South African Road Federation

COTO Standard Specification for Road and Bridge Works

CHATER 20: Quality Assurance

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

Draft Standard (DS)
CHAPTER 20: QUALITY ASSURANCE
October 2020

COURSE DESCRIPTION

During the construction of most projects, 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.

This course will describe 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 contents of the course will focus mainly on the fundamental amendments and additional requirements introduced subsequent to the publishing of the 1998 Edition of the COTO Specifications which has now been replaced by the 2020 Edition.

Acknowledgement

J P (Basie) Nothnagel

A J N (Tony) Lewis

COURSE PROGRAMME

The programme will include:

PART A

A20.1.1 SCOPE

A20.1.2 DEFINITIONS

A20.1.3 TEST METHODS

A20.1.4 PUBLISHED TEST METHODS

A20.1.5 UNPUBLISHED TEST METHODS

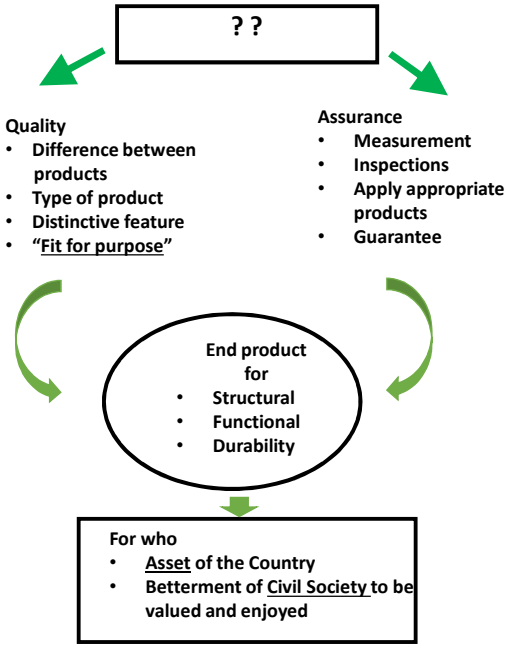
A20.1.6 SPECIAL TEST METHODS

A20.1.7 ACCEPTANCE CONTROL BY STATISTICAL JUDGEMENT PRINCIPLES

PART B: LABOUR ENHANCED PROJECTS

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES WHERE APPLICABLE



"Clouds are the handwriting of the weather"

CLIENT MONITORING AND QUALITY CONTROL

- What do we want?
- How do we order it (Specifications)?
- How do we know that we have got what we ordered?

Non –statistical assessment : Specific relevant Chapters

Statistical: Chapter 20

Client Monitoring and Quality Control

Level Dependent on institutional policy and/or in-house technical capacity

Historical Scenario

Engineer's Site staff

- Resident Engineer (experienced)
- Numerous assistant resident engineers (trainees?)
- Clerk of works/inspectors (experienced)

Quality Control and Site Monitoring

Historical cost of site supervision!

Up to 12% of contract value!

ASPECTS <u>INCLUDED</u> IN CHAPTER 20

1. **Relevant portions of the old 8100 – 8200**
2. **Definitions**
3. **Testing Methods**
   - Standard methods – references
   - Unpublished methods
   - Published methods
4. **Acceptance Control (A1.2.8.2)**
   - Non Statistical – Concrete Durability and Cover : Plan A
   - Statistical judgement : Plan B
5. **Conditional Acceptance**
6. **Measurement and Payment**

ASPECTS NOT INCLUDED IN CHAPTER 20

- Old section 8300 not included
- Details of Process Control (Chapter 1 A.2.8.1)
- Details of Acceptance Control (Chapter 1 A.2.8.2)
- Thickness and level assessment procedures (in each relevant Chapter)
- Non-statistical control assessments, sample sizes and tolerances
- Small lots w.r.t repairs, local reconstruction, etc.
- Ancillary works
- Sundry structures

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CHAPTER 1: GENERAL

October 2020

CHAPTER 1

A1.2.8 WORKMANSHIP

A1.2.8.1 Process Control

Contractor to undertake quality testing in accordance with his Quality Plan and Chapter 20

A1.2.8.2 Acceptance Quality Control

Client or Engineer to undertake quality testing

A20.1.2 DEFINITIONS

- **Ordinary tests**

  Ordinary tests refer to the range of tests that are routinely carried out as part of process and acceptance control.

- **Special tests**

  Special tests refer to tests that require the use of specialised equipment and expertise not normally available in an independent site laboratory, unless otherwise provided for. These tests are applicable to certain products, structural elements, drainage, and in the design of special mixes. The use thereof, in terms of conformance to the requirements and obligations of the contract and the cost of such testing, shall, unless otherwise specified, be included in the Contractor's rates.

A20.1.2 DEFINITIONS

- **Independent site laboratory**

  This laboratory is procured by the Employer for carrying out the ordinary tests required on site for both process and acceptance control testing which serves both the Contractor and the Engineer. This laboratory operates under the auspices of a SANAS accredited testing laboratory facility with the necessary quality assurance plans and a list of accredited tests.

- **Independent commercial laboratory**

  This laboratory refers to a SANAS accredited testing laboratory facility that are located away from site and which conduct ordinary and special tests in terms of their accredited tests. The testing work is charged to whichever client places the order, at the applicable rates and tariffs.

- **Engineer's laboratory**

  This type of laboratory refers generally to the Independent Site Laboratory and/or a specific independent commercial laboratory nominated for certain tests by the Engineer.

A 20.1.2 Definitions

- **Approved laboratory/Testing authority**

  An approved laboratory shall mean any locally accredited laboratory that is located away from site, and has been approved by the Engineer for the testing of materials, products, elements and mixes used on site. Whenever the need exists the Engineer will also seek the consent of the Contractor.

- **Contractor's satellite laboratory**

  A laboratory established by the Contractor at manufacturing plants for asphalt and concrete. The Contractor's satellite laboratory also carries out process control on materials stockpiles and bulk binder storage, as well as during the manufacture of asphalt and concrete mixes. All tests and procedures are undertaken in terms of a quality control plan.

Client Monitoring and Quality Control

Level dependent on institutional policy and/or in-house technical capacity

Cost of Testing

The cost of testing may be borne by the Contractor and employer in several ways, as specified in the project documentation, i.e.:

- Process and acceptance control testing are carried out by the Contractor. The cost of the testing is deemed to be included in the rates, or
- Process control testing is carried out by the Contractor, and acceptance control testing by the engineer. The cost of process control testing is borne by the Contractor and the cost of acceptance control testing is borne by the employer, or
- All materials testing, including process and acceptance control testing is carried out by an independent site laboratory. The Contractor shall contribute to the costs of such laboratory under the pay items under C20.1.

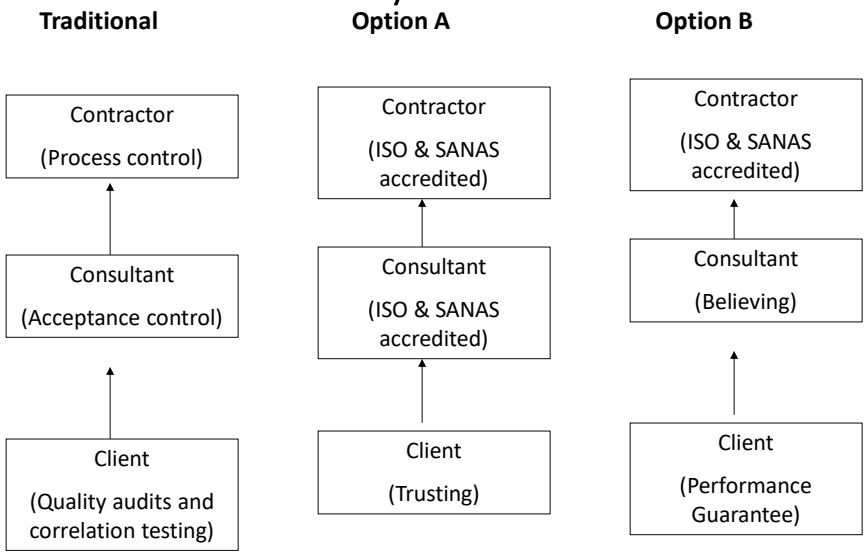
Quality Control and Site Monitoring

Historical cost of site supervision!

Up to 12% of contract value!

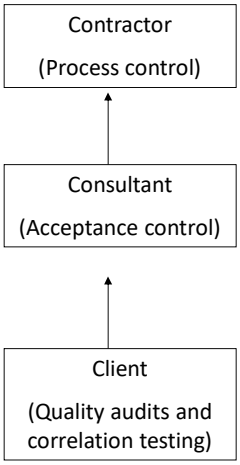
R100m project = ≤ R12m!

Quality Control



Quality Control

Traditional



Traditional acceptance control

- Inspection
- Testing programme
- Data analysis

Acceptance control

Inspection

COTO Chapter 2020

Despite acceptance of those properties measured by testing, materials or work will be rejected where there are other causes for rejection such as

- Obviously defective workmanship
- Excessively variable properties
- Visible signs of poor workmanship
- Similar considerations

which constitute sufficient ground for rejecting work without further testing

Client Monitoring and Quality Control

- Proactive Approach
- Reactive approach

Ins

- “Smoke test”
- Definition of BRD
- Corelock

Visual Observation

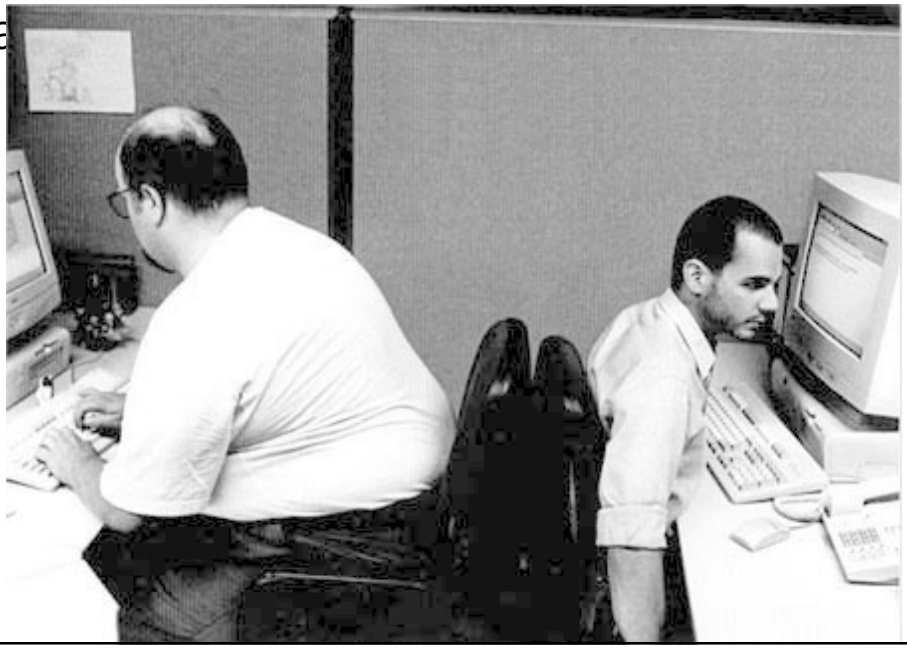
Visual voids in top 10mm – no segregation

Visual Observation

No visual voids – no segregation


7 9 2004

Mea



Testing program

- Confirm what you have already monitored and seen!!!!!!

Quality Control

Testing program

- Prescribed!
- Appropriate!
- Logical!
- Frequency!
- Location!

Different Tests

20.1.4 –Published Test Methods

20.1.5 – Unpublished Test Methods

20.1.6 – Special Tests

A20.1.4: Published Test Methods

SANS

ASTM

BS

AASHTO

Etc –

All test methods listed

A20.1.5 Unpublished Test Methods

Methods published in Chapter 20

e.g

- Concrete: Cover / durability/silicon sealants etc etc
- Asphalt: Contabro abrasion / air permeability etc etc
- Pavements: Riding Quality/rutting/texture/FWD etc etc
- ETC

A20.1.6 Special Test Methods

- All tests not normally carried out in a site/commercial laboratory
- Specifically ordered by the engineer
- Paid for by the Employer but only if it meets the requirements!

A20.1.6 SPECIAL TEST METHODS

1. **Cement, concrete & structural elements**
2. **Durability, cover alkali reactivity**
3. **Durability mill Index, PSV**
4. **Binders**
5. **Asphalt, MMLS, Hamburg, Four point Bending Beam**
6. **Automated road condition measurements**
7. **Geosynthetics**

Testing program

Prescribed testing

P.I's on cohesionless sands???

Testing program

Appropriate

Fatigue testing on patching asphalt?

Testing program

Frequency

- Prescribed?
- Testing frequency relative to material variability?
- Appropriate to road class/level of risk

Testing program

Location

- Random
- Stratified random (contractual)
- Selective

Quality Control and Site Monitoring

Chapter 20.1.3.5 – Taking of samples

- All samples for testing shall be taken in a random pattern, or in any position, as prescribed by the Engineer. Where specified or required by the engineer, stratified random sampling methods shall be followed. For the testing of layer work stratified random sampling methods shall be used for obtaining all the sample positions and for determining the locations for in situ tests.

Air permeability test results

Stratified random positions	Selected positions adjacent to longitudinal joint
0,283 (x10^{-8}cm^2)	1,623 (x10^{-8}cm^2)
0,470	11,471
1,342	8,343
0,457	2.317
0,242	2,514
1,291	16,686
0,680	7,16
No Problem!	**Problem!**

Statistical Assessment

The Truth???

Example:

% Compaction results obtained on HMA layer

97: 96: 97: 95: 89: 88

$\underline{n}$ = 7
X = 94,00
S_n = 3,83
K_a = 0,403
L_s = 92%
Ø = 15%
$L_a = L_s + S_n.K_a$
$\underline{L_a}$ = 93,54
$X > L_a$ Therefore accept @ 100% payment !!!!!

Quality Control and Site Monitoring

Statistical Acceptance (early 80's)

Ø (%) (to take into account variability in material property)

Ø = max % of statistical population of values permitted to fall outside the specification limits where the product may still be acceptable!

Quality Control and Site Monitoring

Table 8206/3 (COLTO)

Material	Properties	Minimum sample size n	L_s (Lower specification limit)	L'_s (Upper specification limit)	Ø (%)
Selected subgrade	Relative compaction	4	90%,93% or 95%	-	15
Subbase	Relative compaction	6	95% or 97%	-	15
Gravel base	Relative compaction	6	98% or 97%	-	15
Crushed stone subbase or base	Relative compaction	6	98% and if stabilised, 97%	-	15
Asphalt base or surfacing	Relative compaction Binder content Voids	6 6 4	See note 1	See note 1	15 15 15
Chemically stabilised layers	Cementitious binder content	10	See note 2	See note 2	10
Strength concrete (structural)	Compressive strength (28 days)	See table 8206/3	See notes 3 and 4	-	5
Pavement concrete	Compressive strength (28 days)	6	See subclause 7103(d)	-	5

Quality Control and Site Monitoring

Product pass or fail!

Contractor's risk of having an acceptable product rejected is 1:20 (5%)

Quality Control and Site Monitoring

Conditional Acceptance

Contractor's risk of having an acceptable product rejected is 1:100 (1%)

Reason for reduced payment?

CONDITIONAL ACCEPTANCE

- **Sole discretion of the Engineer**
- **Condition that all other requirements are met**
- **Reduced payment: fixed or sliding scale**

Table A20.1.7-12 Properties in respect of which conditional acceptance may be applied

Property	Structure
Relative compaction	i) Asphalt base or surfacing ii) Chemically stabilized layers iii) Plant mixed paver laid layers iv) BSM layers
Bituminous binder content	Asphalt base or surfacing
Voids in mix	Asphalt base or surfacing
28-day compressive Strength	All strength concrete (concrete pavements not included. (See note 1)
Concrete cover	All reinforced and pre-stressed concrete
Oxygen Permeability Chloride Conductivity Water Sorptivity	All durability properties (Class D) concrete

CONDITIONAL ACCEPTANCE

- **Fixed reduced factor for Plan A**

Table A20.1.7-13 Fixed payment reduction factors for concrete

Property	Payment reduction
Concrete Cover	70%
Oxygen Permeability	80%
Chloride Conductivity	80%
Water Sorptivity	80%

CONDITIONAL ACCEPTANCE

Sliding scale for Plan B

- **Lower Limit**

$f_r = 0.67 + 0.3\ (\bar{x}_n - L_r) / (L_a - L_r)$

- **Upper Limit**

$f_r = 0.67 + 0.3\ (L'_r - \bar{x}_n) / (L'_r - L'_a)$

Left in place with No payment???????

Quality Control and Site Monitoring

Conditional acceptance requires high level of engineering knowledge and judgment (Understanding of risk)

I.E – position and location on the pavement

Table A20.1.7-14: Rejection limits (L_r en L'_r) for sample mean ($\bar{x}_n$)

Relative compaction	Chemically stabilized layers	$L_r = (L_a - 1.500)$% of relative compaction
	Asphalt base or surfacing	$L_r = (L_a - 1.000)$% of relative compaction $L'_r = (L'_a + 0.500)$% of relative compaction
	Bituminous stabilised materials	$L_r = (L_a - 1.500)$% of relative compaction
Concrete compressive strength	All strength concrete (excluding that in pavement)*1	$L_r = 0{,}9\ L_a$
Concrete Cover	All reinforced and pre-stressed concrete	L_r = (specified cover – 7mm)
Concrete Durability	Oxygen Permeability (OPI)	L_r (OPI) = (Specified OPI – 0,40)
	Chloride Conductivity (CC)	L'_r (CC) = (Specified chloride conductivity + 0,40)
	Water sorptivity (WS)	L'_r (WS) = (Specified water sorptivity + 2,50
Bituminous binder content (%)	Asphalt	$L_r = (L_a - 0.200)$% binder $L'_r = (L'_a + 0.200)$% binder
Voids in mix (%)	Asphalt	$L_r = (L_a - 0.300)$% voids $L'_r = (L'_a + 0.300)$% voids

Client Monitoring and Quality Control

The "What if's"

- No statistical criteria for product?
- No conditional acceptance criteria?
- Product outside rejection limits?
- Outliers?

Quality Control and Site Monitoring

Testing repeatability and reproducibility!

Defined limits!

Quality Control and Site Monitoring

CBR spec for G5 gravel = ≥ 45%

Test result = 44%

Will layer with CBR 44 fail – and 45 not fail????

Quality Control and Site Monitoring

Modified binder (S-E1) spec for Softening Point = ≥ 50 ºC

Standard deviation of test method = 3ºC

Date	S.P (°C)	Pen	Storage stability	Date	SP	Pen	Storage stability
25/9/03	49,0		1,6	6/12/03	51,0	145	
26/9/03	49,8			6/12/03	52,4	151	
3/10/03	51,4			9/12/03	50,2	120	
9/10/03	52,0	64		9/12/03	51,1	115	
11/10/03	51,7	93		9/12/03	53,9	112	
13/10/03	52,2	120		9/12/03	51,5	106	
14/10/03	53,5	105		8/1/04	52,0	113	
15/10/03	52,5	102	2,8	8/1/04	49,6	145	
31/10/03	47,0		0,6	10/1/04	50,3	135	
14/11/03	56,0	106	>28,6	10/1/04	50,1	134	
15/11/03	50,5	-		10/1/04	50,2	132	
17/11/03	52,4	132		12/1/04	52,9	121	
18/11/03	53,8	151		12/1/04	52,0	125	
18/11/03	57,8	-		13/1/04	50,2	150	
19/11/03	48,0	138		13/1/04	52,0	176	
19/11/03	50,2	118		14/1/04	50,0	134	
20/11/03	51,7	115		14/1/04	50,0	141	
20/11/03	50,8	122		15/1/04	50,9	152	
21/11/03	50,6	157	>27,4	15/1/04	57,7	134	
21/11/03	52,0	119		16/1/04	52,4	147	
22/11/03	50,5	124		16/1/04	51,5	122	
22/11/03	53,1	107		16/1/04	50,2	131	
24/11/03	54,6	145		16/1/04	47,3	*Not used*	
25/11/03	51,7	137		16/1/04	50,5	138	
25/11/03	52,0	-		19/1/04	48,4	149 *Not used*	
26/11/03	47,6	163		19/1/04	49,0	143 *Not used*	
26/11/03	48,3	159	8,4	19/1/04	50,1	150	
1/12/03	54,4	114		19/1/04	53,7	131	
2/12/03	51,2	118		20/1/04	48,9	182 *Not used*	
2/12/03	52,0	121		20/1/04	54,1	109	
3/12/03	53,2	123		20/1/04	53,0	115	
3/12/03	53,0	124		20/1/04	51,2	135	
4/12/03	53,2	117		21/1/04	56,0	-	
4/12/03	53,0	109		21/1/04	54,9	-	
5/12/03	56,2	106	34,6	21/1/04	57,1	-	

Client Monitoring and Quality Control

Outliers !

- Is there a visual difference?
- Can you retest?
- Can you assess thru different test/s?

Client Monitoring and Quality Control

If unsure

Telkom
Vodacom
MTN
Cell C

Client Monitoring and Quality Control

SAPEM – South African Pavement Engineering Manual

Client Monitoring and Quality Control

Pro active approach: from material source-batching-placing & finishing

Trial sections!!!!!!!

APPENDIX C1 - ASPHALT TRIAL SECTION

1. Site Selection

Choose a site for the trial. This should have a similar surface, strength and gradient to that on which the job mix is to be laid.

Details of Site.

.....

Check lists for the various products are included in Appendix _____
These should be used as a basis for the evaluation of trials sections.

		Yes	No
2.	**Aggregates**		
i)	Is there sufficient stockpile area?	☐	☐
ii)	Is the material recovered from each pile uniform?	☐	☐

Stockpile (Size of aggregate)	Uniform Yes/No	Conformance to design grading

3.	**Hot storage for Binder**		
a)	Is capacity sufficient for the programmed rate of production?	☐	☐
	Capacity ..... t: Estimated daily demand ..... t / day		
b)	Are tanks fitted with automatic temperature? recording systems?	☐	☐
c)	If a modified binder is to be used, are the blending facilities and methods appropriate to ensure a uniform product having the required properties?	☐	☐
d)	Is heating thermostatically controlled?	☐	☐
e)	Is there a warning system for variation in temperatures?	☐	☐
f)	Is binder circulated in tank and between tank and mixer?	☐	☐

g) Are supply pipes lagged? ☐ ☐
h) Is there a level indicator? ☐ ☐
i) Are sampling points to specification? ☐ ☐

4. Cold feed bins.

i) are methods of controlling rate of feed operating smoothly? ☐ ☐
ii) are these controls accurate? ☐ ☐
iii) are precautions to prevent spill over ☐ ☐
iv) is there an adequate warning system if rate of feed alters? ☐ ☐
v) is there an efficient interlock between cold feed and binder feed? ☐ ☐
vi) are fine aggregate feeds susceptible to arching? ☐ ☐
viii) is there a method of detecting and compensating for variations of moisture in the aggregates? ☐ ☐
ix) has contractor calibrated ates against RPM of belt pulley? attached calibration curves to report. report must indicate gate setting. ☐ ☐

5. Mixing Plant

a) Is rated capacity sufficient for the programmed rate of laying? ☐ ☐

Rate Capacity.....t/h
Required Capacity.....t/h

b) Are the proposed heating fuel and burners compatible? ☐ ☐
c) Is the method of control of the fuel/air mixture adequate? ☐ ☐
d) Are burners clean and nozzles to specification? ☐ ☐
e) Are drum rollers correctly set and in good conditions? ☐ ☐
f) Are drum flights in good conditions? ☐ ☐
g) Are binder spray bar and nozzles clean and in accordance with specification? ☐ ☐
h) Can position of spray bar be altered so as to control filler in mix and can adjustments be easily made? ☐ ☐
i) Method of determining temperatures of binder at plant. Is this adequate and are the results visible to the operator? ☐ ☐
j) Temperature controls of aggregate and and final mix. Are these adequate and are the results available to the operator? ☐ ☐
k) Is the plant fitted with suitable filler [illegible] ☐ ☐

6. Emission Control

a) Type

.....

b) Is dust collector matched to capacity of mixer. ☐ ☐
c) What method is used to return a portion of the recovered fines to the mix?

.....

d) What method is used for the disposal of unwanted fines?

.....

e) Do emissions from the stack comply with Act 45 of 1965 (as amended)? ☐ ☐

7. Buffer Storage

a) Is this of adequate capacity? ☐ ☐
b) Is this properly lagged? ☐ ☐
c) Do discharge gates operate smoothly? ☐ ☐

8. Elevator between Mixer and Buffer Store

a) Are buckets in good condition? ☐ ☐
b) Are chains and cables in good conditions? ☐ ☐

9. Paver

a) Truck pushing rollers are these:
i) Clean? ☐ ☐
ii) Free Running ☐ ☐

b) Hopper
i) Are sides reasonably smooth? ☐ ☐
ii) Does side tilt mechanism work properly? ☐ ☐
iii) Are rubber skirts in good condition? ☐ ☐
iv) Do feed control gates work smoothly? ☐ ☐
v) Are feed conveyors in good condition?
- Flights? ☐ ☐
- Bed (no holes)? ☐ ☐
- Chains, conditions and tension, ok? ☐ ☐

c) Screed Unit

i) Are pivots free running? ☐ ☐

iv) Are tamper bars straight? ☐ ☐
v) Is clearance between tamper bars and screed correct? ☐ ☐
Note clearance ..... mm Specified Clearance .....0.05 ..... mm
vi) Is protrusion of tamper bar below screed correct? ☐ ☐
Note protrusion ..... mm
specified protrusion .....0.05 ..... mm
vii) Is gap between tamper bars and screed clean? ☐ ☐
viii) Are crown controls for screed working smoothly? ☐ ☐
ix) Is locking system for crown control adequate? ☐ ☐
x) Is screed inclination set correctly? ☐ ☐
Note.
Turnbuckle gauge reading.....
Actual:.....
Specified:.....
xi) Are augers in good condition and tight on shaft? ☐ ☐
xii) Are the centre auger flights reversed? ☐ ☐
xiii) Are augers set at correct height? ☐ ☐
Actual height .....
Specified height .....
xiv) If telescope screed is fitted:
a) Do parts move smoothly? ☐ ☐
b) Do wings form a smooth continuation of main screed without steps? ☐ ☐
c) Are spreader screws extensions in good condition? ☐ ☐
d) Are tamper bar extensions to specification and is clearance between tamper and screed correct? ☐ ☐
e) Do tamper bar extensions protrude the correct distance below the screed? ☐ ☐

xv) If screed is not telescopic:

a) Are there sufficient extension boxes? ☐ ☐
b) Are screed, tamper bars, spreader screws in good condition? ☐ ☐
c) Does extension form a continuation of main screed unit without steps? ☐ ☐
d) Are tamper bars and screed correctly set relative to each other? ☐ ☐
e) Do extensions to spreader screws attach tightly to main section? ☐ ☐
xvi) As screed heater burners working properly? ☐ ☐
xvii) Does screed control at working platform work correctly? ☐ ☐

e) Are wheel-cleaning mats in good condition? ☐ ☐
f) Are scrapers in good condition and set? ☐ ☐
g) Check for oil, fuel and hydraulic leaks. Is roller free of leaks? ☐ ☐
h) Do brakes work? ☐ ☐
i) Is reversing smooth? ☐ ☐

F. Pneumatic Rollers

a) Are tyres in good condition? ☐ ☐
b) i) Is there a variable pressure system for tyre pressure. ☐ ☐
If so is it working and is pressure gauge working and visible to driver? ☐ ☐
ii) Are all tyre pressures uniform? ☐ ☐
Note tyre pressures ..... KPa
c) Are rollers properly ballasted (Record mass and position) ☐ ☐
Roller 1
Mass ..... t
Position .....
Roller 2
Mass ..... t
Position .....
d) Are spray bars working uniformly? ☐ ☐
e) Are cleaning pads in good condition? ☐ ☐
f) Check for fuel, oil and hydraulic leaks. Is roller free of leaks? ☐ ☐

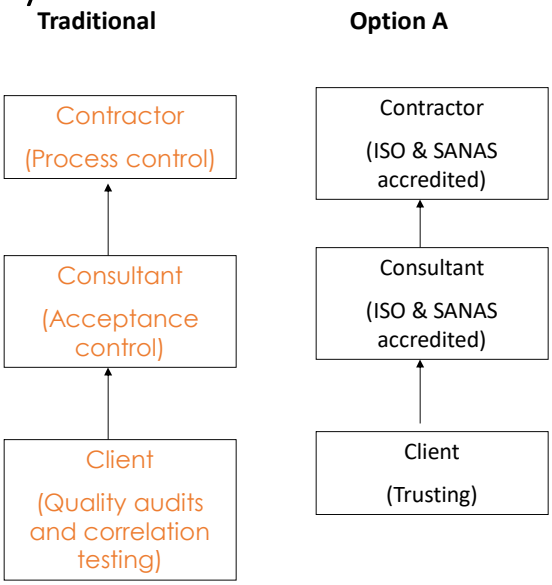
G. Hand Tools, Etc

a) Straight edge, is it clean and straight? ☐ ☐
b) Rakes and shovels, are they clean and in good condition? ☐ ☐
c) Are thermometers available? ☐ ☐
No ..... Size .....

H. Transport Vehicles

a) Are the basins clean? ☐ ☐
b) Do tailgates open and close properly? ☐ ☐
c) Are load covers fitted? ☐ ☐
d) Are vehicles free from fuel, oil and hydraulic leaks? ☐ ☐
e) Does tipping gear work? ☐ ☐
f) Registration numbers of vehicles ☐ ☐

Quality Control



Quality Assurance

ISO 9001

ISO 8402

Part C – Measurement & Payment

PART C: MEASUREMENT AND PAYMENT

Item	Description	Unit
C20.1.1	Special tests on elastomeric bearings (150% vertical load and 150% shear distortion)	Number (No)

The unit of measurement shall be the number of elastomeric bearings tested as described.

The tendered rate shall include full compensation for having the test conducted by an approved laboratory, also for replacing the bearings that may possibly been damaged during testing.

PART C: MEASUREMENT AND PAYMENT

Item	Description	Unit
C20.1.2	Special tests requested by the Engineer	
C20.1.2.1	Employer's contribution to concrete durability tests	
	(a) Tests for water sorptivity	Prime Cost
	(i) Handling costs and profit in respect of Item C20.1.2.1(a)	Percentage (%)
	(b) Tests for oxygen permeability	Prime Cost
	(i) Handling costs and profit in respect of Item C20.1.2.1(b)	Percentage (%)
	(c) Tests for chloride conductivity	Prime Cost
	(i) Handling costs and profit in respect of Item C20.1.2.1(c)	Percentage (%)
	(d) Tests for concrete cover	Prime Cost
	(i) Handling costs and profit in respect of Item C20.1.2.1(d)	Percentage (%)

PART C: MEASUREMENT AND PAYMENT

C20.1.3	Providing testing equipment:	
C20.1.3.1	Core drill	number (No)

The unit of measurement shall be the number of each item provided. The core drill shall be an approved type capable of drilling cores with diameters of 100 mm and 150 mm in concrete, stabilised layers and asphalt. It shall be provided with a water supply and necessary drilling parts. The core drill shall be operated by the Contractor and for acceptance control in the presence of representatives of the Engineer.

PART C: MEASUREMENT AND PAYMENT

C20.1.2.2 Employer's Contribution to other special tests

(a) ..... Prime Cost

(i) ..... Percentage (%)

The Prime Cost provided to cover the cost of special tests as requested by the engineer in terms of Clause A20.1.3.6(b) shall be expended in accordance with the provisions of the Conditions of contract. Payment will not be made for any special test should the test indicate that the specifications have not been complied with.

Item	Description	Unit (No)
C20.1.4.	Special tests using Automated assessment instruments requested by the Engineer for acceptance control	
C20.1.4.1	Using Highspeed Inertial Non-Contact laser profilers (clause A20.1.5.5c) (ii)	Prime Cost
(a)	Handling cost and profit in respect of Item C20.1.4.1	%
C20.1.4.2	Using Direct Contact Devices (Clause A20.1.5.5c) (i))	Prime Cost
(a)	Handling cost and profit in respect of Item C20.1.4.2	%
C20.1.4.3	Rutting measurements (Clause A20.1.5.5 d) (i))	Prime Cost
(a)	Handling cost and profit in respect of Item C20.1.4.3	%
C20.1.4.4	Surface macro texture (Clause A20.1.5.5 b)	Prime Cost
(a)	Handling cost and profit in respect of Item C20.1.4.4	%
C20.1.4.5	Deflection measurements (FWD) (Clause A20.1.5.5e)	Prime Cost
(a)	Handling cost and profit in respect of Item C20.1.4.5	%

The prime cost sum shall be paid in accordance with the provision of the Conditions of Contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost item. The percentage shall cover all the Contractors' sourcing, handling, supervision, profit, payment of the service provider within 30 days of receiving their invoices, and liability costs in providing the services. The Contractor shall arrange with the service provider to forward the test results directly to the Engineer and will forfeit his mark-up when the service provider is not paid in time.

The Contractor shall obtain prices / rates and information from all available and relevant service providers for submission to the Engineer. The Engineer shall approve the service provider(s) based on, amongst others, the following criteria:

- Conformance to the specifications
- Experience and track record
- Quality control procedures and systems
- Prices and rates
- Broad Based Black Economic Empowerment status
- South African Revenue Services Certificate (SARS)

The individual and / multiple claims against the prime cost sum, excluding the mark-up percentage, shall be in the following formats or as otherwise prescribed by the Engineer:

a) Highspeed profilometers
Roughness measurements and surface macro texture in the format of:

i) Establishment cost Number Rate (R)
Amount (R)

ii) Measurements Number in lane kms Rate (R)
Amount (R)

and

b) Falling Weight Deflections
Deflections and traffic accommodation in the format of:

i) Establishment cost Number Rate (R)
Amount (R)

ii) Points measured: Number Rate (R)
Amount (R)

iii) Traffic Accommodation Number of days Rate (R)
Amount (R)

Item	Description	Unit
C20.1.5	Financial contribution for an independent laboratory	Month

The unit of measurement shall be the month.

The monthly contribution by the Contractor shall be a negative amount for all process control testing, excluding acceptance control and other testing ordered by the engineer, as provided in the Project Documentation.

This shall cover the Contractor's contribution towards the establishment and operation of services provided by an independent laboratory over the contract period including any approved extension of time and shall be deducted from the Contractor's interim payment certificates. However, excluded from the tendered contribution shall be the cost of all other special tests requested by the engineer.

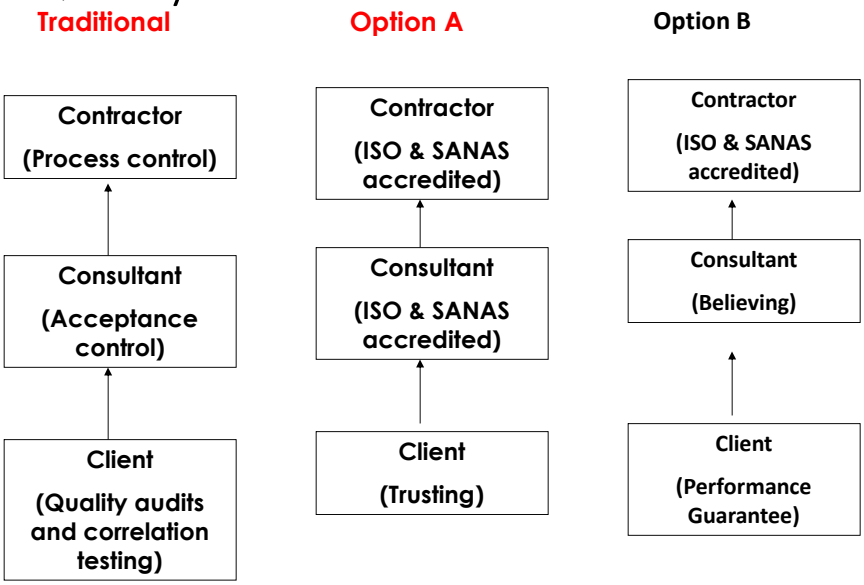
Note:
Providing testing equipment for use by the engineer.
Except for the equipment listed in Item C20.1.3.1, this specification does not envisage the provision of testing equipment by the Contractor for the use of the engineer but where necessary provision shall be made therefore in the project specifications and the relevant pay items shall be described.

PART D

Guarantees and Compliance Certificates

Performance Based Contracts

Quality Control



Normal defects notification period 12 months?

Quality Assurance

Extended Warranty Period:

- Improved technology (plant & products)
- Tighter tolerances (agg.)

Guarantee Period

1Month or 1000 miles

6 Months or 10 000Km's

3 Years or 100 000 Km's

5 Years or 150 000Km's

Client Monitoring and Quality Control

CAPSA 2004

Cost and quality issues in road concession contracts

P Alexander, D W Burger, G Esterhuysen, J J Smit and A Taute

"Construction quality control for most of the contract proved to be inadequate. The contractor opted not to implement the traditional South African quality control model, but rather to implement the traditional European favoured quality assurance procedure."

"While the contractor's Quality Management System (QMS) was ISO 9001: 1994 compliant and applied the requirements of ISO 8402:1994, this did not generally result in consistent good quality workmanship."

"The QMS as developed by the Contractor was a very comprehensive programme based on overseas experience and required extensive paper work and computer based records."

Continued:

For example:

- The pavement surrounding a toll plaza had to be reconstructed
- 34kms of new road had to be totally recycled
- Several fills had to be reconstructed
- Several drainage structures had to be reconstructed
- Early rut filling and sealing was required on some sections

Continued:

" For the normal South African construction foreman (*and management*!!!) the requirements of self applied quality control, versus trying to make profits and early completion bonuses, is still a contradiction in terms."

"In the UK it has taken > 9 years for contractors and their staff to realise that cutting corners does not work"

Quality

- Are we as an industry fully committed to quality?

CONCLUSION

1. **Chapter 20 measures the compliance of some properties "ordered" from the supplier / contractor / seller in terms of the contract between the Parties to ensure the expected performance.**

2. **The measurement for compliance in terms of pure statistics and probabilities is merely a "spot check" which relies on a high level of process control of products and workmanship by the seller (with the buyer looking over his shoulder).**

CONCLUSION

3. **The measurement of the variation of the "sample" of a lot is a preferred approach but a study of the population deviation (S80), the allowable tolerances Ø and risk profiles of more recent work must be undertaken for the refinement of acceptance criteria.**

4. **Invest in the exposure, training and experience of our human capital in the entire quality chain – and appreciate and respect them for their contributions.**

Quality

All quality management systems will not guarantee anything without a fundamental prerequisite:

Ethics + Experience + common sense

A construction quality tool

Future site office????

THANK YOU!