Royal HaskoningDHV
Enhancing Society Together

THE SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LTD
Reg. No.1998/009584/30

APPLICATION OF A NEW UTCRCP DESIGN ON THE N1/1

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29th Road Pavements Forum

12 May 2015

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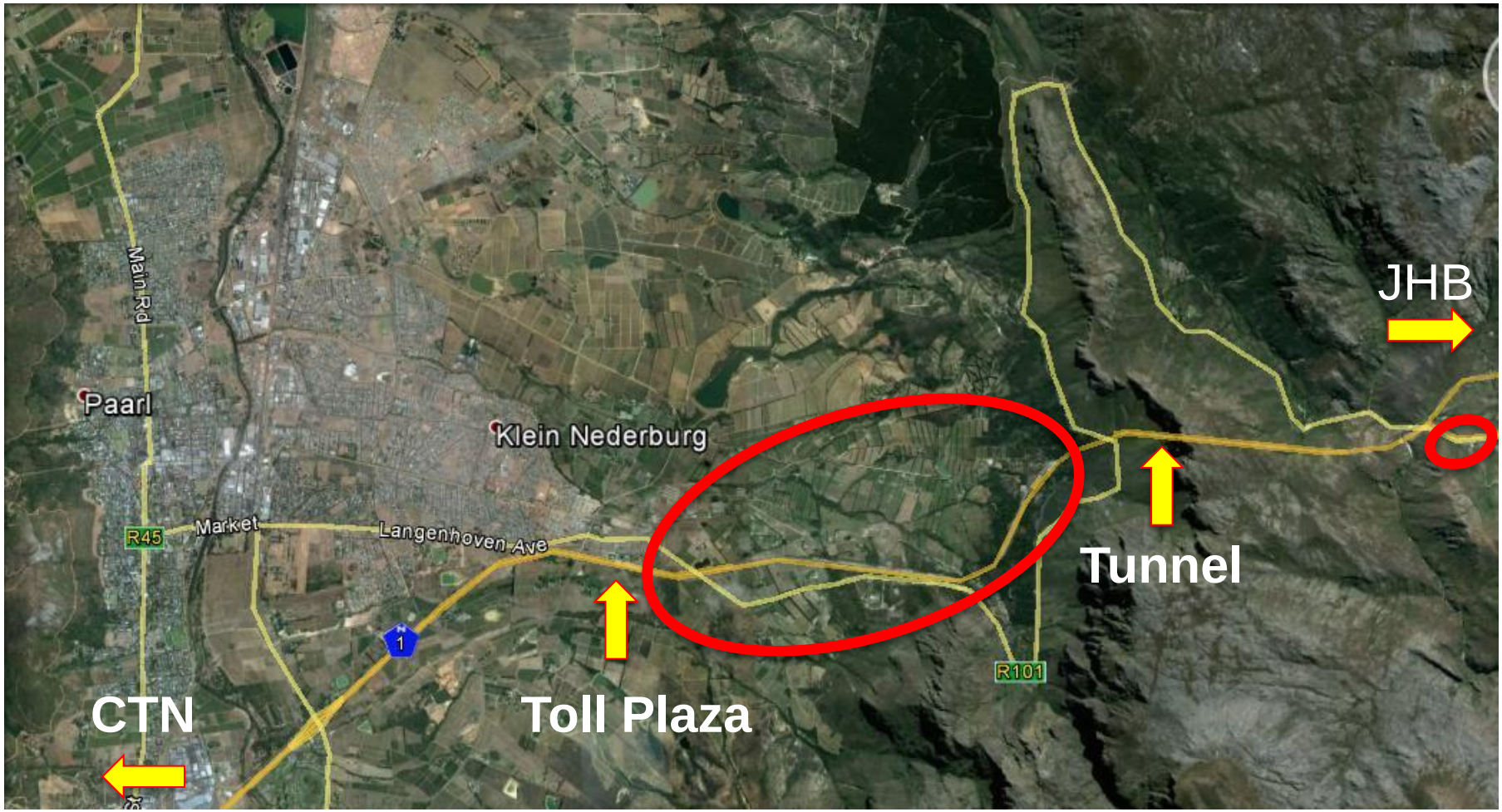
- Project Information and Background
- UTCRCP Performance
- Contributing Factors
- New UTCRCP Design
- FEM Design Review

PROJECT INFORMATION

- **Appointment**:
  - **RHDHV by SANRAL to undertake remedial measures on the pavement of the Truck Crawler Lane (UTCRCP)**

- **Location**:
  - **Huguenot Toll Plaza to Huguenot Tunnel West Portal**

PROJECT LOCATION



PROJECT BACKGROUND

ORIGINAL CONSTRUCTION (*R Burger RPF 2010*):

- 2009 - N1/1 Rehabilitation / Widening (Martin & East)
- Truck crawler lane as an experimental UTCRCP section

LAYOUT: TRUCK CRAWLER LANE

PROJECT BACKGROUND

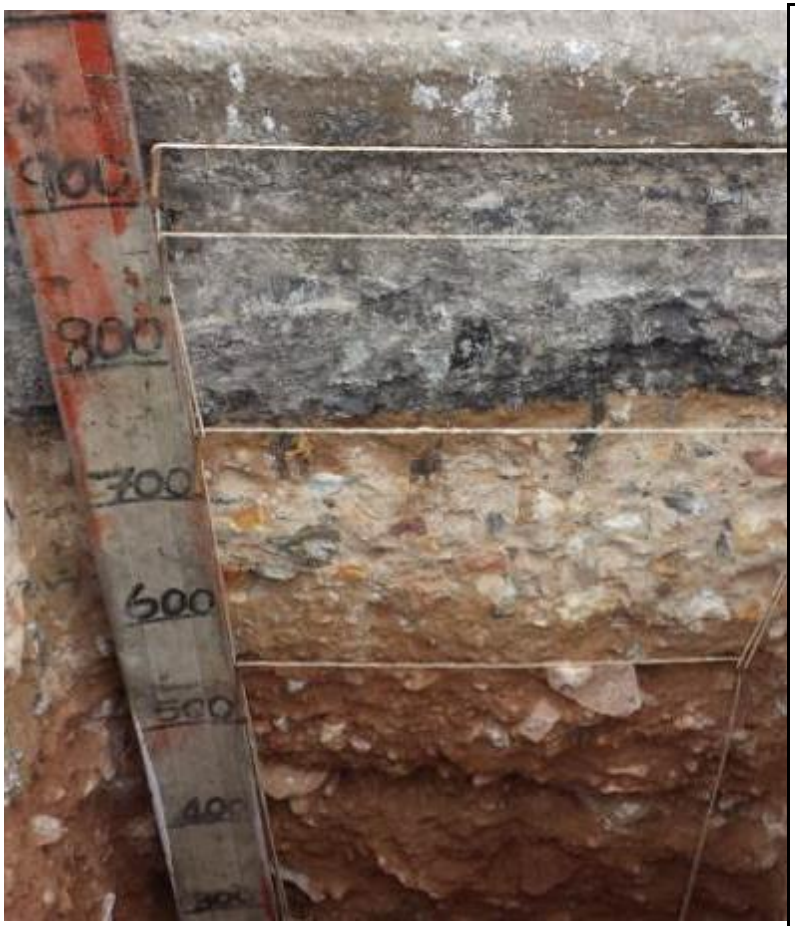
UTCRCP: Ultra Thin Continuous Reinforced Concrete Pavement

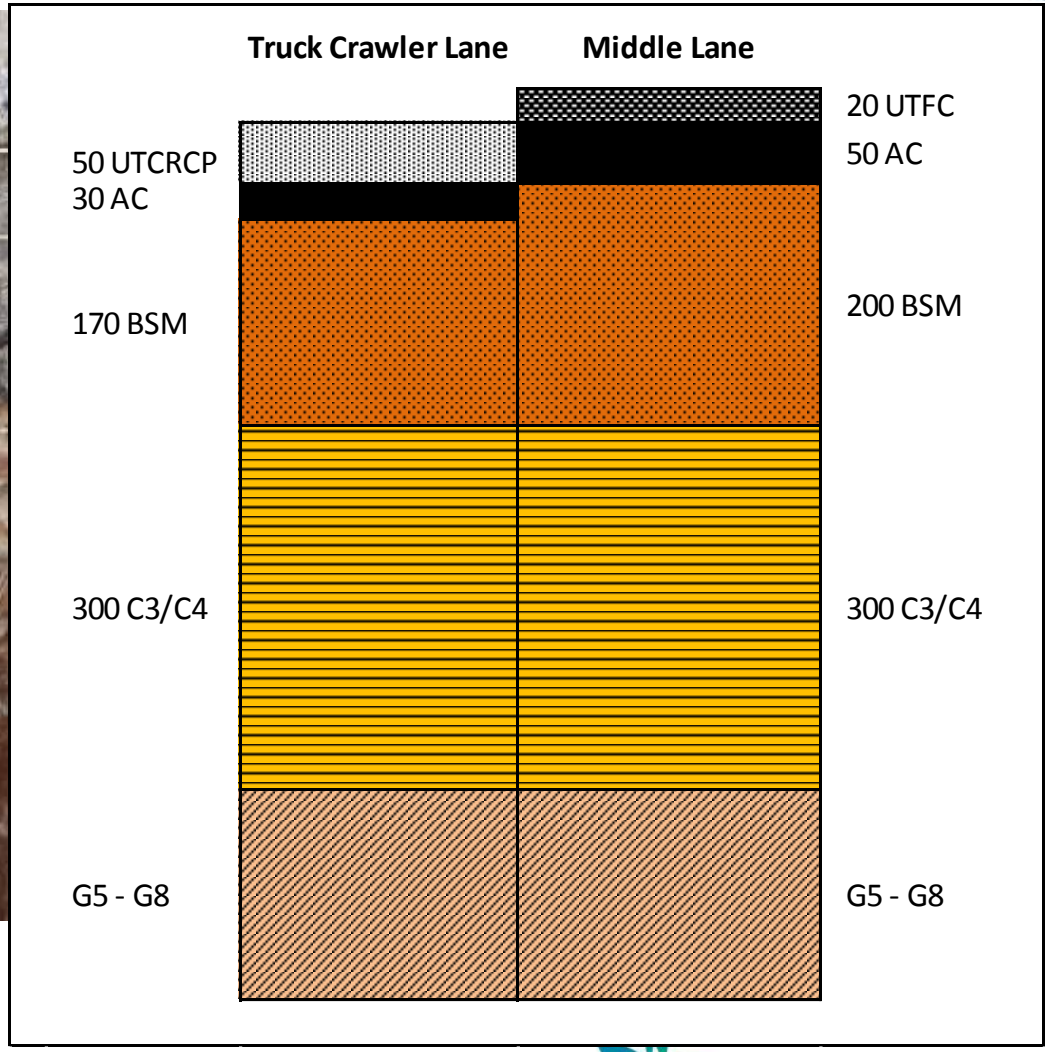
- 50 mm thick concrete pavement
- Concrete strength:
  - 90 MPa minimum Compressive (cubes)
  - 10 MPa minimum Flexural (beams)
- 5.6 mm mesh (50 x 100 mm) – approximately 6% steel
- 100 kg steel fibre per m^3
- Polypropylene fibre (2 kg)
- Intermediate beams at ±300m

PROJECT BACKGROUND

UTCRCP: (17 500m^2)

PROJECT BACKGROUND





PROJECT BACKGROUND





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PROJECT BACKGROUND

UTCRCP: Ultra Thin Continuous Reinforced Concrete Pavement

UTCRCP PERFORMANCE

UTCRCP PERFORMANCE (Good Section)

UTCRCP PERFORMANCE (Blow Up)

UTCRCP PERFORMANCE (Movement)

UTCRCP PERFORMANCE
(Transverse Joints)

Van Zyl

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UTCRCP PERFORMANCE (Movement)

UTCRCP PERFORMANCE
(Transverse Mesh Cracking)

Mbongwa

UTCRCP PERFORMANCE
(Block Mesh Cracking)

van Zyl

UTCRCP PERFORMANCE
(Joint opening)

Mbongwa

UTCRCP PERFORMANCE
(Transverse Joint Spalling)

UTCRCP PERFORMANCE
(Pumping of Fines)

Van Zyl

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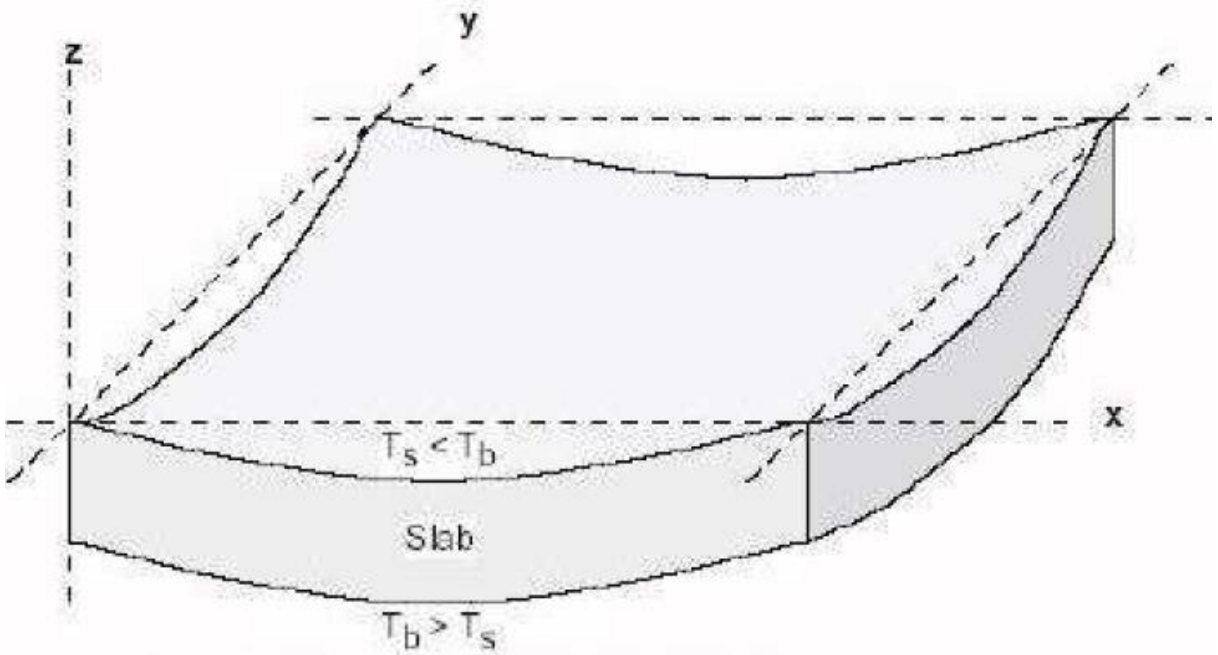
CONTRIBUTING FACTORS

CONTRIBUTING FACTORS

- **Warping**



(b) Night (slab bottom temp > surface temp)

Mbongwa

CONTRIBUTING FACTORS

- **Moisture Ingress**

CONTRIBUTING FACTORS

. Thermal Expansion

- Coefficient: 12.9 x 10^{-6}/ºC
- Typical day joints: 50 – 60m
- For temperature change:
  - from 20 to 50ºC
  - 23mm movement

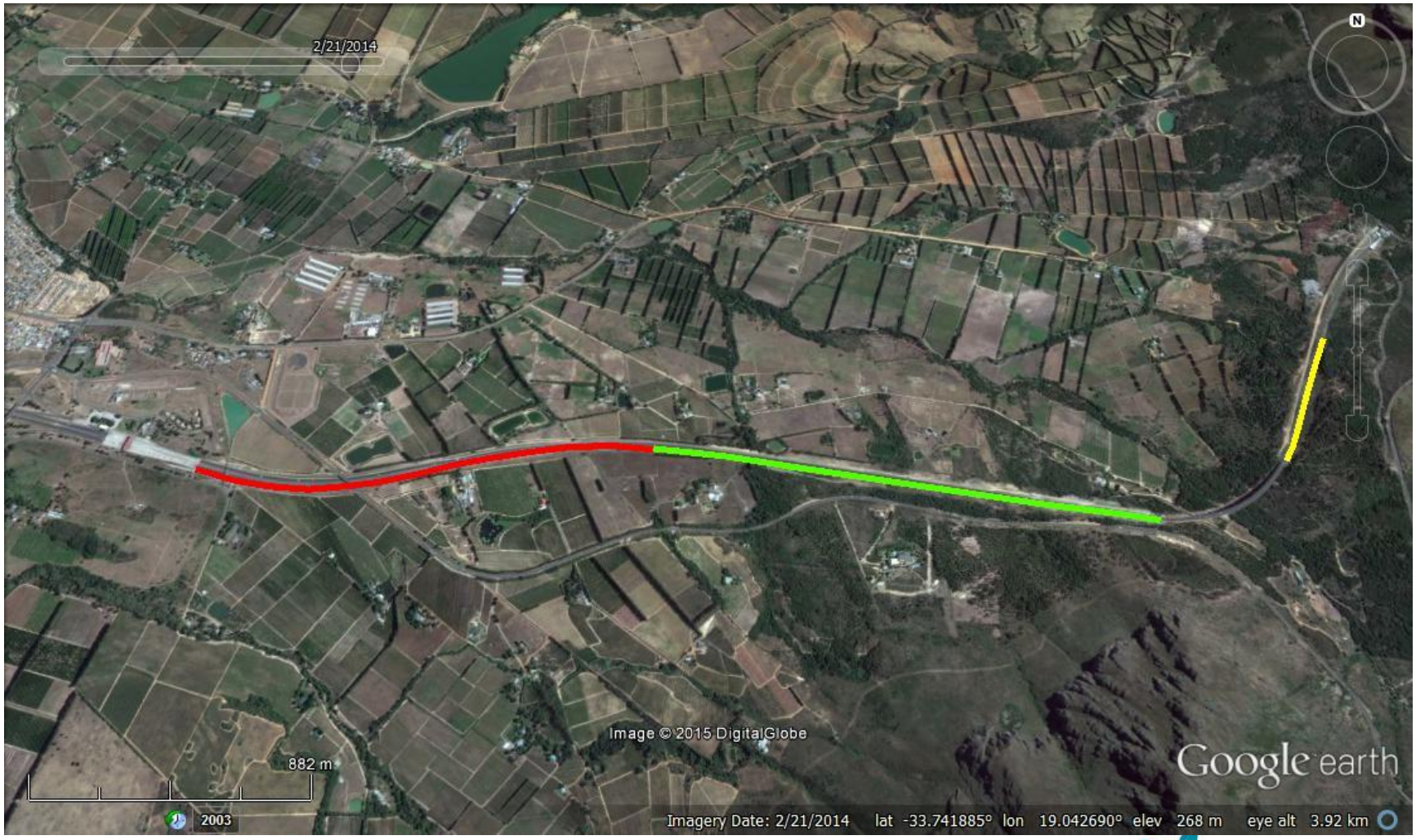
CONTRIBUTING FACTORS

. Traffic Loading Downhill Force

CONTRIBUTING FACTORS

. Delamination

REMEDIAL ACTIONS : CRAWLER LANE



NEW UTCRCP DESIGN

- **Design Objective:**
  - **Address issues identified on the N1/1**

- **R104 Experimental Section:**
  - **Aspects of the design implemented**

NEW UTCRCP DESIGN

- **Buckling / Warping / Construction:**
  - **Thickness 70mm (100mm)**
  - **Longitudinal edge beams (150 x 300)**
  - **Lower concrete strength (FS > 7.5MPa)**
  - **Reduction in % reinforcing**

NEW UTCRCP DESIGN

- **Strengthen day joints:**
  - **Thickened slab**
  - **Tie bars**
  - **Key joints**

NEW UTCRCP DESIGN

- **Movement:**
  - **Intermediate beams @ day joints (60m)**
  - **Improved longitudinal joint seals**

FINITE ELEMENT METHOD (FEM)

UTCRCP DESIGN REVIEW

UTCRCP FEM DESIGN REVIEW

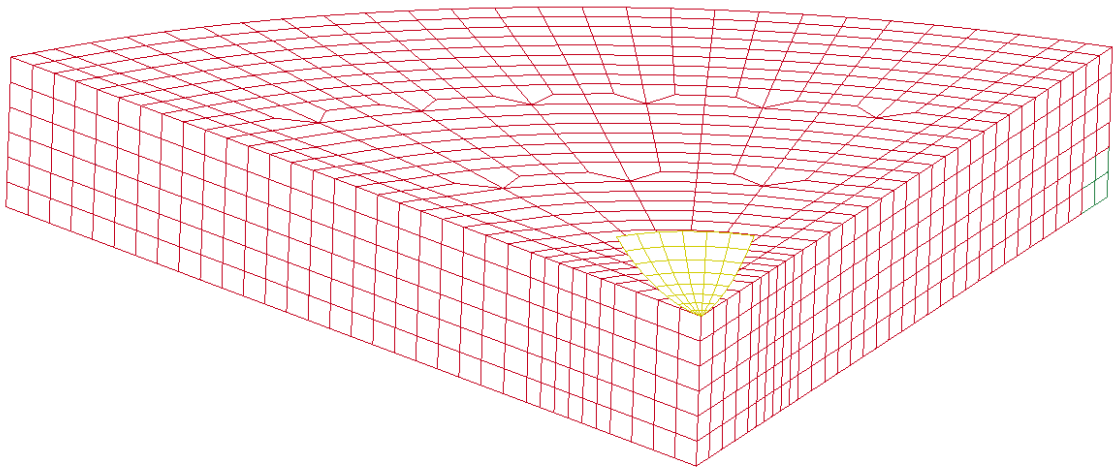
Material Characterization:

- Support layers
  - Subbase
  - Subgrade

- New UTCRCP
  - Universities Pretoria – Mix design
  - University of Stellenbosch – Expansion coefficients

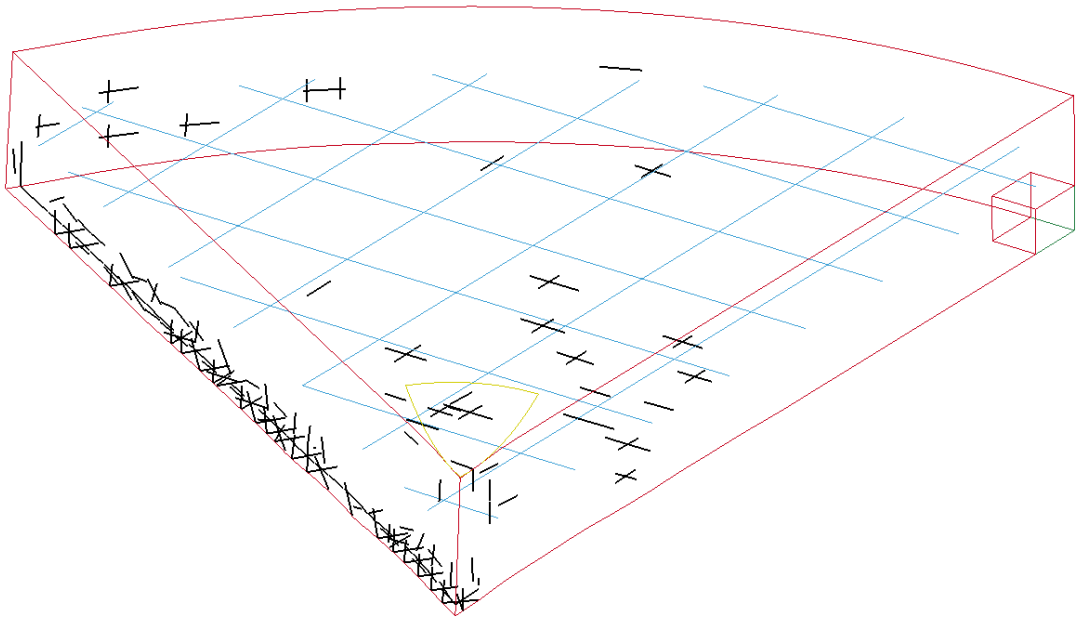
UTCRCP FEM DESIGN REVIEW

Disk Test: TM 35 GPa, UCS 50 MPa, UTS 8 MPa, fe 1.5E-3
Time = 0

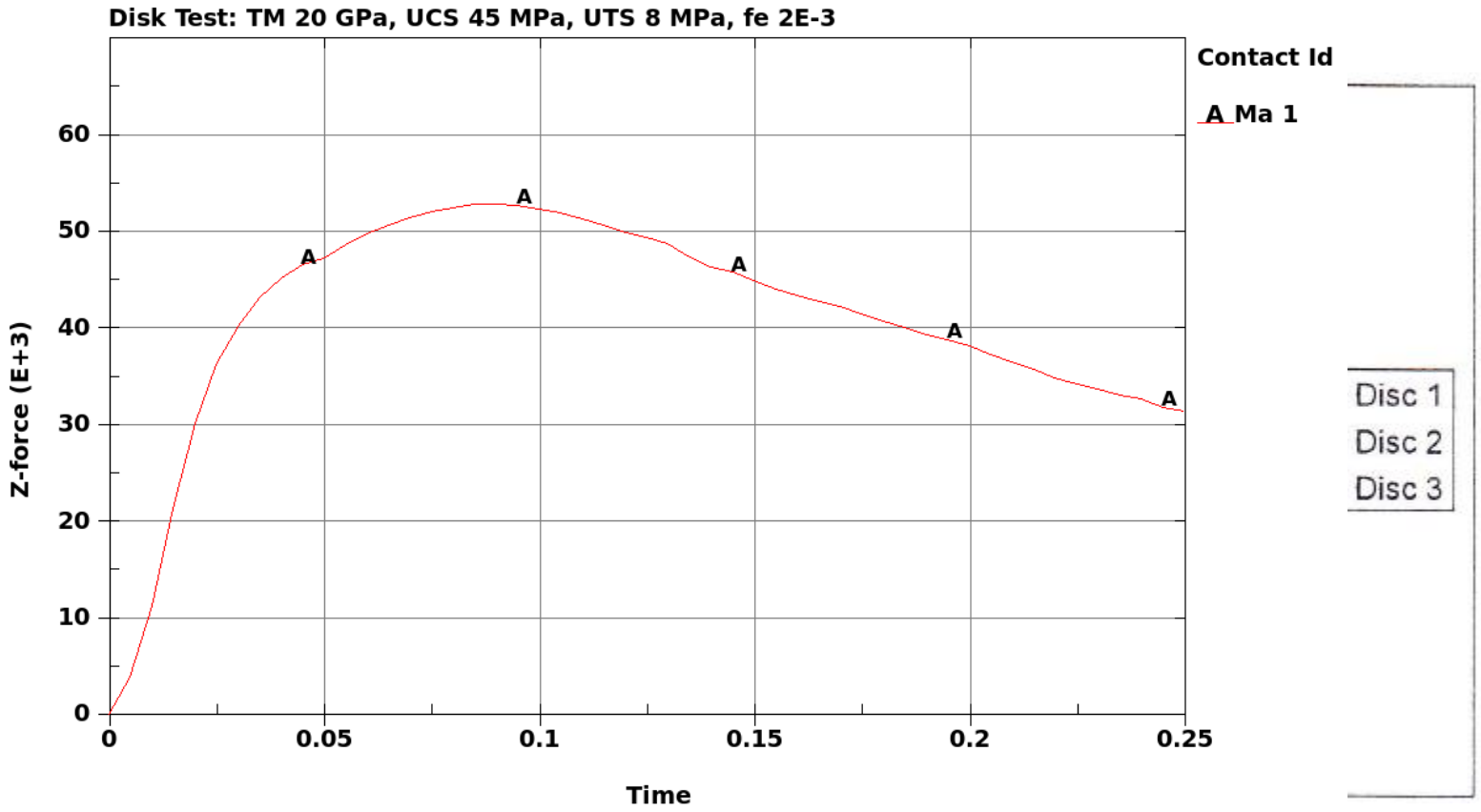


UTCRCP FEM DESIGN REVIEW

Disk Test: TM 35 GPa, UCS 50 MPa, UTS 8 MPa, fe 1.5E-3
Time = 0.25
Number of elements cracked=166



UTCRCP FEM DESIGN REVIEW



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UTCRCP FEM DESIGN REVIEW

- **FEM Analysis:**
  - **Model selection and compilation**
  - **Model calibration**
  - **Existing UTCRCP Pavement**
  - **New UTCRCP**
  - **Report and Recommendations**

CONSTRUCTION COMMENCE

SEPTEMBER 2015

Acknowledgements:

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