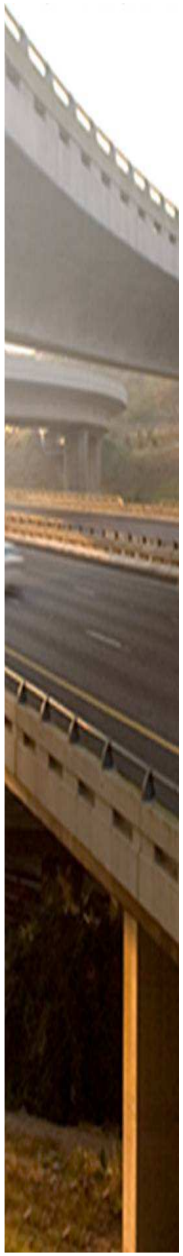
SOUTH AFRICAN PAVEMENT DESIGN METHODS: THIN SURFACINGS

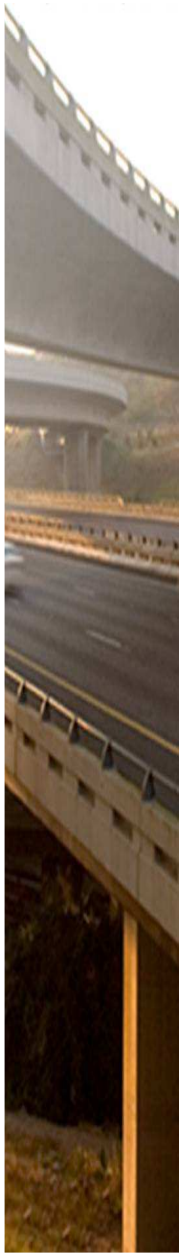


Improved Damage Models for Bituminous Materials (Project PB/2006/D-1): Part 2 – Thin Surfacings

Progress: RPF May 2011

Dr TI Milne

Objectives

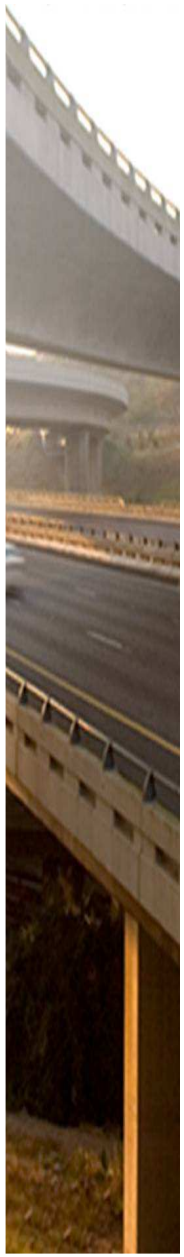


The following outcomes are desired for the thin surfacing categories:

Surfacing seals and non-structural thin-layer bituminous surfacings (e.g. UTFC):

- Typical damage distributions and probabilistic expected life predictions for different types of surfacing seals and non-structural thin-layer bituminous surfacings under prevailing climatic conditions based on historical performance data (e.g. PMS and field data data).
  - FIELD PERFORMANCE ASSESSMENT
- Mechanistic performance and damage models for Surfacing seals and non-structural thin-layer bituminous surfacings.(ie mechanistic model)
  - LABORATORY TESTING AND MODEL DEVELOPMENT

Research Team



Project Manager (Sub-Consultant to CSIR)

- Dr TI Milne (Aurecon)

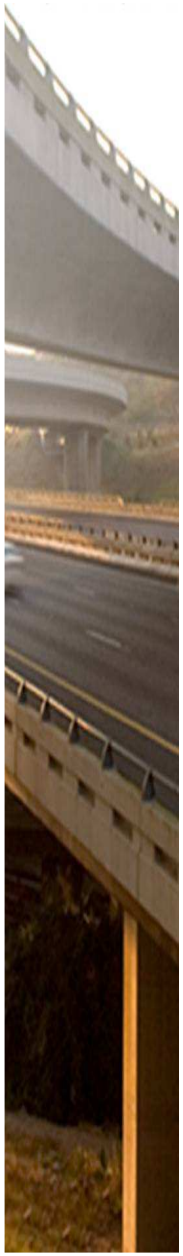
Sub-Contractors

- University of Stellenbosch (modelling of the seal and base, field testing and empirical verification) (J Gerber)
- University of Pretoria (modelling of the bituminous materials and adhesion/cohesion) (E Mukandila)
- Prof A Visser (collation of empirical field testing and assessments and with model)
- MyCube (assessment of seal performance in the field) (Mr G Van Zyl)

And in association with:

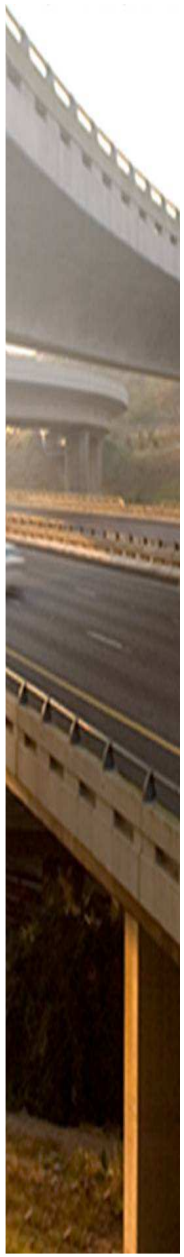
- Technical University Delft (under MoU of the University of Stellenbosch)
- CSIR (materials testing and traffic load model (Prof De Beer)

Programme: Early Milestones



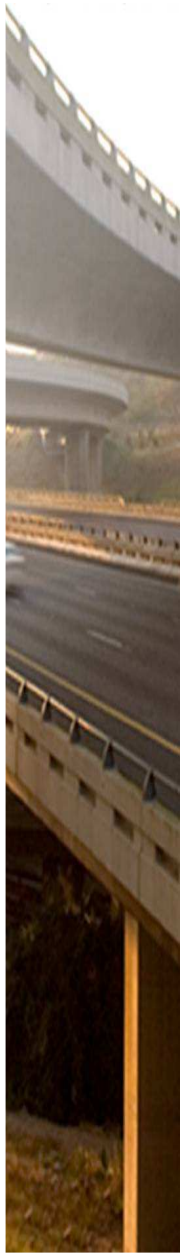
- Inception phase: March 2010 to April 2011
  - **COMPLETE**
- Modelling: commence skills transfer May 2011
  - **CURRENT**
- Lab testing: commence skills transfer May 2011
  - **CURRENT**
- Bitumen characterisation: Lab tests: commence July 2011
- Base characterization: Lab tests: commence July 2011
- Traffic modelling: commence September 2011
- Field assessment: commence July 2011
- Completion scheduled: end 2013/mid 2014

Modelling packages



- Bitumen Characterisation, Adhesion, Cohesion (including binders AND slurry)
  - DSR testing
    - To characterise bitumen and slurry
    - Adhesion and cohesion limits
  - Aggregate classification
    - For adhesion assessment
  - Bitumen response models
    - Behaviour (visco-elasto-plastic modelling)
  - Damage modelling
    - Adhesion (fatigue, surface energy)
    - Cohesion (fatigue)

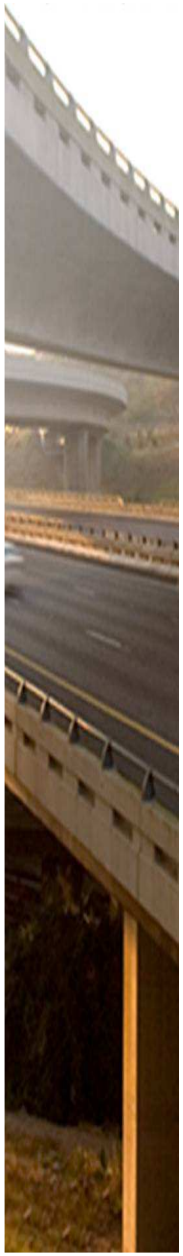
Modelling packages (cont.)



- Seal System
  - CT scans
    - Geometry of seal systems (reproduce exact samples)
  - Base assessment (lab tests)
    - embedment
  - Base response model
    - Elasto-plastic model
  - Base damage model
    - Embedment
  - Seal system
    - Performance model
    - traffic

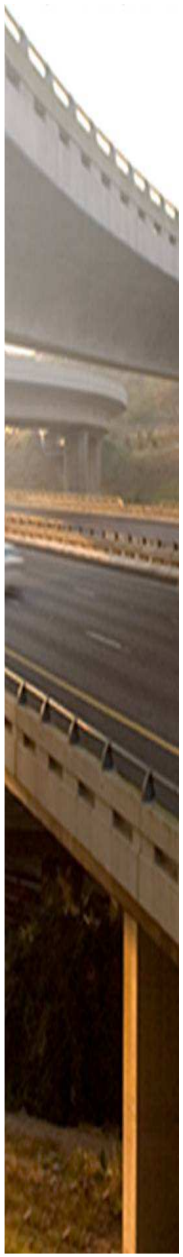
- To be verified by field and empirical testing

Primary Inputs



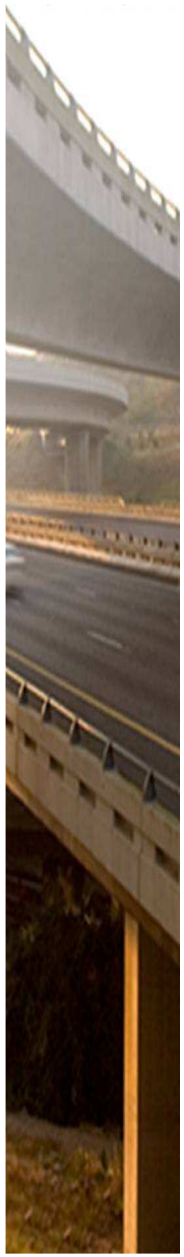
- Binders
  - BR
  - Modified (SBS)
  - 80/100 hot applied
  - Emulsion
  - Cut back
- Aggregate
  - Acidic
  - Basic
- Seals
  - Types
  - Sizes

Binders



- 80/100 spray grade bitumen
- MC 3000 – Cut-back bitumen
- S-E1 – Polymer modified binder with SBS
- S-R1 – Non-homogeneous polymer modified binder – Bitumen Rubber
- 65 % cationic spray grade emulsion

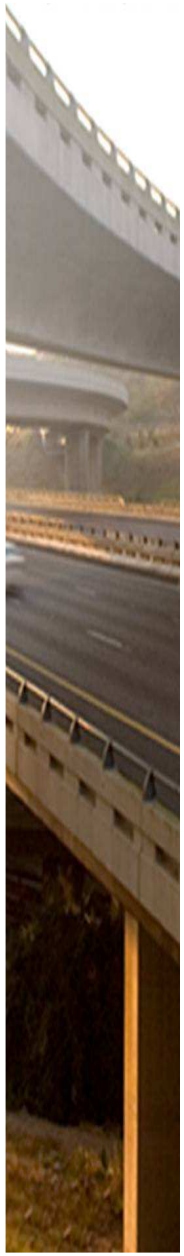
Aggregates



- CSIR's Dr Phil Paige-Green team will sample in short term (before end August) 10 sources of aggregate:

Dolorite:	From Ermelo / Trichard
Dolorite:	From Amersfort
Dolorite:	From Kimberly
Quartzite:	From Ferrolyn
Quartzite:	From George
Tillite:	From Durban area
Granite:	From Midrand
Granite:	From Rooiberg/Naboomspruit
Honfels:	From Cape town
Slag:	From Middelburg or from Newcastle

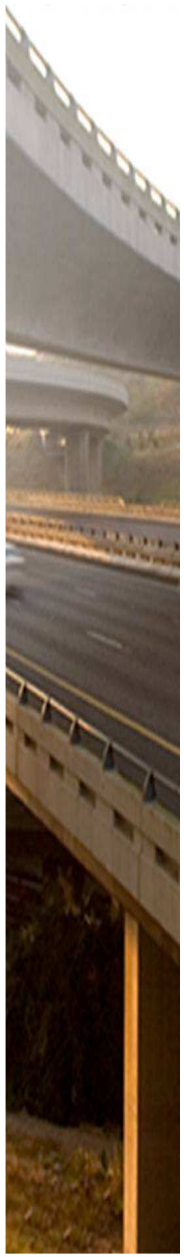
Aggregates (cont.)



- For the purpose of our **seal research** it was suggested that we initially look at the following aggregate:

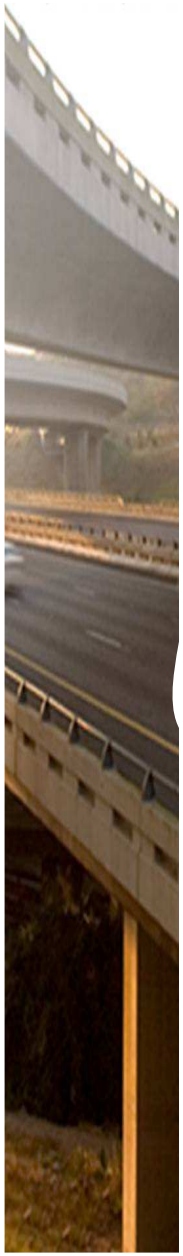
Metamorphic acid:	**Quartzite**
Basic:	**Dolorite**
Igneous Acid:	**Granite**
Sedimentary:	**Tillite**

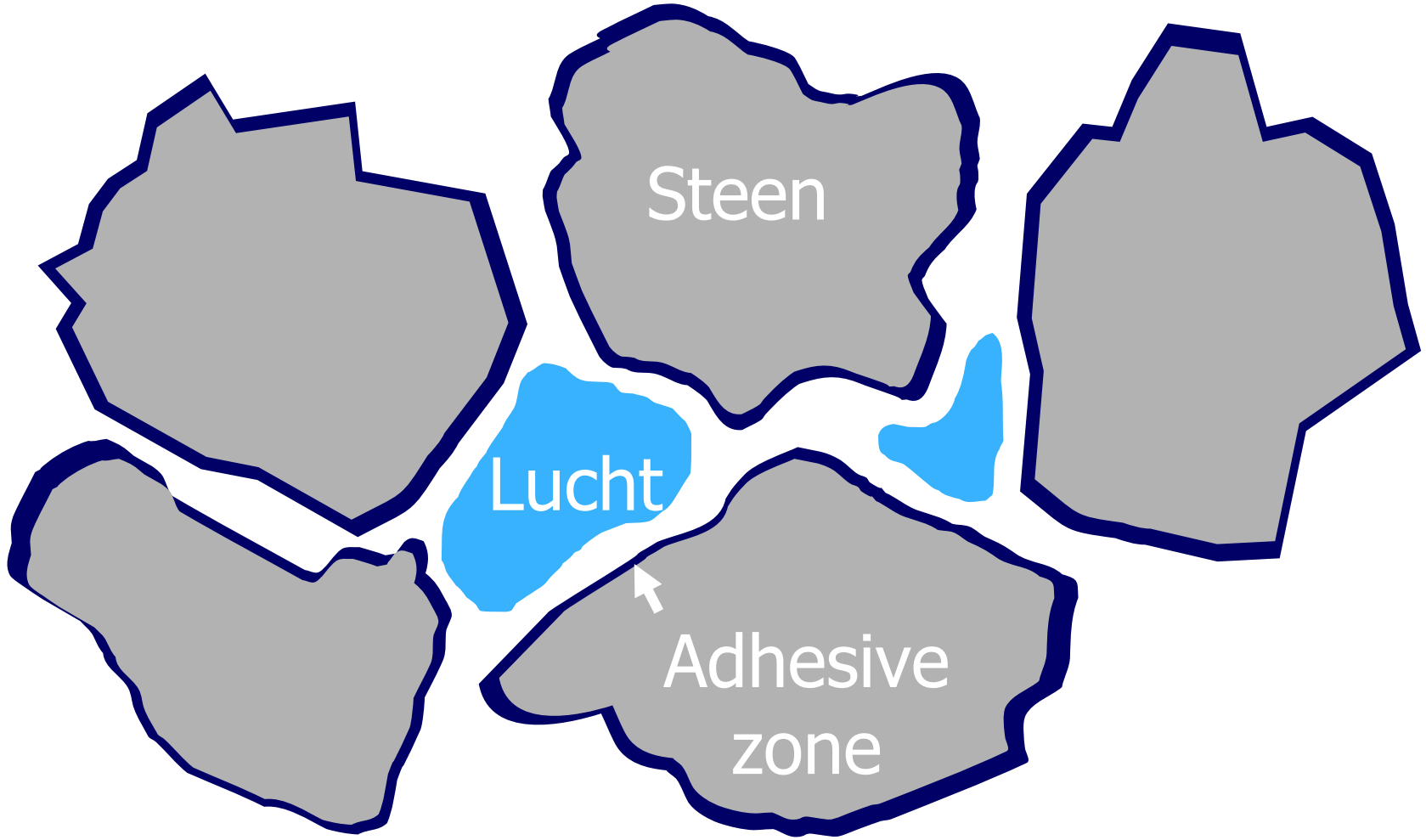
Seals



- On BASE course
  - Single
  - Double
  - Cape
  - UTFC??
- Reseal on Asphalt
  - Single

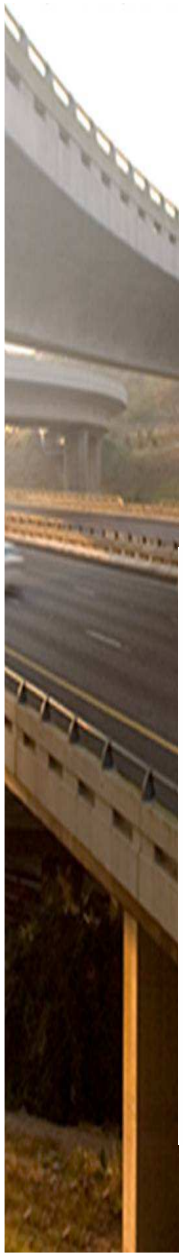
Model: Micro-Mechanic Scale



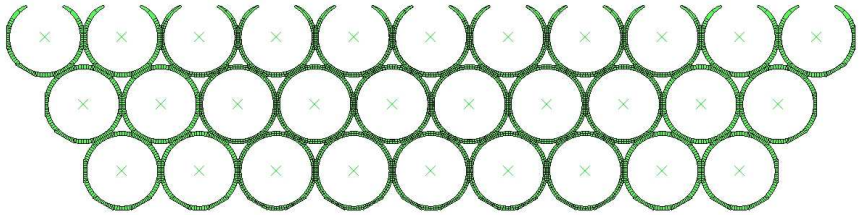


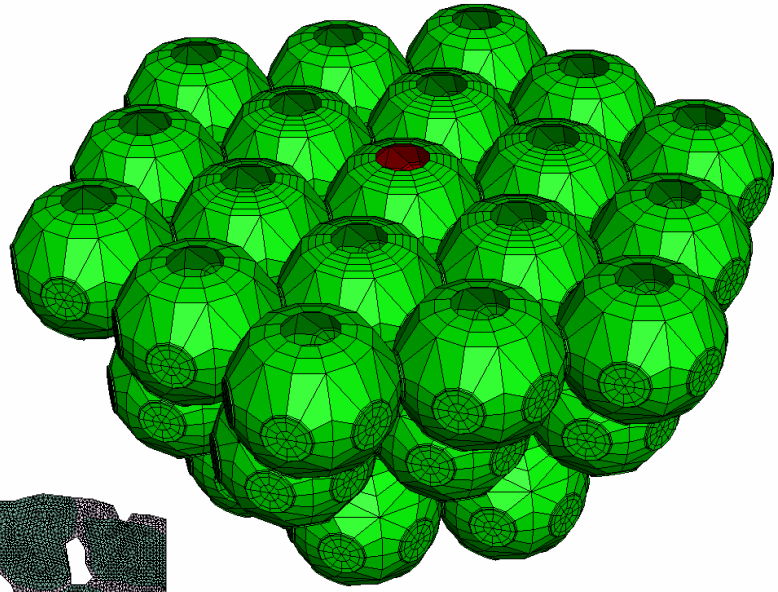
Slide: From Huurman, TUDelft

Model: Micro-Mechanic Scale (cont.)



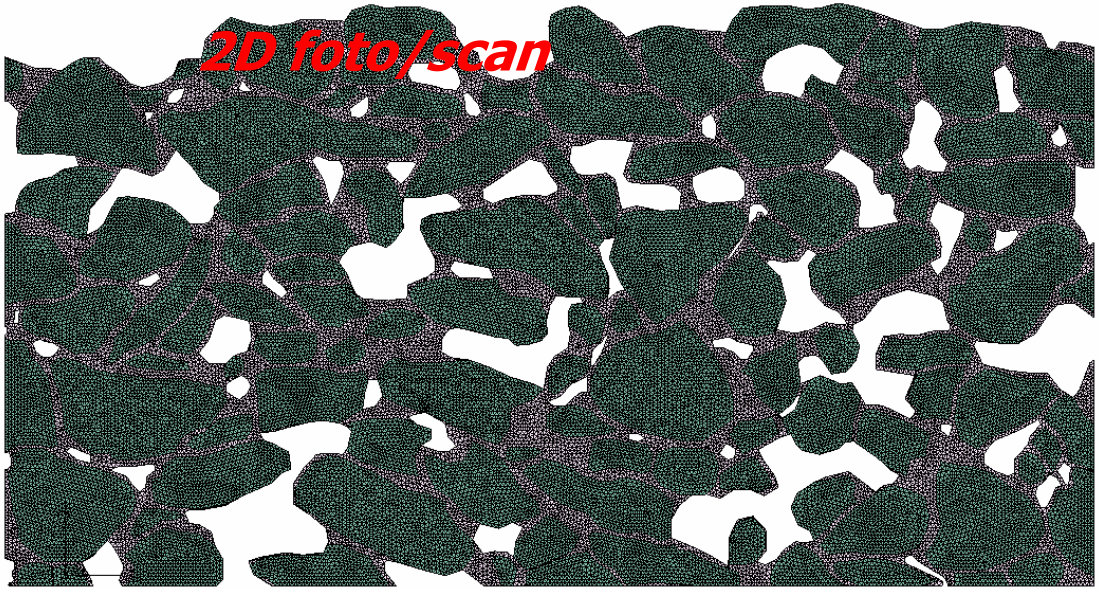
2D geïdealiseerd





3D geïdealiseerd, ∞

2D foto/scan



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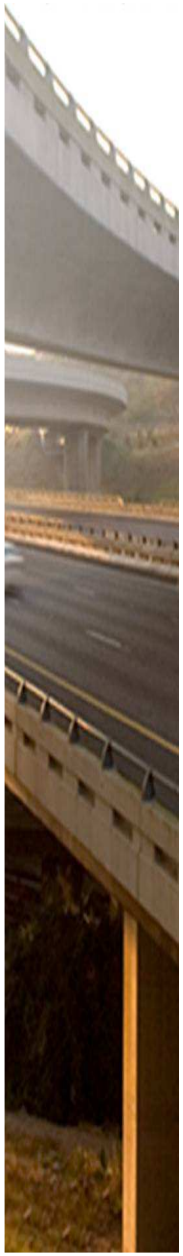
Mukandila: PhD

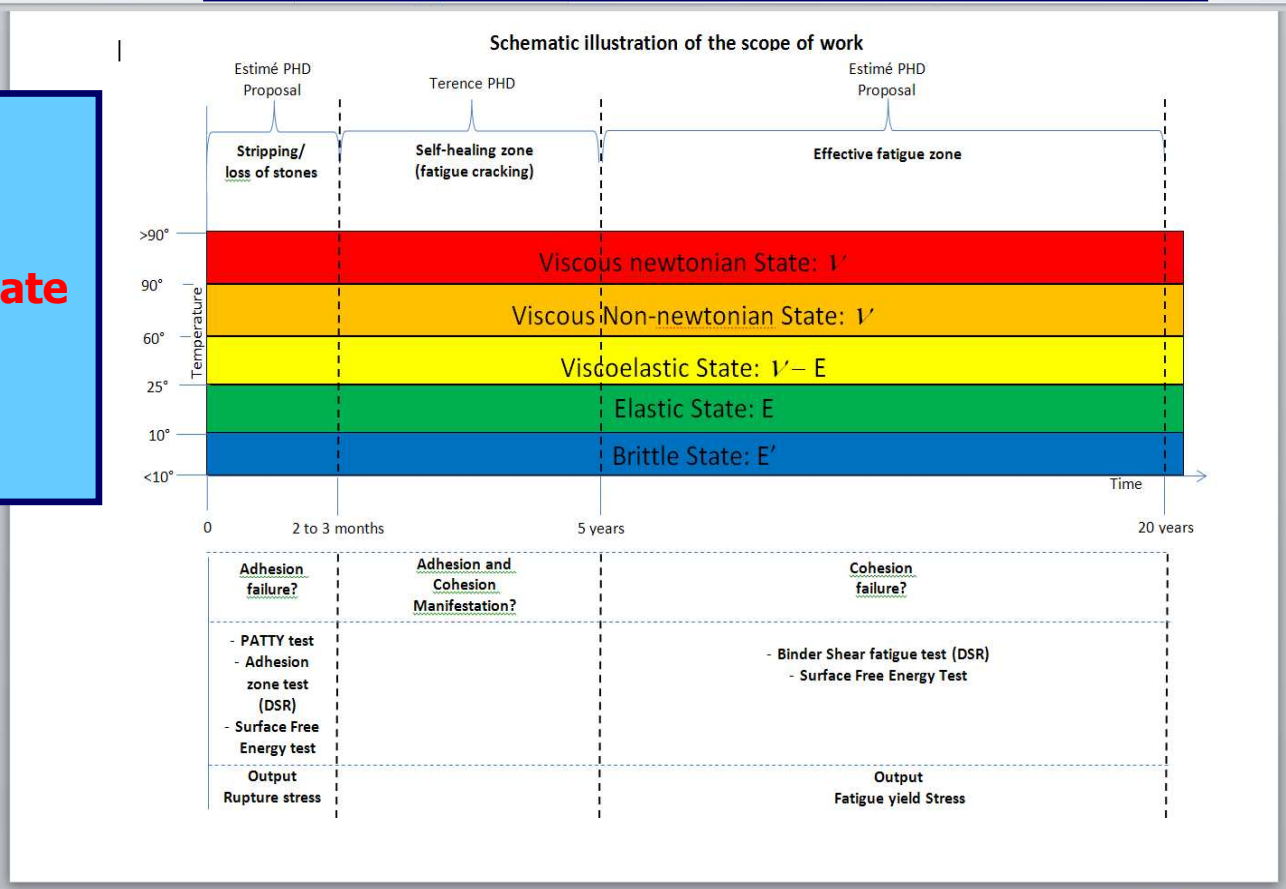


Fresh **Mature** **Aged**

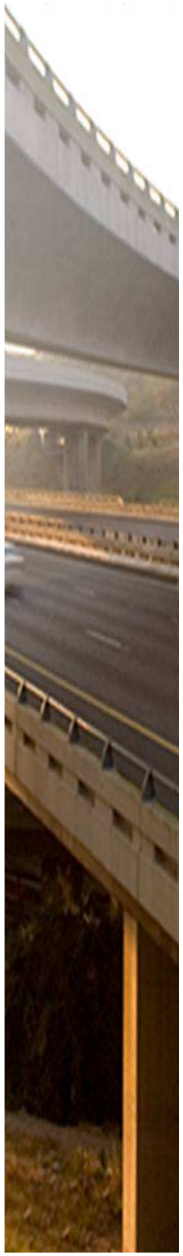
Hot

Moderate

Cold



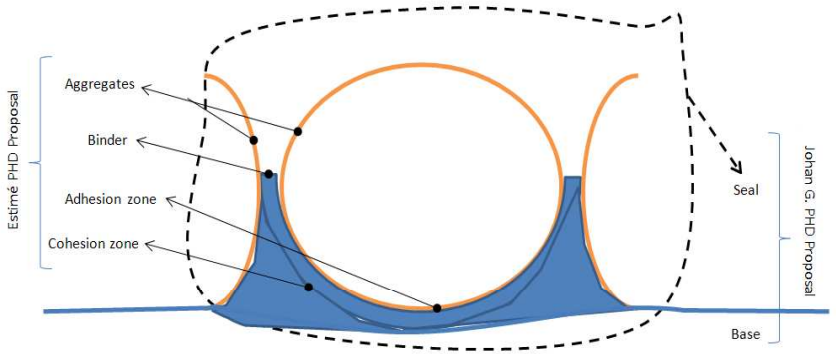
Mukandila: PhD (cont.)



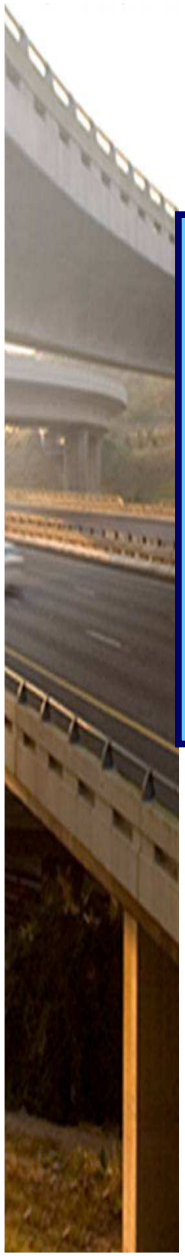
Inputs:
- aggregate and binder type

Outputs: to seal system:
- Binder response and damage models

Schematic illustration at Micro scale of seal



Gerber: PhD



Low

Ability of Seal to support itself varies

High

Macro illustration PhD Johan.pdf - Adobe Reader

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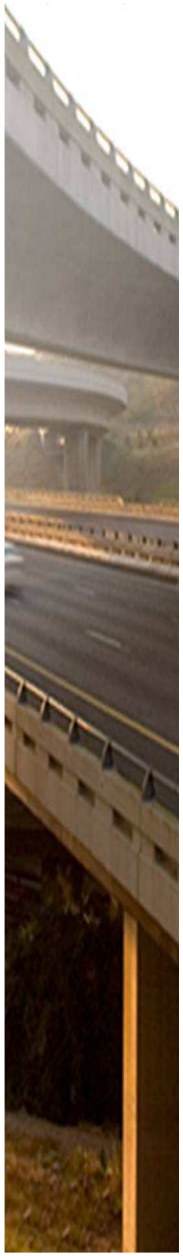
Macro draft 1 illustration of the scope of works. PhD2 Johan

Aging	Bitumen Stabilizes Viscocity Increase	Viscocity Increase & decrease	Viscocity Increase & decrease	Viscocity Increase & decrease
Environmental Condition		Rapid Changes	Rapid Changes	
Temperature Characteristics >90°C				
90°C		Viscous: Newtonian		
60°C		Viscous: non-Newtonian		
25°C		Viscous-Elastic (solid, disppersal phase)		
10°C		Elastic (elastic solid)		
<10°C		Brittle (linear)		
	0	2/3 Months	5 years	20 years
	Resistance to seal stone pennetration?	Resistance to seal stone pennetration?	Resistance to seal stone pennetration under rapid change?	
		Embedment Equalibrium Approximately 3years?	Adiquate Texsture Depth?	
Test	Ball pen test		Sand Patch Test TRIDEM LASER	
Output	Predict Embedment		Pretreatment of Base texture?	

New Equilibrium .....Distress

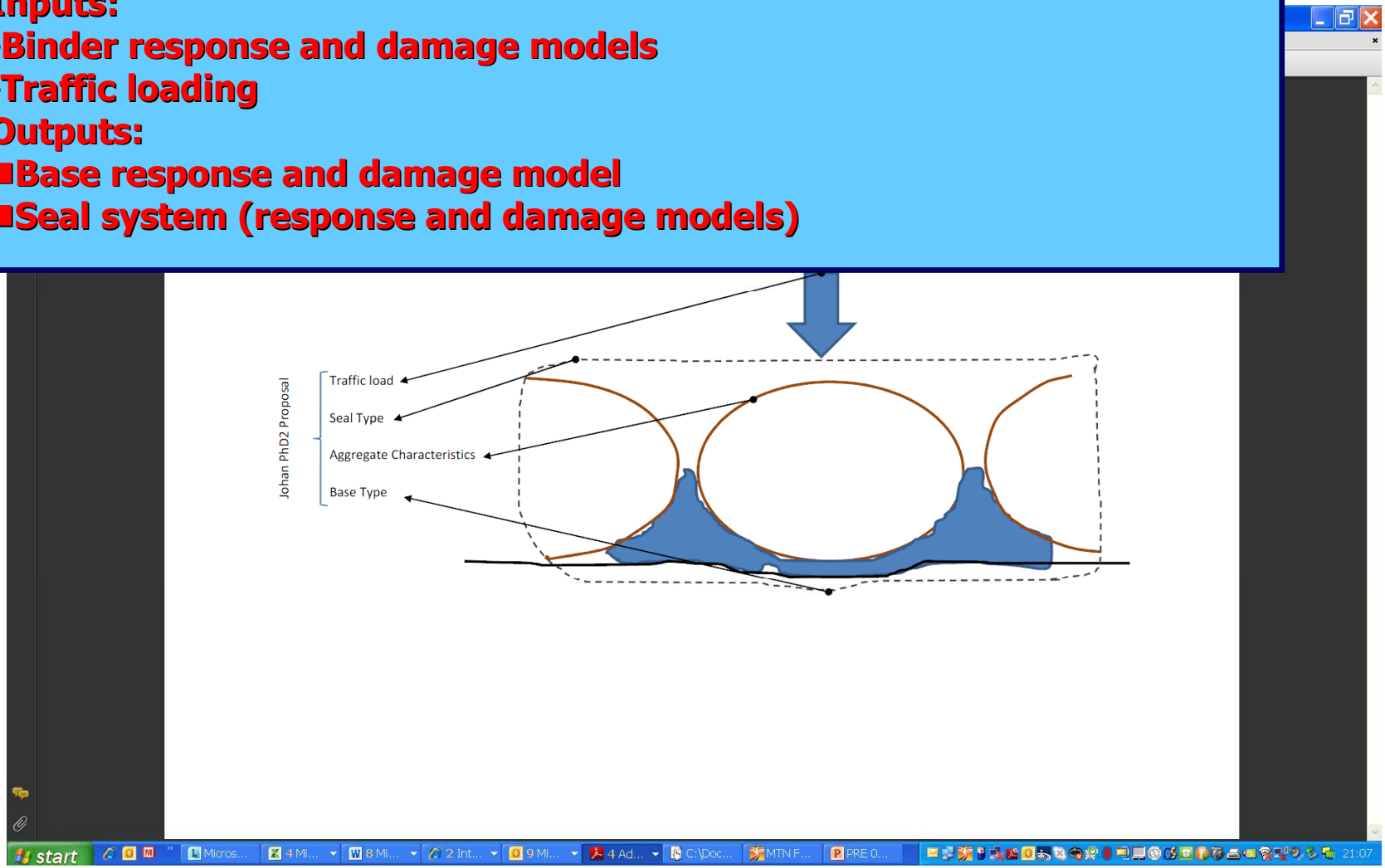
aurecon

Gerber: PhD (cont.)

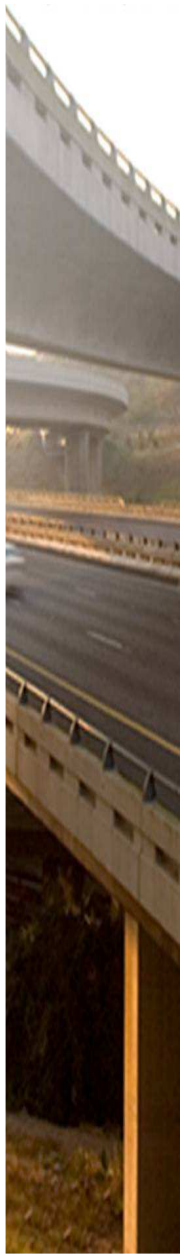


Inputs:
- Binder response and damage models
- Traffic loading

Outputs:
- Base response and damage model
- Seal system (response and damage models)



New Lab Test Methods

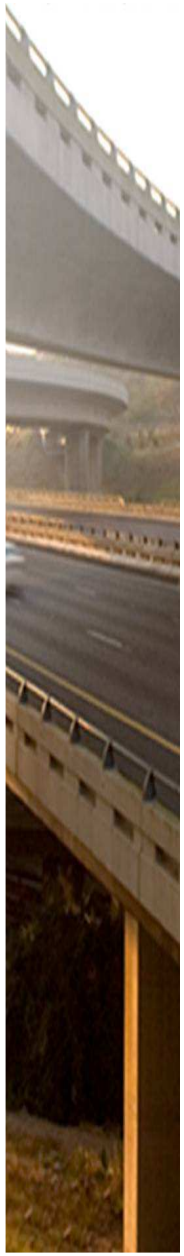


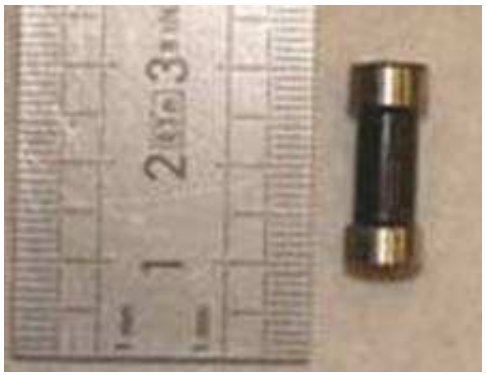
- DSR: binder classification and adhesion
- *DMA: bitumen fatigue (adhesion/cohesion)*
- Surface Energy: ???? (adhesion)
- Dynamic CBR/triaxial: ???? base response model (embedment and support)

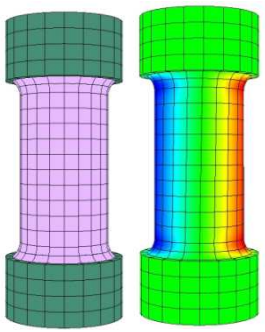
Methodology and equipment being determined to match Modelling requirements

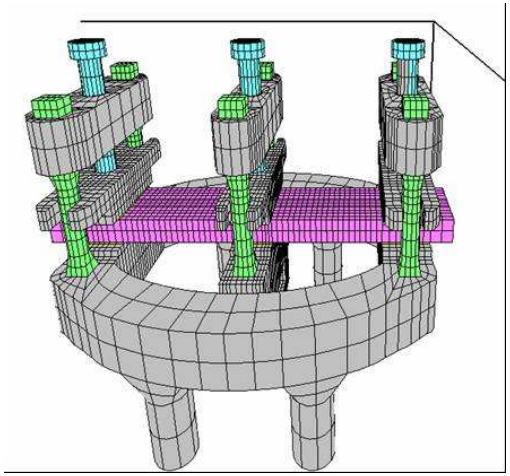
Relate high end research tests to tests available in practice (Pen, R&B, Ball Pen, Patti……..)

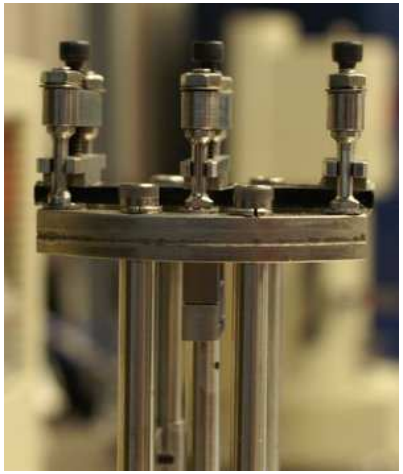
New Lab Test Methods (cont.)

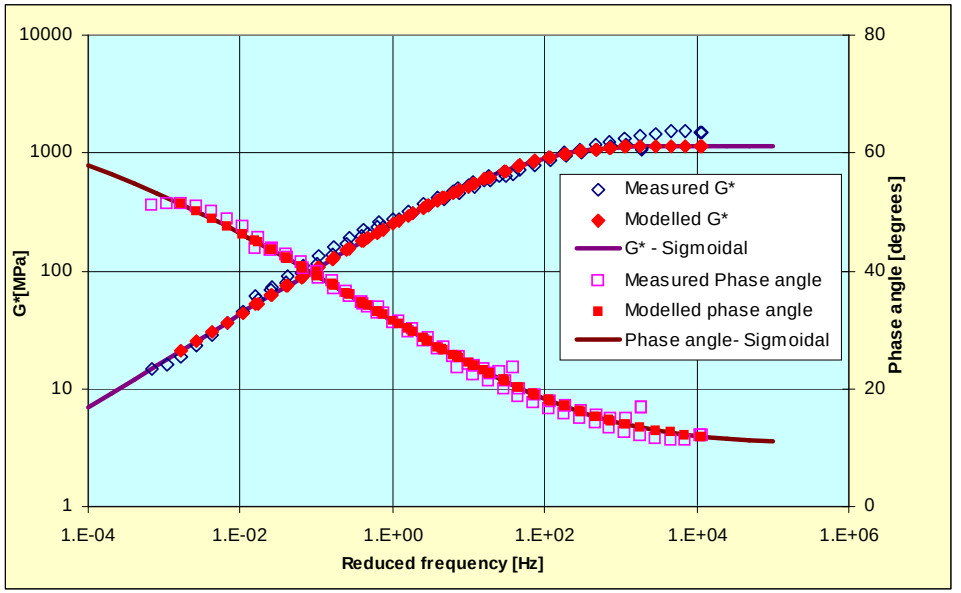






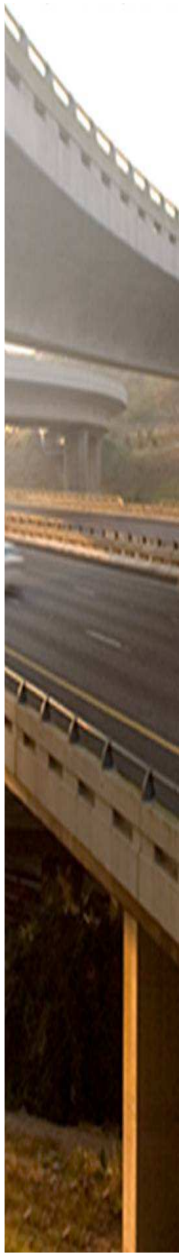




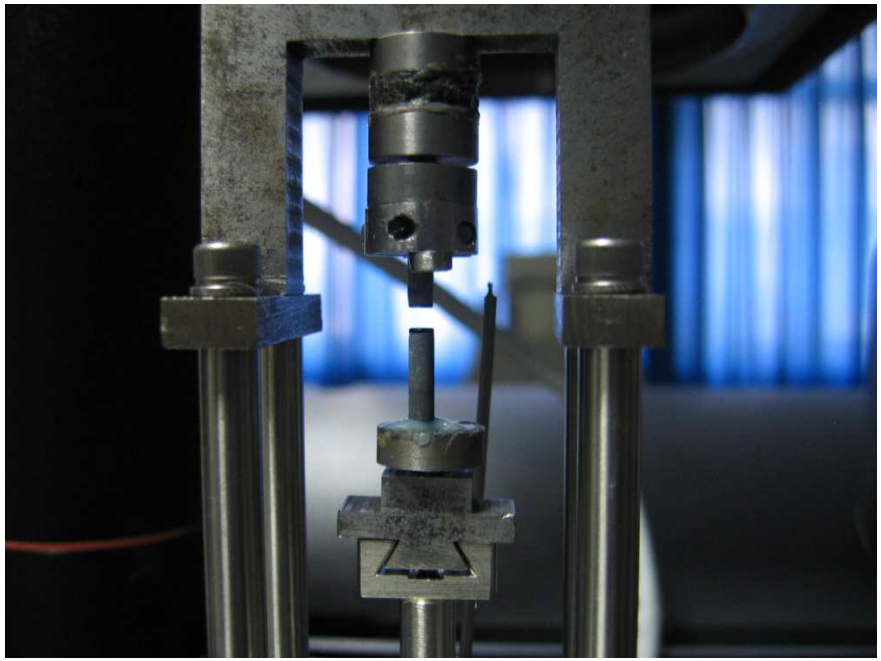


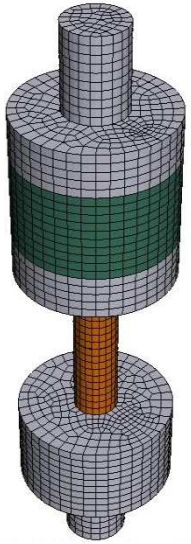
Slide: From Huurman, TUDelft

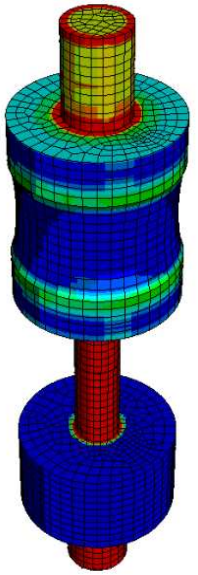
New Lab Test Methods (cont.)



Adhesieve zone schade







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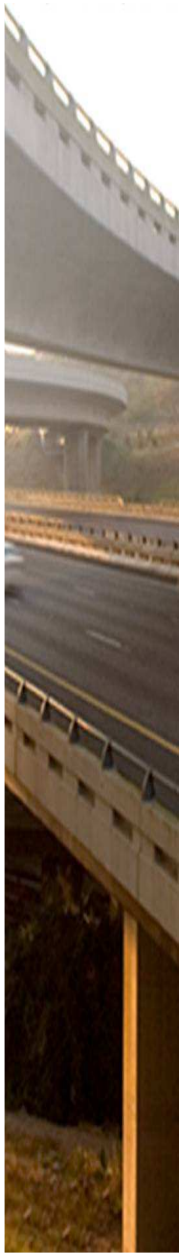
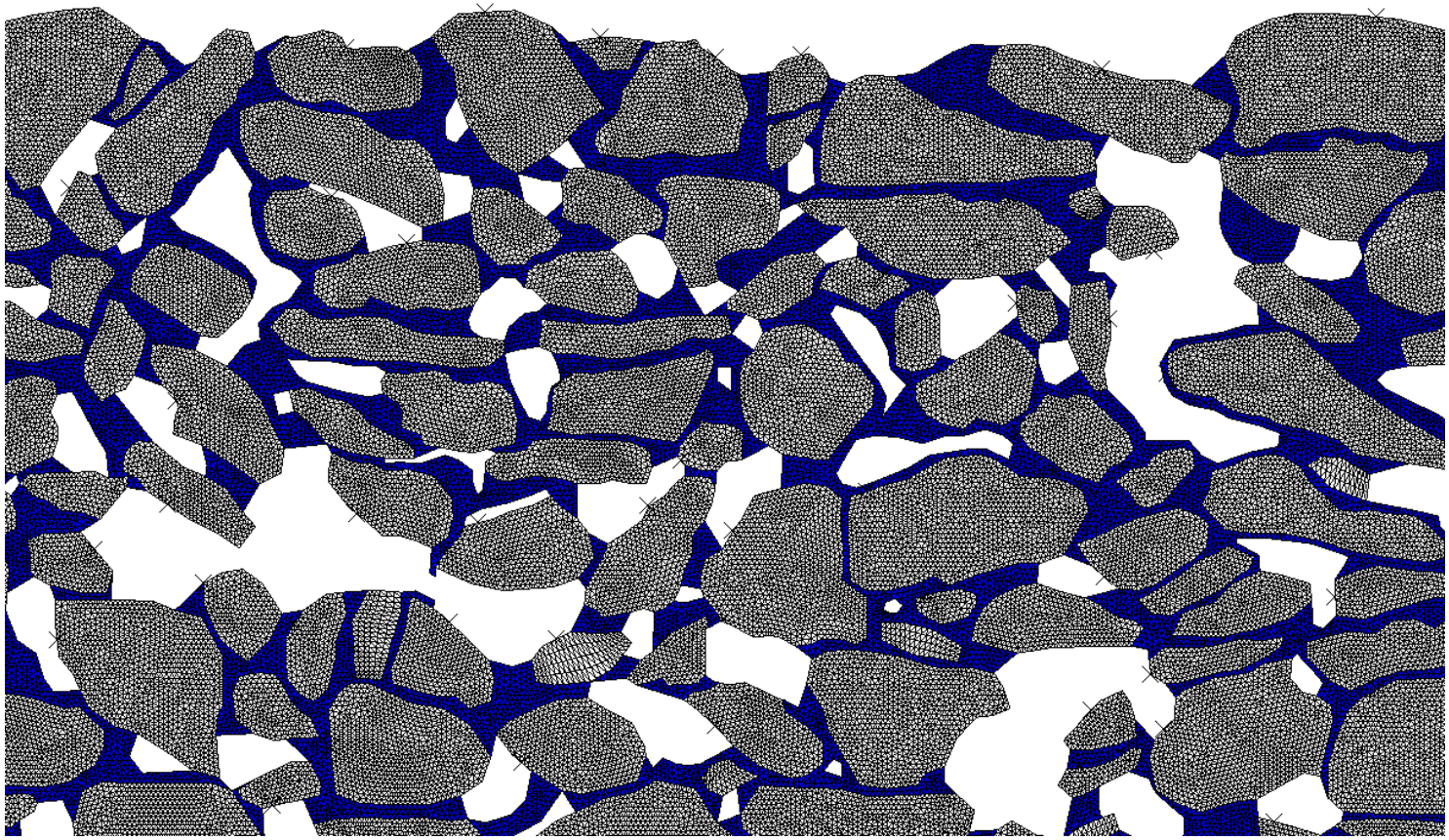
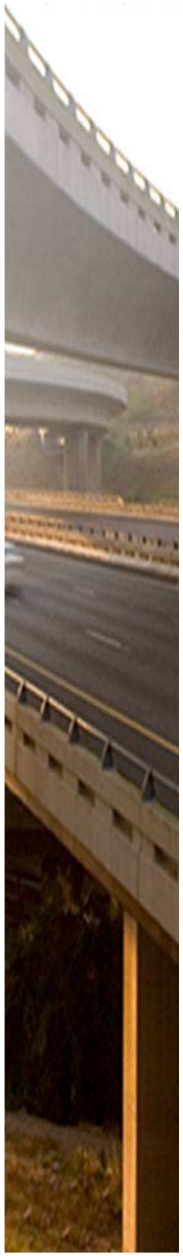
Advanced Modelling





Demo: From Huurman, TUDelft

Conclusion



- Reports to be uploaded:
  - Inception with scope and deliverables
  - Laboratory Report
  - Records of Milestone Project Meetings
  - RoD's of the planning meetings at TUDelft