

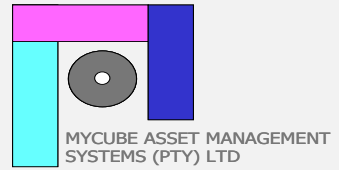
Low Cost Surfacing for Low Volume Roads



International Conference on New Technologies and Sustainable Materials in construction of Rural Roads (Low Volume Roads) and Bridges

Gerrie van Zyl

Scope



- **Introduction**
- **Surface treatment types**
- **Selection of appropriate surface treatment types**
- **Design principles**
- **Conclusions**

Surfacing options for LVRs

Surfacings

Bituminous

Non-Bituminous

Surface treatments

Asphalt

Stone

Clay

Concrete

Sprayed seals

Slurry seals

Combination seals

Rejuvenation sprays

Hot mix (20-40mm)

Cold mix (20-40mm)

Natural

Dressed

Clay bricks

Blocks

Slabs

Reinforced

Sand seals

Graded aggregate seals

Single seals

Double seals

Slurry

Microsurfacing

Cape seal

Slurry-bound Macadam

Chip Sealing – The process

1. Spray binder



2. Spread aggregate



3. Roller compaction



4. Roller compaction



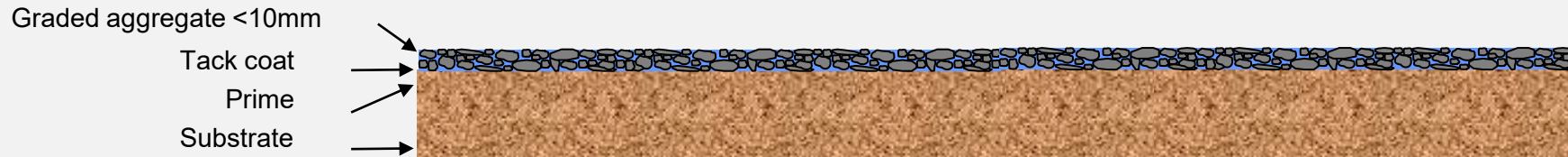
5. Remove excess aggregate



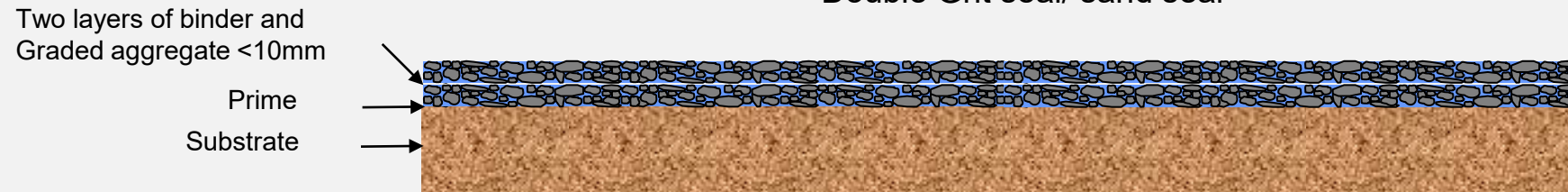
NB: 6. Traffic compaction

Sand seals

Grit seal/ sand seal



Double Grit seal/ sand seal



After construction



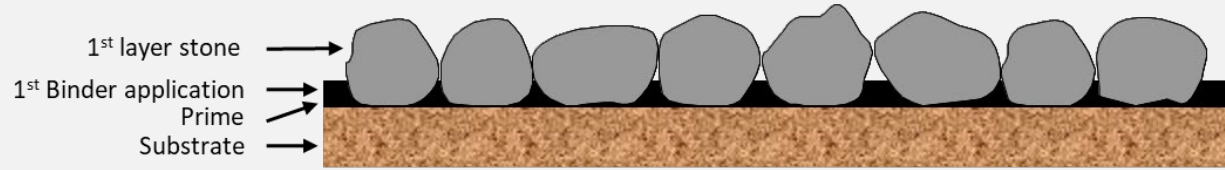
After a period in service



Final surface

Single seal

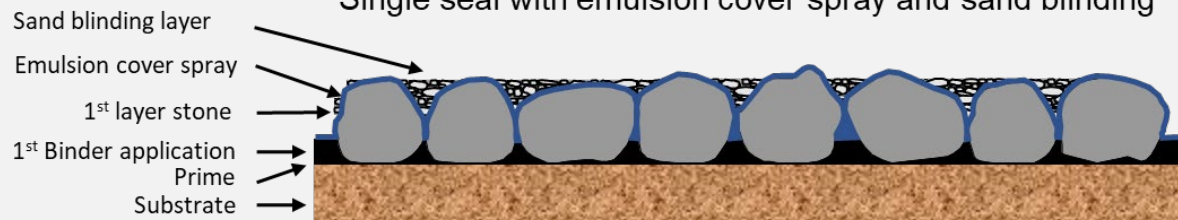
Single seal



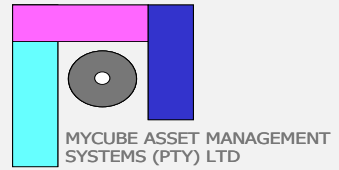
Single seal with emulsion cover spray



Single seal with emulsion cover spray and sand blinding

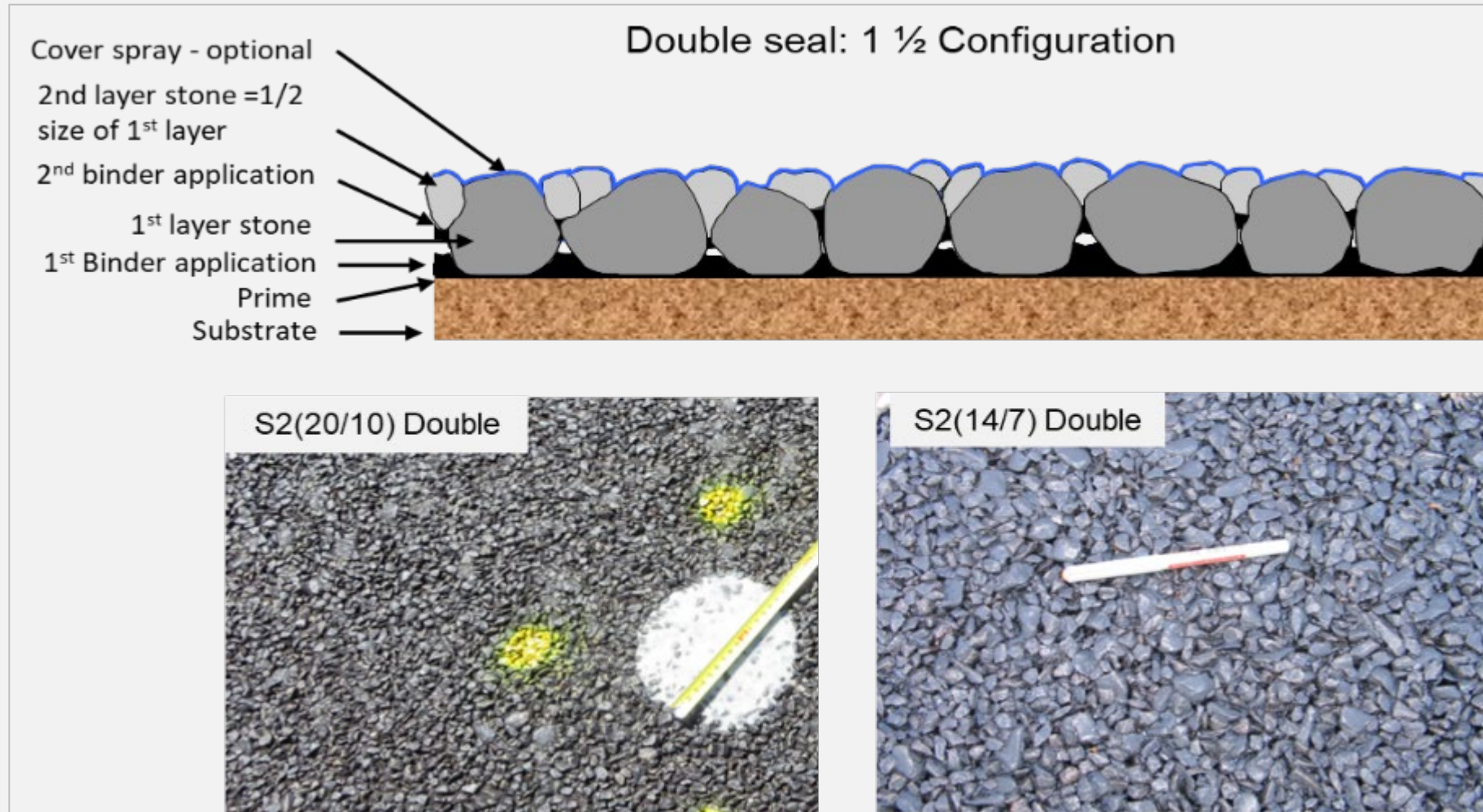


Aggregate nominal sizes

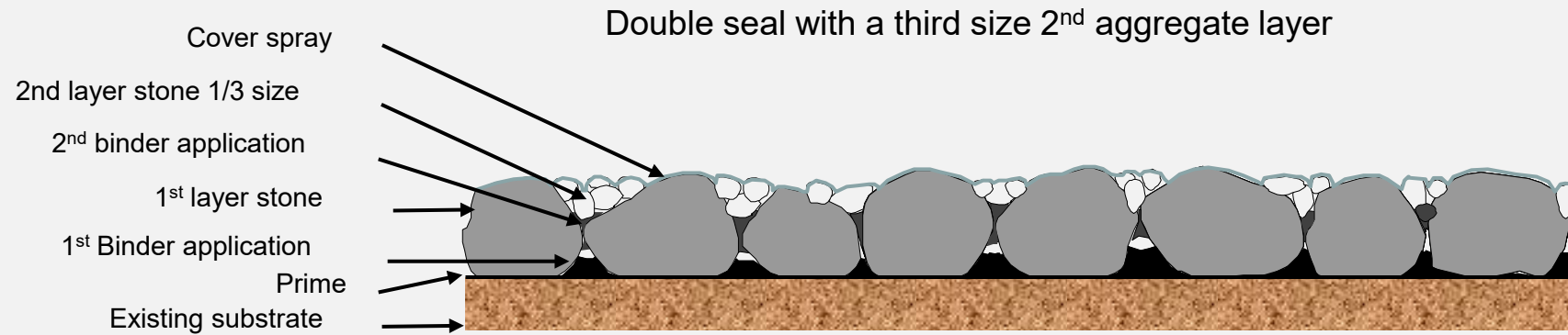


- **19 - 20**
- **13.2 - 14**
- **9.5 - 10**
- **6.7 - 7**
- **4.75 - 5**

Double seal



Double seal (1 + 1/3)



Double seals

19 + 9.5 mm Double



19 + 6.7 mm Double



13.2 + 4.75 mm Double



13.2 + 6.7 mm Double – 14 y



13.2 + 6.7 mm Double – 24 y

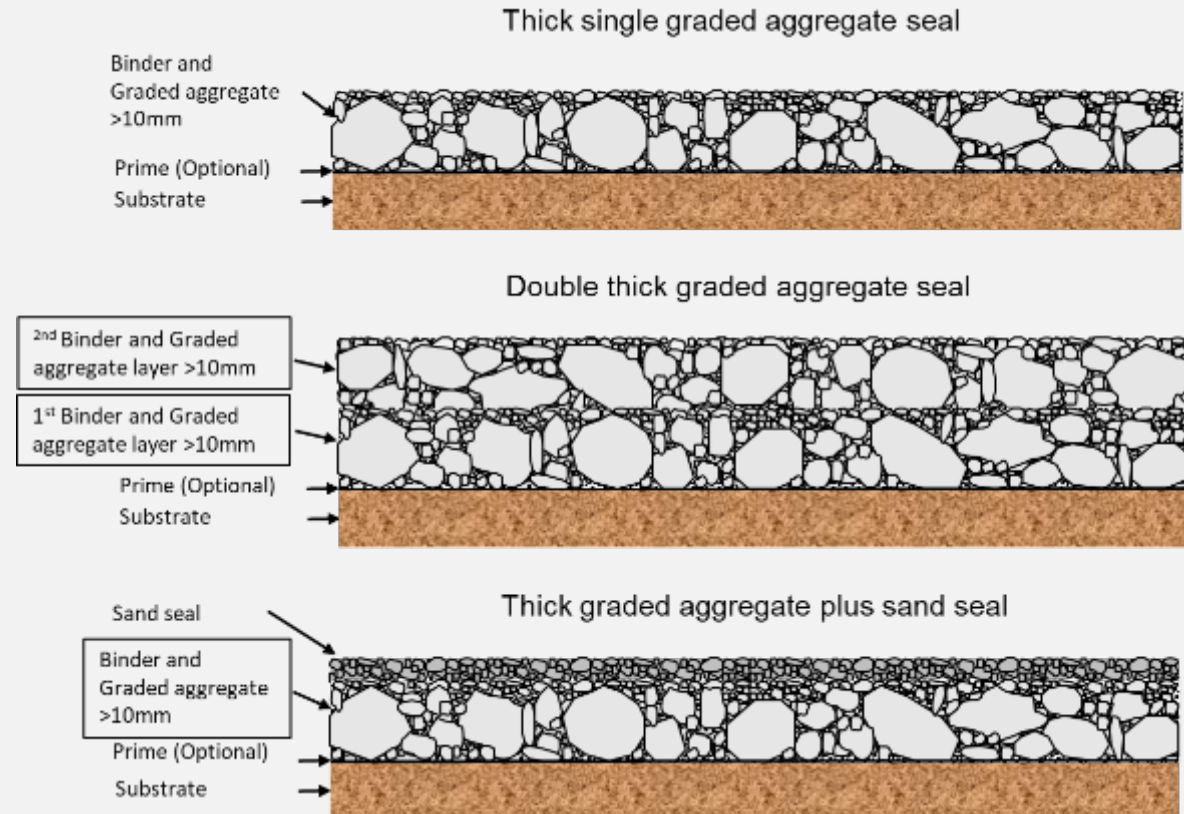


9.5 + 4.75 mm Double – 10y



Graded aggregate seals

- <20 mm (Otta seal)
- 10 mm
- Single
- Double
- Single + Sand seal



Graded aggregate seal "Otta Seal"

Screening of aggregate



20 mm Otta seal

Application of binder and aggregate



20 mm Otta seal close up

Rolling



20 mm Otta seal (26 years)



Source: M Pinard & GD van Zyl

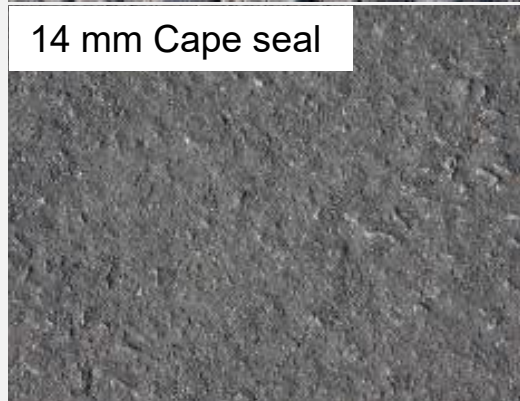
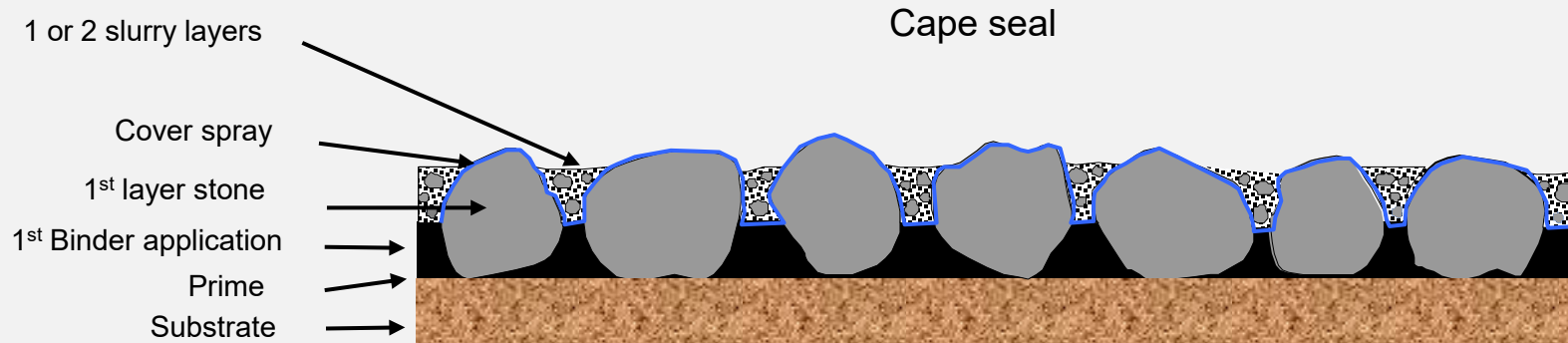
Slurry

- **Combination of crusher dust, emulsion, water, cement**
- **Different gradings for different purposes e.g. thickness**
- **Microsurfacing: Slurry with polymer modified emulsion and chemicals to manage rate of breaking/curing**

Slurry or microsurfacing seal



Cape Seal



Open single seal matrix



Hand application of slurry



Final product



Source: GD van Zyl

Extreme performance

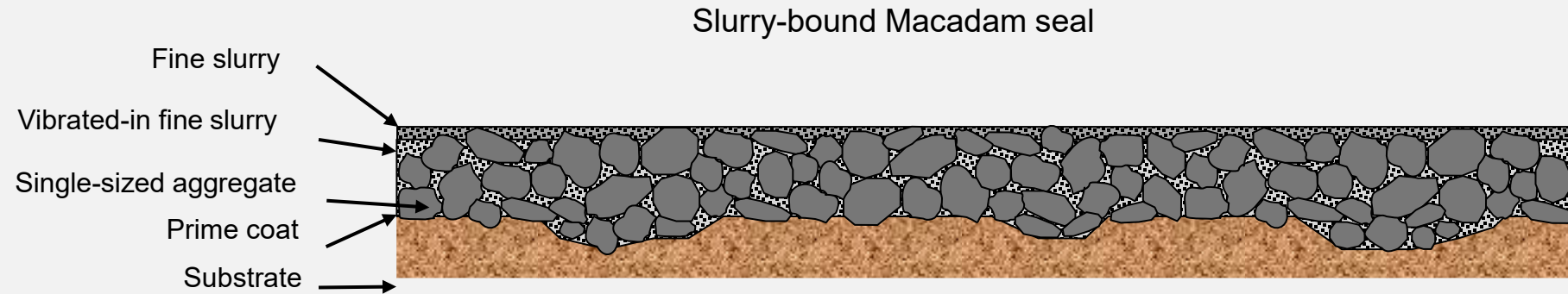
20 mm Cape seal – 24 years



20 mm Cape seal – 44 years



Slurry-bound McAdam seal



Slurry-bound McAdam seal

- **Construction process**

Place, screed, static roll



Apply slurry



Distribute slurry



Vibratory roll



Burlap drag



Fine slurry (next day)



2 years after construction



10 years after construction



10 years after construction



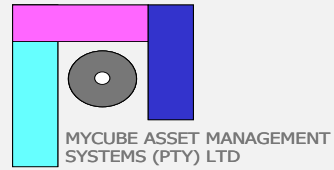
Source: GD van Zyl

Labor intensive

- All surface treatment for LVRs could be constructed by hand, with the exception of Microsurfacing
- Binder application most critical



Selection of initial surface treatment type



- **Note: For resurface/renewal single sprayed seals can work well**
- **1st level selection for initial construction**
 - External stresses expected
 - Coarseness of the base
 - Construction grade

External stresses

- **Water overflow**



- **Equipment damage**
- **Grey water damage**



External stresses

- **Landslides (Material removal)**
- **Construction materials**



External stresses

- **High speed stormwater (Urban drainage)**
 - ❑ Sensitivity of chip seals
 - ❑ Cape seals and slurry bound McAdam perform well
- **Heavy vehicle turning actions**

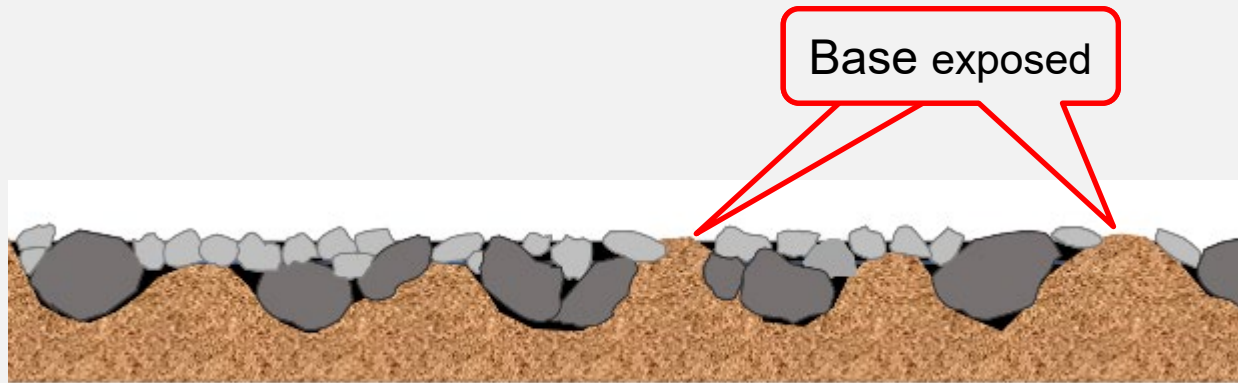


Risk of external stresses categorised

- **Very high**
 - High speed water overflow
 - Equipment damage
 - Landslides and removal
- **High**
 - Many heavy vehicles turning
 - High probability of loose material
 - Grey water
 - Protests (barricades/fires)
 - High speed stormwater (urban drainage)
- **Mild**
 - Occasional heavies turning/breaking
 - Low risk of aspects under “high”
- **Very low risk of damage**

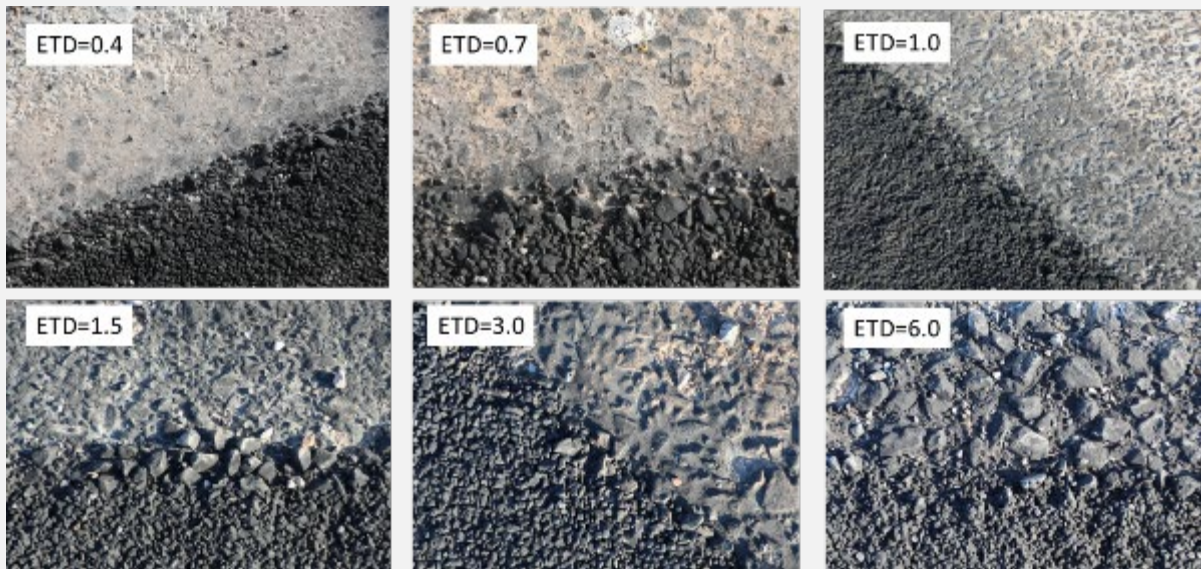
Base coarseness (Macro texture)

- **Too coarse base texture for thickness of seal**



Volumetric Texture Depth (VTD)

- VTD on one project
- VTD = ETD (Estimated Texture Depth)



Applies to thin asphalt & slurry

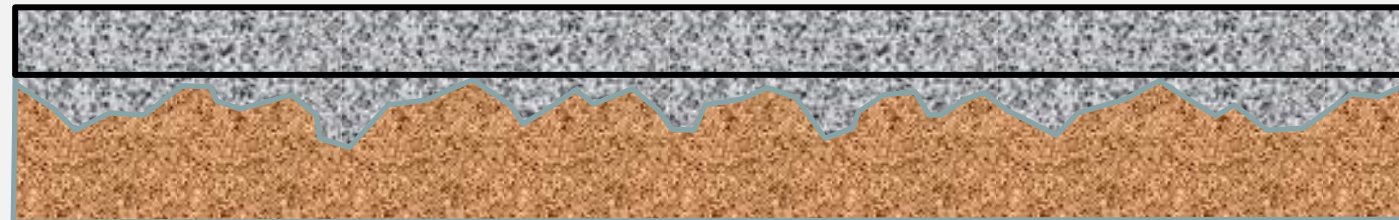


- Also applies to thin asphalt, graded aggregate seals and slurries









- **Options**

- Thicker layers
- Double layers (benefits)



VTD Categories

Category	VTD	Examples	
Coarse	> 3mm (Typical WBM surface or excessively broomed crushed stone)		
Medium	1.0 – 3.0mm (Well broomed Crushed stone base)		
Fine	< 1.0 mm		

Construction grade categories

Category	Grade
Very steep	> 10%
Steep	6 - 10%
Mild - Flat	0 – 6%



- **Could be adjusted based on methods of construction and availability of higher viscosity binders**

1st level Selection

External Stresses	Gradient	Base texture	Material availability							
			Crushed stone			Graded gravel	Graded angular sand			
Very high	Any gradient	Any texture								
High	Very steep	Any texture								
	Very steep	Any texture								
Mild	Steep	Very coarse	SBM	VF + CS	VF + DS	Double slurry	DGAS	Otta seal		
		Coarse		CS	VF + DS	Double slurry				
		Medium		CS	DS	Thick slurry				
		Fine		CS	DS					
	Mild - flat	Very coarse	SBM	VF + CS	VF + DS	Double slurry	DGAS	Otta seal		
		Coarse		CS	VF + DS	Double slurry				
		Medium to fine		CS	DS					
Low	Very steep	Any texture								
	Steep	Very coarse	SBM	VF + CS	VF + DS	Double Slurry	DGAS	Otta seal		
		Coarse		CS	VF + DS	Double Slurry				
		Medium to fine		CS	DS					
	Mild - flat	Very coarse	SBM	VF + CS	VF + DS	Double Slurry	DGAS	Otta seal		
		Coarse		CS	VF + DS	Double Slurry				
Medium to fine		CS		DS	Thick slurry	Double sand seal				

SBM = Slurry-bound McAdam seal **CS** = Cape Seal **VF** = Void Fill e.g. Thin slurry **DS** = Double seal

DGAS = Double graded aggregate seal

2nd Level considerations

- **Urban drainage systems (problem with graded aggregate and sand seals)**
- **Playground for children (Smooth surfaces)**



- **Road noise and skid requirements**
 - ❑ Maximum 7 mm



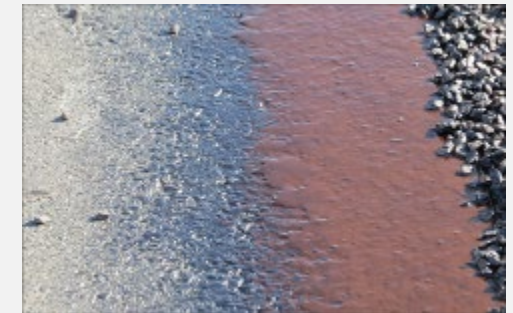
- **Curing period of slurries**

2nd Level considerations

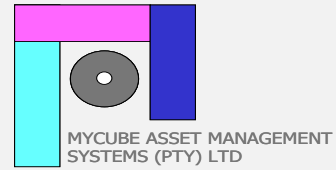
- **Stiffness and initial permeability (Slurry & Microsurfacing)**
- **Maximizing labor/small contractors (Quality ?)**



- **Safety & environmental (Hot binders & solvents)**
 - ❑ Affects the use of graded aggregate seals
- **Availability of suitable emulsion**
- **Maintenance capability**
 - ❑ If none - No other option than expensive thick asphalt/ concrete
- **Costs**



Costs



- High variation
- Function of:
 - Project size
 - Materials
 - Haul distance
 - Construction costs
 - Equipment, labor
 - Climate (standing time)
 - Perceived risks
- Double chip seal (50-70%) of 20mm asphalt

Surfacing type	Size/ thickness	Cost ratio to 14mm Single Seal	Long haul 50 150km
Continuous graded asphalt	40mm	3.27	30mm AC = 3.02
	30mm	3.02	
	20mm	2.30	20mm AC = 2.3
	15mm	1.78	2.15
Cape seal	20mm	2.24	20mm CS = 2.24
	14mm	1.92	
	10mm	1.68	14mm CS = 1.92
Double seals	20+10mm	1.44	
	20+7mm	1.36	20/7DS = 1.36
	14+7mm	1.29	
	14+5mm	1.23	14/5DS = 1.23
Microsurfacing	15mm	2.10	
Double slurry 2x6mm	12mm	2.08	
Slurry Void fill	2 - 4mm	0.87	
Slurry-bound McAdam	25mm	2.55	
Double graded aggregate	12 - 20mm	1.85 - 2.32	
Double sand seal	6 - 8 mm	1.20 - 1.38	
Otta + Sand (Local source)	16+4mm	1.62	
Single Seal	14mm	1.00	14 SS = 1.0

Seal Design Concepts

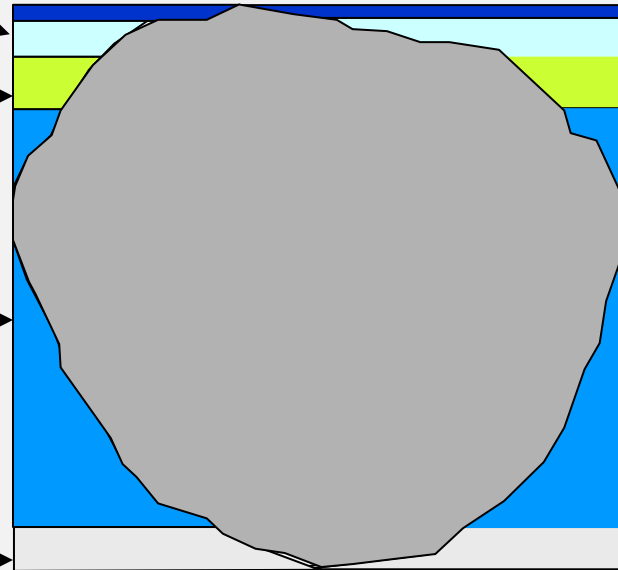
- Volumetric design (Filling voids with bitumen)**

VOID LOSS DUE TO AGGREGATE WEAR

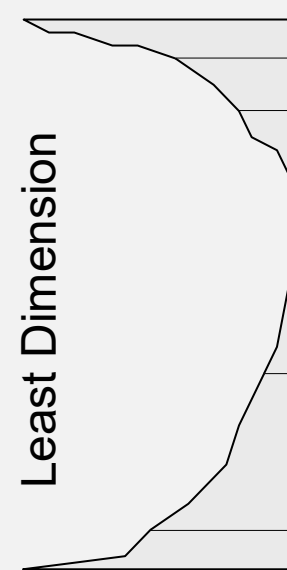
TEXTURE FOR
SKID RESISTANCE

MAXIMUM
VOIDS TO BE
FILLED

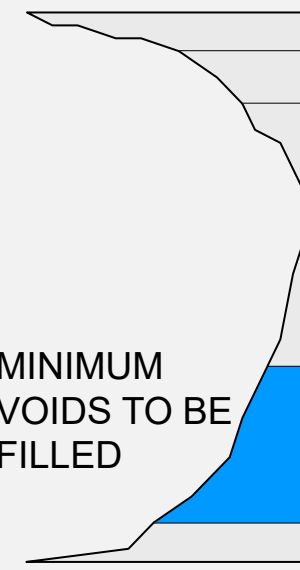
VOID LOSS DUE TO
EMBEDMENT



TOTAL VOIDS



MINIMUM
VOIDS TO BE
FILLED



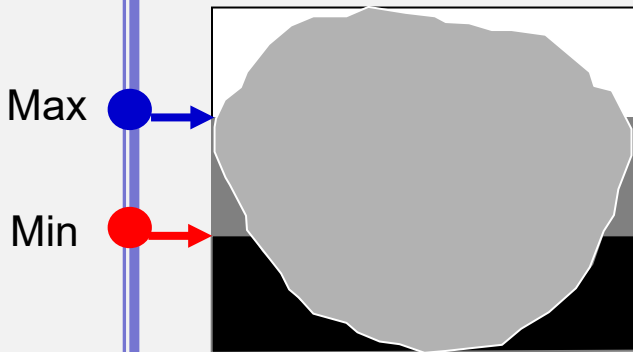
30 %

100 %

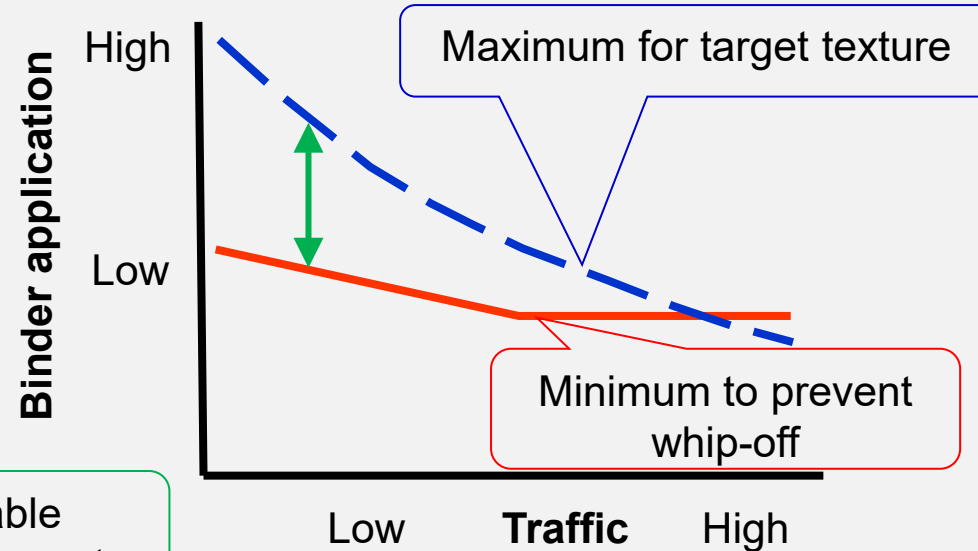
Different for
colder countries



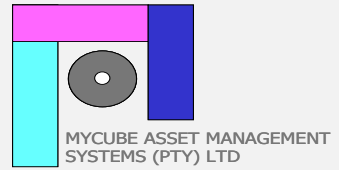
- **LVRs – larger range of suitable application rates**



Suitable application rate



Conclusions



- **Surface treatments are cost-effective in most cases on LVRs**
- **Cost could be 50% or less than alternative surfacings**
- **Selecting appropriate surface treatments for conditions should ensure service lives > 10 years**
- **Except for microsurfacing, all surface treatment could be constructed by hand and small equipment**

End

