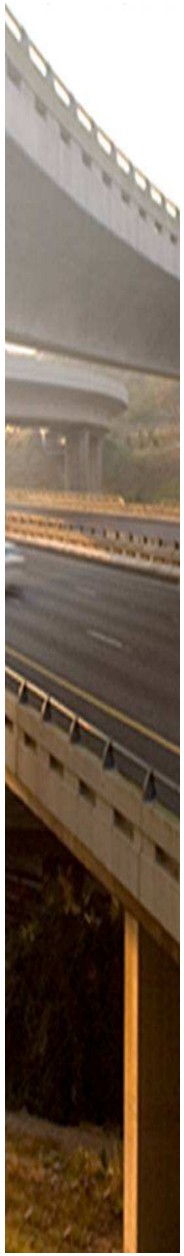
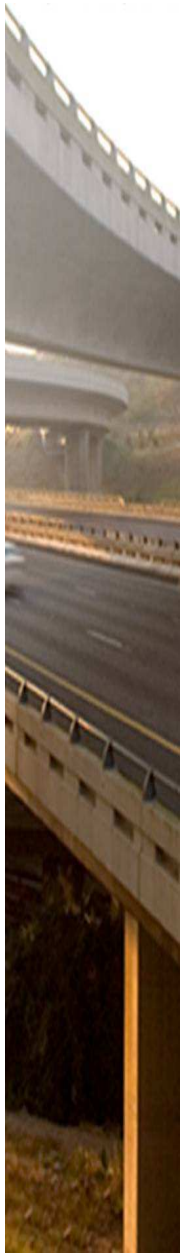


RPF November 2010: Progress Report on the SAPDM

ME design of Flexible Pavements: **Update of the ME design method and revision of *Me* - PADS®**

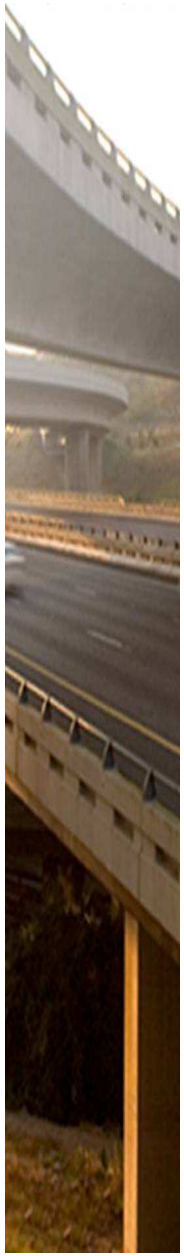
H L Theyse

Background



- TRH4 revision 1994-95
  - Use existing research from 1970s to late 1980s to update the mechanistic-empirical design method for flexible pavements
  - Summary published at TRB in 1996
- Late 1990s, early 2000s implementation in software packages
  - *Me*-PADS®, Rubicon
  - More users – more questions – less answers

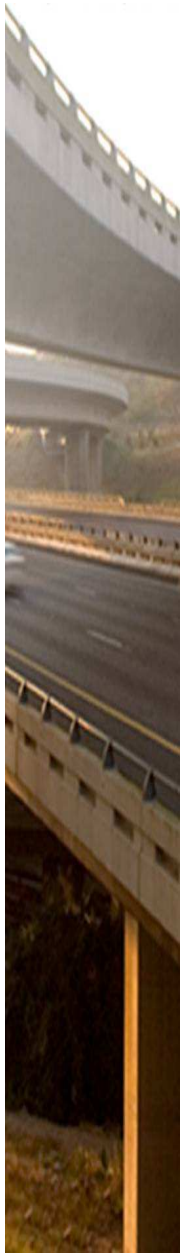
Background (continued)



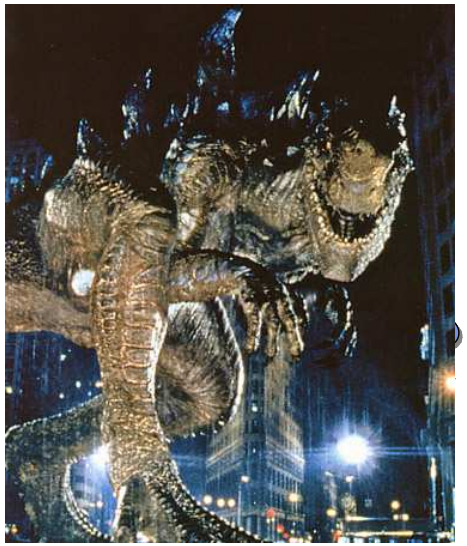
- CAPSA'04
  - Jooste highlighted problems especially with models used for unbound material
  - Some research already initiated at CSIR
- RPF task group 2005
  - Framework for revision of the design method
  - SANRAL stepped forward with funding
- CAPSA'07
  - Research plan presented – Godzilla was born

P_m^c

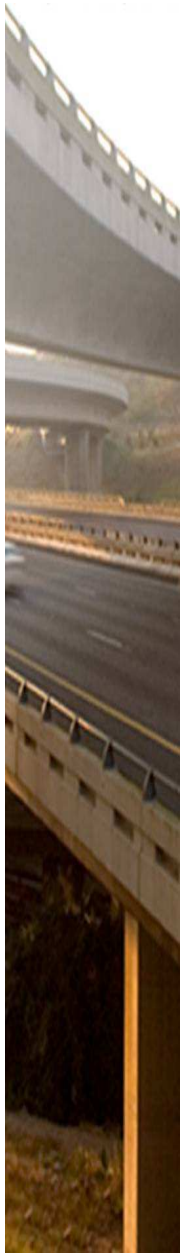
Current status



- SANRAL SAPDM project started in 2008
  - Godzilla alive and well
  - Some progress made, especially on modelling unbound material
- CSIR software
  - Time for an official update of the ME design method for flexible pavements
  - Deliver update in *Me*-PADS®
  - Target for launch – CAPSA'11
  - Only an interim solution
  - Final solution under SANRAL project

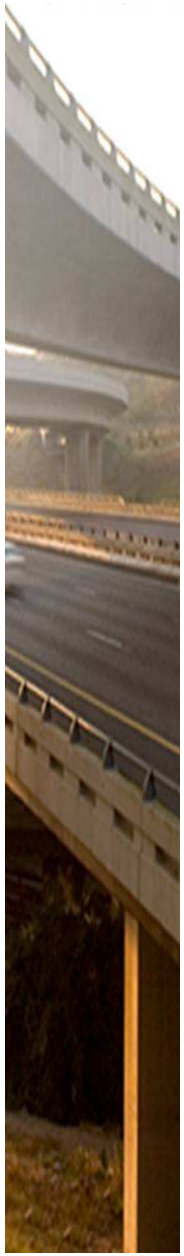


Planned changes



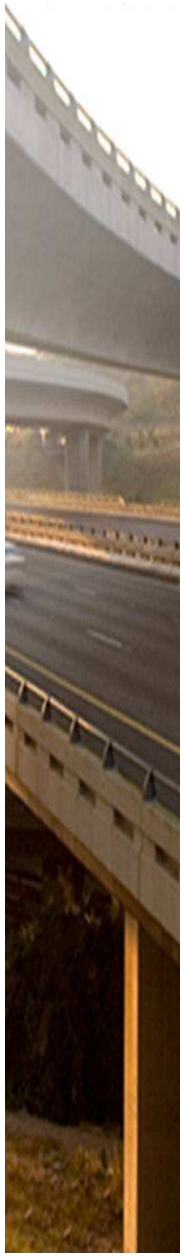
- HMA fatigue
  - Unchanged (for now)
- Unbound base and subbase layers
  - Effective stress analysis
  - Shear strength related to engineering properties
  - New plastic strain damage model
- Stabilised layers
  - Cemented
    - Effective fatigue damage model
    - Crushing failure damage model
    - New shear strength properties with plastic strain damage model

Planned changes (continued)

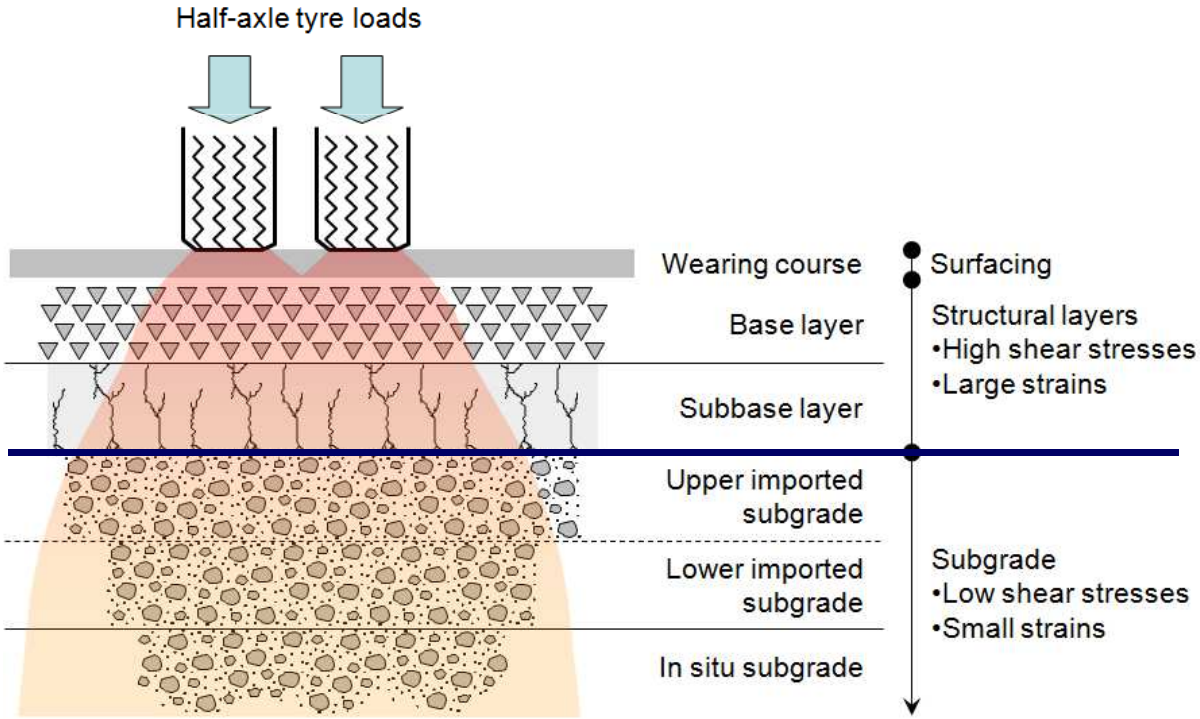


- Stabilised layers
  - Foam and emulsion
    - Effective fatigue
    - Plastic strain damage models

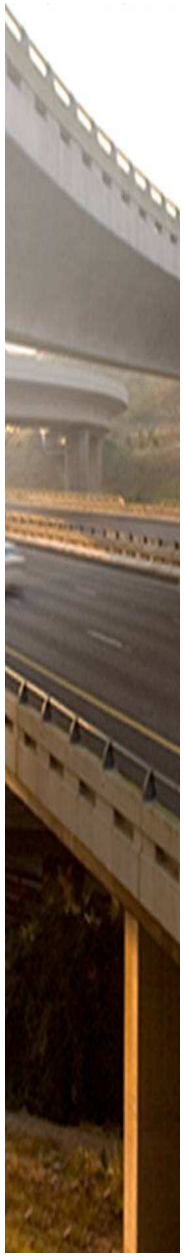
Planned changes (continued)



- Subgrade
  - New critical parameter
  - New permanent deformation model



Unbound material: Subgrade



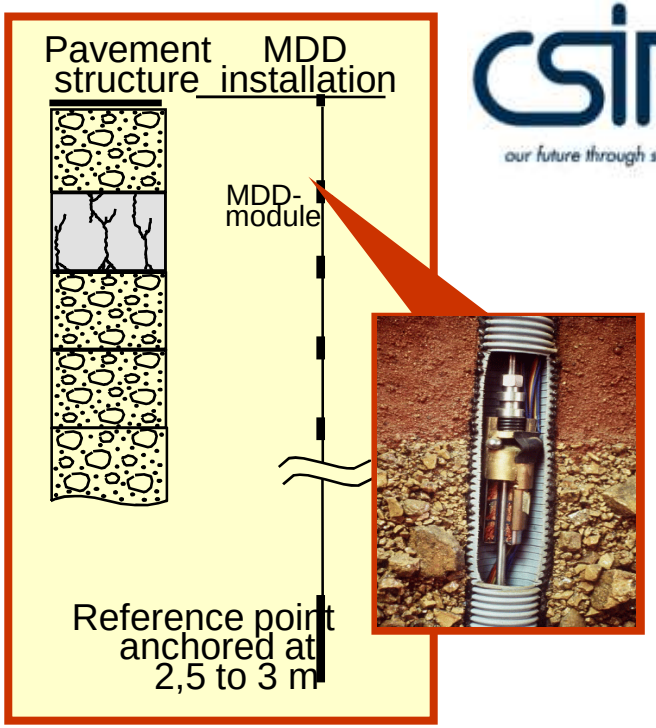
- Dormon and Metcalf vertical strain criterion

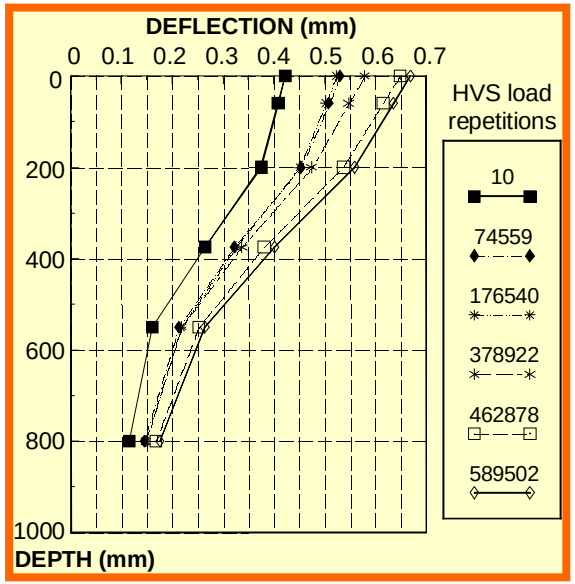
  "First, calculation of vertical compressive strain in the subgrade for several different sections in the AASHO test indicated that a compressive strain of $6.5x10^{-4}$ was associated with 10^6 applications."

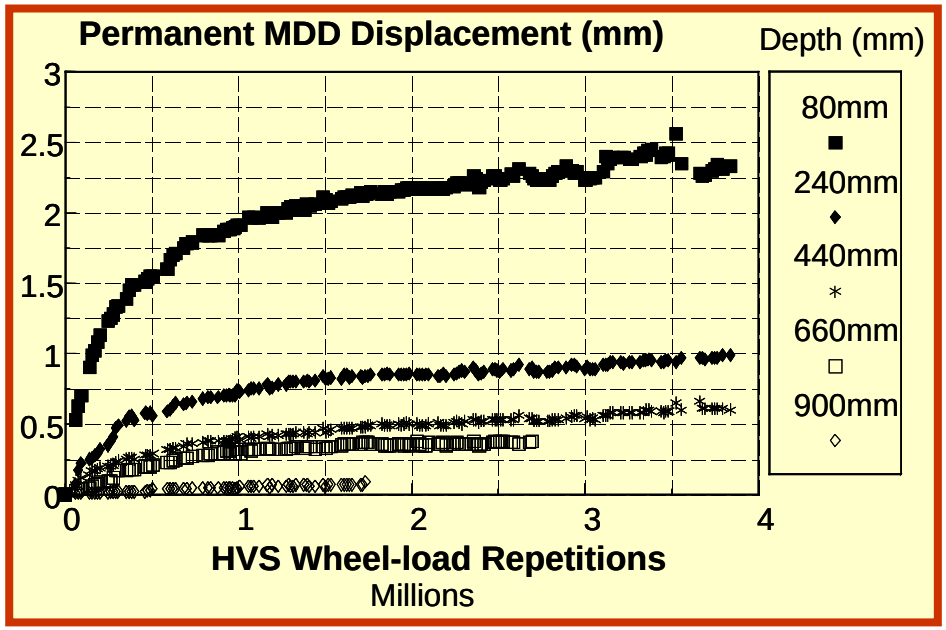
  "The AASHO test also provided information by which the effects of different wheel loads of mixed traffic could be weighted. This relationship, shown in Figure 6 led to the development of the wheel load weighting curve in Figure 7. Subsequently, the compressive strain values previously assigned to different wheel loads were plotted according to their equivalent numbers as shown in Figure 5."

Unbound material: Subgrade

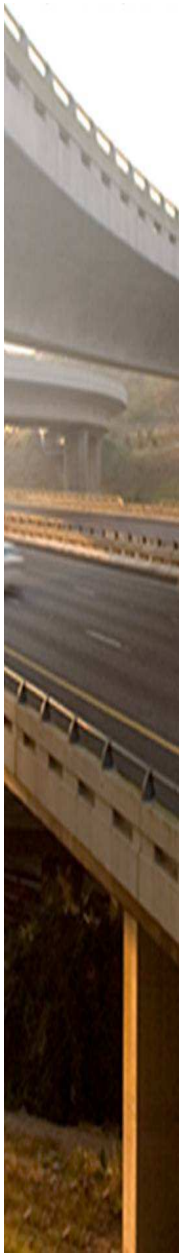
- MDD data from HVS tests
  - Elastic deflection
  - Permanent displacement

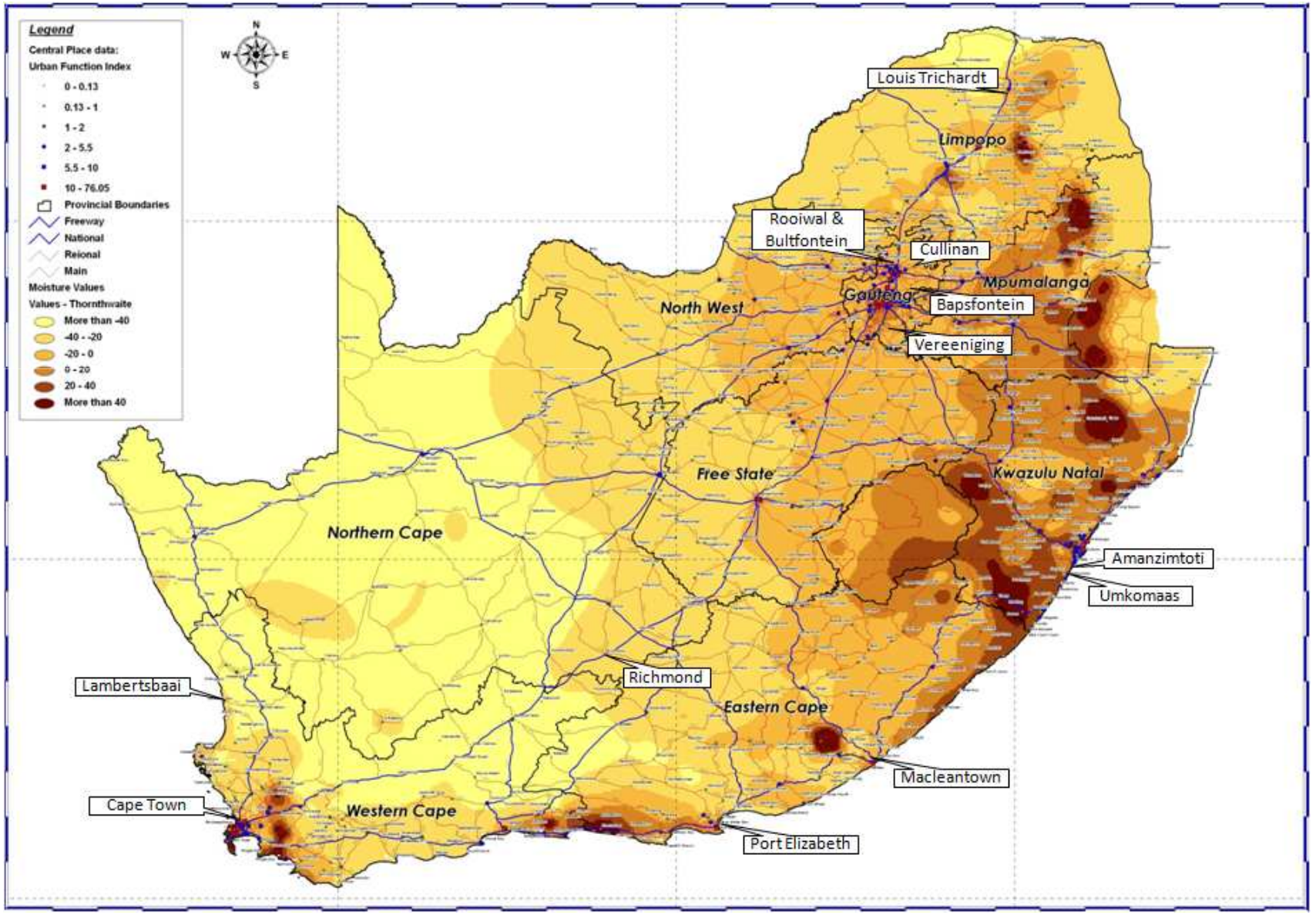




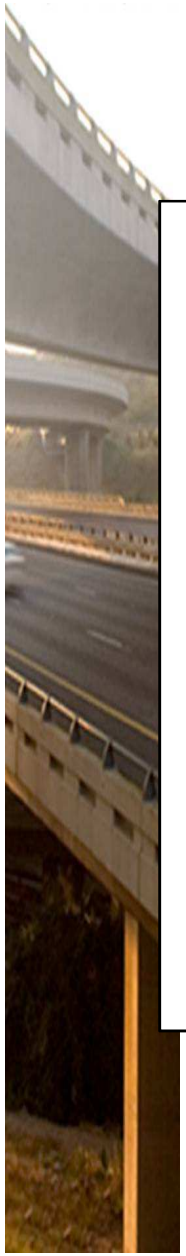


Unbound material: Subgrade

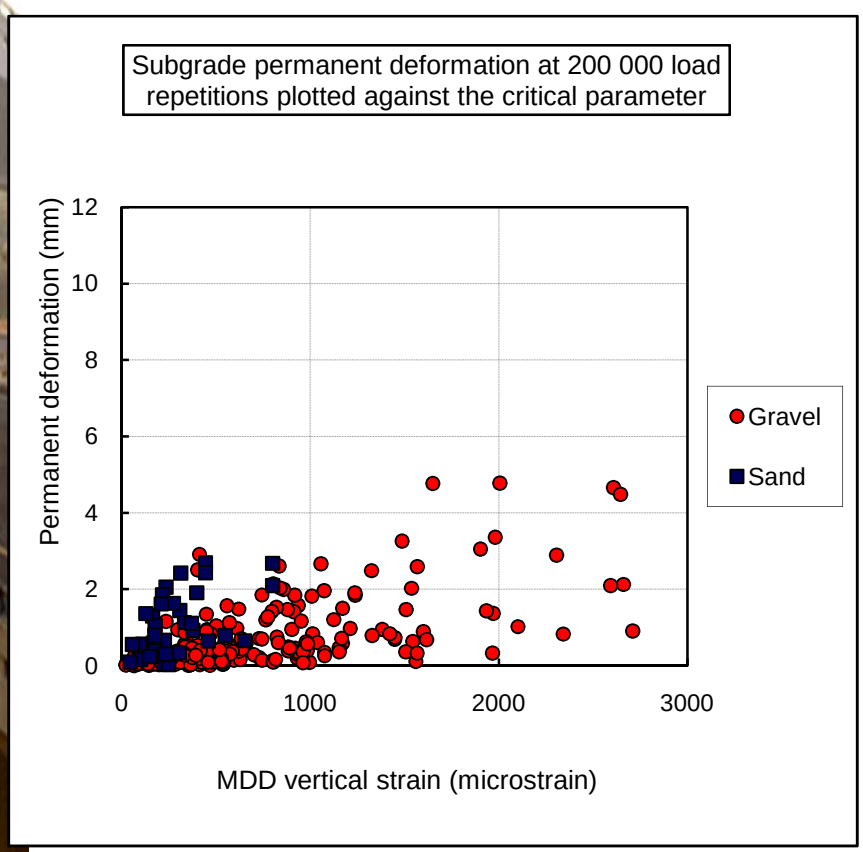




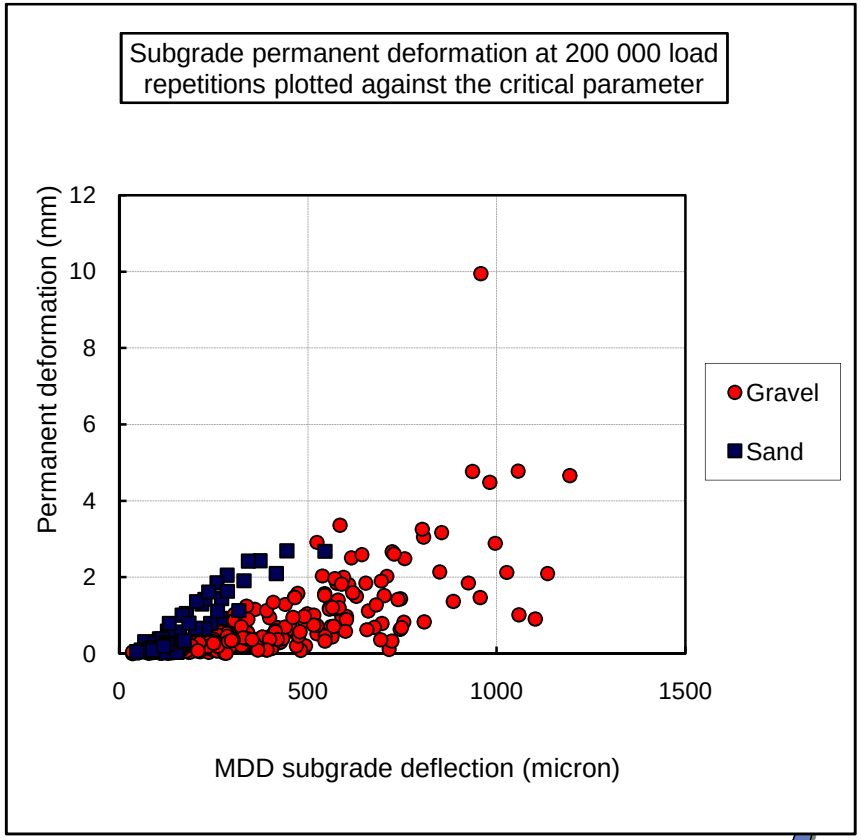
Unbound material: Subgrade PD



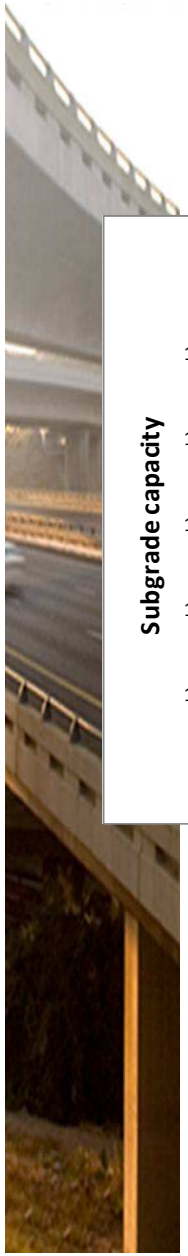
Vertical strain



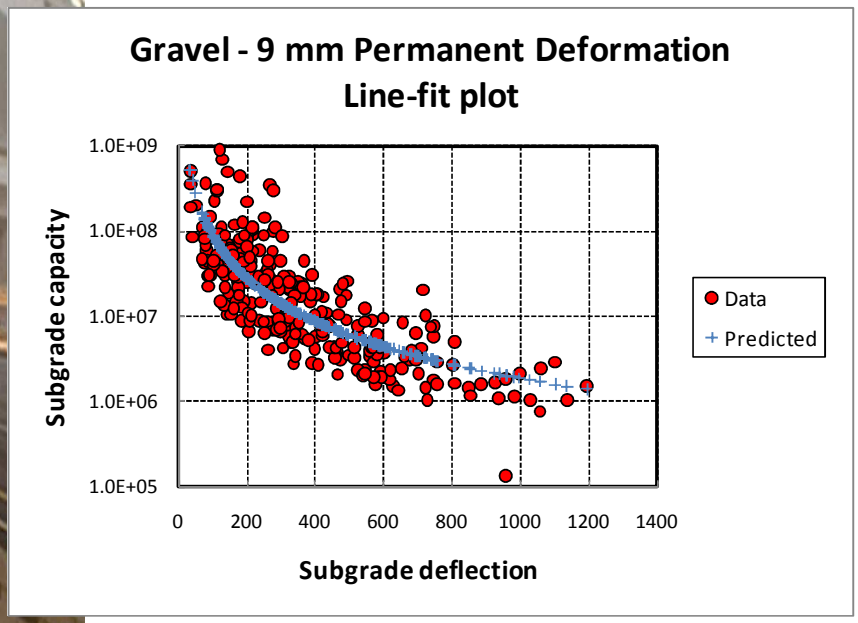
Subgrade deflection



Unbound material: Subgrade PD damage models

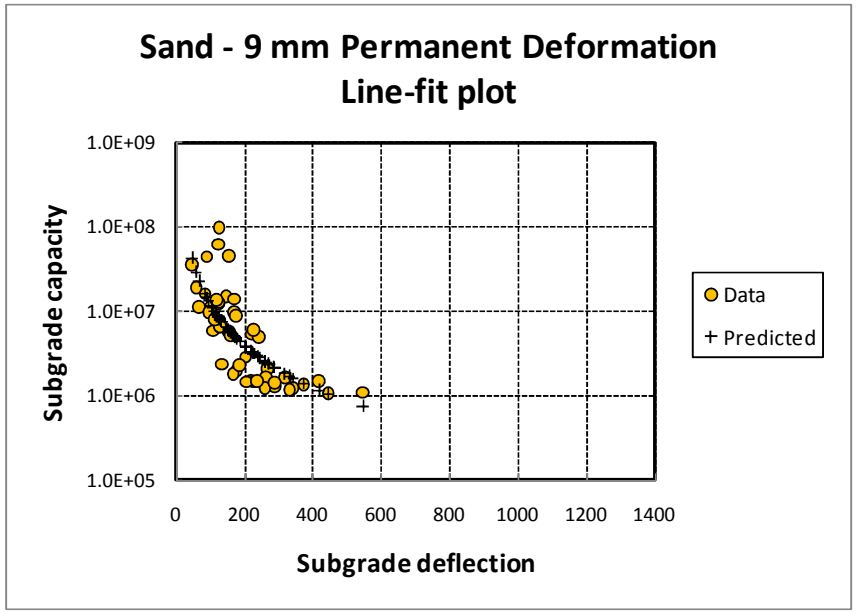


Gravel



$R^2 \sim 0.77$
SEE ~ 0.38

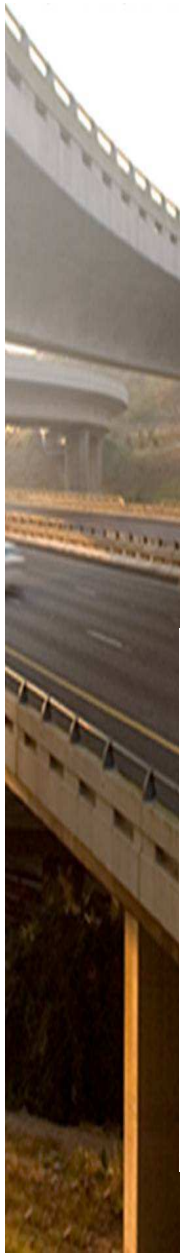
Sand



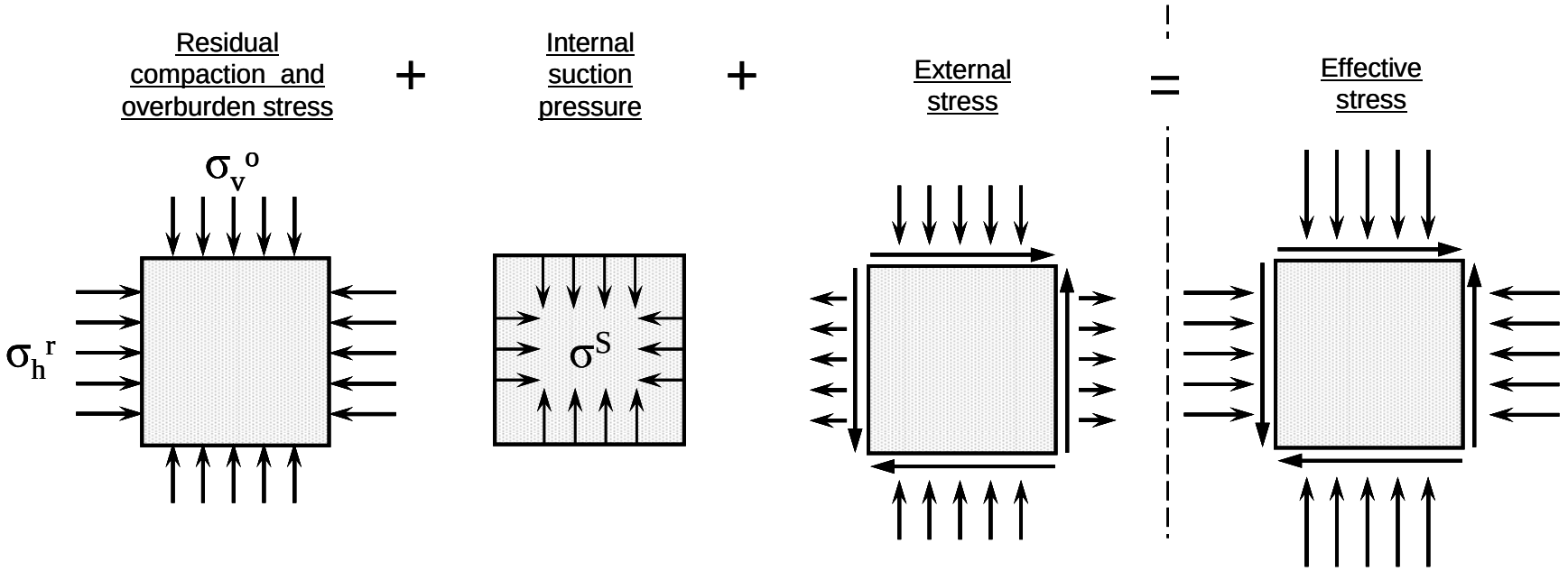
$R^2 \sim 0.98$
SEE ~ 0.35

$$\log N = I - m\log(SD) - offset$$

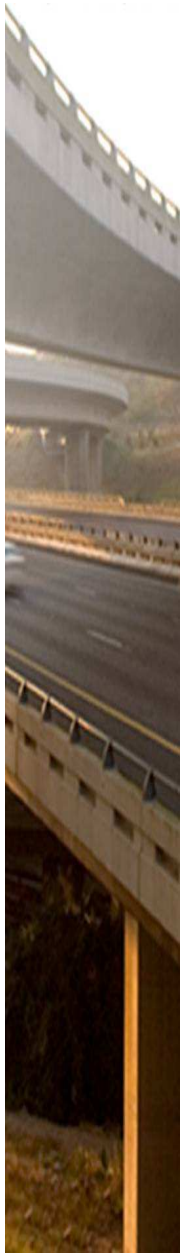
Unbound material: Structural layers



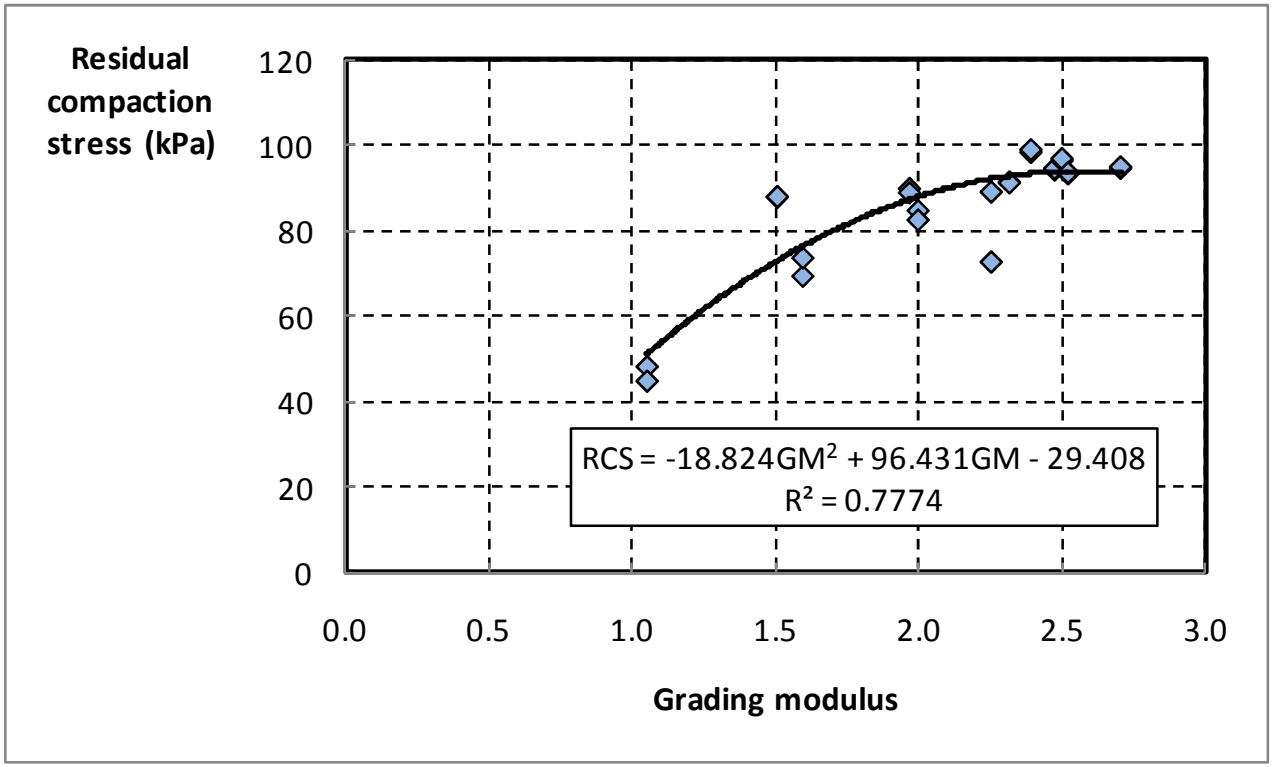
- Effective stress
  - Stress caused by the wheel-load
  - Suction pressure
  - Overburden stress
  - Residual compaction stress



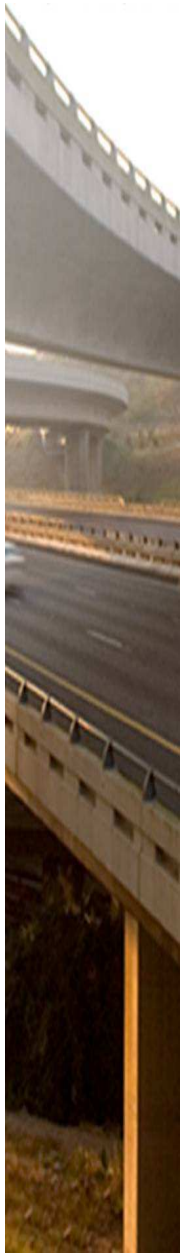
Unbound material: Residual compaction stress



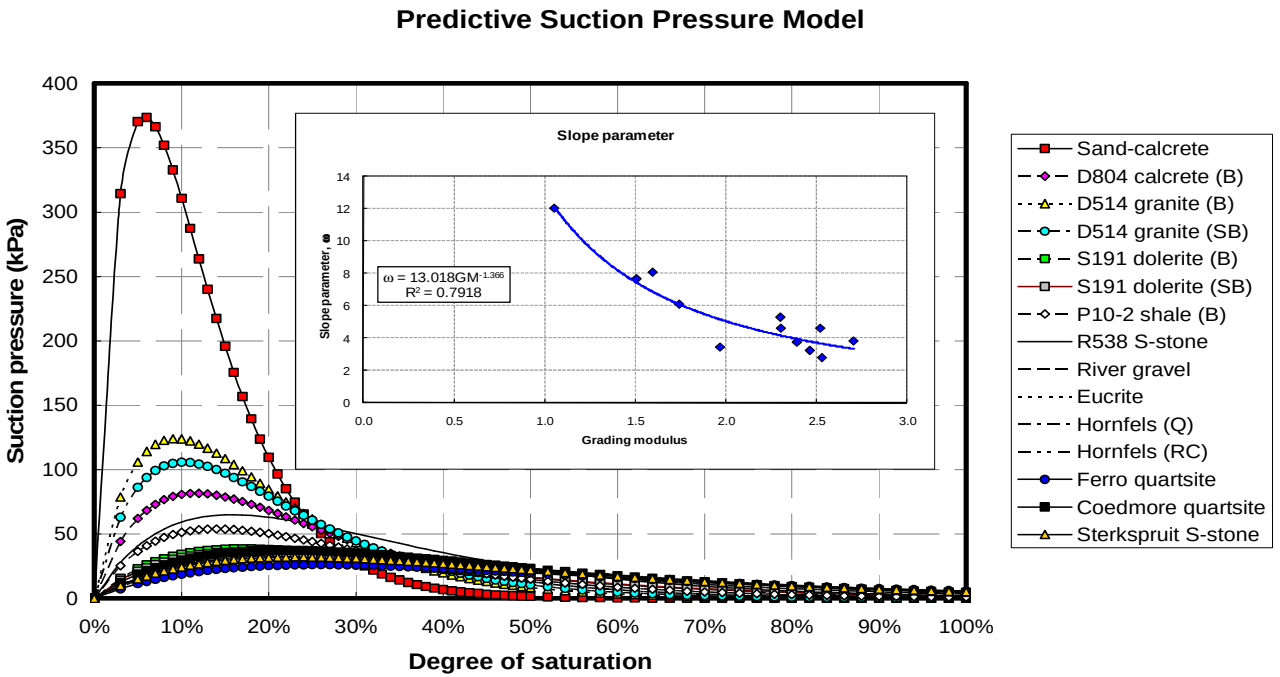
- Observed by Dehlen (1959)
- Static equilibrium model by Uzan (1980s)
  - Design relationship derived from static equilibrium



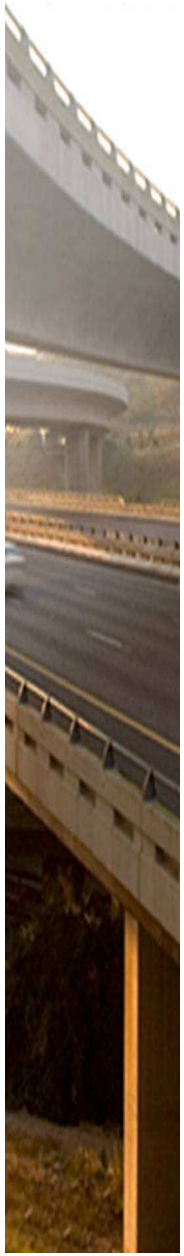
Unbound material: Suction pressure



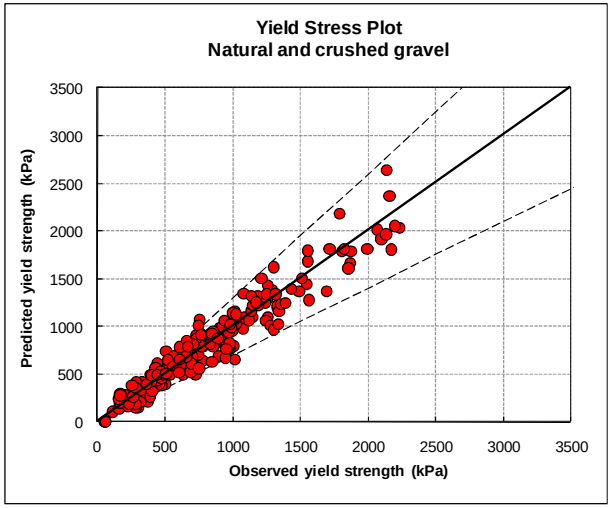
- Suction pressure approximation model (Theyse, 2008)
  - Predictive design model – SANRAL project
  - Validation testing and recalibration - WITS

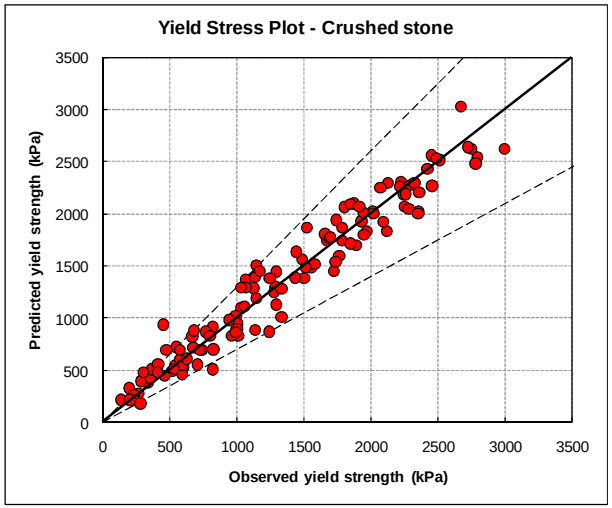


Unbound material: Shear strength model

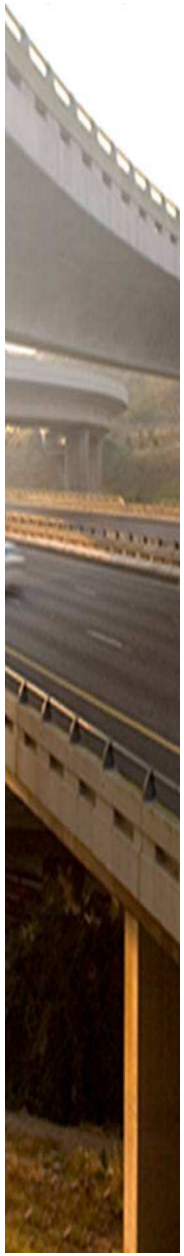


- Data from Theyse, 2008
- Model developed under SANRAL project
- Predictive shear strength model
  - Grading modulus and $P_{0,075}$
  - Liquid limit
  - Linear shrinkage

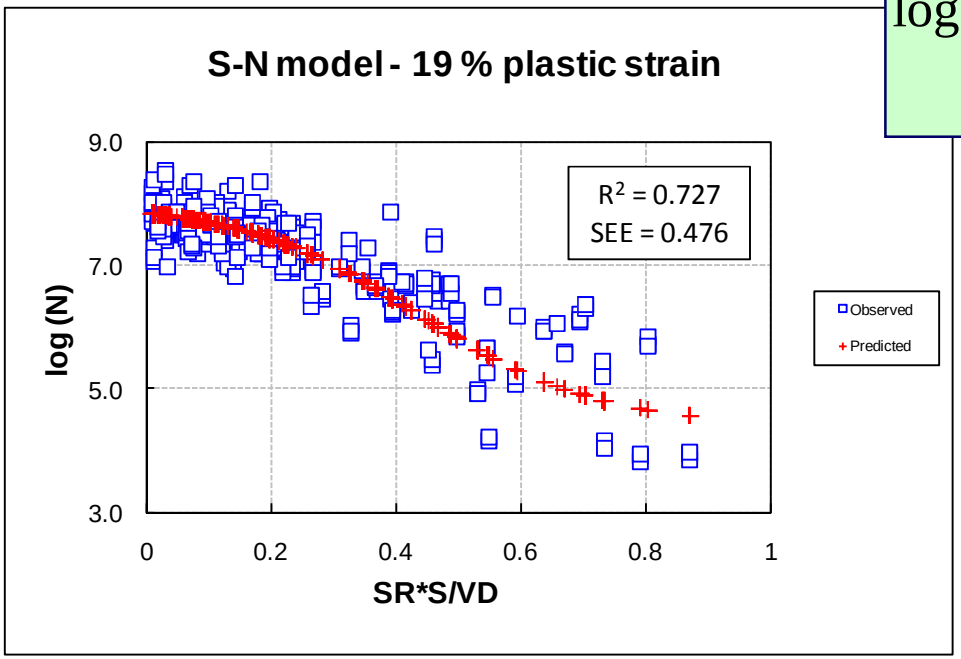




Unbound material: Plastic strain damage model

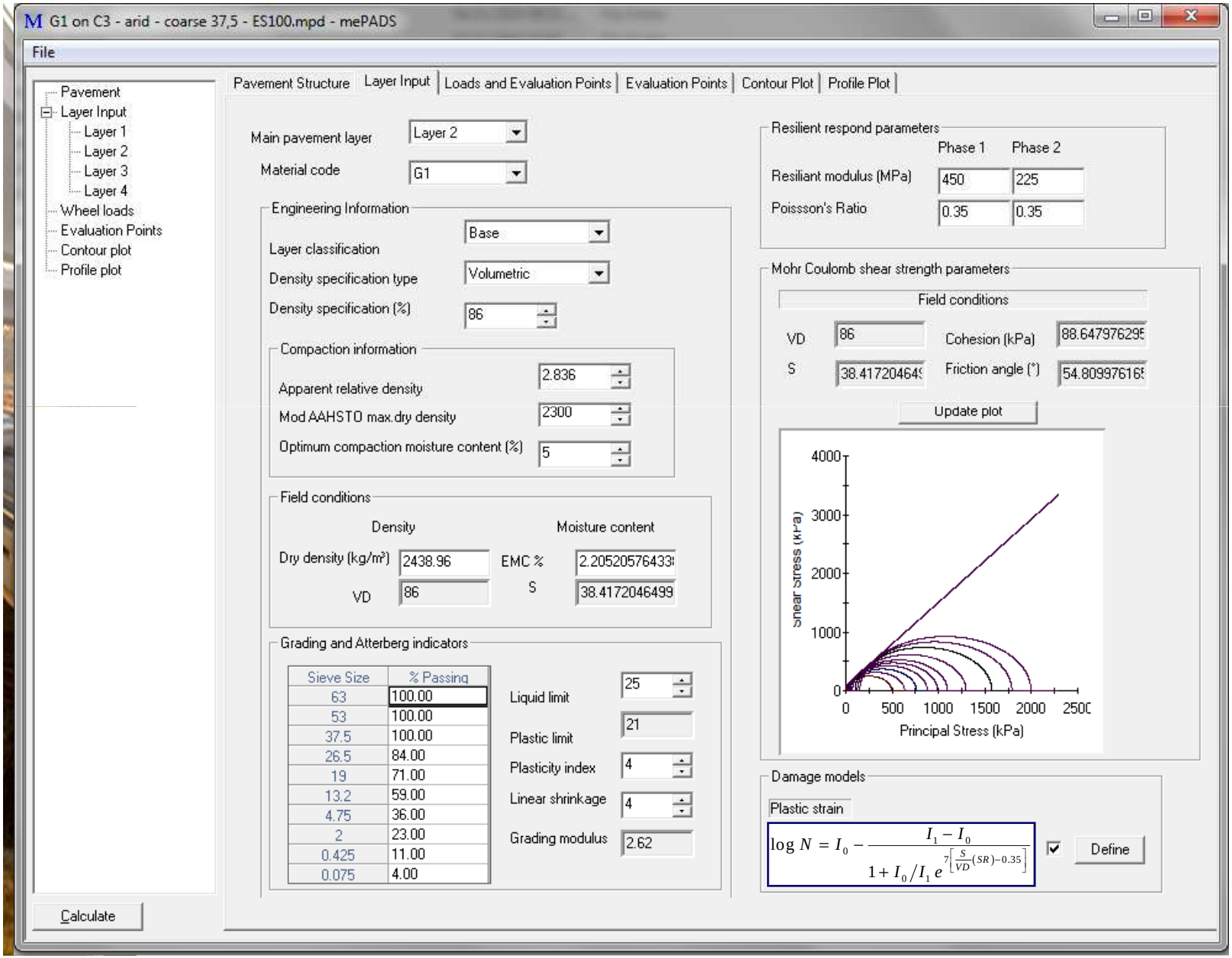


- Data from Theyse, 2008
- Model developed under SANRAL project
  - Stress Ratio
  - Volumetric density
  - Degree of saturation

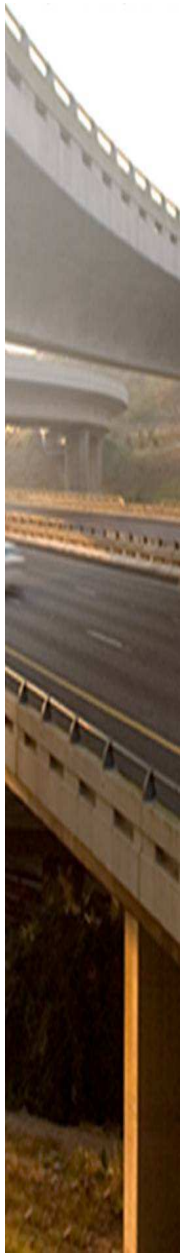


$$\log N = I_0 - \frac{I_1 - I_0}{1 + I_0 / I_1 \, e^{7\left[\frac{S}{VD}(SR) - 0.35\right]}}$$

Software implementation



Closing statements



- ME design inputs for unbound structural layers
  - Input data
    - Resilient response parameters
    - Grading, Atterberg limits, density, moisture content
  - Model not perfect but much better than previous model
    - Separate models required for natural gravel
- Subgrade design
  - Depends on resilient response parameters
  - Working on recommended M_r values
- Models for HMA and stabilised material being developed/refined under SANRAL project
- How do you get your hands on the new method?
  - *Me*-PADS® launch at CAPSA'11
  - After the launch SAMDM'96 will be declared dead and no longer valid
  - Software used to be for free, probably still will be BUT
    - Only available at CSIR/PMC course presented annually