



# **Standard Specifications for Road and Bridge Works for State Road Authorities**

**Committee Draft Final (CDF)**

## **CHAPTER 4: EARTHWORKS AND PAVEMENT LAYERS: MATERIALS**

**August 2019**

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The draft Chapters do not replace the previous COLTO “Standard Specifications for Road and Bridge Works” published in 1998.

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## Comments

Comments on the Chapters must be provided in writing as per the format provided on the SANRAL website [www.nra.co.za](http://www.nra.co.za) and e-mailed to [cotorevision@nra.co.za](mailto:cotorevision@nra.co.za) no later than **04 October 2019**.

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# CHAPTER 4: EARTHWORKS AND PAVEMENT LAYERS: MATERIALS

## A4.1 BORROW MATERIALS

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## PART A: SPECIFICATIONS

### A4.1.1 SCOPE

This Section covers the work requirements for sourcing natural or crushed compliant materials that can be used for the construction of earthworks and pavement layers from borrow pits and quarries that are developed and operated to supply materials for a specific road construction project or projects. It contains the following specifications:

- Definitions applicable for Chapters 4 and 5.
- Responsibilities and duties of the Employer and the Contractor in providing geotechnical information, and information on the preparation of management and utilisation plans for the borrow pits and quarries.
- The material specifications for the earthworks and pavement layers.
- The requirements for the control, excavation, selection of material, and closure of a borrow pit and of a quarry, as well as definitions for the excavation classes.
- Producing of the material by crushing and/or screening.
- The preparation of stockpile sites and the stockpile of materials.

Operations at quarries of commercial suppliers to produce commercial materials are excluded from the requirements in this Section A4.1, except for the material specifications in Clause A4.1.5.

Specifications for aggregate to be used in subsoil drains, asphalt, seals, gabions and concrete are not included in this Chapter 4, but are included in the relevant Chapters where these works are specified.

The sourcing of materials from road cuttings, box cuts and designated excavations, from existing roads, from commercial sources, and the use of alternative materials are covered in the other Sections of this Chapter 4.

Chapter 5 – Earthworks and Pavement layers: Construction, covers the construction of the road layers.

SANS test methods published by the South African Bureau of Standards (SABS) are listed in Chapter 20.

### A4.1.2 DEFINITIONS

The relevant definitions in Chapter 1 shall also be applicable to this section. Additional definitions for this Section are listed below.

**Borrow or sourced material** - any road building material obtained from borrow pits and quarries, and compliant for the construction of earthworks and pavement layers. The purpose of a borrow pit or quarry is to borrow or source or procure the material, or to win the material as defined in the South African Minerals and Petroleum Act. Borrowing or sourcing material from borrow pits and quarries requires statutory authorisation and approval in South Africa.

**Borrow pit area or quarry area** - an area clearly defined by physical boundaries, that delineate the overall area within which the sourced material is to be excavated, stockpiled and produced.

**Borrow pit** - the excavated area within the borrow pit area from which materials such as soil, gravel, cobbles and boulders, and to a lesser extent hard rock, are obtained.

**Crushed stone type G1 base layer** - a crushed stone base layer is the uppermost (top) structural layer of a road pavement that consists of type G1 crushed stone which:

- Is continuously graded;
- Consists of minus 37,5 mm crushed aggregate of high durability equal to that of the parent rock, low permeability because of the continuous grading at maximum particle interlock, and low moisture sensitivity as the material is non-cohesive;
- Is compacted to Apparent Density; and
- Is slush-compacted to refusal or maximum particle interlock.

**Deleterious minerals** - minerals, when present in the natural untreated material, that are detrimental to the road layers. The most common undesirable minerals that are known to have deleterious effects in the earthworks or pavement layers are sulfide, soluble salts and mica:

- **Sulfide** is a compound of sulfur. When exposed to air and water, the sulfide decomposes easily. Oxidation leads to the development of sulfate salts and sulfuric acid that result in acidic materials. The sulfuric acid and sulfate salts can destroy cementitious stabilising agents, and the salts can cause blistering and cracking of a pavement.

Golden-coloured iron pyrite, also known as "fools gold", is the most common sulfide mineral and is usually present in gold and copper mine rocks. However, it can also occur in normal rock quarries in most other rocks. If it can be seen with the naked eye or a hand lens it is potentially troublesome. However, in some materials it can't be seen and other indicators such as a dark grey or black colour in a quartzite, and white, yellow or brown staining, are indicative of sulfide in the rock.

- **Soluble salts** are salts that dissolve easily in water and are sufficiently soluble to cause deleterious physical or chemical effects. Salts that generally occur in such quantities to affect the road materials are sulfates and sodium chloride.

Soluble salts can be encountered in the roadbed, the earthworks and in any of the pavement layer materials. The dissolved salt migrates upwards through the earthworks and pavement layers, and is precipitated at the contact between the base layer and the surfacing. The salt then causes the disruption of the bond between the base layer and the surfacing, and blisters develop. This generally results in the failure of the surfacing.

- **Mica** of which the most striking features are its platy structure and elasticity. In this respect muscovite, the "light" or "white" mica, is the most troublesome. The deleterious properties of mica only manifest themselves when the minerals are separated from the rock, that is when it occurs in a loose state in weathered rock, gravel or soil (also known as free mica). The springy action of free mica, especially muscovite, affects the compaction so that low densities and strengths are achieved. The mica plates may also prevent filling the voids in the material, resulting in a high void ratio and high water demand. Biotite, the "dark" or "black" mica is not as elastic as muscovite and tends to break more easily into smaller pieces during construction. Problems are much less experienced with biotite. Material derived from granite, gneiss, mica schist, phyllite and some sandstones generally always contain mica.

**Drainage layer** - the drainage layer is constructed over a wet roadbed or in the lower fill layers to provide a stable roadbed, or to intercept water or moisture to prevent it from rising into the road prism and/or the pavement layers.

**Earthworks** - all operations involved in sourcing, excavating and removing, spoil of non-compliant material, processing, hauling, importing, depositing and placing, shaping and compacting of compliant soil, gravel, cobbles, boulders and rock. The structure resulting from these operations may comprise a pioneer layer or a roadbed of in situ material, and fill layers. The earthwork layers form the foundation for the subsequent road pavement layers that are constructed on top of the earthworks.

**Fill layers** - fill is that portion of the earthworks that is positioned above the pioneer layer or roadbed, and on which the road pavement layers are to be constructed. Fill layers can either be sand fill, normal fill, coarse fill or rock fill materials:

- **Sand fill material** comprises of non-plastic sand with not less than 95 % passing through the 5 mm sieve, and which can be compacted to a measurable density.
- **Normal fill material** consists of sand, gravel, gravel with cobbles or alternative materials (refer to Section A4.5) with a maximum particle size up to 200 mm in the fill and which can be compacted to a measurable density.
- **Coarse fill material** comprises gravel with cobbles, boulders, lumps of hard material or alternative materials with a maximum particle size up to 500 mm, or a maximum particle size so that the material in the fill layer can be compacted to the specified density by the construction equipment, whichever is the lesser. The strength of coarse fill material does not rely on mechanical interlock of the coarse particles. Coarse fill is constructed by compaction to a measurable density or according to a compaction specification of the number of roller-passes of applicable compaction equipment.
- **Rock fill material** consists predominantly of blasted or crushed angular rock with fine material filling the voids between the rock particles to form a dense layer with minimum voids between the rocks. Rock fill may be constructed with a geotextile separation layer between the rock fill and subsequent layers to prevent loss of material into the rock fill. The stability of rock fill results from the mechanical interlock of the rock particles and not from the compaction of the finer material. The compacted density of a rock fill cannot be measured.

**Low volume roads** - low volume roads have a maximum traffic class ES 0,3, that is a total of 0,3 million 80 kN single axles over 20 years.

**Macadam layer** - a macadam layer is a type of base layer. It consists of a single graded coarse aggregate with a filler between the coarse aggregate.

**Material control personnel** - the personnel for the control of material sourcing and stockpile operations shall be:

- A materials manager who shall be an experienced engineering geologist or engineer, a qualified senior materials technician or an experienced senior general foreman.
- An excavation controller who shall be a materials technician or a general foreman.

- A stockpile controller who shall be an assistant materials technician or a junior foreman.

**Material depth** - the depth below the finished level of the road to which the material characteristics have a significant effect on the pavement behaviour. Below this depth the strength and density of the material are assumed to have a negligible effect on the pavement, except when conditions may arise in the subgrade that require special treatment, such as expansive materials, materials with collapsible or compressible structures, voids or potential sinkholes, mining subsidence, slope instability, non-uniform support or the presence of deleterious minerals.

**Maximum dry density (MDD)** - the maximum dry density of soils and gravels is the density at the peak of the compaction curve at optimum moisture content (OMC) as determined in accordance with test methods SANS 3001-GR30 for natural materials and SANS 3001-GR31 for stabilised materials.

**M&U Plan** - a management and utilisation plan of operations for material sources to ensure that it is worked in a sustainable and sensitive manner, that negative environmental impacts are prevented, material sourcing is optimized and that costs are minimized.

**Overburden** - overburden is the material immediately beneath the topsoil, if any, and above the specifically sourced material in the borrow pit, the quarry or in the cutting. Overburden is normally not compliant for use in the construction of earthworks and pavement layers but may prove compliant in appurtenant works such as banks (earth berms), for covering of organic material and for rehabilitation of the borrow pit or quarry.

**Particle size classification** - the particle size classification hereunder is commonly used for uncrushed natural material in road construction.

Clay has a particle size smaller than 0,002 mm. It has a soapy or greasy feel when rubbed on the palm of the hand with water. Clay is shiny when wet and stains the hands. Clay materials are plastic when wet, and coherent when dry.

Silt has a particle size larger than 0,002 mm and smaller than 0,075 mm. Silt particles are barely felt when rubbed with water on the palm of the hand. It has a chalky feel on teeth and when dry, rubs off the hands. The individual particles cannot be seen, not even with a hand lens.

Sand is a natural untreated material that consists of particles larger than 0,075 mm and smaller than 5,0 mm but may contain a small amount of silt and/or clay:

- Fine sand has a particle size generally between 0,075 mm and 0,3 mm. The particles are not visible to the naked eye and are just visible under a hand lens.
- Medium sand has a particle size generally between 0,3 mm and 0,6 mm. The particles are clearly visible under a hand lens and just visible to the naked eye.
- Coarse sand has a particle size generally between 0,6 mm and 5,0 mm. The individual particles are clearly visible to the naked eye.

Gravel is naturally occurring coarser material from weathered rock that consists mostly of rock fragments between 5,0 mm and 63 mm.

Pebbles, cobbles and boulders are natural occurring rounded stones. Pebbles are between 5,0 mm and 63 mm in size, cobbles are larger than 63 mm and up to 200 mm, while boulders are larger than 200 mm. Core stones and floaters are large individual boulders floating within the residual soil, or lying loose on the surface when the soil has been eroded.

Rock fragments or lumps of hard material are pieces of rock, and can be of any size and shape.

For crushed material the fraction smaller than 5,0 mm is known as the fine aggregate or crusher dust, while the coarse aggregate comprises material 5,0 mm and larger.

**Pavement layers** - the pavement layers of the road comprise the base, shoulder, subbase and selected layers. Collectively the pavement layers are the road pavement or pavement structure.

- **Base layer** - A layer of material constituting the uppermost (top) structural layer of a road constructed on top of other strata or layers, and on which the surfacing will be placed. Where the shoulders of a road are surfaced and constructed with the same material as that of the base layer, the definition for a shoulder layer shall then not be applicable as the base layer also forms the shoulder.
- **Shoulder layer** - The uppermost gravel unsurfaced or unsealed pavement layer lying between the outside edge of the base layer and the shoulder breakpoint. For roads and streets with kerbing edge restraints, the shoulder layer shall be the backfill behind the kerbing. In this instance the shoulder layer is also known as the sidewalk layer.
- **Subbase layer** - The layer of material on top of the selected layers, or in the absence of selected layers on the fill, below the base, shoulder and gravel wearing course layers, or below an asphalt base layer, paving blocks or a concrete pavement.
- **Selected layer** - The lower layer or layers of the pavement below the subbase layer(s) which is constructed immediately on top of the fill, or in the absence of fill, directly on top of the roadbed.

**Pioneer layer** - an initial layer constructed with or without a geotextile on a soft and/or wet roadbed to provide a stable working platform for the construction of subsequent layers.

**Quarry** - the excavated area within the quarry area where rock material is sourced that requires drilling and blasting.

**Soil and gravel** - in road construction, materials that have a large proportion of fine material in comparison to the coarser material, are commonly referred to as "soil(s)". Materials which comprise predominantly of coarser particles with finer material occurring between the larger particles, and which have good strength due to particle interlock, are described as "gravel(s)". The grading modulus of gravel generally exceeds 1,5.

**Soil constants** - the soil constants of a material comprise:

- The Atterberg Liquid Limit (LL), Plastic Limit (PL), and Shrinkage Limit (SL).
- The Plasticity Index (PI).
- The Linear Shrinkage (LS) and the Linear Shrinkage Modulus (LSM = LS x % passing the 0,425 mm sieve).

**Spoil material** - Spoil material is excavated material that is not compliant for use anywhere in the works or is material which is surplus to the requirements of the contract. Spoil material shall therefore be placed in borrow pits or quarries at completion or disposed of in approved spoil sites.

**Stockpile area** – A prepared area designated or used for the temporary stockpiling of material until used elsewhere or placed back in the borrow pit or quarry.

**Unsuitable material** – This is material in or below the roadbed of a quality that would be detrimental to the performance of the completed road, and that must be removed. Unsuitable material can be stable or unstable.

- **Stable material** – This is material which have inadequate bearing strength, active (heaving) clay, material with excessive quantity of unwanted material, and the like. Stable material can be removed or excavated efficiently by means of normal road-construction equipment such as bulldozers, road graders, road scrapers, tractor-loader-backhoes (TLBs) or excavators. Stable material may be taken to spoil, or to stockpile for future use depending on the material properties.
- **Unstable material** – This is material which cannot be removed or excavated efficiently by means of bulldozers, road graders, road scrapers, TLBs, or excavators. The material is unstable by virtue of being soaked, such as being located in marsh or swamp conditions, and cannot provide a stable working platform for the construction of subsequent layers. Unstable material is normally left in place and covered with a pioneer layer but can also be taken to spoil.

**Wearing course** - the gravel layer constituting the uppermost (top) layer of an unsealed road. The wearing course is not considered part of the structural layers (the base and other layers). The purpose of the wearing course is to provide a maintainable surface, which is skid resistant, dust-free and impermeable to moisture as possible.

**Weinert N-value** - is a climatic numerical value, which has become known as the N-value. It is calculated by multiplying 12 times the computed evaporation of the warmest month, mostly January in Southern Africa, divided by the mean annual precipitation. Four N-values are significant:

- Where N is more than 10, no significant weathering profile develops, and only a thin layer of coarse gravel can generally be obtained from the disintegrating rock.
- Where N is between 10 and 5, disintegration or the physical breakdown of all rocks is the predominant form of weathering, and a deeper weathering profile is usually present.
- Where N is between 5 and 2, decomposition or chemical weathering or more specifically, the alteration of minerals, becomes the predominant form of weathering of crystalline rocks. The clay component is kaolinite when derived from an acid crystalline rock, and montmorillonite when derived from a basic crystalline rock which is highly expansive.
- When N drops below 2, decomposed basic crystalline rocks are still expansive. Decomposed acid crystalline rocks may become expansive as montmorillonite may have developed from the little biotite and amphibole present.

## **A4.1.3 GENERAL**

### **A4.1.3.1 Employer identified borrow pits and quarries**

Borrow materials shall be obtained from sources listed and described in the Contract Documentation for which the required statutory authorisation and approvals have been obtained by the Employer to source the materials.

The geotechnical information provided for the borrow pits and the quarries reflects the results of site investigations including the excavation of trial pits and/or drilling, and laboratory tests conducted by or on behalf of the Employer. This information is indicative as to the sufficiency in quantity and quality of the material. The provision of this information shall not in any way be construed as limiting the obtaining of material from the borrow pit or quarry areas and/or to the depth of working shown on the drawings. However, borrow pits and quarries shall not be extended beyond the limits shown on the drawings without prior written approval by the authority that authorised the use of the borrow pit or quarry.

The decision as to which material sources the Contractor shall use at any time shall rest with the Employer or the Engineer. The Contractor shall, at any stage of the work, use the approved source of supply that is the most compliant with regard to the quality and quantities of the various types of available materials and the ultimate cost of the works to the Employer. The Employer shall also have the right at any stage during the construction period to identify new borrow pits and quarries, and to have them approved by the relevant authority.

The Contractor shall be instructed as to the applicable usage of materials always employing the best economic alternative (lowest construction cost in terms of tendered rates) after taking cognizance of the following:

- Quality of the material,
- Haulage distance,
- Hardness of the material, and
- Overburden removal and re-use for rehabilitation of the borrow pit.

The Contractor shall not use borrow material for any purpose other than for the execution of the contract. Material shall not be disposed of, whether processed or not, either by sale or donation to any person without the written authorisation of the Employer.

On completion of the construction works, the Employer or his agent shall apply for a borrow pit or quarry closure certificate. The application shall consist of the required reports compiled by or on behalf of the Employer, and the closure plan compiled by the Contractor.

### **A4.1.3.2 Contractor identified borrow pits and quarries**

Should the Contractor during construction want to propose compliant alternative or additional borrow pits or quarries to those contained in the Contract Documentation, the Engineer's consent shall first be obtained prior to finalising the arrangements for the Contractor identified source. Information to be provided shall be the reasons for the alternative or additional borrow pit or quarry, the cost and time implications, quality and quantity of compliant material and any other information that the Engineer may require. After obtaining the Engineer's initial consent, the Contractor shall proceed with a detailed investigation of the borrow pit or quarry that comprises the following activities:

- Negotiations with the landowner or legal occupant of the property about acquiring the land, compensation and conditions for entering the property, operations at the borrow pit or quarry, and shaping and finishing. Proof must be submitted that successful negotiations have been conducted with all the affected parties, and the landowner or legal occupant.
- An invasive geotechnical investigation of trial pitting, drilling as required, and sampling must be carried out for the intended use by an approved geotechnical engineer, engineering geologist or an experienced road material specialist. The laboratory for the material testing shall also be approved by the Engineer. All field work and laboratory testing shall be carried out under the supervision of the Engineer. The scope and findings of the geotechnical investigation, material test results, quality and quantity of the compliant material, and conditions for excavating and operating the borrow pit or quarry shall be submitted in a report to the Engineer.
- A topographical survey of the entire borrow pit or quarry area with cadastral information shown, as well as the surveyed positions of trial pits and boreholes.
- Obtaining the required statutory authorisation and approvals by the appropriate authorities.

The Engineer shall approve or reject the use of the alternative or additional borrow pit and quarry, after the results of the detailed investigation have been received.

Where the Tenderer during the tender stage, wishes to base the tender on alternative material source(s) to those contained in the Contract Documentation, the alternative material source(s) shall be considered as an alternative design, for which the Engineer's consent shall be obtained prior to tender closure. The Engineer will then also inform the Tenderer which information of the listed activities of the detailed investigation must be submitted with the tender, and which activities can be carried out later during construction.

Where the Contract Documentation specifies that the Contractor must identify compliant borrow pits and / or quarries, the same procedure and requirements apply as for alternative or additional borrow pits or quarries.

The Contractor can also propose for consideration the procurement of compliant commercial materials, should they prove to be economically viable.

The Contractor shall be responsible for all costs relating to the negotiations and compensation, the geotechnical investigation and to obtain the statutory approvals of any alternative or additional source.

The Engineer's approval of the Contractor identified material source shall in no way relieve the Contractor of the responsibility for the quantity and quality of the compliant material in the source. The Engineer can at any time halt operations at the source when the material is no longer compliant for its intended use.

After acceptance by the Employer and the Engineer of the Contractor's identified source of material, the Engineer shall have full control of the use of the material. The Engineer shall have authority to give instructions for excavation, producing, stockpiling, finishing and all other construction issues.

#### **A4.1.3.3 Negotiations with landowners or legal occupants of land**

For Employer identified borrow pits, quarries, and temporary haul and access roads, the acquisition of the land and/or the removal of the material and compensation in respect of the land, material, royalties and/or loss of crops to which the landowner or legal occupant may be entitled, will be negotiated and paid for by the Employer. When compensation is not made directly by the Employer, payment shall be made by the Contractor through a provisional sum in the Pricing Schedule.

The Contractor will be provided with proof of the successful negotiations and compensation, if applicable, of the Employer identified borrow pits, quarries and temporary haul and access roads. The Contractor shall include the proof of the negotiations and compensation in the M&U plan.

The Contractor shall notify the landowner or legal occupant both verbally and in writing at least 14 calendar days before entering upon or occupying the property. The Engineer shall be provided with a copy of such notice, together with acknowledgement of receipt by the landowner or legal occupant. The Contractor shall not enter the property without the approval of the landowner or legal occupant.

On completion of the borrow pit or quarry operations and after the shaping and finishing activities have been carried out, the Contractor shall obtain from the landowner or legal occupant a written statement confirming that:

- The Contractor has fulfilled all obligations under any written agreement, and
- The landowner or legal occupant is satisfied that the borrow pit, quarry and/or temporary haul and access roads have been properly restored and are in a satisfactory condition.

All such statements shall be signed by the Contractor and the landowner or legal occupant, dated and delivered to the Engineer.

#### **A4.1.3.4 Contractor prepared plans for borrow materials**

Based on the information provided in the Contract Documentation, the Contractor shall prepare and submit a Management and Utilisation (M&U) plan for every borrow pit and quarry, whether it be a source identified by the Employer or by the Contractor. The M&U plan shall at least show and include the following:

- The position of a satellite office and camp site, ablution facilities, refuse disposal facilities and workshops as applicable;
- The curriculum vitae of the proposed materials manager, excavation and stockpile controllers as applicable;
- Drainage measures to keep the excavations dry and prevent water ponding;
- Demarcation of the areas for stockpiling of topsoil, overburden and the various earthworks and pavement layer materials;
- Sequence and operation of the borrow pit or quarry for sourcing the material, after the further supplementary exploration described in Clause A4.1.7.2c);
- Method statements and risk assessments for sourcing the material and for operating the borrow pit or quarry;
- The testing protocol of the applicable tests and the frequency of testing;
- Method statements for the blasting of hard material, details for the safe storage and transport of explosives, and the process for obtaining blasting permits in terms of the requirements of these Specifications;

- When blasting within the vicinity of buildings or structures, measures to comply with the relevant Act and Regulations pertaining to the utilisation of explosives, as specified in Clause A1.2.7.5 of Chapter 1, proposals for the examination and recording of the condition of the buildings and structures as specified in Clause A1.2.3.13 of Chapter 1 and compliance with the specifications given in Clause A12.10.7.2 of Chapter 12;
- The positioning of crushers, screens and other plant for crushing and screening of materials;
- Proposed details of a closure plan at completion, including the shaping, finishing and rehabilitation of the borrow pit or quarry side slopes and floor;
- Measures to comply with the conditions of the statutory environmental and mining approvals for the borrow pit or quarry;
- Measures to comply with the safety regulations and obligations in terms of the relevant Health and Safety Act and Regulations; and
- Procedures for regular monitoring, auditing and reporting.

M&U plans need only to be submitted during the course of the construction. However, no operations (including clearing and grubbing) at a borrow pit or a quarry shall commence until the Contractor's M&U plan for that material source has been reviewed and accepted by the Engineer. The Engineer shall respond within one week after receiving an M&U plan.

The M&U plan shall be reviewed after removing of the topsoil and overburden, and revised if the sequence of excavation, type and quality of material or any other issue requires a different operation than detailed in the original M&U plan.

## A4.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

Not required for Section A4.1.

## A4.1.5 MATERIALS

### A4.1.5.1 General

The material specifications in Clause A4.1.5 are the required specifications for the materials constructed on the road, or for the materials produced as applicable.

The materials shall also not contain any visible materials of the following:

- Organic materials, grass and shrubs,
- Wood chippings, tree bark, and roots,
- Plastic (bags, polystyrene and so forth),
- Refuse or other non-compliant material,
- Free asbestos, or

Any of the hazardous material listed in Clause A4.5.5.5.

The relevant test methods related to the material specifications and control thereof are listed in Clauses A20.1.3.2, A20.1.4 and A20.1.5 of Chapter 20 with mention of special tests in A20.1.6. Any ambiguity concerning the relevance and the need for additional test methods shall be brought to the attention of the Engineer for a ruling.

### A4.1.5.2 Grouping of Southern African road construction materials

Table A4.1.5-1 contains the grouping of rocks most frequently used for road construction.

**Table A4.1.5-1: Grouping of rocks**

Group	Members	Characteristic <sup>(1)</sup>
Basic crystalline rocks	Amphibolite Andesite Anorthosite Basalt Diabase Dolerite Gabbro Greenschist Norite Peridotite Phonolite Serpentinite	Quartz very scarce or absent. The end products of decomposition are clay minerals of the smectite group, particularly montmorillonite. These rocks are more susceptible to decomposition than all others and require the most careful assessment of durability particularly where Weinert N ≤ 5.
Acid crystalline rocks	Felsite (quartz porphyry) Gneiss Granite Pegmatite Rhyolite Syenite	Orthoclase and quartz are the two major components except in syenite. The end product of decomposition is kaolinite mostly with quartz, and a smectite stage is absent. May require special attention when used where Weinert N ≤ 2.

High silica rocks	Chert Hornfels Quartzite Vein Quartz	Composed almost entirely of quartz or amorphous silica. Disintegration is the only mode of weathering. These rocks are the most durable of all road building materials.
Arenaceous rocks	Arkose Conglomerate Gritstone Mica schist Quartzitic sandstone Sandstone	Quartz grains in different kinds of matrix. Cementing of matrix determines largely the suitability as road building material. All members are sedimentary rocks. Disintegration is the predominant form of weathering in all environments.
Argillaceous rocks	Mudstone Phyllite Sericite schist Shale Slate	Essentially rocks composed of clay minerals, often with quartz grains and occasionally with mica. The principal mode of weathering is disintegration.
Carbonate rocks	Dolomite Limestone Marble	Mostly composed of calcite and/or dolomite. The rocks weather only by disintegration or are dissolved when water is present.
Diamictites	Greywacke (although greywacke can also be classified as an arenaceous rock) Tillite Volcanic tuff Volcanic breccia	Composition extremely random, and is dependent on the incidental mode of formation.
Metallic ores (mining material)	Ironstone (haematite) Magnesite Magnetite	Material from certain mining operations. Durable materials which disintegrate in most cases when weathering.
Pedogenic materials	Calcrete Ferricrete / laterite Silcrete Gypcrete	Secondarily in place cemented and/or replaced soils with strongest materials on top of the succession. Host soil and cementing material, besides strength, determine the road building properties.

**Note:**

<sup>(1)</sup> Reference is made to TRH14 Appendix A that contains useful information on the properties of the rock groups and the identification thereof.

### A4.1.5.3 Pioneer layer

Material for a pioneer layer shall consist of one of the following:

- Predominantly blasted rock and boulders (shape not completely rounded or polished), generally in the size range 100 mm to 500 mm, and a lack of material finer than 50 mm.
- Coarse sand with a plasticity index less than 6.
- Alternative materials comprising concrete, concrete bricks and hard burnt clay bricks sourced from construction and demolition of structures. The materials shall be selected or crushed to be also generally in the size range 100 mm to 500 mm, with a lack of material finer than 50 mm.

Material for a pioneer layer does not have to conform to gradation or shape requirements, except for boulders as specified above.

### A4.1.5.4 Sand, normal and coarse fill material in the earthworks layers

Compliant sand fill shall have a CBR  $\geq 7\%$  and a swell  $\leq 1\%$  at 100 % of MDD.

The CBR of compliant normal and coarse fill shall comply with the requirements in Table A4.1.5-2.

**Table A4.1.5-2: Requirements for normal and coarse fill**

Position of the roadbed below the final road surface	CBR and swell
Within the material depth of: <ul style="list-style-type: none"> <li>• 1 200 mm for freeways, major interurban roads, rural and urban arterials. (Class 1/Category A roads).</li> <li>• 1 000 mm for interurban collectors, major rural roads, major commercial roads, urban arterials. (Class 2/Category B roads).</li> <li>• 800 mm for lightly trafficked rural and urban collector and distributor roads, bus routes and commercial roads. (Class 3 and 4/Category C roads).</li> <li>• 600 mm for low volume roads, rural local roads, and urban local residential streets carrying few heavy vehicles. (Class 5/Category D roads).</li> </ul>	CBR $\geq 7\%$ at 93 % of MDD. Swell $\leq 2\%$ at 100 % of MDD.
Below the applicable material depth up to 10 m.	CBR $\geq 3\%$ at 93 % of MDD. Swell $\leq 2\%$ at 100 % of MDD.

More than 10 m.	To be specified in the Contract Documentation, as per the design by an experienced geotechnical engineer of the fill slope, settlement and consolidation, the fill toe protection and drains, the foundation stability and any other design issues.
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The normal and coarse fill materials may contain inactive clay and silt, provided that the CBR strength requirements are complied with.

#### A4.1.5.5 Rock fill material in the earthworks layers

Rock fill material shall have a maximum dimension not exceeding 500 mm.

The following rock types that decompose or deteriorate rapidly on exposure to air and moisture shall not be used unless permitted in the Contract Documentation:

- Mudrocks and soft or weathered shales.
- Highly weathered, very soft basic crystalline rocks in the wet eastern part of Southern Africa where Weirert  $N \leq 5$ .
- Highly weathered (brown coloured) tillite.

Rock fill that is deficient in fine material can be used in the works, provided that after placing the rock fill and during the compaction, concrete or plaster sand or non-parent (not from the same source as the rock) sandy material, all passing the 5 mm sieve, is spread uniformly over the surface of the rock fill and vibrated or worked into and between the rocks to fill the voids.

A strength requirement such as the CBR is not required for rock fill material.

#### A4.1.5.6 Requirements for types G7 to G9 materials for the pavement layers

Gravel-soil types G7 to G9 materials shall be classified according to the requirements in Table A4.1.5-3.

**Table A4.1.5-3: Requirements for types G7 to G9 materials**

Property		Type of material		
		G7	G8	G9
DESCRIPTION OF MATERIAL		Soil, gravel with cobbles, boulders and lumps of hard material that may require crushing or grid rolling, or alternative materials.	Soil, gravel, or alternative materials.	
MAXIMUM PARTICLE SIZE		(i) Uncrushed material: Two-thirds of the compacted layer thickness. (ii) Crushed material: 100 mm.	Two-thirds of the compacted layer thickness.	
GRADING MODULUS (GM)		0,75 – 2,7.		
SOIL CONSTANTS ON THE P <sub>0,425</sub> FRACTION (= % passing the 0,425 mm sieve)	All materials except calcrete	$PI \leq (3 \times GM) + 10$ .		
	Calcrete	$PI \leq 20$ .		
STRENGTH (CBR at % of MDD)		CBR $\geq 15$ % at 93 %.	CBR $\geq 10$ % at 93 %.	CBR $\geq 7$ % at 93 %.
SWELL AT 100 % OF MDD		Swell $\leq 1,5$ %.		
DURABILITY		No requirement, except when mudstone or shale is used in the selected layer. Requirements then as specified in Clause A4.1.5.16.		
DELETERIOUS MINERALS		Specified in Clause A4.1.5.17.		

### A4.1.5.7 Requirements for types G4 to G6 materials for the pavement layers

Gravel, natural occurring or modified or processed, types G4 to G6 materials shall be classified according to the requirements in Table A4.1.5-4.

**Table A4.1.5-4: Requirements for types G4 to G6 materials**

Property		Type of material				
		G4A	G4B	G5A	G5B	G6
DESCRIPTION OF MATERIAL		Medium to hard rock, or boulders that require multi-stage crushing and screening.	1. Gravel with pebbles and small cobbles, or gravel with larger cobbles, boulders and lumps of hard material, or soft rock that require single- or two-stage crushing, or grid rolling. 2. Pedogenic materials that require dozer ripping.	Medium to hard rock, or boulders that require multi-stage crushing and screening.	1. Gravel with pebbles and small cobbles, or gravel with larger cobbles, boulders and lumps of hard material, or soft rock that require single- or two-stage crushing, or grid rolling. 2. Pedogenic materials that require dozer ripping.	Gravel with cobbles, or alternative materials.
MAXIMUM PARTICLE SIZE		50 mm.	(i) In a gravel base layer: 50 mm. (ii) In all other pavement layers: Two-thirds of the compacted layer thickness, or 100 mm whichever is the smaller.	50 mm.	(i) In a gravel base layer: 50 mm. (ii) In all other pavement layers: Two-thirds of the compacted layer thickness, or 100 mm whichever is the smaller.	
FLAKINESS INDEX		Flakiness Index $\leq$ 35 on all individual fractions above 14 mm.	None specified.	Flakiness Index $\leq$ 35 on all individual fractions above 14 mm.	None specified.	
FRACTURED FACES		None specified.	Gravels and boulders that are crushed: at least 50 % by mass of the material retained on each of the 5 mm and larger sieves shall have at least one fractured face.	None specified.	Gravels and boulders that are crushed: at least 50 % by mass of the material retained on each of the 5 mm and larger sieves shall have at least one fractured face.	None specified.
GRADING ENVELOPE	Sieve size (mm)	Percentage passing sieve, by mass	None specified.	Percentage passing sieve, by mass	None specified.	
	50	100		100		
	37,5	85 – 100		85 – 100		
	20	61 – 91		61 – 91		
	14	48 – 82		48 – 82		
	5	31 – 66		31 – 66		
	2	20 – 50		20 – 50		
	0,425	10 – 30		10 – 30		
0,075	5 – 15	5 – 15	5 – 15			
GRADING MODULUS (GM)		None specified	1,5 – 2,5.	None specified	1,5 – 2,5.	1,2 – 2,6.
SOIL CONSTANTS ON THE P <sub>0,425</sub> FRACTION <sup>(1)</sup> (= % passing the 0.425 mm sieve)		(a) All materials except calcrete: LL $\leq$ 25. PI $\leq$ 6. LS $\leq$ 3 %. (b) Calcrete: LL $\leq$ 30. PI $\leq$ 8. LSM $\leq$ 170.		(a) All materials except calcrete: LL $\leq$ 30. PI $\leq$ 10. LS $\leq$ 5 %. (b) Calcrete: LL $\leq$ 45. PI $\leq$ 15. LS $\leq$ 6 %. LSM $\leq$ 320.		(a) All materials except calcrete: PI $\leq$ 2GM + 10. LS $\leq$ 7 %. (b) Calcrete: LL $\leq$ 45. PI $\leq$ 15. LS $\leq$ 6 %, or LSM $\leq$ 320, whichever is the more stringent requirement.
STRENGTH (CBR at % of MDD)		CBR $\geq$ 80 % at 100 %.		CBR $\geq$ 45 % at 95 %.  Except in the dry western parts of Southern Africa (Weinert N $\geq$ 10) and when the E80s < 3 million, then the subbase CBR $\geq$ 25 % at 95 % provided that the base thickness $\geq$ 150 mm.		CBR $\geq$ 25 % at 95 %.
SWELL AT 100 % OF MDD		Swell $\leq$ 0,2 %.		Swell $\leq$ 0,5 %.		Swell $\leq$ 0,5 %.
DURABILITY		Specified in Clause A4.1.5.16.				
DELETERIOUS MINERALS		Specified in Clause A4.1.5.17.				

**Note:**

<sup>(1)</sup> The LS and the LSM shall be the primary soil constants for acceptance control of calcrete, and the PI for all other materials.

### A4.1.5.8 Requirements for types G1 to G3 materials for the pavement layers

Graded crushed stone types G1 to G3 materials shall be classified according to the requirements in Table A4.1.5-5.

**Table A4.1.5-5: Requirements for types G1 to G3 crushed stone**

Property		Type of material				
		G1		G2	G3	
PARENT MATERIAL		Sound <sup>(1)</sup> , clean <sup>(2)</sup> , unweathered <sup>(3)</sup> high quality rock.		Sound <sup>(1)</sup> , clean <sup>(2)</sup> rock and boulders.	Sound <sup>(1)</sup> , clean <sup>(2)</sup> rock and boulders, or coarse gravel.	
ADDITIONAL FINES		Only fines crushed from the same sound parent rock may be added for grading correction provided that added fines shall have a LL ≤ 25 and a PI ≤ 4. The quantity of fines shall not exceed 15 % by mass.		May contain up to 10 % by mass of approved natural fines not necessarily obtained from the same parent rock. Added fines shall have a LL ≤ 25 and a PI ≤ 6.	May contain up to 15 % by mass of approved natural fines not obtained from the same parent rock. Added fines shall have a LL ≤ 25 and a PI ≤ 6.	
AGGREGATE STRENGTH		10 % Fines Aggregate Crushing Value (10 % FACT) and Aggregate Crushing Value (ACV) specified in table A4.1.5-6				
FLAKINESS INDEX		Flakiness index ≤ 35 on all individual fractions above 14 mm.				
FRACTURED FACES		All faces shall be fractured faces.		For crushed materials at least 50 % by mass of the fractions retained on each of the 5 mm and larger sieves shall have at least one fractured face.		
SOIL CONSTANTS	Fraction smaller than	E80s > 15 million	E80s ≤ 15 million	LL ≤ 25. PI ≤ 6. LS ≤ 3 %.		(a) All materials except calcrete: LL ≤ 25. PI ≤ 6. LS ≤ 3 %.
	0,425 mm	PI = NP.	LL ≤ 25. PI ≤ 4. LS ≤ 2 %.			
	0,075 mm	PI ≤ 8		PI ≤ 12		PI ≤ 12.
MAXIMUM PARTICLE SIZE		37,5 mm			37,5 mm	28 mm
GRADING ENVELOPE <sup>(4)</sup>	Sieve size(mm)	Percentage passing sieve, by mass		Percentage passing sieve, by mass		Percentage passing sieve, by mass
	37,5	100		100		100
	28	86 – 90		86 – 95		86 – 95
	20	73 – 80		73 – 86		73 – 86
	14	61 – 71		61 – 76		61 – 76
	5	37 – 49		37 – 54		37 – 54
	2	23 – 36		23 – 40		23 – 40
	0,425	11 – 20		11 – 24		11 – 24
0,075	4 – 10		4 – 12		4 – 12	
STRENGTH (CBR at % of MDD)		None specified.			CBR ≥ 80 % at 100 %.	
SWELL AT 100 % OF MDD		None specified.			Swell ≤ 0,2 %.	
DURABILITY		Specified in Clause A4.1.5.16.				
DELETERIOUS MINERALS		Specified in Clause A4.1.5.17.				

**Notes:**

- (1) Sound – adequate strength and durability.
- (2) Clean – Free from visible traces of materials not from the parent rock.
- (3) Unweathered – Fresh or faintly weathered rock with no visible signs under the naked eye of alteration in the rock material, but discontinuity planes or surfaces may be stained or discoloured.
- (4) The grading lines, when plotted to log scale, shall confirm a continuous particle size distribution within the grading envelope, without any abrupt directional changes or meandering.

Crushed stone for G1 and G2 material shall not be processed from the following rock groups:

- Arenaceous rocks except quartzitic sandstone.
- Argillaceous rocks.
- Pedogenic materials, including calcrete.

The aggregate strength requirements, namely the 10 % fines aggregate (10 % FACT) and the aggregate crushing (ACV) limiting values, for the types G1 to G3 materials are given in Table A4.1.5-6.

**Table A4.1.5-6: Requirements for 10 % FACT and ACV values<sup>(1)</sup>**

Rock group	10 % FACT (dry) (minimum)	ACV (maximum)
Arenaceous rocks with a siliceous cementing matrix (quartzitic sandstone)	110 kN	29 %
Arenaceous rocks with non-siliceous material	140 kN	27 %
Diamictites	200 kN	21 %
Calcrete	80 kN	29 %
All other compliant rock groups	110 N	29 %

**Note:**

<sup>(1)</sup> When there is a contradiction between the 10 % FACT and the ACV test results about the acceptance of the material, the Engineer shall instruct whether the material shall be evaluated for acceptance on the 10 % FACT or on the ACV test results.

#### A4.1.5.9 Sand in fill and pavement layers of sealed low volume roads

Natural untreated sand in the fill and pavement layers of sealed low volume roads shall comply with the requirements in Table A4.1.5-7.

**Table A4.1.5-7: Requirements for natural untreated sand in sealed low volume road layers**

Property		Base and shoulder <sup>(1)</sup>	Subbase	Selected	Fill
% Passing 2 mm		95 – 100			None specified
% Passing 0,075 mm (P <sub>0,075</sub> )		5 – 20			
Grading modulus		0,75 – 1,50			
PI on 0,075 mm fraction (PI <sub>0,075</sub> )		SP – 25			
P <sub>0,075</sub> x PI <sub>0,075</sub>		25 – 300			
Strength (CBR at 100 % of MDD)	Soaked	CBR ≥ 50 %	CBR ≥ 30 %	CBR ≥ 15 %	CBR ≥ 7 %
	Unsoaked	CBR ≥ 60 %	None specified		
Swell at 100 % of MDD		Swell ≤ 0,1 %			

**Notes:**

<sup>(1)</sup> Natural untreated sand may only be used in the base layer and unsealed shoulder on low volume roads in the dry western parts of Southern Africa where Weibert N ≥ 10.

<sup>(2)</sup> In the drier western part of Southern Africa and when a choice can be made between different colour sands, then only yellowish-brown to red sand shall be used while white or grey sand shall be avoided. It is also advantageous due to cementation, for the sand to contain at least 0,3 % Fe or 1,2 % Fe<sub>2</sub>O<sub>3</sub> as determined by CBD (citrate-bicarbonate-dithionite) or XRF (X-ray fluorescence) analysis respectively.

### A4.1.5.10 Macadam materials

#### a) Coarse aggregate

Coarse aggregate in a macadam layer shall be obtained from the crushing of sound unweathered rock (refer Clause A4.1.5.8 for definitions), and shall comply with the requirements in Table A4.1.5-8.

**Table A4.1.5-8: Requirements for coarse aggregate in a macadam layer**

Property		Requirement		
STRENGTH <sup>(1)</sup>		ACV ≤ 29 %, or 10 % FACT (dry) ≥ 100 kN and the wet/dry ratio ≥ 75 %		
MAXIMUM PARTICAL SIZE		63 mm	50 mm	37,5 mm
FLAKINESS INDEX		Flakiness Index ≤ 35 on the -50 mm and +37,5 mm fraction	Flakiness Index ≤ 35 on the -37,5 mm and +28 mm fraction	Flakiness Index ≤ 35 on the -28 mm and +20 mm fraction
GRADING ENVELOPE	Sieve size(mm)	Percentage passing by mass	Percentage passing by mass	Percentage passing by mass
	63	100	---	---
	50	85 – 100	100	---
	37,5	0 – 30	85 – 100	100
	28	0 – 5	0 – 50	85 –100
	20	0	0 – 25	0 – 30
	14	0	0-5	0-5

**Note:**

<sup>(1)</sup> When there is a contradiction between the 10 % FACT and the ACV results about the acceptance of the material, the Engineer shall instruct whether the material shall be evaluated for acceptance on the 10 % FACT or on the ACV test results.

#### b) Fine aggregate

The fine aggregate in a dry-bound, waterbound or penetration macadam layer shall comply with the requirements in Table A4.1.5-9.

**Table A4.1.5-9: Requirements for fine aggregate in a macadam layer**

Property		Requirement
GRADING ENVELOPE	Sieve size (mm)	Percentage passing by mass
	7,1	100
	5	85 – 100
	0,075	10 – 20
SOIL CONTANTS ON THE P0,425 FRACTION (= % passing the 0,425 mm sieve)		LL ≤ 25 PI ≤ 6 LS ≤ 3 %

#### c) Slurrybound macadam aggregate

The slurry material for a slurrybound macadam is covered in Chapter 10: Seals and Microsurfacing.

### A4.1.5.11 Unsealed shoulder material

The material for the unsealed shoulder of a sealed or surfaced road where the shoulders are not constructed with the same material as the base layer shall comply with the requirements in Table A4.1.5-10.

**Table A4.1.5-10: Requirements for material of an unsealed shoulder**

Property		Requirement	
Description of material		Natural gravel or crushed material except calcrete	Calcrete
Maximum particle size		100 mm	
Grading modulus (GM)		1,5 – 2,4	
SOIL CONSTANTS ON THE P0,425 FRACTION  (= % passing the 0,425mm sieve)	LL	Not specified	LL ≤ 45
	PI	6 minimum up to (3xGM + 10)	PI ≤ 15
	LSM	Not specified	LSM ≤ 320
Aggregate finger value (AFV)		Not specified	≥ 60 %
Aggregate plier value (APV)		Not specified	≥ 20 %
Strength (CBR at % of MDD)		CBR ≥ 45 % at 95 %	
Swell at 100 % of MDD		Swell ≤ 0,5 %	
10 % FACT (dry)		≥ 50 kN	None specified

Sand shall not be used for untreated shoulder material due to its high erodibility, except for low volume roads in dry areas (Weinert N ≥ 10), and when the sand does not conform to the base layer sand specification in Table A4.1.5-7.

### A4.1.5.12 Wearing course gravel material

Gravel material other than calcrete for the wearing course of an unsealed road shall comply with the requirements in Table A4.1.5-11.

**Table A4.1.5-11: Requirements for gravel wearing course material other than calcrete<sup>(1)</sup>**

Property	Requirement	
	Rural and urban roads	Mine or forest haul roads for heavy vehicles
Description of material	Natural gravel or crushed material except calcrete	
Maximum particle size	37,5 mm	50 mm
Oversize index (I <sub>o</sub> )	N/A	≤ 5%
Grading coefficient (G <sub>c</sub> )	15 – 35	20 – 35
Shrinkage product (S <sub>p</sub> )	100 – 240	100 – 240
PI on the P0,425 fraction	6 – 12	6 - 12
Strength (CBR at % of MDD)	CBR ≥ 15 % at 95 %	CBR ≥ 25 % at 95 %
Treton impact value	20 % – 65 %	20 % – 65 %
I <sub>o</sub> = Percent retained on 37,5 mm sieve. G <sub>c</sub> = (Percent passing 28 mm sieve – percent passing 2,0 mm sieve) x percent passing 5,0 mm sieve/100. S <sub>p</sub> = Linear shrinkage x percent passing 0,425 mm sieve.		

**Note:**

<sup>(1)</sup> Sand alone shall not be compliant as a wearing course, except for very low volume roads and when the sand complies with the base layer specification in Table A4.1.5-7.

Calcrete material for the wearing course of unsealed rural and urban roads shall comply with requirements in Table A4.1.5-12.

**Table A4.1.5-12: Requirements for calcrete wearing course material**

Property		Percentage passing 0,425 mm sieve, by mass			
		20 – 40	41 - 50	51 - 60	61 - 75
MAXIMUM PARTICLE SIZE		37,5 mm			
SOIL CONSTANTS ON THE P <sub>0,425</sub> FRACTION (= % passing the 0,425 mm sieve)	LL	30 - 65	22 - 48	20 - 40	18 - 36
	PI	9 - 22	7 - 23	5 - 13	8 - 13
	LS	2,0 – 9,5 <sup>(1)</sup>	2,7 – 9,0	2,0 – 5,5	2,0 -5,0
	LSM	70 – 340 <sup>(2)</sup>	130 – 395	100 – 320	130 - 330
AGGREGATE FINGER VALUE (AFV)		≥ 65 %	≥ 60 %	≥ 40 %	≥ 35 %
AGGREGATE PLIER VALUE (APV)		≥ 20 %	≥ 20 % <sup>(3)</sup>	≥ 15 %	None specified

**Notes:**

- <sup>(1)</sup> LS between 2,0 and 2,6 may cause slight looseness and dust.
- <sup>(2)</sup> LSM between 70 and 100 may cause slight looseness and dust.
- <sup>(3)</sup> A minimum APV of 14 % is permissible if the AFV ≥ 75 %.

### A4.1.5.13 Drainage layer material

#### a) Drainage blanket layer material

Material for a drainage blanket layer comprising coarse material shall comply with the gradation requirements in Table A4.1.5-13.

**Table A4.1.5-13: Gradation of material for a drainage blanket layer**

Sieve size (mm)	Percentage passing sieve, by mass
50	100
37,5	74 – 100
28	56 – 98
14	42 – 69
5	25 – 37
2	15 – 20
0,425	4 – 9
0,075	0 – 4

#### b) Sand filter material

Sand for filter material in the fill layers shall be clean, durable sand and shall comply with the gradation requirements in Table A4.1.5-14.

**Table A4.1.5-14: Gradation of sand filter material**

Sieve size (mm)	Percentage passing sieve, by mass	
	Natural sand	Crusher sand
5	90 – 100	
0,150	5 – 25	
0,075	0 – 5	0 – 10

#### A4.1.5.14 Soil cement in the pavement layers

Soil cement, also known as soilcrete, may be used in widenings that cannot be constructed efficiently by conventional road construction equipment, or for the backfill of existing manholes and similar structures, and services within the road prism. It shall consist of a wet or stiff mixture of crushed or gravel material with cement. The crushed or gravel material shall be of at least subbase quality material, with a maximum particle size of 37,5 mm and a PI not exceeding 10. When mixed on the site, the soil cement shall either be:

- A wet mixture (5 % cement) consisting of 2 bags of cement: 1,0 m<sup>3</sup> of material and sufficient water for it to be compacted with concrete vibrators, or
- A stiff mixture (3 % cement) consisting of 2 bags of cement: 1,5 m<sup>3</sup> of material and just sufficient water for it to be placed in layers and compacted to a measurable density with applicable compaction equipment.

Where soil cement is provided by commercial suppliers, the 7-day concrete cube strength of the soil cement shall not exceed 7 MPa.

#### A4.1.5.15 Emulsion treated base material

Emulsion treated base material, also known as ETB, for use in patches, narrow widenings and in new base layers where light construction equipment is used or where a crushed stone base layer cannot be constructed, shall consist of the following mix components:

- Crushed stone type G1 or G2 material: 1,0 cubic metre compacted material.
- Cement: 1 % by mass or 25 kg (half a bag) per cubic metre crushed stone material.
- Anionic emulsion: 3 % by mass or 66 litre (one-third of a 200 litre drum) per cubic metre crushed stone material.
- Water for compaction as required.

When instructed by the Engineer the ITS of the ETB shall be verified for compliance with that specified for a BSM2 in Section A4.4, Table A4.4.5-3. If the ITS requirement is not achieved, the above mix design shall be redesigned until the ETB complies with the ITS specification.

#### A4.1.5.16 Durability of materials

##### a) Requirements for crushed stone materials in the base and subbase layers

Crushed stone material types G1 to G5A, when used in the base and subbase layers, shall comply with the requirements hereunder.

##### (i) Basic crystalline rocks

Decomposition of the primary minerals into montmorillonite is the predominant form of weathering.

There is no single basic crystalline aggregate characteristic that can be used to fully determine the suitability of the aggregate. The suite of tests in Table A4.1.5-15 shall be carried out and if any result is outside the specification, the material shall be regarded with caution. The material shall then be further evaluated and declared fit for use by an experienced engineering geologist or a road materials specialist.

**Table A4.1.5-15: Durability tests and requirements for basic crystalline rocks**

Test <sup>(1)</sup>	Requirement	
	Base material	Subbase material
1. 10 % FACT <sup>(2)</sup> value after soaking in ethylene glycol for 1 day, compared to the dry value	≥ 80 %	≥ 70 %
2. Modified Ethylene Glycol Durability Index (mEGDI)	5 days soaking	mEGI < 10
	20 day : 5 day soaking ratio	Ratio < 1,5 if 20 day mEGI > 10
2. Durability mill test (dry material test):		
2.1 Index	≤ 80	≤ 125
2.2 Percentage passing 0,425 mm after the test	None specified	≤ 35
2. Product of maximum increase in PI and maximum increase in P <sub>0,425</sub> mm, between the DMI <sub>dry</sub> and the DMI <sub>glycol</sub> soaked for 5 days <sup>(3)</sup>	≤ 7	None specified
3. Smectite content using the Spot Counting <sup>(4)</sup> and/or the Rietvlei quantitative XRD (X-ray diffraction) tests	≤ 5	None specified
3. Percentage secondary minerals as in the publication "The natural road construction materials of Southern Africa", by HH Weinert	Durability lines in Table 11 on page 95 of the publication	

##### Notes:

- (1) Tests to be carried out in sequence of numbering. Results in a set to be assessed, thereafter samples that fall way below (or above) the limiting values shall be disqualified without further testing.
- (2) i) 10 % FACT can be estimated from the Aggregate Impact Value (AIV) (test method BS 812-112:1990):  

$$10\% \text{ FACT} = 10^{(2,915 - 0,03\text{AIV})}$$
 ii) After soaking, rinse aggregates with water followed by immediate towel drying and air drying at temperatures not exceeding 70 °C.
- (3) i) Gradings of samples shall be identical.  
 ii) Soaking only of material retained on the 2 mm sieve.  
 iii) After soaking, rinse and dry material as for 10 % FACT.
- (4) Spot Counting test to be carried out by an experienced geologist.

In areas where Weirner  $N \leq 2$ , all crushed stone bases to be constructed with material derived from basic crystalline rocks shall be treated with lime, irrespective of the smectite content.

(ii) All other rocks

Disintegration of all rocks is the predominant form of weathering, and the durability of compliant crushed rocks shall comply with the requirements in Table A4.1.5-16.

**Table A4.1.5-16: Durability requirements for all other rocks**

Rock group	10 % FACT Wet / Dry ratio <sup>(1)</sup> (minimum)	Durability Mill test	
		Index (maximum)	% passing 0,425 mm sieve after the test (maximum)
Acid crystalline, high silica and carbonate rocks	75	420	35
Arenaceous rocks with a siliceous cementing matrix (quartzitic sandstone)	75	125	35
Arenaceous rocks with non-siliceous material (not to be use for types G1 and G2 material))	75	125	35
Diamictites	70	125	35
Calcrete	60	480	40

**Notes:**

<sup>(1)</sup> Materials with a 10 % FACT wet to dry ratio of less than the minimum ratio, except for calcrete, may be used, provided that the soaked value is equal to or more than the specified dry limit in Table A4.1.5-6.

**b) Requirements for mudrock (mudstone and shale)**

The durability of mudrock in the pavement layers shall comply with the requirements in Table A4.1.5-17.

**Table A4.1.5-17: Durability requirements for mudrock in the pavement layers**

Material type	10 % FACT (wet) (minimum)	Soundness test class
G5B	90 kN	I or II
G6	80 kN	I or II
G7, G8 and G9	60 kN	I, II or III

Mudrock shall not be used for material types G3 to G5A, unless approved by an experienced road materials specialist.

**A4.1.5.17 Deleterious minerals**

**a) Sulfide minerals**

Material with a pH less than 6 and a total sulphur content of more than 0,1 % by mass shall be evaluated and recommended fit for use with precautionary measures by an experienced road materials specialist.

**b) Soluble salts**

The electrolytic (electrical) conductivity (EC) and the pH of natural or untreated material in the pavement layers (crushed stone or gravel) when tested for soluble salts, shall comply with the requirements in Table A4.1.5-18. Both requirements, namely the EC and the pH, of the soil paste shall be tested for evaluation.

**Table A4.1.5-18: EC and pH requirements for natural or untreated material in the pavement layers<sup>(1)</sup>**

Test	Limiting value for use without precautionary measures or treatment of the material
EC (Siemens/metre) (S/m)	Base and subbase layers: $\leq 0,15 (\leq 0,10)^{(2)}$ Selected layers: $\leq 0,40 (0,20)^{(2)(3)}$
pH	$\geq 6,0$

**Notes:**

<sup>(1)</sup> Soluble salts criteria, and specifically for sulphates, in the natural material considered for use in chemically stabilised layers are given in Clause A4.4.7.3.

(2) Value in brackets applicable in areas of poor drainage such as with high or perched water tables, unlined side drains and seepage in cuttings.

(3) Where the EC > 0.20 S/m the selected layer shall be covered by the next layer within 14 days.

Material can be used where the EC is compliant but the pH < 6.0, provided that it is treated with lime until the pH ≥ 10.

Base and subbase material with the EC > 0.15 S/m can be used, provided that the pH of the material is within specification or treated with lime to specification, if required, and that precautionary measures are prescribed by an experienced road materials specialist.

Where the material is not compliant on both the EC and pH evaluations, the material shall only be considered for use by the Engineer when it has been evaluated and the material has been recommended fit for use by an experienced engineering geologist or road materials specialist.

### c) Micas

Crushed stone base aggregates shall not contain more than 2 % by mass of free mica, especially muscovite, when assessed by visually separating the particles, or more than 4 % by volume when assessed by means of microscopic slides. Other road pavement material that contains free mica that can be detected with the naked eye shall not be used, unless its durability (density reduction, CBR and/or ITS strengths and wet-dry durability) has been evaluated and the material has been recommended fit for use by an experienced engineering geologist or road materials specialist.

## A4.1.5.18 Water in construction

Water to be used for the construction of the earthworks and pavement layers, including for bituminous stabilisation, shall comply with the requirements in Table A4.1.5-19.

**Table A4.1.5-19: Construction water for earthworks and pavement layers**

Purpose	Electrical Conductivity (EC) at 25°C maximum	Total dissolved solids (TDS) maximum	pH range at 25°C	Sulfate as SO <sub>4</sub> maximum
1. Crushed stone base layer compaction and slush – compaction	170 mS/m	1200 mg/l	5,0 – 9,7	-
2. Chemical stabilisation compaction and curing	170 mS/m	1200 mg/l	5,0 – 9,7	450 mg/l
3. Bituminous stabilisation	170 mS/m	1200 mg/l	5,0 – 9,7	-
4. Other layers and materials	370 mS/m	2400 mg/l	4,0 – 10,0	-

**Note:**

(1) Siemens per metre (S/m) is the standard SI unit. The salinity of water can also be expressed in milligram per litre (mg/l) or percentage (%). The relationships between the units are: 1 000 mg/l = 0,1% = 150 mS/m.

Purified waste water, also known as effluent, and water from other sources that may contain visible quantities of physical and aesthetical, chemical or organic determinants expected to have a detrimental effect on the road layers, can be considered for the construction of the earthworks and the pavement layers, provided that it complies with the requirements in the above table. In addition, for chemical stabilised layers, the stabilised material shall comply with the strength requirements for UCS and ITS at extended 28-day curing periods and the durability (WDD) in Table A4.4.5-2. Water containing raw sewage shall not be used anywhere in the construction.

The use of brackish water and sea water can be considered for the compaction, provided that the saline water shall be used instead of the prescribed distilled water in the pH and EC tests and that the requirements for soluble salts in Table A4.1.5-18 shall not be exceeded, except with recommendations by an experienced road materials specialist and proved in a trial experimental section. Brackish water and seawater shall not be used for the curing of any stabilised layer.

Turbid water can be used for compaction without further testing in addition to the tests specified in Table A4.1.5-19, except for crushed stone bases where strict requirements for the PI and the P<sub>0,075</sub> apply. In this instance, a sample shall be prepared of the crushed stone material and mixing it with the required quantity of turbid water to reach optimum moisture content. After drying out of the material, the PI and P<sub>0,075</sub> shall be tested and evaluated for any increase above the specified limits.

Effluent, brackish water and sea water shall not be used for bituminous stabilisation or for diluting a bitumen emulsion, unless the use of the water has been approved in writing by the supplier.

## A4.1.5.19 Quality of materials

It is the Contractor's responsibility to ensure that the material constructed on the road shall comply with the material specifications, subject to the relevant provisions of the Contract Documentation. The Contractor's process control testing shall also comprise for monitoring the quality and quantity of material excavated in the borrow pits and quarries and placed in the stockpiles.

When it is a contract for producing only materials without any construction, such as for the producing of materials for multiple existing or future projects, the material in stockpile shall comply with the material specifications.

Where the Employer provides materials that have been produced and stockpiled by other Contractors or suppliers, it will still be the Contractor's responsibility to ensure that the materials comply with the material specifications for the contract. Where it can be proved that the actual quality of the material is different from that provided at tender stage, or if the material in the stockpile has changed over time to the point where it no longer complies with the specifications, the material shall not be used in the road works unless the Employer confirms in writing that the material may be used.

Based on a visual inspection by the Engineer and on the results of material tests as deemed appropriate, the Engineer shall have the right to declare the material non-compliant for use at any time before construction on the road or stockpiling as applicable. The Contractor shall then submit proposals for acceptance by the Engineer to rectify or replace the non-compliant material. Acceptance control testing of materials by the Engineer shall only be carried out during or after construction on the road, or of the material in the stockpile as applicable.

## **A4.1.6 CONSTRUCTION EQUIPMENT**

Construction equipment to source the borrow materials shall comply with the requirements of Clause A1.2.6 of Chapter 1.

Planned layouts of the appropriate fixed (static) or combined interlinked mobile plants for crushing and screening material provided by the Contractor shall show the configuration of the crushers, screening and separation plants based on the prevailing rock material and on the required material types to be produced.

Crushing plants shall be subject to the requirements of the applicable industrial legislation that governs noise, gas and dust emissions into the atmosphere. Particular attention shall be given to the impact that the siting of crushing plants will have on the nearby built environment.

## **A4.1.7 EXECUTION OF THE WORKS**

### **A4.1.7.1 Haul and access roads**

#### **a) Existing roads and streets**

The Contractor will be entitled to use existing public roads and municipal streets, subject to any constraint on axle load legislated or imposed by the road authority. The Contractor shall be acquainted with any restrictions about the road width, overhead clearance at structures and services, and maximum allowable axle loads.

Where the surfacing of a road or street to be used for hauling is already in a visual poor condition or when it is expected that it will deteriorate considerably during the hauling, the Contractor in conjunction with the Engineer shall conduct a visual assessment and compile a photographic record of the road or street's condition for record purposes before hauling any construction material over the road or street.

The Contractor shall handle all claims by the road authority about damage caused by the Contractor's equipment.

The Contractor will not be required to maintain existing roads and streets of other authorities to haul material or for construction access, except for damage caused by negligence on the Contractor's part. Where the condition of the existing routes is so poor that it results in inefficient haul of the material or causes unavoidable damage to the roads, the Contractor shall request the authority to implement maintenance actions. The Contractor shall refer any maintenance proposals to be conducted by the Contractor, to the Employer for a decision when the responsible road authority cannot or will not carry out the requested maintenance.

The Contractor shall keep records comprising counts and categories, of construction vehicles using the public roads and streets.

#### **b) Temporary new roads on acquired land and over private property**

The Employer or its agents may acquire land, or register a servitude, or conclude arrangements with the landowner or legal occupant of the land for the construction of temporary haul and access roads over a property.

Where the Employer or its agents have not made any arrangements for the new roads, the Contractor shall then engage with the landowner or legal occupant to construct and maintain temporary unproclaimed haul and access roads over the private property. Existing tracks shall be used as far as possible for haul roads. The Employer shall approve any costs relating to the Contractor's arrangements prior to concluding an agreement with the landowner or legal occupant.

#### **c) Construction requirements for new temporary unsealed roads**

In the absence of any specified conditions in the borrow pit or quarry approvals and in the Contract Documentation, the following requirements shall be complied with for the construction, use and maintenance of new temporary haul and access roads:

- The route shall be selected so that no trees, or a minimum number of trees, are felled and existing fence lines shall be followed as far as possible;
- Crossing of major water courses and steep gradients shall be avoided as far as is practicable;
- Adequate drainage and erosion protection in the form of cut-off banks, dykes and temporary culverts shall be provided where necessary;
- The erection of gates in fence lines and the open or closed status of gates in new and existing positions shall be clarified with the landowner, legal occupant or tenant and shall be maintained throughout the operational period;
- The temporary roads shall be cleared and grubbed as defined in Section A1.6 of Chapter 1. Clearing and grubbing shall be carried out to 1,0 m wider than the roadbed width of the temporary road;
- Topsoil shall be removed separately and stockpiled for later use in the rehabilitation of the temporary roads, borrow pits or quarries;
- The necessary agreed roadbed treatment, earthworks, pavement layers and wearing course shall be constructed to accommodate the type and number of construction equipment passes;
- Temporary roads shall be maintained by blading, backfilling of potholes or re-surfacing as applicable and instructed;
- Whenever dust becomes a nuisance to the public or adjacent properties, the Contractor shall when so ordered by the Engineer, apply sufficient water or take other measures to lay the dust; and
- Reasonable speeds shall be observed on temporary roads to avoid accidents, excessive noise, dust and injury to livestock or animals.

#### **d) Reinstatement of the temporary unsealed roads**

Before completing the shaping, finishing and rehabilitation of the borrow pits and quarries, the Contractor shall consult the requirements of the borrow pit or quarry approvals, and any applicable Local Authority Regulations and By-laws, to confirm if the materials used to construct the temporary haul and access roads must be removed and reinstated. If so these materials may be used elsewhere on the project if required, or loaded and hauled back to the borrow pits and quarries.

The temporary roads can only be left in place where acceptance in writing that it can remain is provided by the landowner or legal occupant over which property a temporary road has been constructed.

In the absence of any specific conditions in the borrow pit or quarry approvals and in the Contract Documentation, the following minimum requirements shall be complied with for the reinstatement of the temporary roads:

- The gravel wearing course, cut-off banks, dykes and temporary culverts shall be removed,
- The temporary road shall be shaped to the same level and cross fall to blend in with the surrounding ground, either by removing excess material or backfill hollows. Backfilled material shall be compacted with one pass of a smooth drum roller,
- The road surface areas shall be scarified to promote growth of natural vegetation, or shall be ripped, topsoiled and vegetated when required in the statutory approvals,
- Where necessary suitable drains and/or banks shall be constructed to prevent erosion, and
- The landowner or legal occupant's consent of the reinstated road shall be obtained in writing.

### **A4.1.7.2 Borrow pit and quarry operations**

#### **a) General control at the borrow pits and quarries**

The Contractor shall be responsible for controlling operations at every borrow pit and quarry to ensure compliance with all the requirements of the statutory authorisation, approvals and the Contract Documentation. Sufficient tests shall be conducted on the excavated material to ensure that the quality of the material complies with the specified requirements for the particular layer for which it will be used. The test results shall be delivered to the Engineer for review.

Prior to commencement of the works, the Contractor shall stake the boundary of the borrow pit or quarry area, and erect the boundary beacons. A stock proof or pedestrian fence as required or specified shall be erected along the boundaries. No borrow pit or quarry shall be extended nor shall any sourcing and stockpile operations be conducted beyond the boundaries. Only approved personnel shall be allowed access to the borrow pit and quarry areas.

The Contractor shall keep a digital photographic record of every borrow pit and quarry at regular intervals, from before any investigation or exploratory works are done until the closure. Photos shall be labelled with the date, borrow pit or quarry number or name, and description of the activity. The records shall be submitted monthly to the Engineer.

Quantities shall be calculated from topographical surveys carried out by the Contractor at the following stages:

- After clearing and grubbing and before any material is excavated.
- After removal of the topsoil and of the overburden.
- At completion of the excavation and of the finishing, to compile the closure plan of the borrow pit or quarry.

The Contractor shall carry out the following duties for the control at the borrow pits and quarries:

- Implement all the requirements and conditions of the borrow pit and quarry approvals,
- Manage any subcontractors such as for the blasting and crushing operations,
- Ensure compliance with the relevant Health and Safety Act and Regulations and that the excavation and workings in the borrow pit or quarry are safe,
- Mitigate environmental impacts,
- Ensure that careful and continuous selection of materials is done during the excavation as specified in Clauses A4.1.7.2g) and A4.1.7.2h),
- Report at least weekly on the quantity and quality of the materials excavated, produced and stockpiled, and
- Give a notice or an early warning of any anticipated future problems.

When specified in the Contract Documentation, the Contractor shall have a full time or part time materials manager to conduct and manage the duties for the control at the borrow pits and quarries. The requirements for the materials manager, whether the person shall be an engineering geologist, engineer, a senior materials technician or a senior general foreman, and the required qualifications and experience of the materials manager, shall then also be specified.

#### **b) Classes of excavation**

The excavation of borrow material shall be classified as follows:

##### *(i) Soft excavation*

Soft excavation class is excavation of material that can be efficiently removed by the reference construction equipment specified in the Contract Documentation, without prior breaking down.

Very dense granular or sand material and stiff to very stiff cohesive clay material, which can still be removed by the reference construction equipment without prior breaking up as specified for hard material but that do not comply with the definition of efficient removal of the equipment, shall also be classed as soft excavation.

In the absence of any construction equipment specified to reference the efficient removal of the material, a hydraulic crawler excavator in good mechanical order with nett horsepower (flywheel power) generally between 180 kW and 225 kW, also known as a 30 ton excavator, and equipped with a heavy duty bucket shall be the reference construction equipment. A

minimum continuous production rate of 160 m<sup>3</sup>/h of the excavated material will be taken as the benchmark for the excavator's capacity and efficiency.

(ii) *Boulder excavation class A*

Where material contains in excess of 40 % by volume of boulders, core stones, floaters and lumps of hard material larger than 200 mm but volume less than 20 m<sup>3</sup> in size, in a matrix of soft material, then the full volume excavated shall be classed as boulder excavation class A.

Excavation in dolomite formations other than solid dolomite shall also be classed as boulder excavation class A if the formations contain in excess of 40 % by volume of lumps of hard dolomite larger than 200 mm but volume less than 20 m<sup>3</sup> in size, in a matrix of softer material or smaller lumps of hard dolomite.

Excavation of fissured or fractured rock shall not be classed as boulder excavation but as soft or hard excavation according to the nature of the material.

(iii) *Boulder excavation class B*

Where material contains 40 % or less by volume of boulders, core stones, floaters and lumps of hard material larger than 200 mm but volume less than 20 m<sup>3</sup> in a matrix of soft material, then the volume of the individual boulders, core stones, floaters and lumps of hard material shall be classed as boulder excavation class B.

The volume of the rest of the material shall be classed as soft excavation.

(iv) *Hard excavation*

Hard excavation is excavation of material, excluding boulder excavation that is classed separately, which cannot be removed efficiently by the reference construction equipment specified in the Contract Documentation, and that will require other means of breaking down before removal by one of or a combination of the following:

- Drilling and blasting.
- Ripping with a bulldozer.
- An excavator fitted with a hydraulic percussion hammer or fitted with a ripper.
- Hand operated pneumatic or electro-mechanical equipment such as jackhammers or pavement breakers.
- Drilling and injecting non-explosive, expansive, silent rock-breaking cracking products.

Excavation of individual large boulders, core stones and lumps of hard material in excess of 20 m<sup>3</sup> shall also be classed as hard excavation.

The Contractor shall be at liberty to use any method and construction equipment for excavating any class of material, but the chosen method or construction equipment to excavate the material shall not dictate the classification of the material.

Before any excavation commences the Engineer and the Contractor shall agree on the applicable classes of excavation, based on a visual inspection and the supplementary explorations as in Clause A4.1.7.2c). Agreement shall also be reached on the method of measurement to be used for boulder excavation or blasted rock prior to the commencement of the excavation.

In the event of a disagreement between the Engineer and the Contractor, the Contractor shall if instructed, make available such reference construction equipment as specified at no cost to the Employer, in order to determine whether or not the material can be efficiently removed. The decision of the Engineer as to the classification shall thereafter be final and binding, subject to the relevant provisions of the Contract Documentation.

The Contractor shall immediately inform the Engineer if and when the nature of the material being excavated changes to such an extent that a new classification for further excavation is warranted. Failure to inform the Engineer of any possible change in the class of excavation before the material is excavated, shall entitle the Engineer to classify and measure such excavation as deemed appropriate.

**c) Supplementary exploration**

When agreed to by the Engineer and the Contractor, the Contractor in the presence of the Engineer, shall conduct further investigations to obtain information for the M&U plan of a borrow pit and of a quarry. In doing so the Contractor shall:

- Recommend and request additional trial pits and/or drilling to substantiate the material properties tested during the exploration at the design stage,
- Determine the extent of the clearing and grubbing,
- Determine the thickness of the topsoil,
- Determine the thickness of the overburden, and quality for use in appurtenant works,
- Determine the thickness, quality and quantity of compliant material for earthworks and pavement layers,
- Assess the class(es) of excavation for proposing to the Engineer,
- Determine the sufficiency of the available material compared to the mass haul or information in the Contract Documentation,
- Recommend proposals to supplement any material shortage, and
- Determine any other input required for the Contractor's M&U plan.

**d) Clearing and grubbing**

The borrow pit or quarry from where material is to be sourced shall be cleared and grubbed as specified in Section A1.6 of Chapter 1.

Borrow pits and quarries shall be cleared and grubbed 2,0 m wider than the excavated area or to 2,0 m beyond the outer edge of temporary drainage banks and dykes, as applicable. Material obtained from clearing and grubbing of an area, provided it is not hazardous material, shall be removed to temporary stockpile within the borrow pit or quarry area. Upon closure, it can be placed within the borrow pit or quarry and covered up. The burning of material on the site of the works shall not be permitted.

Where the total thickness of the topsoil and the overburden is less than 1,0 m, all trees and tree stumps including mattered roots shall be removed to a depth of at least 1,0 m below the cleared surface. Where the total thickness is less than 1,0 m a separate grubbing operation is not required and the tree stumps can be removed together with the overburden, unless otherwise instructed by the Engineer.

Individual boulders, core stones, floaters or lumps of hard material which are exposed or lying on the surface and that cannot be removed by the construction equipment used in the clearing and grubbing operation, shall be separated (pushed aside) and left in the borrow pit, or shall be broken down and then removed to spoil or to the road if suitable after breaking down or to a crushing plant for crushing. Breaking down or crushing of the material shall be approved or instructed by the Engineer.

**e) Removal and conservation of the topsoil**

After the clearing and grubbing of an area, the topsoil shall be excavated and stockpiled as specified in Section A1.6 of Chapter 1, for later rehabilitation of the borrow pit or quarry. It shall be stockpiled in a designated area as indicated on the borrow pit or quarry plan.

**f) Removal of the overburden**

No removal of overburden or any further borrow pit/quarry operations shall commence until agreement has been reached with the Engineer in regard to the thickness, the extent, use and quantity of the overburden. Overburden less than 200 mm thick shall be removed with the topsoil and not separately.

Overburden shall be moved to beyond the outer limits of the borrow pit or quarry excavation. This operation shall not be regarded as temporary stockpiling. The Engineer's approval must be obtained for removing and stockpiling of overburden that cannot be moved to beyond the limits of the borrow pit or quarry excavation, or for overburden that is to be used in the works. Overburden shall be kept in a weed-free condition during the construction.

The remaining overburden material shall be placed in the borrow pit or quarry at completion of the borrow operations and levelled.

**g) Selection and excavation of material in borrow pits**

Once the material compliant for the works is exposed in a borrow pit, the Contractor shall:

- Plan the utilisation in such a manner that the pioneer and fill material can be selected, excavated and loaded directly for use on the road. Only after approval, where the fill layers cannot be constructed immediately or for reasons beyond the Contractor's control, shall the material be temporarily stockpiled. The Contractor shall cease excavation of the fill material until it can be processed on the road, at no cost to the Employer.
- For all the pavement layer materials the Contractor shall always select, excavate, remove and place the material into compliant separate stockpiles to provide a uniform material, prior to removal of the material to the road. Where it is not feasible to stockpile the material within the borrow pit or borrow pit area the Engineer shall designate other temporary stockpile areas elsewhere outside the borrow pit area. Measurement and payment shall be made for this stockpile activity.

Borrow material shall be excavated within the depths and area shown on the borrow pit and M&U plans, in a manner that shall not prejudice the use of the material for the intended purpose.

The material in the borrow pits shall be broken down during the excavation to the following maximum particle sizes, depending on the use envisaged for the material, before it is loaded:

- Pioneer material 500 mm.
- Rockfill 500 mm.
- Coarse fill 500 mm, but not exceeding the thickness of the fill layer for efficient compaction by the construction equipment.
- Normal fill 300 mm.
- Pavement layers 300 mm.
- Material to be crushed, to a maximum size that will suit the take of the crusher.

In order that the material can be broken down to the above-mentioned sizes, the Contractor shall adjust and control the blasting, ripping, excavating and other operations so that the desired result can be achieved. Drilling and blasting patterns shall be such as to break down the material to the specified sizes, and where this is impractical, secondary blasting or other methods shall be used for breaking down oversize materials.

Where the working methods of the Contractor are such that large quantities of oversize material are produced, the Contractor shall be instructed to change the working methods, or type of crushing and screening plant, or construction equipment in order to produce less oversize material.

Excessive breaking down of the finer fraction of the material and thereby altering the properties of the material shall be avoided. Any material so altered shall be replaced by the Contractor at any cost to the Employer.

Where any borrow pit contains different types of materials in separate layers which require to be mixed (blended) to produce a compliant pavement layer product, then:

- The materials shall be excavated over the full depth of the working face in one operation without the different types of materials being separated, or
- The materials shall be pushed into heaps by a dozer and then loaded in one operation over the full height of the heap, or
- The materials from the separate layers shall be excavated individually, removed to stockpile, placed and spread in alternate layers. Loading into the trucks for transport to the road shall then be done with a hydraulic excavator stationed on top of the stockpile and filling its bucket through the full height of the stockpile.

Such mixing (blending) of material shall not be classified as mechanical modification, but considered as normal borrow pit operations.

The Contractor shall take all reasonable precautionary measures to avoid contamination of the compliant borrow material with clayey or other non-compliant material from the floor of the excavation, or from the overburden not previously removed, or from any other non-compliant layers in the excavation face. The Contractor shall monitor the quality of material with increasing excavation depth as the quality of some materials may vary with depth. Where the Contractor has contaminated or wasted compliant material, replacement material shall be supplied by the Contractor at no cost to the Employer.

When there is any doubt concerning the quality of the borrow material being excavated at any time, the Contractor shall give notice before such material is removed to stockpile or hauled to the road or to the crusher. After further testing or inspection by the Engineer as required, the Contractor will be instructed regarding the use of the material or may be ordered that the borrow pit be finished off and abandoned.

During borrow operations, and especially when excavating material near the floor and outer boundaries of the borrow areas, the Contractor shall plan his operations to reduce, in so far as is possible, the amount of earth moving work that will be necessary for shaping and finishing the borrow pit. Indiscriminate excavation without due regard being given to the desired final shape shall not be permitted.

When blasting is to be carried out in medium to hard rock, the surface of the exposed rock shall be cleaned of all loose and foreign material that can affect the quality of the blasted material. The rock shall be blasted to sizes without further breaking down that comply with the specified maximum particle sizes for blasted rock in rockfill and for pioneer material, and for material to be crushed to suit the take of the crushing plant.

Rippable material which tends to break into large blocks shall be cross ripped.

Surface water shall be continuously prevented from flowing into or standing in the excavations. The Contractor shall construct temporary banks and dykes for diverting surface water and plan the operations in such a way that the borrow pit shall be self-draining. Where this is not feasible during the excavation, it shall be dewatered by pumping. The Contractor shall ensure that borrow material is sufficiently dry when required for use.

The Contractor shall carry out the following duties during the selection and excavation of the materials:

- Ensure that the borrow pit is managed and utilised in terms of the M&U plan prepared in accordance with the requirements of Clause A4.1.3.3,
- Ensure that the excavation, side slopes, finishing and the like are done in accordance with the borrow pit plans approved by the relevant authority,
- Report immediately any changes in the excavation class and material quality,
- Monitor the quality of the excavated material by process control laboratory testing,
- Ensure proper selection of the material,
- Manage the removal of the material to the road or to the stockpile or to crushing,
- Record the number of vehicles and volumes of material when the volume of material is measured as a percentage of the loose volume in haul vehicles, and
- Control the rehabilitation and closure of the borrow pit.

When specified in the Contract Documentation, the Contractor shall have an excavation controller to carry out the above-mentioned duties for the selection and excavation of the materials. The requirements for the excavation controller, whether the person shall be a materials technician or a general foreman, the controller's required qualifications and experience, and whether the controller shall be full time or only part time at the excavation, shall then also be specified.

#### **h) Selection and excavation of materials in quarries**

After removal of the topsoil and overburden, as applicable, the bedrock shall be cleaned of all loose and foreign material that have remained, and that can affect the quality of the crushed rock.

Blasting shall be done in depths and levels agreed to in the M&U plan. The rock shall be blasted to sizes without further breaking down that comply with the specified maximum particle sizes for blasted rock in rock fill and for pioneer layer material, and for material to be crushed to suit the take of the crushing plant.

The floor of a blasting shall be cleaned of all loose material, prior to the next blast. Any loose material from the excavation face shall also be removed before proceeding. Benches shall be provided in the faces of the excavation for stability and safety, as specified in the Contract Documentation or as instructed by the Engineer upon advice from an experienced geologist or engineering geologist.

Measures to ensure that all seams of deleterious material within the rock body are avoided or separated out from the blasted rock before it is crushed shall be included in the M&U plan.

The blasted material shall be loaded and hauled to the crushing and screening plant. Non-compliant material shall not be taken to the plant, but shall be taken to temporary stockpile or left in the quarry out of the way.

The Contractor shall monitor the quality of the rock material. When there is any doubt concerning the quality of the material at any time, the Contractor shall give notice before such material is removed. After further testing or inspection by the Engineer as required, the Contractor shall be instructed regarding the use and processing of the material, and/or workings in the quarry.

Surface water shall be prevented from flowing into or standing in the excavation. The Contractor shall construct temporary banks and dykes for diverting surface water and plan the operations in such a way that the quarry shall be self-draining.

The Contractor shall carry out the following duties during the selection and excavation of the materials:

- Ensure that the quarry is managed and utilised in terms of the M&U plan prepared in accordance with the requirements of Clause A4.1.3.3,
- Ensure that the excavation, side slopes, finishing and the like are done in accordance with the quarry plans approved by the relevant authority,
- Monitor the quality of the excavated material by process control laboratory testing and report immediately any changes,
- Manage the removal of the material to the road or to the stockpile or to crushing,
- Record the trucks and volumes of material when the volume of material is measured as a percentage of the loose volume in haul trucks, and
- Control the rehabilitation and closure of the quarry.

When specified in the Contract Documentation, a materials manager shall carry out the above-mentioned duties for the selection and excavation of the materials. The requirements for the materials manager, whether the person must be an engineering geologist, engineer

or materials technician, the required qualifications and experience of the manager and whether the manager must full time or part time at the quarry or quarries, shall then also be specified.

**i) Use and treatment of oversize material in borrow pits**

Excavated material from borrow pits that contains oversize material, that is material exceeding the specified maximum particle sizes in Clause A4.1.7.2g), shall be handled as follows:

- Where the material contains less than 5 % by volume of the oversize material, the material can be hauled to the road or placed in the stockpile. The oversize material shall then be bladed out of the layer or removed by hand on the road, and then later returned to the borrow pit as spoil material or to a crusher, if available, for crushing.
- Where the material contains more than 5 % by volume of oversize material but the excess volume is mainly due to a few large oversize rock particles, cobbles or boulders, the larger oversize materials shall not be loaded during the excavation but shall be left in the borrow pit, unless instructed otherwise. Where the remaining material then has less than 5% by volume of oversize material, it can be hauled to the road or to the stockpile.
- Where the material contains more than 5 % by volume of oversize material, even after removing the large oversize particles, the Engineer shall instruct before the material is loaded at the excavation whether all the material, including the non-oversize material, shall be crushed and/or screened or broken down during construction on the road or whether further excavation of the material shall be avoided. Removing large quantities of oversize material from the road shall be avoided.

During loading, any hard oversize material that will not break down during processing on the road shall be excluded.

Oversize material larger than 500 mm left in the borrow pit shall be broken down to a maximum size of 500 mm before it is covered over with softer material when the borrow pit or quarry is rehabilitated.

**j) Explosives and blasting**

Explosives shall be used in accordance with the requirements and specifications given in Clause A1.2.7.5 of Chapter 1 and Section A12.10 of Chapter 12.

All blasting operations shall be carried out in accordance with the requirements and specifications given in Section A12.10 of Chapter 12.

**k) Producing the materials by crushing and screening**

*(i) Borrow pit materials*

Oversize material that must be reduced in size to comply with the requirements of the specified maximum particle sizes of the material types in the pavement layers, and any other material instructed or approved by the Engineer, shall be screened, crushed or crushed and screened.

Screening only of the material shall be done by screening out oversize material by a grizzly type screen, or by the use of mesh screens, or by screening the material into various fractions through a series of screens and thereafter if still necessary, blending some of the fractions to obtain a compliant material.

Crushing shall be accomplished by either a single-stage or a two-stage crushing plant. The Engineer shall instruct breaking down of the material before crushing to suit the take of the crusher, if required.

A single-stage crushing plant comprises only a primary crushing unit in which only a reduction to a maximum size occurs. The single-stage crushing plant shall be capable of crushing oversize material to the maximum size specified for the type of material and layer thickness.

A two-stage crushing plant, while not always necessary to achieve the required reduction ratio, comprises a secondary crushing plant in addition to the primary crushing unit. The two-stage crushing plant shall be capable of crushing the material to ensure that the grading of the product falls within the specified envelope, producing sufficient fines as well as yielding the specified shape characteristics.

For single-stage and two-stage crushing plants, additional selective screening may be required.

Medium to hard rock in borrow pits for types G4A and/or G5A material, shall be produced by multi-stage crushing, similar to specified for quarry materials.

*(ii) Quarry materials*

Material sourced from quarries shall always require crushing and screening.

A multiple-stage crushing plant consisting of two or more crushers, is required to control the grading and shape of the higher quality material types, as well as surfacing and concrete aggregates. Multiple-stage crushing shall always require screening of the material.

After crushing and screening, the different material types required for use in the pavement layers shall be stockpiled as specified in Clause A4.1.7.3.

**l) Use of the borrow material**

The results of laboratory tests, trial pits and borehole drilling of materials carried out during the design stage are included in the Contract Documentation. The results and other information give a preliminary indication as to the purpose for which and where the material shall be used. The Engineer shall give final instructions during construction regarding the use of the borrow material.

Coarse rock encountered shall be utilised for the construction of the lower layers of fills high enough to accommodate thick layers, or, where so required, shall be conserved and used as directed for constructing the sides of embankments or for serving as protection against embankment or channel erosion.

The Engineer may order that particular materials in the borrow pits and quarries be selected for a specific purpose. Where selection is ordered, the method of excavation and the programme of work shall be so arranged as to avoid double handling. When ordered by the Engineer, the better class fill material shall be selected for use in the top layer of the fills and in the lower layers of high fills.

Any surplus or non-compliant material resulting from the excavation shall be disposed of as directed by the Engineer.

The Engineer shall have full control over the use of all borrow pit and quarry materials. The Engineer shall have the right to decide which borrow pit or quarry the Contractor shall operate from at any particular stage of the work, and to deviate from any previous programme of material source at any cost to the Employer.

The Contractor shall plan the operations and particularly the excavation-to-fill operations in such a manner that all borrow material be used to the best advantage of the Employer. This means that no material shall be unnecessarily spoiled, borrowed or hauled. The Contractor shall neither borrow nor spoil any material without the Engineer's approval and without proving to the Engineer that this is necessary and that it is the most economical method of constructing the works.

#### **m) Closing of the borrow pits and quarries**

The operations and requirements for shaping, finishing, rehabilitation and closure of the borrow pits and quarries after the removal of the road construction material is completed, are contained in the borrow pit and quarry plans approved by the control authority and shall be complied with.

In the absence of any specified conditions in the borrow pit or quarry approvals, or elsewhere in the Contract Documentation, the following minimum requirements shall be complied with:

- All gravel and soil material in the borrow pit and quarry areas outside the borrow pit or quarry, whether spoil from the road construction operations, excess stockpiled material, any material from the stockpile fill platform, oversize material left in the borrow pit, material from temporary banks and material resulting from clearing and grubbing operations shall be placed in the floor of the borrow pit or quarry. The material shall be spread evenly and the floor shall be shaped to prevent standing water,
- Material placed in the floor of the borrow pit or quarry incapable of supporting natural vegetation shall be covered with soft material or topsoil,
- Remaining portions of in situ soft material in the floor shall be scarified along the contours so that undue erosion is avoided. Hard material in the floor shall be left intact,
- The floor of the borrow pit or quarry shall generally not be vegetated, unless required in the statutory authorisation or instructed by the Engineer,
- All infrastructure and foundations for buildings and the crushing plants shall be demolished and removed and the surface covered,
- All foreign materials shall be removed,
- Domestic or other waste and rubbish shall not be disposed of in the borrow pit or quarry but shall be removed from the site,
- Hazardous material as specified in Clause A4.5.5.5 of Section 4.5 shall not be spoiled or buried in the borrow pit or quarry,
- Soil contaminated with oil or grease or fuel or other hydrocarbons shall not be disposed of in the borrow pit or quarry excavation but shall be removed from the site,
- Existing banks and dykes shall be reconstructed if required, or new banks and dykes shall be constructed to divert surface water from or around the excavation. Stormwater shall also not be concentrated on the property of an adjoining landowner or legal occupant,
- The excavation shall be self-draining or where this is not possible the control authority's approval shall be obtained,
- Unless otherwise specified in the Contract Documentation and/or environmental and mining approval documents, large boulders or remaining in situ hard material can be left to protrude from the slopes or faces of the excavation,
- The slopes (sides or batters) within soft excavation shall be shaped not steeper than 1 vertical to 3 horizontal,
- All loose and unstable material shall be removed from the faces of excavation in boulder or hard material,
- The finished surfaces in soft material that will be topsoiled shall not have any loose stones larger than 100 mm,
- The soft material embankments shall receive a 75 mm to 150 mm thick topsoil layer, and shall be vegetated when measured in the Pricing Schedule, and
- The entire borrow pit or quarry area shall be fenced along with appropriate access control signage and with a locked gate for access if required, except if the area is not accessible by the public, there are no slopes steeper than 1 vertical to 3 horizontal in the hard material areas and the Engineer, the landowner or legal occupant and the relevant authority agree in writing that it is safe to leave the borrow pit or quarry area unfenced.

### **A4.1.7.3 Stockpiles**

#### **a) Preparation of the stockpile site**

Stockpile sites shall be prepared in positions as indicated on the borrow pit or quarry plans, or at positions agreed to and indicated on the M&U plans.

Before any stockpiling may be done the area shall be cleared and grubbed as specified in Section A1.6 of Chapter 1. The area to be cleared and grubbed shall be 2,0 m wider than the footprint of the stockpile or to 2,0 m beyond the outer edge of temporary banks and dykes, as applicable. Topsoil and overburden material can remain in place, except when it has insufficient bearing strength for the height of the stockpiled material or where a platform of fill material must be constructed. The topsoil shall then be removed and stockpiled in an area that will not be affected by construction activities nor impede the natural flow of water. The stockpiled topsoil and its immediate surrounds shall be kept free of all undesirable vegetation.

Trees and tree stumps shall be removed to 75 mm below the cleared surface.

Stockpile areas shall be constructed with a minimum slope of 2 % to ensure proper drainage. The surface (floor) shall be scarified to a depth of 150 mm, watered, and compacted to a minimum density of 90 % of MDD. Further instructions will be given for the treatment of soft in situ material with low bearing strength, in accordance with the roadbed treatments specified in Section A5.1 of Chapter 5.

On steep sloping landforms, a platform shall be constructed so that the cross fall does not exceed 5 %. The platform shall be constructed of fill material in layers compacted to a minimum density of 90 % of MDD. The compacted surface for stockpiling shall be firm and clean of loose material.

Stockpile areas shall be large enough to allow the different types of material to be stockpiled without overlapping or exceeding the limits of the borrow pit or quarry area or indicated stockpile area.

The Contractor shall ensure that stockpiled material is not washed away during rain. Temporary banks must be constructed on the high side of stockpiles to divert surface water. Care must also be taken to prevent water from damming up against the stockpiles. On the lower side of the stockpile material, temporary banks with stormwater outlets shall be constructed to contain any stockpile material that is washed down during rain.

The Contractor shall only commence the stockpiling activities after the areas have been prepared and approved by the Engineer.

#### **b) Stockpiling of the material**

The material shall be offloaded and spread uniformly in layers in the stockpile. Segregation of the material during the handling shall be avoided.

The different material stockpiles shall be sign posted according to the material type and intended use.

Where different types of excavated or commercial materials are placed in the same stockpile for mixing later on the road for mechanical modification of pavement layer material, the materials shall be placed in lift heights of less than one metre. The different materials shall be placed in layers in every lift, in thicknesses of the same proportion as in the final material mix determined by testing.

The height of stockpiles that consists of different layered materials shall not exceed 3,0 m to enable efficient mixing of the materials during loading to the road. Stockpiles that consist of uniform materials can be built higher depending on the capacity of the loading equipment, unless restrictions are placed on the height in the environmental or other approvals.

Special attention shall be given to the stockpiling of crushed stone material for a base layer. It shall always be placed in stockpiles after crushing. The material shall be dumped and levelled in the stockpile so that any segregated material from the processing operation is blended again. However, extensive working of the crushed stone material in the stockpile shall be prevented to avoid segregation. The side slopes of the stockpile shall be visually assessed for areas or layers of obvious fine or coarse material that is indicative of segregation.

The lower 100 mm of stockpiled material shall not be loaded for construction to avoid contamination with the floor or platform material of the stockpile.

The Contractor shall carry out the following duties at every stockpile:

- Ensure that the stockpile site has been prepared correctly and that all banks and dykes are in place before stockpiling commences,
- Ensure that the material is placed at the correct designated stockpile,
- Manage the correct proportional placing of different materials in the specified lift heights if applicable,
- Ensure that the specified stockpile heights are not exceeded,
- Ensure that the stockpile slopes are safe and not prone to excessive segregation at the edge,
- Regularly inspect and maintain the stormwater banks and dykes,
- Ensure that material washed from the stockpile is contained,
- Control the safe movement of construction equipment, vehicles and personnel on the stockpile site,
- Comply with all the conditions of the borrow pit and quarry approvals by the control authority and in the Contract Documentation, and
- Comply with the requirements of the relevant legislation relating to OHS, Mining and Construction.

When specified in the Contract Documentation, the Contractor shall have a stockpile controller at every stockpile site to conduct and manage the above duties. The requirements for the stockpile controller, whether the person must be an assistant materials technician or a junior foreman and whether the controller is to be present full time or only part time during the stockpiling, as well as the controller's required qualifications and experience, shall then also be specified.

#### **c) Reinstatement of the stockpile site**

After the stockpiled material has been removed, the site shall be reinstated as closely as possible to its original condition.

In the absence of any specified conditions in the borrow pit or quarry approvals, or elsewhere in the Contract Documentation the following minimum requirements shall be complied with:

- All surplus stockpiled material shall be removed and disposed of,
- Material used to construct a fill platform and the temporary banks shall be removed and disposed of, unless the Contractor is instructed to leave the banks in place to prevent future erosion,
- The stockpile floor shall be graded to the original natural contours,
- The stockpile floor shall be ripped 100 mm deep to break all compacted in situ material, and
- The stockpile site shall be lightly scarified to promote growth of natural vegetation, or shall be covered with a 75 mm to 150 mm thick topsoil layer and vegetated when required in the statutory approvals.

### **A4.1.7.4 Weighbridge facility**

Weighing of materials for measurement and payment purposes, if applicable, shall be carried out by a temporary weighbridge facility erected on the site, or by a permanent offsite weighbridge facility.

The temporary weighbridge facility shall consist of a weighbridge and an equipped office. The weighbridge shall be:

- Of sufficient length and width to accommodate the largest truck that will have to be weighed,
- Erected on shaped and compacted ground with concrete approaches,
- Equipped with loadcells for weighing,
- Able to weigh trucks shorter than the length of the weighbridge and standing anywhere on it,
- Able to weigh the maximum gross weight of the envisaged loaded truck, and
- Calibrated after commissioned and thereafter at least every six months.

The weighbridge office shall be:

- A waterproof structure that can be locked,
- Able to accommodate the weighbridge operator and computer hardware, and
- Equipped with its own generator for power supply,

The computer software shall be able to record, store and keep a complete electronic data base of:

- The various products,
- The registration details of all weighed trucks,
- The gross (product and vehicle), tare (the vehicle) and the nett (product) weights of every truck, and
- The daily and monthly product reports of at least the nett weights.

A weighbridge operator shall be stationed full time in the weighbridge office for the operation of the weighbridge facility when in use.

A permanent weighbridge facility shall be in possession of a SANAS verification certificate not older than 2 years.

#### **A4.1.8 WORKMANSHIP**

The Engineer and the Contractor shall determine and agree on the testing protocol and frequency of the applicable process and quality control tests required for each type of the sourced borrow materials to ensure that the quality of materials produced meets the specified requirements for the particular layer for which it will be used. These required laboratory tests and testing frequencies shall be stated in the borrow pit and quarry M&U plans.

Measurement, testing, and evaluation of all individual components and constructed products shall be in accordance with the methods prescribed in this Section or in Chapter 20 as relevant.

## **B4.1 BORROW MATERIALS**

### **PART B: LABOUR ENHANCEMENT**

#### **CONTENTS**

<b>B4.1.1</b>	<b>SCOPE</b>
<b>B4.1.2</b>	<b>DEFINITIONS</b>
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<b>B4.1.4</b>	<b>DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS</b>
<b>B4.1.5</b>	<b>MATERIALS</b>
<b>B4.1.6</b>	<b>CONSTRUCTION EQUIPMENT</b>
<b>B4.1.7</b>	<b>EXECUTION OF THE WORKS</b>
<b>B4.1.8</b>	<b>WORKMANSHIP</b>

#### **B4.1.1 SCOPE**

This Section covers the work involved in sourcing materials from borrow pits and quarries that are developed and operated to supply materials for a specific road construction project or projects.

A relative small proportion of activities as defined in Part A under the various sections are considered suitable for labour enhancement.

PART B only provides additional specifications, not contained in Part A.

#### **B4.1.2 DEFINITIONS**

Definitions as provided in Chapter 1 and Clause A4.1.2 shall also apply.

#### **B4.1.3 GENERAL**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

The provisions of Part A shall apply.

#### **B4.1.5 MATERIALS**

The provisions of Part A shall apply.

#### **B4.1.6 CONSTRUCTION EQUIPMENT**

Where reference is made in Part A to appropriate equipment, the use of light equipment shall be evaluated during trial sections.

The specifications in Part A shall be equally applicable.

#### **B4.1.7 EXECUTION OF THE WORKS**

For Borrow Materials, the finishing of the borrow pit and quarry areas and the stockpile sites are suitable components for labour enhancement.

#### **B4.1.8 WORKMANSHIP**

The provisions of Part A shall apply.

## C4.1 BORROW MATERIALS

### PART C: MEASUREMENT AND PAYMENT

#### (i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

#### (ii) Items that will not be measured separately

The following required activities will not be measured or paid for separately and the Contractor shall include the cost thereof in items describing the activity or other items as deemed appropriate:

- Loading and hauling to any of the following borrow pit and quarry operations required to source and produce the material that are carried out within the same borrow pit and quarry areas:
  - Removing, and stockpiling if required, of the topsoil and of the overburden.
  - Moving the excavated material between the point of excavation and the stockpile sites or crushing and screening areas, and between the crushing and screening areas and the stockpile sites as applicable.
  - During rehabilitation of the stockpile sites removal of the surplus material, the fill platform, temporary banks and material generated in the finishing.
- Separating oversize material to be left in the borrow pit.

#### (iii) Items to be measured and paid for using items specified elsewhere in the Specifications

For activities in Table C4.1-1 items specified in other Chapters or Sections of the specification, where they relate to work under this Section, will be listed in the Pricing Schedule.

**Table C4.1-1: Items from other Chapters or Sections**

Activity	Section 4.1 -Clause reference	Section - Item reference
Fencing and gates around the borrow pit and quarry areas	A4.1.7.2a)	Section C11.5 - All applicable items
Clearing, grubbing, removal of large trees, and removal of buildings and structures	A4.1.7.2d) and A4.1.7.3a)	Section C1.6 - Items C1.6.1 to 1.6.4
Stockpiling topsoil (including overburden less than 200 mm thick)	A4.1.7.2e)	Section C1.6 - Item C1.6.9
Banks and dykes	A4.1.7.2h) and A4.1.7.3a)	Section C3.1 - Item C3.1.6
Blasting of hard material	A4.1.7.2j)	Section C12.10 - Item C12.10.1
Hauling material (when applicable)	A4.1.7.2k) and A4.1.7.3b)	Section C1.7 - Item C1.7.2
Placing of topsoil, and vegetation	A4.1.7.2m)	Section C11.8 - All applicable items

#### (iv) Items specifically for this Section of the Specifications

Item	Description	Unit
<b>C4.1.1</b>	<b>Compiling and implementing M&amp;U plans:</b>	
C4.1.1.1	For borrow pits (list all borrow pits separately)	number (No)
C4.1.1.2	For quarries (list all quarries separately)	number (No)

The unit of measurement shall be the number of compiled M&U plans for borrow pits and quarries.

The tendered rates shall include full compensation for gathering all information and compiling the plans, for topographical surveys and for ensuring the implementation of the plans during the operation of the borrow pit or quarry.

Item	Description	Unit
<b>C4.1.2</b>	<b>Additional material investigations during the supplementary exploration:</b>	
C4.1.2.1	Cost of additional trial pits and/or drilling and laboratory testing	provisional (prov) sum
C4.1.2.2	Handling costs and profit in respect of item C4.1.2.1	percentage (%)

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.3</b>	<b>Construction and maintenance of temporary haul and access roads:</b>	
C4.1.3.1	Temporary unsealed roads	kilometre (km)
C4.1.3.2	Cost to repair existing public roads or streets	provisional (prov) sum
C4.1.3.3	Handling cost and profit in respect of item C4.1.3.2	percentage (%)

The unit of measurement for item C4.1.3.1 shall be the kilometer of temporary unsealed haul and access roads constructed in the contract.

The tendered rate for item C4.1.3.1 shall include full compensation for all loading and hauling material, constructing the completed road, maintaining it including watering for dust control, removing the road, banks and dykes at the end of its use and for revegetation.

Any haul costs shall be included in the tendered rate of item C4.1.3.1.

Drainage culverts and fencing shall be measured separately.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.4</b>	<b>Removing of the overburden:</b>	
C4.1.4.1	In borrow pits	cubic metre (m <sup>3</sup> )
C4.1.4.2	In quarries:	
(a)	Soft material	cubic metre (m <sup>3</sup> )
(b)	Hard material (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of overburden removed.

The quantity shall be measured in place at the borrow pit or quarry before stripping. It shall be based on the thickness of overburden as measured in trial pits, or from topographical surveys carried out after the removal of the topsoil and surveys done after the removal of the overburden. Overburden less than 200 mm thick when removed with the topsoil shall be included in the topsoil measurement.

For removing overburden in borrow pits no distinction shall be made between the classes of excavation of the overburden material.

For removing overburden in quarries distinction shall only be made between removing soft and hard material.

The tendered rate shall include full compensation for excavating the overburden, for moving the material to the outer limits of the borrow pit or quarry or for loading the material for stockpiling as applicable, for replacing the overburden in the borrow pit or quarry after completion of the excavation including loading and hauling from the stockpile when applicable, and for levelling the material.

The tendered rate for item C4.1.4.2b) shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 of Chapter 12.

Approved stockpiling of the overburden shall be measured and paid for under item C4.1.12.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.5</b>	<b>Excavating of materials in the borrow pits and quarries, material obtained from:</b>	
C4.1.5.1	Soft excavation	cubic metre (m <sup>3</sup> )
C4.1.5.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.1.5.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.1.5.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.1.5.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement in each class of excavation shall be the cubic metre of material excavated.

The quantities shall be measured in place in the compacted earthworks or pavement layers. The quantities shall not include excess material, overfill material or additional material placed for bulking (settlement during compaction).

The quantities for earthworks shall be measured from the difference between surveyed cross sections at 20 m maximum intervals taken before and after the construction of the earthworks.

The quantities for pavement layers shall be calculated from the authorised dimensions of the layers. Where the pavement layer materials are placed in stockpile for some time before used on the road, the Engineer and the Contractor shall agree on the interim method of measuring the quantities for this item.

For boulder material the Engineer may approve that the quantities be measured in haul vehicles as an alternative when the boulder material cannot be identified accurately prior to excavating, by taking the volume of the material as equal to 50 % of the loose volume of the material in the haul vehicles.

The tendered rates shall include full compensation for breaking down the materials in the various classes to the specified maximum particle sizes, for excavating, and loading the material.

The tendered rate for item C4.1.5.5 shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 of Chapter 12.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.6</b>	<b>Providing crushing, screening and related plants:</b>	
C4.1.6.1	Single-stage crushing plant	number (No)
C4.1.6.2	Two-stage crushing plant	number (No)
C4.1.6.3	Multiple-stage crushing and screening plant	number (No)
C4.1.6.4	Screening plant	number (No)
C4.1.6.5	Etc, for other plants (as stated by the Engineer and/or the Contractor)	number (No)

The unit of measurement shall be the number of complete plants supplied and erected on the project.

The tendered rates shall include full compensation for providing the plant, transporting the plant to the project, erecting, commissioning and finally dismantling it, and removing it when it is no longer required for the project.

Payment of this item shall be made in two instalments as follows:

- The first instalment, 85 % of the tendered rate, shall be paid after erection and commissioning of the plant.
- The final instalment, 15 % of the tendered rate, shall be paid after removal of the plant from the contract.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.7</b>	<b>Producing the material by:</b>	
C4.1.7.1	Single-stage crushing	cubic metre (m <sup>3</sup> )
C4.1.7.2	Two-stage crushing	cubic metre (m <sup>3</sup> )
C4.1.7.3	Multiple-stage crushing including screening	cubic metre (m <sup>3</sup> )
C4.1.7.4	Screening only	cubic metre (m <sup>3</sup> )
C4.1.7.5	Etc, for other plants (as stated by the Engineer and/or the Contractor)	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material crushed or crushed and screened and finally used in the construction.

The quantity shall be measured in place in the compacted earthworks or pavement layers. The quantities shall not include excess material, screened out material that is not used in the works, overfill material, or additional material placed for bulking (settlement during compaction).

The quantities for earthworks shall be measured from the difference between levelled cross sections at 20 m maximum intervals taken before and after the construction of the earthworks.

The quantities for pavement layers shall be calculated from the authorised dimensions of the layers.

Where the materials are placed in stockpile for some time before used on the road, the Engineer and the Contractor shall agree on the interim method of measuring the quantities for this item.

The tendered rates shall include full compensation for hauling the material from the excavation to the producing plant, for offloading and producing the material. The cost of loading the material at or in the excavation shall be included under item C4.1.5.

No haul shall be paid separately for moving material on the same borrow pit or quarry area. Hauling shall only be paid for material moved from another borrow pit or quarry area than where the crushing and screening plant are located. Haul shall then be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.8</b>	<b>Moving and re-erecting the crushing, screening and related plants on the site:</b>	
C4.1.8.1	Single-stage crushing plant	number (No)
C4.1.8.2	Two-stage crushing plant	number (No)
C4.1.8.3	Multiple-stage crushing and screening plant	number (No)
C4.1.8.4	Screening plant	number (No)
C4.1.8.5	Etc, for other plants (as stated by the Engineer and/or the Contractor)	number (No)

The unit of measurement shall be the number of times on a site that a plant is dismantled after its initial establishment on site (which is measured and paid for under item C4.1.6), transported and re-erected, irrespective of the type of material produced.

The tendered rates shall include full compensation for dismantling the plant, loading, transporting, offloading and re-erecting it at new positions, and recommissioning it.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.9</b>	<b>Breaking down oversize material</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of oversize material that is broken down.

The quantity shall be measured by the volume of individual boulders or lumps of hard material. Where material is moved for breaking down the Engineer may approve that the quantity be measured by taking the volume to be equivalent to 50 % of the loose volume in the haul vehicles of the material to be broken down, as an alternative to measuring the individual volumes.

Breaking down of the material to the specified maximum particle sizes during the excavation operation or on the road by construction equipment shall not be measured in this item. Only breaking down of oversize material instructed or approved by the Engineer shall be measured and paid.

The tendered rate shall include full compensation for breaking down the material.

No distinction shall be made between various methods of breaking down the oversize material.

No haul shall be paid where oversize material must be moved for breaking down.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.10</b>	<b>Compacting the floor of the stockpile sites</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of compacted material.

The quantity shall be measured in place at the stockpile site, of the authorised area covered by the stockpile site.

The tendered rate shall include full compensation for scarifying, watering and compaction of the in situ material.

(Clearing and grubbing, and removal of topsoil if applicable, shall be measured and paid for under other items.)

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.11</b>	<b>Constructing a platform for the stockpile site</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of compacted fill in the platform.

The quantity shall be measured in place at the platform, from the difference between levels taken after compaction of the stockpile floor and levels taken after the construction of the platform.

The tendered rates shall include full compensation for excavating the material on the stockpile site or elsewhere on the borrow pit or quarry area, moving or loading and hauling the material, and for placing, mixing, watering and compacting the fill material in the platform.

No difference shall be made between different types of fill material.

Any haul costs shall be included in the tendered rate of item C4.1.11.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.12</b>	<b>Stockpiling the material:</b>	
C4.1.12.1	Material from a producing plant	cubic metre (m <sup>3</sup> )
C4.1.12.2	Material directly from the excavation	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material stockpiled.

The quantity for overburden shall be measured in place before stripping as specified under item C4.1.4.

The quantities for earthworks and pavement layers shall be measured in place in the compacted layers. The quantities shall not include excess material, overfill material, or additional material for bulking.

The quantities for earthworks shall be measured from the difference between levelled cross sections at 20 m maximum intervals taken before and after the construction.

The quantities for pavement layers shall be calculated from the authorised dimensions of the layers.

Where the materials are placed in stockpile for some time before used on the road, the Engineer and the Contractor shall agree on the interim method of measuring the quantities for this item.

The tendered rate for item C4.1.12.1 shall include full compensation for loading the material at the producing plant, hauling the material to the stockpile, offloading, spreading and maintaining the material in the stockpile.

The tendered rate for item C4.1.12.2 shall include full compensation for hauling the material from the excavation to the stockpile, for offloading, spreading and maintaining the material in the stockpile. Loading the material at or in the excavation shall be measured under items C4.1.4 and C4.1.5 respectively.

Payment for stockpiling of fill material directly from the excavation shall only be made when the Engineer has given prior approval for stockpiling the fill material.

The temporary stockpiling of material within the borrow pit in heaps with a view to loading, or any other stockpiling method used in connection with the loading method adopted by the Contractor in the borrow pit, shall not be classified as stockpiling for measurement under this item.

No additional measurement apart from this item shall be made for building up a stockpile in different layers for the purpose of mechanical modification of pavement layers on the road.

No haul shall be paid separately for moving material within the same borrow pit or quarry area. Hauling shall only be paid for material moved to a stockpile site not located at the same site as the producing plant (for item C4.1.12.1), or at another borrow pit or quarry area (for item C4.1.12.2). Haul shall then be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.13</b>	<b>Removing surplus material from the stockpile</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of stockpiled material not used.

The quantity shall be measured in the haul vehicles by taking the volume to be the equivalent of 70 % of the loose volume of the material in the haul vehicles.

The tendered rate shall include full compensation for loading and hauling the material to the borrow pit or the quarry or a designated site, for offloading and spreading the material.

Material shall be considered as surplus only when an instruction was given to stockpile the material or where the stockpile material was placed by others. Removal of surplus material resulting from over production by the Contractor shall not be measured and paid.

No haul shall be paid separately for moving material within the same borrow pit or quarry area. Hauling shall only be paid for material moved to a designated site not at the same borrow pit or quarry area. Haul shall then be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.14</b>	<b>Removing the fill platform and temporary banks at the stockpile sites upon completion:</b>	
C4.1.14.1	Fill platform	cubic metre (m <sup>3</sup> )
C4.1.14.2	Temporary banks	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material removed.

The quantity shall be measured in place in the fill platform and the temporary banks, from topographical surveys. The Engineer may approve that the quantity be taken as equal to 70 % of the volume of the loose material in the haul vehicles as an alternative to topographical surveys.

The tendered rates shall include full compensation for loading and hauling the material to the borrow pit or the quarry or a designated site, for offloading and spreading the material.

No haul shall be paid separately for moving material within the same borrow pit or quarry area. Hauling shall only be paid for material moved to a designated site not at the same borrow pit or quarry area. Haul shall then be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.1.15</b>	<b>Shaping and finishing the borrow pit and quarry areas, and the stockpile sites:</b>	
C4.1.15.1	Shaping and finishing the borrow pit and quarry areas, and the stockpile sites:	
(a)	Borrow pits (list all borrow pits separately)	hectare (ha)
(b)	Quarries (list all quarries separately)	hectare (ha)
(c)	Stockpile sites	hectare (ha)
C4.1.15.2	Finishing of the borrow pit and quarry areas, and the stockpile sites using labour enhanced methods of construction:	
(a)	Borrow pits (list all borrow pits separately)	hectare (ha)
(b)	Quarries (list all quarries separately)	hectare (ha)
(c)	Stockpile sites	hectare (ha)

The unit of measurement shall be the hectare of area shaped and finished.

The quantities shall be measured from topographical surveys, measured in plan.

The tendered rates for borrow pits and quarries shall include full compensation for shaping and finishing the sides and floor of the excavation to the specified slopes and gradients, forming smooth contours using soft material, placing of spoil or excess material in the floor and covering it, removing all excess material, reconstructing temporary berms or constructing new berms, and final preparation of the slopes prior to the topsoiling and revegetation operations.

Replacing overburden not used in the works in the borrow pit or quarry and levelling of the material are included in item C4.1.4.

The tendered rate for stockpile sites shall include full compensation for ripping and shaping the stockpile floor to the original contours. Measurement and payment to remove any surplus material, the fill platform and the temporary banks shall be made under items C4.1.13 and C4.1.14 respectively.

Distinction shall be made between the construction methods used.

Topsoiling and revegetation of the borrow pit and quarry area and stockpile sites will be measured and paid for under other items.

Any haul costs shall be included in the tendered rates of item C4.1.15.

Item	Description	Unit
<b>C4.1.16</b>	<b>Personnel:</b>	
C4.1.16.1	Materials manager	month
C4.1.16.2	Excavation controller	month
C4.1.16.3	Stockpile controller	month

The unit of measurement shall be the time in month (or part thereof) that the respective personnel are employed on the contract to carry out the specified duties.

The tendered rates shall include full compensation to cover the full cost of the respective personnel including all overhead charges and profit, bonuses, subsistence, allowances, Contractor's contributions, insurances, housing and vehicles for transport.

Item	Description	Unit
<b>C4.1.17</b>	<b>Weighbridge facility:</b>	
C4.1.17.1	Providing, erecting and removal of a weighbridge facility	lump sum
C4.1.17.2	Operating the weighbridge	month

The unit of measurement for item C4.1.17.1 shall be the lump sum.

The tendered rate for item C4.1.17.1 shall cover the cost for providing and erecting the weighbridge and the weighbridge office including all fittings, for the power supply, and for providing the scale equipment and computer hardware and software.

Payment of the item shall be made in two instalments:

- The first installment, 85 % of the lump sum, shall be paid after the weighbridge is commissioned.
- The final installment, 15 % of the lump sum, shall be paid when the weighbridge and office are removed from the contract.

The unit of measurement for item C4.1.17.2 shall be the time in months or part thereof that the weighbridge facility is operational and used for the works.

The tendered rate for item C4.1.17.2 shall cover the cost for operating and maintaining the weighbridge, including the cost of the weighbridge operator and all incidentals.

Item	Description	Unit
<b>C4.1.18</b>	<b>Compensation to landowners or legal occupants in respect of land acquisition, royalties and/or loss of crops:</b>	
C4.1.18.1	Amount allowed, expenditure to be approved or instructed by the Employer	provisional (prov) sum
C4.1.18.2	Handling costs and profit in respect of item C4.1.18.1	percentage (%)

**WHERE CRUSHED STONE MATERIAL IS EXCAVATED, PRODUCED AND STOCKPILED FOR USE ON OTHER PROJECTS, THE ITEMS HEREUNDER SHALL APPLY.**

Item	Description	Unit
<b>C4.1.19</b>	<b>Excavating hard material</b>	cubic metre (m <sup>3</sup> ) or ton (t)
<b>C4.1.20</b>	<b>Producing the material by:</b>	
C4.1.20.1	Single stage crushing	cubic metre (m <sup>3</sup> ) or ton (t)
C4.1.20.2	Multi-stage crushing and screening	cubic metre (m <sup>3</sup> ) or ton (t)
<b>C4.1.21</b>	<b>Stockpiling the crushed material</b>	cubic metre (m <sup>3</sup> ) or ton (t)

The unit of measurement for every item shall be either of the following as specified in the Contract Documentation:

- The volume of loose material measured in the stockpile, or
- The mass of the material in the stockpile as determined by a weighbridge.

The tendered rate for item C4.1.19 shall include full compensation for excavating and loading the material.

The tendered rate for item C4.1.20 shall include full compensation for hauling the material from the excavation to the crushing plant, for offloading and producing the material.

The tendered rate for item C4.1.21 shall include full compensation for loading the material at the producing plant, hauling the material to the stockpile, and for offloading, spreading and maintaining the material in the stockpile.

No haul shall be paid separately for moving material within the same borrow pit or quarry area. Hauling shall only be paid for material moved to a crushing plant not located at the same borrow pit or quarry area from where the material is excavated, or where the stockpile site is not located at the producing plant. Haul shall then be measured from the point where the material is loaded to where it is offloaded.

## **D4.1 BORROW MATERIALS**

### **PART D: GUARANTEES AND COMPLIANCE CERTIFICATES**

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- D4.1.2 GENERAL**
- D4.1.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D4.1.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D4.1.5 VISUALLY ASSESSED PROPERTIES**
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- D4.1.9 NOTIFICATION OF REMEDIAL WORK**
- D4.1.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

## A4.2 CUT MATERIALS

### CONTENTS

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#### PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

## PART A: SPECIFICATIONS

### A4.2.1 SCOPE

This Section covers the work requirements for sourcing natural or crushed materials that can be used for the construction of earthworks and pavement layers from:

- New cuttings.
- The widening of, or altering the side slopes of, or cutting of benches into existing cuttings.
- Box cuts for new roads and from box cuts for the widening of existing roads.
- Designated excavations.

Chapter 5 – Earthworks and Pavement layers: Construction, covers the construction of the road layers.

### A4.2.2 DEFINITIONS

The relevant definitions in Chapter 1 and Clause A4.1.2 shall also be applicable to this Section. Revised or additional definitions for this Section are listed below.

**Cuttings** - are shallow or deep excavations made in the in situ material required for the construction of the road within the road reserve where the road level results in a cutting slope or batter to be constructed and finished. Further or additional excavations, also referred to as under cuts, below the pavement layers to remove unsuitable stable material in the same excavation operation within the cutting shall be deemed part of the cutting excavation.

**Box cuts** - are shallow excavations made in the in situ material required for the construction of the pavement layers below the natural ground level. Additional or further excavations, also referred to as under cuts, below the pavement layers to remove unsuitable stable material in the same excavation operation within the box cut shall be deemed part of the box cut excavation. Box cuts are backfilled with the pavement layer, fill or with other compliant material. Unlike cuttings and designated excavations, box cuts do not have side slopes that must be finished.

**Cut material** - any material excavated from cuttings, box cuts or designated excavations.

**Designated excavations** - are excavations for open drains and channels, canals including channels to direct the course of water flow, that can yield compliant material for use in the works. The excavation criteria for open drains and channels to be classified as designated excavations are provided in Table A3.1.7.2-1 of Chapter 3.

### A4.2.3 GENERAL

#### A4.2.3.1 Employer requirements

The geotechnical information provided for the cuttings, box cuts and designated excavations reflects the results of site investigations including the excavation of trial pits and/or drilling, and laboratory tests conducted by or on behalf of the Employer. This information is indicative as to the sufficiency in quantity and quality of the material.

The Contractor shall use materials strictly in accordance with the requirements in the Contract Documentation and as instructed by the Engineer. The Contractor shall ensure that compliant materials are not unnecessarily contaminated with non-compliant material and that cut materials are not wasted.

All cuttings, and designated excavations where appropriate, must be surveyed and correctly staked before any cut operations commence to ensure that the designated cut lines and slopes are adhered to.

The Contractor shall be instructed as to the applicable usage of the material supply always employing the best economic alternative (lowest construction cost in terms of tendered rates) taking cognizance of the following:

- Quality of material,
- Haulage distance,
- Hardness of the material, and
- Overburden removal and use.

The Contractor shall not use cut material for any purpose other than the execution of this contract. Material shall not be disposed of, whether processed or not, either by sale or donation to any person without the written authorisation of the Employer.

#### **A4.2.3.2 Contractor prepared plans for cuttings**

The Contractor shall prepare and submit a Management and Utilisation (M&U) plan of operations for every cutting where the quantity of cut material will exceed 5 000 m<sup>3</sup>. Only a typical M&U plan can be submitted for cuttings between 5 000 m<sup>3</sup> and 10 000 m<sup>3</sup> where the cuttings have significantly similar material classes. Box cuts and designated excavations do not require M&U plans.

The M&U plan for the cutting shall at least show and include the following:

- The curriculum vitae of the proposed materials manager, excavation and stockpile controllers as applicable;
- The survey methods to stake the cut lines and slopes;
- Demarcation of the areas for stockpiling of topsoil, overburden and the various fill and pavement layer materials as required;
- Sequence and working of the cutting for sourcing the material;
- The testing protocol of the applicable tests and the frequency of testing;
- A method statement and risk assessment for sourcing the material;
- Method statements for the blasting of hard material, details for the safe storage and transport of explosives and the process for obtaining blasting permits in terms of the requirements specified in Section A12.10 of Chapter 12;
- When blasting within the vicinity of buildings or structures, measures to comply with the relevant Act and Regulations pertaining to the utilisation of explosives, as specified in Clause A1.2.7.5 of Chapter 1, proposals for the examination and recording of the condition of the buildings and structures in Clause A1.2.3.13 of Chapter 1 and compliance with the specifications given in Clause A12.10.7.2 of Chapter 12;
- The positioning of crushers, screens and other plant for crushing and screening of materials;
- Measures to comply with the conditions of the statutory road environmental approval;
- Measures to comply with safety regulations and obligations in terms of the relevant Health and Safety Acts and Regulations; and
- Procedures for regular monitoring, auditing and reporting.

M&U plans need only to be submitted during the course of the construction. However, no operations at a cutting including clearing and grubbing, shall commence until the Contractor's M&U plan for that cutting has been reviewed and accepted by the Engineer. The Engineer shall respond within one week after receiving an M&U plan.

#### **A4.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

Not required for Section A4.2.

#### **A4.2.5 MATERIALS**

##### **A4.2.5.1 General**

The specifications given in Clause A4.1.5 shall also apply to cut materials and are the required specifications for the cut material as finally processed and constructed on the road.

##### **A4.2.5.2 Quality of materials**

It is the Contractor's responsibility to ensure that the cut material including all operations such as excavation, loading, hauling, producing and stockpiling as applicable will comply with the material specifications, subject to the relevant provisions of the Contract Documentation.

Monitoring the quality and quantity of the cut materials produced for the construction on the road shall be the responsibility of the Contractor.

Based on a visual inspection by the Engineer and on the results of material tests as deemed appropriate, the Engineer shall have the right to declare the material non-compliant for use at any time before construction on the road or stockpiling as applicable. The Contractor shall then submit proposals for acceptance by the Engineer to rectify or replace the non-compliant material. Acceptance control testing of materials by the Engineer shall only be carried out during or after construction on the road, or of the material in the stockpile as applicable.

## **A4.2.6 CONSTRUCTION EQUIPMENT**

Construction equipment to source the cut materials shall comply with the requirements of Clause A1.2.6 of Chapter 1.

## **A4.2.7 EXECUTION OF THE WORKS**

### **A4.2.7.1 Excavation operations**

#### **a) Control at the cuttings, designated excavations and box cuts**

Control at the cuttings and the designated excavations shall be done in accordance with the requirements in Clause A4.1.7.2a) for borrow pits and quarries. Box cuts, being shallow excavations, do not require control of the excavation operations other than ensuring that the levels are correct and the quality of the box cut material complies with its designated usage, and that the quantity and wastage aspects are controlled.

When there is at any time any doubt concerning the quality of the cut material for its intended use, the Contractor shall notify the Engineer immediately before such material is brought onto the road or taken to stockpile. The results of all the tests conducted by the Contractor shall be submitted. After further testing or inspection as required and agreed to, the Contractor shall be instructed regarding the further use of the cut material.

When specified in the Contract Documentation, the Contractor shall have a full time or part time materials manager to conduct and manage the duties for the control at the excavations. The requirements for the materials manager, whether the person shall be an engineering geologist, engineer, a senior materials technician or a senior general foreman, and the required qualifications and experience of the materials manager, shall then also be specified.

#### **b) Classes of excavation**

Excavation of material in a cutting, in a box cut and in a designated excavation shall be classed as soft, boulder or hard excavation in accordance with the classification in Clause A4.1.7.2b).

In the absence of any construction equipment specified in the Contract Documentation to reference the efficient removal of soft material, the following equipment, all construction equipment to be in good mechanical order, shall be used to determine the efficiency (production rates hereunder refer to a continuous excavation production quantity of the in situ material):

- In road cuttings – a hydraulic crawler excavator with nett horsepower (flywheel power) generally between 180 kW and 225 kW, also known as a 30 ton excavator, and fitted with a heavy duty bucket. A minimum continuous production rate of 160 m<sup>3</sup>/h of the excavated material will be taken as the benchmark for this excavator's capacity and efficiency. When this production rate cannot be achieved the material being excavated shall be classified as hard.
- In box cuts and designated excavations of large or medium size projects where larger excavators form part of the Contractor's approved construction equipment – a hydraulic crawler or wheel excavator with nett horsepower (flywheel power) generally between 100 kW and 150 kW, also known as a 20 ton excavator, and fitted with a general duty bucket for excavation of box cuts and with a fish tail bucket for designated excavations. A minimum continuous production rate of 100 m<sup>3</sup>/h of the excavated material shall be taken for this excavator's capacity and efficiency. If this production rate cannot be achieved the material being excavated shall be classified as hard.
- In box cuts and designated excavations of small projects where only small plant forms part of the Contractor's approved construction equipment, a tractor-loader-backhoe (TLB), or a small or compact excavator with nett horsepower (flywheel power) generally less than 75 kW and fitted with a general duty or general purpose bucket. A minimum continuous production rate of 30 m<sup>3</sup>/h of the excavated material shall be taken as the capacity and efficiency of a TLB or a small or compact excavator. When this production rate cannot be achieved the material being excavated shall be classified as hard.

Excavation of material in existing roads of which the material is to be removed as part of the bulk excavation, shall also be classed in terms of this Clause. When the existing road material is removed in controlled layers, the excavation classes in Section A4.3 shall apply.

The Contractor shall be at liberty to use any method and construction equipment for excavating any class of material, but the chosen method or construction equipment to excavate the material shall not dictate the classification of the material.

Based on the information in the Contract Documentation, the further supplementary exploration during the contract as specified in Clause A4.2.7.1c), and a visual inspection if possible, and before any excavation commences, the Engineer and the Contractor shall agree on the applicable classes of excavation. Agreement shall also be reached on the method of measurement to be used for each class of excavation prior to the commencement of any excavation.

In the event of a disagreement between the Engineer and the Contractor, the Contractor shall if required, make available such reference construction equipment as specified at no cost to the Employer, in order to determine whether or not the material can be efficiently removed. The decision of the Engineer as to the classification shall thereafter be final and binding, subject to the relevant provisions of the Contract Documentation.

The Contractor shall immediately inform the Engineer when the nature of the material being excavated changes to such an extent that a new classification for further excavation is warranted. Failure to inform the Engineer of any possible change in the class of excavation before the material is excavated, shall entitle the Engineer to classify and measure such excavation as deemed appropriate.

#### **c) Supplementary exploration**

The Contractor, in the presence of the Engineer, shall conduct further investigations and obtain information for the M&U plan of every cutting where the quantity of cut material exceeds 5 000 m<sup>3</sup>, in accordance with the requirements of Clause A4.1.7.2c).

For smaller cuttings and box cuts the type of in situ material, the strength and indicator properties and the hardness of the material established during the design stage, must be verified with further trial pits and subsequent laboratory testing.

Designated excavations will not usually have been investigated during the design stage of the project. If some geotechnical investigation results are included in the Contract Documentation, it must only be regarded as indicative information that will require further confirmation. Supplementary exploration comprising trial pits and material testing shall be conducted of every designated excavation to prove that the material is compliant for use in the road or if it must be spoiled.

#### **d) Clearing and grubbing**

The top surface of a cutting, the widening or altering the side slope of an existing cutting, as well as the box cut and the designated excavation surfaces shall be cleared and grubbed as specified in Section A1.6 of Chapter 1.

The extent of the clearing and grubbing for cut materials shall be as follows:

- In cuttings 1,0 m wider than the cut line, cut off bank or drainage dyke as applicable.
- For designated excavations 1,0 m wider on either side of the excavation cut line.
- For box cuts 0,5 m wider on either side of the excavation cut line plus a strip for any sidewalk, if applicable.

For clearing and grubbing of new developments in urban areas the Engineer will instruct the extent of the clearing and grubbing, namely for the full width of the road reserve or for only the width of the cutting or box cut as specified above.

In cuttings where the total thickness of the topsoil and the overburden is less than 1,0 m, all trees and tree stumps including matted roots shall be removed to a depth of at least 1,0 m below the cleared surface. Where the total thickness is less than 1,0 m a separate grubbing operation is not required and the tree stumps can be removed together with the overburden, unless otherwise instructed by the Engineer.

In designated excavations and box cuts, trees and tree stumps including matted roots shall be removed to 1,0 m below the cleared surface.

The removal of buildings and structures is also covered in Section A1.6 of Chapter 1.

The removal of materials generally found in urban areas such as road edging, services structures, and paved sidewalks are specified in Section 4.3.

#### **e) Removal and conservation of the topsoil**

After clearing and grubbing the topsoil shall be excavated and stockpiled as specified in Section A1.6 of Chapter 1, for later use in the works.

#### **f) Spoil material**

Material in the cuttings, the box cuts and the designated excavations that is not compliant for the earthworks and pavement layers or material that is not required for further use shall be excavated, loaded and hauled directly to spoil sites. Only where designated spoil sites are not available at the time of spoiling, shall temporary stockpiles be permitted with prior consent of the Engineer.

#### **g) Cleaning of the bedrock**

Hard rock material in the excavations to be processed by crushing or crushing and screening, shall be cleaned of all loose and foreign material that may have remained from the topsoil and overburden, and that can affect the quality of the crushed rock.

#### **h) Excavation of material in cuttings**

The dimensions of cuts shall be in accordance with the details of the typical cross-sections as shown in the Contract Documentation, and shall further be defined or amended during the course of construction by instructions from the Engineer. The Contractor shall first obtain instructions from the Engineer regarding the slope of the sides of cuttings and the depth to which the cuttings are to be taken, including the dimensions of any in situ treatment of cuts that may be required.

No removal of overburden or any further cutting operations shall commence until agreement has been reached with the Engineer in regard to the thickness, the extent, use and quantity of the overburden. Overburden less than 200 mm thick shall be removed with the topsoil and not separately. Overburden that is not required for further use shall be excavated, loaded and hauled directly to spoil sites. Only where designated spoil sites are not available at the time of spoiling, shall temporary stockpiles be permitted with prior consent of the Engineer. Overburden required for later use shall be moved to beyond the outer limits of the cutting. This operation shall not be regarded as temporary stockpiling. The Engineer's approval must be obtained for removing and stockpiling of overburden that cannot be moved to beyond the limits of the cutting, or for overburden that is to be used in the works.

The Contractor shall take proper care when excavating material not to loosen any material outside the specified cut lines, whether by ripping, blasting or by other means that would endanger the stability of the cutting slopes or that would subsequently cause undue erosion or disintegration of the cutting slopes. This may entail modifying the methods of excavating when work is done in the vicinity of the final cut surface.

Care shall also be taken not to undercut any cutting slopes, and proper control shall at all times be exercised by regular survey checking and by using batter poles at maximum 10 m intervals. The final surface of cuttings in hard excavation shall generally not be more than 0,5 m below the specified cutting slope surface. Where the cutting slopes are nevertheless undercut and overbreak occurs, it shall be backfilled with imported compacted gravel material, soil cement or concrete. Where the imported material may not be considered an appropriate remedy, remedial measures may be ordered such as cutting back the entire or large sections of the cutting slope to a uniform slope, at the Contractor's expense.

For excavations in hard material the Contractor shall design the drilling pattern, depth and explosive charge load according to the nature of the material to achieve a stable cutting slope, at the specified slope with a minimum of overbreak. The Contractor shall not create loose unstable material outside the specified cutting slope due to poor blasting or construction techniques. In such an event the Contractor shall render the cutting slope stable by flattening or other approved methods at no cost to the Employer. When the nature of the material is such that an even cutting slope cannot be achieved by blasting due to rock slope movement or boulders protruding from the slope that may become loose, the Contractor shall inform the Engineer timeously that the overbreak is unavoidable and agreement shall be reached for compensation and backfilling, if any, of the overbreak.

Slope protection measures shall be specified in the Contract Documentation. These works shall be carried out in accordance with the requirements and specifications in Section 12.9 of Chapter 12. When the Contractor is of the opinion that the nature or formation of the material or rock in the cutting is too unstable to achieve the specified cutting slope or that the slope protection measures may be insufficient, the Engineer shall be informed as soon as the unstable material becomes evident so that additional geotechnical measures can be implemented.

Benching shall be made in deep cuttings for maintenance and erosion prevention purposes, and in rock cuttings for stability purposes, in accordance with details in the Contract Documentation.

The excavation of mudrock (shale) formations require special attention to minimise overbreak. On account of its poor durability qualities, mudrock material from the excavation may not be appropriate for backfilling the overbreak and hence its use for this purpose may not be permitted.

The Engineer shall inspect the floor of the cutting as the bulk excavation proceeds, and shall instruct any additional deeper excavation to remove unsuitable material.

The material in the cuttings shall be broken down to the following maximum particle sizes, depending on the use envisaged for the material, before it is loaded:

- Pioneer material 500 mm.
- Rockfill 500 mm.
- Coarse fill 500 mm, but not exceeding the thickness of the fill layer for efficient compaction by the construction equipment.
- Normal fill 300 mm.
- Pavement layers 300 mm.
- Material to be crushed, the take of the crusher.

In order that the material can be broken down to the above-mentioned sizes, the Contractor shall adjust and control the blasting, ripping, excavating and other operations so that the desired result can be achieved. Drilling and blasting patterns shall be such as to break down the material to the specified sizes, and where this is impractical, secondary blasting or other methods shall be used for breaking down oversize materials.

Where the working methods of the Contractor are such that large quantities of oversize material are produced, the Contractor shall be instructed to change the working methods, or type of crushing and screening plant, or construction equipment in order to produce less oversize material.

Excessive breaking down of the finer fraction of the material and thereby altering the properties of the material shall be avoided. Any material so altered shall be replaced by the Contractor without any cost to the Employer.

When specified in the Contract Documentation, the Contractor shall have an excavation controller to manage the selection and excavation of the cut material. The requirements for the excavation controller, namely whether the person shall be a materials technician or a general foreman, the controller's required qualifications and experience, and whether the controller is to be present full time or only part time at the excavation, shall then also be specified.

**i) Excavation of material in box cuts**

The dimensions of box cuts shall be in accordance with the details of the typical cross-sections as shown in the Contract Documentation, and shall further be defined or amended during the course of construction by instructions from the Engineer. The Contractor shall first obtain instructions from the Engineer regarding the depth to which box cuts are to be taken, including any in situ treatment that may be required.

The sides of box cuts shall be stepped as shown in the Contract Documentation or as instructed by the Engineer. Where box cuts are made for the widening of existing roads, the Engineer shall give instructions about the cut back and tie-in to the existing layers, and for saw-cutting of the existing layers.

**j) Excavation of material in designated excavations**

Designated excavations shall be constructed true to line, grade and cross-section as shown to details in the Contract Documentation.

Excavation below the required grades shall be avoided, and any excavation beyond the required grade as a result of negligence or poor construction techniques shall be backfilled with compliant material and compacted as approved by the Engineer, at no cost to the Employer.

For excavations in hard material, the Contractor shall plan the removal of the hard material so that it results in none or a minimum of overbreak.

**k) Selection and use of the cut material**

The results of laboratory tests, trial pits and drilling on cut materials carried out during the design stage are included in the Contract Documentation. The results and other information in the Contract Documentation give a preliminary indication as to the purpose for which and where the cut material shall be used. The Engineer shall give final instructions during construction regarding the use of the cut material.

Cut material shall be selected at the excavation, whether for use in the earthworks or in the pavement layers or in appurtenant works, so that its usage is optimised. Compliant material shall not be excavated together with non-compliant material, unless it is impossible to separate the different classes of material.

Cut to fill material shall be excavated and loaded directly for use on the road. Only after approval, where there is insufficient work space on the road or where the excavation of the cut material cannot be postponed, shall the Engineer instruct that material be stockpiled temporarily. Material placed temporarily adjacent to a trench or excavation for later loading and removal shall not be classified as stockpiling.

The cut material for pavement layers shall be selected, excavated, removed and always placed into suitable separate stockpiles to provide a uniform material.

Coarse rock encountered shall be utilised for the construction of the lower layers of fills high enough to accommodate thick layers, or, where so required, shall be conserved and used as directed for constructing the sides of embankments or for serving as protection against embankment or channel erosion.

The Engineer may order that particular materials in road cuttings, box cuts and designated excavations be selected for a specific purpose. Where selection is ordered, the method of excavation and the programme of works shall be so arranged by the Contractor to avoid double handling. When ordered by the Engineer, the better class fill material shall be selected for use in the top layer of the fills and in the lower layers of high fills.

Any surplus or non-compliant material resulting from the excavations shall be disposed of as directed by the Engineer.

The Engineer shall have full control over the use of all cut material. The Contractor shall plan the operations and particularly the cut-to-fill operations in such a manner that all cut material is used to the best advantage of the Employer. This means that no material shall be unnecessarily spoiled, excavated or hauled. The Contractor shall neither excavate nor spoil any material without the Engineer's approval, and without proving to the Engineer that this is necessary and that it is the most economical method of constructing the works.

**l) Use and treatment of oversize material**

Excavated cut material that contains oversize material, that is material exceeding the specified maximum particle sizes in Clause A4.2.7.1h), shall be handled as follows:

- Where the material contains less than 5 % by volume of the oversize material, the material can be hauled to the road or placed in the stockpile. The oversize material shall then be bladed out of the layer or removed by hand on the road, and then later returned to the borrow pit as spoil material or to a crusher, if available, for crushing.
- Where the material contains more than 5 % by volume of oversize material the Engineer shall instruct before the material is loaded at the excavation whether all the material, including the non-oversize material, shall be crushed and/or screened or broken down on the road during construction or taken to spoil.

**m) Producing the material by blasting, crushing and screening**

The requirements for the control of blasting, and for producing material by crushing and screening of hard, boulder and oversize material in borrow pits and quarries as specified in Clauses A4.1.7.2j) and A4.1.7.2k) respectively, shall also apply for cut material.

**n) Finishing of the side slopes of cuttings and designated excavations**

The side slopes of cuttings (batters) and designated excavations shall be finished (or shaped and formed) as specified in the Contract Documentation or in the statutory road environmental approval. In the absence of any specified requirements, the minimum requirements listed below shall be complied with for the finishing.

The side slopes of road cuttings shall be finished (or shaped) as follows:

- The slopes shall be finished to a standard which is generally achievable with proper care and workmanship in the type of material concerned. Care shall be taken not to undercut any side slopes which can cause sections to have a steeper slope than specified,
- Slopes at the junction of cuttings and fills shall be adjusted and evenly shaped so as to flow smoothly into the other or into the natural ground without a noticeable break that can be readily discerned from the road,
- Slopes within soft material shall be finished to a slope not steeper than 1 vertical to 2 horizontal,
- In soft excavation all loose rocks, boulders and cobbles larger than 75 mm shall be removed and the final surface of the side slopes shall have a slightly roughened surface where it is to be topsoiled,
- Slopes in soft excavation shall be finished to within a tolerance of 100 mm above to 100 mm below the specified side slope line, with all undulations following a smooth line,
- Slopes in hard and boulder excavation shall be finished to remove all loose, unstable and unsafe material, and the slopes will generally not require subsequent topsoiling and grassing,
- Finishing work shall include any measures specified in the Contract Documentation to protect and stabilise unstable slopes,
- Except in solid rock, the tops and bottoms of all side slopes shall be rounded for a width of 1,0 m,
- Where grassing is to be done the side slopes shall receive a 75 mm to 150 mm thick topsoil layer, and
- Cut off drains and/or banks shall be constructed at the top of all cut slopes where the natural ground above the cutting slopes towards the cutting.

The finishing of the cutting slopes shall be completed prior to construction of the subbase layer.

The minimum requirements for finishing or shaping the side slopes of designated excavations are:

- The side slope shall be profiled to suit the specified dimensions and slopes of the structure for which the excavation has been made,
- All loose rocks, boulders and cobbles must be removed, as well as any protruding hard rock,
- Overbreak or over excavation shall be backfilled with stabilised material, soil cement or concrete,
- The surface of soft excavation shall be firm and loose material shall be compacted,
- Excavation lines for unlined designated excavations shall be finished to within a tolerance of 50 mm above to 50 mm below the required levels, and Excavation lines for unlined designated excavations shall be finished to within a tolerance of 50 mm above to 50 mm below the required levels, and
- Excavation levels for designated excavations that will receive a lining, shall not be 25 mm higher or lower than the levels required for the lining.

### **A4.2.7.2 Stockpiles**

The preparation of the stockpile site, stockpiling of the material and reinstatement of the stockpile site shall be done in accordance with the requirements of Clause A4.1.7.3.

Unless the material being obtained from cuttings, box cuts and designated excavations is very variable a full time stockpile controller is not necessarily required.

### **A4.2.8 WORKMANSHIP**

The Engineer and the Contractor shall determine and agree on the testing protocol and frequency of the applicable process control tests required for each type of the sourced cut materials to ensure that the quality of materials produced meets the specified requirements for the particular layer for which it will be used. These required laboratory tests and testing frequencies shall be stated in the cutting M&U plans.

Measurement, testing, and evaluation of all individual components and constructed products shall be in accordance with the methods prescribed in this Section or in Chapter 20 as relevant.

## **B4.2 CUT MATERIALS**

### **PART B: LABOUR ENHANCEMENT**

#### **CONTENTS**

<b>B4.2.1</b>	<b>SCOPE</b>
<b>B4.2.2</b>	<b>DEFINITIONS</b>
<b>B4.2.3</b>	<b>GENERAL</b>
<b>B4.2.4</b>	<b>DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS</b>
<b>B4.2.5</b>	<b>MATERIALS</b>
<b>B4.2.6</b>	<b>CONSTRUCTION EQUIPMENT</b>
<b>B4.2.7</b>	<b>EXECUTION OF THE WORKS</b>
<b>B4.2.8</b>	<b>WORKMANSHIP</b>

#### **B4.2.1 SCOPE**

This section covers the sourcing of materials that can be used for the construction of earthworks and pavement layers from cuttings. A relative small proportion of activities as defined in Part A under the various sections are considered suitable for labour enhancement.

#### **B4.2.2 DEFINITIONS**

Definitions as provided in Chapter 1 and Clause A4.2.2 apply.

#### **B4.2.3 GENERAL**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

The provisions of Part A shall apply.

#### **B4.2.5 MATERIALS**

The provisions of Part A shall apply.

#### **B4.2.6 CONSTRUCTION EQUIPMENT**

Where reference is made in Part A to appropriate equipment, the use of light equipment shall be evaluated during trial sections.

#### **B4.2.7 EXECUTION OF THE WORKS**

For Cut Materials, the shaping and finishing of the cutting faces are appropriate components for labour enhancement.

#### **B4.2.8 WORKMANSHIP**

The provisions of Part A shall apply.

## C4.2 CUT MATERIALS

### PART C: MEASUREMENT AND PAYMENT

#### (i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

Loading of material at the excavation or the stockpile and hauling it for use on the road shall be measured in Chapter 5.

#### (ii) Items that will not be measured separately

The following required activities will not be measured or paid for separately and the Contractor shall include the cost thereof in the items describing the activity or in other items as deemed appropriate:

- Excavation or undercut outside the specified dimensions or limits or the cutting slopes of the cuttings and excavations.
- Backfill or cutting back the slope to remedy the overbreak or undercut that is caused by neglect, poor workmanship or inadequate supervision and management by the Contractor.
- Removal of any material that has become unstable due to the Contractor's poor or inappropriate excavation and/or blasting methods, or any work and materials required to remedy the unstable areas.
- Spoil of oversize material due to poor blasting or construction techniques.

#### (iii) Items to be measured and paid for using items specified elsewhere in the Specifications

For activities in Table C4.2-1 items specified in other Sections of the specification, where they relate to work under this Section, will be listed in the Pricing Schedule.

**Table C4.2-1: Items from other Chapters or Sections**

Activity	Section 4.2 -Clause reference	Section - Item reference
Clearing, grubbing, removal of large trees, and removal of buildings and structures	A4.2.7.1d) and A4.2.7.2	Section C1.6 - Items C1.6.1 to C1.6.4
Stockpiling topsoil (including overburden less than 200 mm thick)	A4.2.7e)	Section C1.6 - Item C1.6.9
Blasting of hard material	A4.2.7.1m)	Section C12.10 - Item C12.10.1
Producing the material by crushing and screening	A4.2.7.1m)	Section C4.1 - All applicable items
Placing of topsoil, and vegetation	A4.2.7.1n)	Section C11.8 - All applicable items
Stockpiling the material	A4.2.7.2	Section C4.1 - All applicable items
Hauling material (when applicable)	A4.2.7.1 and A4.2.7.2	Section C1.7 - Item C1.7.2

#### (iv) Items specifically for this Section of the Specifications

Item	Description	Unit
<b>C4.2.1</b>	<b>Compiling and implementing M&amp;U plans for the cuttings:</b>	
C4.2.1.1	Cuttings exceeding 5 000 m <sup>3</sup> up to 10 000 m <sup>3</sup>	number (No)
C4.2.1.2	Cuttings exceeding 10 000 m <sup>3</sup> up to 20 000 m <sup>3</sup>	number (No)
C4.2.1.3	Cuttings exceeding 20 000 m <sup>3</sup> up to 50 000 m <sup>3</sup>	number (No)
C4.2.1.4	Cuttings exceeding 50 000 m <sup>3</sup> up to 100 000 m <sup>3</sup>	number (No)
C4.2.1.5	Cuttings larger than 100 000 m <sup>3</sup>	number (No)

The volume referred to in the description shall be the total volume of material in place that must be removed. It includes the volume of topsoil and overburden, the material compliant for earthworks and pavement layers and any spoil material.

The unit of measurement shall be the number of cuttings for which M&U plans have been compiled. A distinction shall be made between the various cuttings based on the total volume of material to be excavated in the cutting. When several cuttings are covered by the same M&U plan they shall be measured as one plan.

The tendered rates shall include full compensation for gathering all information and compiling the plans, except for the additional material investigations agreed to by the Engineer that will be measured and paid separately, and to ensure implementing the plans during the operation of the cutting.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.2</b>	<b>Additional material investigations during the supplementary exploration:</b>	
C4.2.2.1	Cost of additional trial pits and/or drilling and laboratory testing	provisional (prov) sum
C4.2.2.2	Handling costs and profit in respect of item C4.2.2.1	percentage (%)
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.3</b>	<b>Excavating of materials in cuttings, material obtained from:</b>	
C4.2.3.1	Soft excavation	cubic metre (m <sup>3</sup> )
C4.2.3.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.3.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.3.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.3.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.4</b>	<b>Excavating of materials in box cuts, material obtained from:</b>	
C4.2.4.1	Soft excavation	cubic metre (m <sup>3</sup> )
C4.2.4.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.4.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.4.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.4.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.5</b>	<b>Excavating of materials in designated excavations, material obtained from:</b>	
C4.2.5.1	Soft excavation	cubic metre (m <sup>3</sup> )
C4.2.5.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.5.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.5.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.5.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement for items C4.2.3, C4.2.4 and C4.2.5 shall be the cubic metre of material excavated for use on the road.

The volume shall be measured in place in its original position in the cutting, box cut or designated excavation. It shall be calculated from the difference between levels taken or topographical surveys carried out after the removal of the topsoil, and from levels taken or surveys done after completion of the excavation of the different material classes. The volume of classified unavoidable overbreak in hard or boulder material shall be included in the measurement.

For boulder material, the Engineer may approve that the quantities be measured in haul vehicles as an alternative when the boulder material cannot be identified accurately prior to excavating, by taking the in situ volume of the boulder material as equal to 50 % of the loose volume of the material in the haul vehicles.

The tendered rates for items C4.2.3, C4.2.4 and C4.2.5 shall include full compensation for breaking down the cut materials in the various classes to the specified maximum particle sizes, for excavating, and loading the material. Should the Contractor choose for designated excavations to temporarily place the excavated material next to the excavation for loading later, it shall not be considered as stockpile of material nor shall the loading be considered as a separate activity for compensation.

The excavation of hard material by blasting shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 in Section 12.10 of Chapter 12.

The excavating and disposing of unsuitable and spoil material shall be measured and paid for under item C4.2.7 and under item C4.2.8 or C4.2.9 as applicable.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.6</b>	<b>Widening of existing cuttings in:</b>	
C4.2.6.1	Soft excavation	cubic metre (m <sup>3</sup> )
C4.2.6.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.6.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.6.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.6.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material excavated during the widening of existing cuttings.

Widening of existing cuttings shall be a widening more than 2,5 m deep (measured vertically from the top of the cutting to the shoulder breakpoint), and where the cutting is widened by less than 4,0 m. Widening of existing cuttings larger than these dimensions shall be measured and paid for under item C4.2.3.

Measurement of the material shall be in place in the original position in the cutting, and the quantity shall be computed by the method of average end areas from surveyed cross-sections at intervals not exceeding 20 m measured along the centre line of the road or from topographical surveys, before and after removal of the material.

For boulder material, the Engineer may approve that the quantities be measured in haul vehicles as an alternative when the boulder material cannot be identified accurately prior to excavating, by taking the in situ volume of the boulder material as equal to 50 % of the loose volume of the material in the haul vehicles.

The tendered rates shall include full compensation for breaking down the various classes, excavating, and loading the material.

The excavation of hard material by blasting shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 in Section 12.10 of Chapter 12.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.7</b>	<b>Removal of unsuitable stable cut material to spoil:</b>	
C4.2.7.1	In layer thicknesses of 200 mm and less	cubic metre (m <sup>3</sup> )
C4.2.7.2	In layer thicknesses exceeding 200 mm	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material removed to spoil in accordance with the Engineer's instructions.

The volume shall be measured in place in its original position and shall be calculated in accordance of the authorized dimensions.

The tendered rate shall include full compensation for excavating and loading the material in the floor of the excavation, and for disposing the material. Payment under this item shall only be made when the material is removed in a separate excavation operation after the bulk excavation is completed on instruction by the Engineer, else the material shall be classified as spoil material and then measured and paid for under item C4.2.8 or C4.2.9 as applicable.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.8</b>	<b>Excavate material to spoil in sites designated by the Employer, material obtained from:</b>	
C4.2.8.1	Soft excavation, overburden and unsuitable material	cubic metre (m <sup>3</sup> )
C4.2.8.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.8.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.8.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.8.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material excavated and spoiled.

The quantities shall be measured in place in its original position in the cutting, box cut or designated excavation, and shall be computed from topographical surveys. The Engineer may approve that the quantities be measured in the haul vehicles as an alternative when the quantities of the spoil material cannot be calculated accurately prior to excavating, by taking the in situ volume of the material in the case of soft excavation as equal to 70 % of the loose volume of material in the haul vehicles, and in the case of boulder and hard material as equal to 50 % of the loose volume of material in the haul vehicles.

The tendered rates shall include full compensation for breaking down the various classes, excavating, for off-loading and disposing the material, including shaping and levelling-off any heaps of spoil material.

The excavation of hard material by blasting shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 in Section 12.10 of Chapter 12.

Haul shall be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.9</b>	<b>Excavate material to spoil in sites designated by the Contractor, material obtained from:</b>	
C4.2.9.1	Soft excavation, overburden and unsuitable material	cubic metre (m <sup>3</sup> )
C4.2.9.2	Boulder excavation class A	cubic metre (m <sup>3</sup> )
C4.2.9.3	Boulder excavation class B	cubic metre (m <sup>3</sup> )
C4.2.9.4	Hard excavation (other than by blasting)	cubic metre (m <sup>3</sup> )
C4.2.9.5	Hard excavation (by blasting)	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material excavated and spoiled.

The quantities shall be measured in place in its original position in the cutting, box cut or designated excavation, and shall be computed from topographical surveys. The Engineer may approve that the quantities be measured in haul vehicles as an alternative when the spoil material cannot be identified accurately prior to excavating, by taking the in situ volume of the material in the case of soft excavation as equal to 70 % of the loose volume of material in the haul vehicles, and in the case of boulder and hard material as equal to 50 % of the loose volume of material in the haul vehicles.

The tendered rates shall include full compensation for negotiations with the landowner or legal occupant of the property or of the spoil site, for breaking down the various classes, excavating, loading and hauling the material to the spoil sites irrespective of the haul distance, for offloading and disposing the material, and for finishing the spoil site and obtaining the approval of the property or spoil site owner, if applicable.

The excavation of hard material by blasting shall exclude the cost of blasting, which shall be measured and paid for under item C12.10.1 in Section 12.10 of Chapter 12.

The tendered rate shall also include the cost of spoiling at a municipal site, if applicable.

All haul costs shall be included in the tendered rates of item C4.2.9.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.10</b>	<b>Backfilling of the unavoidable overbreak in hard and boulder excavation with:</b>	
C4.2.10.1	Compliant gravel material	cubic metre (m <sup>3</sup> )
C4.2.10.2	Soil cement (stiff mix with 3 % cement)	cubic metre (m <sup>3</sup> )
C4.2.10.3	Concrete class 15 MPa	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material used in the backfilling.

The quantities shall be measured from the quantity of material placed in the overbreak.

The tendered rates shall include full compensation for providing the material, and for placing, backfilling and compacting the material in the overbreak.

Payment for backfilling of overbreak shall only be made when the Engineer approves that the overbreak was unavoidable.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.11</b>	<b>Breaking down oversize material</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of oversize material that is broken down.

The quantity shall be measured by the volume of individual boulders or lumps of hard material. Where material is moved for breaking down the Engineer may approve that the quantity be measured by taking the volume to be equivalent to 50 % of the loose volume in the haul vehicles of the material to be broken down, as an alternative to measuring the individual volumes.

Breaking down of the cut material to the specified maximum particle sizes during the excavation operation or on the road by construction equipment shall not be measured under this item. Only breaking down of oversize material instructed or approved by the Engineer shall be measured and paid.

The tendered rate shall include full compensation for breaking down the material.

No distinction shall be made between various methods of breaking down the oversize material.

No haul shall be paid where oversize material must be moved for breaking down.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.2.12</b>	<b>Finishing the side slopes of:</b>	
C4.2.12.1	Cuttings:	
(a)	In soft material	square metre (m <sup>2</sup> )
(b)	In boulder material class A and B	square metre (m <sup>2</sup> )
(c)	In hard material	square metre (m <sup>2</sup> )
(d)	In soft material using labour enhanced methods of construction	square metre (m <sup>2</sup> )
C4.2.12.2	Designated excavations	square metre (m <sup>2</sup> )
C4.2.12.3	Designated excavations using labour enhanced methods of construction	square metre (m <sup>2</sup> )

The unit of measurement for cuttings shall be the square metre of the finished side slope areas.

The unit of measurement for designated excavations shall be the square metre of the side slope areas and the floor (invert) area where applicable.

The areas shall be measured from topographical surveys, or from tape measurements at 5,0 m cross section intervals where accurate tape measurements can be undertaken.

The tendered rates for finishing shall include full compensation for finishing the side slopes, and for loading, hauling and disposing of any excess material arising or brought down during the finishing operations. Placing of topsoil and vegetation shall be measured and paid separately.

Any haul costs shall be included in the tendered rates of item C4.2.12.

## **D4.2 CUT MATERIALS**

### **PART D: GUARANTEES AND COMPLIANCE CERTIFICATES**

#### **CONTENTS**

- D4.2.1 SCOPE**
- D4.2.2 GENERAL**
- D4.2.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D4.2.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D4.2.5 VISUALLY ASSESSED PROPERTIES**
- D4.2.6 INSTRUMENTALLY ASSESSED PROPERTIES**
- D4.2.7 EVALUATION FOR ACCEPTANCE**
- D4.2.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**
- D4.2.9 NOTIFICATION OF REMEDIAL WORK**
- D4.2.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

## A4.3 EXISTING ROAD MATERIALS

### CONTENTS

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#### PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

## PART A: SPECIFICATIONS

### A4.3.1 SCOPE

This Section covers the work requirements for sourcing of existing road construction materials that are:

- Obtained from reclaiming or reconstruction of existing road fills, pavement layers and asphalt materials.
- Used to reconstruct the same road they are obtained from or used on another road project.

This Section also covers the removal of existing concrete pavements and paving blocks from the road, and of materials in urban areas such as road edging, services structures, and paved sidewalk materials.

Chapter 5 – Earthworks and Pavement layers: Construction, covers the construction of the road layers.

### A4.3.2 DEFINITIONS

The relevant definitions in Chapter 1 and Clause A4.1.2 shall also be applicable to this Section. Additional definitions for this Section are listed below.

**Cemented material** - also referred to as bound material, is existing stabilised or treated road layer material that can only be removed by milling, or by pulverising prior to excavation by using conventional road construction equipment.

**Milling** - a process to break down (pulverise) and remove, all or part of bituminous surfacings (seals and asphalt) layers, and/or pavement layers by a milling machine.

**Reclaimed road materials** - are obtained by breaking up and excavating material in controlled separate layers from the existing earthworks and pavement layers and bituminous surfacings, producing compliant material by crushing and/or stockpiling it if required, and then hauling or moving it for use elsewhere on the same road, or on another road project or for other construction purposes.

**Reconstructed road materials** - are existing layer and bituminous surfacing materials that are scarified or pulverised (broken down) by ripping, or broken down by a recycling machine and then subsequently processed in situ, for the construction of reconstructed road pavement layers.

### A4.3.3 GENERAL

#### A4.3.3.1 Employer identified existing road materials

The road layer information provided in the Contract Documentation for the existing layers reflects the results of trial pits and laboratory tests conducted by or on behalf of the Employer. This information is indicative of the type of road layer materials and layer thicknesses. The provision of this information shall not in any way be construed as defining or limiting the extent and thickness of materials nor the quality to be obtained from the existing road.

The use of existing road materials shall be specified in the Contract Documentation. These materials could be re-used on their own or mixed and blended with additional imported material or used with material from underlying layers or a combination of the above in order to increase the new layer thickness, or improve the material properties, or a combination of both requirements for the intended use of the material in the road.

#### **A4.3.3.2 Contractor identified materials**

Should the Contractor wish to propose alternative reclaiming or recycling methods, or use different materials or different proportions of materials, then a method statement shall be provided by the Contractor. The method statement shall be supported by sufficient test results and shall confirm that the Contractor's proposal will meet the Employer's requirements. When accepted, the Contractor's alternative methods and/or identified materials shall then be handled as an alternative in terms of the conditions of contract.

### **A4.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

Not required for Section A4.3.

### **A4.3.5 MATERIALS**

#### **A4.3.5.1 Reclaimed and reconstructed gravel and crushed stone materials**

The specifications given in Clause A4.1.5 for the materials shall also apply to reclaimed and reconstructed gravel and crushed stone materials.

The material requirements for stabilised materials are given in Table A4.4.5-2, and for bitumen stabilised materials in Table A4.4.5-3.

These material specifications are the required specifications for the reclaimed or reconstructed material finally processed and constructed on the road. The Contractor may be instructed to modify or blend reclaimed or reconstructed material by the addition of some imported material and/or treatment agents in order to produce a material with the specified material properties.

#### **A4.3.5.2 Reclaimed asphalt material**

Asphalt material from existing surfacings or base layers may be removed to spoil or reclaimed for use.

Reclaimed asphalt from a surfacing and/or base layer may be used in the construction of earthworks, new pavement layers, recycled pavement layers or placed on the road shoulders. It may also be used as reclaimed asphalt in new asphalt layers, or for a wearing course of an unsealed road. The Contract Documentation shall specify where and in what mix proportions, if any, the reclaimed asphalt shall be used.

During reconstruction of a layer, asphalt may be mixed in situ with the underlying layer material. For bitumen stabilised materials where the material in the reconstructed layer will contain more than 70 % by volume of asphalt, the cohesion and friction angle of laboratory prepared 150 mm diameter x 300 mm high samples shall be tested to ensure compliance with the requirements in Table A4.4.5-3.

#### **A4.3.5.3 Bituminous seal surfacings**

Thin bituminous seal surfacings shall be processed together with the underlying layer during reconstruction, or shall be removed by blading or milled off before being taken to spoil, or shall be treated as reclaimed material if compliant for further use as specified in the Contract Documentation or instructed by the Engineer.

#### **A4.3.5.4 Quality of materials**

It is the Contractor's responsibility to ensure that the processed reclaimed or recycled material resulting from all operations such as milling, pulverising, excavating, stockpiling, loading and hauling operations as applicable shall comply with the required material specifications, subject to the relevant provisions of the Contract Documentation.

### **A4.3.6 CONSTRUCTION EQUIPMENT**

#### **A4.3.6.1 General**

Construction equipment to source the existing road materials shall comply with the requirements of Clause A1.2.6 of Chapter 1.

#### **A4.3.6.2 Milling machine**

The milling machine shall be capable of milling out either bituminous surfacings or unstabilised/stabilised pavement layer materials, or a combination of both simultaneously, to the depth specified in the Contract Documentation or as instructed by the Engineer.

The direction and speed of the milling machine and the speed of rotation of the milling drum shall be adjustable to deliver the required material properties. The machine shall be capable of making a neat vertical cut at the outer edges when milling. The Contractor shall inspect the milling machine's cutting tools, also known as picks, regularly and replace them as required whenever uneven or ineffective milling occurs, or when the gradation of the milled material is adversely affected.

The milling machine shall be equipped with a self-loading conveyor belt which can be easily removed and installed, and adjusted for slope and direction.

#### **A4.3.6.3 Construction equipment for breaking down and excavation**

The type of construction equipment to be used for the breaking down and excavation of existing pavement layers shall be determined by the size and depth of the pavement section to be excavated, taking into consideration that the work is sometimes carried out in restricted areas confined to only the demarcated areas of the pavement layers to be broken up.

## **A4.3.7 EXECUTION OF THE WORKS**

### **A4.3.7.1 Reconstructed layers**

The construction of reconstructed layers, including the breaking down and/or pulverising of the layers and then reconstructing it with or without modification, is covered in Chapter 5.

### **A4.3.7.2 Supplementary exploration**

The Contractor, in the presence of the Engineer, shall conduct further investigations to confirm the quality, thickness, properties and quantity of the material of the existing road layers, that have been identified for reclaiming or reconstruction in the Contract Documentation.

Where it is intended to separately remove the asphalt layers in the existing pavement, investigations shall be carried out to determine the following:

- Potential quantity of the asphalt available for reclaiming,
- The haul distance to the nearest asphalt mixing plant with recycling capability,
- Locating a suitable area for stockpiling the reclaimed asphalt to suit the future recycling on other projects if applicable,
- Basic asphalt mix types in the existing pavement,
- Uniformity of the asphalt in the existing pavement layers,
- Visual condition of the pavement, and
- Ownership of the reclaimed asphalt.

Samples of asphalt layers shall be taken by at least 150 mm diameter cores or by using a small milling machine. The asphalt material shall be examined to establish:

- The thickness of each asphalt layer found in the core or in the excavation side face,
- The asphalt mix types in single or multiple layers,
- The presence of surfacing seals, particularly those containing highly modified binders,
- The presence of coal tar that can normally be detected by its pungent odour, and that will classify the material as hazardous and non-compliant for use as reclaimed asphalt,
- The presence of geosynthetic or other types of asphalt reinforcement interlayers, and
- For signs of stripping of the binder from the aggregate.

Trial pits in the road layers, or coring in cemented layers shall be made to depths as instructed by the Engineer. Sufficient trial pits or coring shall be made so that uniform material sections can be identified.

### **A4.3.7.3 Classes of excavation for reclaimed material**

The classes of excavation of reclaimed material shall be classed according to the type of material being reclaimed, namely:

- Asphalt material, including bituminous surfacing seals thicker than 30 mm.
- Crushed stone and macadam materials.
- Cemented (chemically stabilised) material.
- Natural gravel and sand materials in the pavement layers and earthworks.
- Coarse and rock fill materials.

The removal of road material not excavated in controlled layers shall be classed in terms of Section A4.2, Clause A4.1.7.1b).

### **A4.3.7.4 Milling**

Before milling may be commenced, the surface of the existing road shall be cleaned of all vegetation, dirt, recent fuel spillage, road studs and any other foreign material.

Where the milled material is to be re-used in road pavement layers, the Contractor shall execute trial milling on the various materials to be milled. Trial milling shall consist of milling one strip not longer than 40 m. Trial milling shall not be required for material that is to be milled to spoil or re-used for general filling purposes. During the trial milling, the Contractor shall vary the speed of the milling machine, the speed of rotation of the milling drum and the milling depth, to select the desired optimum milling operation parameters to provide the required material quality and to prove that the milling machine is fit for purpose. The Engineer shall instruct the depth of milling the layer(s) after the trial milling.

Care shall be exercised to avoid damage to any concrete elements such as expansion joints and joint nosings, manholes, kerbing, kerb inlets and any other roadside furniture during the milling and the excavation. Damage caused to any element forming part of the permanent works shall be repaired at no cost to the Employer.

The floor of a milled excavation shall have an even texture without any loose local areas. Loose areas shall be remedied as specified in the Contract Documentation or as instructed by the Engineer.

The floor of a milled excavation shall be tested in the longitudinal direction with a 3,0 m straight-edge, and in other directions with a straight-edge of such length as fits between the longitudinal sides of the excavation. The surface of the milled area shall not deviate by more than 7,0 mm from the bottom edge of the straight-edge.

#### **A4.3.7.5 Safety at milled excavations**

Milled excavations shall not be trafficked unless it is necessary to temporarily accommodate traffic. When shallow milled excavations need to be opened to traffic then all loose material shall first be removed, and all longitudinal and transverse joints caused by the milling excavation shall be tapered where the difference in level between the floor of the milled excavation and the existing road surface exceeds 25 mm. Transverse joints shall be tapered at a slope of 1,0 mm vertical to 20,0 mm horizontal. Longitudinal joints shall be tapered at a slope of 1,0 mm vertical to 5,0 mm horizontal. The tapers shall either be formed by cutting back the joint edges to the specified slope or by constructing a suitable asphalt wedge, which shall be bonded to the cleaned joint with a bituminous tack coat.

#### **A4.3.7.6 Removal of asphalt material**

Reclaimed asphalt material shall be removed separately from the existing road, either by excavating and breaking down the asphalt material into blocks using conventional road building equipment, or by milling off the asphalt material.

Where only part of the asphalt is to be milled off, the area to be milled shall be demarcated and the milling depth shall be specified. Milling shall not exceed the demarcated width by more than 50 mm or the specified depth by more than 5,0 mm.

Where the asphalt consists of layers of various mixes or grades, the results of the sampling investigation will assist in deciding on the most appropriate milling strategy, namely whether to mill different asphalt layers separately (split milling), or to mill multiple asphalt layers together, or selective milling of non-compliant layers that must be discarded.

Contamination of the asphalt with underlying material, or unwanted damage to the underlying layer, during milling shall be avoided. The Contractor shall adjust and carefully control the depth of milling to prevent this by full time monitoring of the milled floor behind the milling machine.

Where the material is contaminated by the actions of the Contractor, it shall be replaced with other approved material at no cost to the Employer.

#### **A4.3.7.7 Excavation of crushed stone, macadam, cemented and gravel materials**

The existing pavement material shall be ripped or pulverised to the specified depth and then excavated using conventional road building equipment or by milling. The underlying layers shall not be damaged. Different material from one layer may not be mixed with that of another layer unless required, and the Contractor shall adjust the depth of ripping, pulverising or milling in accordance with the thickness of the layer. Continuous adjustment will be required to suit any variations in the thickness of the pavement layer. Where unauthorised mixing occurs or where the material is contaminated in any other way by the actions of the Contractor, it shall be replaced with other approved material at no cost to the Employer.

Where a layer or layers required to be excavated over part of the road width only, the limit of the work shall be clearly demarcated and shall not be exceeded by more than 100 mm. Saw-cutting along the demarcated setting out line prior to excavation is obligatory, except where the material is removed by milling.

Excavation outside the demarcated limits shall be repaired by the Contractor at no cost to the Employer.

When specified in the Contract Documentation, the Contractor shall have an excavation controller to manage the selection and excavation of the pavement materials. The requirements for the excavation controller, namely whether the person shall be a materials technician or a general foreman, the controller's required qualifications and experience, and whether the controller is to be present full time or only part time at the excavation of the reclaimed pavement materials, shall then also be specified.

#### **A4.3.7.8 Removal of existing concrete**

The thickness of existing concrete road pavements or paving shall be established by core drilling prior to removal. Sidewalk or driveway concrete pavements do not need to be cored.

The existing concrete shall be removed by one of two methods:

- The break-up method, or
- The lift-out method.

The break-up method comprises breaking of the concrete with hand operated pneumatic or electro-mechanical equipment such as jackhammers or pavement breakers, or high energy impact compaction rollers, and removing it with a front end loader or a tractor-loader-backhoe (TLB) or by labour enhanced methods. Breaking out may be assisted by additional intermediate saw-cuts. In road pavements the breaking operation shall commence from the centre of the concrete pavement towards the boundary saw cuts to eliminate damage to any adjoining slabs. Care shall be taken with this method to avoid damage to the subbase if it is not to be reclaimed or recycled.

The lift-out method requires lifting hooks to be attached to the saw-cut slab and heavy lifting plant to lift out the concrete. Alternatively the slab may be sawn into smaller pieces so that it can be lifted out by a front end loader or TLB. Although this method is less likely to damage the subbase and adjacent slabs, the Contractor is required to dispose of large slabs of concrete.

Where concrete is to be removed over part of the road width only, the limit of the work shall be clearly demarcated. Saw-cutting along the demarcated setting out line is obligatory. Removal of existing concrete outside the demarcated limits shall be repaired by the Contractor at no cost to the Employer.

#### **A4.3.7.9 Removal of existing paving blocks**

Existing paving blocks shall be lifted and used as specified in the Contract Documentation and/or instructed by the Engineer. Paving blocks that are to be handed to a property or landowner or are to be stockpiled for re-use shall be lifted by hand only. Paving blocks removed to spoil can be lifted by construction equipment.

Where paving blocks are to be handed to a property or landowner, the blocks shall be neatly stacked in a location agreed with the owner.

Paving blocks marked by the Engineer for re-use or other purposes, shall be removed to stockpile, and then neatly stacked.

The Engineer shall mark paving blocks that are broken or chipped extensively. These blocks shall be removed to spoil.

Paving blocks that must be handed to the property or landowner, or that will be stockpiled and neatly stacked for re-use, shall be cleaned of dirt, soil, concrete spillage and the like. Existing chips and broken edges do not have to be repaired.

The bedding sand shall be removed after lifting of the paving blocks.

#### **A4.3.7.10 Removal of the existing road edging**

Existing road edging, such as in situ concrete kerbing and edge beams, precast kerbing, kerb inlets (catchpits), grid inlets and so forth, shall be demolished and removed to spoil at an approved spoil site provided by the Contractor, or shall be stockpiled and stacked for re-use as instructed by the Engineer.

#### **A4.3.7.11 Saw-cutting**

When specified or instructed that existing pavement layers are to be saw-cut, the equipment shall be capable of saw-cutting the pavement layers in a single operation without fragmenting the material, and in straight lines. The depth of saw-cutting shall be specified in the Contract Documentation or instructed by the Engineer. Requirements for saw-cutting and the construction of joints between existing and new layers are specified in Clause A5.3.3.7 of Chapter 5.

#### **A4.3.7.12 Stockpiling of material**

Should the reclaimed material have to be stockpiled, the requirements for stockpiles in Clause A4.1.7.3 shall apply. Stockpile sites shall be large enough to allow the placing of different types of material without the stockpiles overlapping.

##### **a) Preparation of the stockpile site**

Stockpile sites shall be prepared in accordance with the requirements of Clause A4.1.7.3a).

When specified in the Contract Documentation or instructed by the Engineer, the floor for the reclaimed asphalt stockpile site shall be stabilised to a depth of 150 mm.

##### **b) Stockpiling of the material**

Different materials shall be stockpiled separately. When instructed by the Engineer, the Contractor shall remove the reclaimed asphalt material obtained from split milling to separate stockpiles.

Stockpiles of unprocessed reclaimed asphalt shall be ramp shaped and lifted in layers. When flattening the tipped material, it shall not be pushed over the edge to cause segregation. Stockpiles of unprocessed reclaimed asphalt shall not be covered, except when instructed by the Engineer.

#### **A4.3.7.13 Spoil of material**

Material from the milling and/or excavations of existing road materials that is non-compliant for the earthworks and pavement layers or material that is not required for further use shall be loaded and hauled directly to approved spoil sites.

Paving blocks, and road edging not suitable for further use or that are not required in future construction shall be loaded and hauled to approved spoil sites. Services structures, and asphalt and concrete material on sidewalks in urban areas shall also be spoiled.

Spoil sites are to be identified by the Employer or by the Contractor.

### **A4.3.8 WORKMANSHIP**

The material properties of the existing road layers shall always be verified by additional trial pits in the road and by subsequent laboratory testing, before any milling and/or excavation is carried out. The depth of the trial pits and applicable laboratory tests shall be determined by the intended use of the material in the existing road, whether the material is to be reclaimed or recycled.

Testing shall be more comprehensive for recycling of layers. The effects of patching and repairs, the variable thickness of layers and the variable addition of new material may result in the fluctuation of material properties. The impact of the fluctuation of these properties must be properly managed.

For the recycling of asphalt and/or bound (stabilised) materials, slabs of the materials shall be removed from the road trial pits and then crushed manually or with a small laboratory crusher to simulate the material produced by the recycler.

Agreement shall be reached with the Engineer on the testing, protocol of the applicable tests and frequency of process control testing on the existing road materials, to ensure that the quality of the materials meets the specified requirements for the particular layer for which it will be used.

Measurement, testing, and evaluation of all individual components and constructed products shall be in accordance with the methods prescribed in this Section or in Chapter 20 as relevant.

## **B4.3 EXISTING ROAD MATERIALS**

### **PART B: LABOUR ENHANCEMENT**

#### **CONTENTS**

<b>B4.3.1</b>	<b>SCOPE</b>
<b>B4.3.2</b>	<b>DEFINITIONS</b>
<b>B4.3.3</b>	<b>GENERAL</b>
<b>B4.3.4</b>	<b>DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS</b>
<b>B4.3.5</b>	<b>MATERIALS</b>
<b>B4.3.6</b>	<b>CONSTRUCTION EQUIPMENT</b>
<b>B4.3.7</b>	<b>EXECUTION OF THE WORKS</b>
<b>B4.3.8</b>	<b>WORKMANSHIP</b>

#### **B4.3.1 SCOPE**

This section covers existing road construction materials that are obtained from reclaiming or recycling existing road earthworks, pavement layers and asphalt materials (whether used as a pavement layer or used as the wearing course).

A relative small proportion of activities as defined in Part A under the various sections are considered suitable for labour enhancement. Therefore, Part B only provides additional specifications not contained in Part A.

#### **B4.3.2 DEFINITIONS**

Definitions as provided in Chapter 1 and Clause A4.3.2 apply.

#### **B4.3.3 GENERAL**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

The provisions of Part A shall apply.

#### **B4.3.5 MATERIALS**

The provisions of Part A shall apply.

#### **B4.3.6 CONSTRUCTION EQUIPMENT**

Where reference is made in Part A to appropriate equipment, the use of light equipment shall be evaluated during trial sections.

#### **B4.3.7 EXECUTION OF THE WORKS**

For existing road materials, the excavation of reclaimed material, the removal of existing paving blocks, the removal of existing road edging and the spoil of material from gravel or crushed stone layers are appropriate components for labour enhancement.

#### **B4.3.8 WORKMANSHIP**

The provisions of Part A shall apply.

## C4.3 EXISTING ROAD MATERIALS

### PART C: MEASUREMENT AND PAYMENT

#### (i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the Conditions of Contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

Loading of the reclaimed material on the existing road and hauling it for use elsewhere shall be measured in Chapter 5.

#### (ii) Items that will not be measured separately

There are no activities in Section A4.3 that will not be measured and paid separately and for which the cost must be included in other items.

#### (iii) Items to be measured and paid for using items elsewhere in the Specifications

For activities in Table C4.3-1 items specified in other Sections of the specification, where they relate to work under this Section, will be listed in the Pricing Schedule.

**Table C4.3-1: Items from other Chapters or Sections**

Activity	Section 4.3 - Clause reference	Section - Item reference
Producing the material by crushing and screening	A4.3.2	Section C4.1 - All applicable items
Loading material	C4.3	Section C1.7 - Item C1.7.1
Hauling material (when applicable)	A4.3.7.11 and A4.3.7.12	Section C1.7 - Item C1.7.2
Stabilising the floor of reclaimed asphalt material stockpile sites	A4.3.7.11	Section C5.4 - Item C5.4.2

#### (iv) Items specifically for this Section of the Specifications

Item	Description	Unit
<b>C4.3.1</b>	<b>Additional material investigations:</b>	
C4.3.1.1	Cost of additional trial pits, sampling of asphalt and laboratory testing	provisional (prov) sum
C4.3.1.2	Handling cost and profit in respect of item C4.3.1.1	percentage (%)
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.2</b>	<b>Cleaning the existing road surface:</b>	
C4.3.2.1	Cost to clean the road surface	provisional (prov) sum
C4.3.2.2	Handling costs and profit in respect of item C4.3.1.1	percentage (%)
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.3</b>	<b>Removal of bituminous seal surfacing (thickness not exceeding 30 mm)</b>	square metre (m <sup>2</sup> )

The unit of measurement shall be the square metre of seal surfacing removed separately.

The quantity shall be measured from the authorised dimensions.

The tendered rate shall include full compensation for blading or milling off the existing seal surfacing, and for loading and hauling the material to spoil sites identified by the Contractor.

All haul costs shall be included in the tendered rate of item C4.3.3.

The removal of a bituminous seal surfacing with the underlying base layer shall not be measured in this item, but the cost shall be included with the excavation of the base layer under items C4.3.9 and C4.3.10 respectively.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.4</b>	<b>Saw-cutting existing materials within the following average depth ranges:</b>	
C4.3.4.1	Asphalt asphalt:	
(a)	Up to 50 mm	metre (m)
(b)	Exceeding 50 mm and up to 100 mm	metre (m)
(c)	Etc, in 50 mm increments	
C4.3.4.2	Crushed stone and gravel material:	
(a)	Up to 100 mm	metre (m)
(b)	Exceeding 100 mm and up to 200 mm	metre (m)
(c)	Etc, in 100 mm increments	
C4.3.4.3	Cemented material:	
(a)	Up to 100 mm	metre (m)
(b)	Exceeding 100 mm and up to 200 mm	metre (m)
(c)	Etc, in 100 mm increments	
C4.3.4.4	Concrete material:	
(a)	Up to 50 mm	metre (m)
(b)	Exceeding 50 mm and up to 100 mm	metre (m)
(c)	Etc, in 50 mm increments	

The unit of measurement shall be the metre of saw-cut. The length in each depth range shall be measured and paid separately.

The quantities shall be measured from the authorised length of saw-cut, the depth specified or instructed by the Engineer.

The tendered rates shall include full compensation for saw-cutting the material.

Where asphalt and the underlying layer(s) are both to be saw-cut and the asphalt is less than 50 mm thick, separate measurement and payment will not be made for the asphalt saw-cutting in item C4.3.3.1. The asphalt thickness shall then be added to the thickness of the material in items C4.3.4.2 and/or C4.3.4.3 as applicable.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.5</b>	<b>Providing the milling machine on the site:</b>	
C4.3.5.1	Small milling machine with a cutting width of 1,2 m or smaller	number (No)
C4.3.5.2	Large milling machine with a cutting width exceeding 1,2 m	number (No)

The unit of measurement shall be the number of milling machines provided on the site, or the number of times a milling machine is brought onto the site where it had to be removed temporarily with prior approval. De-establishment and subsequent re-establishment shall also only be measured if undertaken with prior approval.

The tendered rates shall include full compensation for establishment and for de-establishment of the milling machine.

Payment for returning the machine to the site after removal shall be made only where the removal was in accordance with the Contractor's approved programme of work and not for any other reason. Payment shall not be made for replacing any defective plant.

Payment shall also not be made for moving the milling machine around on the site.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.6</b>	<b>Milling and removal of existing asphalt layers with an average milling depth (Contractor takes ownership):</b>	
C4.3.6.1	Not exceeding 50 mm	cubic metre (m <sup>3</sup> )
C4.3.6.2	Exceeding 50 mm but not exceeding 100 mm	cubic metre (m <sup>3</sup> )
C4.3.6.3	Exceeding 100 mm	cubic metre (m <sup>3</sup> )

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.7</b>	<b>Milling and removal of existing asphalt layers with an average milling depth (Employer takes ownership):</b>	
C4.3.7.1	Not exceeding 50 mm	cubic metre (m <sup>3</sup> )
C4.3.7.2	Exceeding 50 mm but not exceeding 100 mm	cubic metre (m <sup>3</sup> )
C4.3.7.3	Exceeding 100 mm	cubic metre (m <sup>3</sup> )

The unit of measurement for items C4.3.6 and C4.3.7 shall be the cubic metre of material milled from the existing pavement.

The quantities shall be computed in accordance with the authorised dimensions of the excavation.

When instructed, split milling and removal of the different existing asphalt layers shall be measured individually.

The tendered rates for item C4.3.6 shall include full compensation for demarcating the excavation, for milling (excavating) the material, for loading and hauling to a site identified by the Contractor, and for spoil or re-use by the Contractor. All haul costs shall be included in the tendered rates of item C4.3.6.

The tendered rates for item C4.3.7 shall include full compensation for demarcating the excavation, for milling, loading, hauling and offloading the material at a site designated by the Employer. Haul shall be measured from the point where the material is loaded to where it is offloaded.

Trial milling shall be measured and paid for under items C4.3.6 or C4.3.7, and no separate payment shall be made for it.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.8</b>	<b>Excavating material by milling:</b>	
C4.3.8.1	Crushed stone material	cubic metre (m <sup>3</sup> )
C4.3.8.2	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.8.3	Natural gravel material	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of milled material.

The quantities shall be measured in place on the existing road before the excavation commences.

The tendered rates shall include full compensation for milling out and loading the material.

Trial milling shall be measured and paid for under item C4.3.8, and no separate payment shall be made for it.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.9</b>	<b>Excavating material by using conventional road construction equipment:</b>	
C4.3.9.1	Asphalt material	cubic metre (m <sup>3</sup> )
C4.3.9.2	Crushed stone and macadam materials	cubic metre (m <sup>3</sup> )
C4.3.9.3	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.9.4	Natural gravel and sand materials	cubic metre (m <sup>3</sup> )
C4.3.9.5	Coarse fill and rock fill	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of excavated material, by using conventional road building equipment.

The quantities shall be measured in place on the existing road before the excavation commenced.

The tendered rates shall include full compensation for excavating and loading the material.

The tendered rate for cemented material shall include for ripping or pulverising the material prior to excavating.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.10</b>	<b>Excavating material by using labour enhanced methods of construction:</b>	
C4.3.10.1	Asphalt material	cubic metre (m <sup>3</sup> )
C4.3.10.2	Crushed stone and macadam materials	cubic metre (m <sup>3</sup> )
C4.3.10.3	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.10.4	Natural gravel and sand materials	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of excavated material, by using labour enhanced methods of construction.

The quantities shall be measured in place on the existing road before the excavation commenced.

The tendered rates shall include full compensation for excavating and loading the material.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.11</b>	<b>Breaking down a stabilised layer by using conventional road construction equipment</b>	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of stabilised material that is broken down, by using conventional road building equipment.

The quantities shall be measured in place on the existing road, from thickness measurements determined by drilling cores or in trial pits.

The tendered rate shall include full compensation for all equipment, labour and supervision to break the stabilised layer. No distinction shall be made between ripping the material with a grader, or pulverising the material with a recycler or rotary machine.

Measurement and payment in this item shall only be made when the existing material is used in a side-cut to new pavement layer operation. For excavating the existing material and then remove it to stockpile or to spoil, measurement of item C4.3.9 shall apply that includes the breaking down by ripping or pulverising.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.12</b>	<b>Removing of existing concrete material within the following average depth ranges by:</b>	
C4.3.12.1	The break-up method:	
(a)	Not exceeding 150 mm	cubic metre (m <sup>3</sup> )
(b)	Exceeding 150 mm but not exceeding 250 mm	cubic metre (m <sup>3</sup> )
C4.3.12.2	The break-up method using labour enhanced methods of construction:	
(a)	Not exceeding 75 mm	cubic metre (m <sup>3</sup> )
(b)	Exceeding 75 mm but not exceeding 200 mm	cubic metre (m <sup>3</sup> )
C4.3.12.3	The lift-out method:	
(a)	Not exceeding 150 mm	cubic metre (m <sup>3</sup> )
(b)	Exceeding 150 mm but not exceeding 250 mm	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of concrete removed.

The quantity shall be measured in place on the road before the concrete is broken up or lifted.

The tendered rates shall include full compensation for drilling of cores, and for removing and loading the concrete.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.13</b>	<b>Lifting of existing paving blocks (specify the type or size and thickness):</b>	
C4.3.13.1	Using construction equipment	square metre (m <sup>2</sup> )
C4.3.13.2	Using labour enhanced methods of construction	square metre (m <sup>2</sup> )

The unit of measurement shall be the area of paving blocks lifted.

The quantities shall be measured in place on the road before the blocks are lifted.

The tendered rates shall include full compensation for lifting the paving blocks and for removing the bedding sand.

Distinction shall be made between the construction methods used.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.14</b>	<b>Removing of existing road edging and services structures:</b>	
C4.3.14.1	Removing of existing road edging using construction equipment:	
(a)	Kerbing and edge beams:	
(i)	In situ concrete kerbing and edge beams	cubic metre (m <sup>3</sup> )
(ii)	Precast concrete kerbing (specify type or figure)	metre (m)
(iii)	Precast concrete kerbing (specify type or figure) and situ concrete channel (specify dimensions)	metre (m)
(b)	Kerb inlets	number (No)
(c)	Grid inlets	number (No)
(d)	Etc., for other services structures	number (No)
C4.3.14.2	Removing of existing road edging using labour enhanced methods of construction:	
(a)	Kerbing and edge beams:	
(i)	In situ concrete kerbing and edge beams	cubic metre (m <sup>3</sup> )
(ii)	Precast concrete kerbing (specify type or figure)	metre (m)
(iii)	Precast concrete kerbing (specify type or figure) and situ concrete channel (specify dimensions)	metre (m)
(b)	Kerb inlets	number (No)
(c)	Grid inlets	number (No)
(d)	Etc., for other services structures	number (No)

The unit of measurement for items C4.3.14.1(a)(i) and C4.3.14.2(a)(i) shall be the cubic metre of concrete removed.

The unit of measurement for items C4.3.13.1(a)(ii) and (iii) and C4.3.14.2 a)(ii) and (iii) shall be the metre of precast kerbing removed. For items C4.3.14.1(a)(iii) and C4.3.14.2(a)(iii) the length of in situ concrete channel shall not be measured separately.

The unit of measurement for items C4.3.14.1(b) and (c) and C4.3.14.2(b), (c) and (d) shall be the number of inlets.

The quantities shall be measured in place on the road before the items are removed.

The tendered rates shall include full compensation for excavation, breaking down and removing the edging.

Distinction shall be made between the construction methods used.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.15</b>	<b>Stockpiling of road layer materials:</b>	
C4.3.15.1	Asphalt material	cubic metre (m <sup>3</sup> )
C4.3.15.2	Crushed stone material	cubic metre (m <sup>3</sup> )
C4.3.15.3	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.15.4	Natural gravel material	cubic metre (m <sup>3</sup> )
C4.3.15.5	Concrete pavements	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material stockpiled.

The quantities shall be measured in place on the road before excavation commenced.

The tendered rates shall include full compensation for hauling the milled or excavated material to the stockpile and for offloading, spreading and maintaining the material in the stockpile.

Haul shall be measured from the point where the material is loaded to where it is offloaded.

Item	Description	Unit
<b>C4.3.16</b>	<b>Stacking paving blocks and road edging:</b>	
C4.3.16.1	Paving blocks (specify type or size and thickness)	number (No)
C4.3.16.2	Precast concrete kerbing (specify type or figure and length)	number (No)
C4.3.16.3	Precast kerb inlets	number (No)
C4.3.16.4	Precast manholes	number (No)

The unit of measurement shall be the number of units that are neatly stacked at the approved stockpile site.

The quantities shall be measured in the stockpile (stack).

The tendered rates shall include full compensation for cleaning the paving blocks or road edging items, for loading and hauling to the stockpile (stacking) site or to a position as indicated by the land or property owner, offloading and stacking.

Any haul costs shall be included in the tendered rates of item C4.3.16.

Item	Description	Unit
<b>C4.3.17</b>	<b>Excavate non-compliant or excess pavement layer material to spoil in sites designated by the Employer, material consisting of:</b>	
C4.3.17.1	Asphalt material	cubic metre (m <sup>3</sup> )
C4.3.17.2	Crushed stone, macadam, gravel and sand material	cubic metre (m <sup>3</sup> )
C4.3.17.3	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.17.4	Concrete material	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material spoiled.

The quantity shall be measured in place on the road before excavation commenced. Where this method of quantification is not feasible or where the quality of material is only identified after it has been excavated, the Engineer may approve that the quantity be taken as equal to 70 % of the loose volume of the material in the haul vehicles.

The tendered rate shall include full compensation for breaking down the material, excavating, for offloading and disposing the material, including shaping and levelling-off any heaps of spoil material.

Haul shall be measured from the point where the material is loaded to where it is offloaded.

Item	Description	Unit
<b>C4.3.18</b>	<b>Excavate non-compliant or excess pavement layer material to spoil in sites designated by the Contractor, material consisting of:</b>	
C4.3.18.1	Asphalt material	cubic metre (m <sup>3</sup> )
C4.3.18.2	Crushed stone, macadam, gravel and sand material	cubic metre (m <sup>3</sup> )
C4.3.18.3	Cemented material	cubic metre (m <sup>3</sup> )
C4.3.18.4	Concrete material	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material spoiled.

The quantity shall be measured in place on the road before excavation commenced. Where this method of quantification is not feasible or where the quality of material is only identified after it has been excavated, the Engineer may approve that the quantity be taken as equal to 70 % of the loose volume of the material in the haul vehicles.

The tendered rates shall include full compensation for negotiations with the land owner or legal occupant of the property or of the spoil site, for breaking down the various materials, excavating, loading and hauling the material to the spoil sites irrespective of the haul distance, for offloading and disposing the material, and for finishing the spoil site and obtaining the approval of the property or spoil site owner, if applicable.

The tendered rate shall also include the cost of spoiling at a municipal site, if applicable.

All haul costs shall be included in the tendered rates of item C4.3.18.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.19</b>	<b>Spoiling of paving blocks and road edging in spoil sites designated by the Employer:</b>	
C4.3.19.1	Paving blocks	cubic meter (m <sup>3</sup> )
C4.3.19.2	Precast and in situ concrete kerbing, edge beams and channels at precast kerbing	cubic metre (m <sup>3</sup> )
C4.3.19.3	Kerb and grid inlets, and other services structures	number (No)

The unit of measurement shall be the cubic metre of material spoiled.

The quantities shall be taken as equal to 70 % of the loose volume in the haul vehicles. The tendered rates shall include full compensation for loading the materials, for hauling to the spoil site, and for offloading and disposing the materials.

The tendered rate shall also include the cost of spoiling at a municipal site, if applicable.

Haul shall be measured from the point where the material is loaded to where it is offloaded.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.3.20</b>	<b>Spoiling of paving blocks and road edging in spoil sites designated by the Contractor:</b>	
C4.3.20.1	Paving blocks	cubic meter (m <sup>3</sup> )
C4.3.20.2	Precast and in situ concrete kerbing, edge beams and channels at precast kerbing	cubic metre (m <sup>3</sup> )
C4.3.20.3	Kerb and grid inlets, and other services structures	number (No)

The unit of measurement shall be the cubic metre of material spoiled.

The quantities shall be taken as equal to 70 % of the loose volume in the haul vehicles. The tendered rates shall include full compensation for loading the materials, for hauling to the spoil site irrespective of the haul distance, and for offloading and disposing the materials.

The tendered rate shall also include the cost of spoiling at a municipal site, if applicable.

All haul costs shall be included in the tendered rates of item C4.3.20.

## **D4.3 EXISTING ROAD MATERIALS**

### **PART D: GUARANTEES AND COMPLIANCE CERTIFICATES**

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No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

## A4.4 COMMERCIAL MATERIALS

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## PART A: SPECIFICATIONS

### A4.4.1 SCOPE

This Section covers:

- The provision of natural or crushed materials for a specific road construction project or projects that are procured from commercial and other private sources. It includes information on the requirements for providing the commercial materials for earthworks and pavement layers as an alternative to sourcing these materials from borrow pits, from quarries, from cuttings, box cuts and designated excavations or from existing roads.
- The provision of commercial agents and additives that are added or worked into the available materials or layer to enhance, improve or alter its properties so that the materials then comply with the applicable quality and strength requirements. Commercial agents and additives comprise traditional stabilising agents, non-traditional stabilising or soil treatment agents, and dust palliatives. The selection (design) process to determine the optimum quantity of cementitious and bituminous stabilising agents are also covered in this Section.

Chapter 5 – Earthworks and Pavement layers: Construction, covers the construction of the road layers.

SANS test methods published by Standards South Africa (a subdivision of the SABS) are listed in Chapter 20.

### A4.4.2 DEFINITIONS

The relevant definitions in Chapter 1 and Clause A4.1.2 shall also be applicable to this Section. Additional definitions for this Section are listed below.

**Commercial materials** - are natural gravel, sand or crushed rock materials:

- Sourced from commercial suppliers. These materials are sold by commercial suppliers and are generally crushed materials acquired from quarry operations or from stockpiles of non-ore containing material excavated during mining operations and shall already comply with the gradation and other material requirements, or
- Sourced from private or other non-commercial suppliers identified by the Employer or the Contractor, or material from the Employer's or Contractor's own sources. These materials are usually natural materials available in excavations or stockpiles, and the primary objective for excavating the material is/was not for road construction purposes. It is distinguished from material sourced from borrow pits and quarries in Section A4.1, in that the excavation or sourcing does not require a mining right or a mining permit in terms of South African legislation, although other legislative approvals may be required. Commercial materials from private or other non-commercial suppliers or from the Employer's own sources may require removal or breaking down of oversize material, screening, crushing or crushing and screening.

**Dust palliatives** - are products applied to the surface of a wearing course of an unsealed road, or worked into the layer to reduce the dust and loss of fines.

**Non-traditional stabilising or soil treatment agents** - non-traditional stabilisation or soil treatment agents can be:

- Sulfonated petroleum products (SPPs), also known as ionic soil stabilisers.
- Polymers, essentially plastic materials derived from acrylic polymers and commonly used as household glues.
- Nano-technology products that utilise processes at the molecular level within bitumen to improve the material properties.

Non-traditional stabilising or soil treatment agents are sometimes also referred to as proprietary stabilising agents.

**Stabilisation** - is the treatment of natural or crushed material to enhance the strength (load bearing capacity) and stiffness, and/or to make the material more water resistant to improve the durability. Marginal non-compliant material can also be made compliant for use after stabilisation. Stabilisation of material may take place by mechanical modification, also referred to as granular stabilisation (for example material blending), chemical (for example modification or cementation), electrical (for example ion exchange), or material improvement (for example using bitumen emulsion or foamed bitumen) means.

**Traditional stabilising agents** - these are agents that have generally been used through the years to stabilise materials, and are classified as:

- Cementitious stabilising agents (cement and lime), also known as stabilisers.
- Bituminous stabilising agents (added as an emulsion or in a foamed state).

## **A4.4.3 GENERAL**

### **A4.4.3.1 Employer identified commercial materials**

#### **a) Materials from commercial suppliers**

The Employer may identify and include test results of compliant materials from commercial suppliers in the Contract Documentation. However, the Contractor shall still be responsible for sourcing the material and for ensuring the sufficiency in quantity and quality of the material intended for use in the contract.

The Employer will usually not conclude any arrangements with these commercial suppliers, and the Contractor shall enter into negotiations with them and conclude contracts for the price, payments, rate of supply and the like.

Once the Contractor has chosen one or more of the commercial suppliers identified by the Employer, further dealings with the supplier and procuring the material shall be undertaken by the Contractor.

#### **b) Materials from private or non-commercial suppliers**

The sources and results of any material testing of materials from private or non-commercial suppliers that have been identified by the Employer, will be included in the Contract Documentation. This information is indicative as to the sufficiency in quality and quantity of the material.

The Contract Documentation shall also specify the arrangements made with the suppliers and specifically those that the Contractor must comply with, and any further negotiations that the Contractor shall conclude.

#### **c) Materials from the Employer's own sources**

The material is free issued to the Contractor, unless otherwise stated in the Contract Documentation when any conditions of the Employer shall then also be specified.

The results of any material testing will also be included in the Contract Documentation.

### **A4.4.3.2 Contractor identified suppliers or sources**

The Contractor can identify other compliant commercial or private / non-commercial material sources, or material from the Contractor's own sources, than those identified by the Employer for utilisation in the works.

Proof of the approvals and authorisation by the appropriate authorities for the commercial or private / non-commercial sources identified by the Contractor, as applicable, shall be provided by the Contractor.

The Contractor shall be responsible for all contractual and legal matters pertaining to ordering, loading, delivering and paying for materials obtained from the Contractor identified commercial or private / non-commercial suppliers.

The Contractor shall also ensure compliance by the suppliers of commercial or private / non-commercial materials that the necessary negotiations have been concluded with other interested and affected parties, as well as any land acquisitions, royalty payments and any special conditions imposed by these parties. If required, the Contractor shall submit proof or confirmation of all approvals and agreements before delivering any commercial material to the site.

When the materials are to be stabilised, then the Contractor shall arrange for the required testing to determine the type and amount of stabiliser content in accordance with the testing protocol in Clause A4.4.7. The test results, along with a proposal regarding the stabiliser type and stabiliser content, shall be submitted for review to the Engineer before the material is sourced.

## **A4.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

Should the Contractor wish to use, or to propose alternative commercial materials to those available from the designated borrow pits or quarries provided under Section A4.1, then sufficient laboratory test results must be provided to confirm that the Contractor's proposed commercial materials comply with the specified material properties.

The dust palliative shall be subject to a performance based system. Particulars of the system are given in Part D of this Section.

## A4.4.5 MATERIALS

### A4.4.5.1 Earthworks and pavement layer materials

The specifications for a pioneer layer, fill material and crushed stone for earthworks and given in Clause A4.1.5 shall also apply to commercial materials. These material specifications are the required specifications for the commercial material finally processed and constructed on the road.

Test results from representative samples recently processed shall be submitted for review by the Engineer. The Engineer shall declare the sourced or produced material fit for use before construction on the road may commence.

When specified in the Contract Documentation, material procured from commercial suppliers shall be stockpiled separately at the supplier when it cannot be used immediately after producing. The Contract Documentation may then also specify that the stockpile be fenced and sign posted as belonging to the Employer.

### A4.4.5.2 Traditional cementitious stabilising agents

The traditional cementitious stabilising agents for chemical stabilisation shall be either one or more of the agents listed hereunder.

#### a) Cement

Cement, also known as common cement, shall comply with the requirements of SANS 50197. Only extended common cement with a strength class of 32.5 N shall be used.

The following common cements shall not be used for stabilisation:

- CEM I due to rapid setting.
- CEM III/B, III/C and V/B due to a low clinker content.
- High early strength cements, affixed by the symbol "R".

Masonry cement, even if it complies with the requirements of SANS 50413, shall also not be used for stabilisation.

Proprietary cement blends that do not necessarily comply with SANS 50197 will be considered by the Engineer as stabilising agent, provided it has a proven record of being used and the requirements in Table A4.4.5-2 are complied with.

#### b) Lime

Road lime for the treatment of road materials can be calcium lime, magnesium lime or dolomitic lime. Lime shall comply with the requirements of SANS 824. All limes used for road stabilisation shall be slaked lime, also known as hydrated lime. Unslaked lime, also known as quicklime, and agricultural lime shall not be used.

#### c) Blending of cement with GGBS or PFA

The practise of site blending of cement with ground granulated blast furnace slag (GGBS) or pulverised fly ash (PFA) is not necessary, and has been eliminated by the availability of the extended cements classified by SANS 50197.

### A4.4.5.3 Traditional bituminous stabilising agents

#### a) Bitumen

Bitumen used as a stabilisation agent for bitumen stabilised material (BSM) shall be one of the following products and shall comply with the applicable standards:

- Penetration grade bitumen: SANS 4001-BT1 (for BSM – foam).
- Anionic road emulsion: SANS 4001-BT3 (for BSM – emulsion).
- Cationic road emulsion: SANS 4001-BT4 (for BSM – emulsion).

##### (i) Bitumen emulsion

Bitumen emulsion shall usually be slow set, stable grade anionic.

Cationic bitumen emulsion should be used with acidic aggregates having high silica content and low alkali content such as quartzite, granite, sandstone, rhyolite, syenite and felsite.

##### (ii) Foamed bitumen

Foamed bitumen shall be produced by injecting a limited amount of water (typically between 2 % and 4 % by mass of the bitumen) into a 70/100 penetration-grade bitumen, which has been pre-heated to a temperature of 170 °C to 180 °C. The minimum foaming characteristics (in terms of expansion ratio and half-life) shall be as specified in Table A4.4.5-1.

**Table A4.4.5-1: Foamed bitumen characteristic limits (minimum values)**

Aggregate temperature (°C)	15 – 20	> 20
Bitumen temperature (°C)	170 – 180	170 – 180
Expansion Ratio (times)	10	8
Half-Life, $T_{1/2}$ (seconds)	8	6

#### b) Active fillers

Fillers such as hydrated lime or cement may be introduced into the material requiring to be bitumen stabilised depending on the outcome of the laboratory mix design.

Cement and hydrated lime shall comply with the requirements of Clauses A4.4.5.2a) and A4.4.5.2b) above respectively.

Fly ash, when considered, shall comply with the requirements of SANS 50450-1.

#### A4.4.5.4 Non-traditional stabilising or soil treatment agents

The use of non-traditional stabilising or soil treatment agents may be specified in the Contract Documentation. Details of the product, its method and rate of application, construction method statement and any applicable curing measures, measurement and payment shall then be provided.

Should the Contractor propose the use of a non-traditional stabilising or soil treatment agent, either as an alternative to the specified product or to enhance the properties of any material, it shall only be considered when the following information is submitted for review by the Engineer:

- Details of the type of agent and basis material,
- A cost comparison that shows it to be economically viable compared to traditional stabilising or soil treatment agents,
- Test results show that the non-traditional agent is effective in achieving the specified material properties for the applicable layer,
- The product is accredited by a recognised body, such as Agrément South Africa, or project details of previous successful use of the product with the specific project test results, references and contact details are submitted, and
- The application specifications from the supplier, a method statement describing the application and processing of the stabiliser, and an equipment list to apply the agent and for the construction of the layer.

#### A4.4.5.5 Chemically stabilised materials

The material requirements for the different classes of chemically stabilised materials to achieve cementation are given in Table A4.4.5-2.

**Table A4.4.5-2: Requirements for cemented chemically stabilised materials**

Classification		C2	C3	C4
Type of material before stabilisation <sup>(1)</sup>		At least G4A quality	At least G5B quality	At least G6 quality
PI after stabilisation (maximum)		Non-plastic	6 <sup>(2)</sup>	6 <sup>(2)</sup>
UCS (Unconfined Compression Strength) (MPa) at 100 % of MDD <sup>(3)</sup>	Min	3.0	1.5	0.75
	Max	5.0	3.0	
ITS (Indirect Tensile Strength) (kPa) at 100 % of MDD	Min	300	250	200
	Max	500	450	400 (350) <sup>(4)</sup>
WDD (Wet/Dry Durability) (mass loss maximum)		10 %	20 %	30 %

**Notes:**

- <sup>(1)</sup> Material type requirement only indicative and not compulsory to be met unless specified in the Contract Documentation.
- <sup>(2)</sup> For materials derived from the basic crystalline rock group, the plasticity index after stabilisation shall be non-plastic.
- <sup>(3)</sup> It is more important that the ITS requirement be met than the UCS, as the ITS affects both the structural behaviour of the layer and limits the potential to degrade should the durability decreases in time.
- <sup>(4)</sup> ITS in brackets apply for a stabilised base layer.

The UCS and ITS requirements in Table A4.4.5-2 are determined at the standard 7-day curing, and not at the 24-hour rapid or accelerated curing testing. The 7-day cured strengths shall always be taken as the reference requirements, as the rapid curing may give a higher strength. Should rapid curing be done during the construction, both tests shall be done in parallel and a calibration factor derived for that material with that specific stabiliser. The rapid testing can then be used for acceptance control provided that regular calibration checks are made against the 7-day cured strengths to ensure that nothing has changed significantly. When significant variations are found in the relationship between the results of the two types of test, then all further test samples that are rapid cured shall have duplicate samples that are tested by the standard full 7-day acceptance test until a reliable, stable calibration factor has been re-established.

#### A4.4.5.6 Bitumen stabilised materials

The material requirements for the different classes of bitumen stabilised material material (BSM) are given in Table A4.4.5-3.

**Table A4.4.5-3: Requirements for BSMs**

Test <sup>(1)</sup>	Specimen size, compaction effort and curing	BSM Classification	
		BSM1	BSM2
Type of material before stabilisation <sup>(2)</sup>		At least G4A quality	At least G5B quality
ES traffic class (million E80 single axles)		> 10	1 – 10
ITS <sub>DRY</sub> (Indirect Tensile Strength) (kPa)	150 mm dia x 95 mm high vibratory hammer or MDD compaction cured to constant mass <sup>(3)</sup>	> 225	> 175
ITS <sub>WET</sub> (Indirect Tensile Strength) (kPa)		> 125	> 100
Shear properties	Friction angle (°)	> 40	> 35
	Cohesion (kPa)	> 250	> 200
	Retained cohesion (%)	> 75	> 60
	150 mm dia x 300 mm high vibratory hammer compaction cured at equilibrium moisture content <sup>(4)</sup>		

**Notes:**

- (1) All tests are carried out on specimens conditioned at 25 °C.
- (2) Material type requirement only indicative and not compulsory to be met unless specified in the Contract Documentation.
- (3) Specimens cured to constant mass at 40 °C. ITS values determined using constant displacement loading.
- (4) Specimens conditioned to 60 % – 65 % of OMC before sealing in a bag and curing at 40 °C for 48 hours.

The selection of the bituminous stabilising agent is covered in Clause A4.4.7.1.

#### **A4.4.5.7 Treated or modified materials**

The material properties after treatment or modification shall comply with the relevant requirements specified in Section A4.1, Tables A4.1.5-3, A4.1.5-4 or A4.1.5-5.

#### **A4.4.5.8 Quality of materials**

It is the Contractor's responsibility to ensure that the commercial materials including the procuring, loading, hauling, and/or further stockpiling if applicable, shall comply with the material specifications.

Any approval or consent given previously for the use of any commercial material may be cancelled, if the material quality has altered so that it does not comply with the specifications anymore.

### **A4.4.6 CONSTRUCTION EQUIPMENT**

For materials obtained from commercial suppliers, an equipment list does not have to be submitted.

For materials sourced from private or non-commercial suppliers or from the Contractor's own resources, the requirements in Clause A1.2.6 of Chapter 1 shall be applicable for the construction equipment.

### **A4.4.7 EXECUTION OF THE WORKS**

#### **A4.4.7.1 Selection (design) of the stabilising agent content**

##### **a) Purpose of the selection process**

The purpose of selecting the stabilisation content is to find the optimum combination of gravel or crushed material and stabilising agent that will provide the required strength and durability to ensure adequate structural capacity of the layer but not excessive for the design life of the road. This requires that the correct type and quantity of stabilising agent are determined.

##### **b) Sampling of materials**

For determining the positions of sampling and trial pits and during the taking of samples, it shall always be remembered that material properties can vary. Crushed aggregate, and more so gravels which are partly weathered, have properties that can vary considerably as a result of the effect of chemical reactions (hydration, hydrolysis and so forth), physical processes (leaching, saturation and so forth) and the effect of the environment (depth, water flows, temperatures and so forth). Adequate sampling shall always be carried out to ensure that representative test results are obtained. Samples shall also be taken from the point of availability of the material earmarked for stabilisation (generally in stockpile).

### **c) Cementitious stabilising agent for chemical stabilisation**

The Engineer, in consultation with the Contractor, will carry out the process to select the cementitious stabilising agent in an agreed to laboratory.

The Contractor shall provide the laboratory with a sufficient quantity of the natural material and stabilising agent for the laboratory to use in the testing procedures. The stabilisation design testing may take up to 2 months to conclude. The Contractor shall identify the material for stabilisation timeously to prevent delays to the contract.

The cementitious stabilising agent selection process for stabilisation shall be undertaken in a four-step sequence.

#### **Step 1: Determine the compliance of the natural material.**

The natural material shall be tested for compliance. Refer Table A4.4.5-2 in this Section and Tables A4.1.5-3, A4.1.5-4 and A4.1.5-5 in Section A4.1. The material may have to be processed by crushing, screening or crushing and screening, blended with other materials or pre-treated with lime or another stabilising agent if required, to meet the specifications of the material before stabilisation testing commence.

Sugar has deleterious effects on cement that may affect stabilisation in sugar farming areas. The presence of sugar in material in these areas must be tested in accord with SANS 5833.

The pH, electrolytic (electrical) conductivity (EC) and qualitative sulfate tests shall also be carried out on the natural material to establish the presence of soluble salts, and specifically for sulfates. The test results shall be evaluated as follows:

- Where the pH lies between 6,0 and 9,0, the EC is less than 200 mS/m and only traces of sulfate are present, the material can be used without pre-treatment or any precautionary measures.
- When only the EC requirement is not met, the material can be used provided that the durability by the wet/dry brushing test results comply with the requirements in Table A4.4.5-2.
- When the qualitative determination of sulfate shows the presence of more than just traces, the neat material shall be further evaluated and recommended fit for use or disapproved by an experienced road materials specialist.

#### **Step 2: Determine the Initial Consumption of Stabiliser (ICS) of the material.**

The pH shall be tested of samples prepared at varying stabiliser contents. The stabiliser content in percentage at which the pH reading remains constant, shall be taken as the ICS of the material.

#### **Step 3: Determine the compliance of the stabilised material.**

Samples of the material and stabilising agent shall then be prepared at stabiliser contents of 1,0 %; 1,5 %; 2,0 % and 2,5 % more than the ICS percentage identified in Step 2. The PI, UCS and ITS of all samples shall be tested at 7-day curing and evaluated against the requirements in Table A4.4.5-2.

If it is not possible to fully comply with both the UCS and ITS specified requirements, then compliance with the ITS requirement takes precedence.

The selected stabilising agent and content, increased to represent the construction method, will then be chosen that meet the requirements for PI and ITS in Table A4.4.5-2.

The addition of more stabilising agent to allow for variations in material properties and stabiliser distribution shall be assessed during the construction of the trial section, as specified in Chapter 5.

#### **Step 4: Determine the durability of the stabilised material, the effect of the test curing period on the ITS, and the field working time.**

The Engineer will indicate the stabiliser content(s) for the tests below, but it shall generally be carried out at the content chosen in Step 3 and at a stabiliser content of 0,5 % higher.

##### *(i) Durability of the stabilised briquettes*

For durability the wet/dry brushing test shall be done. Should the wet/dry durability (WDD) requirement in Table A4.4.5-2 be met, the Engineer will then confirm the stabilising agent and the application rate. Should the wet/dry durability requirement not be met, the result could be verified by an erosion test or the test shall be repeated with higher contents of stabilising agent until the specification is met. If necessary other types of stabilising agent may have to be considered and the design steps repeated.

Stabilisation on the road may be permitted by the Engineer before the results of the wet/dry durability test are available, but only where historical results of the durability tests on material from the same source have complied with the specification.

##### *(ii) Effect of the curing period on the ITS*

Parallel testing is carried out to establish for quality assurance testing the correlation between the ITS values at 7-day curing at the temperature of the standard test, and of the rapid curing test of 24 hours at elevated temperature, on material with the same stabiliser content.

##### *(iii) Field working time*

This test procedure for the field working time gives an indication of the maximum time for completion of the stabilised layer after commencement of the addition of the stabilising agent to the material. The working time shall be assessed by testing the ITS at rapid curing at increasing standing periods after the stabilising agent is mixed with the material. The field working time limit is then where the specified ITS requirement can still be achieved. The specified working time for construction stabilisation shall not exceed the construction time limitations specified in Section 5.4 of Chapter 5.

### **d) Bituminous stabilising agent for material improvement**

The Engineer, in consultation with the Contractor, will carry out the process to select the bituminous stabilising agent in an agreed to laboratory.

The requirements for the various test results hereunder are specified in Table A4.4.5-3. The Contractor shall provide the laboratory with a sufficient quantity of the bituminous stabilising agent and active fillers for use in the various testing procedures.

The stabilising agent selection process of BSMs shall be undertaken in a three-step sequence.

**Step 1: Determine the compliance of the natural material.**

The selection process starts by testing whether the natural material to be treated is compliant for treating with bitumen and, if not, to ascertain the producing of the material by crushing, screening or crushing and screening, and if pre-treatment is required, with a cementitious stabilising agent or blending with other materials to make it compliant.

**Step 2: Determine the effect of active filler and the optimal binder content.**

ITS tests are carried out to determine the effect of adding an active filler in conjunction with the bituminous stabilising agent. Three samples are normally tested, all with the same application of bituminous stabilising agent. Following the relevant test procedure, no active filler is added to the first sample, 1 % (by mass) hydrated lime is added to the second sample and 1 % (by mass) cement is added to the third sample. (Additional samples may be treated with other active fillers or a greater mass of filler if required.) Six ITS specimens are manufactured from each of the three (or more) treated samples. After curing, half the ITS specimens are soaked in water for 24 hours before testing to determine the ITS<sub>WET</sub> values. The ITS<sub>DRY</sub> values are obtained from the unsoaked ITS specimens.

The active filler in the mix that achieves the highest ITS<sub>WET</sub> value is selected as the preferred active filler and is applied to the mixes used to manufacture specimens for all further tests.

(Note. When there is a significant increase in the ITS<sub>DRY</sub> value of specimens treated with and without active filler, the ITS test procedure is repeated with a reduced application rate of 0,75 % active filler.)

Similar to the procedure to select the optimal filler content, ITS tests are carried out to determine the effect of adding different amounts of bituminous stabilising agent to samples all treated with the same amount of active filler. The ITS<sub>DRY</sub> and ITS<sub>WET</sub> values achieved are plotted against the respective amounts of stabilising agent on a graph, and the amount of agent that yields the ITS values specified for the required BSM classification is selected as the optimum.

**Step 3: Evaluate the shear properties.**

A large sample is prepared by adding active filler and bituminous stabilising agent at the application rates determined in Steps 1 and 2. Ten 150 mm diameter x 300 mm high specimens are manufactured and cured to approximate the equilibrium moisture content by following the standard procedure. Monotonic triaxial tests are then carried out on eight of the specimens (2 each at 4 different confining pressures) to determine the shear properties (the internal friction angle and cohesion) as well as the retained cohesion (determined from tests on the remaining two samples after soaking in water for 24 hours).

#### **A4.4.7.2 Storage of stabilising agents on site**

**a) Cement provided in pockets**

Cement delivered in pockets can be kept at the road on pallets or on a raised platform for no longer than two weeks. The pockets shall always be protected from the ingress of any moisture with a waterproof tarpaulin or plastic cover not less than 1,0 mm thick.

For longer storage periods, the cement bags shall be stored in a shed. The requirements for the shed and for storing are:

- Storage sheds shall be watertight and of solid construction.
- The floor shall be waterproof and covered with plastic sheets not less than 1,0 mm thick.
- The pockets shall be stored on the delivery pallets, which must be stacked closely together (to reduce the circulation of air) and away from any outside walls.
- Pockets shall be stored in such a way that older pockets are used first.
- Vertical stacking of loose pockets shall not exceed 12 pockets high.
- Doors and windows shall be kept shut.

The permitted shelf life of cement stored in a shed is 6 months inland and 3 months in coastal areas. Cement which has been properly stored in an approved shed as specified above for longer than these periods, or at the road side for more than two weeks, shall not be used in the stabilisation works.

**b) Lime**

Lime can be kept at the road for up to six months on pallets or on a raised platform. The pockets shall always be protected from the ingress of any moisture with a waterproof tarpaulin or a plastic cover not less than 1,0 mm thick.

**c) Bitumen**

The allowed temperature ranges between which penetration grade bitumen are stored or heated for application shall be as given in SANS 4001\_BT1. Binders stored in a heated condition shall be kept in a container with a securely fitting lid and the circulatory system that is functioning properly. The container shall be provided with a build-in thermometer. Binders which have been heated above the maximum allowed temperatures shall not be used and shall be removed from the site.

Bitumen emulsion shall be stored at ambient temperature in storage tanks fitted with a circulating pump system, which will enable the stored bitumen emulsion to be properly circulated in the static tank, especially when no bitumen emulsion has been drawn or added for a period of 2 to 3 consecutive days. The supplier shall be contacted for the maximum storage period.

**d) Placing on the road**

Pockets of stabilising agents shall only be placed immediately before the mixing and compaction operations are carried out, and after the gridlines have been marked out on the surface to ensure the correct application rate. Where this is not practical and approved by the Engineer, then pockets shall not be left on the road for longer than one day after placing the pockets prior to spreading the agent, as it may absorb moisture from the underlying layer or be damaged during other construction activities.

When the pockets of stabilising agents are placed on the road during periods of wet weather and get wet before the agent is spread and mixed into the layer, then the agent shall be removed to spoil and replaced with new dry agent at no cost to the Employer.

Where a pocket is broken on the road and mixing and compaction are not done within the specified time, the agent in the broken pocket

shall be removed to spoil and replaced with new dry agent at no cost to the Employer.

When the stabilising agent is delivered to site in bulk tankers then the agent may only be dispensed onto the road immediately before the mixing and compaction operations are carried out.

#### **A4.4.8 WORKMANSHIP**

The Engineer and the Contractor shall determine and agree on the testing protocol and frequency of the applicable process control tests required for the commercial materials, to ensure that the quality of the materials meets the specified requirements for the particular layer for which it will be used.

The stabilised material and designs shall always be tested and evaluated by constructing and testing of a trial section. After the type and quantity of stabiliser have been finalised, the Contractor shall further take full responsibility for compliance of the constructed stabilised layer with the requirements.

Measurement, testing, and evaluation of all individual components and constructed products shall be in accordance with the methods prescribed in this Section or in Chapter 20 as relevant.

## **B4.4 COMMERCIAL MATERIALS**

### **PART B: LABOUR ENHANCEMENT**

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<b>B4.4.8</b>	<b>WORKMANSHIP</b>

#### **B4.4.1 SCOPE**

This Section covers the supply of materials for a specific road construction project or projects which are procured from commercial and other private sources. It includes information on the requirements for providing commercial materials for earthworks and pavement layers as an alternative to sourcing these materials from borrow pits, from quarries, from cuttings, box cuts and designated excavations or from existing roads and that can be used for the construction of the road earthworks and pavement layers.

A relative small proportion of activities as defined in Part A under the various sections are considered suitable for labour enhancement. Therefore, Part B only provides additional specifications, not contained in Part A.

#### **B4.4.2 DEFINITIONS**

Definitions as provided in Chapter 1 and Clause A4.4.2 apply.

#### **B4.4.3 GENERAL**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.4.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

All specifications under this heading in the various sections of Part A, shall apply.

#### **B4.4.5 MATERIALS**

The provisions of Part A shall apply.

#### **B4.4.6 CONSTRUCTION EQUIPMENT**

Where reference is made in Part A to appropriate equipment, the use of light equipment shall be evaluated during trial sections.

#### **B4.4.7 EXECUTION OF THE WORKS**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.4.8 WORKMANSHIP**

The provisions of Part A shall apply.

## C4.4 COMMERCIAL MATERIALS

### PART C: MEASUREMENT AND PAYMENT

#### (i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

#### (ii) Items that will not be measured separately

The following required activities will not be measured and paid for separately and the Contractor shall include the cost thereof in item C4.4.2:

- Taking of samples and laboratory testing of commercial materials identified by the Contractor to prove compliance with the specified properties.
- Loading of the commercial material at the source, hauling it to the road, offloading and placing it on the road.
- Providing cementitious or bituminous stabilising agents for Contractor identified commercial materials that require stabilising.

#### (iii) Items to be measured and paid for using items specified elsewhere in the Specifications

For commercial materials from private or non-commercial suppliers (as defined in point (ii) above) identified by the Employer and that must still be excavated, produced and/or stockpiled, the Employer may decide to have a cost breakdown of the individual activities such as excavation, crushing and so forth. The pricing of item C4.4.1 will then not be applicable, and measurement and payment shall be made in accordance with the applicable items in Section C4.1.

#### (iv) Items specifically for this Section of the Specifications

Item	Description	Unit
<b>C4.4.1</b>	<b>Commercial materials identified by the Employer from commercial, private or other non-commercial suppliers (specify the source/s):</b>	
C4.4.1.1	Pavement layer material:	
(a)	Type G1 material	cubic metre (m <sup>3</sup> )
(b)	Type G2 material	cubic metre (m <sup>3</sup> )
(c) – (l)	Etc, for other Type G3 to G9 materials	cubic metre (m <sup>3</sup> )
(m)	Sand for the base and shoulder layers	cubic metre (m <sup>3</sup> )
(n)	Sand for a subbase layer	cubic metre (m <sup>3</sup> )
(o)	Sand for a selected layer	cubic metre (m <sup>3</sup> )
(p)	Natural or crushed gravel material for an unsealed shoulder layer	cubic metre (m <sup>3</sup> )
(q)	Natural or crushed gravel material for the wearing course of an unsealed road	cubic metre (m <sup>3</sup> )
C4.4.1.2	Macadam material:	
(a)	Coarse aggregate	cubic metre (m <sup>3</sup> )
(b)	Fine aggregate	cubic metre (m <sup>3</sup> )
C4.4.1.3	Drainage blanket layer material	cubic metre (m <sup>3</sup> )
C4.4.1.4	Soil cement material (pre-blended by the supplier)	cubic metre (m <sup>3</sup> )
C4.4.1.5	Fill material in the earthworks:	
(a)	Normal or coarse fill	cubic metre (m <sup>3</sup> )
(b)	Rock fill	cubic metre (m <sup>3</sup> )
(c)	Sand	cubic metre (m <sup>3</sup> )
C4.4.1.6	Pioneer material	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material.

The quantities for items C4.4.1.1 to C4.4.1.4 shall be measured in place in the compacted pavement layers and calculated from the authorised dimensions of the layers.

The quantities for item C4.4.1.5 shall be measured in place, from the difference between levelled cross sections at 20 m maximum intervals taken before and after the construction. The quantities shall not include excess material, overfill material or additional material placed for bulking (settlement during compaction).

The quantity for item C4.4.1.6 shall be taken as equal to 50% of the loose volume of the material in the haul vehicles.

The tendered rate shall include full compensation for negotiations to procure and furnish the commercial materials, for loading the material at the source, hauling it to the road, and for offloading. Temporary stockpiling of the material after procurement by the Contractor shall not be paid for.

The tendered rate for commercial materials from commercial suppliers shall also include full compensation for procuring the material. Additional crushing, screening and stockpiling of commercial material acquired from commercial suppliers shall not be measured and paid for separately.

For commercial materials from private or non-commercial suppliers, separate measurement and payment shall be made for breaking down oversize material, crushing, screening, and stockpiling as may be required and when specified in the Contract Documentation, or agreed to with prior written approval by the Engineer. Measurement and payment shall then be made according to the applicable items in Section C4.1. Procurement of the commercial material from the private or non-commercial suppliers by the Contractor, if specified in the Contract Documentation, shall be measured and paid for separately under item C4.4.3.

The materials from different sources shall be measured and paid separately.

All haul costs shall be included in the tendered rates of item C4.4.1.

Item	Description	Unit
<b>C4.4.2</b>	<b>Commercial materials identified by the Contractor from commercial, private or other non-commercial suppliers:</b>	
C4.4.2.1	Pavement layer material:	
(a)	Type G1 material	cubic metre (m <sup>3</sup> )
(b)	Type G2 material	cubic metre (m <sup>3</sup> )
(c) – (l)	Etc, for other Type G3 to G9 materials	cubic metre (m <sup>3</sup> )
(m)	Sand for the base and shoulder layers	cubic metre (m <sup>3</sup> )
(n)	Sand for a subbase layer	cubic metre (m <sup>3</sup> )
(o)	Sand for a selected layer	cubic metre (m <sup>3</sup> )
(p)	Natural or crushed gravel material for an unsealed shoulder layer	cubic metre (m <sup>3</sup> )
(q)	Natural or crushed gravel material for the wearing course of an unsealed road	cubic metre (m <sup>3</sup> )
C4.4.2.2	Macadam material:	
(a)	Coarse aggregate	cubic metre (m <sup>3</sup> )
(b)	Fine aggregate	cubic metre (m <sup>3</sup> )
C4.4.2.3	Drainage blanket layer material	cubic metre (m <sup>3</sup> )
C4.4.2.4	Soil cement material (pre-blended by the supplier)	cubic metre (m <sup>3</sup> )
C4.4.2.5	Fill material in the earthworks:	
(a)	Normal or coarse fill	cubic metre (m <sup>3</sup> )
(b)	Rock fill	cubic metre (m <sup>3</sup> )
(c)	Sand	cubic metre (m <sup>3</sup> )
C4.4.2.6	Pioneer material	cubic metre (m <sup>3</sup> )

The unit of measurement shall be the cubic metre of material.

The quantities for items C4.4.2.1 to C4.4.2.4 shall be measured in place in the compacted pavement layers and calculated from the authorised dimensions of the layers.

The quantities for item C4.4.2.5 shall be measured in place, from the difference between levelled cross sections at 20 m maximum intervals taken before and after the construction. The quantities shall not include excess material, overfill material or additional material placed for bulking (settlement during compaction).

The quantity for item C4.4.2.6 shall be taken as equal to 50% of the loose volume of the material in the haul vehicles.

The tendered rate shall include full compensation for negotiations, procuring and furnishing the commercial materials, for loading the material at the source, hauling it to the road, and for offloading. Temporary stockpiling of the material after procurement by the Contractor shall not be paid for.

No distinction shall be made for materials acquired from different sources.

All haul costs shall be included in the tendered rates of item C4.4.2.

Item	Description	Unit
<b>C4.4.3</b>	<b>Cost to procure commercial materials identified by the Employer from private or non-commercial sources:</b>	
C4.4.3.1	Cost of procuring	Provisional (prov) sum
C4.4.3.2	Handling cost and profit in respect of item C4.4.3.1	percentage (%)

Item	Description	Unit
<b>C4.4.4</b>	<b>Cementitious stabilising agents:</b>	
C4.4.4.1	Cement	ton (t)
C4.4.4.2	Road lime	ton (t)
C4.4.4.3	Etc, for other agents	ton (t)

The unit of measurement shall be the ton of stabilising agent.

The quantity of stabilising agent shall be determined in accordance with the authorised application rate. No over application or wastage shall be measured for payment.

The tendered rates shall include full compensation for procuring, transporting and delivering the stabilising agent to the site. No distinction shall be made between providing the stabilising agent in bulk or in pockets.

For providing the stabilising agent in pockets, the tendered rates shall also include full compensation for offloading the pockets, for short term and/or long term storage, and to move the pockets from a storage shed to the road if needed.

All haul costs shall be included in the tendered rates of item C4.4.4.

Placing, spreading and mixing in the stabilising agent(s) on the road shall be measured and paid for under the applicable items in Chapter 5.

Item	Description	Unit
<b>C4.4.5</b>	<b>Bituminous stabilising agents:</b>	
C4.4.5.1	Penetration grade bitumen (specify grade)	ton (t)
C4.4.5.2	Emulsion stable grade (specify type)	ton (t)

The unit of measurement shall be the ton of bituminous stabilising agent.

The method of calculating the quantity shall be specified in the Contract Documentation or as agreed between the Engineer and the Contractor, and shall be one of the following methods:

- Determined in accordance with the authorised application rate.
- Based on dipstick readings where the dipstick has been calibrated to the tanker, and the quantity measured at the applicable temperature.
- Based on assized weighbridge tickets issued for each and every tanker-load of stabilising agent consumed in the stabilisation process. The quantity thus measured shall not exceed the quantity calculated using the authorised application rate by more than 4 %.

The quantity shall include for a double treatment of stabilising agent over a nominal 100 mm overlap width along longitudinal joints.

The tendered rate shall include full compensation for procuring, transporting and delivering the bituminous stabilising agent to the site, for transfer into storage tanks, storage, heating and transfer into tankers for delivery to the site, for all transport on site, for issuing the required assized weighbridge ticket showing the mass of the contents in the tanker if applicable, for any re-heating required, for all wastage and for strict adherence to all safety measures required when handling warm bitumen emulsion or hot bitumen.

For foamed bitumen, the rate shall also include for foaming the bitumen on the recycler, including the water and any other additive that may be required to achieve the minimum foaming characteristics, and for injecting the foamed bitumen into the mixing chamber on the recycler.

All haul costs shall be included in the tendered rates of item C4.4.5.

Using and applying the bituminous stabilising agent in the road layers shall be measured and paid for under the applicable items in Chapter 5.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.4.6</b>	<b>Fillers for bituminous stabilisation (specify filler types separately)</b>	ton (t)

The unit of measurement shall be the ton of filler.

The quantity of filler shall be determined in accordance with the authorised application rate.

The tendered rate shall include full compensation for procuring and transporting the filler to the site, for offloading and storing the filler.

Application of the filler and spreading on the road shall be measured and paid for under the applicable items in Chapter 5.

<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.4.7</b>	<b>Sampling and material testing by a commercial laboratory for the stabilisation designs:</b>	
C4.4.7.1	Cost of sampling and material testing	provisional (prov) sum
C4.4.7.2	Handling cost and profit in respect of item C4.4.7.1	percentage (%)

## **D4.4 COMMERCIAL MATERIALS**

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##### **D4.4.10 REMEDIAL WORKS**

#### **D4.4.1 SCOPE**

Dust palliatives shall be subject to the provision of a guarantee.

#### **D4.4.2 GENERAL**

The Employer shall identify the location and extent of the unsealed road for which a dust palliative is required.

#### **D4.4.3 PERFORMANCE GUARANTEE REQUIREMENTS**

##### **D4.4.3.1 Information to be provided by the Employer**

The Employer will provide the following basic information of the gravel wearing course material and requirements of the guarantee:

- Properties of the wearing course material,
- Expected volume and type of traffic on the road,
- Performance and other requirements for the palliative, whether for dust control, strengthening or both,
- Duration and format of the guarantee,
- Payment conditions of the guarantee, and
- Assessments and testing criteria for the treated material during the guarantee period.

##### **D4.4.3.2 Information to be submitted by the Contractor**

The Contractor shall submit the following information about the dust palliative:

- The type of dust palliative, whether it be one of the following types:
  - A surfactant that is added to water in order to improve its ability to wet and penetrate the gravel wearing course,
  - A non-bond forming palliative that is applied directly onto the wearing course surface and where there is no gluing of the surface, or
  - A bond forming or gluing palliative that bonds the dust particles and that is applied by mixing the palliative into the wearing course.
- The basis material of the palliative,
- Further application intervals during the guarantee period,
- Restriction on the use such as near watercourses or other environmentally sensitive areas,
- Construction and application methods,

- Construction equipment required to apply the palliative,
- Curing time and restrictions for opening the road,
- An inspection management system of the inspection frequency, items to be inspected and rating,
- A payment schedule of costs comprising the initial application and of further applications during the guarantee period,
- Expected condition of the wearing course at the assessment times and at the end of the guarantee period, and  
Project details of previous use of the dust palliative with project references and contact details.

#### **D4.4.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**

Details must be provided in the Contract Documentation.

#### **D4.4.5 VISUALLY ASSESSED PROPERTIES**

Details must be provided in the Contract Documentation.

#### **D4.4.6 INSTRUMENTALLY ASSESSED PROPERTIES**

Details must be provided in the Contract Documentation when applicable.

#### **D4.4.7 EVALUATION FOR ACCEPTANCE**

Details must be provided in the Contract Documentation.

#### **D4.4.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**

Details must be provided in the Contract Documentation.

#### **D4.4.9 NOTIFICATION OF REMEDIAL WORK**

Details must be provided in the Contract Documentation.

#### **D4.4.10 REMEDIAL WORKS**

Details must be provided in the Contract Documentation.

## A4.5 ALTERNATIVE MATERIALS

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#### PART C: MEASUREMENT AND PAYMENT

#### PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

## PART A: SPECIFICATIONS

### A4.5.1 SCOPE

This section covers the work requirements for sourcing alternative materials that can be used for the construction of road earthworks and pavement layers, and which are obtained from sources other than from borrow pits and quarries, or from cuttings, box cuts and designated excavations, or from the existing road or from commercial sources.

Chapter 5 – Earthworks and Pavement layers: Construction, covers the construction of the road layers.

### A4.5.2 DEFINITIONS

The relevant definitions in Chapter 1 and Clause A4.1.2 shall also be applicable for this Section. Additional definitions for this Section are listed below.

**Alternative materials** - include all recovered materials considered compliant for the construction of earthworks and pavement layers, with or without additional processing, that are obtained from operations not necessarily related to road construction. Such operations include, but are not limited to:

- Construction and demolition of structures.
- Industrial operations.
- Mining operations.

Geosynthetic material built into the road layers are not defined as alternative materials.

**Construction and demolition material** - is produced in the process of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and non-residential), as well as roads and bridges.

Components of construction and demolition material typically include concrete, bricks, mortar, asphalt, metals, floor tiles, roofing and ceiling materials, dry walls, window materials, pipes, floor materials and other components. It may also contain some wood fragments, soil and rock fragments. Construction and demolition material is also referred to as construction or building rubble.

**Industrial operations material** - material from industrial operations is typically a by-product produced by an industrial activity that includes any surplus, unwanted or discarded material resulting from a manufacturing process at factories, mills, and so forth.

**Mining operations material** - material from mining operations generally consists of unprocessed surplus overburden material or non-ore bearing material that was removed and stockpiled during the mining operation. It is generally not compliant for direct use in the road layers, and requires removal of unwanted material, crushing and screening, and selection as applicable.

**Hazardous material** - contains organic or inorganic elements or compounds which may have a detrimental impact on health and the environment owing to the inherent physical, chemical, toxicological, radioactive or carcinogenic characteristics of the material.

### A4.5.3 GENERAL

The use of alternative materials may be specified in the Contract Documentation or be proposed by the Contractor. These alternative materials could be used on their own or mixed (blended) with additional imported material or with reclaimed road materials.

Before using any alternative materials, compliance with the following properties as applicable shall be ascertained:

- The durability of the material.
- No deleterious minerals or hazardous material and chemicals present.
- The strength characteristics for relation to the proposed use of the material, such as ACV, 10 % FACT, CBR, ITS and the like.

Sufficient tests shall be carried out to verify appropriate compliance with the above aspects and to ensure that the alternative material is compliant for its intended use in the earthworks or pavement layers.

For alternative materials identified by the Employer, initial negotiations or enquiries shall be conducted by the Employer about the availability of the material, price and conditions for procuring. The Employer may then decide to procure the material, whereafter the Contractor shall be responsible for producing, stockpiling and delivery of the material to the road.

Alternatively, when specified in the Contract Documentation, the Employer will not procure the alternative material and the Contractor shall be responsible for all contractual and legal matters pertaining to ordering, processing, stockpiling, loading, delivering and paying for alternative materials obtained from any alternative sources.

The Contractor shall also ensure that the site, property and the works where the material is sourced comply with all the applicable safety requirements.

### A4.5.4 DESIGN BY THE CONTRACTOR / PERFORMANCE BASED SYSTEMS

Should the Contractor wish to propose the use of any alternative materials to replace the specified materials then sufficient laboratory test results, together with a method statement stating how the material will be sourced, placed and processed, shall be submitted for review to the Engineer to determine that the Contractor's proposal meets the Employer's requirements.

There are no performance based systems required for Section A4.5.

### A4.5.5 MATERIALS

#### A4.5.5.1 General

The material specifications given in Clause A4.1.5 shall also apply to any alternative materials produced for use in the earthworks and pavement layers. These material specifications are the required specifications for the alternative materials finally processed and placed in the road. Crushing and screening or modification, etc of the materials may be required to comply with these specifications.

#### A4.5.5.2 Construction and demolition material

The various types of construction and demolition material compliant for use in earthworks and pavement layers are given in Table A4.5.5-1.

**Table A4.5.5-1: Usage of construction and demolition material**

Type of material	Appropriate usage
Crushed concrete	Fill layers, the selected and possibly the subbase layers if the grading is compliant or when the grading can be improved by the addition of other approved material
Broken concrete and clay bricks and mortar, mixed crushed bricks, concrete and clay roof tiles, and glass	Fill and selected layers
Uncrushed concrete and hard burnt clay bricks	Pioneer layer

Construction and demolition material to be used for the construction of earthworks and pavement layers shall not contain any of the following materials:

- Timber,
- Reinforcing steel or mesh, steel, iron or other scrap metal,
- Asbestos products,
- Plastic and PVC materials,
- Dry walling materials,
- Pipes,

- Aluminum,
- Window frames,
- Laminated glass,
- Slate roof tiles,
- Electrical fittings,
- Insulation materials, and
- Carpets.

All such contaminant materials shall be removed before the material is produced by crushing, if applicable, loaded and hauled to the road.

#### **A4.5.5.3 Industrial operations material**

Material obtained from Industrial operations containing organic materials, textiles, plastics, petroleum products, hazardous chemicals or any other deleterious material (metals, sludge and so forth) shall not be used.

Materials from industrial operations that have a proven record of being used are detailed below.

##### **a) Slag from the production of ferrous and non-ferrous materials**

Some industrial slags may be compliant for use in fill layers, the selected and the subbase layers, either on their own or blended with sand or gravel or soil material. Slag is generally not compliant for a crushed stone base layer due to the porosity and high surface voids of the slag.

The most common industrial slags are granulated blast furnace slag and steel slag from the production of iron and steel respectively. Granulated blast furnace slag is a stable material and generally does not require weathering as it does not contain free lime (CaO). However, unlike blast furnace slag, steel slag shows volumetric instability mainly due to the presence of free magnesium oxide (MgO) and free lime (CaO). In the presence of water, these compounds hydrate expansively.

Due to its expansive properties the use of steel slag shall not be considered in the works unless conditions pertaining to its use are agreed to. When steel slag is proposed, then the Contract Documentation shall include the expansion tests to be carried out and what test limits shall apply for the proposed use of the steel slag, and any pre-treatment that may be required.

##### **b) Ash**

Ash from coal burning power plants is generally compliant for fill layers. It may also be compliant for the pavement layers of lower category roads, or for the wearing course of unsealed roads. However, the properties of ash vary considerably from one source to another, and any ash proposed for use in the works shall be tested for compliance with the relevant material specifications given in Clause A4.1.5.

Pulverised fuel ash (PFA), also known as fly ash, is a very fine material that is difficult to compact and may liquefy under wet conditions. It may be compliant for use in fill provided the necessary precautions are taken during the placing, processing and compaction operations but it shall not be used without the written approval of the Engineer.

Furnace bottom ash (FBA) can generally be used for fill layers and possibly for the lower pavement layers.

Ash generates dust that shall be contained during transport, placing and compaction.

#### **A4.5.5.4 Mining operations material**

Material obtained from mining operations shall be free from hazardous material and other unwanted materials such as timber, metal, plastic or organic substances. The material shall also comply with the specifications for deleterious minerals in Clause A4.1.5.17. Depending on the material quality and the grading of the material it can be compliant for use in fill layers and in the pavement layers.

As it comprises sand, gravel or rock or a combination of these natural materials, it shall be used in the same manner as any other naturally occurring road construction material.

Stockpiles of material left over from the ore processing operations and mine dumps are generally non-compliant for use due to their fine grading and the chemical contamination that is often present.

#### **A4.5.5.5 Hazardous material**

The following materials are considered hazardous in road construction, and shall not be used in the works or be present in any of the layers:

- Acid in liquid form,
- Free asbestos,
- Animal carcasses,
- Batteries,
- Chemicals and containers,
- Disinfectants,
- Fertilizers,
- Fireworks,

- Fuel,
- Gas cylinders,
- Insecticides and pesticides,
- Medical waste,
- Oils,
- Paint and solvents,
- Pharmaceuticals,
- Radioactive material, or
- Weed killers.

#### **A4.5.5.6 Quality of materials**

It is the Contractor's responsibility to ensure that the alternative material including the furnishing, loading, hauling, further stockpiling if applicable, shall comply with the material specifications.

Any approval or consent given previously for the use of any alternative material shall be withdrawn, when the material no longer complies with the specifications anymore.

### **A4.5.6 CONSTRUCTION EQUIPMENT**

Construction equipment to source the alternative materials shall comply with requirements of Clause A1.2.6 of Chapter 1.

### **A4.5.7 EXECUTION OF THE WORKS**

#### **A4.5.7.1 Separation and selection of material**

Compliant road construction material shall be separated from unwanted contaminant material specified in Clause A4.5.5.2 and hazardous material in Clause A4.5.5.5. The road construction material shall have no visible signs under the naked eye of any unwanted material.

Material that is too large for acceptance by the crusher, such as pieces of concrete, shall be broken down to smaller sizes by conventional or handheld equipment.

#### **A4.5.7.2 Producing the material by crushing and screening**

Alternative materials, except ash and slag material from commercial suppliers, are seldom compliant for direct use in the road. It will generally require crushing, or screening, or crushing and screening.

For producing by crushing or by crushing and screening, and for the stockpile of the produced alternative materials, Clauses A4.1.7.2k) and A4.1.7.3 respectively shall apply.

#### **A4.5.7.3 Use of the material**

The Engineer shall have full control of the use of all alternative materials. The Contractor shall plan the operations and particularly the separation of unwanted material, breaking down of oversize material, and crushing and screening, in such a manner that any alternative material is used to the best advantage of the Employer. This means that no material shall be unnecessarily processed, produced or hauled.

### **A4.5.8 WORKMANSHIP**

The Engineer and the Contractor, shall determine and agree on the testing protocol and frequency of the applicable process control tests on any alternative material being used, to ensure that the quality of the materials produced complies with the specified requirements for the particular layer for which it will be used.

In addition to the standard tests used for the testing of earthworks and pavement layers materials, the following material tests shall be carried out where applicable:

- Chemical analysis by a recognized chemical laboratory to determine the presence and quantity of deleterious minerals and hazardous material.
- Determine the amount of expansion and degree of disintegration of the material when immersed in water for a prolonged period. The required soaking period will depend on the particular material.
- Hardness and durability tests depending on the use of the material. The relevant material properties specified in Clause A4.1.5 shall be applicable unless otherwise specified in the Contract Documentation.
- Determine the presence of unwanted material and hazardous material listed in Clauses A4.5.5.2 and A4.5.5.5 respectively.

Measurement, testing, and evaluation of all individual components and constructed products shall be in accordance with the methods prescribed in this Section or in Chapter 20 as relevant.

## **B4.5 ALTERNATIVE MATERIALS**

### **PART B: LABOUR ENHANCEMENT**

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<b>B4.5.5</b>	<b>MATERIALS</b>
<b>B4.5.6</b>	<b>CONSTRUCTION EQUIPMENT</b>
<b>B4.5.7</b>	<b>EXECUTION OF THE WORKS</b>
<b>B4.5.8</b>	<b>WORKMANSHIP</b>

#### **B4.5.1 SCOPE**

This Section covers the work requirements for sourcing alternative materials that can be used for the construction of road earthworks and pavement layers, and which are obtained from sources other than from borrow pits and quarries, or from cuttings, box cuts and designated excavations, or from the existing road or from commercial sources.

Part B only provides additional specifications, not contained in Part A.

#### **B4.5.2 DEFINITIONS**

Definitions as provided in Chapter 1 and Clause A4.5.2 apply.

#### **B4.5.3 GENERAL**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.5.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**

The provisions of Part A shall apply.

#### **B4.5.5 MATERIALS**

The provisions of Part A shall apply.

#### **B4.5.6 CONSTRUCTION EQUIPMENT**

Where reference is made in Part A to appropriate equipment, the use of light equipment shall be evaluated during trial sections.

#### **B4.5.7 EXECUTION OF THE WORKS**

Any activity specified in Part A, where hand work is given as an alternative, shall be executed in such a way as to maximise labour.

#### **B4.5.8 WORKMANSHIP**

The provisions of Part A shall apply.

## C4.5 ALTERNATIVE MATERIALS

### PART C: MEASUREMENT AND PAYMENT

#### (i) Preamble

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

#### (ii) Items that will not be measured separately

The following required activities will not be measured and paid for separately and the Contractor shall include the cost thereof in other items as deemed appropriate:

- Taking of samples and laboratory testing of alternative materials identified by the Contractor to prove compliance with the specified properties.
- For alternative materials identified and sourced by the Contractor, the removing of unwanted contaminant and hazardous material, breaking down oversize material, crushing, screening and separation, all as required, and for loading, hauling and offloading.

#### (iii) Items to be measured and paid for using items specified elsewhere in the Specifications

- **Alternative materials identified by the Employer**

For alternative materials that must still be separated, cleaned, broken down, produced by crushing or crushing and screening as applicable, and then stockpiled, measurement and payment shall be made according to the applicable items in Section C4.1. Procurement of the material by the Contractor, if specified in the Contract Documentation, shall be paid separately in item C4.5.3 hereunder. Loading and hauling the material to the road shall be measured and paid for in Chapter 5.

Alternative materials that are already produced into the correct gradation compliant for use in the road layers and that are sold as a commercial material, shall be measured and paid for in accordance with Section 4 item C4.4.1. The cost for procuring the alternative material, for loading and hauling it to the road shall then be included in the tendered rate.

- **Alternative materials identified and sourced by the Contractor**

Alternative materials identified and sourced by the Contractor shall be measured and paid for in accordance with item C4.4.2 as for commercial materials. Procuring the alternative material, producing, crushing and/or breaking down and stockpiling as required, for loading at the source and hauling it to the road irrespective of the haul distance, and offloading shall then be included in the tendered rate.

#### (iv) Items specifically for this Section of the Specifications

Item	Description	Unit
<b>C4.5.1</b>	<b>Additional material investigations:</b>	
C4.5.1.1	Cost of sampling and laboratory testing	provisional (prov) sum
C4.5.1.2	Handling cost and profit in respect of item C4.5.1.1	percentage (%)
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.5.2</b>	<b>Removing unwanted material from alternative materials identified by the Employer:</b>	
C4.5.2.1	Contaminant material	provisional (prov) sum
C4.5.2.2	Handling cost and profit in respect of item C4.5.2.1	percentage (%)
C4.5.2.3	Hazardous material	provisional (prov) sum
C4.5.2.4	Handling cost and profit in respect of item C4.5.2.3	percentage (%)
<b>Item</b>	<b>Description</b>	<b>Unit</b>
<b>C4.5.3</b>	<b>Cost to procure alternative materials identified by the Employer:</b>	
C4.5.3.1	Cost of procuring	provisional (prov) sum
C4.5.3.2	Handling cost and profit in respect of item C4.5.3.1	percentage (%)

## **D4.5 ALTERNATIVE MATERIALS**

### **PART D: GUARANTEES AND COMPLIANCE CERTIFICATES**

#### **CONTENTS**

- D4.5.1 SCOPE**
- D4.5.2 GENERAL**
- D4.5.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D4.5.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D4.5.5 VISUALLY ASSESSED PROPERTIES**
- D4.5.6 INSTRUMENTALLY ASSESSED PROPERTIES**
- D4.5.7 EVALUATION FOR ACCEPTANCE**
- D4.5.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**
- D4.5.9 NOTIFICATION OF REMEDIAL WORK**
- D4.5.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.