Appropriate Road Pavement Technologies in a Developing Changing World

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Challenging areas in Roads
Where can biggest difference be made?

General
• Skills training
• Education and Mentoring
• Resistance to Change
• Scope for Innovation

Technical
• Material response models
• Damage models
• Recursive analysis
• Specs / QC
• Constructability
• Lab “simulating reality”
Research versus practice?
In pavement engineering
Where does the SANRAL Chair fit in?

Organigram of Academic Structures in the Roads Industry

- Research Centres
  - Asphalt Academy
  - CSIR
  - C&CI
  - Sabita

- Training Programmes
  - TRAC (School)
  - SETA (Civ Eng)
  - etc

- Tertiary Education
  - Technikons
    - Cape Tech
    - Pentech
    - etc
  - Universities
    - Maties
    - etc
    - UCT
    - etc

- SANRAL

- International Partners
PG Programme: Courses

1. Pavement Materials I (granular, cemented)
2. Pavement Materials II (asphalt)
3. Pavement Materials III (bitumen stabilised mat’s)
4. Advanced Binder Technology
5. Flexible Pavement Design
6. Pavement Evaluation & Rehabilitation
7. Rigid Pavement Design
8. Pavement Construction
9. Pavement Management Systems
Co-operation with Overseas Universities

• Overseas experts on our PG courses and research (25 in 10 years):
  – Molenaar, van de Ven (TU Delft), Zollinger (Texas A&M), van Niekerk (KOAC), Francken (BRRC), Bahia (Wisconsin)

• Many local experts
• Co-operation: CSIR
• Sabita etc
Specialist Research Apparatus
Need for research and innovation in SA

- Low Volume Roads *(cost-effective)*
- Pre-coating fluids *(no tar)*
- Energy and emissions *(Enviro)*
- Recycled building materials *(Enviro)*
- Surface seals *(design and modelling)*
- Material performance, granular, BSM, asphalt, polymers, nano *(lab eval)*
- Etc
Closing the loop

Acquire knowledge

Develop tools

Implement

Awareness

Damage

Response

Reality check

- Rutting
- Cracking

Number of loads

Failure (%)
Variability

Enormous variation in life

Log N

100  120  140  160  180  200
Strain  100  με  1.E+03  1.E+04  1.E+05  1.E+06  1.E+07

Effective fatigue

Cracked area (%)

100  50  0

Variable h, tyre-pressure, load etc

Can get a good idea from δ0-δ300
Traffic
Tyre-Pavement Interaction
Stress in Motion SIM

Install TyreStress-C

Frequency

Install TyreStress-C1 and TyreStressSIM

Frequency

Tyre Load

Tyre Inflation Pressure

CSIR, de Beer
Pavement Materials & Behaviour

Greater flexibility
Greater rut resistance
Less economical mixes

"Linear-elastic"

Stress dependent

Time, temp dependent

Greater flexibility

Bitumen binder

Lean Mix Concrete
Lightly cemented

Unbound
Crushed stone / gravel / soil

Active Filler

6%
4%

BSM
flexural

HMA

Cemented

granular

Less economical mixes

Visco-elast

fatigue

brittle

Lean Mix Concrete
Lightly cemented

Unbound
Crushed stone / gravel / soil

Greater flexibility

Time, temp dependent

Greater flexibility

Time, temp dependent

Greater flexibility

Time, temp dependent

Greater flexibility
Recycled Materials

Patches

RAP

CDW/RCM

Weathered Gravels

Crushed Aggregate
Resilient Modulus of Recycled Base

- Granular Type Behaviour: BSM-foam BC = 2%
Granular Structural Layers

- **Effective stress**
  - Stress caused by the wheel-load
  - Suction pressure
  - Overburden stress
  - Residual compaction stress

\[
\sigma_{\text{eff}} = \sigma_{v}^0 + \sigma_{h}^r + \sigma_S + \text{External stress}
\]
New “Simple triaxial”
Density ± 80%
(Fluffed up)
+90% ± 80% +90%
“BRIDGING”
2164 kg/m³

2013 kg/m³

± 7% difference

100%

93%
Cause: Grader before primary compaction

“TRAFFIC COMPACTION”

CUT 1   CUT 2

HIGHER DENSITY   HIGHER DENSITY

LOWER DENSITY   LOWER DENSITY
Seals

BASE
Visco-Elastic Numerical Modelling

Uni Stell TUD, Milne
Seal Fatigue

Creating a composite beam of road seal and polyurethane

FIELD

LAB

Uni Stell, Cloete
Four Point Beam Fatigue

Flexural Stiffness (MPa)

Repetitions

Uni Stell, Cloete
Closing remarks

• Education and training
  – Structured programme (courses)
  – Laboratory facilities
  – International cooperation (2 way)

• Appropriate research (LVRs, Seals, Gran)

• CLOSE THE LOOP! - requires
  – Sustained effort over long period
  – Sound data, good models & calibration

• Construction (QC, variability)
Are we heading the right direction?

Mmm...promising!