

South Africa

COTO

Committee of Transport
Officials

Standard Specifications for Road and Bridge Works for South African Road Authorities

Draft Standard (DS)

CHAPTER 6: CONCRETE LAYERS

October 2020

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FOREWORD

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Existing publication:

The new COTO Standard Specifications for Road and Bridge Works for South African Road Authorities was approved by COTO on 18 August 2020 as a Draft Standard (DS) and will be replacing the COLTO Standard Specifications for Road and Bridge Works for State Road Authorities (1998 Edition).

Existing contracts and tenders in the design phases based on the COLTO Standard Specifications (1998 Edition) will remain unaffected but will be phased out during the next 6 months and the COTO Standard Specifications (2020 Edition) will be mandatory for use in procurement documents advertised as from 1 March 2021.

Document versions:

Draft Standard (DS). The Draft Standard will be implemented in industry for a period of two (2) years, during which written comments may be submitted to the COTO subcommittee. Draft Standards (DS) have full legal standing.

Final Standard (FS). After the two-year period, comments received are reviewed and where appropriate, incorporated by the COTO subcommittee. The document is converted to a Final Standard (FS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a final standard. This Final Standard is implemented in industry for a period of five (5) years, after which it may again be reviewed. Final Standards (FS) have full legal standing.

Comments:

Comments on the Draft Standard Chapters should be provided in writing on the Excel spreadsheet provided on the websites mentioned below and e-mailed to cotorevision@nra.co.za.

Please note:

This document and its various Chapters will only be available in electronic format.

The Draft Standard (DS) Chapters will be made available for download on the South African National Roads Agency SOC Ltd (SANRAL) and Department of Transport websites.

August 2020 version replaced with October 2020 version due to amendments to Chapters.

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CHAPTER 6: CONCRETE LAYERS

6.1 PAVER LAID CONCRETE LAYERS

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A6.1 PAVER LAID CONCRETE LAYERS

PART A: SPECIFICATIONS

A6.1.1 SCOPE

This Section covers all the material requirements and work pertaining to the construction of mechanically paver laid concrete layers on new supporting layers or existing concrete or asphalt layers and include, inter-alia, the following pavement types:

- Jointed concrete pavement (JCP- Plain) – with or without dowels, for new construction or overlays
- Continuously reinforced concrete (CRCP) for new construction or overlays

It includes, inter alia, the specifications for materials, manufacture and construction requirements as relevant to the specific pavement as prescribed.

This Chapter does not apply to the repair and or rehabilitation of concrete pavements, which is covered in Chapter 7: Maintenance and Repair of Concrete Layers. The construction of concrete pavements utilising labour based methods or relatively small or isolated sections of concrete pavement are covered in Part B of this Chapter.

A6.1.2 DEFINITIONS

Jointed Concrete Pavement (Plain JCP) - concrete pavements that contain sufficient joints to control all expected natural cracks. All necessary cracking occurs at joints and not elsewhere in the slab. However, there may be load transfer devices (e.g. dowel bars) at transverse joints and deformed steel bars (e.g. tie bars) at longitudinal joints, which are not considered as reinforcement.

Continuously Reinforced Concrete Pavement (CRCP) - concrete pavements that include continuous longitudinal reinforcement steel typically between 0,50 and 0,70 % of the cross-sectional area of the pavement slab. They also typically include transverse reinforcing consisting of individual bars placed at approximately 1,0 m intervals or as specified in the Contract Documentation.

Aggregate - granular material of natural, manufactured or recycled origin used in the manufacture of concrete products to the specific grade/class as defined in these specifications and the latest published version of SANS 1083, or as may be otherwise specifically specified in the Contract Documentation:

- Course aggregate – all aggregate > 5,0 mm as further defined in the latest SANS 1083 specification for the specific class of aggregate and nominal maximum aggregate size as required.
- Nominal maximum particle size (NMPS) – designated as one sieve size larger than the largest sieve to retain a minimum of 15 % of the aggregate particles.
- Fine aggregate – all aggregate fractions \leq 5,0 mm and which shall consist of clean material derived from crushing competent parent rock, or naturally occurring sand conforming to SANS 1083 and any further specified requirements listed herein.

Cement - as defined in SANS 50197-1 for the various classes as listed.

Cement extenders or supplementary cementitious materials - the following as defined in the relevant SANS documents:

- Ground Granulated Blast Furnace Slag: As defined in SANS 55167-1

- Fly Ash: As defined in SANS 50450-1

Characteristic compressive strength - characteristic strength of concrete is the compressive cylinder or cube strength below which no more than 5 % of the test results in a statistical population shall fall, tested as specified in SANS 3001-CO 1 and 2.

Valid test result (F_{cu}) - a valid test result, for the purpose of evaluating compressive strength, shall comprise of the arithmetic mean of three cube or cylinder specimens where the difference between the highest and lowest result does not exceed 15 % of the arithmetic mean of the specimens.

Water: cementitious binder ratio - the ratio of the total water content to total cementitious binder content by mass in the mixed concrete.

A6.1.3 GENERAL

A6.1.3.1 Quality Plan

Prior to commencing with any permanent works, the Contractor shall submit a Quality Plan, for review and acceptance by the Engineer, detailing all checks and hold points relating to construction of the specified product. All work shall be completed in accordance with accepted Plan, with any deviations resubmitted to the Engineer for evaluation and acceptance prior to implementation thereof.

A6.1.3.2 Trial sections

Where so provided for in the pricing schedule, the Contractor shall construct a trial section for each pavement type specified. The location and area of the trials in an area that simulates the permanent work condition shall be as directed by the Engineer. The purpose of the trial is for the Contractor to demonstrate that the equipment, processes and intended concrete mix that he proposes to use will enable him to construct the particular concrete layer in accordance with all the specified requirements. Evaluation and monitoring of the trial section shall include all items listed in the South African Pavement Engineering Manual (SAPEM), Chapter 12 Appendix, Table 19: Concrete Pavement Trial Section Checklist. The Contractor shall calibrate the equipment and refine the mix design and construction process at his own cost.

The Contractor may, unless advised of any deficiencies in the trial section, proceed with the construction of the pavement ten days after the completion of the trial section or such earlier time as the Engineer may determine. In the event of deficiencies in the trial section, the Engineer may order the Contractor to construct a further trial section, which shall again be regarded as the initial trial section with no additional cost. The Contractor may then proceed with the construction of the pavement ten days after the satisfactory completion and acceptance of the second or subsequent trial section.

If the Contractor should make any alterations in the methods, processes, equipment or materials used and approved, or if he is unable to comply consistently with the specifications, the Engineer may require that a new trial section be constructed, at the Contractor's cost, before allowing the Contractor to continue with any permanent work. The intention of this clause is to avoid any experimentation by the Contractor on the permanent work.

The trial sections shall be laid where indicated by the Engineer. The Contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surface on which it was constructed, all at the Contractor's cost.

Provision is made for payment of the first approved trial section of any particular mix type, but subsequent trial sections that may be required for the same mix type shall be at the Contractor's own cost. Payment will be made for the specified area of each approved first trial section for any particular mix type.

A6.1.3.3 Weather limitations

a) Responsibility for protection

The Contractor shall be responsible for the quality and strength of the concrete placed and for its protection. Any concrete damaged by adverse weather, such as, any combination of high or low ambient temperature, low humidity, wind, rain and hail, shall be removed and replaced at the Contractor's expense.

b) Protection against rain or hail

No concrete shall be placed during rainy weather. For the concrete to be properly protected against rain and hail before it has sufficiently hardened, the Contractor shall have available at all times frame-mounted waterproof covers for protecting the surface of the unhardened concrete. In addition, when slip-form pavers are used, the Contractor shall also provide acceptable emergency protection for the slab edges. When rain appears to be imminent, all paving operations shall cease and the Contractor shall take the necessary steps to protect the unhardened concrete. The Contractor shall be responsible for the repair of any damage to the concrete, texturing or the curing compound that may occur.

c) Cold-weather paving

All reasonable precautions shall be taken to prevent the temperature of the pavement concrete from falling below 5°C during the first 48 hours after casting. When prevailing temperatures are low, or when cold weather is forecast and there is a danger that the temperature of the freshly constructed concrete pavement will fall below the prescribed limits the Contractor shall either cease all pavement operations, or he may be permitted to proceed, provided that the Engineer is satisfied that adequate protective measures are available and will be taken to ensure that the temperature of the pavement will be maintained above 5°C for the period stated.

d) Hot-weather paving

When paving is done during hot weather and when the temperature of the fresh concrete can be expected to exceed 24°C, the Contractor shall implement appropriate precautionary measures to place the concrete at the coolest temperature practicable. Paving operations shall cease when the concrete temperature as discharged at the paver exceeds 32°C.

e) Hot and windy weather paving

Unless appropriate and adequate protection measures to the plastic concrete are provided, all production of concrete and paving operations shall cease when the prevailing evaporation rate, as determined in accordance with the nomograph given in Clause A 20.1.5.15 of Chapter 20 exceeds 1,0 kg/m²/hr.

Provision has been made in the Pricing Schedule in Chapter 1 for the establishment of a portable weather station to be located in the immediate vicinity of the paving site and positioned at 1,0 m above the level of the pavement being constructed. During paving operations the Contractor shall provide the Engineer with all the relevant data as recorded by the weather station.

A6.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A6.1.4.1 General

The Contractor shall be responsible for providing suitable materials as prescribed in Clause A6.1.5, determining the mix proportions, and manufacturing the concrete of the required quality and consistency.

The specifications prescribed for materials to be used for concrete shall not limit the Contractor's responsibility to design and manufacture concrete which complies with the requirements of these specifications. If the Contractor finds it necessary to work to more stringent tolerances than those specified, or that the aggregates have to be further processed in any way (e.g., by washing or sieving) to permit, or to facilitate, paving operations, all costs resulting therefrom shall be for the Contractor's account. However, if the Contractor is of the opinion that the requirements of the specifications regarding the materials to be used will prevent him from manufacturing concrete of the required quality, he shall submit the necessary supporting evidence to the Engineer. If such evidence is acceptable to the Engineer, he may amend certain requirements of the materials specification.

A6.1.4.2 Design requirements

a) Water-cement ratio

The water-cement ratio shall not exceed 0,53.

b) Minimum cement content

The total cementitious content of the mix shall be not less than 320 kg/m³.

c) Specified strength

The relationship between the 28-day cube compressive and the 28-day flexural of the concrete shall be established by laboratory tests.

The specified compressive strength shall be the highest of the following four values:

- (i) 35 MPa at 28 days; or
- (ii) 0,85 f_{c1} where f_{c1} is the 28-day compressive strength corresponding to a 28-day flexural strength of 4,5 MPa.
- (iii) 0,85 f_{c2} , where f_{c2} is the 28-day compressive strength corresponding to a water: cement ratio of 0,53.
- (iv) 0,85 f_{c3} , where f_{c3} is the 28-day compressive strength corresponding to a cement content of 320 kg/m³.

Where f_{c1} , f_{c2} and f_{c3} shall be the 28-day compressive strengths determined from laboratory mixes as prescribed in Clause A6.1.4.3.

d) Workability of the concrete

The mix proportions and consistency of the concrete mix shall be such that, with the equipment in use, the concrete can be adequately transported, discharged, and fully consolidated without excessive bleeding or segregation of the components. The concrete consistency shall be appropriate to the type of paving equipment used, the haul, the weather and the site conditions. Where consistency is measured by way of a slump test in accordance with SANS 3001-CO1-3, the slump shall not deviate by more than 20 mm from the optimum value for mixes with a target slump of 35 mm or greater.

Where the required consistency of the concrete is such that the desired slump is less than 35 mm, the consistency of the concrete shall be determined by means of the Vebe test in accordance with SANS 3001-CO1-4.

e) Air content

Where an air-entraining agent is prescribed in the Contract Documentation, the total air content in the freshly mixed concrete shall be $M \pm 1\%$, where M is the target value within the limits of 2 % to 4 %. Tests shall be conducted in accordance with SANS 3001- CO1-8.

A6.1.4.3 Design procedure

a) General

The proportions of cement and aggregate required for producing concrete which complies with the requirements of these specifications shall be determined by means of laboratory tests on concrete manufactured from the cement, coarse and fine aggregates, admixtures (if any) and water proposed for use in the works.

b) Preliminary tests

At least thirty days prior to the construction of the trial pavement, as specified in Clause A6.1.3.2, the Contractor shall submit to the Engineer samples of all the components of the concrete he proposes to use, together with a report by an approved testing laboratory showing the mix proportions proposed for each combination of material sources for the concrete. The report shall also include the following:

- (i) The results of tests on the specified properties of all components.
- (ii) The relationship between the 28-day compressive strength and flexural strength of the concrete at each of at least three water cement ratios namely 0,48; 0,53 and 0,58.
- (iii) The effect of the particular admixture (if any) proposed by the Contractor in regard to variations in admixtures, air content (if air entraining), concrete setting and sawing times.
- (iv) The effect of at least three water contents on concrete consistency.

In determining the relationship between compressive and flexural strength, the tests shall be based on not less than six compressive-strength specimens and six flexural-strength specimens for each water-cement ratio. All tests shall be conducted in accordance with the methods in SANS 3001 CO1, SANS 3001 CO2 and SANS 3001 CO3 as relevant.

c) Changes in the mix proportions or the materials

- (i) If during the progress of the work the requirements set out in Clause A6.1.4.2 are not being met by concrete manufactured from the materials or material mix proportions as approved, the Contractor shall immediately cease producing such concrete and shall effect such changes to the mix proportions and/or materials as may be necessary in order to meet those requirements.

- (ii) If during the progress of the work the Contractor wishes to use materials or mix proportions other than those originally approved, or if the materials from the sources originally approved change with regard to any properties, he shall, before proceeding with further work, submit adequate evidence to the Engineer that the new materials or combination of materials will produce concrete which complies with the requirements of Clause A6.1.4.2 and shall not bring about any detrimental changes in the properties of the concrete.
- (iii) Any such changes made shall be at the Contractor's expense, and no extra payment shall be allowed for reason of such changes.
- (iv) Where concrete is required to be placed, vibrated or finished with hand equipment for any specific reason, the requirements of Clause A6.1.4.2 shall remain applicable irrespective of the size of the concrete panel or concrete patch placed. The mix proportions, however, shall be adjusted to promote hand placing, vibrating and finishing, but only if the Contractor has produced written proof to the Engineer that the requirements of Clause A6.1.4.2 cannot be complied with under the specific circumstances.

d) Changes in requirements

The Engineer shall have the power, at any time during the progress of the work, to order changes in the requirements set out in Clause A6.1.4.2. In such cases the Contractor shall be compensated in accordance with the terms of the contract for the additional cost of materials or additional handling, placing and/or other costs, if any, resulting from such changes. If such changes result in savings, the Engineer shall recover such savings from the Contractor.

e) Mix designs

The mix design requirements as specified in Clause A1.2.5.2 will also apply. Testing for mix designs shall be performed by laboratories accredited by SANAS for the relevant tests.

A6.1.5 MATERIALS

A6.1.5.1 Cementitious materials

The cementitious materials used for concrete shall comply with the following standards:

- Cement shall comply with SANS 50197-1 (EN 197-1) with a strength class of 32,5 or greater, and a rate of strength gain N or greater. Cement shall hold valid certification in the form of a Letter of Authority issued as certified approval pursuant to the Compulsory Specification for cement published by Government Notice R.544. Masonry cement shall not be used. The cement type and class incorporated in the mix shall be appropriate to the type of pavement to be constructed and the placing, finishing and saw cutting constraints envisaged.
- Ground Granulated Blast Furnace Slag - SANS 55167-1
- Fly ash - SANS 50450-1

Blends of cement complying with SANS 50197-1 and supplementary cementitious materials complying with the above standards may be used subject to a maximum of 20 % of the total cementitious content.

In order to promote resource sustainability principles, cement shall have a maximum average carbon dioxide emission value of 925 kg CO₂e per ton, determined in accordance with the World Business Council for Sustainable Development Greenhouse Gas Protocol.

All cementitious materials shall be protected from moisture until used, and there shall be sufficient facilities to ensure that the cementitious materials to be used in the work are kept separate from each other and from other cementitious materials.

Where cementitious materials are stored in a silo, the silo must be emptied before using the silo for a different cementitious material. Blended cements with a percentage of SCM differing by more than 2 % shall be considered different cementitious materials.

The cementitious binder shall comprise either cement, complying with SANS 50197-1, or an approved site blend of such cement and supplementary cementitious materials that take appropriate cognisance of environmental conditions, durability and strength requirements. The site blending of cement with supplementary cementitious materials shall only be conducted on the basis of an acceptable quality assurance system approved by the Engineer.

A6.1.5.2 Water

Water for washing aggregates, mixing concrete, and curing shall comply with relevant requirements specified in SANS 51008.

A6.1.5.3 Aggregates for concrete

a) General

Aggregates shall not contain any deleterious quantities of organic material, particularly pieces of timber, grass or similar matter as assessed by visual inspection, which will cause unacceptable surface defects when they float to the top of fresh concrete during vibration. Aggregates shall comply with the requirements of SANS 1083 for concrete but subject to the following:

The average 28 day drying shrinkage of 3 concrete samples made from each of the required three concrete mixtures for preparing the compressive-strength and flexural-strength samples in accordance with Clause A6.1.4.3 shall not exceed 0,040 %. Drying-shrinkage tests shall be conducted in accordance with SANS 3001-CO2-7. Where the drying shrinkage exceeds the specified maximum value, either alternative aggregates shall be used, further investigations undertaken, or evidence shall be produced with a view to confirming the suitability of the aggregates proposed for use. The historical behaviour of the aggregate in concrete may serve as a recommendation in such cases if accepted by the Engineer.

b) Alkali-aggregate reaction

Where there is any risk of a particular combination of aggregate and cement giving rise to a harmful alkali-aggregate reaction, the proposed combination shall be tested in accordance with SANS 6245 (SANS3001- AG 46). Where the result indicates such potential reaction, the aggregate, shall be replaced so that an acceptable combination may be obtained.

c) Coarse aggregate

(i) Hardness

When tested in accordance with SANS 3001 No AG10, the 10 % FACT value shall comply with the following requirements:

10 % FACT Dry - 210 kN minimum: Wet – 160 kN minimum.

(ii) Flakiness Index

The flakiness index of the coarse aggregate, as determined in accordance with SANS 3001 – AG4 shall not exceed 35.

(iii) Nominal Maximum Particle Size (NMPS)

The maximum nominal particle sizes of the coarse aggregate fraction in the mix shall be as follows:

- Slab thickness >175 mm: 37,5 mm, plus one or more of the following 20,0 mm, 14,0 mm and 10,0 mm.
- Slab thickness >150 mm < 175 mm: 28,0 mm (Where recommended by an approved laboratory and approved by the Engineer, smaller sizes of aggregate, nominal 20,0 and/or 14,0 mm sizes shall be provided).
- Slab thickness >100 mm <150 mm: 20 mm (Where recommended by an approved laboratory and approved by the Engineer, smaller sizes of aggregate, nominal 14,00 and/or 10,0 mm sizes, shall be provided).
- Slab thickness <100 mm: 14,0 mm (Where recommended by an approved laboratory and approved by the Engineer, smaller sizes of aggregate, nominal 10,0 mm and/or 7,1 mm shall be provided).

d) Fine aggregate

The fine aggregate shall be either a natural or crusher-produced sand or a blend of natural and crusher sands. Where a mixture is used, and the quantity passing through each of the 0,150 mm and 0,075 mm sieves shall not exceed the relevant interpolated values for the approved blend. Where required by the Engineer the fine aggregate shall contain more than 20 % quartz by mass.

The acid insolubility of the fine aggregate, or fine aggregate blend, as determined in accordance with SANS 642, shall exceed 40 %.

The fineness modulus (FM), as determined in accordance with SANS 3001 AG-1 and PR-5, FM of the fine aggregate (or mixtures thereof) shall not deviate from the approved fine aggregate component (or mixtures thereof) by more than 0,20.

e) Additional requirements for aggregates

Where instructed by the Engineer, aggregates shall be checked and shall be free of the following deleterious substances:

- (i) Tests for the presence of sugar shall be determined in accordance with SANS 3001-AG-30 (SANS 5833) and shall be free from the presence of sugar;
- (ii) Tests for soluble deleterious impurities shall be conducted in accordance with SANS 3001-AG-31 (SANS 5834) and shall have minimum compressive strength of 85 % of the reference;
- (iii) Test for the presence of material of low density shall be determined in accordance with SANS 3001-AG-?? (SANS 5837) and shall have maximum 0,5 % by mass;
- (iv) Tests for soluble salts shall be determined in accordance with SANS 3001-AG-40 (SANS 5849) and shall have maximum 0,5 % by mass;
- (v) Tests for water soluble sulfates shall be determined in accordance with SANS 3001-AG-31 (SANS 5850-1) and shall have maximum 0,2 % SO₃ by mass; and
- (vi) Tests for the presence of shell material shall be determined in accordance with SANS 3001-AG-35 (SANS 5840) and shall be maximum 5 % by mass.

A6.1.5.4 Admixtures to concrete

No admixtures shall be used without the written permission of the Engineer. The admixtures proposed for use shall be assessed during the mix design process and construction of the trial section.

All admixtures for concrete shall comply with the requirements of SANS 50934 (EN 934), ASTM C494 or AASHTO M194. Admixtures shall be approved by the Engineer and be compatible with the exposure environment and cementitious binder composition. Admixtures shall have no deleterious effects on the steel or concrete, and shall not contain any chlorides, nitrates, sulphides or sulphites, which may be detrimental. Admixtures shall generally be supplied in liquid form and accurately dispensed by a mechanical dosing unit in a manner appropriate to the method batching e.g. dry versus wet batching. Unless extraordinary circumstances dictate otherwise, under no circumstances shall a mixture be dispensed directly onto the mix components. Where extraordinary circumstance does exist, other methods of feeding into the concrete mixture shall be agreed with the Engineer. Where specified, air entraining agents may alternatively comply with the requirements of SANS 50934 (EN 934), ASTM C260 or AASHTO M154.

Where combinations of two or more admixtures are utilised, they shall be tested for compatibility. The total amount of admixtures shall not exceed the maximum dosage recommended by the admixture producer and also shall not exceed 5 % by mass of the total cementitious binder, unless the influence of the higher dosage of admixture on the performance and durability of the concrete is established and taken into account.

If the total quantity of liquid admixture equals or exceeds 3 litres per cubic metre of concrete, the admixture quantity shall be included in the water content of the concrete mixture when calculating the water: cementitious binder ratio.

The alkali content (Na₂O-equivalent) of all admixtures shall form part of the calculation of the alkali content of concrete in order to limit the degree of reactivity as specified in Clause A13.4.7.2a) of Chapter 13.

Where so specifically specified, or proposed by the Contractor, any chemical or air-entraining admixtures used shall comply with the requirements of SANS 50934 Parts 1 to 6 and shall be of an approved type and brand. In addition, admixtures shall be subject to such tests as may be prescribed by the Engineer, carried out at an approved testing laboratory at the Contractor's expense to determine the effect of the admixture on the concrete mix including early strength development. Admixtures containing calcium chloride shall not be used.

Admixture properties shall be uniform throughout their use in the work and stored and dispensed in liquid form.

If more than one admixture is used, the admixtures must be compatible with each other such that the desirable effects of all the admixtures used are realized.

Admixtures shall be utilised in compliance with the manufacturer's written instructions. The instructions shall include a statement that the admixture is compatible with the types and quantities of cementitious material intended for use.

If the use of admixtures is not specified, the dosage thereof shall be as recommended by the admixture manufacturer to achieve any enhanced fresh or final concrete characteristics required.

A6.1.5.5 Reinforcing steel, tie-bars and dowels

a) Dimensions

The dimensions for reinforcing steel, tie-bars and dowels shall be as indicated on the drawings and Contract Documentation.

b) Reinforcing steel and tie bars

Reinforcing steel and tie-bars shall comply with the requirements of SABS 920. Tie-bars shall be deformed mild-steel bars or deformed high-yield steel, except that any tie-bars intended to be bent and subsequently straightened shall be hot-rolled deformed mild-steel bars. The use of plate type tie bars shall be approved by the Engineer.

c) Welded steel fabric

Welded steel fabric shall comply with the requirements of SABS 1024.

d) Dowel bars at transverse joints

Dowel bars shall be mild-steel bars having a smooth, circular section produced on a Kocksblock to ¼ DIN tolerance of the DIN 1013 specification. Dowel bars shall be straight and free from irregularities and without any burred ends, and shall have their sliding ends sawn and bevelled. Cropping of dowels shall not be permitted. The free or un-bonded end of the dowel shall be coated with a bond-breaking coating, as directed by the Engineer, to prevent the concrete from adhering to it. The coating or sheath shall cover at least two-thirds of the dowel length. The bond-breaking coating shall be an approved synthetic material applied at a thickness of 0,5 mm in accordance with the manufacturer's recommendations. The sheath shall be a tough polyethylene material with an average thickness of 1,0 mm ± 0,2 mm.

The use of alternative plate dowels shall be approved by the Engineer.

A6.1.5.6 Curing compound

The curing compound used shall be a white-pigmented resin-based curing compound containing no water and which complies with the requirements of ASTM C 309, except that the water loss requirement be substituted with the efficiency-index as determined in accordance with BS 7542. The efficiency-index shall exceed 90 % at an application rate of 0, 2 l/m². A recent certificate not older than 3 months from an approved testing laboratory shall be submitted, certifying that the curing compound complies with the specifications. Further testing shall be conducted at regular intervals.

The curing compound shall be capable of hardening within 30 minutes of having been applied and of being sprayed onto a wet surface without loss of stability, change in colour or becoming less efficacious. This characteristic shall also be confirmed by the approved testing laboratory.

A6.1.5.7 Materials for joints

a) Joint filler for expansion joints

Joint filler for expansion joints shall be manufactured from a closed-cell polyethylene and the filler strips shall be provided with tear-off cover strip. The joint filler shall comply with the requirements of AASHTO M 153, and the particular type used shall be subject to the Engineer's approval. Joint filler for isolation joints shall be pre-formed expansion joint filler for concrete (bituminous type) complying with ASTM D 994.

b) Silicone sealant

Unless specifically approved by the Engineer, the joint sealant shall be silicone specifically formulated for use on concrete.

(i) Sealant

The silicone sealant shall be a one-component material with low-modulus properties. The use of acid cure sealants shall not be permitted. Silicone joint sealant must be compatible with the surface it is applied to and have properties shown in the Table A6.1.5-1:

Table A6.1.5-1: Silicone joint sealant

Property	Test method	Specification
Tensile stress, 150 % elongation, 7-day cure at 25°C ± 2°C and from 45 % to 55 % Relative Humidity	ASTM D 412 (Die C)	0,31 MPa max
Flow at 25°C ± 2°C with 15 % slope channel A	ASTM C 639	must not flow from channel
Extrusion rate through 3.18mm opening at 0.62 MPa at Material temperature - 18°C	ASTM C 603	min 75 g/min
Extrusion rate through 3.18mm opening at 0.62 MPa at Material temperature 38°C	ASTM C 603	max 250 g/min
Relative density /Specific gravity	ASTM D 792 Method A	1.01 to 1.51
Durometer hardness, at -18°C, Shore A, cured 7 days at 25°C ± 2°C	ASTM C 661	10 to 25
Ozone and UV resistance, after 5,000 hours	ASTM C 793	no chalking, cracking or bond loss
Tack-free at 25°C ± 2°C and 45 % to 55% Relative Humidity	ASTM C 679	less than 75 minutes
Elongation, 7 day cure at 25°C ± 2°C and 45 % to 55 % Relative Humidity	ASTM D 412 (Die C)	500 % min.
Set to Touch, at 25°C ± 2°C and 45 % to 55 % Relative Humidity	ASTM D 1640	Less than 75 minutes
Shelf Life, from date of shipment	--	6 months min.
Bond, to concrete mortar-concrete briquettes, air cured 7 days at 25°C ± 2°C	AASHTO T 132	0,34 MPa min
Movement capability and adhesion, 100 % extension at -18°C after, air cured 7 days at 25°C ± 2°C, and followed by 7 days in water at 25°C ± 2°C	ASTM C 719	no adhesive or cohesive failure after 5 cycles
Colour		Grey

The Contractor shall submit a certificate, less than six months old, from an approved testing laboratory, certifying that the sealant conforms to all the specified requirements.

The silicone sealant shall be applied by means of pumping the sealant from a storage container by means of compressed air powered pumping equipment and applied to the joint slot by means of nozzles designed to ensure that the slot is filled with sealant as indicated on the drawings. Application of the sealant into the joint slot by hand shall not be permitted.

(ii) *Silicone sealant applied in terms of a Product Performance Guarantee System*

Sealant installed in accordance with the above shall be in accordance and be assessed in terms of Part D of these specifications

(iii) *Additional materials for silicone sealant*

Backer rods shall comply with ASTM D 5249, Type 1. The backer rod diameter shall be at least 25 % greater than the saw cut joint width. Backer rod material shall be expanded, cross-linked, closed-cell polyethylene foam.

The sealant shall be supported by a bond breaker backing strip, and, unless otherwise recommended by the manufacturer and approved by the Engineer, the faces of the joint groove shall first be treated with an appropriate primer.

Supporting and priming materials shall be compatible with adjacent materials or surfaces in contact with the materials and shall be in accordance with the recommendations by the manufacturer and subject to approval by the Engineer. Any primer used shall form a barrier layer between the silicone and the concrete.

(iv) *Materials for cleaning, repairing and resealing of existing joints and cracks*

Materials used for cleaning existing joints and for repairing and sealing or resealing joints and cracks shall comply with the provisions of the Contract Documentation. Cleaning agents shall be such that they will not stain the concrete or cause the existing bituminous or other material to soak into the concrete.

c) Liquid sealant for joints between concrete or asphalt pavement

The liquid sealant used in joints between concrete and asphalt pavement shall be of the hot-poured type and shall comply with the requirements of US Federal Specification SS-S-1401, or any other type as may be approved by the Engineer.

A6.1.6 CONSTRUCTION EQUIPMENT

A6.1.6.1 General

The Contractor shall ensure the equipment and tools intended for use shall meet the following:

- The capability for handling the proposed materials and performing all parts of the work within the specifications.
- Production rates of such capacity that the paver operates continuously and at a constant rate of production, with starting and stopping reduced to a minimum.

Before any concrete may be cast, the Engineer shall approve the concrete source, batching methodology, all assembled side-forms, guide wires and/or rails and the paving train configuration. For this purpose, the Engineer shall be given sufficient notice and opportunity. Approval by the Engineer shall not relieve the Contractor of any of his obligations to construct the concrete pavement in accordance with the specified quality, dimensions and relevant tolerances.

A6.1.6.2 Concrete batching plant

The intended concrete batching plant or supply source shall be of sufficient capacity to ensure that, as far as practically possible, there is an uninterrupted supply of concrete during paving operations. Concrete may be produced in either of the following manner:

- Batching on site by an approved and dedicated plant
- Sourced from a ready-mix commercial supplier

Where concrete is supplied by a commercial source outside the direct control of the Engineer, the concrete supplier shall ensure compliance with the requirements of SANS 50206 (SANS 878). The Contractor shall have full responsibility to implement process control testing in accordance with the specifications. Commercial concrete suppliers shall ensure that the plant, measuring, mixing, transporting and associated processes are audited by a recognised independent body in accordance with the following requirements for commercially sourced concrete:

- (i) ISO 9002 (Standardisation);
- (ii) ISO 14001 (Environment);
- (iii) ISO 39001 (Road transport safety management);
- (iv) OHSAS 18001 (Legal compliance);
- (v) SANS 50206 (SANS 878), ISO 22965-2 or ISO 9001 (Quality management system for concrete production).

A6.1.6.3 Side-form paving

a) Side forms

Before any side-forms may be ordered or brought onto the site, particulars regarding the side-forms shall have been approved by the Engineer. Side-forms and rails shall be so designed, manufactured, set and supported that the completed concrete pavement will comply with all the requirements of Clause A6.1.8. When assessed with a 3,0 m straight-edge, the top edge of the form shall not deviate by more than 3,0 mm at any place, and the sides by more than 6,0 mm. The sides shall not deviate by more than 3,0 mm from the vertical. The maximum height that the side-forms may be raised in order to achieve the specified layer thickness shall be 15 mm.

The wheels of spreading, compaction, finishing machines and frame-mounted covers shall not run directly on the top surface on the side-forms but on rails rigidly attached to the forms, unless the forms are specially made to double as rails.

There shall be sufficient length of side forms available and provided so that it is not necessary to remove them less than 12 hours after placing the concrete. All forms shall be thoroughly cleaned and treated with an approved releasing agent prior to reuse.

b) Paving train

The equipment shall be of such dimensions and arrangement so as to cover the full width of the pavement strip being placed with the minimum amount of hand work required. The paving train shall essentially consist of the following items of equipment:

(i) *Hopper/spreader*

A purpose made spreader/hopper running on rails and capable of spreading the delivered concrete laterally and evenly to a uniform un-compacted density over the entire surface of the slab without segregation.

(ii) *Consolidation/compaction equipment*

Consolidation of the concrete shall be executed by appropriate mechanical surface vibrators, internal vibrators and tampers. The power supply to the vibrators shall cut out automatically as soon as the compaction equipment stops moving. Suitable internal vibrators shall be used against the side-forms and at joint assemblies to ensure full compaction throughout the pavement layer. For the surface vibrators, a frequency of not less than 3,500 impulses per minute shall be utilised. For internal type vibrators, a frequency of not less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators shall be utilised.

Where spud-type internal vibrators adjacent to forms are utilised, either hand-operated or attached to spreaders or finishing machines, a minimum frequency of 3,500 impulses per minute shall be used. The Contractor shall measure and record the frequency of internal vibrators in plastic concrete and submit data to the Engineer. Where spud vibrators are mounted such that the free tip trails, they shall be spaced at a maximum interval of 750 mm.

(iii) *Initial finisher*

The surface of the concrete shall be finished smooth and true to grade and level by means of an initial finishing machine equipped with a transverse or oblique oscillating beam. The machine shall be capable of being readily adjusted for changes in slab thickness, cross-fall, height and tilt.

(iv) *Final finisher*

The final finish of the surface shall be carried out by a machine which incorporates twin oblique oscillating finishing beams. The beams shall be readily adjustable for both height and tilt. The leading beam shall be vibrated. The beam shall be supported on a carriage with two wheels on either side at least 3,5 m apart in the longitudinal direction. The oscillating beams shall be of rectangular section, spanning the full width of the slab and each weighing not less than 170 kg/m.

(v) *Frame mounted canopy.*

The Contractor shall provide a frame mounted canopy to protect the plastic finished concrete from any damage as a result of rain or other unfavourable weather conditions. The length of the protective canopy shall be appropriate to the expected production rates.

A6.1.6.4 Slip-form paving

a) Slip-form paver

The Contractor shall provide a slip-form paver that is self-propelled and equipped to spread, strike-off, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the equipment in such a manner that a minimum amount of hand-finishing will be necessary to provide a dense and homogeneous pavement. The equipment shall be of such dimensions and arrangement so as to cover the full width of the pavement strip being placed.

The paving equipment shall be adjustable as to crown and super elevation and capable of shaping and consolidating the concrete into a dense and stable mass to the required cross-section. Any crown adjustments shall be readily controllable for accuracy in crown transitions.

The paver shall operate on tracks having sufficient contact area to prevent track slippage under load. Ensure that the length of ground contact per track and the arrangement of tracks are adequate to meet the straightedge and other riding-quality requirements specified. Spreading shall be accomplished by either:

- oscillating screeds,
- an extrusion device, or
- a combination of both.

If necessary, the slip-form paver shall be equipped with traveling side forms of sufficient dimension, strength and of proper shape in order to support the concrete laterally for a sufficient length of time during placing and finishing.

b) Electronic control systems

Where a slip-form paver is used, the alignment levels for placing the concrete, shall be controlled automatically from guide wires by sensors attached at the four corners of the slip-form paving machine. The alignment and level of ancillary machines for finishing, texturing and curing shall be automatically controlled relative to the guide wires and to the surface and edges of the slab. Guide wires shall be so designed, manufactured and fixed that the paver will be capable of producing a completed slab which will comply with the requirements of Clause A6.1.8.

Other control methods, such as a string-less paving system incorporating appropriate 3D/GPS technology may be permitted after assessment and approval by the Engineer.

A6.1.6.5 Burlap drag equipment

Unless otherwise authorised by the Engineer, the burlap drag shall be attached to the front of the texturing machine or to an additional machine which spans the full width of the concrete pavement and is placed in such a way that the full width of the concrete pavement is covered in one operation and, when not in use, the entire drag can be lifted clear off the pavement.

The dimensions of the burlap drag shall be such that at least 1,0 m of the material is in contact with the surface of the concrete pavement measured in the direction in which the drag is being moved. The burlap drag shall consist of at least two layers of approximately 340 g/m² burlap with the bottom layer at least 150 mm longer than the top layer at the dragging end. However, if the required texture is not obtained, then at the discretion of the Engineer, the number of layers may be increased to four. The transverse threads of the trailing 150 mm to 300 mm of the burlap drag shall be removed.

A6.1.6.6 Texture grooving equipment

Unless otherwise approved, the required tine texturing shall be effected by means of a machine which spans the full width of the concrete pavement, and which is guided in regard to both level and direction by the rails in the case of side form construction, or by the paver guide wires in the case of slip form construction.

The grooving tines shall be made from individual flat spring steel approximately 0,6 mm in thickness and 3,0 mm in width, 125 mm in length and spaced at between 12 mm and 25 mm in an approved random pattern. The Engineer may, however, require a different random pattern or equal spacing of the tines during the course of the work, and provision shall be made to supply different sets of combs as required. No additional payment will be made for the first two changes in the spacing of the tines. The comb frame for applying the texturing shall be at least 2,0 m wide. It must also be possible to adjust the combs to a lower position in order to compensate for wear.

Where so specified in the Contract Documentation, the fresh concrete shall be broom textured utilising appropriate equipment just prior to applying the curing compound.

A6.1.6.7 Applicator for curing compound membrane

The Contractor shall provide equipment for applying curing compound that is self-propelled and capable of uniformly applying the curing compound at the specified rate. The equipment shall be capable of continuously stirring the curing compound by effective mechanical means to keep the pigmentation in suspension. The curing compound shall be thoroughly atomized during the spraying operation so that the finished surface appearance of the fresh concrete will not be marred. The entire surface of the pavement shall be covered by a single pass of the machine and, with slip-form type paving, shall also include the vertical exposed faces. Spray nozzles shall be equipped with appropriate wind guards to ensure uniform application.

Hand operated power-spray equipment may be used to apply curing compound to areas where it is impracticable to operate the self-propelled equipment.

A6.1.6.8 Equipment for paving small or narrow areas

For minor roads, variable width areas, other than mainline, ramps, and shoulders, the Engineer will not require the full slipform paver as specified for the standard run of paving. In such instances the Contractor shall utilise appropriate hand equipment and construction methods as prescribed in Part B of this Chapter in order to achieve the desired final product as specified. The Contractor shall provide a comprehensive method statement and quality plan to the Engineer for approval prior to commencing with any such work.

A6.1.7 EXECUTION OF THE WORKS

A6.1.7.1 Preparing the underlying layers

a) General

The underlying layers shall be constructed in accordance with the relevant standard specifications, and any additional relevant Contract Documentation as may be prescribed, up to the level of the underside of the concrete slab. The surface of the layer directly below the concrete should not be smooth, loose or show signs of lamination.

The Contractor shall note the provisions of Chapter 1 in regard to the use of construction tolerances for successive pavement layers and shall make provision in his prices for any additional concrete which may be necessary in respect of irregularities in the layer underlying the concrete pavement.

b) Applying the prime or bond coat

Unless otherwise specified in the Contract Documentation, a bituminous prime coat shall be applied to the completed cementitious stabilised subbase layer in accordance with the requirements of Chapter 8: Pre-treatment and Repair of existing Layers. Where the underlying subbase layer consists of asphalt, a bituminous bond coat shall be applied in accordance with the relevant requirements of Chapter 9: Asphalt Layers. The nominal application of 0,3 l/m² net bitumen shall be applicable in each instance. Before any pavement concrete is placed, the prime or bond coat shall be cured and shall be checked. Any areas having deficient or poor application, or where damaged, shall be repaired as directed by the Engineer. The coated surface shall then be thoroughly cleaned and shall be dry before any reinforcing steel, tie bars, dowels or concrete may be placed.

c) Wetting the subbase

The subbase shall be kept continuously wet for a period of at least one hour before the concrete is placed. Immediately before the concrete is placed, the excess water shall be broomed off the road ahead of the paver so as to ensure that the subbase will still be damp when the concrete is placed. No puddles of water or deleterious matter shall be left on the road.

A6.1.7.2 Batching and mixing of concrete

a) General

Concrete may be batched at a dedicated mixing plant on site, or supplied by a commercial ready mix facility. In either instance the concrete shall conform to the requirements as listed in Clause A6.1.6.2 Concrete Batching Plants. All constituent materials shall be stored and handled so that their properties do not change, for example due to climate conditions, intermingling or contamination, and that their conformity with the respective standard is maintained.

b) Cement and supplementary cementitious materials

Cement and supplementary cementitious materials stored on the site shall be kept separately under cover which provides adequate protection against moisture and other factors which may promote deterioration of the cement or supplementary cementitious material.

Cement and supplementary cementitious material may only be used if stored and maintained at a temperature less than 45°C. In hot weather concreting conditions, the cement and supplementary cementitious material storage facilities shall be painted with white high solar reflectance paint and insulated to reduce any temperature rise in the stored cement or supplementary cementitious material.

Cement or supplementary cementitious material supplied in bags shall be closely and neatly stacked, separately to a height not exceeding 12 bags and arranged so that they will not be in contact with the ground, the floor or the walls, and can be used in the order in which they were delivered to the site.

Cement or supplementary cementitious material supplied in bulk shall be stored separately in waterproof containers so designed as to prevent any dead spots from forming, and the cement or supplementary cementitious material drawn for use shall be measured by mass.

Cement shall not be kept in storage for longer than 8 weeks without the Engineer's permission, and different brands or types of the same brand of cement or supplementary cementitious material shall be stored separately.

c) Aggregates

Aggregates of different nominal sizes, sources or types shall be stored separately. Intermixing of different materials and contamination by foreign matter shall be avoided. Aggregates exposed to a chloride (XS) environment (refer Table A13.4.7-2 of Chapter 13) shall be covered to protect them from salt contamination. Sufficient quantity of fine aggregate shall be stockpiled on site and handled in a manner that ensures the thorough mixing of the various deliveries in order to achieve a stable fineness modulus within the specified limits.

In hot weather concreting conditions, both the coarse- and fine-aggregate stockpiles shall be shaded from the sun. When the ambient temperature reaches and at all times when it exceeds 30°C, only the coarse aggregate shall be sprayed with water to assist cooling by evaporation. Water shall be delivered by means of an approved water droplet sprayer system. The Contractor shall ensure adequate drainage of the aggregate stockpile area.

Where concrete is batched on site, the aggregates shall be stored in bins with a minimum 150 mm thick concrete floor constructed below the aggregate stockpile to prevent contamination during the storage and handling the aggregate. The floor slab shall be appropriately sloped to facilitate drainage of the stockpile area. A 3,0 m wide concrete apron slab shall be constructed around the entrance and outer edge of the aggregate stockpile area and sloped for drainage away from the main stockpile area. The aggregates shall be tipped on the concrete apron slab to prevent contamination during the process of tipping and hoisting the aggregate.

d) Water

In hot weather concreting conditions, the sides and tops of water tanks for mixing water, including pipework leading to and from tanks, shall be insulated.

e) Storage capacity

The storage capacity provided and the quantity of material stored, whether cement, supplementary cementitious materials, aggregates, admixture or water, shall be sufficient to ensure that no interruptions to the progress of the work will be occasioned by any lack of materials.

f) Deteriorated material

Deteriorated or contaminated or otherwise damaged non-conforming material shall not be used in concrete. Such material shall be removed from the site without delay.

g) Proportioning the components

(i) Cementitious binder

Where cementitious binder is supplied in standard bags, the bags shall be assumed to contain 50 kg for batching purposes. Cementitious binder taken from bulk storage containers and from partly used bags shall be batched by mass, accurate to within 2 % of the required mass.

(ii) Water

The mixing water for each batch shall be measured, either by mass or by volume, accurate to within 2 % of the required quantity. The quantity of water added to the mix shall be adjusted to make allowance for any moisture in the aggregates.

(iii) Aggregates

All aggregates for concrete shall be measured separately by mass, except as otherwise provided in this Clause, accurate to within 3 % of the required quantity.

(iv) Admixture

Admixtures shall generally be supplied in liquid form and accurately dispensed by a mechanical dosing unit, into solution with the mixing water, except where the admixture cannot be dispersed homogeneously into the mixing water. Unless extraordinary circumstances dictate otherwise, under no circumstances shall admixtures be dispensed on to dry mix components. Where such extraordinary circumstances do exist, in such cases, other methods of feeding into the concrete mixture shall be agreed with the Engineer.

All admixtures shall be dispensed in quantities accurate to within 2 % by mass of the desired quantity. The mechanical dosing unit shall be checked daily for accuracy using a nominal dispensing volume, typically 2 litres, or as recommended by the dosing unit manufacturer or admixture supplier. At least once a week, the dosing unit shall be checked for accuracy using the full dispensing volume suited to the concrete mixing procedures employed on site, typically for 6 cubic metre concrete batch mixed by a standard mixing truck and proportionally for other standard batch volumes.

h) Mixing the concrete

(i) General

Mixing the material for concrete shall be conducted by an experienced operator. Unless otherwise authorised, mixing shall be carried out in a mechanical mass batch-mixer of an approved type which will be capable of producing a uniform distribution of ingredients throughout the batch.

(ii) Charging the mixer

The sequence of charging the ingredients shall be subject to approval by the Engineer, and, unless otherwise instructed, the same sequence of charging the ingredients shall be maintained. Fibres, pigments and colouring agents shall be added to the mix in a manner that ensures that they are uniformly dispersed in the mix.

The volume of the mixed material by batch shall not exceed the volume recommended by the manufacturer of the mixer.

(iii) Mixing and discharging

The period of mixing shall be measured from the time when all the materials are in the drum until the commencement of discharge.

The mixing period for the materials shall be at least 90 seconds and may be reduced only if the Engineer is satisfied that the reduced mixing time will produce concrete with the same strength and uniformity as concrete mixed for minimum 90 seconds. The reduced mixing time, however, shall be not less than 50 seconds or the manufacturer's recommended mixing time, whichever is the longer. A suitable timing device shall be attached to the mixer to ensure that the minimum mixing time for the materials has been complied with.

The first batch to be run when starting with a clean mixer, shall contain only 75 % of the required quantity of coarse aggregate to make provision for coating the mixer drum. Refer Clause A13.4.7.12g) of Chapter 13 for a similar provision for richer concrete mix placed at horizontal construction joints.

Discharge shall be so carried out that no segregation of the materials will occur in the mix. The mixer shall be emptied completely before it is recharged with fresh materials.

(iv) Maintaining and cleaning the mixer

If the mixer has stopped running for a period in excess of 30 minutes, it shall be thoroughly cleaned out with particular attention being given to the removal of any build-up of materials in the drum, in the loader, and around the blades or paddles.

Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed. Worn or bent blades and paddles shall be replaced.

i) Transporting the concrete

Concrete shall be so transported to its final position that segregation or loss of any of the ingredients, or contamination, will be prevented, and that the mix is of the required workability at the point and time of placing.

The Contractor will be permitted to use appropriate truck mixers which agitate previously mixed concrete in transit.

The fresh concrete shall be protected against rain, heat, direct sunlight and/or evaporation by means of covers on all open vehicles. No additional water may be added in transit or where delivered.

The time lapse from the moment when the cement and aggregate are intermingled up to the time of placing and compacting the concrete shall not exceed 60 minutes when concrete is transported in truck agitators, and shall not exceed 45 minutes in mild weather, or 30 minutes when the concrete temperature is 30°C or higher, when transported in ordinary trucks.

A6.1.7.3 Placing, Compacting and Finishing Concrete

a) General requirements for both side-form and slip-form paving

(i) Maintaining continuity during placing

The Contractor shall make adequate advance arrangements for preventing delay in delivering and placing the concrete. An interval of more than thirty minutes between the placing of any two consecutive batches or loads of concrete shall constitute sufficient reason for the Engineer to have the paving operations stopped, and the Contractor shall, then at his own expense, make a construction joint in the concrete already placed, at the location and of the type directed by the Engineer. Paving operations shall be continuous, and the rate of paving shall be adjusted to suit the rate of delivery of the concrete.

(ii) Time for placing and compacting

The placing, compacting and finishing of the concrete shall be carried out as quickly as possible, and the operations shall be so arranged that, in any transverse section of the pavement, the concrete shall be fully compacted and finished within 2,5 hours of having been mixed. This time shall be reduced by half an hour for every 5°C by which the concrete temperature is above 20°C at the time of placing, unless otherwise permitted by the Engineer.

Unless adequate lighting facilities, approved by the Engineer, are provided beforehand by the Contractor, the placing of concrete pavement shall cease in good time so that the finishing operation can still be completed during daylight hours.

(iii) Compacting

The concrete shall be fully compacted by means of approved equipment and shall be free from honeycombing and planes of weakness. The average amount of air voids in concrete cores shall not exceed 1,5% when measured by the visual assessment method described in SANS 5865 (SANS 3001-CO3-5).

Over-vibration resulting in segregation, surface laitance, or leakage (or any combination of these) shall not be acceptable.

No paving in the downhill direction will be allowed if tearing of the concrete occurs. The Contractor shall take the necessary measures to the satisfaction of the Engineer to prevent tearing of the concrete, for example by carrying out the paving in the uphill direction.

(iv) Width of placing

The width of concrete pavement strip to be placed in a single uninterrupted operation shall be as agreed with the Engineer so that longitudinal construction joints do not, as far as practical, fall within the wheel paths of the relevant lanes.

(v) Placing of tie bars

Tie-bars shall be placed as indicated on the drawings and shall be placed at right angles to joints. Tie-bars shall be free from paint, grease or other matter which may affect bonding with the concrete.

At longitudinal construction joints the one half of each tie-bar shall be supported on the subbase by means of suitable stools, while the other half shall project into the adjacent lane through the side forms. The arrangement and spacing and fixing of the tie bars and stools shall be such that they shall be supported in position without deflection or displacement when a dead load of 100 kg is applied or during placement and compaction of the concrete. Mild steel tie-bars at longitudinal joints may be bent parallel to the edge of the first lane constructed and later on straightened into its final position before the concrete of the adjacent lane is placed. The method of fixing and supporting the tie-bars shall be approved by the Engineer. Where tie-bars are bent and later straightened due to traffic accommodation constraints, any damage to the concrete shall be made good by the Contractor.

At longitudinal weakened-plane hinge joints the bars shall be firmly supported in position by steel supporting devices fixed to the subbase. If the paver or other paving equipment is equipped with a device for placing tie-bars into the plastic concrete, such device may be used only after it has been demonstrated that the tie-bars will be located in their correct positions after the slab has been compacted and finished.

(vi) Placing of dowel bars

Dowel bars shall be installed at locations as indicated on the drawings. Dowels shall be fixed rigidly both in horizontal and vertical alignment parallel to the centre line of the road and the surface of the slab, by robust supporting frames or cradles which do not project within 150 mm of the joint and are left permanently in place. The frames shall be fixed to the subbase so that they will be stable and remain undisturbed during paving operations. The free end of the dowel shall not be tack-welded to the frame but shall be held in position by soft binding wire. Dowels may be mechanically inserted, in which case no frames will be required for securing the dowels, provided that conclusive evidence is submitted that the proposed method is an accepted method and has already been used successfully. Dowel alignment shall be accurate to within the tolerance given in Clause A6.1.8.

(vii) Placing of continuous reinforcing steel in continuously reinforced concrete pavement

The continuous steel reinforcement shall be free from dirt, oil, paint, grease or other organic materials, which may adversely affect or reduce the bond with the concrete. Loose surface rust caused by lengthy storage shall be removed.

The arrangement and spacing and fixing of the chairs or stools shall be such that the reinforcing shall be supported in position without deflection or displacement when a dead load of 100 kg is applied or during placement and compaction of the concrete. The chairs shall be so supported as to prevent them overturning on the subbase when the paving train passes over them.

(viii) Placing of steel mesh in jointed concrete pavement

The reinforcing concrete welded mesh detail shall be as indicated on the drawings. The steel shall be free from dirt, oil, paint, grease or other organic materials which may adversely affect or reduce the bond with the concrete. Loose surface rust caused by lengthy

storage shall be removed. The steel mesh sheets shall be handled with care so that they remain reasonably flat and free from distortions. The sheets shall be free from kinks or bends that will prevent them from being properly assembled and installed. The arrangement and spacing and fixing of the chairs or stools shall be such that the reinforcing shall be supported in position without deflection or displacement during placement and compaction of the concrete. The reinforcement shall not straddle intended joints.

(ix) *Burlap drag finish*

This texture shall be obtained by first applying a burlap-drag, as specified in Clause A6.1.6.5, as a finish to the concrete surface. The first pass of the burlap drag shall be made as soon as construction operations permit and before the wet sheen has disappeared from the surface. Burlap dragging shall be repeated until a gritty and uniform texture having the required finish and depth of texture has been obtained.

Every morning the burlap drag shall be wetted and shall be kept moist throughout the day. At the end of each day's production the burlap mats shall be cleaned or discarded and replaced with new burlap if cleaning is not possible.

(x) *Surface texturing*

After completing the burlap finish described above, the pavement surface shall be further textured by means of a broom finish or grooving comb as stated in the Contract Documentation. The grooving comb shall be as specified in Clause A6.1.6.6. The direction of the texturing shall be at right angles to the longitudinal axis of the pavement. Surface texturing shall extend over the full width of the pavement.

The surface texture shall be applied and completed before the concrete is so hard that the surface will be torn and coarse aggregate unduly loosened during texturing. When measured with a suitable depth gauge, the grooves shall be not less than 2,0 mm and not more than 4,0 mm in depth.

After the concrete has hardened, all loose particles generated by the cutting of the grooves shall be broomed off the surface with stiff hand brooms or mechanically-operated rotary brooms.

The Engineer may permit the use of texturing equipment other than the grooving comb, provided that it produces a texture similar to that produced by the metal tines.

Texturing the surface with hand-held brooms or combs shall be allowed only where the pavement is so small or irregular, or the site is so restricted as to make the use of the texturing machine impracticable, or in cases of mechanical breakdown of the texturing machine, in which case it may be used for the required texturing of concrete already placed. The brush or comb to be used then shall be of the same type and width used in the machine. In order to ensure straight grooves the comb shall be operated against a straight-edge placed at right angles to the pavement centre line. The same requirements regarding groove dimensions or texture depth as for machine-texturing shall apply.

(xi) *Curing*

Immediately after the completion of texturing, a white-pigmented curing compound complying with the requirements of Clause A6.1.5.6, and in accordance with the direction of the manufacturer, shall be applied.

In the case of slip-form paving, the exposed surfaces, including the sides of the slab, shall be treated immediately after the required texturing of the surface has been effected. In the case of side-form paving the surface shall be treated immediately after the texturing has been completed and the sides of the panels after the side formwork has been removed.

The curing compound shall be sprayed onto the surface at a rate of 0,35 l/m² or as directed by the Engineer by means of a mechanical distributor capable of producing a fine fog-type of spray which will not damage the surface of the concrete. The curing compound shall be applied in two layers with the distributor moving in opposite directions for the two applications. Coverage shall be uniform over the entire surface and the rate of application of the curing compound shall be carefully controlled.

During spraying operations the curing compound shall be continuously stirred mechanically to keep the pigmentation in suspension. The spray nozzles shall be adequately protected against wind.

After shutting off the spray nozzles, no dripping of curing compound on the concrete surface may occur. If necessary, the Contractor shall provide drip pans suspended below the nozzles to prevent dripping of the curing compound onto the pavement.

The curing membrane shall be maintained intact for at least seven days after the concrete has been placed. Any damage to the curing membrane shall be repaired by hand-spraying the affected areas.

Areas inaccessible to the mechanical distributor such as odd shaped areas, those with varying widths or shapes or the sides of the slabs after removal of the form work, shall be sprayed with curing compound by means of approved hand spraying equipment, at the specified rate of application.

b) Side-form paving

(i) *Side form set up*

The side forms shall be accurately set to line and grade and in such a manner that they rest firmly, throughout their entire length, upon the subgrade surface. The forms shall be connected neatly and tightly, and braced in order to resist the pressure of the equipment operating on the forms. The Contractor shall obtain the Engineer's approval of the alignment and grade of all forms immediately prior to the placing of concrete.

Any voids between the established grade of the form line and the layer on which it is supported shall be caulked with a stiff mortar consisting of one part of rapid-hardening cement and 3 parts of sand by volume and finished vertically on the inside. The mortar shall have hardened sufficiently before any concrete may be cast against it. The rails, side-forms and running surface shall be kept clean in front of the wheels of all paving equipment.

As an exception, when placing forms on a cement-treated or asphalt subbase layer, the Contractor may use wedging, provided that the wedging system used adequately supports the forms without causing detrimental deflection under the weight of the paving equipment.

A sufficient number of forms shall be available on site at all times to ensure that at least 150 m of formwork can be accurately set and maintained true to line and grade in advance of the point where concrete is being placed. Sufficient forms shall also be provided

so that it is not necessary to remove them less than 12 hours after placing the concrete. All forms shall be thoroughly cleaned and treated with an approved releasing agent prior to reuse.

(ii) *Placing and spreading the concrete*

The concrete shall be spread uniformly by means of a purpose-made mechanical hopper spreader running on rails and capable of spreading the concrete uniformly to a specified level and to a uniform un-compacted density over the entire surface of the slab. The machines shall be capable of being rapidly adjusted for changes in slab thickness or cross-fall.

(iii) *Compaction*

The concrete shall be fully compacted by vibration or by a combination of mechanical surface vibration, internal vibration and tamping. The power supply to the vibrators shall cut out automatically as soon as the compaction equipment stops moving. Suitable internal vibrators shall be used against the side-forms and at joint assemblies to ensure compaction throughout the pavement layer.

(iv) *Final finishing*

The surface of the concrete shall be finished smooth and true to grade and level by means of an initial finishing machine equipped with a transverse or oblique oscillating beam. The final finish of the surface of the slab shall be carried out by a machine which incorporates twin oblique oscillating finishing beams. The beams in the case of both machines shall be readily adjustable for both height and tilt, and the leading beam shall be vibrated. The beam shall be supported on a carriage with two wheels on either side, at least 3,5 m apart in the longitudinal direction. The oscillating beams shall be of rectangular section, spanning the full width of the slab and each weighing not less than 170 kg/m.

Hand-finishing of the concrete surface shall be reduced to the absolute minimum and shall be used only to correct minor imperfections and marks on the surface. Before the concrete starts setting, all pavement edges, and the edges of joints, shall be rounded off to the prescribed radius.

After finishing, the Contractor shall test the concrete surface with a straight-edge of at least 3,0 m in length. Irregularities indicated by the straight-edge shall be removed with a long-handled hand-operated scraping straight-edge of at least 3,0 m length. A gangplank shall be used when walking on the concrete.

Before the concrete starts setting, all pavement edges, and the edges of joints, shall be rounded off to the required radius.

(v) *Constructing the pavement in more than one contiguous strip*

Where concrete is placed adjacent to an existing pavement, that part of the paving equipment running on the existing pavement shall have flanged wheels on flat-bottom section rails weighing not less than 15 kg/m or by replacing the flanged wheels on that side of the machines by smooth flangeless wheels. Before the paving operation commences the surface regularity of the existing pavement shall comply with Clause A6.1.8 and be thoroughly cleaned and brushed to remove all extraneous materials. The wheels shall run at a distance of not less than 300 mm from the edge of the pavement to prevent the pavement edge from spalling or cracking.

No equipment or construction traffic shall be permitted on the completed pavement until the concrete is strong enough to prevent damage from occurring, but in any case not earlier than 14 days after the construction of the slab.

Where visible cracks occur or any other damage is done to the pavement, further work involving the paver shall be suspended immediately. The Contractor shall repair all damage at his own cost.

(vi) *Removal of side forms*

Side-forms shall not be removed before the concrete has hardened sufficiently to prevent damage being done to the sides and loosening of tie-bars or dowels, if any, and not earlier than 12 hours after the completion of the construction of the slab. The side-forms shall also be removed timeously to permit the sawing of transverse joints up to the edges of the concrete slab. Projecting tie-bars and/or the concrete shall not be damaged during removal of the side-forms.

c) Slip-form paving

(i) *Placing and spreading*

The paver shall include a spreader box or auger capable of distributing the delivered concrete evenly to the specified level and to a uniform un-compacted density over the entire surface of the slab. The machines shall be capable of being rapidly adjusted for changes in slab thickness or cross-fall requirements.

(ii) *Compaction*

The slip-form paver shall compact the concrete over the full paved width by means of internal vibration only, or by a combination of internal and surface vibration. The vibration shall be variable with a maximum energy output of at least 2,5 kN per metre width of slab per 300 mm depth for a laying speed of up to 1,5 m per minute or pro rata for higher speeds.

(iii) *Finishing*

The level and grades of the surface shall be automatically controlled within the prescribed tolerances by means of a sensing device running on guide wires or a suitable 3D string-less system as approved. The consistency of the concrete shall be so controlled that the edge slump will not exceed the tolerance specified in Clause A6.1.8. If approved by the Engineer, metal side-forms of sufficient thickness and stability may be used to maintain the proper shape and line.

After the concrete layer has been completed by the finishing devices incorporated in the slip-form paving equipment, the surface of the concrete shall be checked by means of a straight-edge of not less than 3,0 m in length. High spots indicated by the straight-edge shall be removed by hand floats.

After the final finishing and texturing of the concrete, but before curing, the pavement edges shall be rounded manually to the prescribed radius.

(iv) *Constructing the concrete pavement in more than one contiguous strip*

Except for the wheels, which shall, in the case of slip-form pavers, be replaced with rubber cushioned crawler tracks, the provisions of Clause A6.1.8 shall apply when concrete is being placed in more than one contiguous strip.

(v) *Track support*

The Contractor shall at his own cost ensure that adequate track support is provided to suit the needs of the slip-form paver, either by extending the upper pavement layers or by providing alternative support layers.

d) Placing, compacting and finishing with hand equipment

Where the slabs are too small or irregular, or the site is so restricted as to render the use of the methods described in Part A of this Chapter impracticable, concrete shall be placed, compacted and finished in accordance with Part B of this Chapter.

A6.1.7.4 Joint forming

a) Construction joints

Construction joints shall be made only in accordance with the details and in the positions shown on the drawings or determined by the Engineer. Where the pavement is constructed in more than one strip, longitudinal construction joints shall be constructed, and where edge slump in excess of 6,0 mm occurs with slip-form paving, the sides of the pavement shall be supported by an approved method.

Transverse construction joints shall be formed at the end of a day's work or where necessary on account of any unavoidable suspension of work.

The upper edges of the pavement shall be rounded off or chamfered at a construction joint as shown on the drawings. Where sealing of the construction joint is required, the groove may be sawn only after seven days' curing of the concrete.

b) Weakened-plain longitudinal hinge joints

Hinge joints shall be sawn where the pavement is constructed in widths of two or more lanes at a time. Sawing shall be done at an appropriate time, dependant on the cement type used and ambient temperatures to prevent longitudinal cracking from occurring, but not later than 24 hours after concrete placing.

The widths and depths of the groove and the joint filler shall be in accordance with the drawings. The width tolerances for hinge joints shall be as prescribed out in Clause A6.1.8.

Deformed steel tie bars shall be installed where indicated on the drawings.

c) Weakened-plain transverse contraction joints

Transverse contraction joints shall initially be sawn as specified in Clause A6.1.7.4e) and shall not exceed 3,0 mm in width. The grooves shall be sawn to the depth shown on the drawings. The exact time and sequence of sawing shall be determined by the Contractor, bearing in mind the risk of excessive ravelling and spalling with early sawing, and the risk of cracking with delayed sawing, but shall not later than 24 hours after the concrete has been placed.

When the pavement is constructed in more than one strip, the transverse joints opposite those which have opened in the adjacent pavement shall be sawn within the first 24 hours. The Contractor may initially omit up to two consecutive planned contraction joints and shall saw such joints within 48 hours of the concrete having been placed, but before uncontrolled cracking takes place.

All transverse joints shall initially be sawn to the full depth as indicated, and not more than 3,0 mm wide. In sealed joints the top portion of the groove shall be reamed out to the specified final width and depth not sooner than 7 days after the initial sawing.

Joints shall be sealed in accordance with the details shown on the drawings or as specified in the Contract Documentation.

d) Expansion joints

Expansion joints shall be constructed in accordance with the details shown on the drawings. The joint filler shall comply with the requirements of Clause A6.1.5.7 and holes for the dowels shall be accurately drilled. The filler for each joint shall be supplied in a single piece for the full depth and width required for the joint unless otherwise authorised by the Engineer. Where the use of more than one piece is authorised for a joint, the abutting ends shall be securely fastened, and held accurately in shape, by stapling or by another suitable method acceptable to the Engineer.

The joint filler together with the sealing groove shall completely separate adjacent slabs. Any loose-fitting dowel bars and any spaces between the subbase and the filler shall be caulked with joint-filler material after the joint has been assembled.

If expansion joints incorporate dowels, the dowels shall be encased at one end in a close-fitting cap. The cap shall be placed on the free half of each dowel which half shall be coated as late as possible before concreting, with a bond-breaking coating or sleeve which complies with the requirements of Clause A6.1.5.5d).

The sealing groove in the upper portion of the expansion joints shall be sealed with a preformed neoprene compression seal or any other appropriate sealant prescribed or approved.

e) Sawing of joints

The Contractor shall be responsible for determining the optimum time for the sawing of joints. This shall depend on the strength gain characteristics of the cementitious products incorporated in the concrete mix, the hardness of the aggregate and weather conditions at the time of placing. The Contractor shall use the type of blade and equipment best suited to the hardness of the concrete, type of aggregate and the site conditions in order to prevent uncontrolled cracking and any spalling adjacent to the joint being sawn.

Sufficient standby power saws shall be held available by the Contractor, ready for use, at all times when concrete is being placed in the pavement. Immediately after sawing, the joint grooves shall be washed out with a jet of clean water to remove all fine material which shall be appropriately disposed of at an approved site. The joints shall then be sealed temporarily by means of an approved material, flush with the permanent surface. No traffic of any kind shall be allowed on the pavement until all the joints have been permanently sealed.

f) Opening to traffic

No vehicle with an axle load exceeding 20 kN shall be permitted to travel over the completed surface within 14 days after it has been completed, or such longer period as may be directed by the Engineer.

A6.1.7.5 Joint sealing

Joints shall be permanently sealed before the pavement is opened to any traffic.

a) Silicone sealant

(i) Materials

The silicone sealant and appurtenant materials shall be as specified in Clause A6.1.5.7b). The dimensions and positions of the sealant and appurtenant materials shall be as shown on the drawings, as specified in the Contract Documentation, or as approved by the Engineer.

(ii) Installation

Just prior to sealing, the joint grooves shall be reamed to their prescribed final dimensions and shall then be cleaned by means of a high pressure jet of water over the full depth of the joints to remove all fine matter and to produce dust-free joint grooves. Immediately before the supporting material is supplied, the grooves shall be dried by means of oil-free compressed air at a pressure of 700 kPa. Compressors shall be equipped with an apparatus which removes water and oil from the compressed air. Where a primer is required, it shall be applied before the supporting materials are installed.

After the joints have been finally cleaned and the primer (if any) has been applied, a supporting backing cord shall be installed by means of an approved rolling tool in the prescribed positions. Where the joints are dirty, wet or moist, the supporting material shall be removed, the joints cleaned and dried, and fresh material applied.

The procedure(s) to be followed by the Contractor to prevent the sealant from being spilt onto the concrete pavement shall be subject to approval by the Engineer. The silicone sealant shall be pumped continuously directly into the joints with a suitable pneumatically driven pump. Sealing shall be done from the upper surface of the supporting material. Immediately after installation and before a skin appears, the surface of the sealant shall be worked to compact the sealant and to press it against the sides of the joint so as to ensure that the prescribed clearance under the road surface is obtained. As an alternative to separate installation and finishing of the sealant, an approved injection nozzle incorporating a finishing apparatus may be used, in which case only closed-cell polyethylene may be used as supporting material. Further directions supplied by the manufacturer shall be strictly complied with, particularly with regard to temperatures for application, opening to traffic, and safety aspects. No traffic shall be permitted to pass over a sealed joint before the sealant is able to withstand the penetration of foreign matter.

The top surface of the sealant shall not be less than 5,0 mm and not more than 7,0 mm below the paved surface. All surplus sealant and other foreign matter shall be removed from the concrete pavement surface in accordance with the directions of the manufacturer of the sealant.

b) Liquid sealant for joints between concrete and asphalt pavements

These joints shall be sealed with a hot-poured joint-sealing compound as specified in Clause A6.1.5.7c). Prior to application, the joints shall be clean and free from water. Curing compound adhering to joint walls shall be removed by sandblasting or with an abrasive wheel. Dirt, dust and laitance shall be blown out of the joint with oil-free compressed air at a pressure of at least 700 kPa immediately before the sealing operation. The sealant shall be applied in accordance with the manufacturer's instructions, particularly in regard to the temperature of application, which shall be strictly controlled.

A6.1.8 WORKMANSHIP

a) Process control

The Contractor shall conduct all and a sufficient number of tests necessary for ensuring compliance with the requirements, as specified in this Chapter, during all phases of the work. Accelerated 20-hour compressive-strength tests as described in Clause A20.1.5.16 of Chapter 20 shall be conducted regularly with a view to predicting the 28-day compressive strength of the concrete in consultation with the Engineer. Where the accelerated tests indicate that the required 28-day compressive strengths will not be attained, the Contractor shall immediately effect the necessary changes to the materials and/or mix proportions in order to ensure that further work will comply with the requirements.

b) Acceptance control

Routine inspection and testing will be carried out by the Engineer to determine whether the quality of materials and workmanship complies with the requirements of this section. The lot sizes and sampling for compressive strength shall be done in accordance with Clause A20.1.7 of Chapter 20, using Judgement Plan B as stated in Clause A20.1.7.5b)(ii) of Chapter 20 for acceptance control. The assessment of test results and measurements shall be done in accordance with the provisions of Chapter 20 as relevant. In addition to the above, the following shall also apply:

- (i) The Engineer may, at his discretion, decide to use the Contractor's test results in the judgement plan if he is satisfied that the Contractor has complied with all the process control requirements.
- (ii) The relationship between the 28-day compressive and the 28-day flexural strengths of the concrete established by the preliminary tests shall be monitored during paving operations by regular tests at the discretion of the Engineer.
- (iii) For this purpose sets of three beams and three cubes shall be manufactured from the same batch of concrete and tested for flexural and compressive strength respectively. If the test results indicate a relationship which deviates from that established by the preliminary tests, the specified compressive strength, as specified in Clause A6.1.4.2 shall be adjusted accordingly.
- (iv) Where air entrainment has been included in the specification, and any test for air content shows a value falling outside the specified limits, the quantity of air-entraining agent added to the concrete mix shall be adjusted, until the air content of the concrete is within the specified limits.

c) Construction tolerances

The work in this Chapter shall be constructed to the tolerances given below.

(i) Level and grade

The lot shall comply with the requirements specified if at least 90 % of all levels are within the H₉₀ tolerance of 15 mm before any level correction is made. Individual spots where levels deviate by more than the H_{max} tolerance of 20 mm shall be repaired as agreed to by the Engineer to bring the levels within the H₉₀ tolerance.

The levels shall be taken in a random pattern or as directed by the Engineer, before and after the concrete layer has been constructed, at exactly the same positions. The number of measurements representing the lot shall be a minimum of 30 or more.

(ii) Layer thickness

Layer thickness shall be established from the difference in actual levels as measured before and after the concrete layer has been constructed as described in Clause A6.1.8c(i) above. In addition to the thickness from levels, the Engineer can request for cores from the lot where the average of 4 measurements per core will be reported for thickness at the position of the core.

The layer shall comply with the requirements specified if at least 90 % of the thickness measured for the lot:

- are equal to or thicker than the specified thickness minus the D₉₀ tolerance of 14 mm
- the mean layer thickness for the lot is not less than the specified thickness minus the D_{ave} tolerance of 1,0 mm and
- individual spots where the thickness is less than the specified thickness minus the D_{max} tolerance of 18 mm be repaired as agreed to by the Engineer to bring them within the D₉₀ tolerance.

(iii) Grade

Deviations from the specified longitudinal grade on account of deviations from the specified levels shall not exceed those relevant requirements given in Chapter 5.

(iv) Width of pavement

The average width shall be at least equal to the specified width and the edge of the pavement shall not deviate by more than 25 mm from the specified positions.

(v) Joints

Joints shall not deviate by more than 10 mm from their specified positions in the pavement or by more than 10 mm from the edge of a 3,0 m straight-edge placed so as to touch the line of the joint. Neither shall the line of a joint be discontinuous. The tolerance for the groove width of sawn joints shall be as follows:

- Longitudinal hinge joints ± 0,5 mm
- Transverse contraction joints ± 0,5 mm

(vi) Cross section

When tested with a 3,0 m straight-edge placed at right angles to the road centre line, the surface shall not deviate from the bottom of the straight-edge by more than 6,0 mm.

(vii) Surface regularity

Surface regularity or roughness can be measured using one or a combination of instruments, as specified in the Contract Documentation viz:

- Inertial High speed profilometers (IRI)
- Direct Contact Devices (IRI)
- Rolling straight edge

1. Inertial Profiler

The operations and calculations in Average 100 meter IRI values for three runs are in accordance with Clause A20.1.5.5c(ii) of Chapter 20. The assessment of the data for compliance shall be in accordance with Clause A9.1.8.4 of Chapter 9.

2. Direct Contact Device

The operations and calculations in Average 100m IRI values shall be in accordance with Clause A20.1.5.5c(i) of Chapter 20. The assessment of the data for compliance is in accordance with Clause A9.1.8.4 of Chapter 9.

3. Rolling Straight Edge

The equipment is operated and calibrated in accordance with method ST3 of TMH6. The number of irregularities in excess of a setting of 3,0 mm shall not exceed 8 over 100 m sections and not exceed an average number of 5 per 100 m taken over 300 – 600 meter sections. Any individual irregularity when measured with the rolling straight edge or a 3,0 m straight edge when laid parallel to the road centre line shall not exceed 7,0 mm.

(viii) Dowels

Dowels shall be positioned at the depth specified, measured from the surface level of the slab, within a tolerance of ± 10 mm. They shall be aligned parallel to the finished surface of the slab, to the centreline of the carriageway and to each other within the following tolerances:

1. Dowels supported on cradles, prior to construction of the slab:

All dowels in a joint shall be within $\pm 2,0$ mm per 300 mm length of bar. No individual dowel shall differ in alignment from an adjoining bar by more than 3,0 mm per 300 mm length of bar in either the horizontal or vertical planes.

2. Dowels supported on cradles or mechanically installed, after construction of the slab.

Dowels in a joint shall be within $\pm 2,0$ mm per 300 mm length of bar. No individual dowel shall differ in alignment from an adjoining bar by more than 6,0 mm per 300 mm length of bar in either the horizontal or vertical planes.

3. All dowels shall be equally positioned about the intended line of the joint within a tolerance of ± 25 mm.

4. Random checks of the dowels positioning shall be ordered by the Engineer by taking cores at the position of the bar ends. The coring shall be measured and paid for separately.

d) Unacceptable work or materials

(i) General

Any work or materials which does not comply with the specified requirements shall be removed and replaced with work, or materials, which comply with all the requirements. If the Engineer so approves, the defects shall be repaired as specified in Chapter 7: Maintenance and Repair of Concrete Layers, relative to the defects identified.

(ii) Acceptance of concrete of inferior strength or thickness at reduced payment

In lieu of requiring the removal of work that has been rejected on account of insufficient strength or thickness, the Engineer may accept such work at his sole discretion, at reduced payment for the pavement concrete, on the following conditions:

Where concrete is deficient in thickness or in strength, the reduced payment shall be calculated in accordance with the following formula:

$$P = \frac{(dw)^5 (fw)^4}{(ds)^5 (fs)^4} \times 100$$

where P = percentage of normal compensation

dw = actual average thickness of slab

ds = specified average thickness of slab

fw = actual 28-day compressive strength of slab (average of 28-day compressive-strength tests)

fs = specified 28-day compressive strength of slab (L_a) in accordance with Chapter 20.

The above shall be subject to the rejection of a pavement with an average thickness of less than 93,1 % of the specified thickness or a strength of less than 91,5 % of the specified strength, as determined above. Where both thickness and strength are deficient, it will be rejected if P is less than 70 %. Where P exceeds 100 %, normal compensation only will be payable.

(iii) Any other deficiencies.

Any other deficiencies not accepted by the Engineer shall be repaired in accordance with Chapter 7: Maintenance and Repair of Concrete Layers, as approved by the Engineer.

B6.1 PAVER LAID CONCRETE LAYERS

PART B: LABOUR ENHANCEMENT

CONTENTS

- B6.1.1 SCOPE**
- B6.1.2 DEFINITIONS**
- B6.1.3 GENERAL**
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- B6.1.5 MATERIALS**
- B6.1.6 CONSTRUCTION EQUIPMENT**
- B6.1.7 EXECUTION OF THE WORKS**
- B6.1.8 WORKMANSHIP**

B6.1.1 SCOPE

This Section covers all the material requirements and work pertaining to the construction of concrete layers utilising predominantly labour enhanced methods for the following pavement types:

- Jointed concrete pavement (JCP- Plain), with or without dowels
- Continuously reinforced concrete (CRCP)

It includes, inter alia, the specifications for materials, manufacture and construction requirements as relevant to the specific pavement as prescribed.

This Chapter does not apply to the large-scale rehabilitation of concrete pavements, which is covered in Chapter 7: Maintenance and Repair of Concrete Layers.

B6.1.2 DEFINITIONS

The definitions as listed in Clause A6.1.2 shall be applicable.

B6.1.3 GENERAL

B6.1.3.1 Quality plan

Prior to commencing with any permanent works, the Contractor shall submit a Quality Plan, for approval by the Engineer, detailing all methods checks and hold points relating to construction of the specified product.

B6.1.3.2 Trial sections

Where so provided for in the pricing schedule, the Contractor shall construct a trial section for each pavement type specified. The location and area of the trials shall be as directed by the Engineer. The purpose of the trial is for the Contractor to demonstrate that the equipment and processes that he proposes to use will enable him to construct the particular concrete layer in accordance with all the specified requirements. The Contractor shall calibrate the equipment and refine the mix design and construction process at his own cost.

The Contractor may, unless advised of any deficiencies in the trial section, proceed with the construction of the pavement ten days after the completion of the trial section or such earlier time as the Engineer may determine. In the event of deficiencies in the trial section, the Engineer may order the Contractor to construct a further trial section, which shall again be regarded as the initial trial section with no additional cost. The Contractor may then proceed with the construction of the pavement ten days after the satisfactory completion and acceptance of the second or subsequent trial section.

If the Contractor should make any alterations in the methods, processes, equipment or materials used and approved, or if he is unable to comply consistently with the specifications, the Engineer may require that a new trial section be constructed, at the Contractor's cost, before allowing the Contractor to continue with any permanent work. The intention of this clause is to avoid any experimentation by the Contractor on the permanent work.

The trial sections shall be laid where indicated by the Engineer. The Contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surface on which it was constructed, all at the Contractor's cost.

Provision is made for payment of the first approved trial section of any particular mix type, but subsequent trial sections that may be required for the same mix type shall be at the Contractor's own cost. Payment will be made for the specified area of each approved first trial section for any particular mix type.

B6.1.3.3 Weather limitations

The provisions of Part A shall apply.

B6.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

B6.1.4.1 General

All the requirements of Clause A6.1.4.1 shall be applicable.

B6.1.4.2 Design requirements

All the requirements as specified in Clause A6.1.4.2 shall be applicable with the exception that the mix proportions and consistency of the concrete mix shall be such that, with the methods and equipment in use, the concrete can be adequately transported, discharged, spread and fully consolidated without excessive bleeding or segregation of the components. The concrete consistency shall be appropriate to the type of paving equipment used, the haul, the weather and the site conditions.

B6.1.4.3 Design procedure

All the requirements as specified in Clause A6.1.4.3 shall be applicable.

B6.1.5 MATERIALS

B6.1.5.1 Cementitious materials

All the requirements specified in Clause A6.1.5 shall apply. The cementitious materials incorporated in the mix shall, however, be such that, dependant on the production rates achieved, the concrete shall have sufficient time to be transported, placed consolidated and finished prior to initial setting occurring.

B6.1.5.2 Water

Water for washing aggregates, mixing concrete, and curing shall comply with the requirements in Clause A6.1.5.2.

B6.1.5.3 Aggregates for concrete

All the requirements as specified in Clause A6.1.5.3 shall be applicable.

B6.1.5.4 Reinforcing steel, tie-bars and dowels

All the requirements as specified in Clause A6.1.5.5 shall be applicable.

B6.1.5.5 Curing compound

All requirements as specified in Clause A6.1.5.6 shall be applicable.

B6.1.5.6 Materials for joints

All the material requirements for joints as specified in Clause A6.1.5.7 shall be applicable.

B6.1.6 CONSTRUCTION EQUIPMENT

B6.1.6.1 General

The Contractor shall ensure the equipment and tools intended for use shall meet the following:

- The capability for handling the proposed materials and performing all parts of the work within the specifications.
- Production rates of such capacity that the paving operation proceeds continuously and at a constant rate of production, with starting and stopping reduced to a minimum.

Before any concrete may be cast, the Engineer shall approve the concrete source, batching methodology, all assembled side-forms, guide wires and/or rails and the paving train configuration. For this purpose the Engineer shall be given sufficient notice and opportunity. Approval by the Engineer shall not relieve the Contractor of any of his obligations to construct the concrete pavement in accordance with the specified quality, dimensions and relevant tolerances.

B6.1.6.2 Concrete batching plant

Where concrete is batched on site it must comply with the requirements of SANS 50206 (SANS 878). The Contractor shall have full responsibility to implement process control testing in accordance with the specifications.

B6.1.6.3 Paving

a) Side forms

Before any side-forms may be ordered or brought onto the site, particulars regarding the side-forms shall have been approved by the Engineer. Side-forms and rails shall be so designed, manufactured, set and supported that the completed concrete pavement will comply with all the requirements of Clause A6.1.8. When assessed with a 3,0 m straight-edge, the top edge of the form shall not deviate by more than 3,0 mm at any place, and the sides by more not than 6,0 mm. The sides shall not deviate by more than 3,0 mm from the vertical. The height of the side-forms shall not be less than the nominal thickness of the concrete slab less 15 mm.

b) Paving equipment

The paving equipment is not prescribed but the Contractor shall utilise appropriate hand operated equipment and construction methods in order to achieve the desired final product as specified. The Contractor shall provide a comprehensive method statement and quality plan to the Engineer for approval prior to commencing with any such work.

The equipment shall be of such dimensions and arrangement so as to cover the full width of the pavement strip being placed.

B6.1.6.5 Burlap drag equipment

The burlap drag shall be either attached to a suitable apparatus running on the side forms as prescribed in Clause A6.1.6.5, or fixed to a sufficiently rigid rod capable of being dragged across the full width of the pavement by labour located on either side of the side forms. When not in use, the entire drag shall be lifted clear off the pavement.

The dimensions of the burlap drag shall be such that at least 1,0 m of the material is in contact with the surface of the concrete pavement measured in the direction in which the drag is being moved. The burlap drag shall consist of at least two layers of approximately 340 g/m² burlap with the bottom layer at least 150 mm longer than the top layer at the dragging end. However, if the required texture is not obtained then, at the discretion of the Engineer, the number of layers may be increased to four. The transverse threads of the trailing 150 mm to 300 mm of the burlap drag shall be removed.

B6.1.6.6 Texture grooving equipment

Where texture grooved finish is specified, whether textured by machine or hand, the requirements shall be such that the specified texture is achieved. The requirements for the grooving/texturing tines shall be as specified in Clause A6.1.6.6.

Where so specified in the Contract Documentation, the fresh concrete shall be broom textured utilising appropriate equipment just prior to applying the curing compound.

B6.1.6.7 Applicator for curing compound membrane

Hand operated power-spray equipment may be used to apply specified curing compound.

B6.1.7 EXECUTION OF THE WORKS

B6.1.7.1 Preparing the Underlying Layers

The requirements as listed in Clause A6.1.7.1a), b) and c) shall be applicable.

B6.1.7.2 Batching and mixing of concrete

The requirements as listed in Clause A6.1.7.2 shall be applicable.

B6.1.7.3 Placing, Compacting and Finishing Concrete

a) General

All the requirements as listed in Clause A6.1.7.3 shall be applicable, with the following are additional requirements.

b) Placing of concrete

Where concrete is delivered from the side of the pavement by means of transit mixes, the distribution from the chute shall be such that lateral movement of the concrete by labour shall be as minimal as possible in order to prevent segregation occurring.

Where concrete is delivered in tipper trucks ahead of the paving operation, the rate and manner of tipping shall be such as to prevent a height of greater than 500 mm in the deposited pile having to be redistributed by hand.

c) Fixing of steel

Where the concrete is to be spread and initially levelled by hand, the type and spacing of supporting spacer blocks/stools, and installation detail of any tie bars, dowels, continuous reinforcing steel or steel mesh shall be such that their final position shall not deviate from specified location tolerances, as specified, during placement and distribution by labour based methods. The method to ensure this shall be approved by the Engineer.

d) Texturing and curing

Sufficient gang planks of appropriate rigidity shall be supplied to enable the workman to access the centre of the pavement in order to complete the texturing and application of curing compound without disturbing the burlap finished surface.

In order to ensure straight grooves the comb shall be operated against a straight-edge placed at right angles to the pavement centre line. The same requirements regarding groove dimensions or texture depth as for machine-texturing shall apply.

B6.1.7.4 Joint forming

All joints shall be formed in accordance with the requirements listed in Clause A6.1.7.4 as relevant.

B6.1.8 WORKMANSHIP

Unless otherwise specifically stated in the Contract Documentation, all the requirements specified in Clause A6.1.8 shall be applicable.

C6.1 PAVER LAID CONCRETE LAYERS

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 necessary to carry out the activity or construct the works under the relevant pay item, unless otherwise stated.

No extra over payment shall apply to work carried out in restricted areas for work carried out in conformance to this Chapter. The rates tendered for the payment items in this Chapter shall include full compensation for any work in restricted areas.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay Items

Not applicable.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

Table C6.1-1: Payment items from other Chapters or Sections

Activity	Section 6.1 reference	Section item reference
Loading and hauling	C6.1	C1.7 of Chapter 1 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C6.1.1	Construction of trial section (Complete: including texturing and curing)	
C6.1.1.1	Mechanical construction (state pavement type and nominal thickness)	square metre (m ²)
C6.1.1.2	Labour enhanced construction (state pavement type and nominal thickness)	square metre (m ²)

The unit of measurement for the trial pavement shall be the square metre of completed trial section. Not more than a total length of 200 m of paver laid trial pavement and not more than 60m of manually constructed trial pavement shall be measured for payment as described in Clause A6.1.3.2.

Item	Description	Unit
C6.1.2	Construction of jointed concrete pavement (JCP) (Excluding texturing and curing)	
C6.1.2.1	JCP without dowels:	
(a)	Paver laid construction (state nominal thickness)	square metre (m ²)
(b)	Labour enhanced construction (state nominal thickness)	square metre (m ²)

C6.1.2.2	JCP with dowels:	
(a)	Paver laid construction (state nominal thickness)	square metre (m ²)
(b)	Labour enhanced construction (state nominal thickness)	square metre (m ²)
C6.1.2.3	Additional concrete placed to thicken up the slab at joints as specified in the Contract Documentation	cubic metre (m ³)

Item	Description	Unit
C6.1.3	Construction of continuously reinforced concrete pavement (Excluding texturing and curing)	

C6.1.3.1	Continuously reinforced concrete pavement (CRCP):	
(a)	Paver laid construction (state nominal thickness)	square metre (m ²)
(b)	Labour enhanced construction (state nominal thickness)	square metre (m ²)

The unit of measurement for payment items C.6.1.2 to C6.1.3 shall be the square metre of concrete pavement placed and finished in accordance with the Contract Documentation. The quantity shall be calculated from the authorised dimensions of the completed surface, except when the Engineer requires or the drawings show local deviations from the specified thickness, such as at bridge approach slabs. The volume of concrete in such cases shall be converted into an equivalent area in square metres based on the specified thickness of the slab.

The tendered rate shall include full compensation for procuring and furnishing all the materials, storing the materials, providing all plant, determining the mix proportions, mixing, transporting, placing and finishing the concrete, including formwork, repairs done to defective work, protecting the pavement against damage, construction joints and process control.

The tendered rate shall also include full compensation for the provision of any additional width required by the Contractor to the earthworks and/or pavement layers to suit the particular requirements of the paving equipment. It shall also include full compensation for the removal of the additional widening which extends beyond the limits of the specified cross-section.

The quantity of additional concrete over and above the specified layer thickness and required at thickened joints shall be the cubic metre of concrete determined from the dimensions as detailed in the Contract Documentation.

The tendered rates shall also include full compensation for constructing concrete pavements which cannot be constructed with conventional plant, as envisaged in this Chapter.

Item	Description	Unit
C6.1.4	Texturing and curing the concrete pavement	

C6.1.4.1	Burlap-dragged and grooved texture:	
(a)	Paver constructed	square metre (m ²)
(b)	Labour enhanced construction	square metre (m ²)
C6.1.4.2	Burlap-dragged and broom finish only	square metre (m ²)
C6.1.4.3	Curing:	
(a)	Paver constructed	square metre (m ²)
(b)	Labour enhanced construction	square metre (m ²)

The unit of measurement for texturing and curing shall be the square metre of completed pavement which has received the specified surface texturing, and which was cured as specified. The quantity shall be calculated from the specified horizontal dimensions of the completed concrete surface in the case of texturing and from the specified horizontal dimensions of the completed concrete surface, plus the surface area of the slab sides, in the case of curing.

The tendered rate for texturing shall include full compensation for providing the plant and equipment required and for applying the specified surface texture.

The tendered rate for curing shall include full compensation for providing the curing compound and its application as specified at the specified nominal rates of application by means of an approved pressure distributor. The tendered rate shall also include compensation for spraying the curing compound in unsealed joints after the sawing has been completed.

Item	Description	Unit
C6.1.5	Variation in the rate of application of the curing compound	litre (ℓ)

The unit of measurement in respect of increases or decreases in the rate of application of the curing compound from the nominal application as specified, shall be the litre. Payment for variations shall be made as specified in Chapter 1.

Item	Description	Unit
C6.1.6	Joints	
C6.1.6.1	Expansion joints complete (excluding dowels)	metre (m)
C6.1.6.2	Longitudinal hinge joints:	
(a)	Sealed hinge joints (indicate type and reference to drawings)	metre (m)
(b)	Unsealed hinge joints (indicate type and reference to drawings)	metre (m)
C6.1.6.3	Sealed transverse contraction joints sawn in two separate operations (widths as shown on the drawings)	metre (m)
C6.1.6.4	Dowel bars: mild steel inserted in new concrete (indicate diameter, length and position on drawings):	
(a)	Inserted by mechanical dowel bar inserter	number (No)
(b)	Pre-installed on approved frame	number (No)
C6.1.6.5	Tie-bars: installed in new concrete (indicate, diameter and length):	
(a)	Mild steel	number (No)
(b)	High tensile steel	number (No)
C6.1.6.6	Forming and sealing joints between asphalt and concrete pavements	metre (m)

The unit of measurement for joints in the pavement shall be the metre of completed joint, except that dowel bars and tie-bars across joints shall be measured separately by the numbers of each type installed.

Construction joints as such shall not be measured for payment and their cost shall be deemed to be included in the rate tendered for the concrete pavement. However, if the position of a longitudinal construction joint coincides with that of a hinge joint, the Contractor will be paid at the rate tendered for the type of hinge joint replaced by the construction joint, provided that the requisite number and sizes of tie bars for the hinge joints are installed. Where the hinge joint replaced by the construction joint is a sealed hinged joint, the construction joint shall be sawn and sealed, in which case the Contractor will be paid at the tendered rate for sawn and sealed hinge joints.

The tendered rates for expansion joints shall include full compensation for forming the joint, complete with joint filler, rounding or chamfering the corners (if required) and installing the seal.

The tendered rates for longitudinal hinge joints shall include full compensation for sawing the joint (if required) and supplying and inserting the seal (if required).

The tendered rate for transverse contraction joints shall include full compensation for sawing the joint and installing the specified type of seal, including appurtenant materials, and for temporarily sealing the joint with paper rope.

The tendered rates for dowel bars and tie-bars shall include full compensation for supplying, cutting, placing, holding the bars in position, including a supporting framework or cradles where required, and fixing the end caps and bond breaking materials to dowels.

The tendered rate for forming and sealing the joints between asphalt and concrete pavements shall include full compensation for supplying all the necessary plant and materials, for forming a joint to the required dimensions in the asphalt seal, cleaning the joint and sealing as specified in Clause A6.1.7.5b)

Item	Description	Unit
C6.1.7	Steel reinforcement in concrete pavements	
C6.1.7.1	Mild steel bars	ton (t)
C6.1.7.2	High tensile steel bars	ton (t)
C6.1.7.3	Welded steel fabric	kilogram (kg)

The unit of measurement for steel bars shall be the ton of reinforcing steel in place in accordance with the drawings or as authorised.

The unit of measurement for welded steel fabric shall be the kilogram of welded steel fabric in the panels of concrete paving which require non-contiguous reinforcement as specified. The quantity shall be calculated from the area of the mesh used in accordance with the drawings or as authorised.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, placing and fixing the steel reinforcement, including all tying wires, spacers and waste.

Item	Description	Unit
C6.1.8	Drilling of testing of cores	
C6.1.8.1	100 mm cores drilled from pavement for testing of compressive strength	number (No)
C6.1.8.2	150 mm cores drilled from pavement for testing of compressive strength	number (No)

The unit of measurement shall be the number of cores drilled or drilled and tested on the instruction of the Engineer. Cores drilled by the Contractor at his own initiative as part of his process control, or for testing cracks sealed at the Contractor's own cost, shall not be measured for payment.

The tendered rates shall include full compensation for drilling the cores and, where applicable, having them tested by an approved laboratory, and for all labour, transport, testing charges and other incidentals, save only the cost of providing a core-drilling machine on the site, which shall be paid for separately. It shall also include compensation for restoring the concrete pavement where holes were drilled.

D6.1 PAVER LAID CONCRETE LAYERS

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Only for joint sealant

6.2 SEGMENTAL BLOCK PAVING LAYERS

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PART B: LABOUR ENHANCEMENT

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PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A6.2 SEGMENTAL BLOCK PAVING LAYERS

PART A: SPECIFICATIONS

A6.2.1 SCOPE

This Section covers the furnishing of materials and the construction of segmental block paving for roads.

A6.2.2 DEFINITIONS

Segmental block paving – a system of individual shaped blocks arranged to form a continuous hard-wearing and durable surface overlay.

A6.2.3 GENERAL

Not applicable to this Section.

A6.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

Where it is specified in the Contract Documentation that the blocks shall be manufactured in a dedicated on-site facility by the Contractor, all the requirements as listed in SANS 1058 for the specific class of block specified shall be applicable.

A6.2.5 MATERIALS

A6.2.5.1 Paving blocks

Concrete paving blocks shall comply with the requirements of SABS 1058. The block shall be of the class, type and thickness specified in the Contract Documentation. The surface texture and colour of all blocks shall be uniform.

A6.2.5.2 Bedding sand

Bedding sand shall not contain any silt, clay or other deleterious impurities. The sand shall comply with the following grading requirements in Table A6.2.5-1.

Table A6.2.5-1: Grading requirements for bedding sand

Sieve size (mm)	Percentage passing by mass
7,1	100
5,0	95 – 100
2,0	80 – 100
1,0	50 – 85
0,600	25 – 60
0,300	10 – 30

0,150	5 – 15
0,075	0 - 10

A6.2.5.3 Jointing sand

100 % of the sand used to fill the joints between the concrete blocks shall pass through a 1,0 mm sieve and between 10 % and 15 % of it shall pass through a 0,075 mm sieve.

A6.2.5.4 Concrete beams, kerbs and channelling

Cast in situ concrete edge beams or intermediate beams shall be constructed in accordance with the provisions of Chapter 13: Structures, as relevant. Prefabricated kerbing and channelling shall comply with the requirements of Section A3.3 or Section B3.3 of Chapter 3 as specified in the Contract Documentation.

A6.2.5.5 Herbicide and ant poison

The herbicide and ant poison shall be environmentally friendly and shall be subject to the Engineer's approval.

A6.2.6 CONSTRUCTION EQUIPMENT

A suitable vibrating-plate compactor shall be supplied operating at a frequency of 65 Hz to 100 Hz and a low amplitude. Its plate surface shall be 0,2 m² to 0,4 m² and it shall develop a centrifugal force of 7 kN to 16 kN..

A6.2.7 EXECUTION OF THE WORKS

A6.2.7.1 Preparing the underlying layers

The underlying pavement layer/s shall be as specified in the Contract Documentation. The underlying pavement layers shall be constructed and prepared in accordance with the requirements for the relevant pavement layers in Chapters 4 and 5 of these specifications, or as may be specifically otherwise prescribed in the Contract Documentation. Where specified by the Engineer the prepared surface shall be treated with approved herbicide and ant poison before the layer of sand for bedding is placed.

A6.2.7.2 Concrete edge and intermediate beams

Cast in situ or prefabricated concrete edge beams or intermediate beams shall be constructed on the underlying pavement layer in accordance with the details shown on the drawings. No paving blocks shall be laid before the edge and intermediate beams have developed sufficient strength to withstand the construction forces.

A6.2.7.3 Bedding sand

A layer of bedding sand complying with the requirements of Clause A6.2.5.2 shall be placed on top of the prepared surface of the underlying pavement layer. It shall be accurately levelled to an un-compacted thickness of 25 mm (\pm 5,0 mm), or as specified, so that the concrete paving blocks will have the correct level after compaction. The bedding sand shall be placed immediately before the concrete paving blocks are laid and shall be allowed to dry out to permit upward creep during compaction. The sand shall not be compacted before the blocks have been laid.

A6.2.7.4 Laying of the blocks

The blocks shall be laid in the pattern shown on the drawings or as directed by the Engineer. Unbroken blocks shall be laid first and the filler pieces afterwards. Filler pieces shall be neatly sawn or hewn to fit exactly into the space to be filled. Any space of which the size is less than 25 % of the size of an unbroken block, shall be filled with 35 MPa concrete. The size of the joints between blocks shall be between 2,0 mm and 4,0 mm, and the top faces of the blocks shall be flush.

After the paving blocks have been laid, the pavement shall be compacted by two passes of a suitable vibrating-plate compactor operating at a frequency of 65 Hz to 100 Hz and a low amplitude.

After compaction of the pavement as described above, jointing sand shall be spread and brushed into the joints until the joints have been properly filled. Any surplus sand shall then be broomed off and the pavement shall then be subjected to two further passes by the plate vibrator. Jointing sand shall not be hosed into the joints. The block paving shall be inspected after 2 months, and the joints shall be resanded where required.

A6.2.8 WORKMANSHIP

A6.2.8.1 Construction tolerances

The completed concrete block paving shall comply with the following construction tolerances:

- a) Line of pattern
 - (i) Maximum deviation from a 3,0 m straight edge: 3,0 mm
 - (ii) Maximum deviation from a 20 m straight line: 10 mm
- b) Vertical deviation from a 3,0 m straight edge
 - (i) At the edge beams: 3,0 mm
 - (ii) Elsewhere: 3,0 mm
- c) Differences in the surface levels of adjacent units: 2,0 mm

B6.2 SEGMENTAL BLOCK PAVING LAYERS

PART B: LABOUR ENHANCEMENT

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- B6.2.7 EXECUTION OF THE WORKS**
- B6.2.8 WORKMANSHIP**

B6.2.1 SCOPE

The provisions of Part A shall apply.

B6.2.2 DEFINITIONS

The definitions as in Clause A6.2.2 shall apply.

B6.2.3 GENERAL

The provisions of Part A shall apply.

B6.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A shall apply.

B6.2.5 MATERIALS

The provisions of Part A shall apply.

B6.2.6 CONSTRUCTION EQUIPMENT

The provisions of Part A shall apply.

B6.2.7 EXECUTION OF THE WORKS

The provisions of Part A shall apply.

B6.2.8 WORKMANSHIP

The provisions of Part A shall apply.

C6.2 SEGMENTAL BLOCK PAVING LAYERS

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 necessary to carry out the activity or construct the works under the relevant pay item, unless otherwise stated.

No extra over payment shall apply to work carried out in restricted areas for work carried out in conformance to this Chapter. The rates tendered for the payment items in this Chapter shall include full compensation for any work in restricted areas.

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.

The requirements of Section C1.1 of Chapter 1 shall apply.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

(ii) Notes on measurement and pay items

Not applicable.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to, 1,0 km.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

The following items of work, when specified, shall be carried out, measured and paid for in accordance with the appropriate Sections of the specifications.

Table C6.2-1: Payment items from other Chapters or Sections

Activity	Section 6.2 reference	Section item reference
Prefabricated concrete kerbing and channelling	C6.2.2	C3.3 of Chapter 3 - All applicable items

(v) Items specifically for this Section of the specifications

Item	Description	Unit
C6.2.1	Segmental block paving	
C6.2.1.1	Concrete block paving (indicate class, type and thickness of blocks)	square metre (m ²)

The unit of measurement shall be the square metre of completed concrete block paving. The quantity shall be calculated from the dimensions shown on the drawings or authorised by the Engineer. The tendered rate shall include full compensation for furnishing all materials, constructing the sand bedding, laying and compacting the concrete pavement blocks, filling the joints with jointing sand and for all other work necessary to complete the concrete block paving as specified.

The tendered rate shall include full compensation for furnishing all materials, constructing the sand bedding, laying and compacting the concrete pavement blocks, filling the joints with jointing sand, and for all other work.

Item	Description	Unit
C6.2.2	Cast in-situ concrete edge and intermediate beams	cubic metre (m³)

The unit of measurement shall be the cubic metre of concrete placed in edge and intermediate beams. The quantity shall be calculated from the dimensions shown on the drawings or as authorised by the Engineer.

All prefabricated concrete kerbing and channelling shall be measured and paid for under Part C, Section C3.3 of Chapter 3 as relevant.

The tendered rate shall include full compensation for furnishing all materials, and constructing the edge and intermediate beams complete as specified, including all excavation and backfilling in all classes of material.

Item	Description	Unit
C6.2.3	Provision and application of approved herbicide and ant poison.	
C6.2.3.1	Provision of materials	prime cost sum
C6.2.3.2	Contractor's charges and profit added to the prime cost sum	percent (%)

Payment under the prime cost sum for providing ant poison and herbicide and the Contractor's costs and profit in this respect shall be made in accordance with the provisions of the general conditions of contract, but, in addition, the Contractor's tendered rate for costs and profit shall include full compensation for applying the chemicals as specified.

Item	Description	Unit
C6.2.4	Re sanding of joints in segmental block paving	
C6.2.4.1	Concrete block paving (indicate class, type and thickness of blocks)	square metre (m ²)

The unit of measurement shall be the square metre of completed concrete block paving where re-sanding (filling) of the jointing sand is required after initial completion of the work. The quantity shall be calculated from the dimensions shown on the drawings or authorised by the Engineer. The tendered rate shall include full compensation for furnishing all materials to refill the joints with jointing sand where required.

D6.2 SEGMENTAL BLOCK PAVING LAYERS

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- D6.2.9 NOTIFICATION OF REMEDIAL WORK**
- D6.2.10 REMEDIAL WORKS**

No specific items in this Section.

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