results of the on-going laboratory tests of the manufacturer/supplier...

The initial type test reports and the results of the periodic internal production control tests shall be duly documented and made available to the Contractor, the Supervisor and the EQC upon request.

The contractor or the internal quality control of the contractor must carry out a detailed examination and verification of the manufacturer’s or supplier’s documentation already in the preparation phase of technological studies and the search for resources that meet the quality requirements of this TSPI and/or the design requirements.

Before supplying and first installing the aggregate on the construction site, the supervisor and/or the EQC must check the documentation and determine whether the declared properties and results of laboratory tests of the aggregate actually meet the requirements set out in point 3 of this TSPI and/or the design requirements.

7.2 Internal quality control (IQC)

During the execution of the works, the contractor must ensure the internal control performed by the contractor's qualified laboratory or on its behalf by another qualified laboratory. The laboratory carrying out the internal control shall comply with the conditions set out in point 7.1 of TSC 04.100. The laboratory performing internal control tasks must provide evidence of the competence of its personnel and the metrological traceability of its equipment for performing the required measurements and tests in the average frequency programmes. If so requested or in case of doubt, the above may be checked by the Supervisor and/or the EQC prior to the execution and at any time during the execution phase of the works. This is not required if the IQC provider has the laboratory test procedures in question within the scope of accreditation under standard SIST EN ISO/IEC 17025, as evidenced by an accreditation document and an annex to the accreditation document.

The internal control shall determine the conformity of the aggregate characteristics and the properties of the installed layers with the requirements given in this TSPI and/or in the contractual requirements. The frequency and type of tests carried out by internal quality control shall be laid down in the approved average quality control frequency programme.

If specified in the average frequency programme, the IQC contractors must ensure that the following laboratory and field tests are carried out:

- granularity and percentage of fine particle (SIST EN 933-1),
- sand equivalent and methylene blue (SIST EN 933-8 and SIST EN 933-9),
- percentage of broken grain surfaces (SIST EN 933-4),
- determination of the potential presence of humus (SIST EN 1744-1, point 15.1),
- determination of optimum moisture and maximum volumetric mass by the modified Proctor procedure (SIST EN 13286-2 or SIST EN 13286-2, Appendix A),
- compaction with isotope probe (TSC 06.711),
- bearing capacity with falling-weight dynamic plate and static plate (TSC 06.720).

In the event that the supervisor identifies major deviations from the results of previous tests in ongoing tests, it may further increase the scope of the minimum on-going tests. On the basis of the proposal of the Contractor, the Supervisor may also reduce the frequency of tests in the case of homogeneous results.

Note 10: The declaration of performance does not necessarily provide all the information from which a conclusion can be drawn as to the performance of the product and its conformity with the design requirements. Some of the categories declared in the declaration of performance do not sufficiently define the actual characteristics of the aggregate. E.g. MS_{18} is the lowest category according to SIST EN 13242 and represents the result of the test *MS* from 0 % to 18 %. Since the aggregate for ZNNP requires MS ≤ 10 %, in case of doubt or lack of knowledge of the aggregate compliance has to be further verified (results in initial type test reports, results of periodic examinations by the manufacturer, etc.).

Exceptionally, the quality of installed SNNP, ZNNP and NOP may also be determined according to other recognised procedures, which must be approved in advance by the designer and the contracting authority. In this case, in agreement with the designer and the contracting authority, the criteria for the quality of installation and the method and scope of the tests must also be indicated.

Internal control should carefully and diligently perform measurements and tests to the required extent, which is not only under the responsibility of the laboratory, but also under the responsibility of the contractor. If it identifies deviations from the requirements set out in this TSPI and/or in the contractual requirements, the contractor and the IQC must identify the reasons for these deviations and take immediate action. The derogations and the measures envisaged to ensure that the quality requirements are met must be notified to the supervisor and to the EQC.

The results of the internal control must be documented and made available at all times to the supervisor and the EQC.

7.3 External quality control (EQC)

External control shall be provided by the contracting authority. On his behalf, external quality control shall be carried out by an institution which must have the laboratory testing activity accredited according to the SIST EN ISO/IEC 17025 standard.

If defined in the average frequency programme, the EQC contractors must ensure that the following laboratory and field tests are carried out, which must be within the scope of accreditation, as the EQC proves by means of an annex to the accreditation document:

- granularity and percentage of fine particle (SIST EN 933-1),
- fine particle character – sand equivalent and methylene blue (SIST EN 933-8 and SIST EN 933-9),
- percentage of broken grain surfaces (SIST EN 933-4),
- determination of the potential presence of humus (SIST EN 1744-1, point 15.1),
- Los Angeles fragmentation resistance (SIST EN 1097-2)
- frost resistance (SIST EN 1367-1 or SIST EN 1367-2),
- determination of optimum moisture and maximum volumetric mass by the modified Proctor procedure (SIST EN 13286-2 or SIST EN 13286-2, Appendix A),
- compaction with isotope probe (TSC 06.711),
- bearing capacity with falling-weight dynamic plate and static plate (TSC 06.720).

External control supervises internal control, determines the conformity of the produced aggregate and installed layers with the requirements given in this TSPI and/or in the design requirements. The results of external control, which are given in the final report, are the basis for taking over and accounting for the works of SNNP, ZNNP and NOP.

The taking of samples as well as field tests shall take place in the presence of the Contractor and, as a general rule, the Supervisor. The Contractor shall be obliged to ensure the presence of personnel at the acceptance.

7.4 Control tests

Control tests may be ordered by the contractor or the contracting authority or by an approved institution if he considers that the results of the internal or external control do not reflect the actual state of the work carried out. Control tests must be carried out by an independent institution whose activity and laboratory testing procedures must be accredited in accordance with the SIST EN ISO/IEC 17025 standard and which did not participate in the implementation of internal or external control and is determined in an agreement between the contractor and the investor or an institution authorised by the investor.

The costs of the control tests shall be borne by those whose results deviate more from the control results, taking into account the fulfilment of the design requirements.

7.5 Average Quality Control Frequency Programme

The quality of implementation of the SNNP, ZNNP and NOP shall be checked in accordance with the frequency given in this TSPI, on the basis of which a programme of average internal and external control frequencies must be drawn up.

As a general rule, the internal control programme is drawn up by the contractor or internal control of the contractor or other qualified manufacturer on the basis of the quantities and minimum frequency of tests, in accordance with point 7.6 of the TSPI. The average frequency programme for IQC, prepared in a clear tabular format, must include the date of preparation, number or version, and name of the preparer. As a rule, the programme is reviewed and approved by the supervisor and/or the EQC. The programme may also be an integral part of the contractor’s technological study for pavement structures, which shall be reviewed and approved by the supervisor.

The external control programme may be drawn up by the institution, supervisor or contracting authority. The programme definitively specifies the frequency of testing, which is also confirmed by the contracting authority or a supervisor authorised by it.

When carrying out quality control, it is necessary to take into account the specificity of smaller construction sites or reconstructions, where sections are usually short, and works are carried out in several phases and under traffic, in partial closures, etc. In such cases, the scope of tests into the compaction and bearing capacity after installation should be proportionately increased in such a way that all phases of the execution of works are covered by the control. Since it is more difficult to predict such specificities in advance in test programmes, it should be possible to reasonably adapt the test programme during its implementation, taking into account the actual situation on site, subject to prior approval by the supervisor.

7.6 Minimum frequency of internal and external quality control tests

The minimum frequency of tests for the internal and external quality control of the aggregate and installed layers of SNNP, ZNNP and NOP is given in Tables 7.1, 7.2, 7.3 and 7.4. The type and frequency of tests shall be differentiated into:

- preliminary tests of the characteristics of the aggregate – usually on landfill,
- tests on the properties of the aggregate during installation; and
- tests on the properties of the aggregate and the installed layer.

The frequency of tests shall depend on the nature and specificity of the construction sites (motorways, express roads, wide urban entry roads, large homogeneous areas, main and regional roads, railways, etc.). The producer must take this into account when drawing up the average frequency programme.

7.6.1 Preliminary tests of the properties of aggregates

By carrying out preliminary tests, the IQC and the EQC shall verify the characteristics for the installation of the intended aggregate and compliance with the design requirements. Preliminary tests shall be carried out on landfills with the manufacturer (applicable to large and, as a general rule, medium-sized infrastructure projects) and in intermediate or construction site landfills.

Preliminary tests shall consist of representative sampling (according to SIST EN 932-1 or other comparable documented procedures), appropriate packaging and transport to the laboratory, laboratory tests and the production of a test report.

In preliminary tests, the results of factory production control carried out by the manufacturer at the plant at the prescribed intervals in accordance with the requirements of harmonized standard SIST EN 13242, Appendix ZA, may also be taken into account.

The average frequency of internal and external quality control of preliminary tests (in landfills) of aggregates characteristics for SNNP is given in Table 7.1 and for NNP and NOP in Table 7.2.

Table 7.4: *Average frequency of preliminary tests of aggregate properties for SNNP at the landfill*

Preliminary tests (landfill)	Test procedure		IQC	EQC
examination and sampling of the landfill	SIST EN 932-1	m^3	1000	4 000
grain size and proportion of fine particles	SIST EN 933-1	m^3	1000	4 000
quality of fine particles[1]	SIST EN 933-8 ali SIST EN 933-9	m^3	2 000	8 000
proportion of crushed grains (if required)	SIST EN 933-5	m^3	2 000	8 000
potential presence of humus particles	SIST EN 1744-1, pt. 15.1	m^3	4 000	16 000
Proctor test	SIST EN 13286-2	m^3	4 000	16 000
frost resistance[2]	SIST EN 1097-6, 1367-1, 1367-2	m^3	10 000	40 000

[1] Only in cases where the share of fine particles is > 5 %.
[2] Verified by EQC, and IQC only in case of doubt or unknown new source without declared properties.

Table 7.5*: Average frequency of preliminary tests of aggregate properties for ZNNP and NOP at the landfill*

Preliminary tests (landfill)	Test procedure		IQC	EQC
examination and sampling of the landfill	SIST EN 932-1	m^3	1000	4 000
grain size and proportion of fine particles[1]	SIST EN 933-1	m^3	1000	4 000
grain size and proportion of fine particles[2]	SIST EN 933-1	m^3	1000	4 000
quality of fine particles[3]	SIST EN 933-8 ali SIST EN 933-9	m^3	2000	8 000
form of coarse grains	SIST EN 933-3 ali SIST EN 933-4	m^3	4 000	16 000
proportion of crushed grains (if required)	SIST EN 933-5	m^3	2 000	8 000
potential presence of humus particles	SIST EN 1744-1, pt. 15.1	m^3	4 000	16 000
Proctor test	SIST EN 13286-2	m^3	4 000	16 000
crushing resistance (LA)[4]	SIST EN 1097-2	m^3	10 000	40 000
wear resistance (Micro Deval)[4]	SIST EN 1097-1	m^3	10 000	40 000
frost resistance[4]	SIST EN 1367-1 ali 1367-2	m^3	10 000	40 000

[1] Unbound load bearing layer or skeletal base of unbound wearing layer.
[2] Grains for wedging.
[3] Only in cases where the share of fine particles is > 3 %.
[4] Verified by EQC, and IQC only in case of doubt or unknown new source without declared properties.

7.6.2 Tests of the properties of the aggregate during construction and after installation

During construction, the aggregate shall be sampled to determine the granular composition, content and character of fine particles. If necessary, IQC may also carry out additional compaction measurements to optimise the installation.

The examinations of the installed layers shall include, in particular, measurements of compaction and bearing capacity, and, if necessary and in case of doubt, the taking of samples from the installed layer to determine the grain composition and character of fine particles after the end of compaction. After installation, samples must be taken from the compacted parts of the layer. Samples taken from the edges of installed layers and shoulders are not a representative indicator of the granularity of the material after installation, as they are, as a rule, subject to segregation.

The average frequency of internal and external quality control of aggregate characteristics during construction and after installation for SNNP and ZNNP is given in Table 7.3.

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATES

Table 7.6: *Average frequency of tests during construction and after installation for SNNP and ZNNP*

Tests during construction and after installation	**Test procedure**		AC, HC		M+R+R	
			IQC	**EQC**	**IQC**	**EQC**
grain size and proportion of fine particles	SIST EN 933-1	m^2	2 000	8 000	1000	4 000
quality of fine particles[1]	SIST EN 933-8 ali 933-9	m^2	4 000	16 000	2000	8 000
Proctor test	SIST EN 13286-2	m^2	8 000	32 000	4 000	16 000
potential presence of humus particles	SIST EN 1744-1, pt.15.1	m^2	8 000	32 000	4 000	16 000
density and humidity (with isotopic probe)	TSC 06.711	m^2	200	800	150	600
dynamic deformation modulus – E_{vd}	TSC 06.720	m^2	200	800	150	600
static deformation modulus – E_{vs2}	TSC 06.720	m^2	1000	4 000	750	3 000
CCC[2]	TSC 06.713	m^2	All	-	All	-
straightness and height of the formation	TSC 06.610	m^1	20	-	20	-

Legend: AC, HC – motorway, expressway, broad urban access roads, etc.; large homogeneous surfaces
M+R+R – main and regional roads, railways

[1] Only in cases where the proportion of fine particles is > 3 % for ZNNP and > 5 % for SNNP.

[2] In the case of CCC implementation, the range of IQC measurements of compaction/bearing capacity shall be reduced by 75 %.

If the surface area of the installed layer is less than the surfaces given in Table 7.3, the minimum range of tests required during construction/post-installation is as follows: one sample for testing the granularity and proportion of fine particles and the quality of fine particles, and six measurements of dynamic deformation modules.

The average frequency of internal and external quality control of aggregate characteristics during and after installation for the NOP is given in Table 7.4.

Table 7.7: *Average frequency of tests during construction and after installation for the NOP*

Tests during construction and after installation	**Test procedure**		**IQC**	**EQC**
grain size and proportion of fine particles[1]	SIST EN 933-1	m^2	1000	4 000
grain size and proportion of fine particles[2]	SIST EN 933-1	m^2	1000	4 000
Proctor test	SIST EN 13286-2	m^2	4 000	16 000
potential presence of humus particles	SIST EN 1744-1, pt. 15.1	m^2	4 000	16 000
density and humidity (with isotopic probe)	TSC 06.711	m^2	200	800
dynamic deformation modulus – E_{vd}	TSC 06.720	m^2	400	1600
static deformation modulus – E_{vs2}	TSC 06.720	m^2	1000	4 000
straightness and height of the formation	TSC 06.610	m^1	20	-

[1] Skeletal base of an unbound wearing layer.

[2] Grains for wedging.

8 Measurement, acceptance and accounting of works

8.1 Measurement of works

As a rule, the work carried out must be measured and calculated in m^2 and m^3 respectively, according to the extent and type of work actually carried out as part of the measurements under the project.

8.2 Acceptance of works

The installed lower and upper unbound load bearing layer or unbound wearing layer shall be accepted by the supervisor upon written notification from the contractor of the completion of works related to SNNP, ZNNP or NOP. The contractor must submit all data and reports with the results of the internal quality control tests and measurements and the assessment of compliance of the IQC in a timely manner. The final assessment of compliance shall be made by the institution or external control in the final report. In doing so, it shall take into account its own results and those of the IQC. If the IQC laboratory does not ensure metrological traceability or a sufficient range of measurements and tests carried out, such results shall be taken into account conditionally and with reservation.

The supervisor shall accept the SNNP and the ZNNP or the NOP in accordance with the requirements in this technical specification and any additional requirements that are the subject of the contractual documentation for the execution of the works.

If the acceptance of works reveals deficiencies and failure to meet the minimum quality requirements, the contractor shall be obliged to remedy those deficiencies at his own expense before continuing the work; the costs shall also include the costs of any additional measurements and tests to be carried out after the deficiencies have been rectified.

For all works that do not meet the quality requirements defined in this TSPI or the conditions defined in the project, which are the subject of the contract, and which have not been repaired by the contractor, the contractor is, as a rule, not entitled to payment or the method of payment is decided by the contracting authority.

8.3 Accounting of works

The quantities of works carried out, determined under the conditions in point 8.1 of this TSPI should be accounted for at the contractual uniform price. As a general rule, the work carried out should be measured and calculated in m^2 and m^3 respectively.

The contractual uniform price must cover all services necessary for the full implementation of the lower and upper unbound load bearing layers or of the unbound wearing layer. The contractor shall not be entitled to claim additional payments unless otherwise specified in the contract.

8.4 Deductions due to inadequate quality

Due to the condition of appropriate quality, there are generally no deductions.

If the contractor installs an aggregate in the lower unbound load bearing layer, in the upper unbound load bearing layer or in the unbound wearing layer that does not meet the minimum quality requirements set out in point 3 of this TSPI and/or in the design requirements, the contracting authority shall decide on the method of payment.

The quality requirements for installed SNNP, ZNNP, and NOP, which represent 100 % of the value at the uniform price offered, are given as lower/upper limit values for:

- granular composition, content and character of fine particles (points 3.1.2 and 3.2.2),
- compaction (point 6.1.2),
- bearing capacity (point 6.2.2) and

- straightness and height (point 6.3).

Due to the conditional guarantee of the acceptance value of the quality of the work performed, no deductions shall be made in the accounting, and the work may not be continued until completion. If the contractor fails to ensure the required quality, the contracting authority shall decide on the method of accounting.

9 Material properties and requirements for layers for other applications

The aggregate quality requirements for SNNP, ZNNP and NOP and the frequency of tests of IQC and EQC given in this TSPI can also be applied mutatis mutandis to other transport infrastructure and elements of pavements and walking areas, such as airports, pedestrian corridors, cycle paths, paving areas, shoulders, separation lanes on motorways and expressways, car parks, etc.

9.1 Airports

Specific design and execution rules defined by others, including international regulations and standards, shall apply at airports. Nevertheless, the quality requirements specified in this TSPI may be applied appropriately at the discretion of the contracting authority/designer. For the production of SNNP and ZNNP, it is recommended to use an aggregate of quality classes PO1 and NNP1 and installation requirements for extremely heavy and very heavy traffic loads:

- on the SNNP formation: compaction ≥ 98 %, E_{vs2} ≥ 100 MPa and E_{vd} ≥ 45 MPa; bearing capacity ratio E_{vs2}/E_{vs1} ≤ 2.5. The ratio E_{vs2}/E_{vs1} is not decisive if E_{vs1} is ≥ 50 % of the required E_{vs2}.
- on the ZNNP formation: compaction ≥ 98 %, E_{vs2} ≥ 150 MPa and E_{vd} ≥ 70 MPa; bearing capacity ratio E_{vs2}/E_{vs1} ≤ 2.2. The ratio E_{vs2}/E_{vs1} is not decisive if E_{vs1} is ≥ 60 % of the required E_{vs2}.

The recommendation applies to airports with high traffic loads. Lower road construction requirements may be applied to sports airports with lower traffic loads.

9.2 Pedestrian corridors and cycle paths

For the arrangement of SNNP, ZNNP, and NOP in pedestrian corridors and cycle paths, aggregates of all classes specified in this TSPI are applicable.

Sidewalks and cycle paths are significantly less loaded than road pavements, except in mixed traffic areas (e.g. entries, crossings, field routes, maintenance routes), where compaction and bearing capacity requirements must be adapted to actual traffic loads. The design should take into account that the upgrading with asphalt layers is significantly lower than on roads, i.e. the effects on the installed layer in the mixed traffic area are higher.

Where the pedestrian corridor or cycle path is located outside a mixed traffic zone, the recommended values for the compaction and bearing capacity of the layer are as follows:

- on the SNNP formation: compaction ≥ 98 %, E_{vs2} ≥ 60 MPa and E_{vd} ≥ 30 MPa; bearing capacity ratio E_{vs2}/E_{vs1} ≤ 2.5. The ratio E_{vs2}/E_{vs1} is not decisive if E_{vs1} is ≥ 50 % of the required E_{vs2}.
- on the ZNNP formation: compaction ≥ 98 %, E_{vs2} ≥ 80 MPa and E_{vd} ≥ 40 MPa; bearing capacity ratio E_{vs2}/E_{vs1} ≤ 2.2. The ratio E_{vs2}/E_{vs1} is not decisive if E_{vs1} is ≥ 60 % of the required E_{vs2}.

If the sidewalk or cycle path is in an area of mixed traffic, it is designed as a road with a very light (VL) traffic load.

9.3 Paved surfaces

All aggregates of all classes specified in this TSPI are suitable for the construction of SNNP and ZNNP in paved surfaces.

In paved areas, the bearing capacity requirements must be adapted to the actual traffic loads. If the paved surface is rideable, the requirements given in point 6.2.2 of this TSPI apply depending on traffic loads. In the case of walking areas and cycle paths, the requirements given in point 9.2 of this TSPI may be applied.

9.4 Shoulders

A shoulder is a reinforced longitudinal part of the roadway along the outer edge of the carriageway, which ensures the lateral stability of the carriageway or roadway and embankments and allows for the installation of traffic signs and traffic equipment (ZCes-2). In exceptional cases, it must take over the traffic load (e.g. extraordinary avoidance of vehicles, slipping off the road), and above all provide lateral support to the layers of the road structure, directed surface drainage, etc.

The construction of the shoulder shall consist of one or more layers of material provided for in the project. The basic materials for the manufacture of shoulders are all types of aggregates for the lower and upper unbound load bearing layer (which may contain up to 25 % of asphalt milling), humus, cement concrete slabs for grassing.

The foundation for the construction of the shoulder may be the SNNP formation or the ZNNP formation. The formation must be prepared depending on the traffic load, in accordance with the requirements for bearing capacity (point 6.2). If the project so requires, the quality of the installation may be demonstrated by additional procedures (compaction, point 6.1, etc.).

The thickness of the layer of stone material must be at least 30 cm. For humus-enriched shoulders, the thickness of the base layer must be at least 20 cm. A layer of crushed stone with a thickness of at least 10 cm is laid on top of it, which is filled with a layer of humus with an average thickness of 5 cm, which must be mixed into the crushed stone layer and seeded with grass.

The quality control of the installation shall be carried out mutatis mutandis by measurements of bearing capacity, with a dynamic plate with falling weight. The recommended frequency of IQC is at least one measurement for every 100 m of shoulder, and for EQC at least every 400 m of shoulder. Depending on the position of the shoulder layer, the bearing capacity requirements may be 20 % lower than the bearing capacity requirements for the lower/upper NNP. Measurements may be carried out in parallel with lower/upper NNP measurements, and the report must clearly show that the measurements are made in the shoulder area.

9.5 Centre separation lanes on motorways and expressways

The centre separation lanes on motorways and expressways generally have a similar function to the shoulder. Due to the specificity and possible additional functionality of the centre separation lanes, the quality requirements for compaction and bearing capacity shall be determined by the designer. We suggest that the quality of installation be checked in a reasonable way by measuring bearing capacity with a dynamic plate, similar to shoulder testing. If the project so requires, the quality of the installation may be demonstrated by additional procedures (compaction, measurement of static deformation modules, etc.).

9.6 Car parks

Designers are proposed to design unbound load bearing layers of car parks in accordance with *the Recommendations for the Design of Asphalt Pavement Structures in Stationary Traffic Areas*, whereby the requirements given in points 6.1.2 and 6.2.2 of this TSPI and in the instructions of the dimensioning manual (stationary traffic) may also be applied mutatis mutandis. Quality control is carried out in a manner similar to that used on roads.

10 Specification of works

The TSPI introduces the new items and code lists referred to in points 10.1, 10.2 and 10.3 of this TSPI. The new items replace and remove the code list items from the special technical conditions referred to in point 10.4 of this TSPI.

Under the item "production"/*Description of the work,* the costs of materials, supplies and implementation are included.

10.1 Lower unbound load bearing layer – SNNP (unbound subbase or mineral capping layer)

Code		Unit of measurement	Description of the work
31	111	m^3	Production of SNNP class PO1 0/63 in thickness up to 30 cm
31	112	m^3	Production of SNNP class PO1 0/63 in thickness of 31-40 cm
31	113	m^3	Production of SNNP class PO1 0/63 in thickness of 41-50 cm
31	114	m^3	Production of SNNP class PO1 0/63 in thickness over 50 cm
31	115	m^3	Production of SNNP class PO1 0/90 in thickness up to 30 cm
31	116	m^3	Production of SNNP class PO1 0/90 in thickness of 31-40 cm
31	117	m^3	Production of SNNP class PO1 0/90 in thickness of 41-50 cm
31	118	m^3	Production of SNNP class PO1 0/90 in thickness over 50 cm
31	119	m^3	Production of SNNP class PO1 0/125 in thickness up to 30 cm
31	120	m^3	Production of SNNP class PO1 0/125 in thickness of 31-40 cm
31	121	m^3	Production of SNNP class PO1 0/125 in thickness of 41-50 cm
31	122	m^3	Production of SNNP class PO1 0/125 in thickness over 50 cm
31	123	m^3	Production of SNNP class PO2 0/63 in thickness up to 30 cm
31	124	m^3	Production of SNNP class PO2 0/63 in thickness of 31-40 cm
31	125	m^3	Production of SNNP class PO2 0/63 in thickness of 41-50 cm
31	126	m^3	Production of SNNP class PO2 0/63 in thickness over 50 cm
31	127	m^3	Production of SNNP class PO2 0/90 in thickness up to 30 cm
31	128	m^3	Production of SNNP class PO2 0/90 in thickness of 31-40 cm
31	129	m^3	Production of SNNP class PO2 0/90 in thickness of 41-50 cm
31	130	m^3	Production of SNNP class PO2 0/90 in thickness over 50 cm
31	131	m^3	Production of SNNP class PO2 0/125 in thickness up to 30 cm
31	132	m^3	Production of SNNP class PO2 0/125 in thickness of 31-40 cm
31	133	m^3	Production of SNNP class PO2 0/125 in thickness of 41-50 cm
31	134	m^3	Production of SNNP class PO2 0/125 in thickness over 50 cm
31	135	m^3	Production of SNNP class PO3 0/63 in thickness up to 30 cm
31	136	m^3	Production of SNNP class PO3 0/63 in thickness of 31-40 cm
31	137	m^3	Production of SNNP class PO3 0/63 in thickness of 41-50 cm
31	138	m^3	Production of SNNP class PO3 0/63 in thickness over 50 cm
31	139	m^3	Production of SNNP class PO3 0/90 in thickness up to 30 cm
31	140	m^3	Production of SNNP class PO3 0/90 in thickness of 31-40 cm
31	141	m^3	Production of SNNP class PO3 0/90 in thickness of 41-50 cm
31	142	m^3	Production of SNNP class PO3 0/90 in thickness over 50 cm
31	143	m^3	Production of SNNP class PO3 0/125 in thickness up to 30 cm
31	144	m^3	Production of SNNP class PO3 0/125 in thickness of 31-40 cm
31	145	m^3	Production of SNNP class PO3 0/125 in thickness of 41-50 cm
31	146	m^3	Production of SNNP class PO3 0/125 in thickness over 50 cm

10.2 Upper unbound load bearing layer – ZNNP

Code		Unit of measurement	Description of the work
31	151	m^3	Production of ZNNP class NNP1 0/32 in thickness up to 20 cm
31	152	m^3	Production of ZNNP class NNP1 0/32 in thickness 21-30 cm
31	153	m^3	Production of ZNNP class NNP1 0/32 in thickness 31-40 cm
31	154	m^3	Production of ZNNP class NNP1 0/45 in thickness up to 20 cm
31	155	m^3	Production of ZNNP class NNP1 0/45 in thickness 21-30 cm
31	156	m^3	Production of ZNNP class NNP1 0/45 in thickness 31-40 cm
31	157	m^3	Production of ZNNP class NNP2 0/32 in thickness up to 20 cm
31	158	m^3	Production of ZNNP class NNP2 0/32 in thickness 21-30 cm
31	159	m^3	Production of ZNNP class NNP2 0/32 in thickness 31-40 cm
31	160	m^3	Production of ZNNP class NNP2 0/45 in thickness up to 20 cm
31	161	m^3	Production of ZNNP class NNP2 0/45 in thickness 21-30 cm
31	162	m^3	Production of ZNNP class NNP2 0/45 in thickness 31-40 cm
31	163	m3	Production of ZNNP class NNP3 0/22 in thickness up to 20 cm
31	164	m3	Production of ZNNP class NNP3 0/22 in thickness 21-30 cm
31	165	m3	Production of ZNNP class NNP3 0/22 in thickness 31-40 cm
31	166	m3	Production of ZNNP class NNP3 0/32 in thickness up to 20 cm
31	167	m3	Production of ZNNP class NNP3 0/32 in thickness 21-30 cm
31	168	m3	Production of ZNNP class NNP3 0/32 in thickness 31-40 cm
31	169	m3	Production of ZNNP class NNP3 0/45 in thickness up to 20 cm
31	170	m3	Production of ZNNP class NNP3 0/45 in thickness 21-30 cm
31	171	m3	Production of ZNNP class NNP3 0/45 in thickness 31-40 cm
31	172	m^3	Production of ZNNP class NNP4 0/22 in thickness up to 20 cm
31	173	m^3	Production of ZNNP class NNP4 0/22 in thickness 21-30 cm
31	174	m^3	Production of ZNNP class NNP4 0/22 in thickness 31-40 cm
31	175	m^3	Production of ZNNP class NNP4 0/32 in thickness up to 20 cm
31	176	m^3	Production of ZNNP class NNP4 0/32 in thickness 21-30 cm
31	177	m^3	Production of ZNNP class NNP4 0/32 in thickness 31-40 cm
31	178	m^3	Production of ZNNP class NNP4 0/45 in thickness up to 20 cm
31	179	m^3	Production of ZNNP class NNP4 0/45 in thickness 21-30 cm
31	180	m^3	Production of ZNNP class NNP4 0/45 in thickness 31-40 cm
31	181	m^3	Production of ZNNP class NNP5 0/22 in thickness up to 20 cm
31	182	m^3	Production of ZNNP class NNP5 0/22 in thickness 21-30 cm
31	183	m^3	Production of ZNNP class NNP5 0/22 in thickness 31-40 cm
31	184	m^3	Production of ZNNP class NNP5 0/32 in thickness up to 20 cm
31	185	m^3	Production of ZNNP class NNP5 0/32 in thickness 21-30 cm
31	186	m^3	Production of ZNNP class NNP5 0/32 in thickness 31-40 cm
31	187	m^3	Production of ZNNP class NNP5 0/45 in thickness up to 20 cm
31	188	m^3	Production of ZNNP class NNP5 0/45 in thickness 21-30 cm
31	189	m^3	Production of ZNNP class NNP5 0/45 in thickness 31-40 cm

10.3 Unbound wearing layer - NOP

Code		Unit of measurement	Description of the work
32	111	m^3	Production of NOP class MA1 in thickness up to 15 cm
32	112	m^3	Production of NOP class MA1 in thickness 16-20 cm
32	113	m^3	Production of NOP class MA1 in thickness of 21-25 cm
32	114	m^3	Production of NOP class MA1 in thickness of 26-30 cm
32	115	m^3	Production of NOP class MA1 in thickness over 30 cm
32	121	m^3	Production of NOP class MA2 in thickness up to 15 cm
32	122	m^3	Production of NOP class MA2 in thickness 16-20 cm
32	123	m^3	Production of NOP class MA2 in thickness 21-25 cm
32	124	m^3	Production of NOP class MA2 in thickness 26-30 cm
32	125	m^3	Production of NOP class MA2 in thickness over 30 cm

10.4 Removed code list items from special technical conditions

Mineral capping layer (removed code list items)

Code	Unit of measurement	Description of the work
24 411	m^3	Installation of a capping layer in a layer thickness of up to 30 cm of binding soil – Category 3
24 421	m^3	Installation of a capping layer with a layer thickness of up to 30 cm made of granular rock – Category 3
24 431	m^3	Installation of a capping layer in a layer thickness of up to 40 cm of binding soil – Category 3
24 441	m^3	Installation of a capping layer with a layer thickness of up to 40 cm made of granular rock – Category 3
24 451	m^3	Installation of a capping layer in a layer thickness of up to 50 cm of binding soil – Category 3
24 461	m^3	Making a capping layer with a layer thickness of up to 50 cm from granular rock – Category 3
24 471	m^2	Making of a capping layer from crushed stone grains in a thickness of 15 cm
24 472	m^2	Making of a capping layer from crushed stone grains in a thickness of 20 cm
24 473	m^2	Making of a capping layer from crushed stone grains in a thickness of 25 cm
24 474	m^2	Making of a capping layer from crushed stone grains in a thickness of 30 cm
24 475	m^2	Making of a capping layer from crushed stone grains in a thickness of 40 cm
24 476	m^2	Making of a capping layer from crushed stone grains in a thickness of 50 cm
24 477	m^3	Making of a capping layer from crushed stone grains in a thickness over50 cm
24 481	m^2	Making of a capping layer of mixed stone grains in a thickness of 15 cm
24 482	m^2	Making of a capping layer of mixed stone grains in a thickness of 20 cm
24 483	m^2	Making of a capping layer of mixed stone grains in a thickness of 25 cm
24 484	m^2	Making of a capping layer of mixed stone grains in a thickness of 30 cm
24 485	m^2	Making of a capping layer of mixed stone grains in a thickness of 40 cm
24 486	m^2	Making of a capping layer of mixed stone grains in a thickness of 50 cm
24 487	m^3	Making of a capping layer from mixed stone grains with a thickness over 50 cm

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Unbound load bearing layer (removed code list items)

Code	Unit of measurement	Description of the work
31 111	m^3	Production of an unbound load bearing layer of gravel in a thickness of up to 20 cm
31 112	m^3	Production of an unbound load bearing layer of gravel in a thickness of 21 to 30 cm
31 113	m^3	Production of an unbound load bearing layer of gravel in a thickness of 31 to 40 cm
31 114	m^3	Production of an unbound load bearing layer of gravel in a thickness of over 40 cm
31 121	m^3	Production of an unbound load bearing layer of shingle in a thickness up to 20 cm
31 122	m^3	Production of an unbound load bearing layer of shingle in a thickness of 21 to 30 cm
31 123	m^3	Production of an unbound load bearing layer of shingle in a thickness of 31 to 40 cm
31 124	m^3	Production of an unbound load bearing layer of shingle in a thickness over 40 cm
31 131	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock with a thickness of up to 20 cm
31 132	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock with a thickness of 21 to 30 cm
31 133	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock with a thickness of 31 to 40 cm
31 134	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock with a thickness over 40 cm
31 141	m^3	Production of an unbound load bearing layer of equal-sized crushed rock with a thickness of up to 20 cm
31 142	m^3	Production of an unbound load bearing layer of equal-sized crushed rock with a thickness of 21 to 30 cm
31 143	m^3	Production of an unbound load bearing layer of equal-sized crushed rock with a thickness of 31 to 40 cm
31 144	m^3	Production of an unbound load bearing layer of equal-sized crushed rock with a thickness over 40 cm
31 151	m^3	Production of an unbound load bearing layer of evenly granulated crushed slag with a thickness of up to 20 cm
31 152	m^3	Production of an unbound load bearing layer of evenly granulated crushed slag with a thickness of 21 to 30 cm
31 153	m^3	Production of an unbound load bearing layer of evenly granulated crushed slag with a thickness of 31 to 40 cm
31 154	m^3	Production of an unbound load bearing layer of evenly granulated crushed slag with a thickness over 40 cm
31 161	m^3	Production of an unbound load bearing layer of equal-sized crushed slag with a thickness of up to 20 cm
31 162	m^3	Production of an unbound load bearing layer of equal-sized crushed slag with a thickness of 21 to 30 cm
31 163	m^3	Production of an unbound load bearing layer of equal-sized crushed slag with a thickness of 31 to 40 cm
31 164	m^3	Production of an unbound load bearing layer of equal-sized crushed slag with a thickness over 40 cm
31 171	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock from secondary raw materials with a thickness of up to 20 cm
31 172	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock from secondary raw materials with a thickness of 21 to 30 cm
31 173	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock from secondary raw materials with a thickness of 31 to 40 cm

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Code	Unit of measurement	Description of the work
31 174	m^3	Production of an unbound load bearing layer of evenly granulated crushed rock from secondary raw materials with a thickness over 40 cm

Unbound wearing layer (removed code list items)

Code	Unit of measurement	Description of the work
32 111	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of crushed grains with a thickness of up to15 cm
32 112	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of crushed grains with a thickness of 16 to 20 cm
32 113	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of crushed grains with a thickness of 21 to 25 cm
32 114	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of crushed grains with a thickness of 26 to 30 cm
32 115	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of crushed grains with a thickness over 30 cm
32 121	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of naturally crushed grains with a thickness of up to 15 cm
32 122	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of naturally crushed grains with a thickness of 16 to 20 cm
32 123	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of naturally crushed grains with a thickness of 21 to 25 cm
32 124	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of naturally crushed grains with a thickness of 26 to 30 cm
32 125	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of naturally crushed grains with a thickness over 30 cm
32 131	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of gravel grains with a thickness up to 15 cm
32 132	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of gravel grains with a thickness of 16 to 20 cm
32 133	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of gravel grains with a thickness of 21 to 25 cm
32 134	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of gravel grains with a thickness of 26 to 30 cm
32 135	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of gravel grains with a thickness over 30 cm
32 141	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of mixed grains with a thickness up to 15 cm
32 142	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of mixed grains with a thickness of 16 to 20 cm
32 143	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of mixed grains with a thickness of 21 to 25 cm
32 144	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of mixed grains with a thickness of 26 to 30 cm
32 145	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture of mixed grains with a thickness over 30 cm
32 151	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture from secondary raw materials with a thickness of up to 15 cm
32 152	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture from secondary raw materials with a thickness of 16 to 20 cm
32 153	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture from secondary raw materials with a thickness of 21 to 25 cm
32 154	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture from secondary raw materials with a thickness of 26 to 30 cm
32 155	m^3	Production of an unbound (mechanically stabilised) wearing layer from a mixture from secondary raw materials with a thickness over 30 cm

Code	Unit of measurement	Description of the work
32 161	m^3	Supply and installation of a mixture of crushed grains for the wedging of an unbound wearing layer
32 162	m^3	Supply and installation of a mixture of naturally crushed stone grains for the wedging of an unbound wearing layer

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13 ANNEX 1: *Summary table of quality requirements for ZNNP, SNNP and NOP (roads)*

		Classes according to the application purpose									
Application purpose		Upper unbound load bearing layer – ZNNP					Lower unbound load bearing layer - SNNP (mineral capping layer)			Unbound wearing layer – NOP	
Traffic load		EH, VH, H, M, L, VL		M, L, VL		L, VL	EH, VH, H, M, L, VL		M, L, VL	L, VL	VL
Class		NNP1	NNP2	NNP3	NNP4	NNP5	PO1	PO2	PO3	MA2	MA2
Category by SIST EN 13242		Requirement (category, declared value)									
Chapter	Quality characteristics										
4.3	Granularity SIST EN 933-1	G_A 85 in the limit curves for d/D= 0/32 or 0/45 mm		G_A 85 in the limit curves for d/D = 0/22, 0/32 or 0/45 mm			G_A 85 d/D = 0/63, 0/90 or 0/125 mm[1]			G_A 75	
	Coefficient cu	8 - 50			15 - 100		8 - 50	15 - 100		-	
	Coefficient cc	1 - 5								-	
4.6	Content of fine particles SIST EN 933-1	before installation (landfill / before compaction): ≥ 3 % and ≤ 6.5 % of particles ≤ 0.063 mm[2] after installation: ≤ 8.0 % of particles ≤ 0.063 mm								after installation: ≥ 8 % and ≤ 15 % of particles ≤ 0.063 mm	
4.7	Quality of fine particles	if the particles are ≤ 0.063 mm ≤ 3 %: no requirements					if the particles are ≤ 0.063 mm ≤ 5 %: no requirements				
	SIST EN 933-8, or SIST EN 933-8, or	*SE* (10) ≥ 50 % or *MB* ≤ 1.5 g/kg		*SE* (10) ≥ 40 % or *MB* ≤ 2.0 g/kg			*SE* (10) ≥ 35 % or *MB* ≤ 2.5 g/kg			-	
		In borderline cases, the Methylene Blue or Suction test is relevant.									
6.5.1	Potential presence of humus particles SIST EN 1744-1, pt. 15.1	negative test (lighter than standard colour)									
4.4	Shape index SIST EN 933-4, or Flakiness index SIST EN 933-3	SI_{20} or FI_{20}		SI_{40} or FI_{35}			SI_{NR} or FI_{NR}				
4.5	Mass percentage of crushed or broken and completely round grains SIST EN 933-5	$C_{90/3}$	$C_{70/10}$[3]	$C_{90/3}$	$C_{50/30}$	C_{NR}	$C_{90/3}$	$C_{50/30}$	C_{NR}	$C_{50/30}$	C_{NR}
5.2	Resistance to crushing SIST EN 1097-2	LA_{30}[4]		LA_{35}						LA_{NR}	
5.3	Wear resistance SIST EN 1097-1	$M_{DE}15$		$M_{DE}20$			$M_{DE}NR$				
7.3.3	Frost an thaw resistance SIST EN 1097-6 SIST EN 1367-2 SIST EN 1367-1	MS_{18} (MS ≤ 10 %) or F_1					In case of doubt: $WA_{24}2$ or MS_{18} or F_1			MS_{NR} or F_{NR}	

(1) If specified in the project (no local sources, low traffic loads, etc.), local materials of nominal granularity and quality of ZNNP may be used.

(2) If the stone grain mixture contains less than 3.0 % or more than 6.5 % of fine particles before compaction, the installability/over-crushing shall be demonstrated using a test field.

(3) In cases of traffic loads EH, VH and H, additional stabilisation with a cement binder is recommended for class NNP2.

(4) In the case of crushed siliceous Mura gravels, category LA_{35} is permitted for class NNP2

Application purpose	Upper unbound load bearing layer – ZNNP			Lower unbound load bearing layer - SNNP (mineral capping layer)		Unbound wearing layer – NOP	
Traffic load	EH, VH, H	M	L, VL	EH, VH, H	M, L, VL	L, VL	VL
Quality characteristics	Installation (applies to road construction)						
Bearing capacity E_{VS2} TSC 06.720	**150 MPa** (180 MPa)[5]	**120 MPa** (100 MPa)[6]	**100 MPa** (80 MPa)[7]	**100 MPa** (80 MPa)[6] (120 MPa)[5]	**80 MPa** (60 MPa)[7]	**100 MPa** (80 MPa)[6]	**80 MPa** (60 MPa)[7]
Ratio E_{VS2}/E_{VS1} TSC 06.720	≤ 2.2; not required if E_{vs1} ≥ 60% of the required E_{vs2}			≤ 2.5; not required if E_{vs1} ≥ 50 % of the required E_{vs2}		≤ 2.2; not required if E_{vs1} ≥ 60 % of the required E_{vs2}	
Bearing capacity E_{vd} TSC 06.720	**70 MPa** (> 70 MPa)[5]	**55 MPa** (45 MPa)[6]	**45 MPa** (40 MPa)[7]	**45 MPa** (40 MPa)[6] (55 MPa)[5]	**40 MPa** (30 MPa)[7]	**45 MPa** (40 MPa)[6]	**40 MPa** (30 MPa)[7]
Density, moisture, compaction (MPP) TSC 06.711, TSC 06.712	**≥ 98 %**						
Altitude deviation	≤ ± 15 mm			≤ ± 30 mm		/	
Straightness below 4 m lato TSC 06.610	≤ 15 mm / 4 m			/		/	

(5) Only for NNP1 and PO1, if so specified in the project.

(6) Municipal and local roads, cycle paths and pedestrian corridors (in a mixed traffic area), if so specified in the project.

(7) Cycle paths and pedestrian corridors (outside the mixed traffic area), if so specified in the project.

UNBOUND LOAD BEARING LAYERS AND UNBOUND WEARING LAYERS MADE OF NATURAL AGGREGATES

14 ANNEX 2: *Summary table of quality requirements for ZNNP and SNNP (railways)*

		Classes according to the application purpose					
Application purpose		Upper unbound load bearing layer – ZNNP			Lower unbound load bearing layer – SNNP		
Line type		main, regional, industrial track		regional, industrial track	main, regional, industrial track		industrial track
Class		NNP1	NNP2	NNP3	PO1	PO2	PO3
Category by SIST EN 13242		Requirement (category, declared value)					
Chapter	Quality characteristics						
4.3	Granularity SIST EN 933-1	G_A 85 in the limit curves for d/D = 0/32 or 0/45			G_A 85 d/D = 0/63, 0/90 or 0/125 mm(1)		
	Coefficient cu	8 - 50			8 - 50	15 - 100	
	Coefficient cc	1 - 5			1 - 5		
4.6	Content of fine particles SIST EN 933-1	before installation (landfill / before compaction): ≥ 3 % and ≤ 6.5 % of particles ≤ 0.063 mm(2) after installation: ≤ 8.0 % of particles ≤ 0.063 mm					
4.7	Quality of fine particles SIST EN 933-8, or SIST EN 933-9	if the particles are ≤ 0.063 mm ≤ 3%: no requirement			if the particles are ≤ 0.063 mm ≤ 5 %: no requirement		
		SE (10) ≥ 50 % or *MB* ≤ 1.5 g/kg		*SE* (10) ≥ 40 % or *MB* ≤ 2.0 g/kg	*SE* (10) ≥ 35 % or *MB* ≤ 2.5 g/kg		
		In borderline cases, the Methylene Blue or Suction test is relevant.					
6.5.1	Potential presence of humus particles SIST EN 1744-1, pt. 15.1	negative test (lighter than standard colour)					
4.4	Shape index SIST EN 933-4, or Flakiness index SIST EN 933-3	SI_{20} or FI_{20}		SI_{40} or FI_{35}	SI_{NR} or FI_{NR}		
4.5	Mass percentage of crushed or broken and completely round grains SIST EN 933-5	$C_{90/3}$	$C_{70/10}$ $C_{80/10}$(3)	$C_{90/3}$	$C_{90/3}$	$C_{50/30}$	C_{NR}
5.2	Resistance to crushing SIST EN 1097-2	LA_{30}(4)		LA_{35}			
5.3	Wear resistance SIST EN 1097-1	$M_{DE}15$		$M_{DE}20$	$M_{DE}NR$		
7.3.3	Frost an thaw resistance SIST EN 1097-6 SIST EN 1367-2 SIST EN 1367-1	MS_{18} (MS ≤ 10 %) or F_1			In case of doubt: $WA_{24}2$ or MS_{18} or F_1		

(1) If specified in the project (no local sources, low traffic loads, etc.), local materials of nominal granularity and quality of ZNNP may be used.

(2) If the stone grain mixture contains less than 3.0 % or more than 6.5 % of fine particles before compaction, the installability/over-crushing shall be demonstrated using a test field.

(3) In cases of traffic loads EH, VH and H, additional stabilisation with a cement binder is recommended for class NNP2.

(4) In the case of crushed siliceous Mura gravels, category LA_{35} is permitted for class NNP2

Application purpose	Upper unbound load bearing layer – ZNNP			Lower unbound load bearing layer – SNNP		
Line type	Main line	Regional line	Industrial line	Main line	Regional line	Industrial line
Quality characteristics	Installation (applies to railways)					
Bearing capacity E_{VS2} TSC 06.720	**100 MPa**	**80 MPa**	**60 MPa**	**80**	**60**	**60**
Ratio E_{VS2}/E_{VS1} TSC 06.720	≤ 2.2; not required if E_{vs1} ≥ 60 MPa					
Bearing capacity E_{vd} TSC 06.720	**45 MPa**	**40 MPa**	**30 MPa**	**40 MPa**	**30 MPa**	**30 MPa**
Density, moisture, compaction (MPP) TSC 06.711, TSC 06.712	**≥ 98 %**					
Transverse tilt of the layer / formation	≥ 5 % ± 0.4 %			≥ 5 % ± 1 %		
Altitude deviation	≤ ± 10 mm			≤ ± 25 mm		
Straightness below 4 m lato TSC 06.610	≤ 20 mm / 4 m			≤ 30 mm / 4 m		