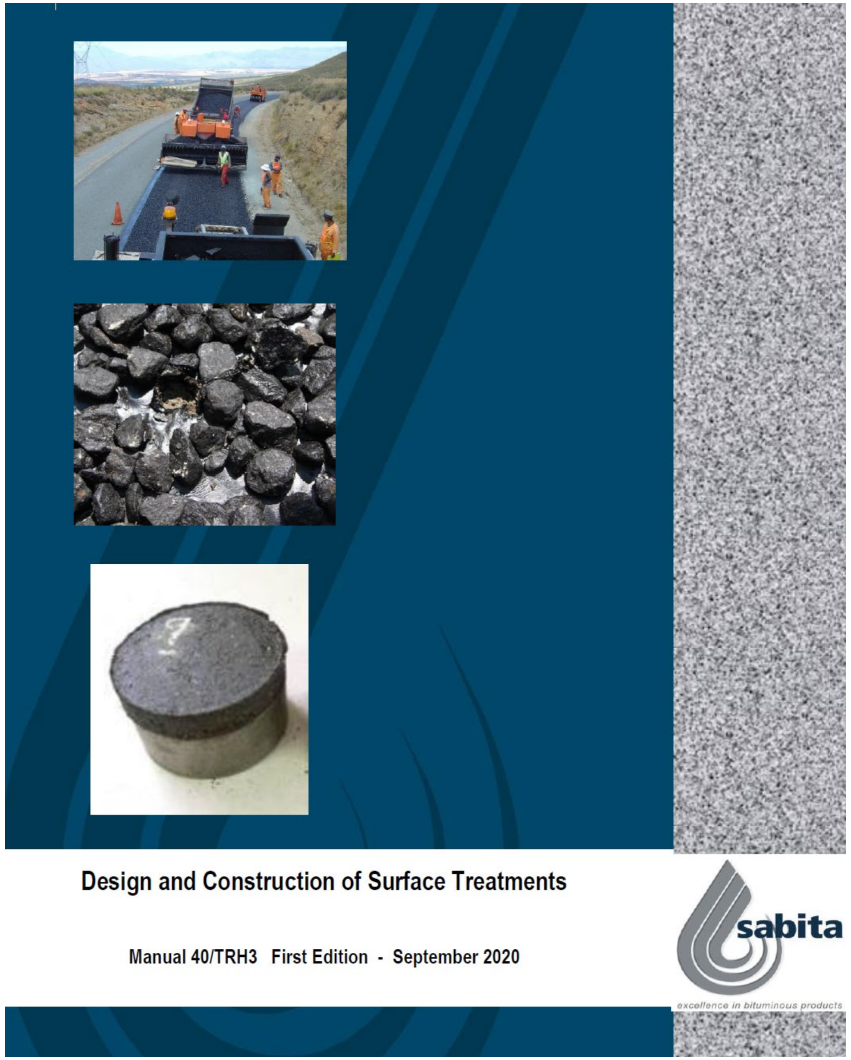
Contents

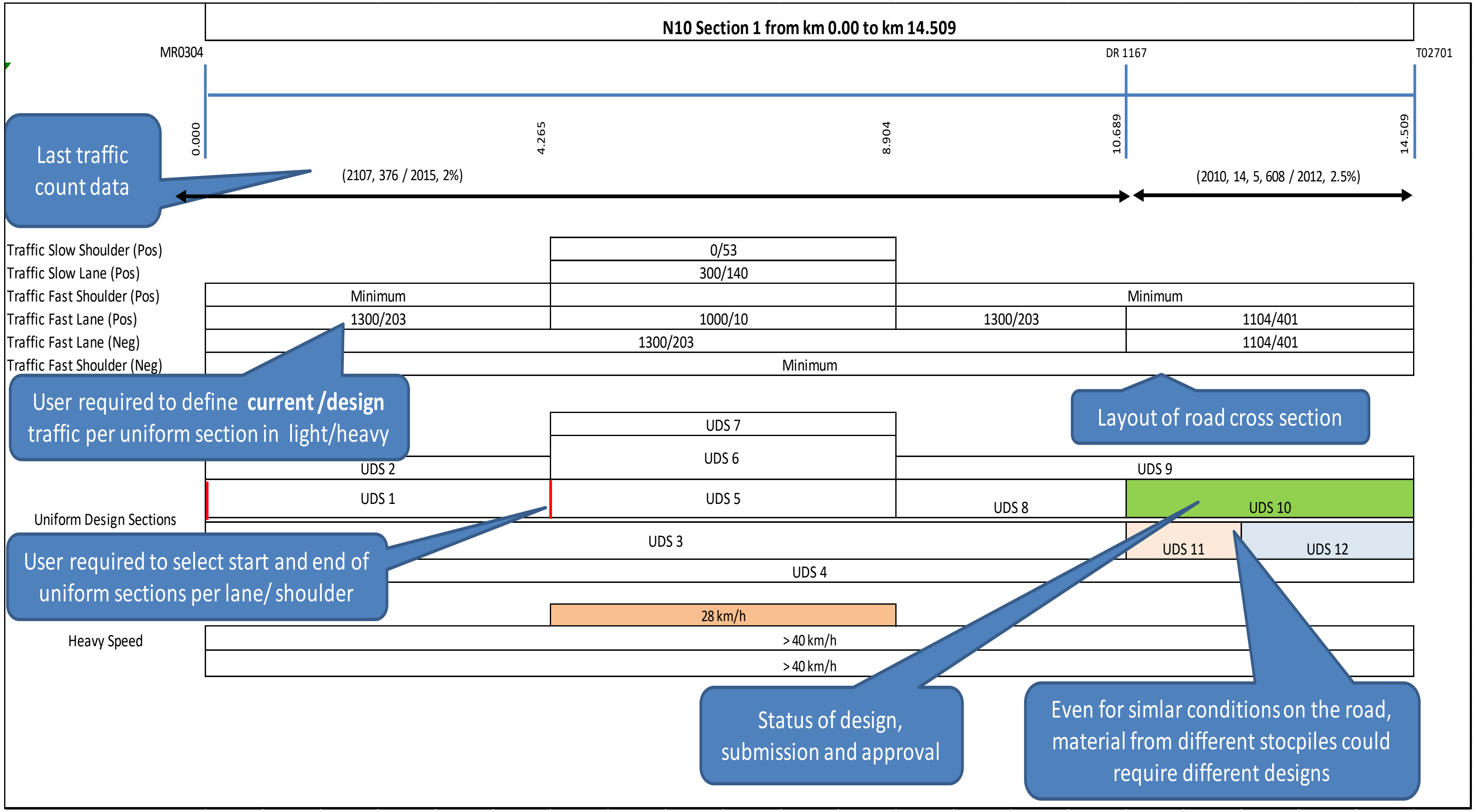
MYCUBE ASSET MANAGEMENT SYSTEMS (PTY) LTD



Part E: Design

- Uniform design sections
- Single and double seals
- Cape seals
- Slurry seals
- Microsurfacings
- Inverted double seals
- Choked seals
- Geotextile seals
- SAMIs
- Sealing during winter
- Designing for Very Low and Very High traffic volumes

Uniform design sections



Design parameters

- **Traffic – Equivalent light vehicles per lane per day (1 Heavy = 40 Light)**
- **Average least dimension (ALD)**
- **Embedment potential (Ball penetration)**
- **Preferred texture depth**
- **Adjustments**
  - ❑ existing texture
  - ❑ slow traffic / gradients/ HV speed
  - ❑ climate (macro and micro climates)
  - ❑ aggregate micro texture
  - ❑ preferred aggregate matrix
- **Binder distribution**
- **Conversions**
  - ❑ modified binder conversion
  - ❑ cold to hot binder

Basic application rate	• Traffic (ELVs/lane/day) • Embedment (Corrected ball penetration) • Average Least Dimension (ALD)
Adjustments	• Existing macro texture • Heavy vehicle speed • Macro climate • Cold microclimates • Aggregate micro texture
Binder distribution	• Cover spray • Tack coat • Penetration coat
Conversions	• Conventional to modified • Cold to hot

Design…

Design considerations

- **Strategy/ Risks**
  - Lean/ Full
  - Maintenance capacity
- **Traffic**
  - seasonal variations
  - channelisation

ALD determination

- **SANS 3001 (AG2) – Recommended**
  - ❑ Average least dimension of aggregates by direct measurement.
- **SANS 3001 (AG3) – Not recommended**
  - ❑ Average least dimension of aggregates by computation.
- **Notes:**
  - ❑ SANS 3001 (AG3) was developed as an improvement to international practice, using the median size of the aggregate between the larger and smaller sieve sizes, relevant to the nominal size. However, the calculated ALD becomes less accurate with cubical shaped aggregate.
  - ❑ At least five samples should be taken and tested.
  - ❑ Aggregate samples should be taken on site and not from stockpiles at the crusher.

ELV

- **Equivalent Light Vehicles/lane/day**
  - Recent traffic counts.
  - Construction traffic.
  - Attracted traffic.
  - Seasonal variations e.g. due to harvesting periods.
  - Channelization (lane width)
- **Notes:**
  - Based on the evaluation of current best practice, it is recommended that the design traffic volume is increased with 20% for two-lane roads (gravel shoulders), carrying more than 5000 ELVs and with lane widths of 3.5m or less
  - Current research is focussed on relating traffic induced vertical and horizontal stresses to embedment and aggregate orientation, which will replace the existing concept and calculation of ELVs

Embedment potential (SANS 3001-BT10).

- Road surface temperature measurement (minimum 25°C if sealing on temperature susceptible surfaces).
- Recording of the existing substrate type and binder dryness condition (with photograph).
- A zero reading after placement of the 20 mm ball.
- First blow with the Marshall hammer and first penetration reading (with photograph).
- Second blow with the Marshall hammer and second penetration reading (with photograph).
- Selection of applicable/representative penetration value.

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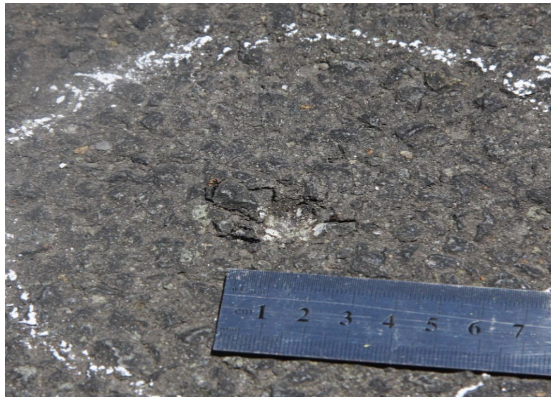
Embedment observations

- **Interpretation of test results**
  - ❑ Ball penetration testing

1st penetration value

2nd penetration value

2nd penetration value



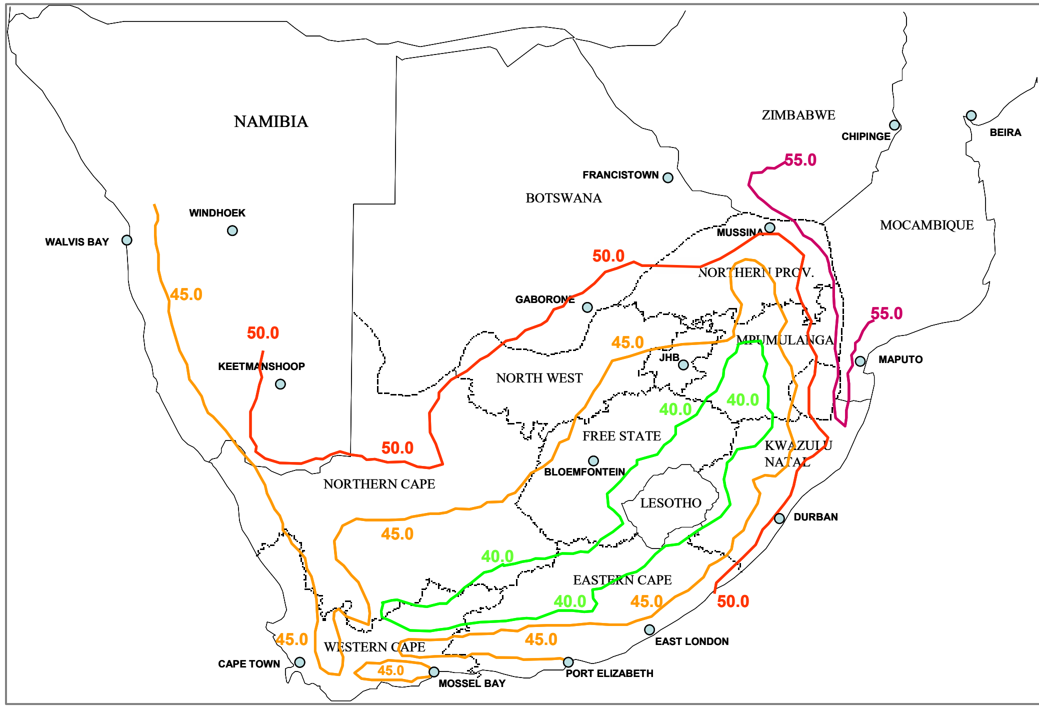
Average 1st and 2nd

Ball penetration Correction

- **BPC = BPT1 – k (T1 – TD)**

  where

  - BPC is the temperature corrected ball penetration value, in millimetres (mm);
  - BPT1 is the ball penetration value measured at the road surface temperature, in millimetres (mm);
  - k is the correction value given in Table E 4 in millimetres per degree Celsius (mm/°C);
  - T1 is the road surface temperature at the time of the test, in degrees Celsius (°C);
  - TD is the design road surface temperature for the climatic zone in which the road is located, in degrees Celsius (°C).



K – Temperature susceptibility

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Existing surface type	k value (mm/°C)			
	Surface defects as described in TMH9 [13]			
	Dry and brittle		Bleeding	
	Degree ≥ 3	Degree <3	Degree 3 - 4	Degree 5
Natural gravel base	0	0	0	0
Crushed stone base	0	0	0	0
Emulsion treated base (< 2 % bitumen)	0	0	0	0
Foamed bitumen base (> 3 % bitumen)	0,02	0,04	0,05	0,08
Single and multiple seals	0	0,02	0,04	0,08
Slurry seals and sand seals	0,03	0,05	0,06	0,08
Cape seals	0,03	0,06	0,07	0,08
Asphalt (sand mastic)	0,05	0,07	0,08	0,08
Asphalt (stone mastic)	0,02	0,04	0,05	0,08

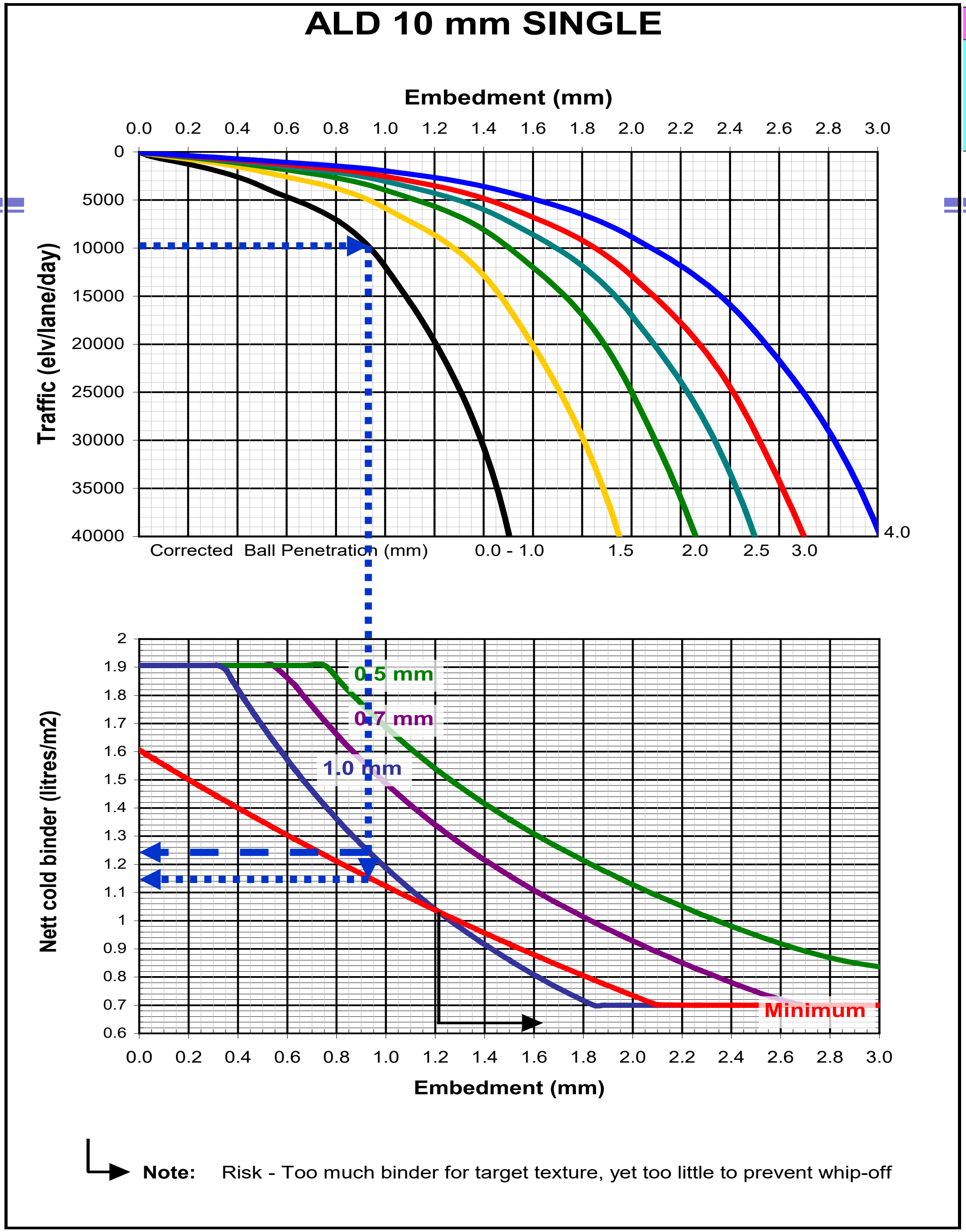
?

Simplified design charts

- **ALD = 10mm**
- **Traffic (ELV = 10 000)**
- **Corrected BP = 1mm**
- **Graph problems**
  - ❑ Black and white copies
  - ❑ Double seal charts

- Min binder required
  = 1.15 l/m²

- Max binder for 1mm texture = 1.25 l/m²



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Volumetric design: Manual 40

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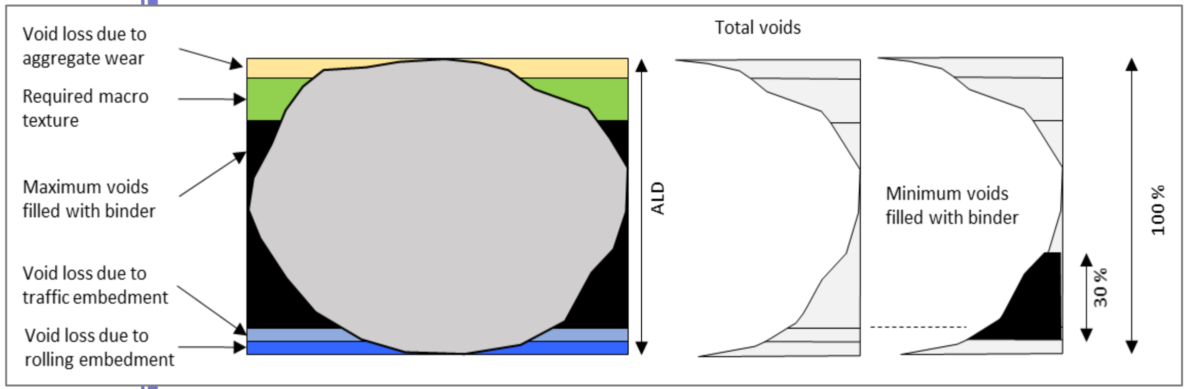


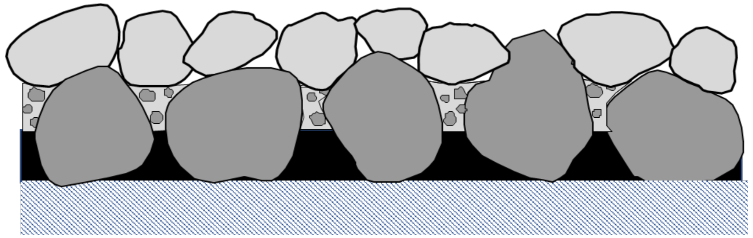
- **Full rational design**
- **All equations provided**
- **Practical tests & Warnings**

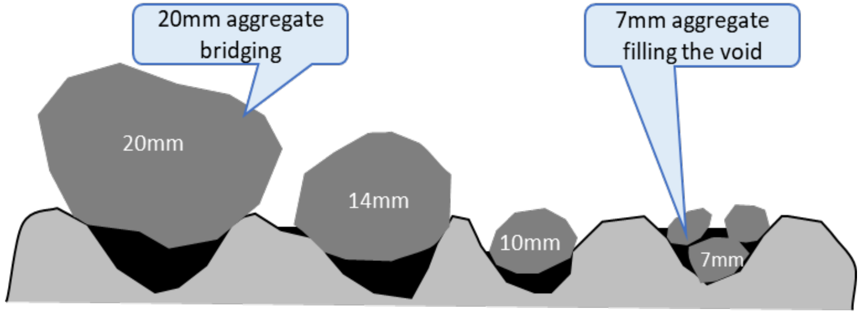
Single seal design

Input parameters	Example	
Corrected Ball penetration (CBP) in mm	2	If CBP <1.0, then 1.0
Equivalent Light Vehicles per lane per day (ELV)	4000	Design for minimum ELVs of 2000
Average Least Dimention of aggregate (ALD)	8.2	
Macro texture requirement	0.7	
Aggregate hardness - 10%Fact (kN)	210	
Calculations		
Equivalent layer thickness (ELT) = 0,85679 x ALD + 0,46715 (mm)	7.49	
Embedment =((0.1816*LN(CBP)+0.4184)*LN(ELV))-(0.8365*LN(CBP)+2.9284) - Note: Design for Minimum ELV=2000	1.01	
Embedment as fraction of ELT = (Embedment/ELT)	0.13	
Fractional void loss due to embedment =3.0556*(Embedment/ELT)^3-4.5833*(Embedment/ELT)^2+2.5263*(Embedment/ELT)+0.0002	0.26	
Maximum ELV for wear calculation = 5000	4000	
Wear (mm) =-0.0011x(10%FACT)+0.2533x(ELV)^0.1747	0.85	
Wear as fraction of ELT = (Wear/ELT)	0.11	
Fractional void loss due to wear =3.0556*(Wear/ELT)^3-4.5833*(Wear/ELT)^2+2.5263*(Wear/ELT)+0.0002	0.23	
Estimated void content for a single seal (%) = 45,3333 - 0,333 x ELT.	42.84	
Fractional Void loss for macro texture = Macro texture requirement/(Estimated void content%*ELT)	0.22	
Total fractional void loss =Fractional void loss due to (Embedment + Wear + Macro texture requirement)	0.71	
Available void fraction to be filled with binder = (1 - total fractional void loss)	0.29	
% Rolling embedment of total embedment (Assumed 50%)	50%	
Rolling Embed (50% * Total embedment) in mm	0.50	
Rolling Embed as fraction of ELT = (Rolling embedment/ELT)	0.07	
Fractional void loss due to rolling =3.0556*(Rolling embedment/ELT)^3-4.5833*(Rolling embedment/ELT)^2+2.5263*(Rolling embedment/ELT)+0.0002	0.15	
The minimum amount of voids to be filled with binder to prevent stone loss when there is no ... is 42 per cent for single seals	42%	
Filled vo... Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment	0.27	**Warning 1**
		If the filled void fraction to hold the stone is more than the available void fraction, then the target texture cannot be achieved at end of design period
NCCBmin = (Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment)*(Estimated void content for a single seal (%) *(ELT)	0.[illegible]7	**Warning 2**
Practical Construction Minimum	**0.72**	Practical minimum NCCB = Maximum of 0.6 and (0.7226ln(ALD) - 0.7976) l/m^2. If NCCBmin is less than the practical minimum, then a larger stone should be selected, or the practical minimum applied with the risk of too low macro texture
NCCBmax = Estimated void content * Available void fraction to be filled with binder * ELT	**0.92**	**Warning 3**
		If the calculated NCCBmax < NCCBmin, then the target texture will not be achieved for the design period of ten years
Selected practical maximum NCCBmax = 0.1458*ALD+0.1444	**1.34**	**Warning 4**
		If the calculated NCCBmax > selected practical NCCBmax, then select the practical maximum

Existing texture

- **Interpretation of test results**
  - Existing macro texture





Can we seal without a texture treatment ?

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Seal Code	Description	Max Texture Depth
S1(10)	Single seal with 10 mm aggregate	0.8
S1(10)	Single seal with 10 mm aggregate (with cover spray)	1.0
S1(14)	Single seal with 14 mm aggregate	0.8
S1(14)	Single seal with 14 mm aggregate (with cover spray)	1.2
S1(14)	Single seal with 14 mm aggregate (with Bitumen rubber)	1.2
S2(10/S)	Double seal with 10 mm aggregate and sand	1.0
S2(14/S)	Double seal with 14 mm aggregate and sand	1.5
S4(10)	Cape Seal with 10 mm aggregate and one layer of slurry	1.5
S4(14)	Cape Seal with 14 mm aggregate and one layer of slurry	1.8
S4(20)	Cape Seal with 20 mm aggregate and two layers of slurry	2.0
S2(14/7)	Double seal with 14 mm aggregate and a layer of 7 mm aggregate	1.5
S2(14/5)	Double seal with 14 mm aggregate and a layer of 5 mm aggregate	1.5
S2(20/10)	Double seal with 20 mm aggregate and a layer of 10 mm aggregate	1.8
S2(20/7)	Double seal with 20 mm aggregate and a layer of 7 mm aggregate	1.8
S2(20/7/7)	Double seal with 20 mm aggregate and two layers of 7 mm aggregate	1.5

How much additional binder ?

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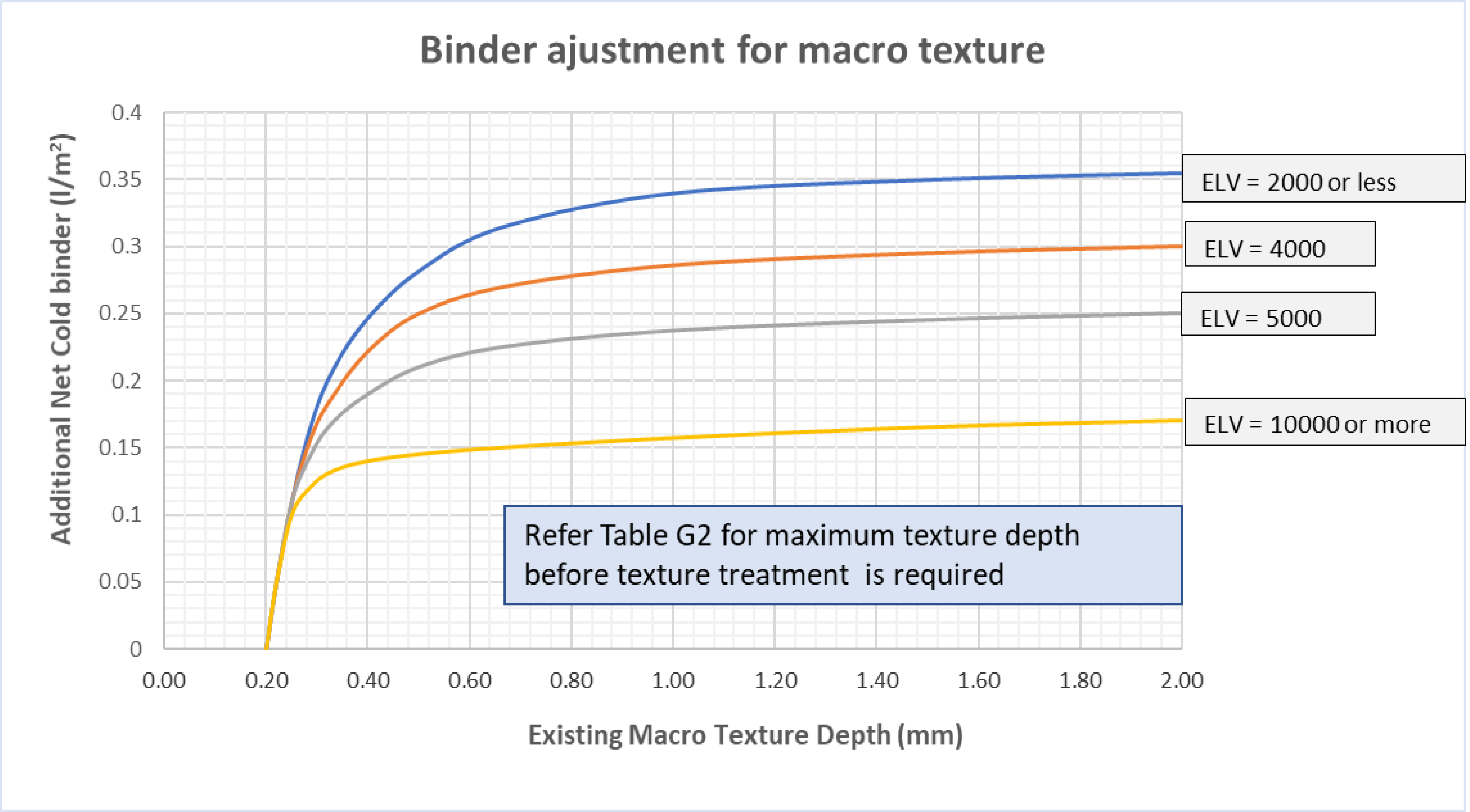
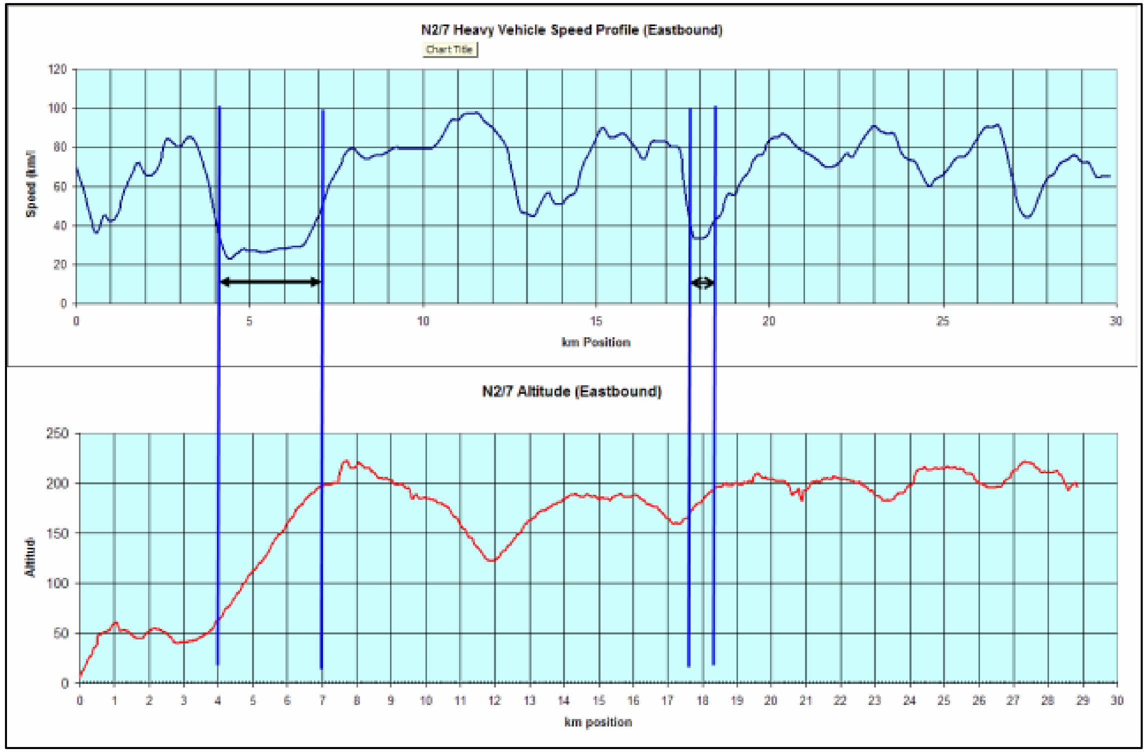


Slow-moving heavy vehicles

- Reduction in binder for slow-moving vehicles and channelisation
- >40km/h = 0% of basic NCCB
- <20 km/h = 10%

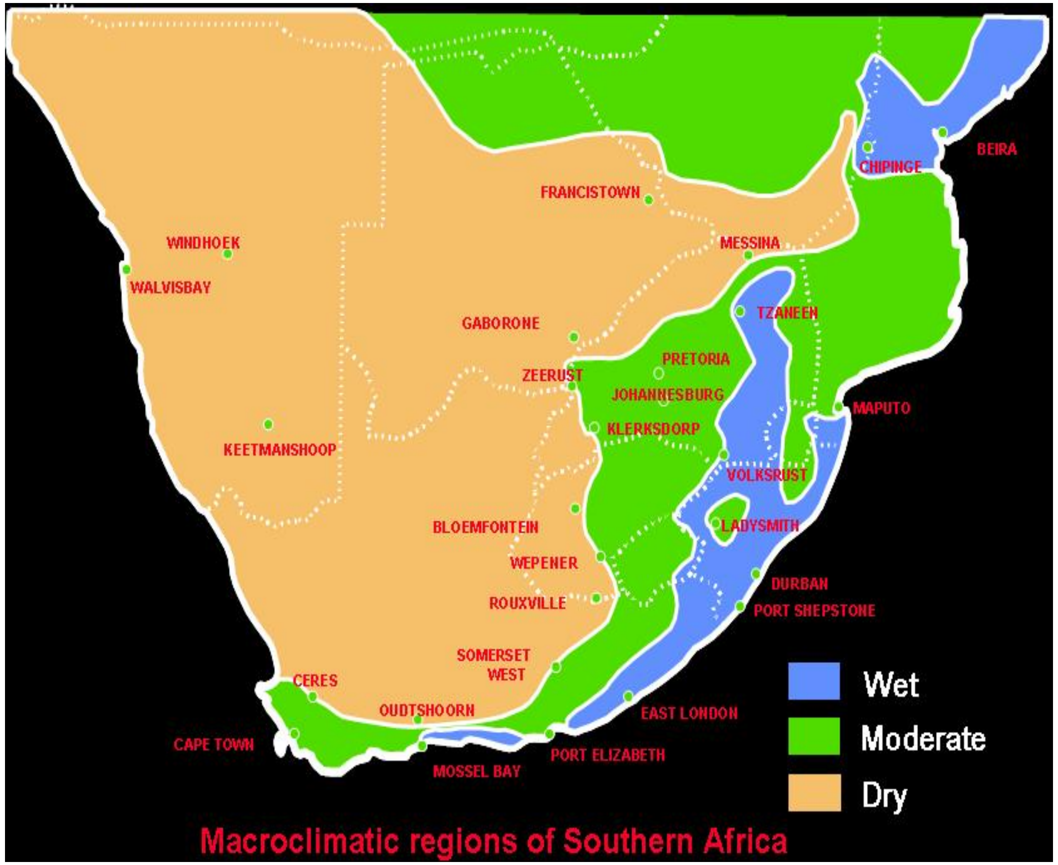
HV Speed	Adjustment
40	0
38	-1
36	-2
34	-3
32	-4
30	-5
28	-6
26	-7
24	-8
22	-9
20	-10



Design…

Macro climate adjustment

- **Adjustment for specific climate**
  - Reduction in hot humid areas
  - Increase in hot dry areas
- **Not applicable to modified binders**



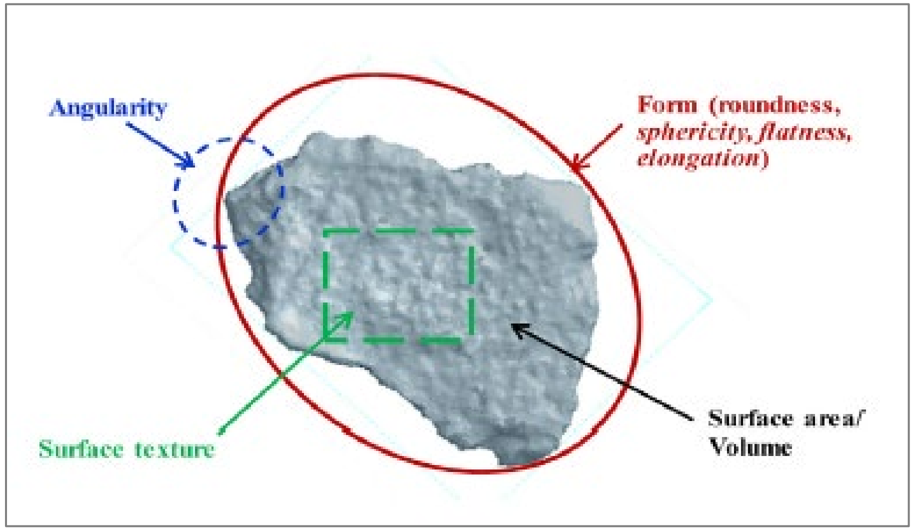
Note: Although incorporated in TRH3 (1998) and TRH3 (2007) for conventional binders, it is no longer recommended until specific research confirms a reason for this adjustment.

Cold microclimates

- Sensitive areas are constructed separately, close with immediate extra rolling.
- Emulsion cover spray and sand blinding or alternative seal (Stone+1/3, Cape seal).
- Selection of different binder. Hot binders are not recommended unless they are cut back or modified.
- Increase of binder application rates 10 to 20 % (penetration coat of double seals)
- Apply tight control on traffic speed and turning actions for at least two weeks after construction
- Close the new seal overnight - only allow traffic when road surface temperatures increase above 20°C.

Micro texture & porosity

- **Principles**
  - ❑ Surface area in contact
  - ❑ Porosity – loss of binder
- **Decision**
  - ❑ Do not design for minimum
  - ❑ Cover spray provision
  - ❑ Precoat
  - ❑ Additional research required



Aggregate spread

- Adjustment for preferred aggregate matrix
- Designs based on shoulder-to-shoulder matrix
- Open textures require adjustment

  Note: experience required

Ignore !: Design for full matrix

Other considerations/adjustments

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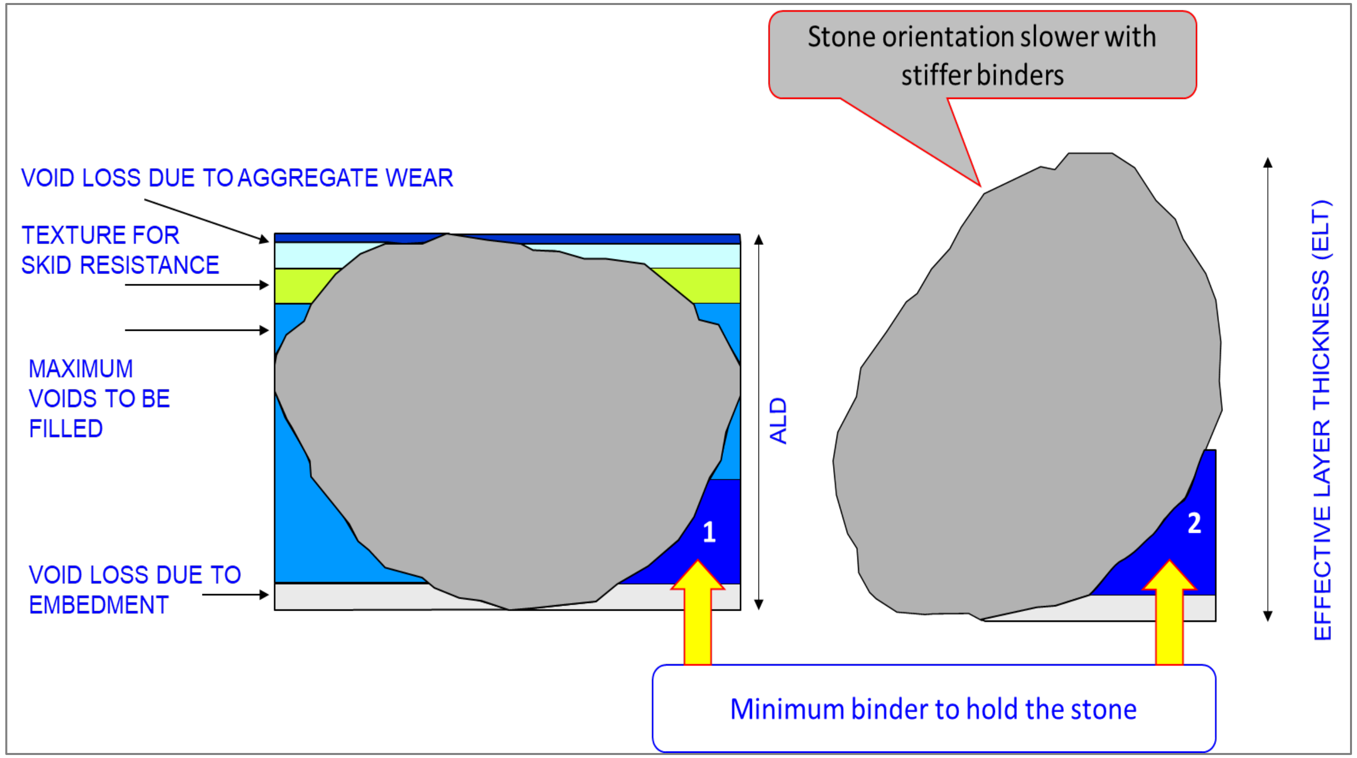
- Stone and sand combination (add 15%)
- Sealing during winter
- Fatty surfaces
- Porous surfaces
- No initial traffic
- Construction traffic
- Cracked surfaces
- Contractor allowance (5%)

Conversions

- **Conversions for modified binders**
  - ❑ Sensitivity to orientation



S-E1 Conversion

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S-E1 ADJUSTMENT (Conventional to modified binder)			
Traffic (ELV)	**Single seal**	**Double Seal**	**Split application double seal**
< 5000	1.3	1.1	1.2
5001 - 20000	1.2	1.0	1.1
> 20000	1.1	1.0	1.0

S-E2 Conversion

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S-E2 ADJUSTMENT (Conventional to modified binder)			
Traffic (ELV)	Single seal	Double Seal	Split application double seal
< 5000	1.4	1.2	1.3
5001 - 20000	1.3	1.1	1.2
> 20000	1.2	1.0	1.1

S-R1

S-R1 ADJUSTMENT (Conventional to modified binder)			
Traffic (ELV)	**Single seal**	**Double Seal**	**Split application double seal**
< 5000	1.8	1.6	1.6
5001 - 20000	1.9	1.7	1.7
> 20000	2.0	1.8	1.8

S-R2

S-R2 ADJUSTMENT (Conventional to modified binder)			
Traffic (ELV)	**Single seal**	**Double Seal**	**Split application double seal**
< 5000	1.7	1.7	1.7
5001 - 20000	1.8	1.7	1.7
> 20000	1.9	1.7	1.7

Conversion for Polymer modified emulsions

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- **Conversion for SC-E1 = 50% of the conversion for S-E1**
- **Conversion for SC-E2 = 50% of the conversion for S-E2.**

- Adjustment cold to hot binder
- Designs based on residual binder (net cold binder)
- Typical conversions
- Some products – supplier specific

Type of binder	Conversion factor*** (Net cold to hot)
Cutback bitumen	
MC 3000	1.19 – 1.27
MC 70	1.63 – 1.72
MC 30	1.88 – 1.99
Penetration grade bitumen	
150/200 pen	1.09
70/100 pen	1.09
Polymer modified bitumen	
S-E1	1.08
S-E2	1.06
Bitumen rubber (S-R1)	1.07
Bitumen rubber (S-R2)	1.07
Bitumen emulsions	
60% emulsion	1.68
65% emulsion	1.55
70% emulsion	1.44

Final application rates

- If there is a high level of uncertainty with regards to traffic and the ability exists to add binder (application of diluted emulsion) when necessary, a strategy can be followed of applying the minimum amount of binder.
- Risks related to inclement weather shortly after construction. Sealing close to winter could influence the rate of stone orientation and sensitivity to stripping. Designing for the minimum application rate is not recommended in this case
- Existing cracking and need to extend the service life before crack reflection
- Contractor experience and equipment quality. In selecting the target application rate cognisance should be taken of the 5 per cent permissible variation in binder application rates To minimise the risk of early stripping, good practice suggests adding 5% binder if designing on the minimum application rate

Final application rates

- Practical minimum and maximum application rates.
- Check for practical minimum spray rates (now calculated).
- Check for practical maximum spray rates to prevent run-off by evaluating the maximum gradient/cross fall combination, texture and binder viscosity (approximately 1,75 ℓ/m2 for hot conventional binders and 1.5 ℓ/m2 for emulsions).
- Each type of binder has its own minimum practical spray rate. In the case of polymer-modified binders, it should be borne in mind that the use of minimum spray rates will tend to defeat the objective for which the polymer-modified binder was selected in the first place.

Ouble seals

- **Traffic – Equivalent light vehicles per lane per day (1 Heavy = 40 Light)**
- **Average least dimension (ALD)**
  - 1.5 (ALD1 + ½ ALD2), Full double (ALD1 + ALD2), Stone +1/3 (ALD1 + ALD2)
- **Embedment potential (Ball penetration)**
- **Preferred texture depth (select ?)**
- **Adjustments**
  - existing texture
  - slow traffic / gradients/ HV speed
  - climate (macro and micro climates)
  - aggregate micro texture
  - preferred aggregate matrix
- **Binder distribution**
- **Conversions**
  - modified binder conversion
  - cold to hot binder

Basic application rate
- Traffic (ELVs/lane/day)
- Embedment (Corrected ball penetration)
- Average Least Dimension (ALD)

Adjustments
- Existing macro texture
- Heavy vehicle speed
- Macro climate
- Cold microclimates
- Aggregate micro texture

Binder distribution
- Cover spray
- Tack coat
- Penetration coat

Conversions
- Conventional to modified
- Cold to hot

Double seals

- **Basic application rate**
- **Adjustments and conversions as for single seals**

Double seal design		
Input parameters	**Example**	
Corrected Ball penetration (CBP) in mm	1	If CBP <1.0, then 1.0
Equivalent Light Vehicles per lane per day (ELV)	5100	Design for minimum ELVs of 2000
Average Least Dimention of 1st aggregate (ALD1)	8.5	
Average Least Dimention of 2ndt aggregate (ALD2)	4	
Macro texture requirement	0.7	
Aggregate hardness (top layer) - 10%Fact (kN)	210	
Calculations		
Equivalent layer thickness (ELT1) = 0,85679 x ALD1 + 0,46715 (mm)	7.75	
Equivalent layer thickness (ELT2) = 0,85679 x ALD2 + 0,46715 (mm)	3.89	Note: In case of the 1 1/2 stone configuration use ALD2/2
Equivalent design layer thickness (ELTd) = 0,86028 x (ELT1 + ELT2) + 0,19188 mm	10.21	
Embedment =((0.1816*LN(CBP)+0.4184)*LN(ELV))-(0.8365*LN(CBP)+2.9284) - Note: Design for Minimum ELV=2000	0.64	
Embedment as fraction of ELT = (Embedment/ELT)	0.06	
Fractional void loss due to embedment =3.0556*(Embedment/ELT)^3-4.5833*(Embedment/ELT)^2+2.5263*(Embedment/ELT)+0.0002	0.14	
Maximum ELV for wear calculation = 5000	5000	
Wear (mm) =-0.0011x(10%FACT)+0.2533x(ELV)^0.1747	0.89	
Wear as fraction of ELT = (Wear/ELT)	0.09	
Fractional void loss due to wear =3.0556*(Wear/ELT)^3-4.5833*(Wear/ELT)^2+2.5263*(Wear/ELT)+0.0002	0.19	
Estimated void content for a double seal (%) = 63,01263 + 0,04743 x ELT_d^2 - 2,41172 x ELT_d.	43.33	
Fractional Void loss for macro texture = Macro texture requirement/(Estimated void content%*ELT)	0.158	
Total fractionl void loss =Fractional void loss due to (Embedment + Wear + Macro texture requirement)	0.49	
Available void fraction to be filled with binder = (1 - total fractional void loss)	0.51	
% Rolling embedment of total embedment (Assumed 50%)	50%	
Rolling Embed (50% * Total embedment) in mm	0.32	
Rolling Embed as fraction of ELT = (Rolling embedment/ELT)	0.03	
Fractional void loss due to rolling =3.0556*(Rolling embedment/ELT)^3-4.5833*(Rolling embedment/ELT)^2+2.5263*(Rolling embedment/ELT)+0.0002	0.08	
The minimum amount of voids to be filled with binder to prevent stone loss when there is no embedment, is 42 per cent for single seals and 55 per cent for double seals	0.55	
Filled void fraction to hold stone = Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment	0.47	**Warning 1**
		If the filled void fraction to hold the stone is more than the available void fraction, then the target texture cannot be achieved at end of design period
NCCBmin = (Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment)*(Estimated void content for a single seal (%) *(ELT)	**2.10**	**Warning 2**
Practical Construction Minimum for double seal	**1.33**	Practical minimum NCCB for double seal = maximum of 1.2 and (0.9539ln(ALD1+ALD2) - 1.0792) l/m^2. If NCCBmin is less, then a larger stone should be selected, or the practical minimum applied with the risk of too low macro texture
NCCBmax = Estimated void content * Available void fraction to be filled with binder * ELT	**2.27**	**Warning 3**
		If the calculated NCCBmax < NCCBmin, then the target texture will not be achieved for the design period of ten years
Selected practical maximum NCCBmax = 0.5248*ALD^0.606	**2.43**	**Warning 4**
		If the calculated NCCBmax > selected practical NCCBmax, then select the practical maximum

Binder distribution for double seals

- Subtract 50% of cover spray
- Distribute remainder between tack and penetration coat
- Old rule of thumb 60/40
- Now at least 50/50
- Even 45/55
- Consider
  - ❑ Minimum
  - ❑ Aggregate shape

Table E 11 Minimum Quantity of Net Cold Binder Required for Penetration Coat

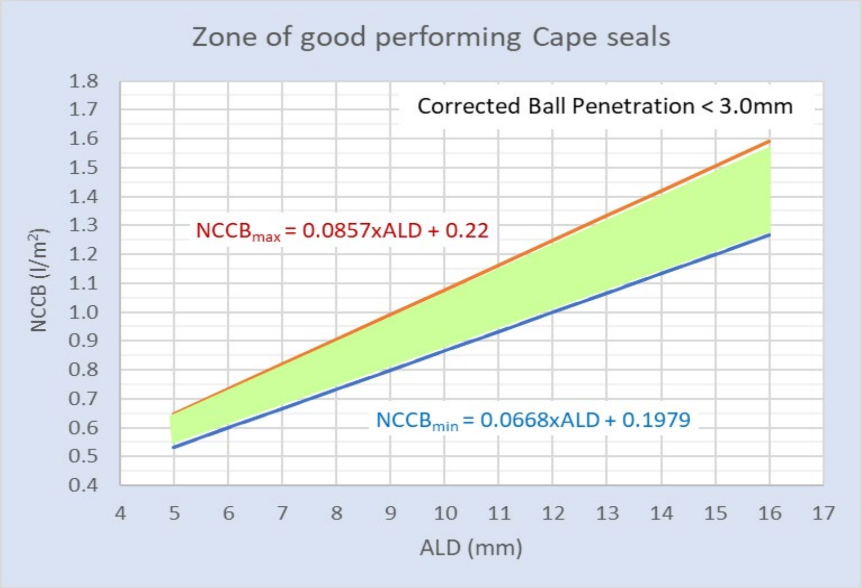
Aggregate size in top layer	5 mm or less	7 mm	10 mm
Minimum net binder required	0,3 ℓ/m^2	0,6 ℓ/m^2	0,7 ℓ/m^2

Table E 12 Minimum quantity of net cold binder required for tack coat

Aggregate size	10 mm	14 mm	20 mm
No traffic	0,5 ℓ/m^2	0,7 ℓ/m^2	1,0 ℓ/m^2

Cape seals

- TRH3(2007) & WCape too high
- Minimum to hold aggregate
- 20% Texture & 80% Cor BP
- Cover spray preferred
- No subtraction for cover spray



Cape seal design		
Input parameters	**Example**	
Corrected Ball penetration (CBP) in mm	1.5	If CBP < 1.0, then 1.0
Equivalent Light Vehicles per lane per day (ELV)	7300	Design for minimum ELVs of 2000
Average Least Dimention of aggregate (ALD)	12.8	
Macro texture requirement	1	
Aggregate hardness - 10%Fact (kN)	210	
Calculations		
Equivalent layer thickness (ELT) = 0,85679 x ALD + 0,46715 (mm)	11.43	
Embedment =((0.1816*LN(CBP)+0.4184)*LN(ELV))-(0.8365*LN(CBP)+2.9284) - Note: Design for Minimum ELV=2000	1.11	
Embedment as fraction of ELT = (Embedment/ELT)	0.10	
Fractional void loss due to embedment =3.0556*(Embedment/ELT)^3-4.5833*(Embedment/ELT)^2+2.5263*(Embedment/ELT)+0.0002	0.20	
Maximum ELV for wear calculation = 5000	5000	
Design period (Default 10 years)	10	For temporary Cape seals select less than 10 years
Wear (mm) =-0.0011x(10%FACT)+0.2533x(ELV)^0.1747*(10/design life)	0.89	
Wear as fraction of ELT = (Wear/ELT)	0.08	
Fractional void loss due to wear =3.0556*(Wear/ELT)^3-4.5833*(Wear/ELT)^2+2.5263*(Wear/ELT)+0.0002	0.17	
Estimated void content for a single seal (%) = 45,3333 - 0,333 x ELT.	41.53	
Fractional Void loss for macro texture = Macro texture requirement/(Estimated void content%*ELT)	0.21	
Total fractional void loss =Fractional void loss due to (Embedment + Wear + Macro texture requirement)	0.59	
Available void fraction to be filled with binder and slurry = (1 - total fractional void loss)	0.41	
% Rolling embedment of total embedment (Assumed 30% as a result of slurry filling)	30%	
Rolling Embed (30% * Total embedment) in mm	0.33	
Rolling Embed as fraction of ELT = (Rolling embedment/ELT)	0.03	
Fractional void loss due to rolling =3.0556*(Rolling embedment/ELT)^3-4.5833*(Rolling embedment/ELT)^2+2.5263*(Rolling embedment/ELT)+0.0002	0.07	
The minimum amount of voids to be filled with binder to prevent stone loss when there is no embedment, is 30 per cent for Cape seals	30%	
Filled void fraction to hold stone = Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment	0.23	**Warning 1** If the filled void fraction to hold the stone is more than the available void fraction, then the target texture cannot be achieved. For temporary cape seals select a shorter period than 10 years
NCCBmin = (Min void fraction to be filled with binder - Fractional void loss due to Rolling Embedment)*(Estimated void content for a single seal (%) *(ELT)	**1.09**	**Warning 2**
Practical Construction Minimum	**1.04**	Practical minimum NCCB = Maximum of 0.6 and (0.7226ln(ALD) - 0.7976) l/m^2. If NCCBmin is less than the practical minimum, then a larger stone should be selected, or the practical minimum applied with the risk of too low macro texture
Selected maximum NCCBmax = 0.0857*ALD+0.22	**1.32**	**Warning 2** If the calculated NCCBmin > selected practical NCCBmax, then select the practical maximum

Slurry

- Simplified (Aggregate within COTO specs)
- Texture slurry

ELV/lane/day	Percentage of residual bitumen in mix by mass of aggregate	Typical emulsion contents for texture treatments
> 10 000	7 - 8	180 - 200 ℓ/m^3
1000 - 10 000	8 - 10	200 - 220 ℓ/m^3
<1000	10 - 12	220 - 260 l ℓ/m^3

Slurry

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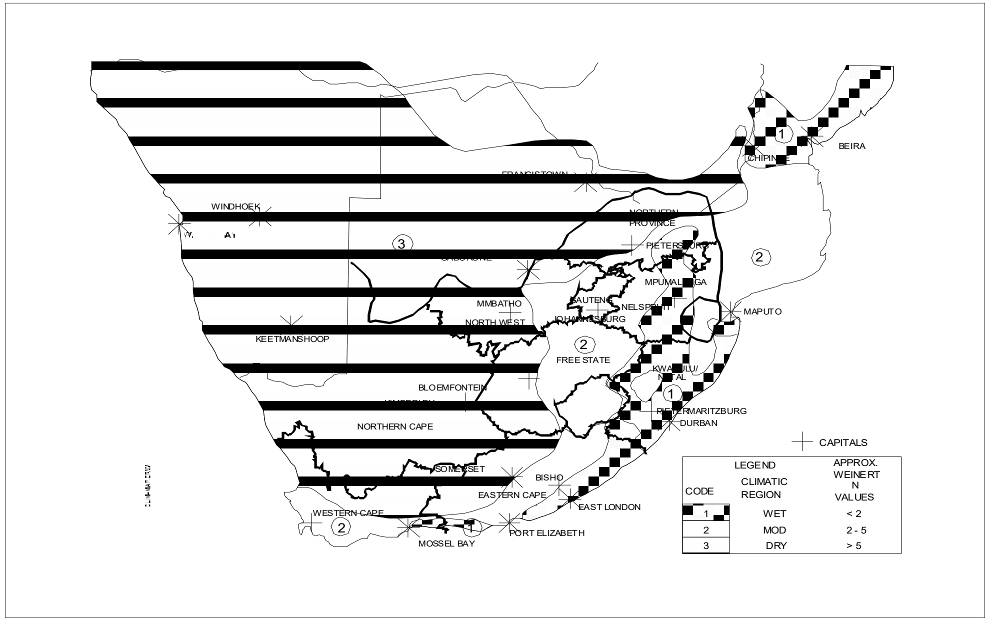
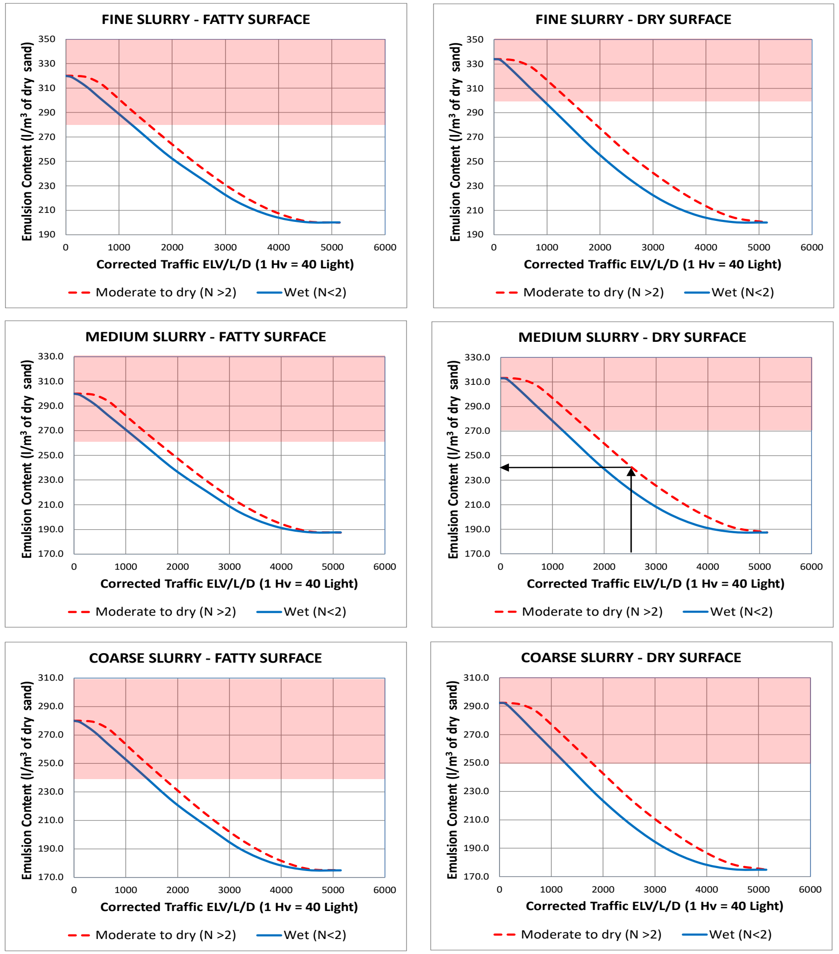
- **Simplified (Aggregate within COTO specs)**
- **Overlays (Fig E36)**
  - Macro climatic areas
  - ELV, fatty/dry, Slurry type





Slurry

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Slurry design - detail

- Sample preparation and compaction.
- Preliminary evaluation.
- Abrasion testing.
- Determining of voids filled with binder.
- Evaluation and decision.

Colas Method

- Several slurry mixtures are made up, varying the emulsion content from 180 ℓ/m^3 to 240 ℓ/m^3
- The slurry mixtures are poured into Marshall briquette moulds to approximately 15 mm in depth
- Samples are heated overnight at 60 °C to allow water evaporation
- Samples are then compacted using the Marshall hammer - 150 blows (only one side)
- Evaluate (Colour, brittleness, plastic deformation)

Slurry Seals – Colas Method

- **Additional guidelines and hints on**
  - Texture treatment
  - Compensation for grading variations
  - On-site design check

Detailed slurry design

- **Wet Track Abrasion (Minimum Binder)**
- **Mixing and coating (Consistency and stability)**
- **Water demand**
- **Maximum binder (Briquettes - Marshal/ Colas)**
  - Stability
  - Voids filled with binder

Briquette compaction

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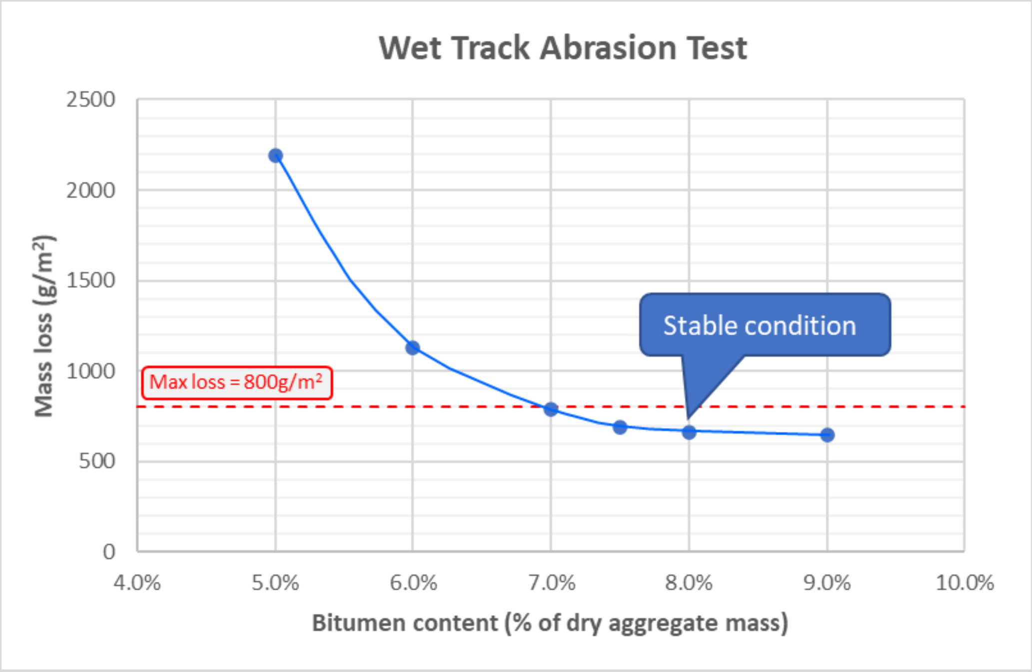
Wet Track Abrasion



Mixing & Coating & Water demand

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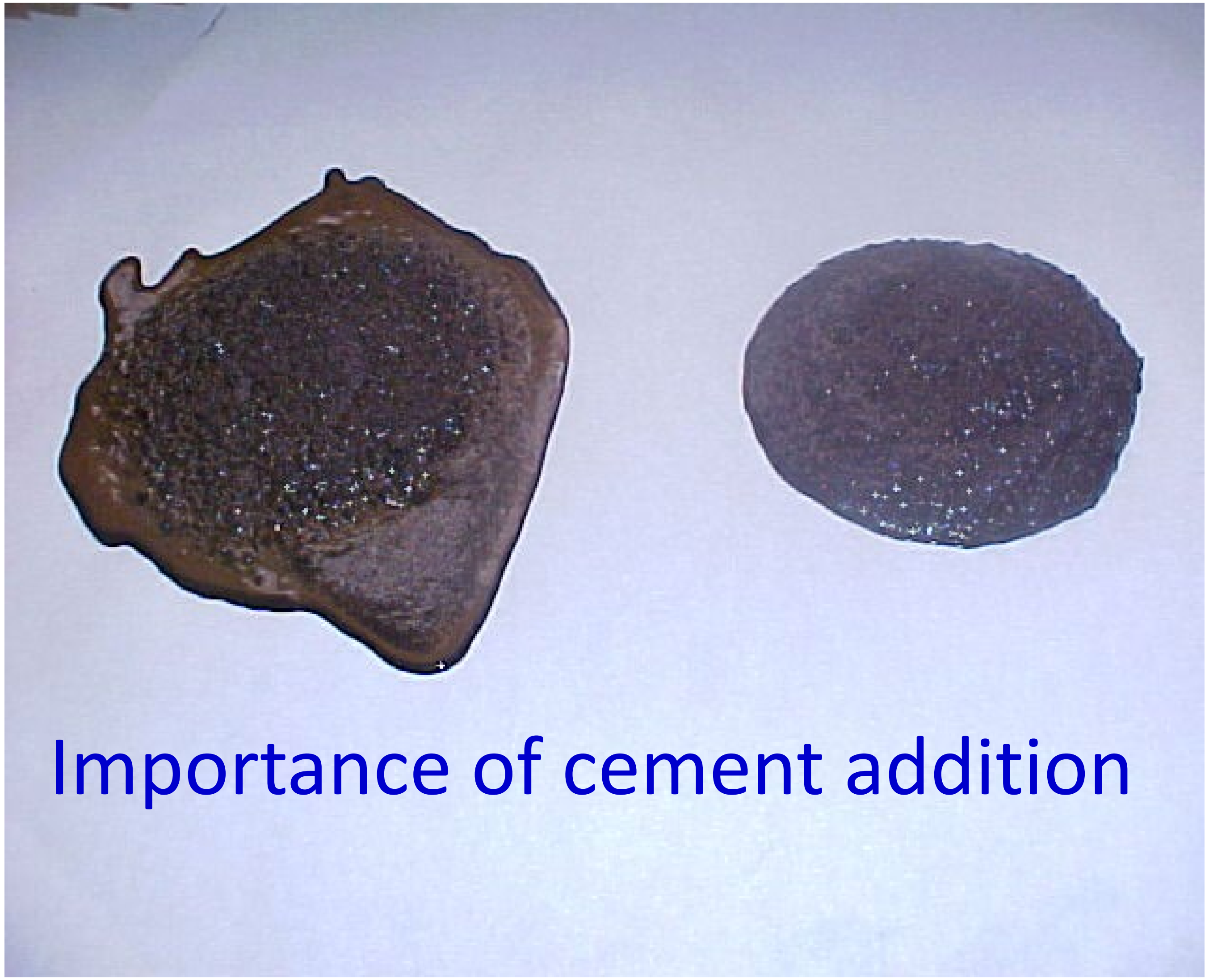
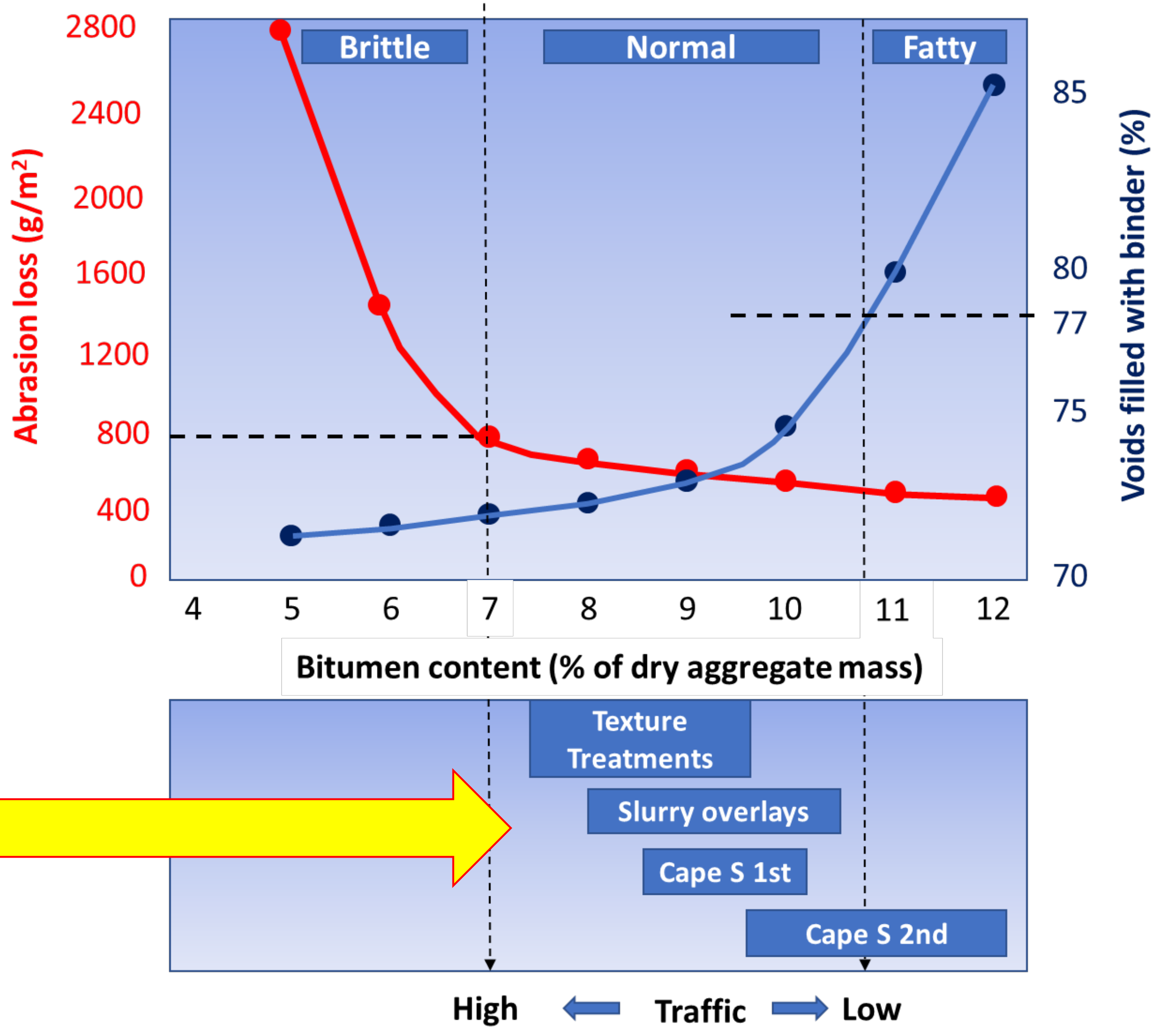


Importance of cement addition

Slurry design - detail

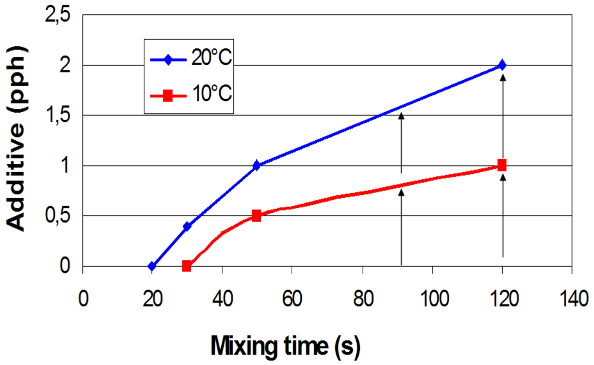
- **Colas test**

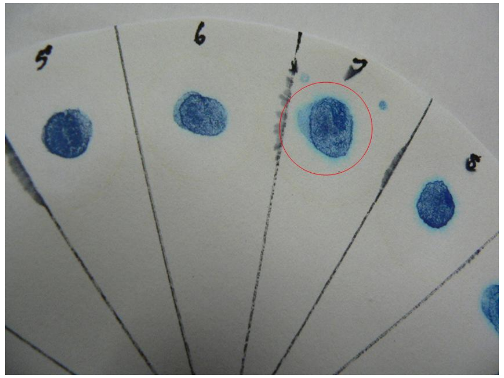
- **Binder increase**



Microsurfacing

- **Best left for suppliers**
- **Additive dosage - Highly sensitive to road conditions**
- **Mixing time**





- **Methylene Blue test**
  - ❑ Additive concentration
- **Cohesion development**

Sand and grit seals

- **Sand**
  - Appropriate for ELV/L/D <1000
- **Grit**
  - Appropriate for ELV/L/D = 3000
- **MC 3000 sensitive to high road temp**
- **Alternative = emulsions**
- **Application rate 1.0 l/m^2 residual binder**
  - Penetration grade bitumen….1,1 - 1,3 ℓ/m2
  - Cut-back bitumen…………………1,2 - 1,4 ℓ/m2
  - Emulsion……………………….……1,4 - 1,6 ℓ/m2
- **Precoated grit**
  - Pre-coating approximately 14 l/m^3
  - Reduce with 0.1 l/m2 residual binder

Sand & Grit seals

- **Typical problems**
  - ❑ Dust
  - ❑ Back brooming
  - ❑ Dry dusty aggregate (2% to 1% dust)

Precoated Grit seal

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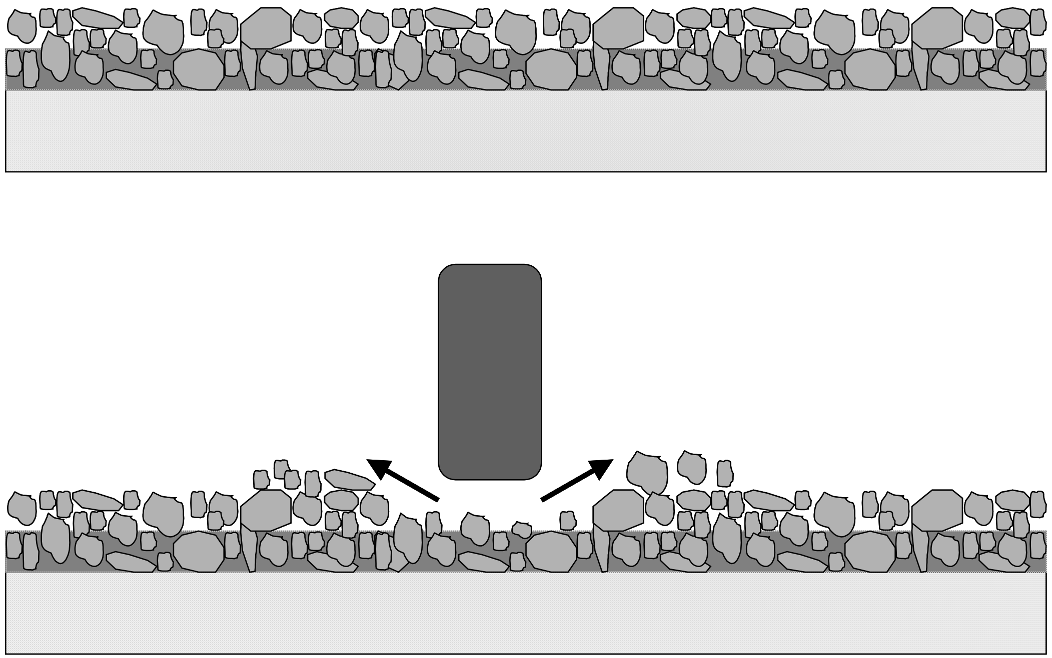
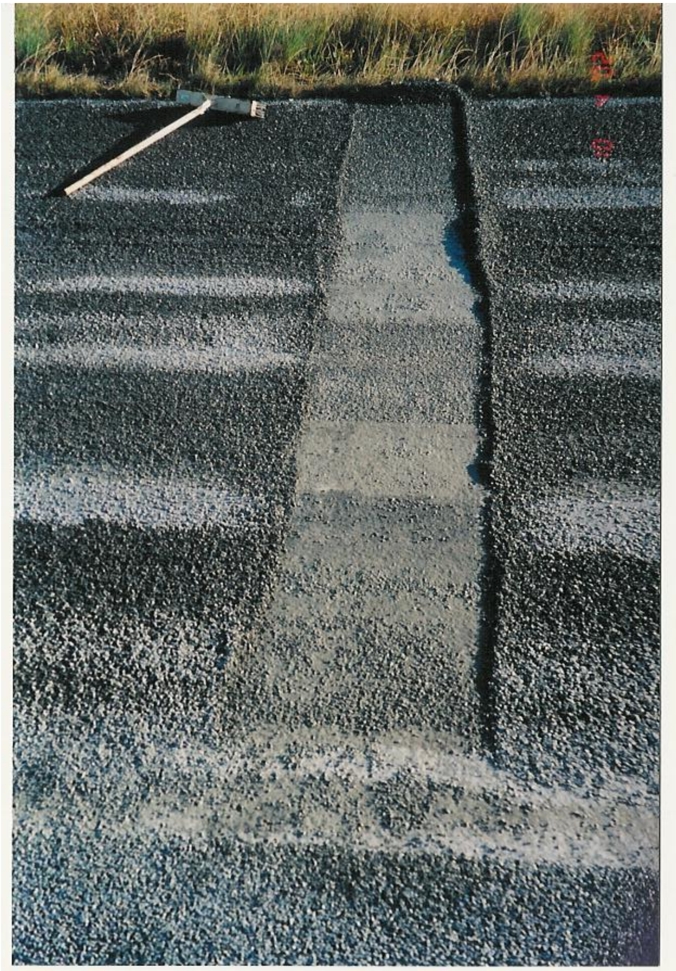
- **Benefits**
  - ❑ Cheap
  - ❑ No dust
  - ❑ Line marking not delayed
  - ❑ No back brooming
  - ❑ Can handle relatively high traffic

- **Sensitivities**
  - ❑ MC 3000 at high surface temperatures
  - ❑ Rain
  - ❑ Construction (only light brooming)
  - ❑ High dual traffic
- **Practical guidelines provided**

Grit seals

- **Sensitivity to rain**
- **Need for traffic compaction**





Traffic emulsifying MC3000

Otta seal

Bitumen spray rates					
Hot bitumen spray rates for un-primed base course (ℓ/m²)					
		Grading			
				Dense	
Type of Otta seal		Open	Medium	AADT <100	AADT >100
Double	1st layer	1.6	1.7	1.8	1.7
	2nd layer	1.5	1.6	2	1.9
Single with sand cover seal	1st layer	1.6	1.7	2	1.9
	Fine sand	0.7	0.7		0.6
	Crusher dust or coarse river sand	0.9	0.8		0.7
Single		1.7	1.8	2	1.9
Maintenance reseal (single)		1.5	1.6	1.8	1.7

Otta Seals

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Aggregate application rates			
Type of seal	Aggregate spread rates (m^3/m^2)		
	Open grading	Medium grading	Dense grading
Otta seals	0.013 – 0.016	0.013 – 0.016	0.016 – 0.020
Sand cover seals	0.010 – 0.012		

Applicability to South African conditions

- **Construction process**
  - 15 passes with heavy pneumatic and 1 pass with 10-12 ton steel
  - 15 passes with heavy pneumatic for 2 days after construction
  - Max speed of 50km/h for 2 – 6 weeks after construction
  - Min 8 – 12 weeks between first and second layer
  - Back-brooming of sand for 4 weeks
  - Provision for sand blinding team for 8 weeks during first hot season
  - Permanent road markings delayed for as long as possible
- **Appropriate for LVSR**
- **Variations on Graded Aggregate Seals**

Stone and sand combinations

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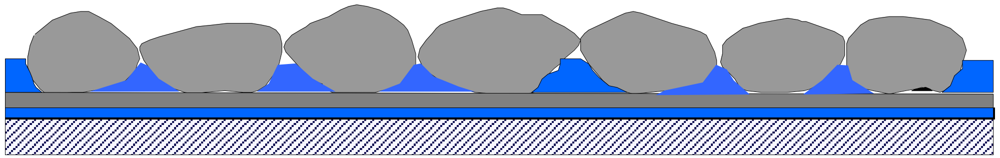
Geotextile seals

Aggregate
Binder
Geotextile

Binder



Geotextile seals

- **Tack coat for geotextile**
  - ❑ High traffic and fine existing texture (0,5 l/m^2)
  - ❑ Low traffic and coarse existing texture (1,1 l/m^2)
- **Geotextile**
  - ❑ Double punched (140g/m^2)
- **Rolling and trafficking (6 - 8 weeks preferred)**
- **Design seal according to Manual 40**
  - ❑ Add 30% additional binder if not saturated
  - ❑ Add additional 0,3 l/m^2 if not trafficked
- **Practical hints provided**
  - ❑ Seals with cover spray or double seals – lower risk
  - ❑ Select binder for tack coat without cutters
  - ❑ Overlap of geotextile

End