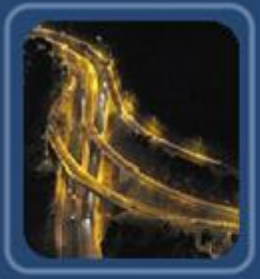
COTO STANDARD SPECIFICATIONS FOR ROAD & BRIDGE WORKS FOR SOUTH AFRICAN ROAD AUTHORITIES
OCTOBER 2020 - DRAFT STANDARD

CHAPTER 3: DRAINAGE

Presented by Kobus van der Walt

SARF

better roads



South African Road Federation

CURRICULUM VITAE

J.C. VAN DER WALT

1. Qualification: B Engineering (Civil) – University of Pretoria

2. Professional bodies: Registered as Professional Engineer with ECSA (April 1986)

3. Experience: January 1980 to March 1998

Institution: Department of Transport
Position: Started as Engineer to Chief Engineer
Duties:

- Assistant and Resident Engineer on various projects.
- Project Manager
- Pavement Design and Pavement Management Systems

4. Experience: April 1998 to March 2017

Institution: The South African National Roads Agency SOC Ltd (SANRAL)
Position: Regional Manager
Duties:

- Responsible for the management of the national road network in the Western– and Northern Cape

CURRICULUM VITAE

J.C. VAN DER WALT

5. Experience: March 2017 to December 2020

Institution: The South African National Roads Agency SOC Ltd (SANRAL)
Position: Head of the Technical Innovation Hub and Technical Excellence Academy
Duties:

- Establish a needs driven research and innovation programme.
- Implement new innovations on projects.
- Skills development of new engineering entrants.
- Monitoring of new entrants working on live projects to ensure professional registration.

6. Author (5) and co-author (6) of various papers

7. Member of the following technical committees:

- TRH15 – Subsurface drainage for roads 1994
- TMH9 – Standard Visual Assessment Manual for flexible Pavements 1992
- TRH22 – Pavement Management Systems 1994
- Draft TRH4 – Structural Design of Interurban and rural road pavements 1994/5
- TRH3 – Surfacing seals for rural and urban roads and compendium of design methods for surfacing seals used in South Africa 1995

CURRICULUM VITAE

J.C. VAN DER WALT

Member of the following technical committees: (continued)

- COLTO Standard Specifications for Road and Bridge Works 1998
- Routine Road Maintenance Guidance Manual – June 2000 (revised in 2007)
- South African Pavement Engineering Manual (SAPEM) 2013
- COTO Standard Specifications for Road and Bridge Works – Draft Standard 2020

DISCLAIMER

This presentation was prepared by the presenter , and any comments or responses are that of the presenter and not of SARF.

South Africa

COTO

Committee of Transport Officials

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

Draft Standard (DS)

October 2020

Permission is granted to freely copy, print and distribute this Draft Standard document for industry use.

FOREWORD

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.

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.

BACKGROUND

Development of SA Standard Specifications.

- **1970's: The Red Book" (used only by N-DoT/NTC and TPA ?)**
- **1987: The "Orange Book" CSRA**
- **1998: The "Green Book" COLTO**
- **2020: The "Green Book " COTO Draft Standard**

All the above were developed by a process of "evolution"?

Previous Document is some what "haphazard" in structure!!!

All the Chapters in COTO now have the same structure ☺

COTO SUITE OF DOCUMENTS

VOLUME 1	GENERAL CONDITIONS OF CONTRACT (FIDIC; GCC&NEC3)
VOLUME 2	STANDARD SPECIFICATIONS FOR:
	2.1 ROADS AND BRIDGE WORKS 2.2 ROUTINE ROAD MAINTENANCE
VOLUME 3	CONTRACT DOCUMENT
VOLUME 4	ROADWORK DRAWINGS
VOLUME 5	STRUCTURES DRAWINGS
VOLUME 6	MATERIAL UTILISATION
VOLUME 7	ENVIRONMENTAL MANAGEMENT PLAN

CONTRACT DOCUMENTATION (A1.1.2)

Contract Documentation - includes all the documents which define the content and terms of the Contract entered into by the Employer and the Contractor. **<u>The Contract Documentation usually consists of the following documents:</u>**

- Conditions of Contract.
- Contract Agreement.
- Drawings.
- Letter or Form of Tender.
- Letter or Form of Acceptance.
- Pricing Schedule.
- Project Specifications.
- Scope of the Works.
- Special (or Particular) Conditions of Contract.
- **Standard Specification (this document**) and
- Any other documents forming part of the contract.

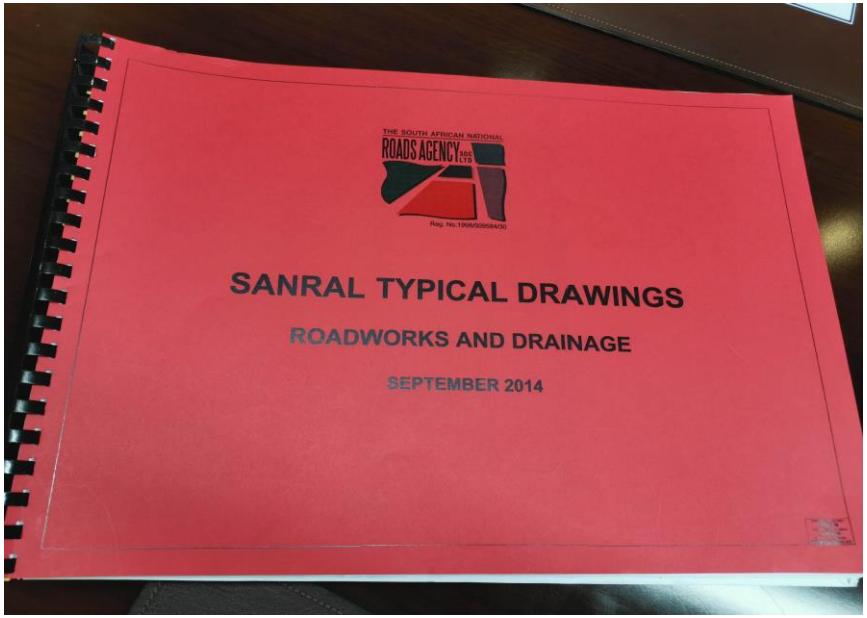
CONTRACT DOCUMENTATION

WHAT DO YOU EXPECT FROM SPECIFICATIONS??

- **No reference to proprietary products**
- **Must cover all options (road classes)**
- **Must be clear and specific (What is required)**
- **How will the quality of the end product be measured ?.**
- **How much are you willing to pay for the product ?**
- **End product must perform over its life span**

ROADWORKS & STRUCTURES DRAWINGS

- The different **Road Authorities** have their **own standard drawings** that must be complied with and needs to be **adjusted and updated to be project specific**.
- **Furnish the Contractor with drawings ,specifications and instructions necessary for the proper and adequate execution of the Works**
- **Quality and accurate** detailed drawings are therefor of utmost importance.
- **As built drawings** need to reflect what was constructed for future usage



COLTO STANDARD SPECIFICATIONS 1998

SERIES	TITLE	SECTIONS (55)
1000	GENERAL	7
2000	DRAINAGE	4
3000	EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CRUSHED STONE	9
4000	ASPHALT PAVEMENTS AND SEALS	9
5000	ANCILLARY ROADWORKS	9
6000	STRUCTURES	8
7000	SUNDRY STRUCTURES	5
8000	SUNDRIES	4

COTO DRAFT STANDARD CHAPTERS

CHAPTER	TITLE	SECTIONS (90)
1	GENERAL	7
2	SERVICES	4
3	DRAINAGE	3
4	EARTHWORKS AND PAVEMENT LAYERS: MATERIALS	5
5	EARTHWORKS AND PAVEMENT LAYERS: CONSTRUCTION	5
6	CONCRETE LAYERS	2
7	MAINTENANCE & REPAIR OF CONCRETE LAYERS	6
8	PRE-TREATMENT AND REPAIR OF CONCRETE LAYERS	9
9	ASPHALT LAYERS	1
10	SURFACE TREATMENTS	1
11	ANCILLARY ROAD WORKS	9
12	GEOTECHNICAL APPLICATIONS	12
13	STRUCTURES	14
14	REPAIR AND REHABILITATION OF STRUCTURES	11
15 TO 19	RESERVED FOR FUTURE USE	
20	QUALITY ASSURANCE	1

CHAPTERS

- **EACH CHAPTER SECTION CONSISTS OF:**

❑ PART A: SPECIFICATIONS

- ***Table of Contents:***
- **Scope**
- **Definitions**
- **General**
- **Design by Contractor/Performance Based Systems**
- **Materials**
- **Construction Equipment**
- **Execution of the Works**
- **Workmanship**

❑ PART B: LABOUR ENHANCED

- **1. to 8.**

❑ PART C: MEASUREMENT AND PAYMENT

❑ PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

For more information on the above read Sections A1.1 GENERAL PREAMBLE and A1.2 GENERAL REQUIREMENTS AND PROVISIONS

PART A: MATERIALS

GENERAL

During the designs process one need to take note of vandalism and theft in the area that the contract will take place when considering the use of certain materials like <u>bricks/ paving blocks / steel /iron / wood/ fencing /aluminium etc.</u>

<u>Need</u> to think out of the box, be innovative and consider the use of innovative products manufacture <u>from polymers /plastic /rubber /fibre glass etc</u> .Have therefor included in every section for "Alternative materials ".

PART A: MATERIALS

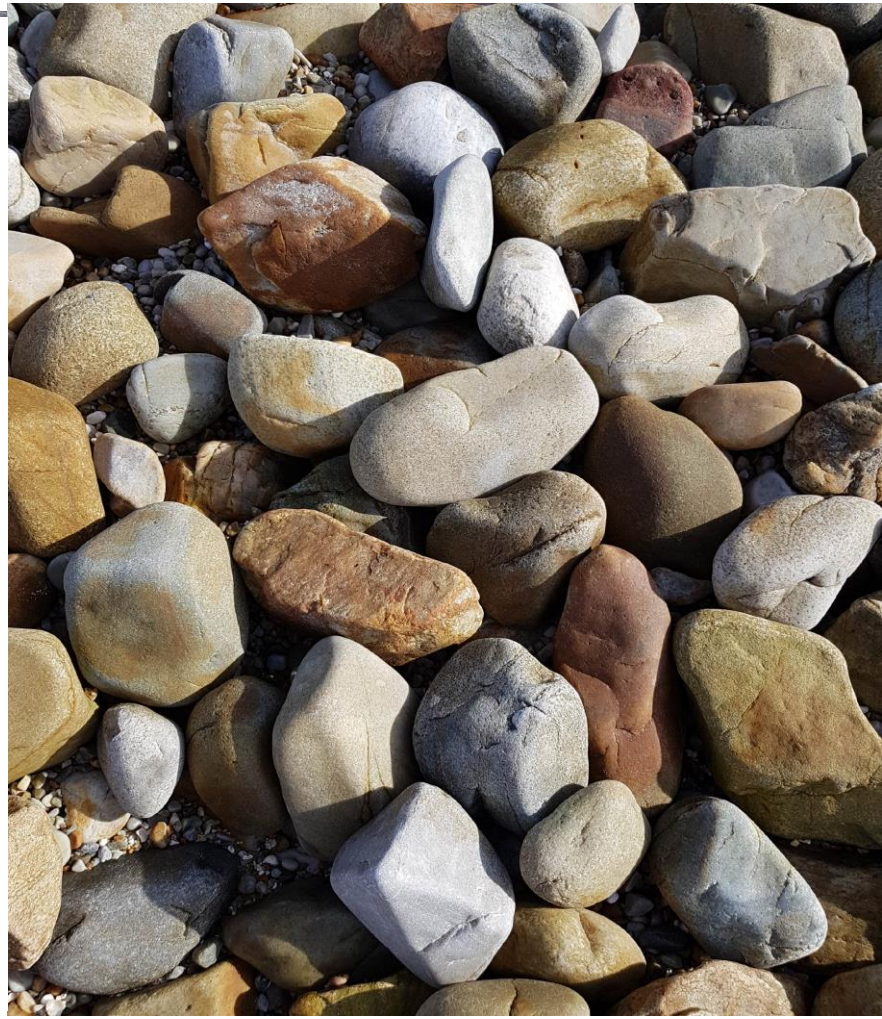
GENERAL

- The **material specifications are the required specifications** for the materials as placed and/or processed in its final position within the road reserve.
- **It is Contractor's responsibility** to ensure that the materials delivered to the road shall **meet the specified requirements**
- **Materials removed from existing works**, except where excavated materials are specified **to be reused or disposed of, or except** where provision has been made **in Part C for their reuse or specific disposal**, shall be deemed to be the **property of the Contractor. (or the Client) .See item C1.2.9: Disposal of non-useable assets**

AGGREGATE for concrete shall **comply with the requirements of SANS 1083** and for nominal size with SANS 3001 –AG1 in table A13.4.7-1.

SAND for **concrete, cement slurry and mortar** shall comply with the requirements of SANS 1083.

PART A: MATERIALS



PART A: MATERIALS

STONE :

•**Stone for pitching** shall be **sound, tough and durable**, without any stones **less than 150/200 mm** in dimension, except that smaller pieces or spalls may be used for filling spaces between the larger stones. **Rounded boulders shall not be used on slopes steeper than 2:1 unless cement grouted.** Unless suitable stone can be located on site, the stone for pitching shall be procured from commercial sources.

•**Stone for masonry walls** shall have a **minimum mass of 8,0 kg** for each stone, except that smaller pieces or spalls may be used . Stones shall have a **minimum vertical dimension of 75 mm** and have **a flat and stratified shape**.

•**Stone for riprap** shall be **hard or quarry stone of angular shape**. It shall be free from soft material such as sand, clay, shale or organic material and shall not contain an excessive quantity elongated stones.

The required size of the stone will depend on the "critical mass" specified (**30kg max**). At least **50 %** by mass of the material comprising the riprap shall consist of stones with a **mass heavier than the critical mass**, and **not more than 10 %** by mass of the material shall consist of stones with a mass of **less than 10 % of the critical mass** or **more than 5 times the critical mass**.

PART A: MATERIALS

CONCRETE AND MORTAR

- **All concrete work shall be carried out in accordance with the requirements of Section A13.4 of Chapter 13,** read together with the provisions of this Section. Cement shall comply with SANS 50197-1 for CEM I or CEM II with a strength class of 32.5 or greater, and a rate of strength gain of N or greater.
- Contractor shall be responsible for providing suitable materials, determining the mix proportions and manufacturing the concrete of the required quality to comply with SANS 50206.
- The **mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength** so that, considering the **expected variability** of the concrete and test procedures, **no more than 5 % of strength tests** will be expected to **fall below the specified characteristic compressive strength**.
- 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),** and **the Contractor** shall have full responsibility **to implement acceptance control testing** in accordance with the specification.

PART A: MATERIALS

<u>CONCRETE AND MORTAR</u> (CONTINUE)

- Unless otherwise specified, **mortar** shall consist of a **mixture of six parts of concrete sand to one part of cement**.
- **Concrete and mortar** shall be properly mixed to a uniform consistency. The total period between the **time that the cement is placed into the mix until mixing starts shall not exceed 15 minutes.**
- **Concrete and mortar** 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. **No additional water may be added in transit or were delivered or placed.**
- Once the **casting of concrete** has begun, it shall be carried out **in a continuous process between construction joints**. Concrete shall be **placed within 60 minutes from the start of mixing**. This **time may be extended** by the Engineer **where a retarding admixture has been used**. All excavations and other contact surfaces of an absorbent nature shall be damp, but no standing water shall be permitted to remain on these surfaces.

PART A: MATERIALS

CONCRETE (CLASS C) STRENGTH

The compressive strength class is indicated by the designated concrete code C, the characteristic 28-day cylinder strength in MPa, the characteristic 28-day cube compressive strength in MPa and the nominal size of coarse aggregate in the mix. For example, C20/25-20 means strength concrete class with a **characteristic cylinder strength of 20 MPa at 28 days** or **characteristic cube compressive strength of 25 MPa** at 28 days and a **nominal size coarse aggregate of 20 mm.**

PORTLAND CEMENT TYPES (CEM1TO 5)

CEM1 42,5N would be expected to achieve at least **42,5 MPa at 28 days using the specified mortar prism test .**

While **real concrete** made from the cement will achieve **42,5 MPa in concrete cube tests depend on a range of other factors** like **concrete porosity, water /cement ratio, soundness of aggregate ,aggregate bonding and cement related parameters** (alite content, alite and belite reactivity, cement sulfate content)**.**

PART A: MATERIALS

<u>Geotextiles</u> are planar soil and polymeric (synthetic or natural) textile material which may be nonwoven, knitted, woven knitted or stitch-bonded fibres or yarns. Its selection is based on:

- **Permeability reduction(clogging)**
- **Piping (retention criteria)**
- **Permeability**
- **Strength (construction survivability)**
- **Durability criteria**

<u>During the design phase</u> soil sampling and testing based on sound statistical principles must be undertaken on site, to simulate long term field conditions in the laboratory. The specified tests are stated in Chapter 20, Clause A20.14.13.

PART A: MATERIALS

Geotextiles are covered in Chapter 12 Section A12.11 under Geosynthetics. The section does not contain any **measurement and payment items which should be covered in the chapter/section of use.**

What is the minimum geotextile recommendation grade ??

This should be determined in the design phase and specified in the contract documentation.

Not to favour any suppliers the minimum recommendation properties for geotextiles similar to table 2104 in COLTO are not specified. (permeability criteria)

PART A: EXECUTION OF THE WORKS

CLASSIFICATION OF MATERIAL

All excavations shall be classified as follows for payment purposes:

Hard material:

- Material which **cannot be excavated except by drilling and blasting**, or with the use of pneumatic tools or mechanical breakers.
- **Boulders exceeding 0,1 m^3**; where more than **40 %** by volume of any material consists of boulders, each exceeding 0,1 m^3 in size, the material shall be classified as hard material.

Existing stabilized road layers : Existing layer material which has been stabilized (irrespective of stabilizing agent)and requires careful cutting and excavation without damage to surrounding existing rad layers by whichever method

Soft material: **All material not classified as hard material** shall be classified as soft material

NO MORE INTERMEDIATE CLASSIFICATION !!

WORKMANSHIP/ QUALITY ASSURANCE

Quality

- Difference between products
- Type of product
- Distinctive feature
- "Fit for purpose"

Assurance

- Measurement
- Inspections
- Apply appropriate products
- Guarantee

End product

- Structural
- Functional
- Durability

For whom?

- Asset of the Country
- Betterment of Civil Society to be valued and enjoyed

PART A: WORKMANSHIP

- The **Contractor shall determine the required frequency of testing and conduct sufficient tests** on the sourced material for each type of material **in order to ensure that the quality of materials produced will meet the specified requirements for which it will be used.**
- The **Engineer may, at his discretion, decide to use the Contractor's test results** if he is satisfied that the Contractor has complied with the process control requirements **as acceptance control.**
- **Any work or materials which do not comply with the specified requirements, shall be removed and replaced with work or materials which comply with the requirements or, if the Engineer so permits, shall be repaired so that it shall comply with the specified requirements after having been repaired**.

PART A: WORKMANSHIP

A20.1 TESTING MATERIALS AND JUDGEMENT OF WORKMANSHIP

SCOPE

- **During the execution of the work, control testing shall be conducted on materials and workmanship to monitor compliance with the requirements of the specifications**. **Tests, measurements, and inspections** shall be carried out using manual, mechanical and electronic equipment on materials and workmanship before, during and after construction **to ensure compliance** with the quality requirements of the specifications.
- **Chapter 20 also describes the schemes that are specified to ascertain compliance with the specification of certain materials properties and workmanship**. This is achieved by means of tests and measurements, and, where applicable, by applying statistical judgement plans.
- **The statistical acceptance control requirements, unless otherwise specified, apply to Class A, B, C and D roads, as classified in TRH 26 South African Road Classification & Access Management Manual**. The acceptance control requirements for lower classes of roads shall be specified in the Contract Documentation.

PART B: LABOUR ENHANCED

Definition: Labour Enhanced means to improve the scope for labour

The methods and specifications related to labour enhanced construction are contained in **Part B** of each of the relevant sections of these Standard Specifications. **The requirement for the use of labour enhanced construction methods to satisfy any particular project goals should be set out in the contract documentation. (decided/considered in design stage already)**

The **Specifications given in Part A will apply to all work carried by using labour** enhanced construction methods unless some of **the Specifications in Part A are replaced with revised Specifications in Part B that are specifically applicable to the specified labour enhanced construction or additional Specification for labour enhanced construction are provided in Part B.**

PART B: LABOUR ENHANCED

ADVANTAGES

- **All projects have components of labour.**
- The **Specifications are applicable to both machine and labour work**.
- **Emerging contractors are exposed to the entire document**, although small part may be applicable.
- The **Specifications combined with the payment items** were compiled **to be able to enhance the labour component.**

PART B: LABOUR ENHANCED

PAYMENT ITEMS

- **Part C contains the payment items for both the conventional and labour enhanced options.**

- **A special payment item is provided to allow for the disclosure of the labour content for the full duration of the project in order to satisfy the project goals.**

- **Where the excavation of material is specified by means of labour enhanced construction methods, the tendered rates shall include loading and <u>transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles</u> for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.**

PART B: LABOUR ENHANCED

CONCRETE MIXING BY HAND

- **Concrete may be mixed by hand or in hand-turned concrete mixers for small pours up to one (1) cubic metre**. Larger pours greater than one cubic metre shall be machine mixed with on-site mechanical mixers and/or batch plants.
- The **mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength so that, considering the expected variability of the concrete and test procedures, no more than 5 % of strength tests will be expected to fall below the specified characteristic compressive strength**.
- **All concrete mixed on the site of works shall be weigh-batched unless the Contractor can demonstrate to the Engineer that his method of proportioning the concrete ingredients consistently produces uniform concrete, which meets the strength requirements.**

PART B: LABOUR ENHANCED

CLASSIFICATION OF EXCAVATED MATERIALS

Table B11.1.7-1: Classification of Excavated Materials

Materials Classification	Description
Soft	Material which can be excavated by means of a suitable shovel with or without the use of a pick or other hand-swung tool.
Intermediate	Material which is difficult to excavate by hand even with the aid of a crowbar and requires the assistance of pneumatic tools for economic removal.

Table B11.1.7-2: Classification of Materials in Terms of Consistency and Shear Strength

Materials Classification	Consistency		Number of DCP blows to penetrate 100 mm *1	
	Granular soil	Cohesive soil	Granular soil	Cohesive soil *2
Soft	Very loose to dense	Very soft to stiff	≤ 15	≤ 8
Intermediate	Very dense	Very stiff	>15	>8

*1 Only applicable to materials comprising not more than 10 % gravel of size less than 10 mm and materials containing no cobbles or isolated small boulders.

*2 Classification depends on the moisture content of the cohesive material.

DRAFT

PART C: MEASUREMENT & PAYMENT

ALL MEASUREMENT & PAYMENT SECTIONS IN THE VARIOUS CHAPTERS CONSIST OF THE FOLLOWING:

- Preamble
- Items that will **not be measured separately**
- Items to be measured and paid for using payment **items specified else where in the Specification**
- Payment **items specified for the Section**

PART C: MEASUREMENT & PAYMENT

CONTRACT RATES

In computing the final contract amount, payment shall be based on the actual quantity of authorized work done in accordance with the specifications, instructions and drawings. The contract rates shall apply, subject to the provisions of the Contract Documentation, irrespective of whether the actual quantities are more or less than the scheduled quantities

Where NO rate or price has been entered against a pay item in the Pricing Schedule by a Contractor, it shall be accepted that NO compensation for such work is required or will be paid regardless of the final measured quantity.

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

Any prime cost or provisional sums shall be paid in accordance with the provisions of the Conditions of Contract.

PART C: MEASUREMENT & PAYMENT

PAYMENT ITEMS FROM DIFFERENT SECTIONS

Whenever a payment item that is specified in a particular Section is required to be used in another section of the Pricing Schedule then the relevant payment item number will be preceded by a reference to the Section in which it is being used.

For example, the loading and hauling payment items from Section C1.7 may be inserted into the Pricing Schedule for the loading and hauling of the material required for the pavement layers which are paid for under the payment Section C5.3 as follows:

C5.3/1.7.1.1	**Loading from stockpile**	**cubic metres (m^3)**
C5.3/1.7.2.1	**Hauling material for use in the Works and off-loading it on the site of the Works**	**cubic metre kilometres (m^3-km)**

PART C: MEASUREMENT & PAYMENT

PAYMENT ITEMS FROM DIFFERENT SECTIONS

Examples :

- **C3.(sections)/ 1.2.9 Disposal of non-useable assets**
- **C3.(sections)/1.6 Clear and grubbing designated excavation areas**
- **C3.(sections)/1.7.1 Loading –no payment for loading**
- **C3.(sections)/1.7.2 Hauling**
- **C3.3/3.2.4 Metal and U-PVC culverts**
- **C3.3 /11.2.3 Gabions linings**

PART C: MEASUREMENT & PAYMENT

C1.7 LOADING AND HAULING

Loading is the operation of picking material from an excavation or stockpile and placing it in a haul vehicle.

Payment item C1.7.1: Loading – only payment if it is from stockpiles, heaps or windrows.

Hauling is the moving of loaded construction material from point of excavation or from a stockpile to the point of use or designated spoil area (including –offloading).

Payment item C1.7.2 Hauling – 70 % of loaded haul vehicle volume for soil and gravel and 50 % for hard material or boulders.

Note that for Sections C3.1 to C3.3. No separate payment will be made for the loading of any material or hauling of material over a distance of less than and up to 1,0 km. Payment for these items to be include in tender rates.

PART C: MEASUREMENT & PAYMENT

PRACTICAL ADVICE

- **Ensure that supervision team has files on site which reflect the calculation of the design quantities.**

- **Supervision team must do independent calculations of quantities for payment purposes and not rely on that of the contractor.**

- **Payment quantities must be signed off with the contractor on monthly basis.**

- **Supervision team must monitor the contractors working program to be able to provide accurate cash flow for payment purposes.**

- **Supervision team needs to do at least two remeasurements of the expected final contract amount (over and under expenditure).**

- **Supervision team needs to carry out daily site inspections to monitor the works.**

PART C: MEASUREMENT & PAYMENT

PRACTICAL ADVICE

- **Where no specific payment items exist in the Part C Measurement and payment , the work can still be undertaken through negotiations between the Client /Engineer/Contractor on a basis of**

  1) Dayworks (item C1.2.6) or

  2) Variation Orders /Work Authorisation (WA)

- **How does the Contractor price in advance on an item which is " as determined /instructed by the Engineer " ? Rather specify the item clearly in the Contract document or in the drawings .**

- **The use of drones to measure quantities – borrow pits / stockpiles /cuts /fills /clear and grub/finishing the road reserve etc. How effective when its small measurements ???**

PART C: MEASUREMENT & PAYMENT

Master-COTO - Bill Project

File | Items | Columns | Section | Schedule | Contract | Estimator | Rates | Certificates | Project | View | Tools

Use Spreadsheet | Delete Spreadsheet | Calculate | Cut | Copy | Paste | Clipboard | Add | Delete | Insert from Bill | Insert from Master | Rows | Find | Replace | Find | Sort Asc | Sort Desc | Clear Sort | Sort | Set Filter | Clear Filter | Filter | Bold | Italic | Underline | Description | Selected Items | Filtered Items | Format All | Set Fill Color | Clear Fill Color | Set Font Color | Clear Font Color | Color | Insert Item No | Insert Symbol | Insert

Bill

- Contract
  - COTO Schedule
    - 1.2 GENERAL REQUIREMENTS AND PROVISIONS
    - 1.3 CONTRACTOR'S SITE ESTABLISHMENT AND GENER
    - 1.4 FACILITIES FOR THE ENGINEER
    - 1.5 ACCOMMODATION OF TRAFFIC
    - 1.6 CLEARING AND GRUBBING
    - 1.7 LOADING AND HAULING
    - 2.1 GENERAL REQUIREMENTS AND TRENCHING FOR S
    - 2.2 DRY SERVICES
    - 2.3 WET SERVICES
    - 2.4 ENERGY AND OTHER SERVICES
    - 3.1 DRAINS
    - 3.2 CULVERTS
    - 3.3 CONCRETE KERBING AND CHANNELING, ASPHALT
    - 4.1 BORROW MATERIALS
    - 4.2 CUT MATERIALS
    - 4.3 EXISTING ROAD MATERIALS
    - 4.4 COMMERCIAL MATERIALS
    - 4.5 ALTERNATIVE MATERIALS
    - 5.1 ROADBED
    - 5.2 FILL
    - 5.3 ROAD PAVEMENT LAYERS
    - 5.4 STABILISATION
    - 5.5 RECONSTRUCTION OF PAVEMENT LAYERS
    - 6.1 PAVER LAID CONCRETE LAYERS
    - 6.2 SEGMENTAL BLOCK PAVING LAYERS
    - 7.1 REPLACEMENT OF EXISTING JOINT SEALANT
    - 7.2 REPAIR TO CONCRETE PANELS AND CONCRETE A
    - 7.3 REMOVAL AND REINSTATEMENT OF EXISTING COI
    - 7.4 REINSTATEMENT OF SLAB SUPPORT BY GROUT IN
    - 7.5 REINSTATEMENT OF RIDING QUALITY
    - 7.6 REINSTATEMENT OF SURFACE TEXTURE
    - 8.1 PRIME COAT

Item	Description	Unit	Quantity	Rate	Amount R	Amount c
C1.5.5.5	Base patching using crushed stone material stabilised with bitumen emulsion and cement	m³				

Printout rule:

Flag | No escalation | New page | Code
Comment | No retention | Append | Special material %
Rate only | % of previous item | New sub-section | Quantity decimals 1

Notes

Document Links

	Item	Description	Unit	Quantity	Rate	Amount
▶	C1.5.5.5	Base patching using crushed stone material stabilised with bitumen...	m³			
	C1.5.5.6	Base and/or surface patching using cold premixed asphalt	kg			
	C1.5.5.7	Base and/or surface patching using hot plant mixed asphalt	t			
	C1.5.5.8	Replacement of damaged guardrails	m			
	C1.5.5.9	Grading of temporary deviations and existing roads used as detours	km			
	C1.5.5.10	Watering of temporary deviations and existing roads used as deto...	kℓ			
	C1.5.5.11	Other road maintenance work ordered by the Engineer	prov sum			
	C1.5.5.12	Handling cost, profit and all other charges in respect of item C1.5....	%			
	C1.5.6	Removal of temporary deviations	km			
	C1.5.7	Temporary traffic control facilities				
	C1.5.7.1	Delineators including mounting bases and ballast:				
	(a)	Single sided, reversible left or right (size indicated)	No			
	(b)	Double sided, reversible left or right (size indicated)	No			
	C1.5.7.2	Traffic cones, minimum height 750 mm	No			
Totals						0.00

Allow multi-section selection

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PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

The requirements for any performance guarantees and/or compliance certificates are specified in Part D of each chapter where applicable.

All product quality / performance / safety certificates issued by the South African Bureau of Standards (SABS) and by Agrément South Africa (ASA) will be accepted. (Agrement certification/specification is used where no SANS certification/specification exist)

Product quality / performance / safety certificates issued by testing authorities based in foreign countries will only be accepted if specified in the Contract Documentation or at the discretion of the Employer.

COMMENTS ON COTO CHAPTERS

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Written comments are to be completed on the Excel spreadsheet format provided with the Draft Standard documents on the SANRAL website and emailed to cotorevision@nra.co.za

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COMMENTS ON COTO CHAPTERS

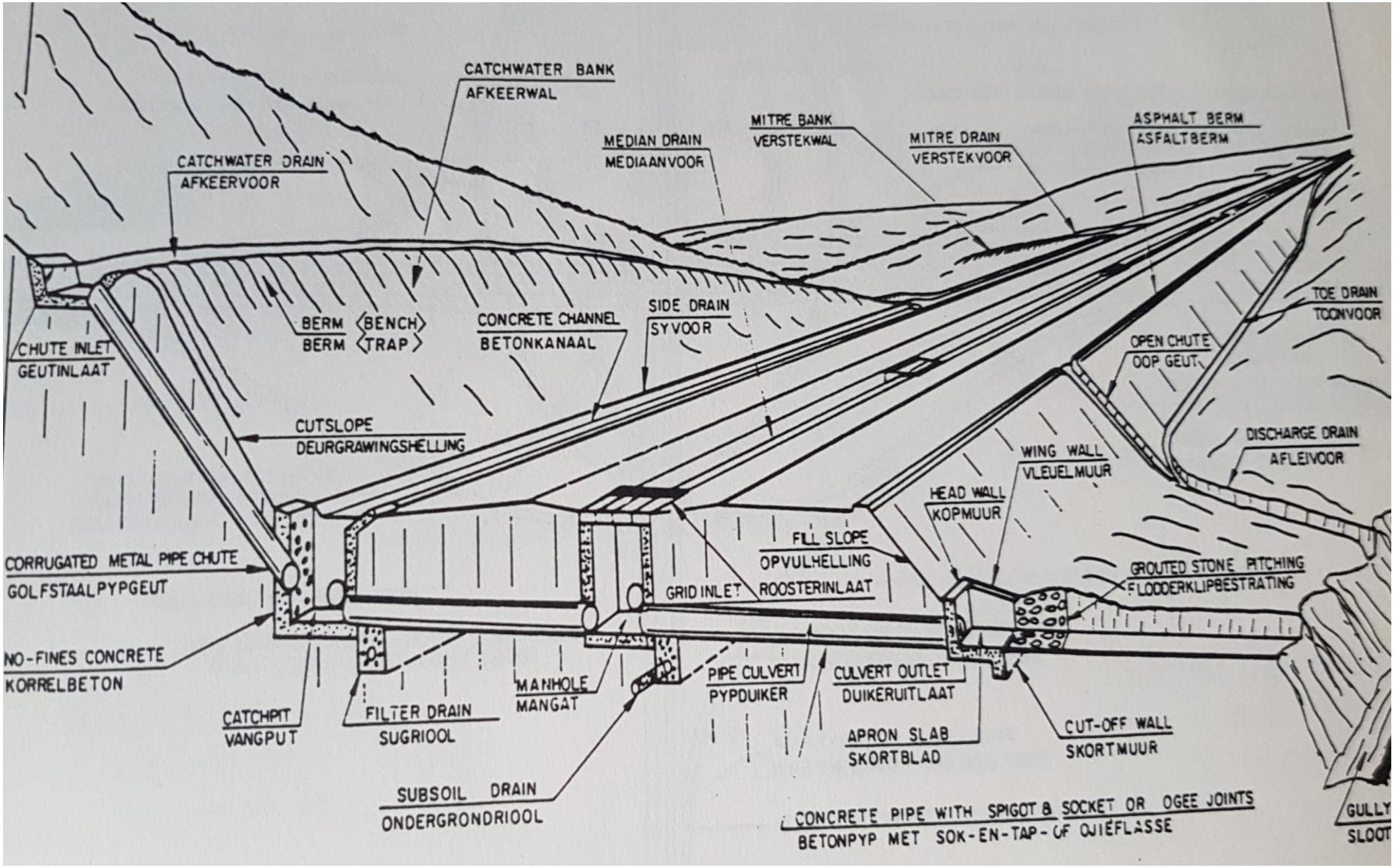
Example of spreadsheet for COTO comments

COTO Chapter	Comment number (name/surname initials followed by number eg for John Smith would be JS1, JS2, etc.	Your name	Your Road Authority /Institution/ Company	Page	PART A, B, C or D Section/Clause	Type of comment: General comment – GC Editorial comment – EC Technical comment - TC	Comments : justification for change	Proposed change	Observations of the COTO subcommittee on each comment submitted

Written comments to be emailed to cotorevision@nra.co.za

COMMENTS

CHAPTER 3:DRAINAGE –ADD DIAGRAM TO ILLUSTRATE TERMINOLOGIES



COMMENTS

Relook at structure of Chapter 3 and including first to Sections of Chapter 11 in to Chapter 3 :

Section 11.1 : PITCHING, STONEWORK, CAST IN SITU CONCRETE FOR PROTECTION AGAINST EROSION

Section 11.2 : NON-STRUCTURAL GABIONS

Sections 3.1 DRAINS AND 3.3 CONCRETE KERBING AND CHANNELING ,ASPHALT BERMS ,CHUTES ,DOWNPIPES ,AS WELLAS CONCRETE ,STONE PITCHING AND GABION LINING FOR OPEN DRAINS

QUESTIONS

CHAPTER 3: DRAINAGE

Comparison between COLTO 1998 and COTO DS

SERIES 2000: DRAINAGE

SERIES	DESCRIPTION
2100	DRAINS
2200	PREFABRICATED CULVERTS
2300	CONCRETE CURBING, CONCRETE CHANNELLING, CHUTES AND DOWNPIPES AND CONCRETE LININGS FOR OPEN DRAINS
2400	ASPHALT AND CONCRETE BERMS

CHAPTER 3

SECTION	DESCRIPTION
A3.1	DRAINS
A3.2	CULVERTS
A3.3	CONCRETE CURBING, CHANNELLING, ASPHALT BERMS , CHUTES ,DOWNPIPES , AS WELL AS CONCRETE , STONE PITCHED AND GABION LININGS FOR OPEN DRAINS.

CHAPTER 3: DRAINAGE

NEW ASPECTS ?

- **Rehabilitation/repair works included in different Sections**
- **Pipes – different types and materials (alternative systems)**
- **Classes of excavation**
  - Soft excavation
  - Exiting stabilised road layers
  - Hard excavation (boulder)

  No more intermediate classification only in Labour Enhancement
- **Excavation for both machine or by hand (limited to 1,5 m depth)**
- **Specifications for Gabion and Mattresses in Chapter 12 (A12.6)**
- **Specifications for Geotextiles in Chapter 12 (A12.11)**

CHAPTER 3: DRAINAGE

NEW ASPECTS ?

- **Ownership of material from existing works not reused , either that of Client or Contractor .**
- **Construction tolerances indicated in each Section .**
- **Submission of as built drawings by Contractor to the Engineer**
- **Where applicable Guarantees & Compliances Certificates must be provided by the Contractor**
- **For trenchless technology i.e. installation of conduits /pipes see Chapter 12 Section A12.7.1**

CHAPTER 3 :DRAINAGE

PRACTICAL ADIVICE

- **The supervision team to inform the Designer responsible for drainage before making any drainage changes on site**

- **It is always good to have background knowledge of TRH 15 or a drainage design manual when making decisions regarding drainage on site .**

- **When culverts are extended ensure that outlet level is not below or the inlet level above the natural ground level . (permanent maintenance problem)**

- **Need to also carry out site inspections when it is raining to pick up drainage problems like kerb inlets in wrong positions or water running across the road pavement ,ponding of water on road surfaces etc**

- **Need to check the pipe levels of sub–surface drain pipes ,minimum slope of 0,5% with absolute minimum of 0,25% for laterals .For slopes steeper than 2%,pipes with couplings should be used to prevent erosion of material around the joints caused by excessive eddying at the joints.**

CHAPTER 3 :DRAINAGE

CHAPTER 3 :DRAINAGE

CHAPTER 3 :DRAINAGE

CHAPTER 3: DRAINAGE

This Chapter deals with <u>surface</u> and <u>sub-surface drainage</u> within the cross-sectional elements of a road or road reserve.

<u>(i) Surface drainage :</u> The following elements are put into place to manage the run-off from roads and shoulder through the provision of -

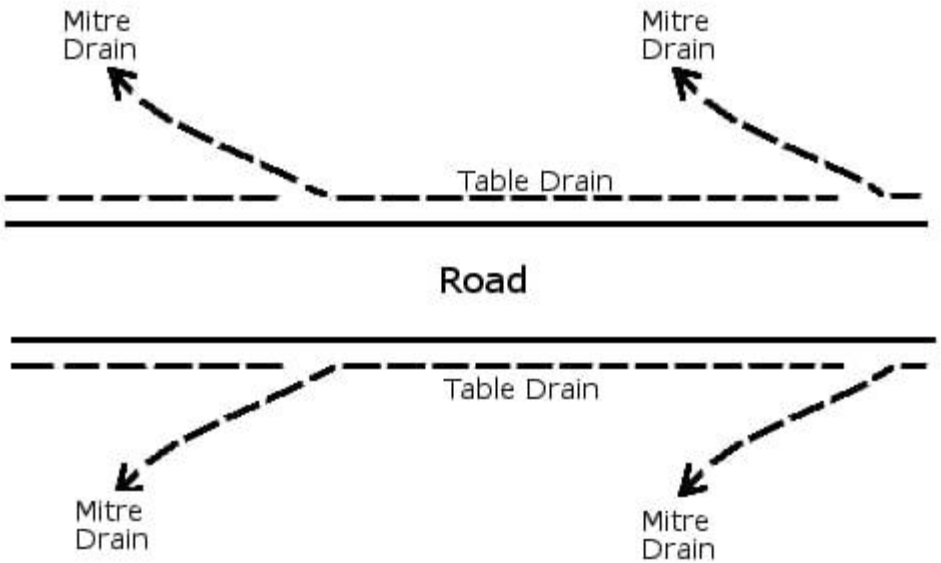
- **Side and median drains**
- **Catchwater drains**
- **Kerbs**
- **Channels**
- **Berms/ mitre banks**
- **Discharge chutes and down pipes**
- **Culverts**

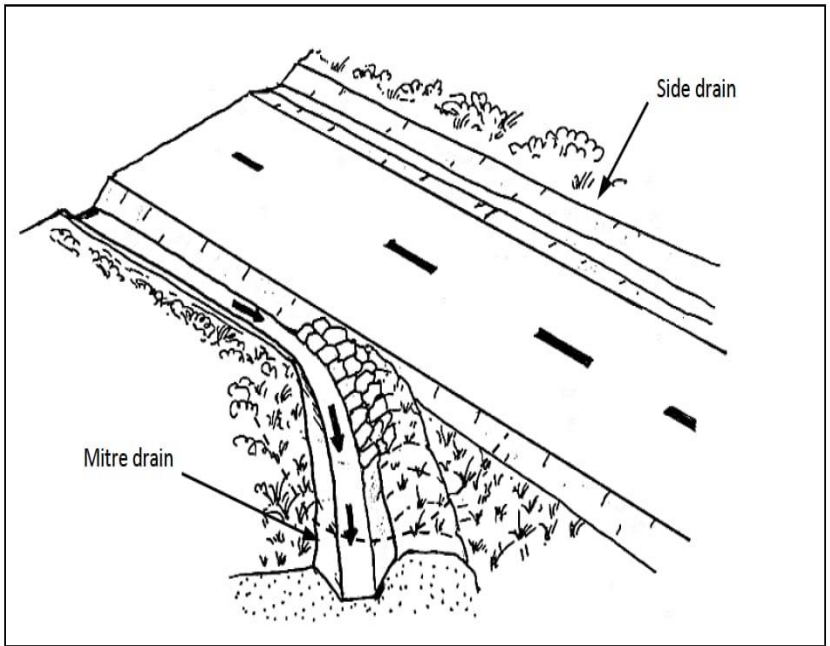
The minimum slope along a flow path should be 2%

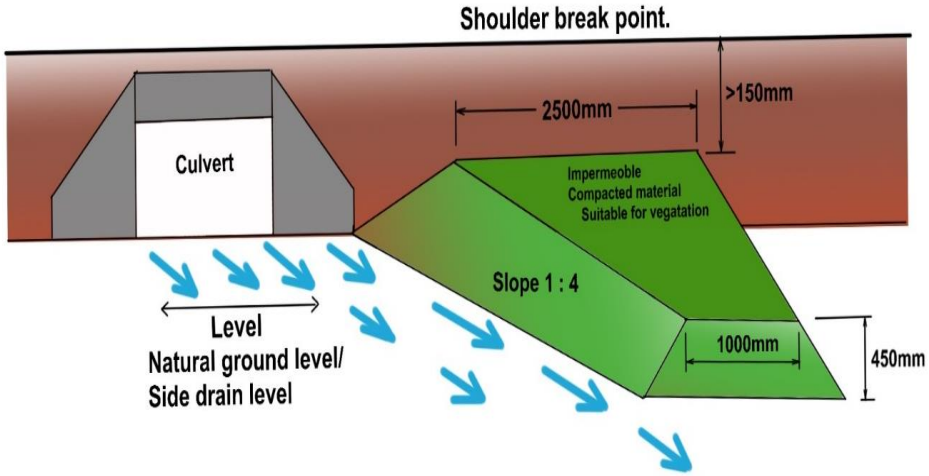
<u>(ii) Sub-surface drains</u> :Put in place to address under ground water ie natural water tables and rainfall infiltration through following systems

- **Interception drainage**
- **Herringbone drainage**
- **Layer drainage**
- **Structural drainage**

CHAPTER 3 :DRAINAGE

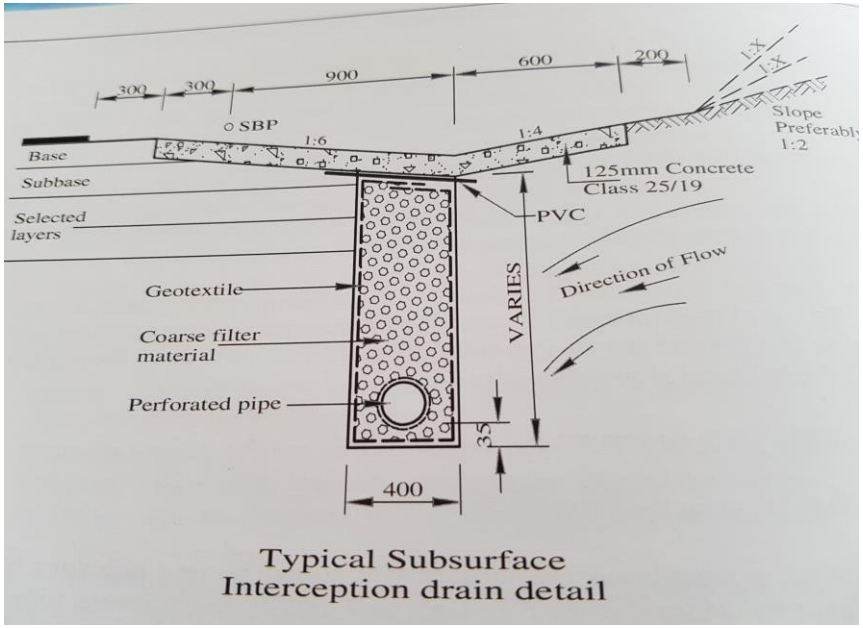




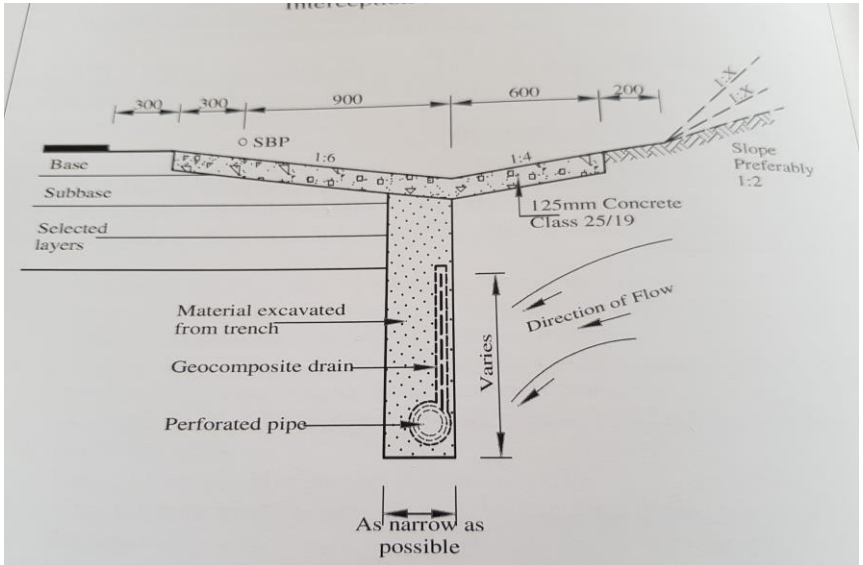


3.1 DRAINS

3.1 DRAINS



Typical Subsurface
Interception drain detail



Typical Subsurface Interception
Geocomposite drain detail

3.1 DRAINS

3.1 DRAINS

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A3.1.5 MATERIALS

A3.1.6 CONSTRUCTION EQUIPMENT

A3.1.7 EXECUTION OF WORKS

A3.1.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A3.1 DRAINS

A3.1.1 SCOPE

This Section covers mainly **open drains** as well as **subsurface drains** and their associated works **for both rehabilitation and new work**, in connection with the **excavation and construction of open drains, channels, subsoil drainage and banks and dykes**

It also covers the **cleaning of existing open drains, as well as the test flushing of existing and new subsoil drains and the repairing of existing subsoil drainage**.

Excluded are the lining of any drains such as with concrete, stone pitching, vegetation, synthetic and alternative materials; and wired mesh, which are covered under Chapter 11.

A3.1.5 MATERIALS

A3.1.5.2 Subsoil drainage Materials

a) **Pipes** for subsoil drainage systems shall be either **unplasticised PVC (U-PVC**) pipes or **high-density polyethylene (HDPE)** pressure pipes with smooth inner bore and internal diameters as indicated on the drawings or in the Contract Documentation. Pipes shall have the specified **internal diameter of not less than 100mm (150mm) (except for composite subsoil drainage systems**), and shall be one of the following types:

- **U-PVC pipes** complying with SANS 791 for solid wall pipes (category-heavy duty) or SANS 1601 for structured wall pipes (stiffness class 350), **which may be slotted or perforated for drainage in-flow as specified. The carrier portions of pipes shall not be slotted or perforated.**

- **HDPE pipes** to be used with aggregate filled subsoil drains systems shall be slotted or perforated for groundwater in-flow as specified. HDPE pipes shall have a ring stiffness >450 kPa and slotted / perforated with 30 % solid invert and of twin wall construction, with a smooth inner bore and ribbed outer wall. **The carrier portions of pipes shall not be slotted or perforated**.

- **Pipes for geocomposite fin type** subsoil drainage systems may be HDPE, extruded into an open lattice wall structure with a wall thickness of minimum of 5 mm. Of the circumference area, 70 % shall consist of an open structure, and the remaining 30 % being the invert, shall be solid.

A3.1.5 MATERIALS

A3.1.5.2 Subsoil drainage Materials

a) Pipes (continue)

- **All slotted or perforated pipes shall retain 30 % of the pipe invert for conveyance of drainage and the top of the pipes shall externally carry a longitudinal marker line to ensure that pipes are correctly placed during construction.**
- **Pipes must be stored in a shaded area without exposure to direct sunlight and stacked according to supplier's instructions**

b) Natural and crushed permeable material.

- **Sand used for natural permeable material** shall be clean, hard sand obtained from approved sources. The sand shall comply with the requirements of **SANS 1083, Table 1: Sand**, and shall be either coarse, **medium or fine grade** as specified with not more than 5 % of the material passing through the 0,075mm sieve.
- **Crushed stone used for natural permeable material** shall comply with the requirements given in **SANS 1083: Table 3: Stone for Concrete** and shall be either be **fine (14 mm nominal size) or coarse (20mm nominal size)** as specified. Crushed stone shall be clean with not more than 5 % of the material passing through the 0,075 mm sieve.

A3.1.5 MATERIALS

A3.1.5.3 Geo-composite drainage systems (fin type drains)

Geo-composite in-plane drains shall **consist of a drainage core connected to a drainage pipe**, all of which shall be enclosed in a geotextile as specified (grade and type), required to fully enclose the drainage core.

The **drainage core shall act as a flow net** and shall include the physical characteristics as listed in Table A3.1.5-2.

a) Mesh-structured pipe component of Geo-composite drain.

Pipes for **in-plane subsoil drainage systems** shall have an **internal diameter of 65 or 100 mm,** as specified. The pipe shall be manufactured from High Density polyethylene (HDPE) with a solid 5 mm wall thickness. It shall be extruded in an open lattice wall structure, with 70 % of the diameter consisting of open area and a 30 % solid area along the invert. Perforations in the open structure of the pipe shall be greater than 5mm but less than 12mm.

The infiltration capacity of the pipe, without geotextile, under a 200mm static head shall not be less than the following:

- For 65mm ID pipe = 20litres per metre per second
- For 100mm ID pipe = 55litres per metre per second

A3.1.5 MATERIALS

A3.1.5.3 Geo-composite drainage systems (continue)

b) Geo-composite strip drains or prefabricated vertical drains (wick drains):

Geo-composite **strip drains** shall consist of a drainage core enclosed in geotextile .The drainage core shall act as a flow net and combined with the geotextile shall include the physical characteristics as listed in Table A3.1.5-3.

c) Geo-composite Panel Drains

Geo-composite **panel drains** shall consist of a rigid corrugated plastic core of a flat pipe configuration with a well-defined invert enclosed in a geotextile and shall be classified according to the following minimum requirements as listed in Table A3.1.5-4.

A3.1.5.4 Concrete

A3.1.5.5 Mesh for subsoil drain outlets

Where specified on the drawings, the outlets of subsoil drains shall be covered by mesh built into the outlets or other material as specified. Galvanised woven wire mesh shall comply with the requirements of SANS 675.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.1 Classification of Materials

A3.1.7.2 Open Drains

Table A3.1.7-1: Open drain excavation classification criteria

Drain	Trapezoidal shape / channel	V-shaped	Trapezoidal shape / channel	V-shape	Road prism drains
Bottom width	< 4,0 m	n/a	≥ 4,0 m	n/a	All new or existing drains within the road prism namely median drains, side drains and drains on cut or fill slopes.
Side-slope (steepest side-slope is the determining slope)	not applicable (n/a)	Steeper than 1v : 4h (v=vertical; h=horisontal)	n/a	Flatter than 1v : 4h	
Top width	n/a	≤ 5,0 m	n/a	> 5,0m	
Classification criteria	Bottom width only	Steepest side-slope or top width	Bottom width only	Steepest side-slope or top width	
Drain classification for excavation	Open drain excavation Chapter 3	Open drain excavation Chapter 3	Designated excavation Chapter 4 compliant material		Shape, trim and/or clean Chapter 5
			Excavation to spoil Chapter 5		

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.2 Open Drains

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.1 Classification of Materials

A3.1.7.2 Open Drains (continue)

- Shall involve the excavation of **open drains and channels, including channels to direct the course of water flow**, all as detailed in the Contract Documentation
- Where **clearing and/or grubbing** is required for new open drains to be constructed, it shall be executed as specified in Section A1.6 of Chapter 1.
- Open drains shall be **constructed within 5 % true to line, grade and cross-section** and shall be so maintained for the duration of the contract. **Open drains shall at all points be graded to flow in the direction of intended flow without low points where water may pond**.
- Care shall be taken to **avoid excavation below the required grades** for the open drains and any excavation carried out below the required grade **shall be backfilled with material of minimum G7 quality and compacted to at least 93 % of MDD by the Contractor at no cost to the Employer.**
- **Material resulting from the excavations for open drains shall be used in the construction of fills, banks and dykes, or for other purposes, or shall be disposed of to spoil, all as specified by the Engineer**.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.1 Classification of Materials

A3.1.7.2 Open Drains(continue)

- **In respect of material resulting from open-drain excavation and not taken to spoil but used elsewhere in the construction of the works, payment will be made for open drain excavation as well as for any item of temporary or permanent construction built from such material**.

- **Material from open drain excavation, which is taken to spoil will be paid for as open-drain excavation only.**

- Where specified by the Engineer that **existing open drains**, but excluding new open drains constructed by the Contractor, **shall be cleared and, where necessary, shaped by removing the sediment and trimming the floors and side slopes**, the specified requirements for constructing new open drains shall apply similarly to clearing and shaping existing open drains.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.3 Banks and Dykes

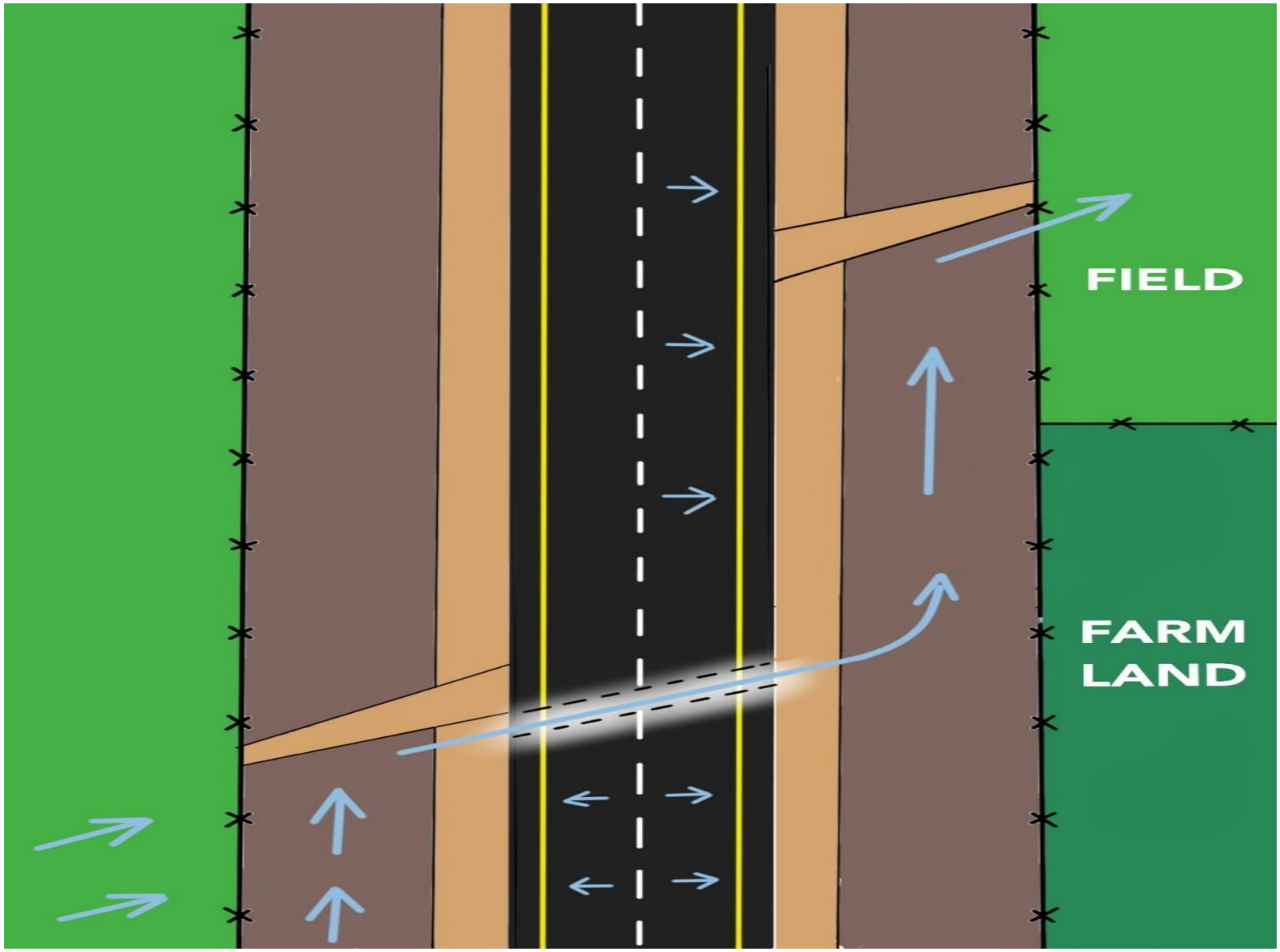
- Where **clearing and/or grubbing is required for new banks and dykes** to be constructed, it shall be executed as specified in Section A1.6 of Chapter 1.
- **Mitre banks, catchwater banks and dykes shall be constructed of approved soil or gravel obtained from cut and/or open drain excavation** or, if no suitable material can be obtained from **suitable approved alternative sources**, and be placed in such a way that the water will flow in a shaped open drain or on the natural ground and against the bank. Where open drains with bank/dyke are constructed as combination, excavation and fill shall be measured and paid for separately.
- The banks and dykes shall be **properly compacted to 93 % of MDD** in layers not exceeding 150 mm.
- The appearance of the completed mitre bank shall present an even, tight surface.
- **If so specified, mitre banks facing shall be constructed of hand packed stone pitching as detailed in Clause A11.1.7 of Chapter 11.**

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.3 Banks and Dykes

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.3 Banks and Dykes



A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

a) Construction of subsoil drainage systems

(i) With natural permeable material

- **Trenches** required for subsoil drainage systems shall be **excavated to the dimensions and gradients shown on the drawings** i.e. neatly trimmed to line and level.
- In case of **deeper excavations, or excavations in unstable or saturated ground, the Contractor shall take all necessary steps to assure the safety of such excavations and to ensure that specified lines and levels are complied with. Such steps may entail the provision of temporary shoring or battering of side slopes. All such steps shall be deemed to be included in the tendered rates for excavations.**
- After the placing of natural permeable material of the grade and thickness as shown on the drawings , pipes of the type and size specified shall then be firmly bedded on the natural permeable material, true to line and level Thereafter the trench shall be backfilled with the specified natural permeable material to such height above the pipes as shown on the drawings . Further layers of finer specified natural permeable material shall then be placed, in layers not exceeding 300 mm in thickness .

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

a) Construction of subsoil drainage systems

(i) With natural permeable material (continue)

- **The remainder of the trench, if any, shall be backfilled with approved impermeable material in layers not exceeding 150 mm**, and compacted to at least the same density as the surrounding material.
- **The trench shall be specially protected against the ingress of water until the impermeable layer has been completed**. The width of the backfill as measured for payment shall not exceed the specified width of the trench. Perforated and slotted pipes shall be joined by means of couplings, the provision and installation of which shall be deemed to be covered under the rates for the pipes
- Perforated pipes shall be laid with perforations either at the top or bottom as specified on the drawings, specifications or specified be the Engineer.
- The **higher end of each subsoil drainage pipe shall be sealed off with a loose concrete cap of class C20/25-20concrete**, as shown on the drawings The outlet of the pipe shall be built into a concrete head wall providing a positive outlet, or it shall be connected to structures for stormwater pipes or concrete culverts.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

(i) With natural permeable material (continue).

- **No continuous section of subsoil drain shall be longer than 80m long and cleaning eyes constructed in accordance with the details shown on the drawings shall be spaced at a maximum spacing of 80m**.
- Any section of a **subsoil drainage system constructed of pipes without perforations or slots shall be backfilled with impermeable material**. Where suitable, the excavated material may be used for backfilling.

(ii) With polymer film lining to trenches for subsoil drainage systems

Where shown on the drawings, **trenches for subsoil drainage systems shall be lined with approved polymer film sheeting 0,15 mm or 0,25 mm thick as shown on the drawings or specified in the Contract Documentation**. The polymer film sheet shall cover the bottom of the trench and shall extend upwards on both sides for as far as may be specified, in order to form a waterproof channel. At joints the polymer film sheeting shall be heat-welded together or lapped by a minimum of 200 mm. Lapping shall be in direction of the flow of water.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

(ii) With polymer film lining to trenches for subsoil drainage systems (continue)

- Pipes of the type and size specified shall be installed as specified, true to level and grade, and be coupled in accordance with requirements.
- **When backfilling the trench** with the specified natural permeable material, care shall be taken **not to displace or damage the polymer film lining in any way. The use of plastics other than polymer film will be considered, provided that the material is proven to the Engineer to be of equal or better quality.**

(iii) With geotextiles

- Where specified that geotextiles shall be used for lining in subsoil drainage systems, it shall be procured, furnished and installed as specified and shown on the drawings. The **geotextile shall be lapped both longitudinally and transversely by at least 300 mm or as specified by the manufacturers.**

- **Pipes of the type and size specified shall be installed as specified, true to line and grade**, and be coupled in accordance with the pipe manufacturer's requirements

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

a) Construction of subsoil drainage systems(continue)

(iv) With composite in-plane drainage systems

Wherever specified, composite in-plane drainage systems shall be constructed in accordance with the details shown on the drawings and in accordance with the manufacturer's requirements. **The elements of the system shall be assembled above ground in manageable lengths, and all exposed surfaces shall be sealed with an approved geo-fibre seal. The trench sides shall be vertical, and the composite in-plane system shall be installed against the side through which the subsoil flow is expected. The trench shall then be backfilled with natural permeable sand, which shall be saturated with water after placement, up to the prescribed level.** The upper part of the trench shall be backfilled with impermeable material, which shall be compacted to the density of the surrounding material, in layers not exceeding 100 mm in thickness.

(v) With alternative drainage systems

Alternative drainage systems, where relevant, shall be specified and detailed in the Contract Documentation.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

a)Construction of subsoil drainage systems (continue)

(vi) Proving of pipes in subsoil drainage systems

The laying of slotted/perforated pipes supplied in coils shall be subject to providing a method statement to ensure accurate installation .

On completion of the pipe laying and prior to backfilling over pipes, all pipe joints shall be surveyed as proof of their installation to line and grade. After backfilling, the pipes shall be proved by pulling through a cylindrical cleaning brush followed by a wooden mandrill ± 400 mm long and 5,0 mm in diameter less than the bore of the pipe. Proving of installed pipes shall not be paid for separately and the cost thereof shall be deemed to be included in the rate tendered for laying the pipe.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.4 Subsoil drainage

b) Test flushing

Final acceptance of longitudinal subsoil drains constructed by the contractor will be subject to satisfactory test flushing after completion and installation of the rodding eye inlets. Flushing tests shall be carried out in the presence of the Engineer's representative by flushing the drain and metering the outflow to ensure the drain is clear of blockage. **Should blockages be apparent the Contractor shall locate and clear the obstruction and repeat the test**.

Proving of the lack of **obstructions may also be undertaken by camera equipment inserted** into the subsoil drains should this be specified by the Engineer.

A3.1.7.5 Manholes, outlet structures and cleaning eyes

Manholes ,outlet structures and cleaning eyes for subsoil drainage systems shall be constructed in accordance with the details shown on the drawings

The **end of each subsoil outlet shall be marked with a suitable visible marker clearly indicating the position of each subsoil outlet structure in accordance with the details on the drawings.**

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.6 As-Built Drawings

The **Contractor shall furnish the Engineer with a detailed set of relevant drawings verifying and recording the subsoil drainage systems as installed**. **Such records shall include <u>accurate coordinates of all starting points, bends, cleaning eyes, manholes, junctions and outlet structures, including the depth below surface level at each such point</u>.**

C3.1 DRAINS

PART C :MEASUREMENT AND PAYMENT

- **C3.1.9 Pipes in subsoil drainage systems (add HDPE pipes ?)**

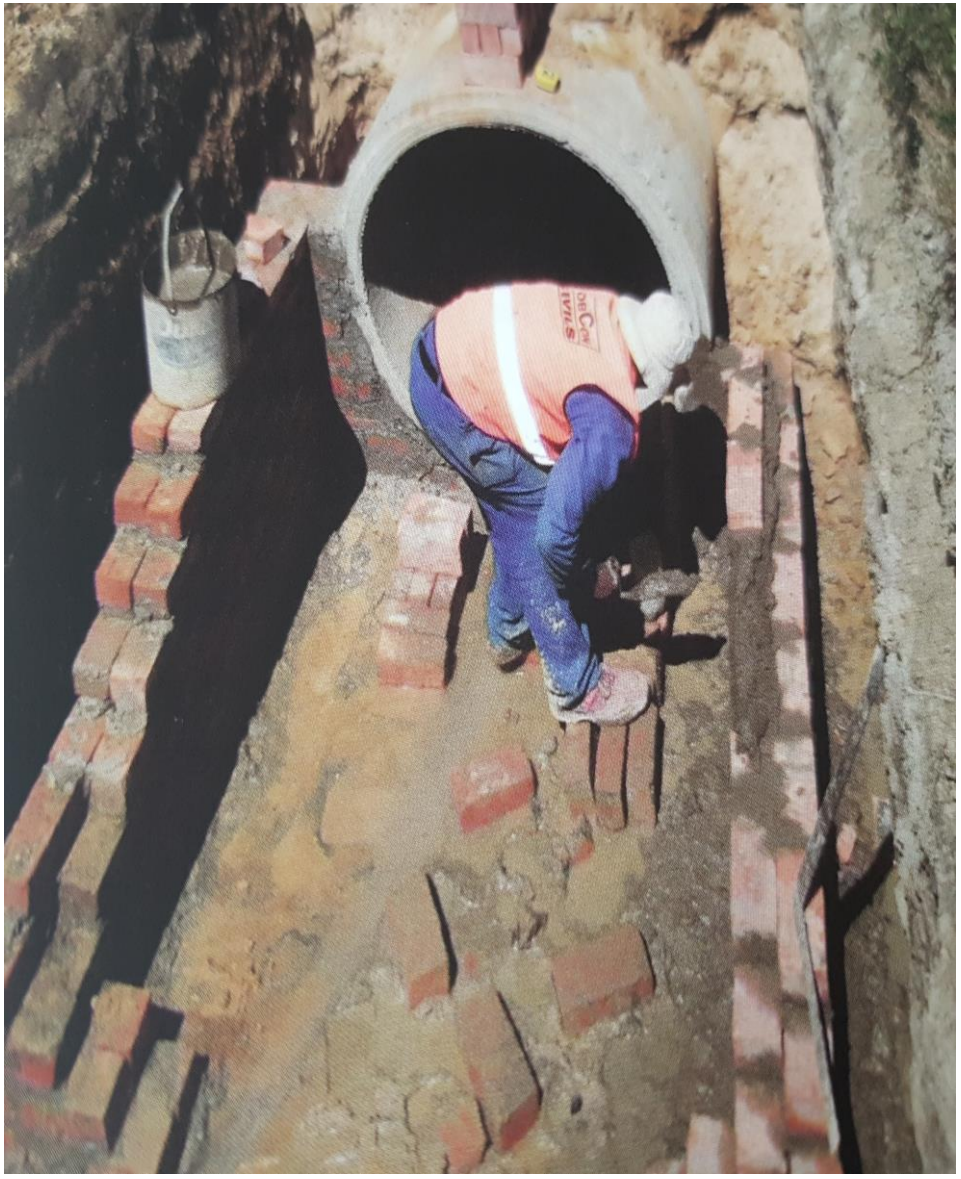
  C3.1.9.1 U-PVC or HDPE pipes and fittings ,normal duty ,complete with couplings(state size and whether or not perforated or slotted)

- **C3.1.13 Concrete or engineering bricks ? outlet structures ,manhole boxes ,junction boxes and cleaning eyes for subsoil drainage systems**

QUESTIONS

3.2 CULVERTS

3.2 CULVERTS



3.2 CULVERTS

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PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

A3.2 CULVERTS

A3.2.1 SCOPE

This Section **covers mainly culverts and conduits and their associated works** in water courses or from natural or shaped areas but may **also cover drainage of road or bridge surfaces**. It also covers work in connection with the construction of in **situ constructed and prefabricated culverts and other closed conduits to provide such drainage, together with inlet and outlet structures, manholes and other appurtenant structures.**

Different Road Authorities may differentiate between minor culverts, lesser culverts or major culverts. Major culverts are covered in Chapters 13 and 14.

This Section also **covers the replacing and/or lengthening of existing culverts, modification of and repairs to existing drainage structures and catch pits as well as sleeving or lining, partly of fully, of the insides of existing culverts.**

A3.2 CULVERTS

A3.2.2 DEFINITIONS

Culvert is a **structure other than a bridge** which provides an opening under the carriageway or median for drainage or other purposes.

Major Culvert is a **cellular structure with dimensions less than those defining a bridge** but with any **clear span length** (as measured horizontally at the soffit perpendicular to the faces of its supports) **equal to or larger than 2,1 m, or diameter equal to or larger than 2,1 m, or a culvert with a total cross-sectional opening equal to or larger than 5,0 m^2. (TMH19)**

Minor Culvert is **all culverts smaller than that defined as a Major Culvert** are classified as lesser culverts. (TMH19)

A3.2 CULVERTS

A3.2.3 GENERAL

- **The attention of the Contractor is drawn to the requirement that information given on the drawings, longitudinal sections or drainage schedules <u>may have to be verified and reviewed</u> to suit actual site conditions and therefore the Contractor shall only construct these culverts after the Engineer has amended or verified the information on the drawings based on detail surveys taken on site.**

- **Prefabricated units shall be ordered by the Contractor from <u>actual measurements of lengths determined on site</u> and not from lengths stated in the drainage schedules or from the schedule of quantities**

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- **All existing stormwater culverts, which are to be extended, shall be <u>inspected on site and any defects reported to the Engineer prior to extensions being constructed.</u> Likewise, existing and new culverts are to be inspected for possible damage after completion of layerworks over the culverts**.

A3.2 CULVERTS

A3.2.3.1 Types of culverts

a) **Reinforced concrete floors and roofs and reinforced concrete walls**, hereinafter referred to as "**rectangular concrete culverts**". The reinforced concrete floors and/or roofs may be either cast in situ or prefabricated units constructed elsewhere;

b) **Reinforced concrete floors and roofs and reinforced brickwork walls**, hereinafter referred to as "**rectangular brickwork culverts**". The reinforced concrete floors and/or roofs may be either cast in situ or prefabricated units constructed elsewhere;

c) **Prefabricated reinforced concrete pipes with circular sections**, hereinafter referred to as "**concrete pipe culverts**";

d) **Prefabricated reinforced concrete culverts other than pipe culverts** hereinafter referred to as "**prefabricated portal culverts**", generally of combined wall and roof prefabrication. The reinforced floors may be either cast in situ or prefabricated units constructed elsewhere.

e) **Prefabricated corrugated metal pipes and pipe arches**, hereinafter referred to as "**metal culverts**".

f) **U-PVC (HDPE?) pipes with circular section**, hereinafter referred to as "**U-PVC culverts**"

g) Other types of culverts shall be specified in Contract Documents .

A3.2 5 MATERIALS

A3.2.5.1 General materials

Prior to the manufacture of any prefabricated units by the Contractor's manufacturer, **the manufacturer shall submit his Quality Plan** to the Engineer to verify that **all prefabricated units will be manufactured in full compliance with the relevant SANS requirements**. No prefabricated units shall be ordered until the Engineer has satisfied himself that the proposed units have been or will be manufactured to the required specifications and tolerances as well as the load bearing requirements. In particular **the manufacturer shall check <u>each</u> prefabricated portal culvert unit for steel cover compliance, and <u>random</u> checking of units shall not be accepted**. The Engineer's representative may visit the factory at any stage to ascertain adherence to the quality plan**. Should the manufacturer fail to adhere to their Quality Plan the Engineer may exercise the right to reject the use of products from the manufacturer concerned.**

A3.2.5.2 Culvert materials

a) In situ concrete

All concrete work shall be carried out in accordance with the requirements of Section A13.4 of Chapter 13

A3.2 5 MATERIALS

A3.2.5.2 Culvert materials (continue)

b) Prefabricated portal culverts and prefabricated in/outlet, floor and roof slabs units

The **prefabricated units shall comply with the requirements of SANS 986**.

For durability requirements, **all durability testing shall be done** in accordance with Clause A20.1.5 for testing and Clause A20.1.7 for assessment in Chapter 20 and shall fall within the severe category**. For units within the 5,0 km zone from the coast the very severe category shall be used, and increased cover shall be as specified by the Engineer.**

Portal and rectangular prefabricated units shall be transported and handled with sufficient care to prevent stressing, cracking or damage to the unrestrained elements of the units. Cracks or damage shall constitute adequate reason for rejection by the Engineer or required confirmation by the manufacturer of their serviceability.

All broken, bent, chipped, cracked, dented, corroded or otherwise damaged or substandard units, thinner than the specified thickness, **shall be removed and replaced** with units which conform to the specifications.

A3.2 5 MATERIALS

A3.2.5.2 Culvert materials (continue)

c) Prefabricated concrete pipe culvert units

Shall comply with the requirements of SANS 677. Pipes with ogee joints shall be provided, unless otherwise specified.

All broken, bent, chipped, cracked, dented, corroded or otherwise damaged or substandard units shall be repaired or, where this is not acceptable or does not comply with the relevant SANS specification, they **shall be removed and replaced with undamaged units, at the Contractor's cost.**

d) Brickwork

Bricks shall be **engineering bricks conforming to the requirements of SANS 227**. Bricks may be manufactured on site or elsewhere.

The limit for water absorption in the 24 hour immersion test shall be 8 % maximum.

e) Plaster

Shall consist of **one part of CEM I class 32.5 cement to four parts of approved fine sand and shall conform to the requirements of SANS 2001**.

A3.2 5 MATERIALS

A3.2.5.2 Culvert materials (continue)

f) Manhole covers, grid inlets, frames, etc.

Manhole covers and frames, grid inlets and accessories of metal, or nonmetal composition shall be supplied and/or manufactured in accordance with the details shown on the drawings and be of the size and type indicated . **All steel elements shall be galvanised in accordance with SANS 121. Frames, grids/gratings covers and accessories of cast iron, synthetic or composite materials shall comply with the requirements of SANS 558, SANS 1115, or SANS 50124 and be of the strength class, size and type specified,**

Before fixing cast iron manhole covers and frames, they shall be dipped in an approved preservative and gratings and frames painted with two coats of bituminous paint.

g) Corrugated metal culvert units

Corrugated metal culverts shall either be supplied fully assembled; or as unassembled nestable arch or circular segments, in which case they shall be assembled in accordance with the manufacturer's specifications.

A3.2 5 MATERIALS

A3.2.5.2 Culvert materials (continue)

h) Protective coating for metal culverts

Metal culverts shall have a protection coating as specified in the Contract Documentation or indicated on the drawings, and may be of galvanized, aluminized or polymer coatings to the specified thickness. Where soil or water conditions are likely to cause excessive corrosion of metal culverts, the Engineer may prescribe that prefabricated units be protected by the application of a mastic asphalt protective coating. The coating shall be applied to either the inside, the outside or to both sides of the metal culvert units as may be directed by the Engineer.

i) U-PVC culverts (HDPE ?)

U-PVC culverts shall comply to the requirements of SANS 791 for solid wall pipes (category-heavy duty) and shall have socketed ends should joining be required.

j) Alternative culvert materials

Alternate culvert materials, if any, shall be specified and detailed in the Contract Documentation

A3.2 5 MATERIALS

A3.2.5.3 Skewed ends

These prefabricated culvert units at the inlet and outlet of the culvert **shall be supplied with skew ends by the manufacturer**, if required. **The cutting of skew ends on the site shall not be allowed.**

Prefabricated portal and rectangular culverts placed on a skew shall be constructed with cast in-situ skewed ends as shown on the drawings. In-situ skew ends are to be constructed simultaneously with the wingwalls and headwalls.

<u>Note</u>: Where half-length pipe units is required for <u>Item C3.2.3 Concrete pipe culverts</u> –"the actual length of such half –length pipe unit will be measured for payment and no additional compensation will be paid in respect of such half-length pipe unit" .

A3.2 5 MATERIALS

A3.2.5.4 Prefabricated energy dissipaters in outlet structures

Where shown on the drawings, the Contractor shall supply and install in the outlet structures, **prefabricated reinforced concrete energy dissipaters of class C25/30-20 concrete with dimensions as shown on the drawings.**

A3.2 5 MATERIALS

A3.2.5.5 . Fine granular material

Wherever the use of **fine granular material is specified in this section for the bedding of the prefabricated concrete floor slabs of the culverts, it shall mean sand or other cohesionless material, all of which shall pass through a 7,0 mm sieve and not more than 10 % of which shall pass through a 0,15 mm sieve**.

A3.2.5.6 Materials at joints

Joint filler and joint sealing material shall comply with the requirements of Section A13.7 of Chapter 13.(Cover all types of joints in structures ,horizontal and vertical joints in walls and slabs – different type of polymers)

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A3.2 7 EXECUTION OF THE WORKS

A3.2.7.1 Construction methods (Prefabricated culverts)

- The "**trench method**", where the units are laid in a trench excavated below the existing ground level or in a trench excavated in constructed subgrade and, if necessary, subbase layers, or, in the case of an existing road, in a trench excavated through all road layers; **OR**
- The "**embankment method**", where the units are laid approximately on the existing ground surface or on a prepared bedding and the subgrade is then constructed on either side and over the culvert.
- If **lengthening of existing culverts** are specified such lengthening shall generally be according to the "**embankment method**".
- The **Contractor shall at all times ensure that the existing drainage is at all times maintained** and any damage caused as a result of blocked culverts during construction shall be repaired at the Contractor's cost.
- All **new prefabricated culverts/portals** shall be installed by the “t**rench method**”, unless specified otherwise by the Engineer.
- The bottom of the excavation for culverts that are to be replaced or lengthened shall be inspected by the Engineer prior to the placing of the bedding .

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.1 Construction methods (Prefabricated culverts)

- Where the **material is found to be unsuitable, it shall be removed** to a depth specified and replaced with selected material compacted to at least 93 % MDD in layers not exceeding 150 mm thickness.
- **Design invert levels of drainage culverts shall be verified on site** by the Engineer with the assistance of the Contractor **before installation of new or lengthened culverts may commence.**
- In all cases **where soft founding material is classified as suitable for bedding** construction, the in-situ material shall be scarified, moistened and **compacted** to a depth of 150 mm below founding **level to 90 % or 93 % MDD, as specified by the Engineer.**
- The **larger sizes of portal or rectangular culverts shall normally be constructed by the embankment method.**
- **Surface drainage shall be controlled by the construction of temporary earth berms and drainage diversion channels.**
- **The Contractor shall strictly comply with all the appropriate statutory safety provisions in regard to trench excavations.**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.2 Excavation for construction by <u>trench method</u>

a) Classification of Materials

b) Excavation

- All excavations for culverts shall be excavated **in the position and to the required dimensions.**
- In the case of culverts to be constructed by the trench method, the Contractor shall **first construct the fill, subgrade and, if necessary, the subbase to such level as will provide a minimum cover(as per the drawings)**, **above the proposed level of the top of the culvert**. **Road <u>base layers</u> shall not be constructed before the culvert and backfill have been completed**
- For **metal culverts, the minimum cover height shall be 0,25 times the diameter of the pipes, or 0,25 times the span of pipe arches**. The Contractor may then commence excavating the trench for the culvert from the downstream end.
- **Excavations shall be continuously monitored and assessed for stability and safety and if any risk of instability is evident the Contractor shall not proceed with culvert excavation until safe working conditions have been re-established**.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.2 Excavation for construction by <u>trench method</u>

c) Width of excavation

The width of excavations shall be sufficient to allow the bedding, proper construction and backfilling of culverts. **The width of the excavation for each size of culvert shall be as shown on the drawings**

d) Excavation by hand

Where the circumstances prevent the use of mechanical excavators due to possible damage to existing works and soft material can only be removed by hand tools, the Engineer shall authorise the excavation by hand ,

e) Drainage of excavations

The **Contractor** shall, in terms of Clause A1.2.3.19 of Chapter 1, **apply suitable, effective drainage and dewatering methods for preventing the ingress of water into the excavation and to keep them dry.**

Drainage methods, with the exception of pumping, shall be maintained until the backfilling has been completed..

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.3 Preparation for construction by the <u>embankment method</u>

The Contractor shall level the existing ground by excavating, filling and compacting as may be necessary **to provide exactly the required slope and a uniform density over the entire length of the culvert**.

The finished level of the ground for the bedding of the culvert shall be not lower than 75 mm in the case of culverts with prefabricated invert slabs. In the case of culverts with cast in situ invert slabs, the level shall exactly accommodate the floor slab.

A3.2.7.4 Unsuitable founding conditions

Where **the bottom of the trench does not provide a suitably firm foundation** for the culvert on account of soft, unstable, or otherwise unsuitable material being encountered, **the unsuitable material shall be excavated to a depth below the bottom of the culvert as may be indicated by the Engineer**.

The **width of the excavation and foundation later** shall be in the case of culverts to be constructed by the embankment method, **be wider by at least one culvert diameter on each side of the culvert or set of culverts or as shown on drawings .**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.5 Disposal of excavated material

Where **excavated material does not comply with the requirements for backfilling material as specified** hereinafter or is surplus to backfilling requirements, such **excavated material shall be removed from the site and disposed of in approved spoil areas**

Material suitable for use in the works, however, shall be used as prescribed Payment for such material will be made as for excavation under item C3.2.1, and also under the appropriate item for such part of the works as may be constructed.

A3.2.7.6 Construction of culverts

a) General requirements

The construction of culverts shall be **commenced at lower end** of the culvert

Units which have been **deformed or cracked, shall be removed and replaced**

Prefabricated slabs shall be lifted and handled by means of approved lifting devices only. During such procedures all relevant safety regulations shall be adhered to. Lifting eyes shall be caulked with a suitable mortar after the units have been installed. All lifting holes shall be filled with cement mortar and covered with class 3 geotextile.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.6 Construction of culverts

b) Rectangular concrete and brickwork culverts

(i) Cast in situ floor slabs

Cast in situ floor slabs shall be constructed to the dimensions and at the locations ,with steel reinforcement and joints of the types detailed on the drawings. **A screed layer shall be cast to the specified dimensions and details, prior to casting the floor slab.** In addition, longitudinal construction joints as shown on the drawings between the invert slabs of each the barrels of multiple culverts are required. Allowance for Class F1 surface finish and soft board in these joints is made in the schedule of quantities. No payment shall be made for formwork on the outside edges of invert slabs (closest to the excavated face).

(ii) Prefabricated floor slabs

A layer of fine-grained material at least 75 mm thick shall be placed on the bottom of the excavation or backfilled bedding, leveled, compacted and trimmed to line and grade, to form a bed to receive the prefabricated slabs.

The slabs shall be carefully placed on the prepared bed, true to line and grade, and so bedded that they will be uniformly supported over their whole area on the bedding.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.6 Construction of culverts

b) Rectangular concrete and brickwork culver (continue)

(iii) ***Concrete walls for concrete culverts***

Cast in situ concrete reinforced walls shall be constructed to the dimensions and at the locations as shown on the drawings. **Joints of the types detailed on the drawings shall be formed in the walls, and between the wall and the inlet and outlet structures.**

(iv) ***Brickwork walls for brickwork culverts***

Brickwork shall be built in English bond in a mortar consisting of one part of CEM I class 32.5 cement and six parts of sand, or in stretcher bond where its thickness does not exceed 115 mm. It shall be well and regularly bonded without any false headers. Engineering bricks shall be well wetted before laying and each brick shall be pressed into its bed so as to leave a finished joint not exceeding 10 mm in thickness. **All joints shall be filled solid with mortar, and joints for exposed faces shall be pointed as the work proceeds.**

Where pipes enter brickwork, such pipes shall be thoroughly caulked into the wall and rendered with mortar.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.6 Construction of culverts

b) Rectangular concrete and brickwork culver (continue)

(v) Plaster for brickwork culverts

- Where the plastering of brickwork is required, all joints shall be well raked out and the brick face thoroughly wetted before plaster is applied. **Plaster shall not be less than 12 mm or more than 20 mm thick.**
- **Plaster shall be cured for at least 48 hours, where after installation of roof slabs may commence.**

(vi) Cast in situ roof slabs

Cast in situ reinforced roof slabs shall be constructed to the dimensions and at the locations as shown on the drawings. Joints of the types detailed on the drawings shall be formed in the roof slabs, coinciding with similar joints in the floor slabs, and between the roof slabs and the inlet and outlet structures.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.6 Construction of culverts

b) Rectangular concrete and brickwork culver (continue)

(vii) Prefabricated roof slabs

Shall be placed accurately and symmetrically on the concrete walls, with a thin layer of mortar of one part of CEM I class 32.5 cement and six parts of sand between the contact surfaces to ensure a firm and uniform support.

The units shall be butted end to end with butt joints, which joints shall be covered with two layers of grade 3 geotextile , pre-impregnated with a bituminous emulsion, or a similar approved material. The strip of geotextile shall be at least 150 mm wide and placed symmetrically over the joint. The units shall first be treated with a primer of 60 % bitumen emulsion over the width of the strip of geotextile.

Where **two or more roof slabs** are placed side by side to form a multi-barrel culvert, **the space between the slabs, if any, shall be filled with concrete up to the level of the top of the slab. Alternatively, such joints shall be sealed as for butt joints.**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.7 Laying and bedding of prefabricated culverts

a) Concrete pipe culverts

Prefabricated concrete pipe culverts shall be laid on Class A, B, C or D bedding as shown on the drawings or as specified. **The pipe ends shall be laid hard up against each other so as to obtain tight joints. Ogee pipes shall be laid with their spigot ends pointing downstream. The joints shall be sealed on the outside with two layers of bitumen-impregnated grade 3 geotextile**.

(i) Class A bedding

The **pipe shall be laid with its bottom part on a C20/25-20 <u>concrete bedding</u> <u>cradle</u> of specified thickness** below the lower part of the pipe, which **concrete shall extend upwards on both sides of the pipe to a specified portion of its height, as shown on the drawings.**

(ii) Class B and Class C beddings

The **pipe shall be laid on a <u>bedding cradle of compacted selected granular material</u> as specified**. **The bedding shall extend upwards on both sides of the pipe to a specified portion of its height, as shown on the drawings. <u>Grooves for thickened pipe ends , shall be formed in the bedding cradle to ensure support through out the barrel length</u>** .

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.7 Laying and bedding of prefabricated culverts

a) Concrete pipe culverts (continue)

(iii) ***Class D bedding***

The **pipe shall be laid on the in-situ material of the excavation after the bottom has been hand trimmed to support the pipe along the entire length of its barrel in accordance with the details shown on the drawings**. Wherever necessary, the in-situ material shall first be stabilised in accordance with the details shown on the drawings. Grooves for thickened pipe ends, if applicable, shall be formed in the trench bottom for pipe sockets and couplings, to ensure that each pipe is fully supported throughout the length of its barrel on the bedding cradle.

(iv) Rock foundation

Where rock, shale or other hard material is encountered on the bottom of excavations, the installation of pipes on Class B bedding shall proceed as follows:

The material below the pipe shall be excavated and replaced with a bed of sand or approved gravel or soil to a depth as shown on the drawings . Such material shall be classed as backfill for purposes of payment. Class B bedding shall then be prepared .

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.7 Laying and bedding of prefabricated culverts

a) Concrete pipe culverts (continue)

(v) Concrete casing

Where **shown on the drawings or specified by the Engineer, pipes shall be fully encased in concrete according to class and dimensions as shown on the drawings. Supports shall be provided close to the pipe ends to support the pipes during the placing of concrete**. The concrete shall be so placed as to fill all spaces below and around the pipe completely. **Poker vibrators shall be used for this purpose. Concrete casing shall be cast in one continuous operation until completed**.

b) Prefabricated portal culverts

(i) Cast in situ floor slabs

Cast in situ floor slabs shall be constructed to the dimensions and at the locations as shown on the drawings Where **specified a screed layer shall be cast to the specified dimensions and details, prior to casting the floor slab**.

Transverse construction joints are required in cast in situ concrete invert slabs as well as **longitudinal construction joints** as shown on the drawings between the invert slabs of each the barrels of multiple culverts are required

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.7 Laying and bedding of prefabricated culvert

b) Prefabricated portal culverts (continue)

(ii) Prefabricated floor slabs

A **layer of fine-grained material at least 75 mm thick shall be placed on the bottom of the excavation** or backfilled bedding, leveled, compacted and trimmed to line and grade, to form a bed .

The slabs shall be carefully placed on the prepared bed, true to line and grade, to ensure uniformly supported over the bedding.

(iii) Placing the portal portions of culverts

Shall be placed accurately and symmetrically on the floor slabs, with a thin layer of mortar of one part of CEM I class 32.5 cement and six parts of sand between the contact surfaces to ensure a firm and uniform support.

The units shall be butted end to end with butt joints, which joints (both horizontally and vertically) shall be covered externally with two layers of grade 3 geotextile , pre-impregnated with a bituminous emulsion, or a similar approved material. The strip of geotextile shall be at least 150 mm wide and placed symmetrically over the joint. The units shall first be treated with a primer of 60 % bitumen emulsion over the width of the strip of geotextile.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.7 Laying and bedding of prefabricated culvert

c) Metal culverts

- The excavation shall be trimmed to the shape of the invert of the culvert and **a bed of fine granular material not less than 75 mm thick** shall be placed, compacted and shaped to enable the culverts to be bedded **as shown on the drawings.**
- **Where rock is encountered, the depth of excavation shall extend to a depth of at least 200 mm below the invert of the culvert and shall be filled with granular material as before.**
- The **culverts shall be assembled and installed in accordance with the manufacturer's specifications** . Anchor bolts shall be installed at the ends of metal pipe culverts in accordance with the manufacturer's instructions to bond them into inlet and outlet head walls, which head walls shall be constructed as soon as possible after installation of the culverts.
- **No concrete bedding or casing shall be used in the installation of metal culverts**.
- **Where prescribed, the inner invert of metal culverts with diameters or spans exceeding 1 500 mm which are laid on steep grades shall be protected with a layer of concrete with dimensions and class as shown on the drawings**.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.8 Extension of existing culverts

- Where an existing portal or rectangular culvert requires extension, the new section **shall be constructed at the same grade and, where it joins the existing structure, at the same level as the existing structure**.
- Any sections of **existing wing walls, approach slabs and head walls, which may obstruct any new work, shall be demolished and removed**. Existing culvert ends shall not be damaged, but should damage occur, the repair work shall be done before the construction of the extension
- **Joining shall be done in accordance with the drawings After completion of the extension of a culvert, new approach slabs, head walls, wing walls, catchpits, etc. shall be constructed .**

A3.2.7.9 Construction of culverts in half widths in existing roads

Unless otherwise prescribed, the **downstream section shall be constructed first. The end of the excavation adjoining the traffic lane shall be properly supported and shored up to prevent displacement or collapse from occurring**. **The necessary warning signs and barriers shall be erected in accordance with the requirements of Section A1.5 of Chapter 1. No work may be commenced with before safety barriers and traffic signs have been erected and approved .**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.10 Backfilling of culverts

- **No backfilling of a brickwork or in situ concrete structure may be done for a period of at least 7 days after the structure has been completed**, unless otherwise specified. **No backfilling of a brickwork structure may be done until the roof slab has been installed**.
- The material used for the backfilling of those portions of culverts subject to traffic loads shall be selected material of at least subbase quality or such other lower quality as may be permitted by the Engineer.
- **Backfilling alongside and over all culverts** shall be placed at optimum moisture content and **compacted in layers not exceeding 150 mm** after compaction, to a density of at least the density required for the material in adjoining layers of fill, subgrade and subbase. **The density of backfilling in excavations made in natural ground shall be at least 93 % of MDD.**
- **Backfilling shall be carried out simultaneously and equally on both sides of a culvert to prevent unequal lateral forces from occurring.**
- **Whenever specified** or as may be specified by the Engineer, **a wet or a stiff mixture of soil cement in lieu of a compacted gravel placed between the side of the culvert and the excavation up to the top of the culvert shall be used.**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.10 Backfilling of culverts (continue)

- The **wet mixture of soil cement** shall consist of an **approved soil or gravel mixed with 5,0 % of CEM II class 32.5 cement and only sufficient water to give a consistency that will permit the soil cement to be placed with vibrators.**
- A **stiff mixture of soil cement** shall **contain 3,0 % of CEM II class 32.5 cement and just sufficient water for it to be placed and compacted like ordinary backfill material.** The height to which the soil cement backfill shall be taken shall be as prescribed or shown on the drawings, and any remaining backfill shall be carried out as described above with selected material.
- The **material used for soil cement shall preferably be a sandy material but may contain larger particles up to 38 mm, and it shall not have a plasticity index exceeding 10.** Detrimental percentages of silt or clay shall be avoided, and where the excavated material is not of adequate quality, the material shall be obtained from an approved source
- . **The soil cement shall be mixed on the site with suitable concrete mixers, and the water and cement contents shall be carefully controlled**. **Should the Contractor provide adequate quality control mechanisms for hand mixing, the Engineer may approve alternative mixing methods.**

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.11 Inlet and outlet structures, catchpits and manholes

Inlet and outlet structures for culverts as well as catchpits and manholes shall be constructed in accordance with the details shown on the drawings.

a) Excavation and backfilling

- **The specifications of Clause A3.2.7 for excavating and backfilling the culverts shall apply to inlet and outlet structures, catchpits and manholes**.
- **No backfilling of a structure may be done for a period of at least 7 days after the structure has been completed, unless otherwise specified** .

b) Concrete work

- **The specifications of Clause A3.2.5.2a) for in situ concrete shall apply to inlet and outlet structures, catchpits and manholes**.
- The **type of surface finish for in situ concrete** in the culverts shall be **indicated on the drawings**. **Generally, all exposed faces shall be of Class F2 formwork and faces covered by backfill shall be Class F1. The top parapet walls and wingwall shall be finished to a Class U2 surface finish** .

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.11 Inlet and outlet structures, catchpits and manholes

c) Brickwork

The specifications of Clause A3.2.7.6b)(iv) for brickwork walls shall apply to inlet and outlet structures, catchpits and manholes.

d) Plaster

The specifications of Clause A3.2.7.6b)(v) for plaster shall apply to inlet and outlet structures, catchpits and manholes.

e) Manhole covers, grid inlets, etc

The specifications Clause A3.2.5.2f) for manhole covers and frames, grid inlets and other metal accessories shall apply to inlet and outlet structures, catchpits and manholes.

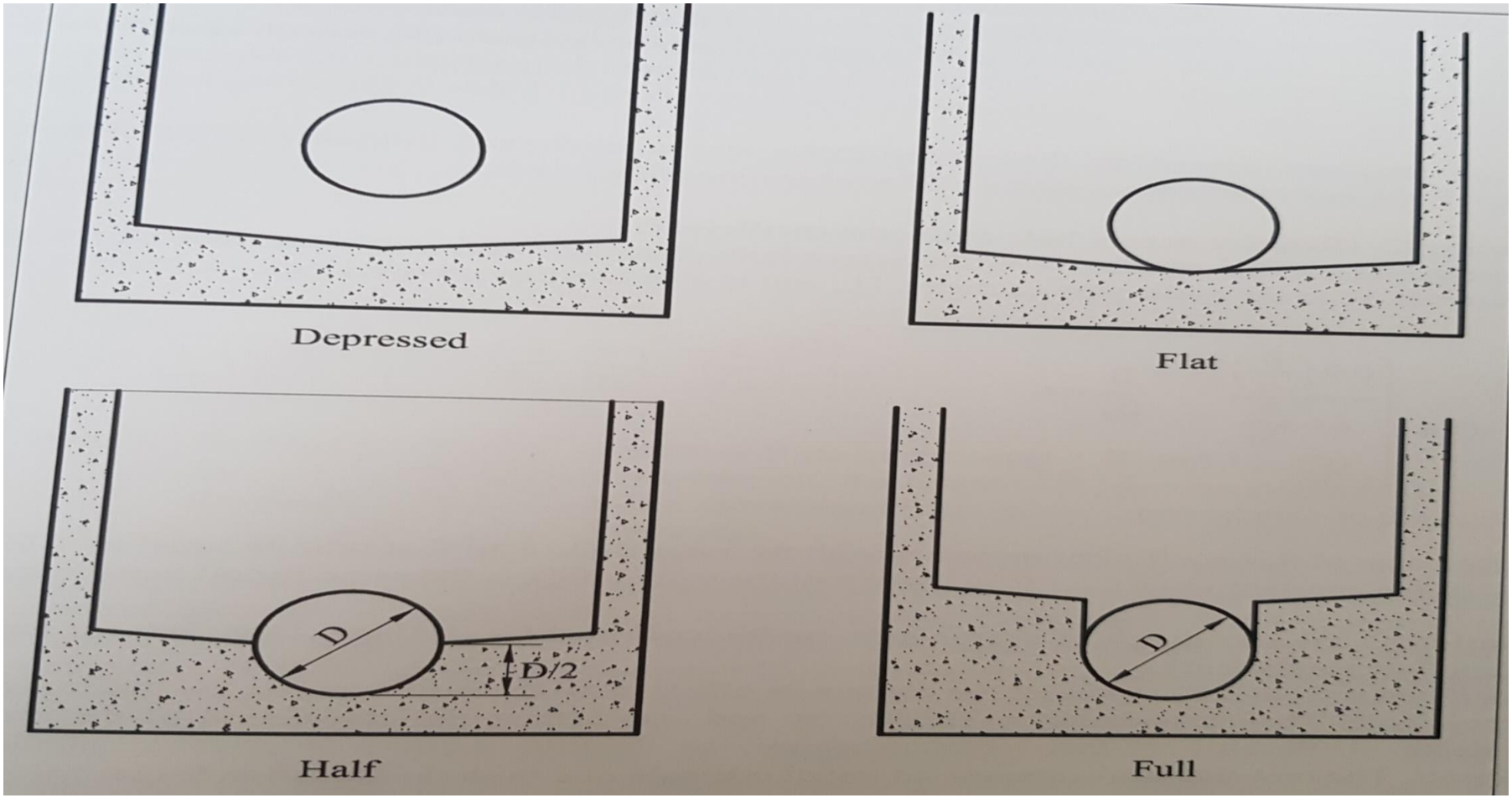
f) Benching (finishing plaster to influence hydraulic flow in manholes)

All benching shall be rendered in 20 mm granolithic plaster and finished smooth and true with a steel trowel. Corners shall be rounded to dimensions shown on the drawings.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.11 Inlet and outlet structures, catchpits and manholes

f) Benching (finishing plaster to influence hydraulic flow in manholes)



A3.2 7 EXECUTION OF THE WORKS

A3.2.7.11 Inlet and outlet structures, catchpits and manholes

g) Inlet and outlet structures.

Prefabricated c**oncrete inlets and outlets shall not be installed until** the **installation procedures have been approved by the Engineer. Contractor shall provide details of joining precast inlet and outlet elements to installed culverts as well as the bedding and backfill procedures to ensure that the ingress of water and undermining of inlets and outlets is avoided**. Cast in situ concrete wingwall type inlets and outlets shall be constructed as indicated on the drawings and shall comply with the requirements of Section A13.4 of Chapter 13.

h) Prefabricated energy dissipaters in outlet structures

Where shown on the drawings, the Contractor shall supply and install in the outlet structures, prefabricated reinforced concrete energy dissipaters of class C25/30-20 concrete with dimensions as shown on the drawings

A3.2.7.12 Removal of existing work

Section A1.6 of Chapter 1 specifies which structures have to be removed as part of the clearing and grubbing operations, the removal of which will therefore not be measured and paid for under this Section.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.12 Removal of existing work (continue)

Undamaged recovered pipes may be re-used in the works were indicated by the Engineer. **Recovered pipes which cannot be re-used shall remain the property of the Employer and shall be stacked within the road reserve or were directed by the Engineer.**

A3.2.7.13 Joining new work to old

Where partial or full demolition is required for extension work to existing concrete structures, **the demolition and removal work shall be executed as specified in Section A14.3 of Chapter 14**. **The provision of reinforcing anchoring shall be as specified in Section A14.5 of Chapter 14; and the surface repair shall be executed as specified in Section A14.4 of Chapter 14**. Larger concrete extensions shall be executed as specified under the relevant concrete element for cast in situ concrete and paid under item C3.2.7.

A3.2.7.14 Sleeving or lining of existing culverts

Specifications for sleeving or lining of existing culverts, which have specific defects as well as the measurement and payment, shall be specified under the Contract Documentation.

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.15 Culverts on steep gradients

- **Where culverts are constructed on gradients exceeding 1 in 4, such culverts shall be referred to as <u>inclined culverts</u>**. Inclined culverts shall be constructed from the type of unit required, normally either circular concrete pipe units or metal culvert units as described in Clause A3.2.5.2.
- **Particular care shall be taken to protect excavations for inclined culverts against stormwater damage during the construction stage.** The trenches shall be excavated down to firm ground and backfilled with selected gravel or concrete if it is necessary to over-excavate for obtaining a firm floor.
- After the **outlet structure has first been completed**, the culvert units shall **be laid in the normal manner by starting from the lower end and placing successive units firmly against each other to prevent subsequent movement.** The lower unit shall be securely cast into the outlet structure, and metal culverts shall be provided with the necessary anchor bolts at both inlet and outlet structures .
- **Thrust and anchor blocks shall be constructed from concrete as required in accordance with the drawings** . Anchor bolts, straps and other anchoring devices shall be provided.
- **The backfilling of trenches shall be done in horizontal layers starting at the lower end** .

A3.2 7 EXECUTION OF THE WORKS

A3.2.7.16 Other stormwater pipes and closed conduits

- Unless provided for elsewhere the specifications given in this Section for culverts, including the method of measurement and payment, shall apply to the construction of pipes in closed or urban type stormwater systems, **tremies**(watertight pipe used to pour concrete below ground level or under water) or any other closed conduits constructed in situ or from prefabricated units, whether intended for drainage or for any other purpose.
- **No distinction will be made in the schedule of quantities between the construction of culverts as defined elsewhere in Section A3.2 and that of the other closed conduits described in this Clause A3.2.7.16, all being classed as culverts**.
- **Tremies constructed from prefabricated units, shall be classed as inclined culverts were laid to a grade steeper than 1 in 4.**

A3.2.8 WORKMANSHIP

A3.2.8.1 Construction tolerances and surface finish

a) Culverts

(i) Horizontal alignment

The maximum deviation from the true position of the edges or centerline shall be 25 mm.

(ii) Vertical alignment

The invert level shall nowhere deviate by more than 25 mm from the required level and nowhere shall the inverts have an adverse grade

(iii) Trueness of exposed surface

When tested with a 3,0 m straight-edge, no exposed formed or cast concrete or precast surface shall have surface irregularities exceeding 10 mm.

(iv)Cross-sectional dimensions

All cross-sectional dimensions shall be within 10 mm of the specified dimensions, and the average thickness of a floor, wall or roof slab shall not be less than the specified thickness.

b) Surface finish : Unformed exposed concrete surfaces shall have a class U2 surface finish and formed exposed concrete surfaces a class F2 surface finish.

C3.2 CULVERTS

PART C : MEASUREMENT AND PAYMENT

- **C3.2.2 Backfilling**

C3.2.2.3 (a) With wet mixture (specify cement content) ~~of 3%cement~~ .

(b) With dry mixture (specify cement content) ~~of 3% cement~~

- **C3.2.13 Removal and relaying existing culverts**

The tendered rate shall include full compensation for lifting, loading, transporting for a haul distance within 1,0 ~~5,0~~km without additional payment, off-loading, stacking (if required) and laying pipes according to the specifications

- **C3.2.19** Should read **Manhole or catch pit Accessories**

QUESTIONS

3.3 CONCRETE KERBING AND CHANNELING ,ASPHALT BERMS ,CHUTES ,DOWNPIPES ,AS WELLAS CONCRETE ,STONE PITCHING AND GABION LINING FOR OPEN DRAINS

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3.3 CONCRETE KERBING AND CHANNELING ,ASPHALT BERMS ,CHUTES ,DOWNPIPES ,AS WELLAS CONCRETE ,STONE PITCHING AND GABION LINING FOR OPEN DRAINS

A3.3.1SCOPE

This **Section mainly covers the drainage of road and bridge surfaces into open structures or conduits**. Drainage may transfer into culverts or conduits or to natural or formed drainage channels. **It covers** work in connection with the **construction of concrete kerbing and its channeling, asphalt berms, kerb inlets, chutes, downpipes, and linings for open drains constructed from concrete, stone pitching, gabions, mattresses or alternative materials** at the locations and to the details as shown on the drawings or specified by the Engineer. This Section also **covers the replacement of damaged kerbing, channeling, asphalt berms, and lining of all types of construction**.

3.3 CONCRETE KERBING AND CHANNELING ,ASPHALT BERMS ,CHUTES ,DOWNPIPES ,AS WELLAS CONCRETE ,STONE PITCHING AND GABION LINING FOR OPEN DRAINS

A3.3.3 GENERAL

A3.3.3.1 Types of structures

Kerbing shall include barrier kerbs, mountable and semi-mountable types. All these elements may be prefabricated or constructed in a continuous operation using slipforms. Kerb inlets shall generally be cast in situ concrete.

Channeling may be cast in situ concrete, prefabricated units, slipform construction, stone pitched, or gabion lined.

Chutes may be prefabricated units, cast in situ concrete, stone pitched, or gabion lined.

Lining of open channels may be cast in situ concrete or stone pitched or gabions, except that side slabs may be precast on site or elsewhere.

Downpipes shall be prefabricated elements, of concrete, steel or U-PVC or HDPE.

Asphalt berms may be cast in situ in moulds or constructed by means of a suitable machine.

A3.3.5 MATERIALS

A3.3.5.2 Drainage structure materials

a) Concrete

b) Cement
Cement shall comply with SANS 50197-1 for **CEM I or CEM II with a strength class of 32,5 or greater,** and a rate of strength gain N or greater.

c) Kerbing and channeling
Prefabricated kerbing and channeling **shall be manufactured on site or elsewhere and shall comply with the requirements of SANS 927**. Cast in situ kerbing and channeling shall be of the class of concrete indicated.

d) Joint sealant
Two-part cold applied **polysulphide sealing** compound shall conform to the requirements of BS 4254.
Polyurethane-based joint sealants shall comply with the requirements of SANS1077.
Silicone-based joint sealants shall comply with the requirements SANS 1305 unless otherwise indicated in the Contract Documentation.

A3.3.5 MATERIALS

A3.3.5.2 Drainage structure materials (continue)

e) Bedding material

Concrete as bedding or backing material, in shall be a class C16/20-20 cast in situ concrete.

Alternative bedding shall consist of crushed stone, slag, sand or other approved porous material with a maximum particle size of 14 mm.

f) Asphalt berms

Asphalt berms shall be bedded on completed surfacing layers or primed base layers. Asphalt shall be a continuously graded fine or medium mix, as specified, with aggregate grading as specified in Table A9.1.5-5 of Chapter 9 and mix properties as specified in Table A9.1.3-2 of Chapter 9.

g) Stone

h) Sand for concrete

i) Gabions and mattresses

The materials used for the construction of gabions and mattresses which may include rock, PVC-coated and/or galvanized wire and wire mesh **shall comply with the requirements of Section A12.6 of Chapter 12.**

A3.3.5 MATERIALS

A3.3.5.2 Drainage structure materials (continue)

j) Geotextiles

k) U-PVC & HDPE pipes

U-PVC and HDPE pipes shall comply to the requirements of SANS 791 for solid wall pipes (category-heavy duty) and **shall have socketed ends should joining be required.**

l) Bituminous binders

Should a **prime coat** be required, it **shall conform to the specifications of the prime for the base layer.**

The **bond coat** shall consist of a **stable grade bituminous emulsion diluted to have 30 % net bitumen content**

m) Polymer film sheeting

Plastic for drainage systems to be used shall be polymer film type sheeting of 150-to-250-micron (0,15 to 0,25 mm) thickness, **complying with SANS 952-1**

n) Alternative materials

Shall be specified and detailed in the Contact Documentation Alternative materials shall be submitted for approval, accompanied by the verification of being fit for purpose, specific performance guarantees.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

a) Excavation and preparation of bedding

(i) Kerbs and channels

Trenches shall be excavated to the required depth and all unsuitable material shall be removed and replaced with a layer of approved bedding material at least 75 mm thick. The bedding shall be compacted and accurately shaped to the required grade and level. No in situ concrete or precast concrete units shall be placed on uncompacted or disturbed material.

(ii) Asphalt berms

If indicated on the drawings the **base layer prime coat shall extend wider to cover the area where the berms are to be constructed**. Asphalt berms should be constructed after the completion of surfacing and any vehicle restraint systems in order to minimise the risk of damage.

Before any specified berms or priming commences, the specified width of the base projecting beyond the surfacing shall be thoroughly cleaned.

The bond coat shall consist of a **stable grade bituminous emulsion diluted to have a 30 % net bitumen content and shall be applied at a rate of 0,4 litres per square metre onto the entire berm foundation**. The bond coat shall be left to dry before the berm is constructed.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

a) Excavation and preparation of bedding (continue)

(iii) Linings for open drains

The excavation work for open drains and clearing and grubbing if required, shall be executed and paid for under and in accordance with the provisions of Section A3.1.

All <u>loose material</u> shall be compacted to a density of not less than 93 % of MDD. Where the in-situ material is unsuitable, the Engineer may instruct that it be removed to the required depth and replaced with selected material compacted to a density of 93 % of MDD to the required grade and level.

Where **<u>stone pitching or gabions</u> are specified, the area shall be prepared by excavating, shaping and trimming as necessary and by thoroughly compacting the area by hand-ramming to prevent subsequent settlement**. A trench shall be excavated as directed by the Engineer along the toe of any slopes to be lined or along the unprotected edge of the linings in the beds of streams to allow the construction of a thickened edge of the specified lining.

Where **excavations for <u>open drains are in rock</u>**, **overbreak shall be backfilled as specified, either with mass concrete or with selected gravel or soil compacted to a MDD of at least 93 %.**

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

a) Excavation and preparation of bedding (continue)

(iv) Chutes

Excavations for chutes **shall be neatly trimmed. All loose material shall be thoroughly compacted, and where overbreak occurs in hard material, the excavations shall be backfilled with mass concrete**.

b) Prefabricated concrete kerbing and channeling

Unless otherwise specified in the Contract Documentation, prefabricated concrete kerbs shall be laid with a class C16/20-20 cast in situ concrete bedding and support behind the kerbs in accordance with the details shown on the drawings.

Prefabricated concrete kerbing and channeling shall be laid on the approved **bedding with close joints filled with 3:1 sand: cement mortar** not exceeding 10 mm in thickness and neatly pointed with a pointing trowel. Kerbing around curves shall first be laid along the full curve length before the joints are filled, unless otherwise allowed by the Engineer.

Unless otherwise specified, prefabricated **concrete kerb units shall be 1,0 m in length, except at curves at road junctions, where the kerb units shall be 0,5 m in length for curve radii between 5,0 m and 20 m and 0,3 m in length for curve radii between 1,0 m and 5,0 m. For curves with a radius less than one metre the kerbs shall be cast in situ.**

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

c) Chutes and downpipes on side slopes of fills and cuts

(i) Prefabricated chutes and downpipes

Shall be manufactured in accordance with the dimensions shown on the drawings, and the **units shall fit neatly into each other. The bottom unit shall rest against the outlet structure or footing as shown on the drawings**. The units shall be laid true to line and grade from the bottom up so that each unit fits neatly into the previous one.

Downpipe joints shall socket into each other with the external joint facing toward the inlet of the drain.

(ii) Stone pitched chutes

Stone pitched chutes **shall be constructed as specified for stone pitched open drains** as specified in Clause A3.3.7.1i).

d) Slip-form kerbing

Shall be placed on an approved bedding by a continuous process with an approved slip form machine. Contraction joints shall be sawn at intervals shown on the drawings . The concrete shall be cured in accordance with the requirements of Section A13.4 of Chapter 13.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

d) Slip-form kerbing (continue)

Where transverse cracks occur, the Contractor shall replace the entire section between the contraction joints at his own cost.

Curing shall be carried out strictly in accordance with the approved method statement

Special care shall be taken to ensure that expansion joints are constructed and sealed as shown on the drawings

e) Cast in situ kerbs and channels

Forms for kerbs and channels shall be accurately set to line and elevation and shall be firmly held in position during the placing of the concrete. Stops and jointing material at the ends of sections shall be accurately placed to ensure that joints between adjacent sections are perpendicular to the surface of the concrete and at right angles to the edge of the road.

After **concrete has been placed in the forms, it shall be tamped and worked until mortar entirely covers any exposed faces**. Exposed faces shall then be finished to smooth and even surfaces and edges shall be rounded to the radii shown on the drawings.

Special care shall be taken to assure that expansion joints are constructed and sealed as shown on the drawing

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

f) Cast in situ chutes on cut slopes

Cast in situ concrete chutes on cut slopes, **together with the inlet and outlet structures, shall be constructed in accordance with the drawings. On slopes steeper than 1:2 cast in situ concrete shall be constructed by boxed shuttering**.

Where specified a concrete screed shall first be cast on excavations that cannot be trimmed accurately. The screed shall be finished to the level of the underside of the chute floor slab and allowed to set before the floor slab is cast.

g) Asphalt berms

Berms shall be constructed with the toe of the berm not encroaching more than 25 mm into the surfacing of the adjacent roadway or shoulder.

When <u>placed by hand</u>, the asphalt shall be placed and shaped in situ in a rigid portable mould to form a trapezoidal berm of the dimension specified or indicated on the drawings. The asphalt mixture shall be thoroughly compacted to form a hard unyielding berm, true to level, shape and line, within the specified tolerances. **The moulds may be removed as soon as the asphalt has cooled or hardened .**

A <u>machine</u> of approved design may be used for placing the berm, machine placed berms will not require additional compaction but in areas where compaction is inadequate, the machine shall be ballasted with additional mass.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

g) Asphalt berms (continue)

Should the berms be **constructed before the construction of vehicle restraint systems, the post holes shall be excavated with care to prevent damage to the berms.**

Where **chute or downpipe inlets are required against fills, the berm shall be discontinued until the inlet is constructed, and thereafter finished to form a tie in with the inlet.**

h) Concrete-lined open drains

The exposed surfaces of the concrete linings of open drains shall have a class U2 surface finish. Concrete shall be cured in accordance with the requirements of Section A13.4 of Chapter 13.

Sealed joints in concrete shall be in accordance with the details indicated on the drawings as well as the provisions of Section A13.7 of Chapter 13. **Cold joints shall be painted with a coat of approved bituminous emulsion containing 60 % of net bitumen by mass, or with an approved anti-adhesive before any adjoining slabs are cast**.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

h) Concrete-lined open drains (continue)

Expansion joints shall be made in accordance with the drawings.

The **surfaces on which concrete lining is to be cast shall**, after having been trimmed, **be covered with polymer film sheeting of 0.15mm thickness** and all joints in the sheeting shall be overlapped by at least 150 mm. **Alternatively the surface could be sprayed with invert bituminous emulsion as soon as possible after the excavations have been trimmed and compacted**. The sprayed surfaces shall be maintained until the concrete lining is cast. The nominal rate of application of the emulsion shall be 0,5 litre/m^2 unless otherwise specified .

i) Stone pitched open drains

(i) Grouted stone pitching with mortar

Commencing from the bottom of the trench, the stone shall be moistened and embedded in freshly laid cement mortar composed of one part of cement to every six parts of sand by volume. The stones shall be firmly bedded against adjoining stones. Any **spaces between the stones shall be filled with cement grout** of the same composition as the mortar, with the approximately 20 mm of stones protruding.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

j) Gabion lined open drains

Generally, 0,3 m thick mattresses will be used to line open drains.

Gabions and mattresses shall be constructed in terms of the requirements of Section A12.6 of Chapter 12. **The stones used in the top layer of all gabions shall be selected to resemble normal stone pitching**.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

k) Backfilling

After completing the concrete work, the spaces at the backs of kerbs shall be backfilled with approved material to pavement or road shoulder level. **Spaces adjoining open drains and chutes shall be backfilled level with the adjacent road or embankment surface.** Such backfill shall be placed in layers not exceeding 150 mm and each layer shall be thoroughly compacted

Where **kerbs and channels are laid after construction of the base, the spaces between the concrete and adjoining base shall be backfilled with approved premixed asphalt material**.

l) Construction sequence

*Where **kerbs and channeling are constructed before the base**:*

In this case slip-form units or cast in situ units may be constructed. During working and constructing the base, **precautionary measures shall be taken to prevent the concrete work from being damaged or disturbed**.

*Where **kerbs and channeling are constructed after the granular base:***

The **base shall be constructed wider** than the specified width, after which a **neat trench shall be excavated for the kerbing or channeling. Any over-excavation shall be back filled with concrete**

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

l) Construction sequence (continue)

Where ***kerbs and channeling are constructed*** ***<u>after the asphalt base and/or asphalt surfacing</u>****:*

The **asphalt base and/or asphalt surfacing shall be constructed wider than the specified width and shall then be cut back accurately with a mechanical saw to a marked line** to give a neat joint line between the kerbs or channeling and the asphalt layer. **The surfacing and base shall then be removed to the required depth.**

m) Protection

The Contractor shall take all precautions to prevent concrete spillage onto the adjacent completed road surfacing. Any concrete spilt onto the road surface shall be removed. Where so required by the Engineer, the Contractor shall, without any additional compensation, sand blast the stained surface and treated with bitumen emulsion to get an evenly coloured surface.

During transporting and laying, care shall be taken to protect all precast units against chipping or breakage.

Concrete kerbing and channeling as well as any other structures adjacent to the road **shall be protected against staining by prime or bitumen being sprayed, or premix being placed.**

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage structures

n) Cutting existing bituminous surfacing and pavement layers

Where <u>kerbing, channeling or concrete-lined drains</u> to be constructed against existing bituminous surfacing is specified, the full depth of the bituminous surfacing, and the base and subbase, if necessary, **shall be accurately cut with a mechanical saw to the required line and depth before the kerbing, channeling or concrete-lined drain is constructed** .**The concrete shall then be cast directly against the cut edge without formwork** .The bituminous surfacing shall be protected and kept clean to the Engineer's satisfaction.

o) Demolition of existing kerb and channel and concrete lined drains

Where shown on the drawings and/or indicated by the Engineer, the existing kerb and channel and concrete lined drains shall be demolished to a specified maximum size, removed and transported to an approved spoil site as provided by the Contractor. **All adjoining existing work shall be protected against damage during such excavation and removal**.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.2 Inlet and outlet structures and transition sections

Inlet and outlet structures may be either precast or partially precast concrete units or may be cast in situ concrete.

Where shown on the drawings, **the Contractor shall supply and install within the outlet structures, energy dissipaters consisting of prefabricated reinforced-concrete blocks of class C20/25-20 concrete of the dimensions shown on the drawings** or listed in the schedule of quantities, or alternatively stones as detailed on the drawings shall be set in the freshly cast concrete.

Components or accessories such as grids, covers and frames shall be in accordance with the details shown on the drawings and the requirements of Clause A3.2.5.2.

A3.3.8 WORKMANSHIP

A3.3.8.1 Construction tolerances and surface finish

a) Concrete kerbing and channeling.

(i) Horizontal alignment

The **maximum deviation of edges, centre line, or vertical surfaces from the specified position shall be 25 mm,** read together with the alignment tolerance hereunder.

The rate of **deviation of edges, centre line, or vertical surfaces from the specified alignment, shall be less than 1:500 when taken over any section exceeding 10 m in length**.

(ii) Vertical alignment and level

Unless designed as such, the inside edge of channeling **shall nowhere be above the finished road level nor more than 10 mm below the finished road level.** The invert level of channels and open drains and the top of kerbing shall nowhere deviate by more than 10 mm from the required level and nowhere shall channels or drains have any adverse grade. **Any ponding resulting from such deviations shall be resolved as specified by the Engineer**

(iii) Trueness of exposed surfaces

When tested with a 3,0 m straight-edge, no surface irregularities shall exceed 6mm.

A3.3.8 WORKMANSHIP

A3.3.8.1 Construction tolerances and surface finish

a) Concrete kerbing and channeling.(continue)

(iv) Cross-sectional dimensions

All cross-sectional dimensions **shall be within 6,0 mm of the specified dimensions except that the underside of channeling may extend up to 25 mm below the level at which it would have the required thickness**.

b) Asphalt berms

Berms shall be placed true to level, shape and line. Berms **shall not deviate more than 10 mm** from the specified line when measured at the inner edge of either their crests or bases. **The height or width of berms shall not deviate by more than 5,0 mm form the specified height or width**.

c) Concrete- and stone pitched-lined open drains, chutes and downpipes

(i) ~~(v)~~ Horizontal alignment

The maximum deviation from the true position of the edges or centerline shall be 25 mm.

(ii) ~~(vi~~) Vertical alignment

The invert level **shall nowhere deviate by more than 25 mm** from the required level and nowhere shall the inverts have an adverse grade.

A3.3.8 WORKMANSHIP

A3.3.8.1 Construction tolerances and surface finish

c) Concrete- and stone pitched-lined open drains, chutes and downpipes

(iii)(~~vii~~) Trueness of exposed surface

When tested with a 3,0 m straight-edge, no exposed formed or cast concrete or precast surface shall have surface irregularities exceeding 10 mm.

(iv) (~~viii~~) Cross-sectional dimensions

All cross-sectional dimensions shall be within 10 mm of the specified dimensions, and the average thickness of a floor or side slab shall not be less than the specified thickness when considering any complete slab or a slab section with a surface area of 10 m² or more, and disregarding a thickness exceeding 10 mm of the specified thickness.

d) Surface finish

All **unformed exposed** concrete surfaces shall have a **Class U2** surface finish, and all **formed exposed** concrete surfaces shall have a **Class F2** surface finish.

QUESTIONS