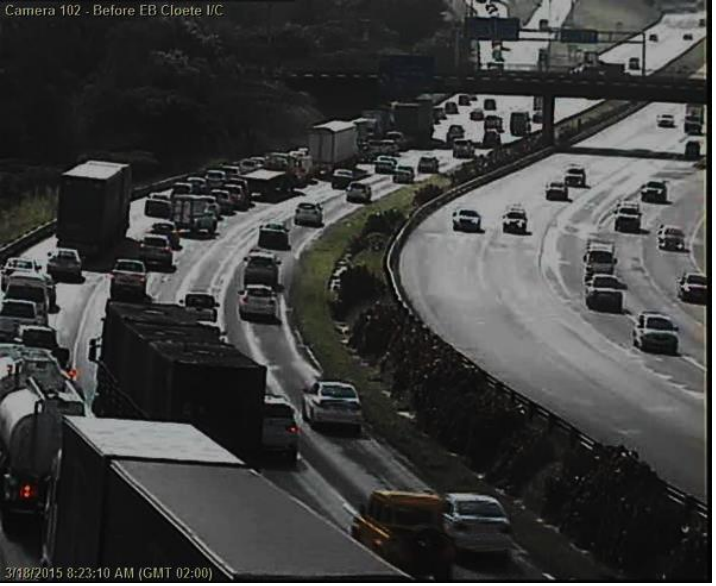


Lessons from the first full scale EME Construction Project in South Africa – N3 Durban

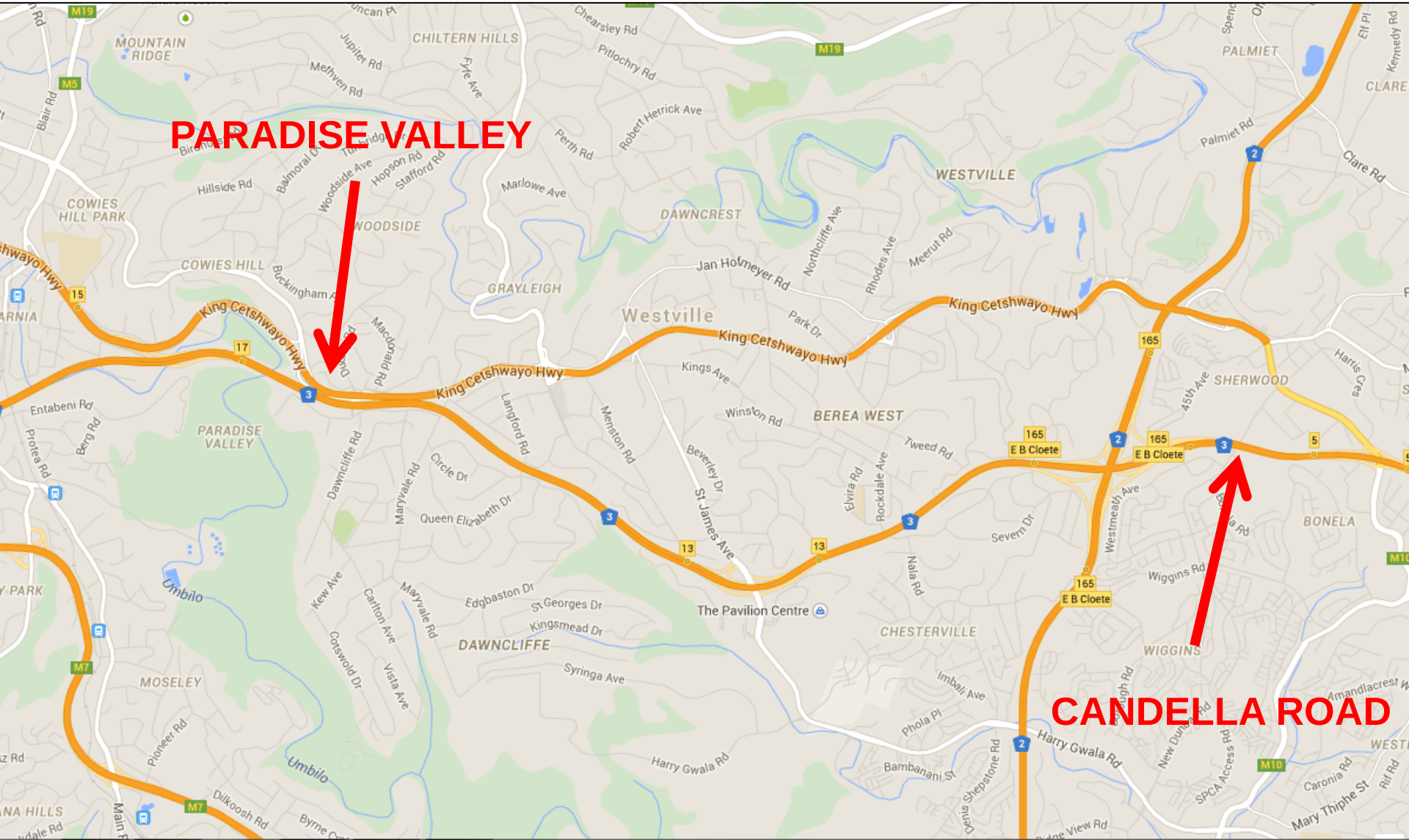
SNA

RAUBEX

THE SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LTD

Reg. No.1998/009584/30

LOCALITY PLAN



Site Description

- 8.5 km dual carriage highway
- 4 to 5 lanes in each direction
- 3 major interchanges
  - Paradise Valley (N3 / M13)
  - N3 & Spine Road (Pavilion Shopping Centre)
  - EB Cloete I/C (N2 / N3)
- Economic Route - Durban Harbour and Gauteng
- Commuter Route
- 100000 vpd (6-10% Heavies)

Pavement History

Description	Sub-section A	Sub-section B
Locality and construction date		
Approximate applicable chainages	km 8.5 – ± km 16.8	± km 16.8 – km 17.0
Start description	Candella Road	km 16.8
End description	km 16.8	Paradise Valley I/C
Construction date	1974	1982
Pavement details		
Surfacing (original)	40mm semi-gap graded asphalt (AS)	40mm semi-gap graded asphalt (AS)
Base	125mm continuously graded asphalt (BC2)	125mm continuously graded asphalt (BC2)
Subbase (upper)	150mm stabilized (C3)	150mm stabilized (C4)
Subbase (lower)	150mm stabilized (C4)	150mm stabilized (C4)
Selected layer(s)	100mm natural gravel (G7)	150mm natural gravel (G7)

Traffic Volumes (2012)

Description	CTO station			
	792* (EB East)	979* (EB West)	809 (St. James)	384 / 1388** (Paradise V.)
Average Daily Traffic (ADT)	56,079	53,309	83,765	95,739
Average Daily Truck Traffic (ADTT)	1,615	3,485	8,540	8,279
Percentage of heavies (%)	2.88%	6.54%	10.20%	8.65%
Truck split % (Short : Medium : Long)	58 : 26 : 16	46 : 22 : 32	44 : 22 : 34	48 : 20 : 32
Directional split : Heavy vehicles (%)	N.A.	N.A.	51.2 / 48.8	Varies (limited data)
Highest directional volume of heavies	N.A.	N.A.	To Durban	Varies (limited data)
Equivalent vehicle units (evu's)***	59,809	60,279	100,845	112,297

Existing Pavement

- Rutting and cracking restricted to upper 120mm asphalt base and surfacing layers
  - Similar to previous intervention 2002
- Cemented sub-base still sound
  - Block cracked – risk of reflection in base
- FWD deflection - very low.
- remaining life : 30 msa
- Ideal perpetual pavement candidate

Pavement Rehabilitation

- >ES100 required
- Replace 75mm BC on fast lanes (1 lift)
- Replace 120mm BC on slow lanes (2 lifts)
- UTFC final wearing course
- BC life >>>> UTFC life of 12 years
- Alternative to concrete pavement required

EME ?

- Uncertainty in Pavement Design
  - Previous modified BC lasted only 12-years
  - Typically >180mm BC required for ES100
- High performance asphalt required
  - High Rutting and Fatigue cracking resistance
  - Road levels unchanged & sound subbase
- Next intervention to be only surfacing
  - Perpetual pavement
- View to future projects : N3 upgrade expected to be concrete, but EME could work
- 120mm EME (25-30% more efficient)

EME Principles

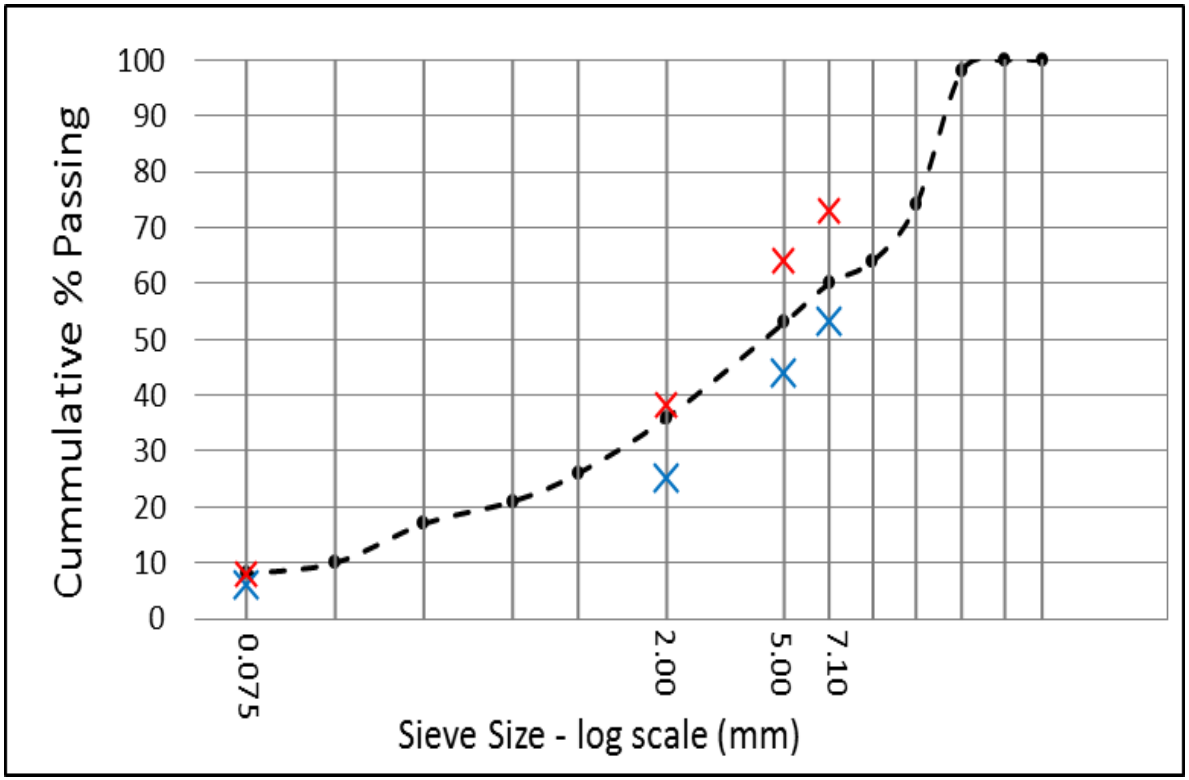
- Based on the French technology Enrobé à Module Élevé(EME),developed in 1980's
- Low penetration Binder – very hard but not brittle resulting in very stiff asphalt layers
- Superior load spreading, fatigue resistance and rutting resistance
- Thinner asphalt layers (30%) for same structural benefit
- Comparable to Polymer Mod Binders on performance and cost

Mix Design

Property	Test	No of specimens	Test standard	Requirements	
				HiMA class	
				Class 1	Class 2
Workability	Gyratory compactor, air voids after 45 gyrations	3	ASTM D6926	≤ 10%	≤ 6%
Durability	Modified Lottman, TSR	6	ASTM D4867	≥ 0.80	≥ 0,80
Resistance to permanent deformation	RSST-CH, 55 ^{o}C, 5 000 reps	3	AASHTO T320	≤ 1,1% strain	≤ 1,1% strain
Dynamic Modulus	Dynamic modulus at 10 Hz, 15 ^{o}C	3	AASHTO TP62	≥ 14 GPa	≥ 14 GPa
Fatigue	Beam fatigue test at 10 Hz, 10 ^{o}C, to 50% stiffness reduction	9	AASHTO T321	≥ 10^6 reps @ 300 με	≥ 10^6 reps @ 390 με

MIX

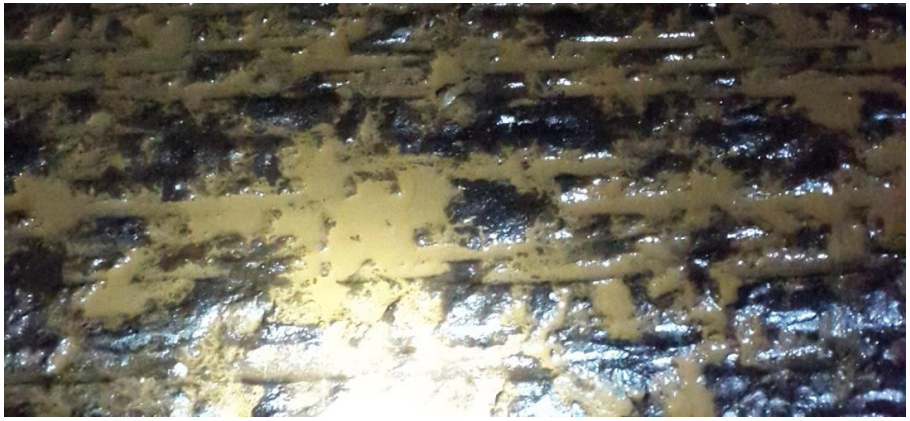
- Max 14 mm Aggregate - Tillite
- 5.6% 10/20 Pen Bitumen
- 20% RAP
- SABITA Manual 33

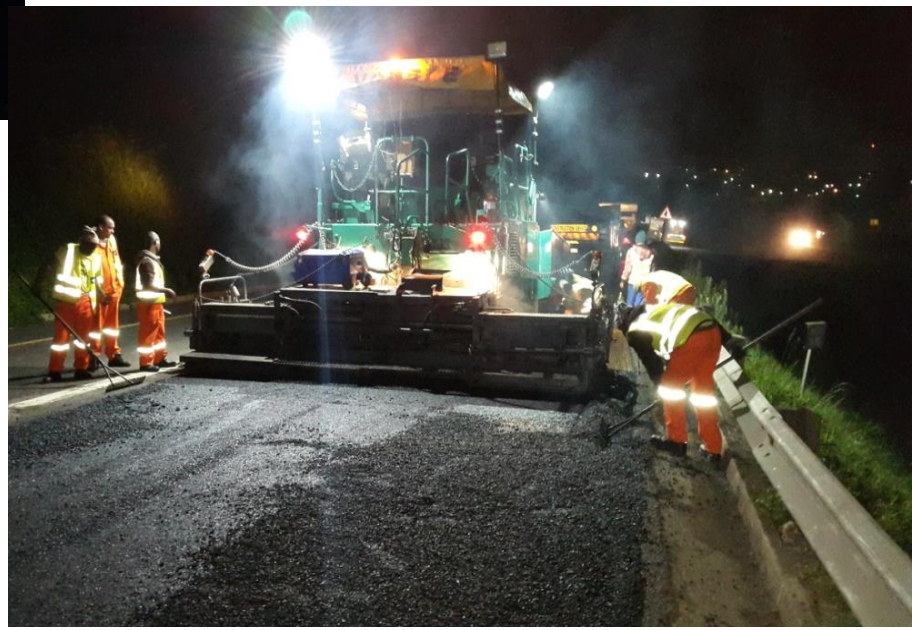


Construction

- Night-work:
  - Lane closures at 7pm
  - Construction under lighting
  - Milling
  - Cleaning
  - Inspection
  - Crack Sealing
  - Tack Application
  - EME Asphalt Paving
  - Opened to traffic by 5am

Construction





Compaction

- 20-ton Three Point Roller (TPR)
- 2 x 22-ton Pneumatic Tyre Rollers (PTR)
- 10-ton Tandem Vibrating Roller (TVR)
- 5 roller passes required to achieve compaction of 94%
  - 96% recommended
- No vibration on upper lifts
  - After poor riding quality initially observed

Lessons learnt

- Stiffening of the EME
  - In the haul trucks
  - During compaction
- Density at the Longitudinal Joint
- Cracking at Longitudinal Joints
- Single layer paving
  - 20mm aggregate trial

Lessons learnt

- Paving continuity (start-stop)
  - Affected riding quality
- Cold weather paving
  - >8 degrees
- EME as temporary Riding Surface
  - 10-months
- Riding quality correction

QUICK STATS

- Final Project Cost R167-million
- EME paved = 75000 tons
- Production 400 tons/shift
- Imported bitumen cheaper than locally produced..resulting in project savings

Sustainability

- Green Roads Foundation Pilot Project

- Energy Saving 21,75 million mega joules
  - 604,000 Litres Diesel = R6,6-million
- 1600 ton Reduction in Carbon Emissions

- Combination of EME and RAP

What next?

- Continue monitoring N3/1
  - Fatigue and rutting
- N3 Cedara – Temperature effects (IR Camera)
- N2 Controlled research Section for Pavement Design
  - N2/25 SBC at Edwin Swales (M7)
  - 300m sections each EME,GB5 and AP-1
  - Performance testing, workability gyratory compaction

What next?

- Dynamic Modulus stiffness factors
- Acceptance testing requirements
  - Voids, Binder, Grading Curve 4 points
  - Workability Gyratory compaction every (5000 t)
- Long-term comparisons of the 4 projects
  - Fatigue, Rutting and Dynamic Modulus
  - Life cycle cost analysis

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Conclusion

- Project successful
  - time/quality/budget/expectations
- Large scale project was required to build confidence and reduce uncertainty
- Some difficulty experienced, but practical solutions developed