19th Road Pavements Forum (RPF) – May 4-5, 2010,

Overview of Parliamentary Grant Funded Research Activities at the CSIR

Reporter:
Morris De Beer
CSIR Built Environment

our future through science

19th Road Pavements Forum (RPF) – May 4-5, 2010,

CSIR Flagship Project (i-Roads)
Innovative technologies and solutions for enhanced road system performance ?

our future through science

Need and Rationale for the R&D project(s)

- Road infrastructure – A key driver supporting and stimulating socio-economic development of South Africa
- Market needs / gaps in knowledge
  - Current and future road network conditions
    - *National road network > 20% - poor to very poor*
    - *Provincial road network > 40% - poor to very poor*
    - *Rural access network > 80 – 85% (estimated) poor to very poor*
  - Traffic volumes and heavy vehicle (HV) mass
    - *20 yr design traffic currently applied in less than 10 yrs*

Need and Rationale for the R&D project(s)

- Material availability
  - *Scarcity of good quality road construction materials (soil maps)*
  - *Sustainability issues*
- Transport logistics costs (**14,7% of GDP ~ R340bn, 6thState of Logistics)**), *compared with Brazil (~10%) and USA (9.4 %)*
- Sustainability
  - *Human capacity development (HCD)*

Overarching (Research) Question

- *In search for innovative technologies and solutions that can be developed to enhance and sustain performance of our road system(s) …*

Envisaged Solutions

- Uniquely SA solutions to be developed, calibrated & validated
  - *Allowing for cost effective, optimal & sustainable utilisation of **limited resources aligned with National imperatives***

Research methodologies: General

- Mostly 3 year project (2007-2009/10 – 001 to 016 subprojects) with ongoing re-focus;
- Currently, support of SANRAL SAPDM long-term projects (S);
- Support of Ad hoc internal / external projects;
- Human Capacity Development (HCD):
  - 2 x PhD studies
  - 1 x MSc
  - 2 x M.Techs (Completed practical training at CSIR)

Project Groups:

- ***Exploratory research (x 4)***
- ***Experimental development (x 4)***
- ***Quantitative analysis (x 8)***

Exploratory Research Projects:

- ***Exploratory research (x 4)***
  - 006 - **Nanotechnology** applications in pavement engineering;
  - 011 - Durability of **stabilized** materials;
  - 014 - Karst aquifer **groundwater hazard** and risk mapping;
  - 016 - **Field softening point** test method (feasibility study);

Experimental Development Projects:

- ***Experimental development (x 4)***
  - 001 – Development of **software support** platforms (FEMPA, PADS suite, TyreStress viewer etc.);
  - 003 - **Advanced Stress-In-Motion (SIM)** Analyses (New SIM Mk VI);
  - 005 - Advances in **existing testing methods** (LORRI, Strain@Break);
  - 015 - Evaluation of **3D laser device** for determining road aggregates shape and surface properties;

Quantitative analysis Projects – Slide 1:

- ***Quantitative analysis (x 8)***
  - 002 – **Non-traditional additives** / Chemical stabilisers;
  - 004 - Prediction of **fatigue fracture propagation** in high performance concrete pavements (*PhD*);
  - 007 – **Scanning Electron Microscope (SEM)** Techniques for pavement materials analysis;
  - 008 - Possible factors affecting the observed variability in durability of **basic igneous rocks** *(~ PhD);*

Quantitative analysis Projects – Slide 2:

- ***Quantitative analysis (x 8)***
  - 009 - **Secondary cementation of stabilized** materials (recycling / sustainability issues);
  - 010 – Application of **soil mapping** to infrastructure / geotechnical engineering (*MSc / Possible PhD*);
  - 012 - Structural failures **(slopes)** / **risk analysis** of road environment;
  - 013 - **Chemical Properties** (Dielectric Constant) of materials.

006: *Explore:*
- Nanotechnology - pavement engineering

TRB 2007 - Paper & Poster by Prof Steyn (UP): **DEVELOPMENT OF AUTO-LUMINESCENT SURFACINGS FOR CONCRETE PAVEMENTS**

Nanotechnology - pavement engineering

Prof Steyn (UP)

Abstract

- Nanotechnology covers design, construction and utilization of functional structures with at least one dimension measured in nanometers
- This poster focuses on a potential pavement engineering application of nanotechnology where nano-phosphors are utilized to provide auto-luminescent pavements
- Scanning Electron Microscope images and data from luminescence measurements of pavement materials with nano-phosphors embedded are shown and discussed
- This application may potentially lead to the provision of safer and more economical transportation to the traveling public
- Challenges remain and conclusions show that nanotechnology can play a role in improving understanding and service delivery in pavement engineering

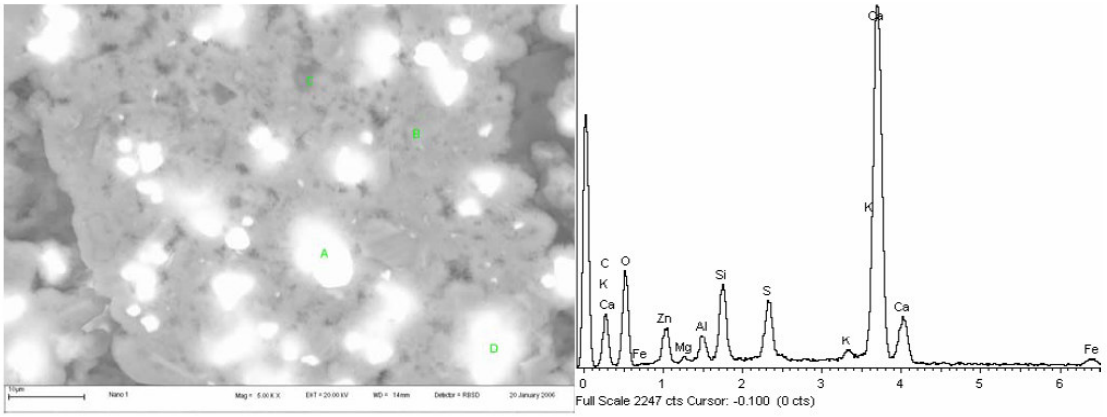
Nanotechnology background

Nanotechnology - pavement engineering

Prof Steyn (UP)

Nanotechnology - pavement engineering

Prof Steyn (UP)



SEM – Constituent Elements of Nano Phosphor

FIGURE 6 a) SEM image (left) of 10 per cent nano-phosphor concrete sample with b) EDX analysis output (right) showing the constituent elements of the nano-phosphor.

Luminescence Decay - Rates.

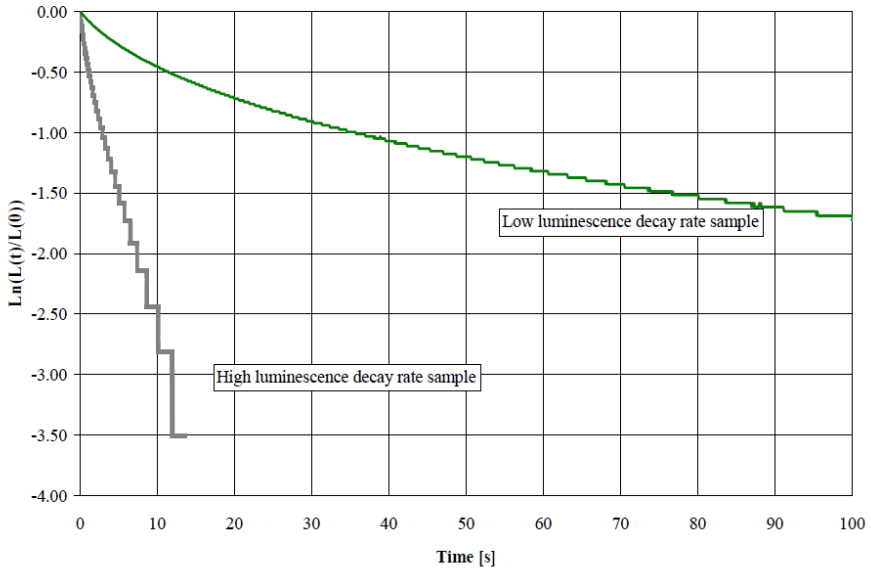


FIGURE 7 Decay curves for sample with relatively low luminescence decay rate and sample with relatively high luminescence decay rate.

Nanotechnology - pavement engineering

Prof Steyn (UP)

Challenges and further work

- **Duration** of luminescent behavior of materials should be increased substantially. Work conducted at Universities of Free State and Zululand currently focuses on these aspects
- Interesting behavior observed with bitumen under loaded conditions (decreasing the luminescent decay rate slightly) are investigated in more detail
- Nano-phosphor / substrate **binding mechanism** should be quantified - either through mechanical bond or chemical bond. Chemical bond should lead to improved durability as the action of vehicle tires should not affect such a bond as much as for a mechanical bond
- **Health and safety** implications of the application of nano-materials in infrastructure requires detailed analysis. Concerns regarding potential leaching of nano-phosphors dislodged from pavement surface through action of vehicle tires into ground water, air and natural environment needs attention
- Issues around **cost of production** and the **quantities of material required** for typical road applications are important and will be addressed later on in the project

011: *Explore:*
- Durability of Stabilized Materials

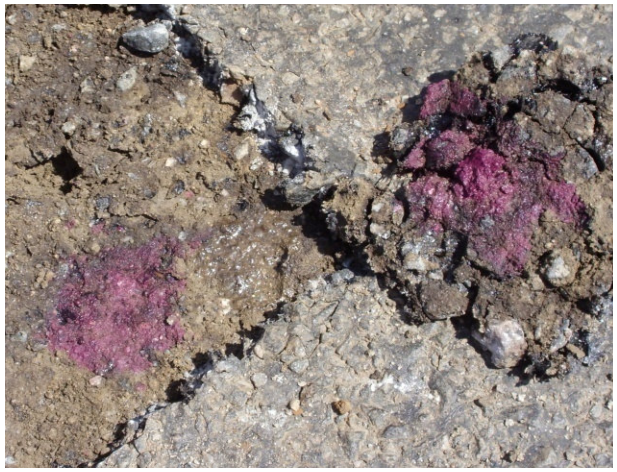
Project Leader: Dr Phil Paige-Green:

- So called “water driven reaction” theory published in 2005 (TREMTI);
- Numerous contractual claims attributed to this “problem”;
- Investigated feasibility/possibility of the reaction;

Durability of Stabilized Materials

Project Leader: Dr Phil Paige-Green:

- 2005 paper full of errors and unsubstantiated/ unscientific statements;
- Carried out extensive additional carbonation and erosion testing and SEM work ;
- Could not recreate situation described in 2005 paper or identify it in the field;



Durability of Stabilized Materials

Project Leader: Dr Phil Paige-Green:

- Paper published at 2010 TREMTI refuting the 2005 paper;
- Other papers on stabilization durability published (SATC, 2008; 12th IACMAG, India, 2008);
- Water driven reaction may be possible but highly unlikely – need to check more sites;
- See http://researchspace.csir.co.za;

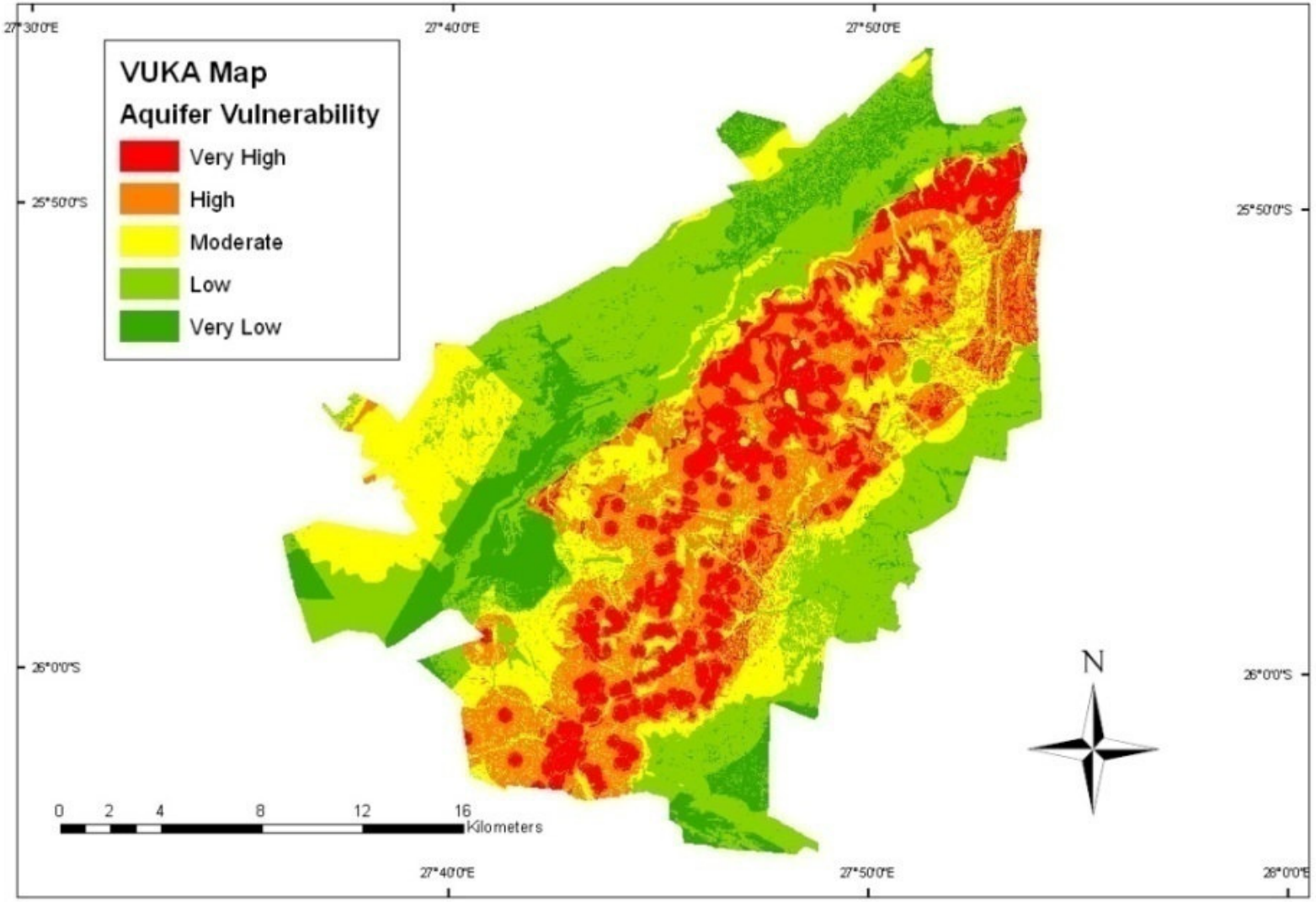
014: *Explore:*
Ground Risk and Hazard Maps

Project Leader: Mr Robert Leyland:

- Karstified dolomites (Karst) terrain vulnerability mapping procedure developed in 2008;
- Only be implemented by town/regional planners if proven effective;
- Karst aquifer vulnerability & risk management plan needed - e.g.Cradle of Humankind World Heritage Site.

Problem identification

Project Leader: Mr Robert Leyland:

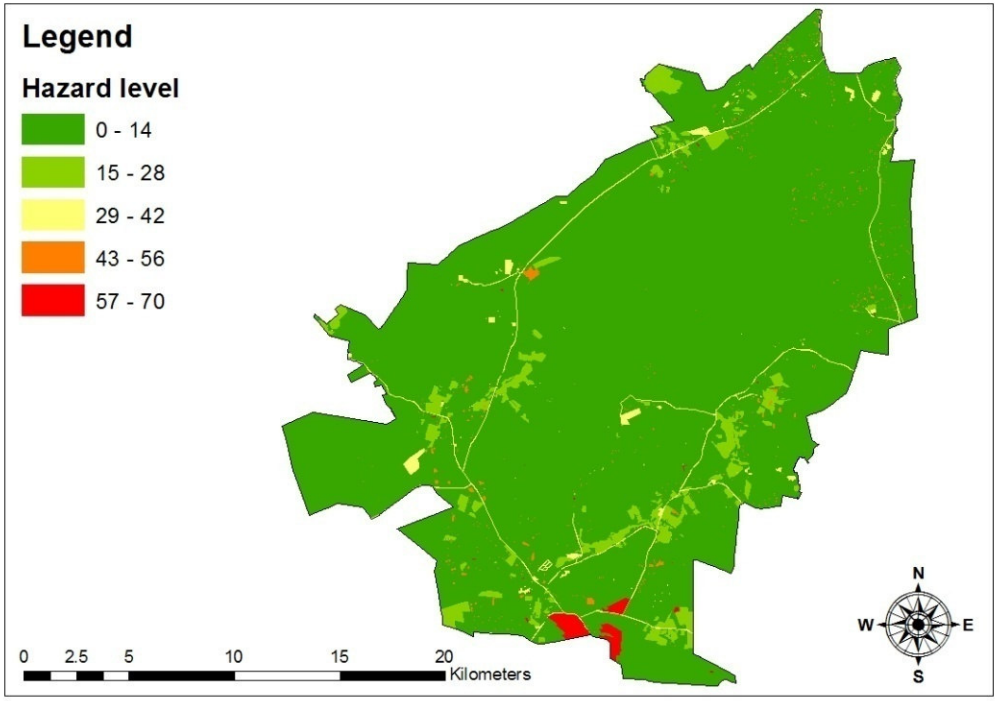


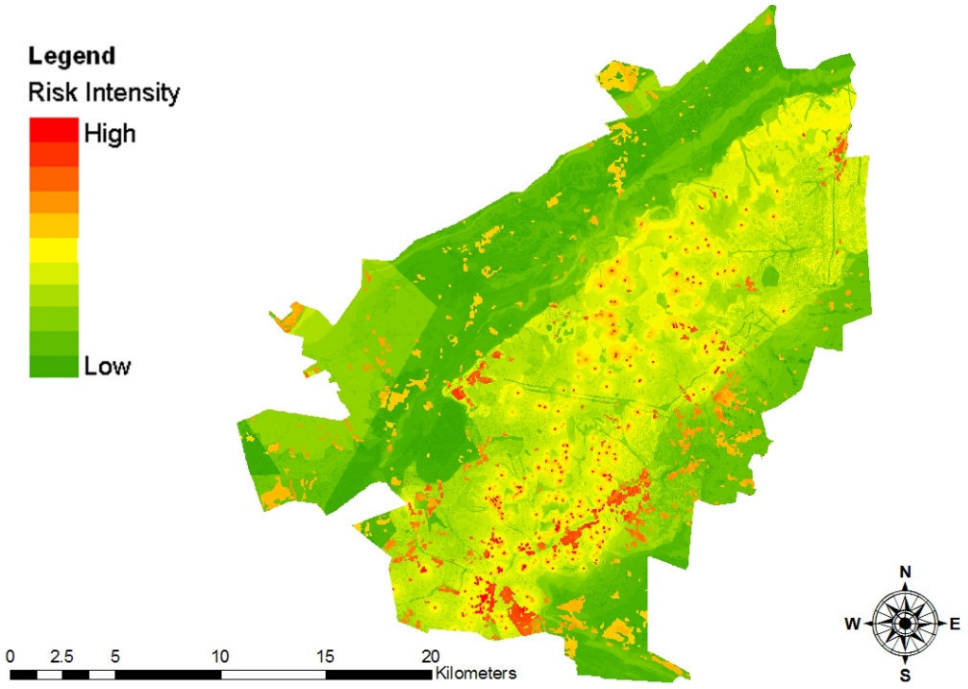
Research outcome

Project Leader: Mr Robert Leyland:

Karst aquifer vulnerability & risk management tools and guidelines:

- Vulnerability map (previous research);
- Hazard and Risk maps.





Outstanding issues

Project Leader: Mr Robert Leyland:

- Integration of tools into active management plan

Potential applications

Use by groundwater resource authorities and land use planners to:

- Identify vulnerable areas;
- Focus monitoring in high hazard (risk) areas;

016: *Explore:*
Modified Binder: Quality Control on Site

Project Leader: Mr Johan O'Connell:

Softening Point = ????

- In South Africa results from binder samples are typically available after 4 – 24 hours after sampling.
- By that time the seal has already been constructed !!!!

Modified Binder: Quality Control on Site

Project Leader: Mr Johan O'Connell:

Consequences of non-compliance for soften point specification

- Too low: insufficient tack depth, insufficient polymer concentration to resist crack reflection;
- Too high: insufficient wetting of the aggregate, i.e. stone loss.

Modified Binder: Quality Control on Site

Project Leader: Mr Johan O'Connell:

For bitumen-rubber this problem is overcome by use of a portable hand-held **Rion Viscometer**.

Rion Viscometer **is not an option for SBS- or SBR-** modified binder at spray temperature because:

Rion Viscometer is not discerning enough at the ***lower viscosities*** of SBS and SBR-modified binders

- ***The Softening point / Viscosity relationship is not consistent*** – especially for polymer-modified binders

Modified Binder: Quality Control on Site

Project Leader: Mr Johan O'Connell:

Extensive international literature search has indicated that there is ***currently no portable, battery-operated site equipment that will give a reliable estimate of the softening point of polymer-modified within 15 minutes of sampling.***

Therefore, a market need (national and international) for developing such equipment does exists.

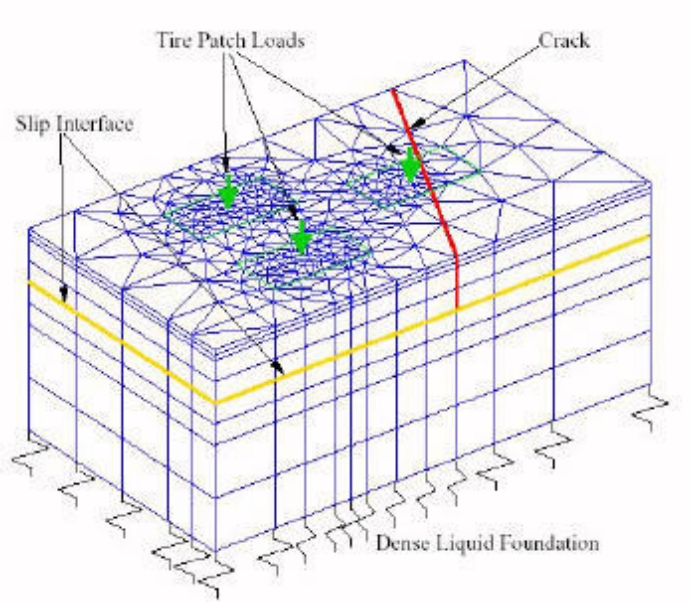
001: *Experimental Development:*

Project Leader: Prof Morris De Beer:

- ***Experimental development (x 4)***
  - Development of **software support** platforms (FEMPA, PADS suite, TyreStress viewer etc.);
  - Software Benchmark Paper at SATC 2008
    (Maina, Denneman and De Beer)

001: Finite Element Method for Pavement Analysis: **FEMPA…**

- Finite Element Method (FEM)
  - Used in local pavement engineering since 1970s, Computational expensive, Allows for:
    - Dynamic vehicle/pavement interaction,
    - Realistic pavement structure geometry, and
    - Non-linear material properties.



- Latest: FEMPA (Finite Element Method for Pavement Analysis)
  - 2-D plane strain, plane stress, axi-symmetric, 3-D

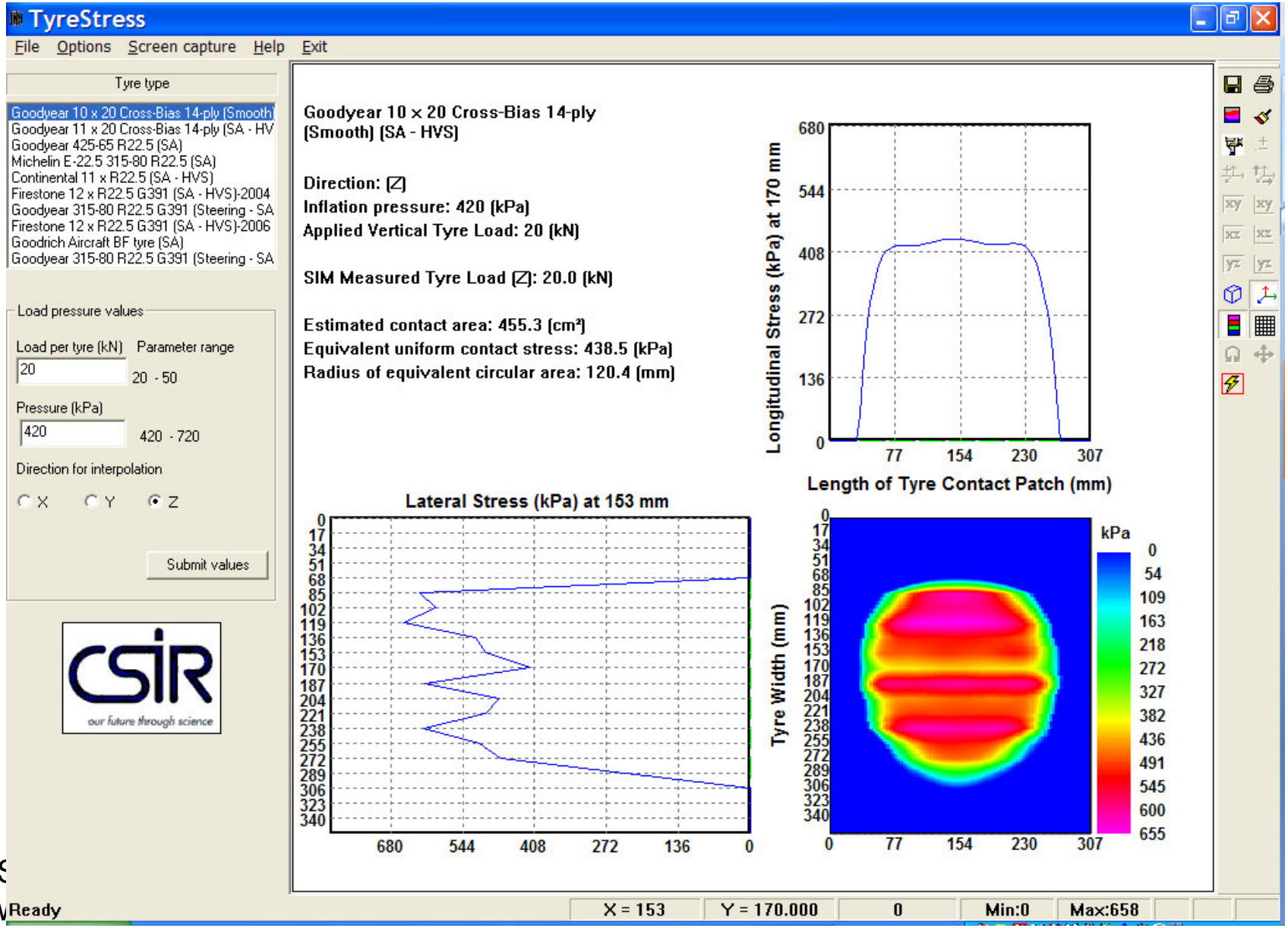
003: *Experimental Development:*
- Advanced Stress-In-Motion (SIM) Analyses

Project Leader: Prof Morris De Beer:

- Development of Framework for TyreStress software packages for tyre data viewing by interpolation (Beta version-linked with SANRAL Project);
- Design Pack for SIM Mk VI;
- Technology demonstrator - SIM Mk VI (with WIM capabilities).

Example of TyreStress Viewer:

Project Leader: Prof Morris De Beer:



Example of TyreStress Viewer: Tyre Modeling

Project Leader: Prof Morris De Beer:

Goodyear 315-80 R22.5 G391
(Steering - SA)-2006

Direction: (Z)

Inflation pressure: 520 (kPa)

Applied Vertical Tyre Load: 20 (kN)

SIM Measured Tyre Load (Z): 20.4 (kN)

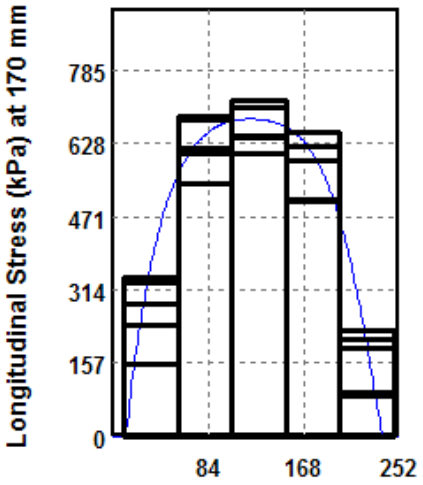
Estimated contact area: 510.5 (cm²)

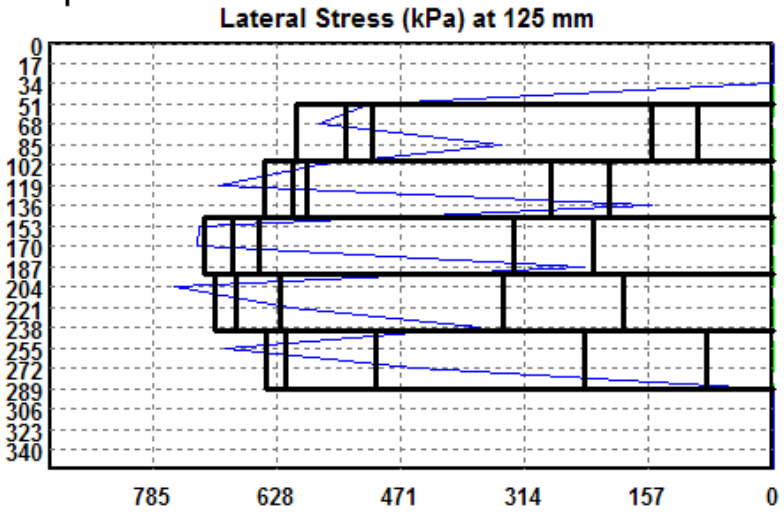
Equivalent uniform contact stress: 399.8 (kPa)

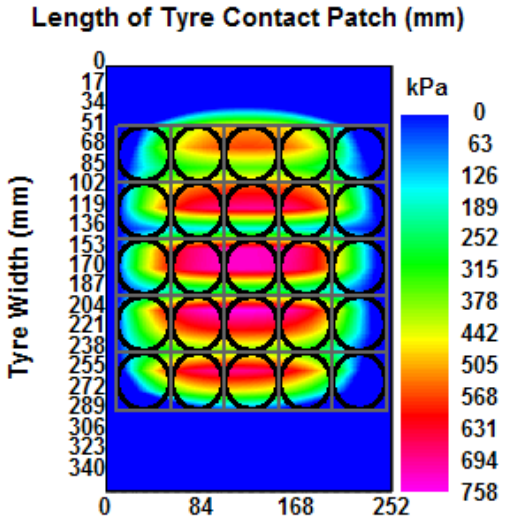
Radius of equivalent circular area: 127.5 (mm)

Sum of circular areas (25) = 444.9 (cm²)

Multiple Discs

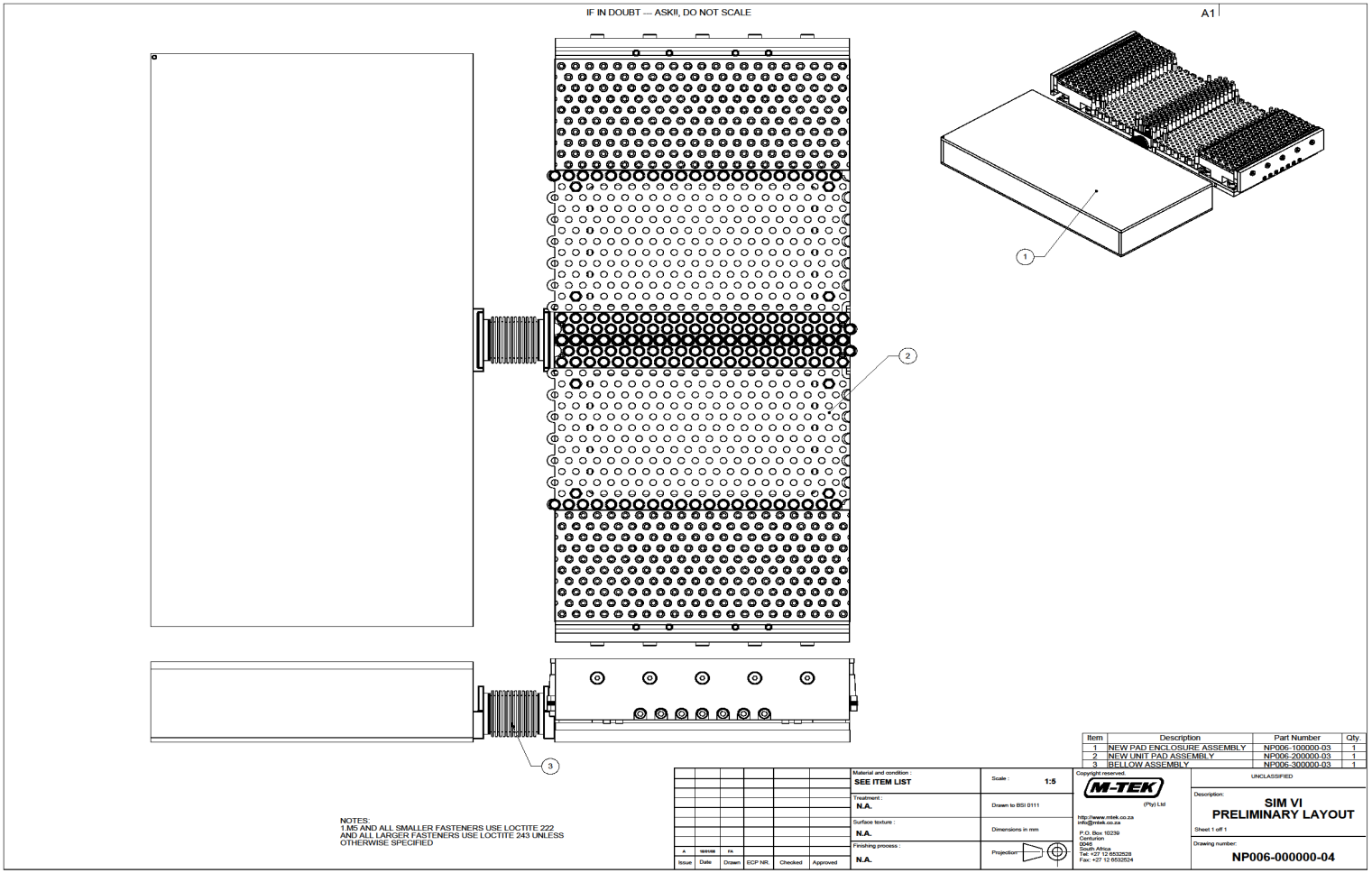






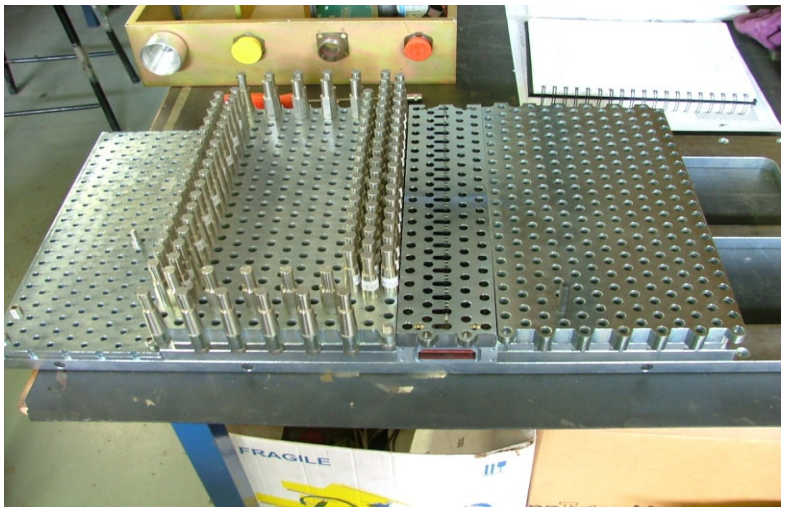
New SIM Mk VI Schematics(1): Advanced SIM System (2 x WIM now included)

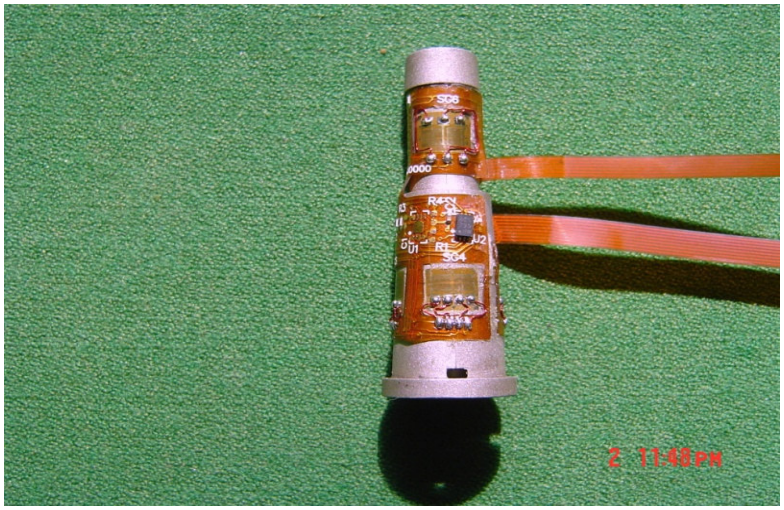
Project Leader: Prof Morris De Beer:

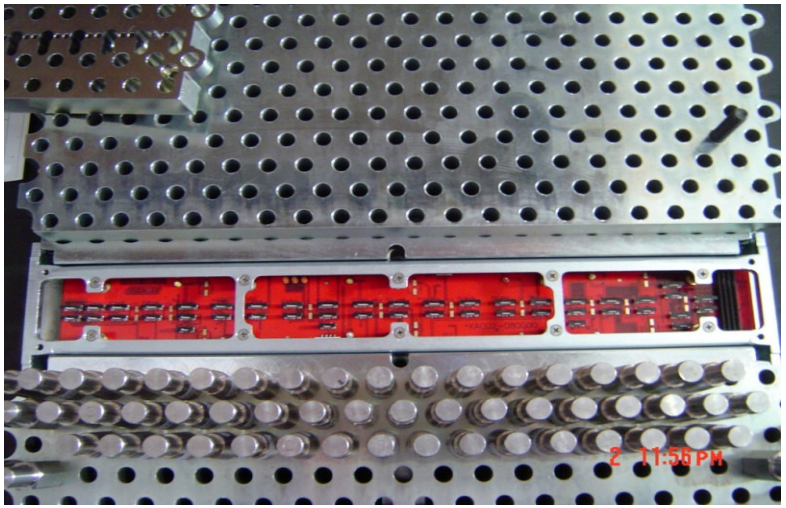


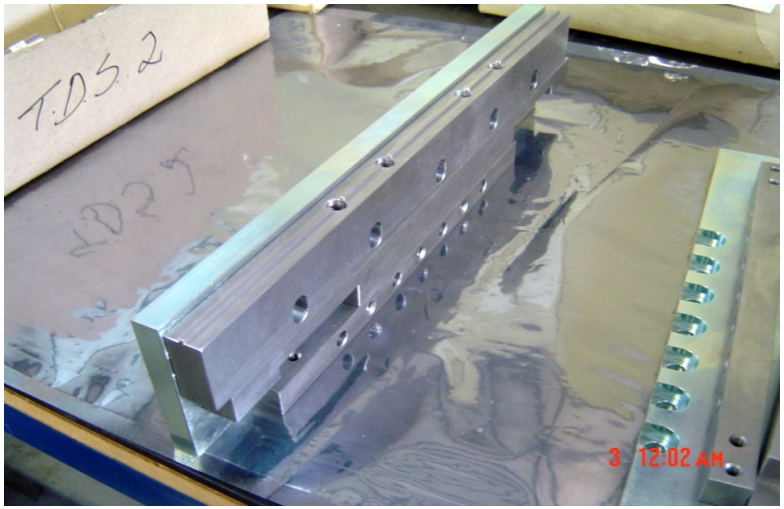
New SIM Mk VI – some parts: Advanced SIM

Project Leader: Prof Morris De Beer:









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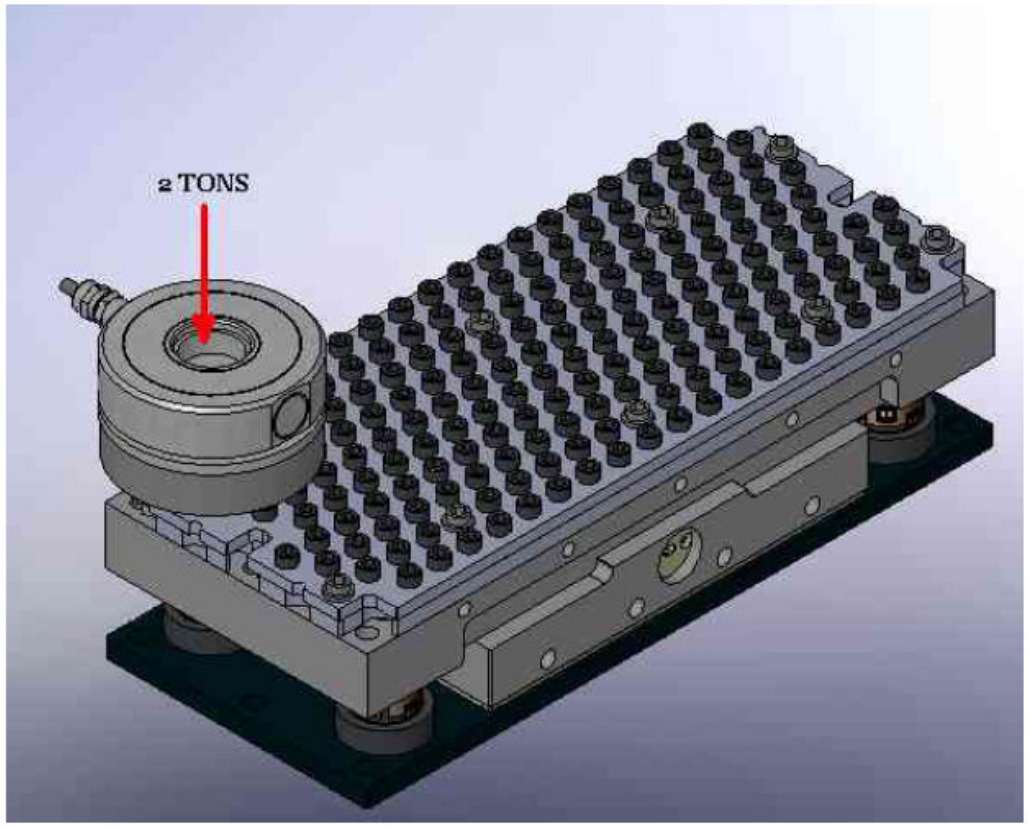
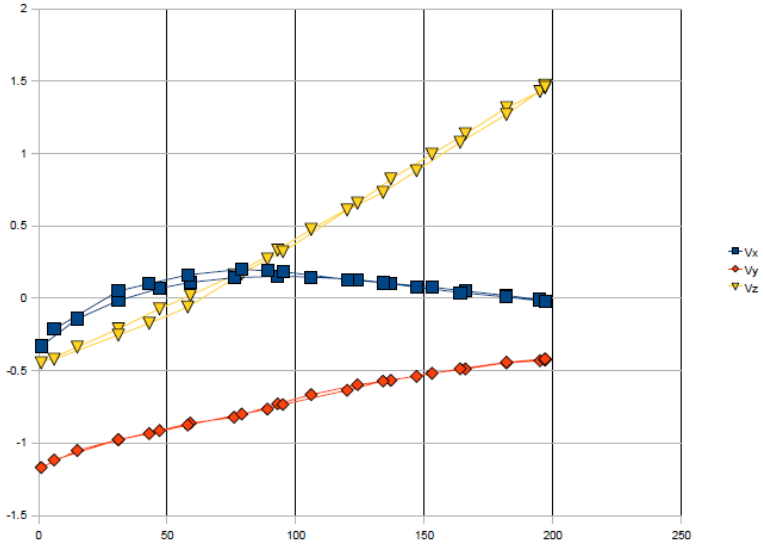
New SIM Mk VI – some new parts: Advanced "WIM-SIM" system

Project Leader: Prof Morris De Beer:



Total Load Sensor (TLS)



005: *Experimental Development:* Advances in existing testing methods

Project Leader: Dr Martin Mgangira:

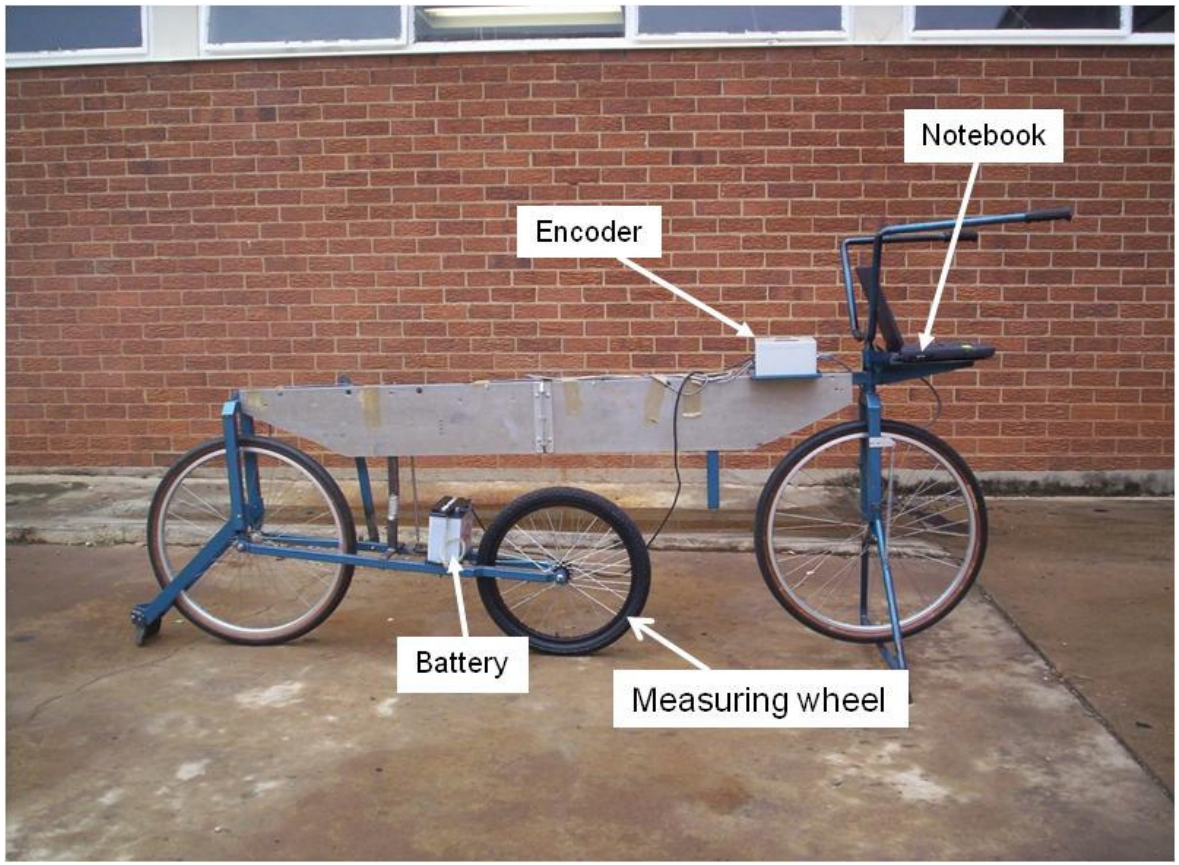
- Low Cost Road Roughness Integrator (LORRI);
- Road Maintenance Kit;
- Strain @ Break device;

The Low Cost Road Roughness Integrator (LORRI)

Project Leader: Dr Martin Mgangira:

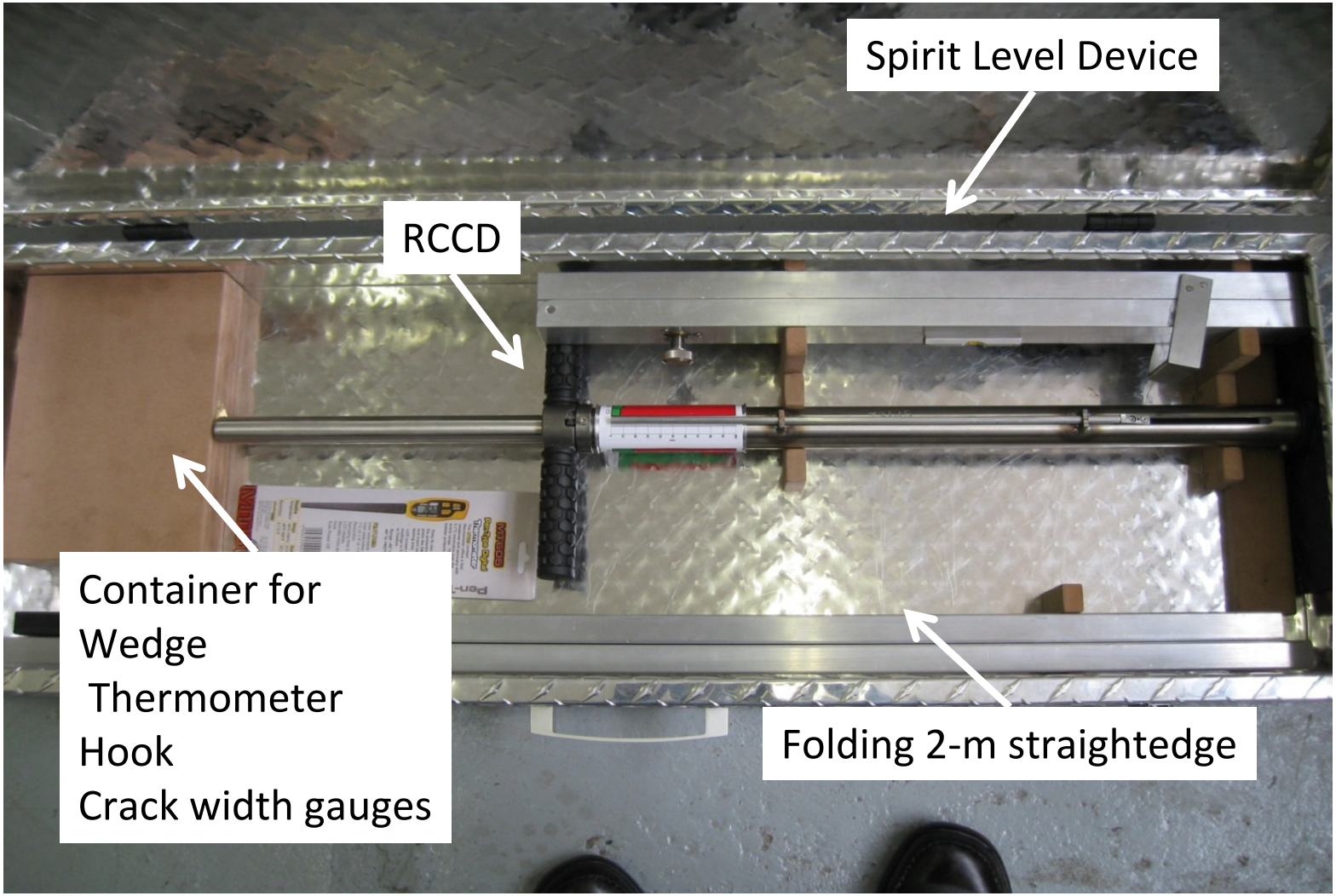
The LORRI is a tool to monitor the quality of short sections of paved or unpaved roads by measuring the surface profile.

The LORRI (Calibration issues not complete…)



Road Maintenance Kit (Market ready)

Project Leader: Dr Martin Mgangira:



Strain-at-Break device (Technology Package ready)

Project Leader: Dr Martin Mgangira:

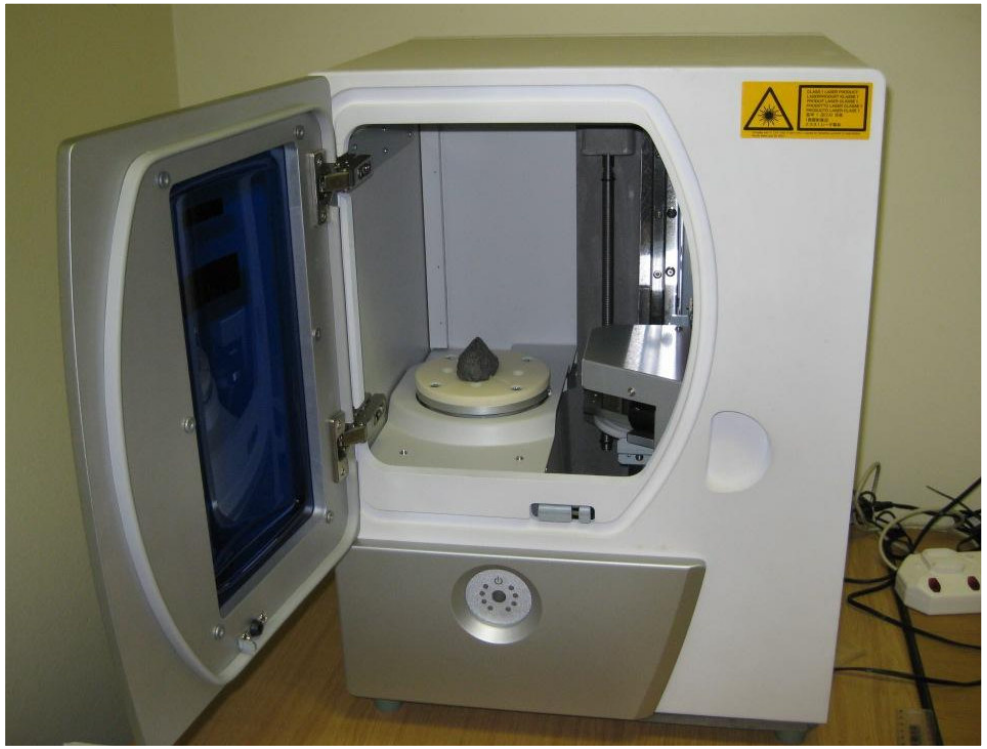
015: *Experimental Development:* Laser based aggregate research

Project Leader: Dr Joseph Anochie-Boateng:

- Develop a strong platform in the areas of:
  - Accurate and reliable measurement of aggregates properties
  - Data collection, analysis, modelling & simulation of aggregates surface and shape properties
- Evaluate impact of aggregate surface and shape properties on the performance of road pavements

Application of 3D laser technology in roads and airfield pavements (new 3D Scanner)

Project Leader: Dr Joseph Anochie-Boateng:



Aggregate Particle shape & Surface

Project Leader: Dr Joseph Anochie-Boateng:

- Rock aggregates constitute about 80 to 90% by mass of materials in seal, asphalt and concrete roads.
- There is no direct and objective measurements of the aggregate particle shape and surface properties
- Existing guidelines and test methods use empirical
- There is a need to use precise, cost effective innovative technology to determine aggregate shape and surface characteristics to ensure good performance of seal, asphalt and concrete roads;

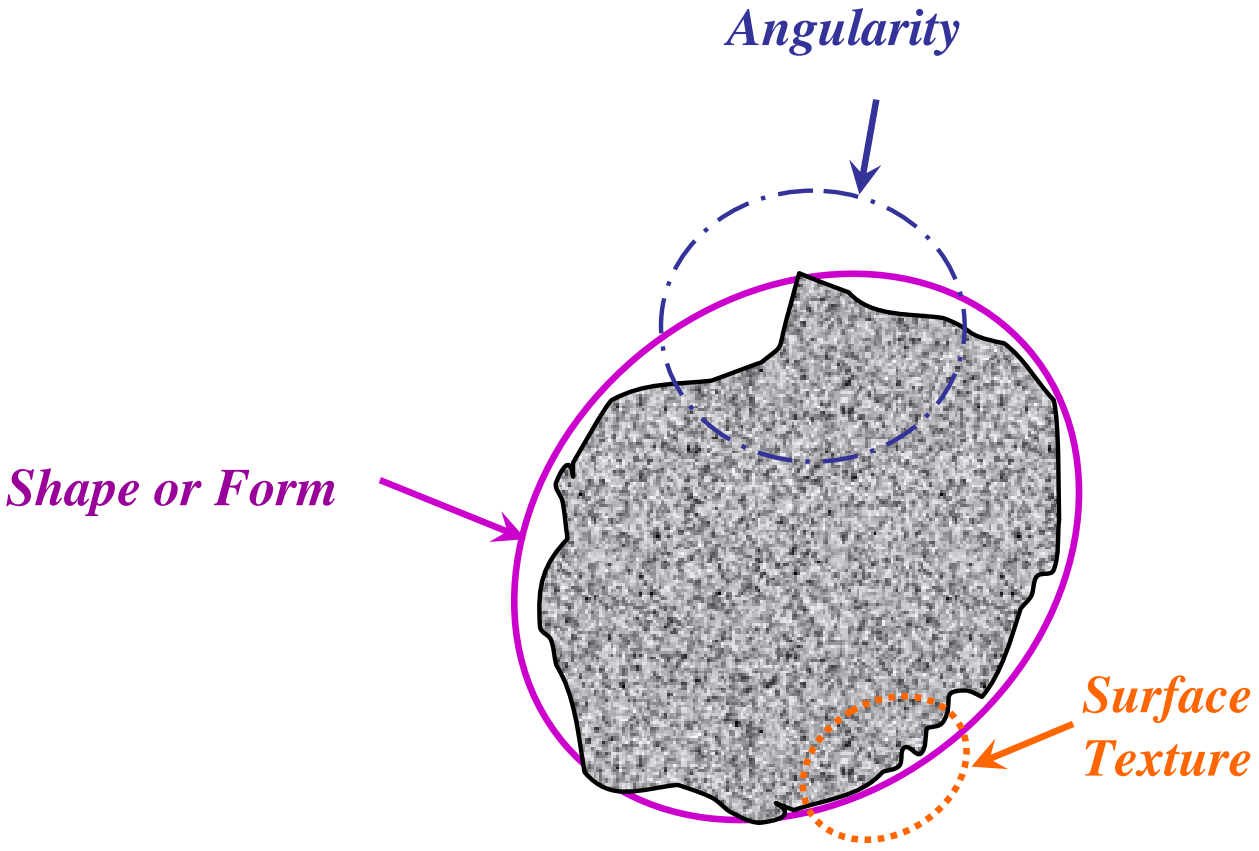
Why focused on aggregates characteristics ?

Project Leader: Dr Joseph Anochie-Boateng:

- **Coarse aggregates influence pavement performance and relate to:**
  - Permanent deformation;
  - Bearing capacity /shear resistance – strength;
  - Skid resistance;
  - Stiffness, fatigue resistance, etc;

Three key characteristics of rock aggregates that need investigation

Project Leader: Dr Joseph Anochie-Boateng:



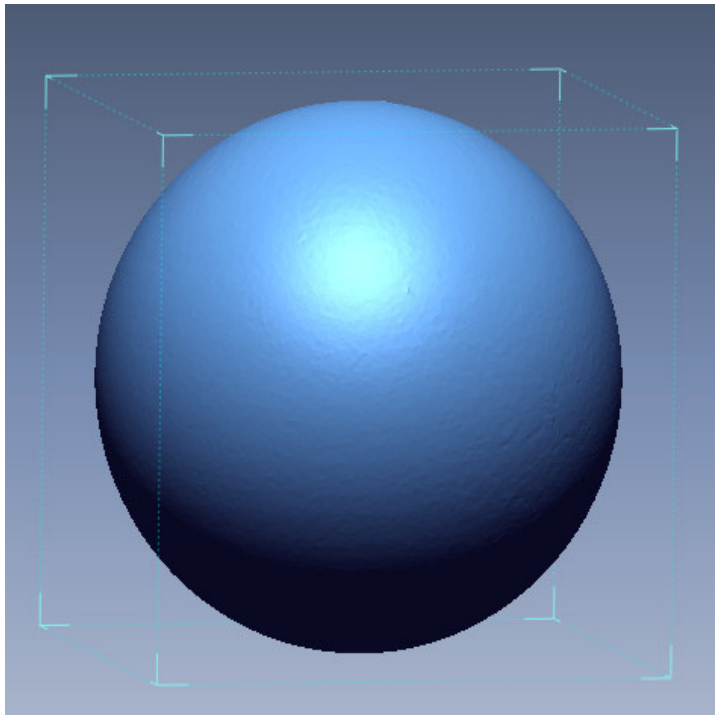
Roughness or irregularity at a micro level in contrast with angularity at a macro level

Project Leader: Dr Joseph Anochie-Boateng:

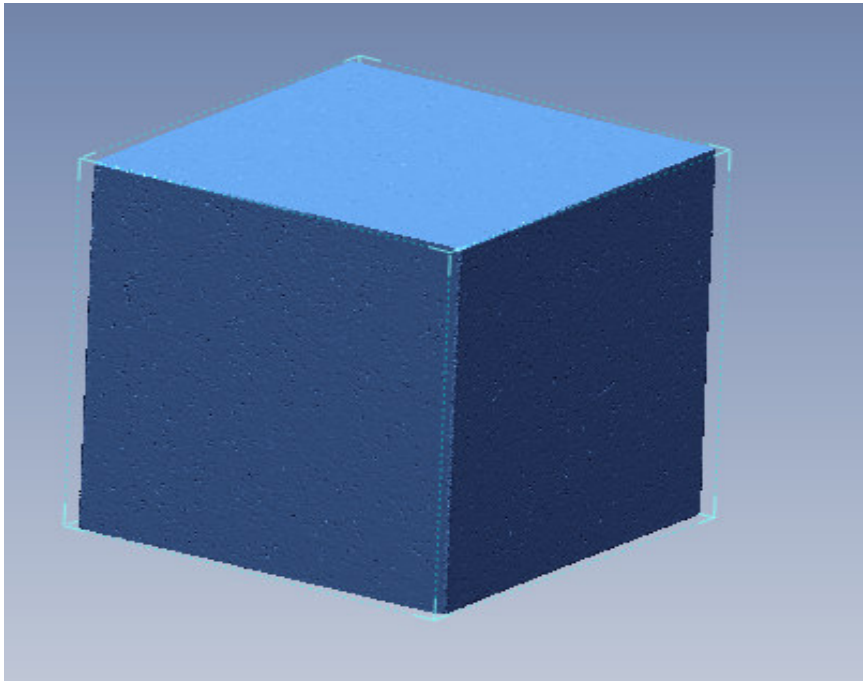
Existing standard test methods classify these three groups of aggregates as 19 mm size..!

Evaluation: Objects with known dimensions

Project Leader: Dr Joseph Anochie-Boateng:



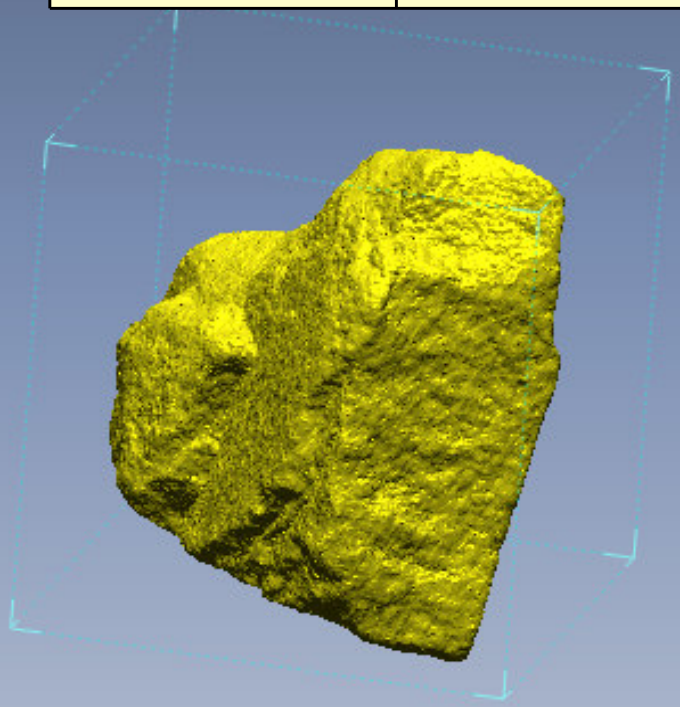
Theoretical S.A. (m^2))	Measured S.A. (m^2))
126.6	127.09

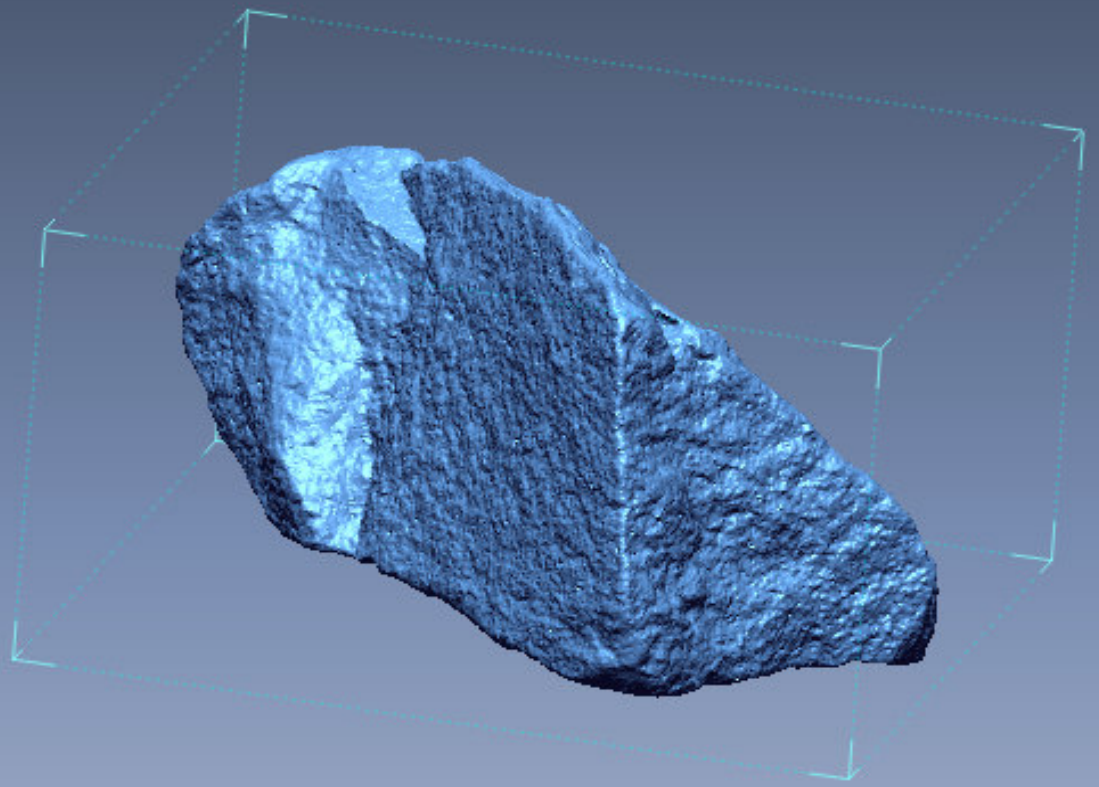


Theoretical S.A. (m^2)	Measured S.A. (m^2))
150	150.05

Project Leader: Dr Joseph Anochie-Boateng:

Surface Area	38.15 cm^2
Volume	14.83cm^3
Bonding box (mm)	Width =34.87
	Height =62.64
	Depth = 31.38





Surface Area	65.97 cm^2
Volume	27.19 cm^3
Bonding box	Width =62.15 mm
	Height = 56.51 mm
	Depth = 33.52 mm

Expected research outcomes

Project Leader: Dr Joseph Anochie-Boateng:

- Correlations and realistic criteria relating aggregate properties to pavement performance
- Advanced modelling and simulation of aggregates in roads and airfield pavements
- Specifications and guidelines for aggregate shape, angularity, surface texture for South Africa road aggregate materials

002 & 007: *Quantitative analyses*
Chemical stabilisers: Enzyme-based

Project Leader: Dr Martin Mgangira:

Problem identification

Limited and independent local knowledge on the performance of materials treated with **enzyme-based products** and guidelines for their effective use.

Research outcome/output

The focus was on how to provide documented and independent evidence of the **performance of these products** for use in road construction.

Chemical stabilisers: Enzyme-based

Project Leader: Dr Martin Mgangira:

Methodology

Execution of laboratory testing on marginal materials, considering **two enzyme-based additives**, additive quantity, curing period through tests such as compaction, unconfined compression test, abrasion, erosion and limited triaxial as well as use of advanced equipment in material characterisation: **Scanning Electron Microscope (SEM), X-Ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR)** to characterise the treated materials

Chemical stabilisers: Enzyme-based

Project Leader: Dr Martin Mgangira:

Potential application/outstanding issues

- The recommendations should assist government and non-governmental organisation as well as engineers to enable them make **informed decisions** in the use of enzyme-based products.

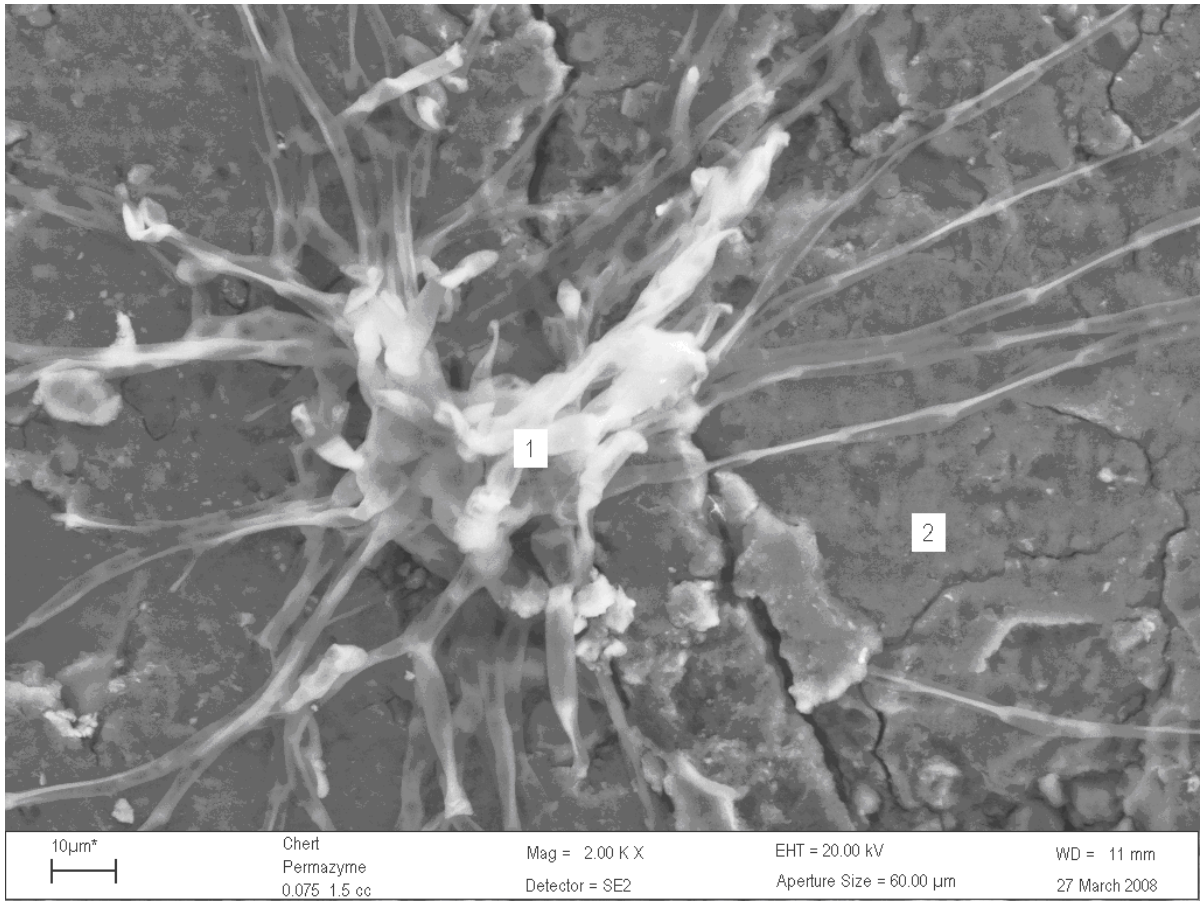
- There still exists the problem that the **performance of these products is not consistent.**

- **Their use is limited** and they are not a universal solution to the treatment of marginal materials as the manufacturers of these products want the industry to believe.

Enzyme-based : SEM (1)

Project Leader: Dr Martin Mgangira:

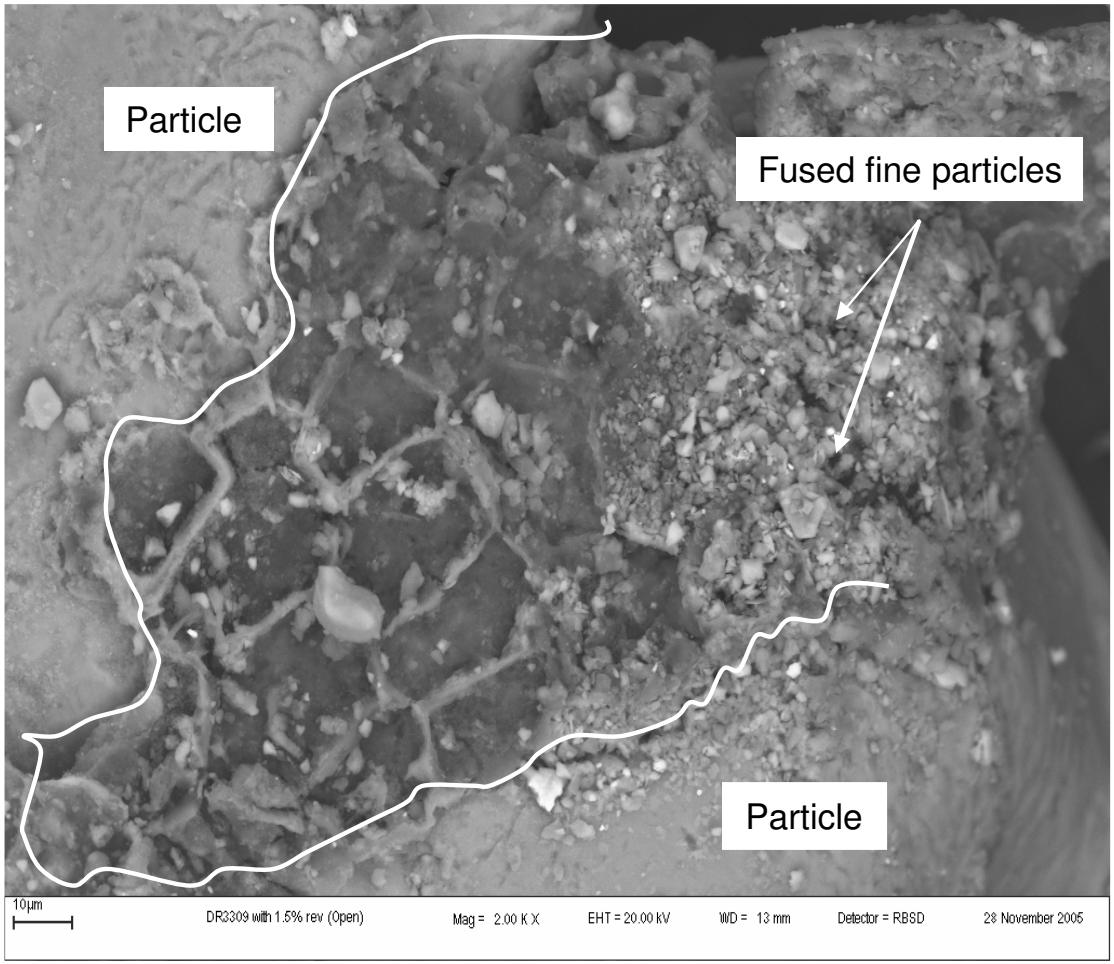
An example of SEM analysis: Microstructure characteristics of sample of a soil treated with enzyme-based liquid chemical stabilizer at 2000 x magnification - see "*Dendrites like* "..



Enzyme-based : SEM (2)

Project Leader: Dr Martin Mgangira:

Image from SEM showing particle **bonding** of sandy soil after treatment



004: *Quantitative analyses*
Ph.D. Fatigue damage evolution in UTCRCP

Project Leader: Mr Erik Denneman:

Problem statement:

Current concrete pavement design methods lack a mechanistic approach to prediction of ***fatigue crack formation and propagation.***

Objective:

Develop improved methodology for prediction of fatigue damage to UTCRCP based on fracture mechanics principles.

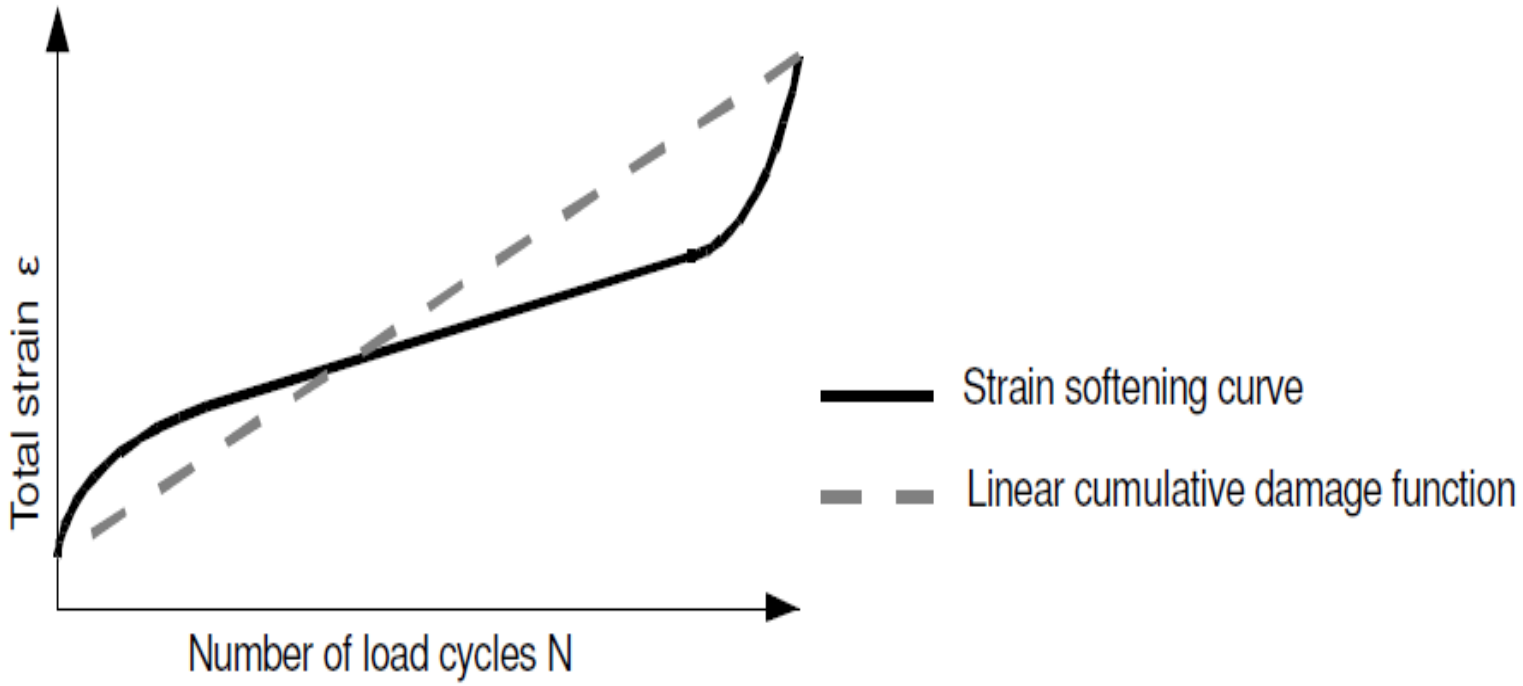
[UTCRCP: ultra-thin continuously reinforced concrete pavement]

Ph.D. Study on fatigue damage evolution in UTCRCP

Project Leader: Mr Erik Denneman:

Why fracture mechanics ?

- Crack propagation depends on energy dissipation,
- Quasi-brittle materials subject to size-effects

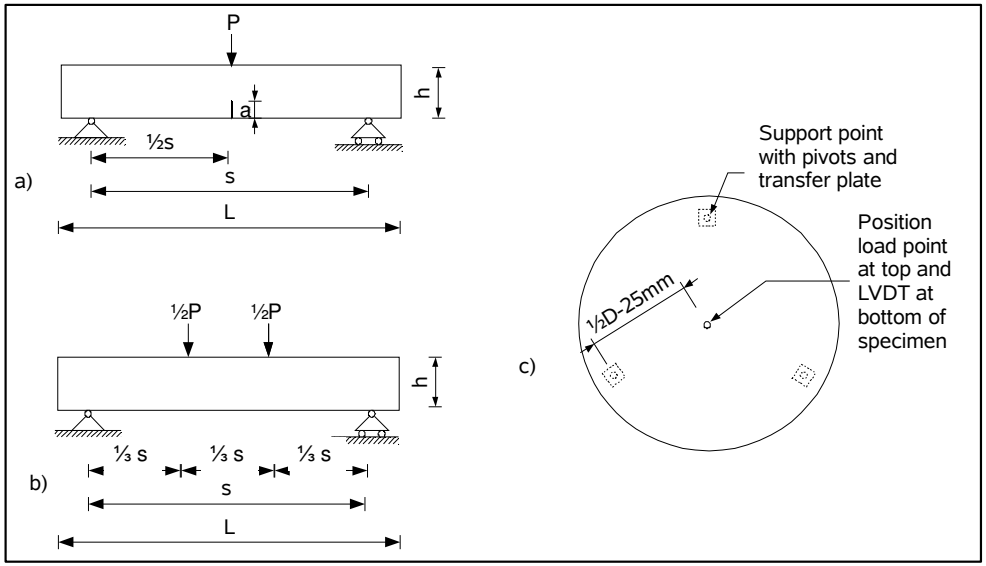


Experiments and analysis

Project Leader: Mr Erik Denneman:

Monotonic and cyclic testing at Univ. Pret. and Univ. Cal. Davis

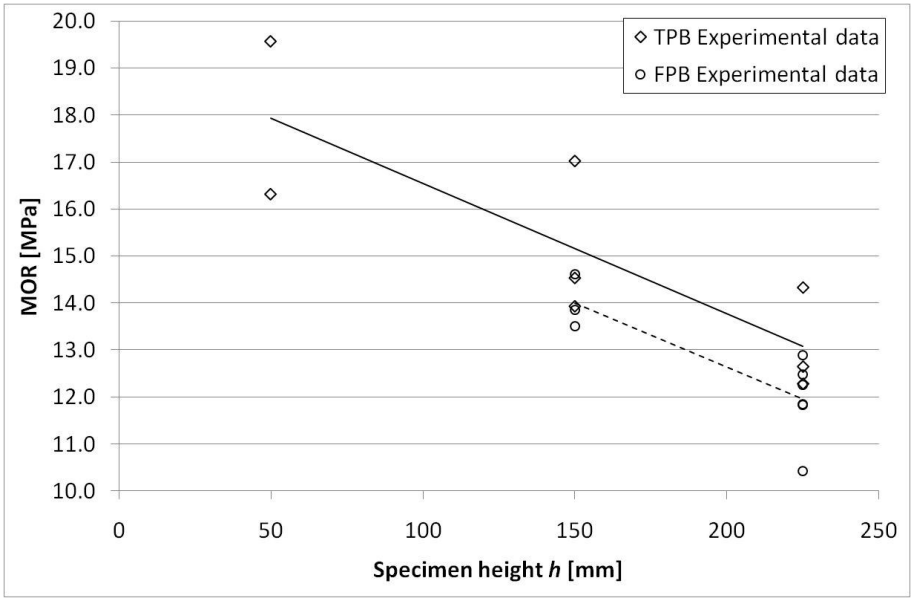
- Various specimen geometries and mix designs,
- Size-effect study,
- Numerical simulation of tests using fracture mechanics,
- Prediction of fatigue performance using fracture mechanics properties from monotonic tests.

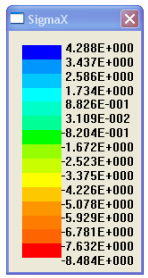


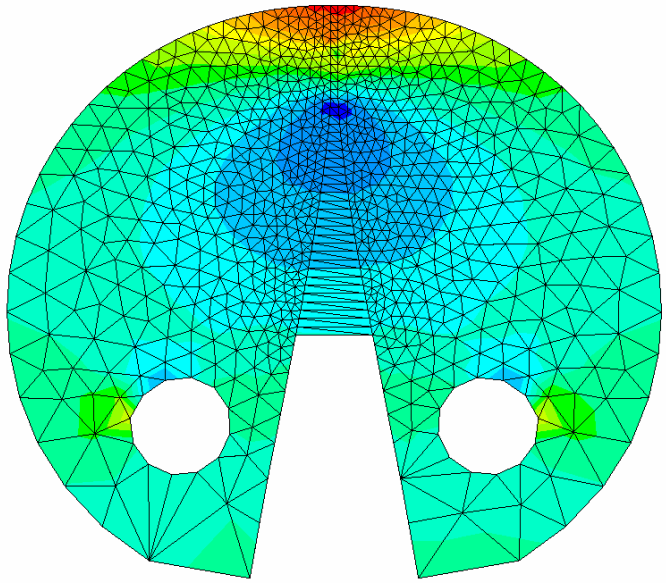
Progress and outcomes to date

- Monotonic tests completed,
- Cyclic testing 50 % complete,
- Significant size-effect in Modulus of Rupture (MoR) of Fibre Re-inforced Concrete (FRC) shown,
- Split cylinder test adjusted for FRC,
- Fracture mechanics knowledge now being applied to Hot Mix Asphalt (HMA) as well

Project Leader: Mr Erik Denneman:







008: Quantitative analyses

Project Leader: Mr Robert Leyland:

POSSIBLE FACTORS AFFECTING THE OBSERVED VARIABILITY IN DURABILITY OF ***BASIC IGNEOUS ROCKS*** ***(towards PhD)***

Problem identification

Project Leader: Mr Robert Leyland:

- Currently only one laboratory test (dependant of layer)
- Basic igneous rocks that meet the requirements often seen to perform variably and unacceptably
- Performance history shows tests are not analyzing all the durability factors

Research outcome

Project Leader: Mr Robert Leyland:

- Comprehensive literature review;
- Preliminary sampling and testing;
- Assistance with road failure investigations.

Outstanding issues

Project Leader: Mr Robert Leyland:

- *Poor* construction records;
- Link between materials and source locations
- ***Potential Applications:***
  - Test methodology for consistent identification of materials with poor durability;
  - Prevent *premature failure* of roads.

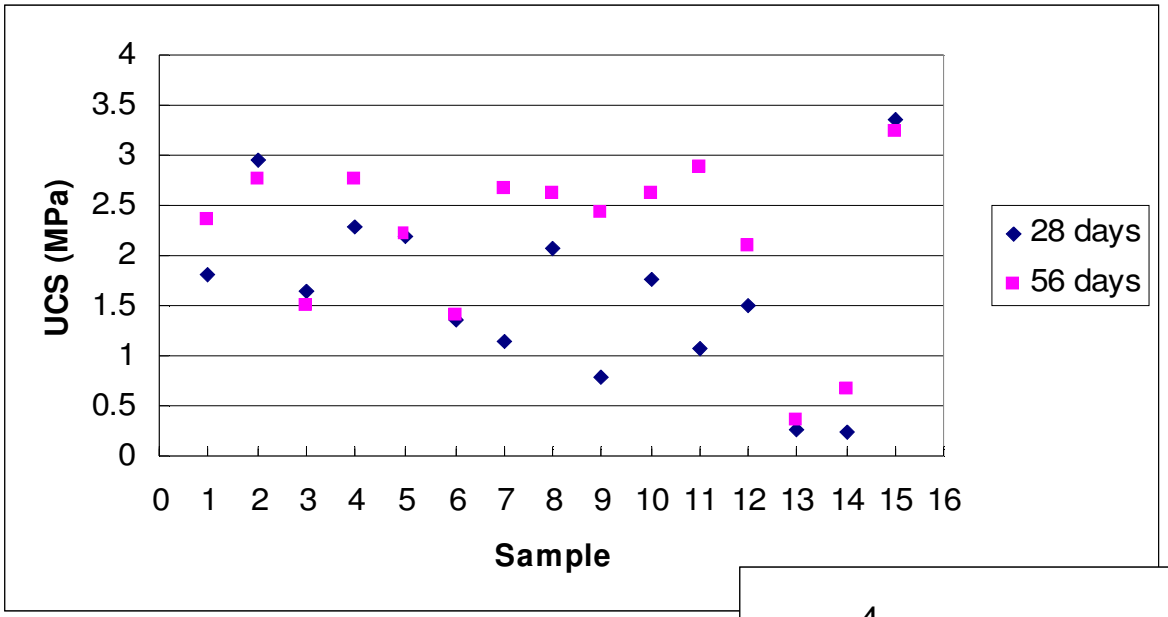
009: *Quantitative analyses*
Secondary cementation

Project Leader: Dr Phil Paige-Green:

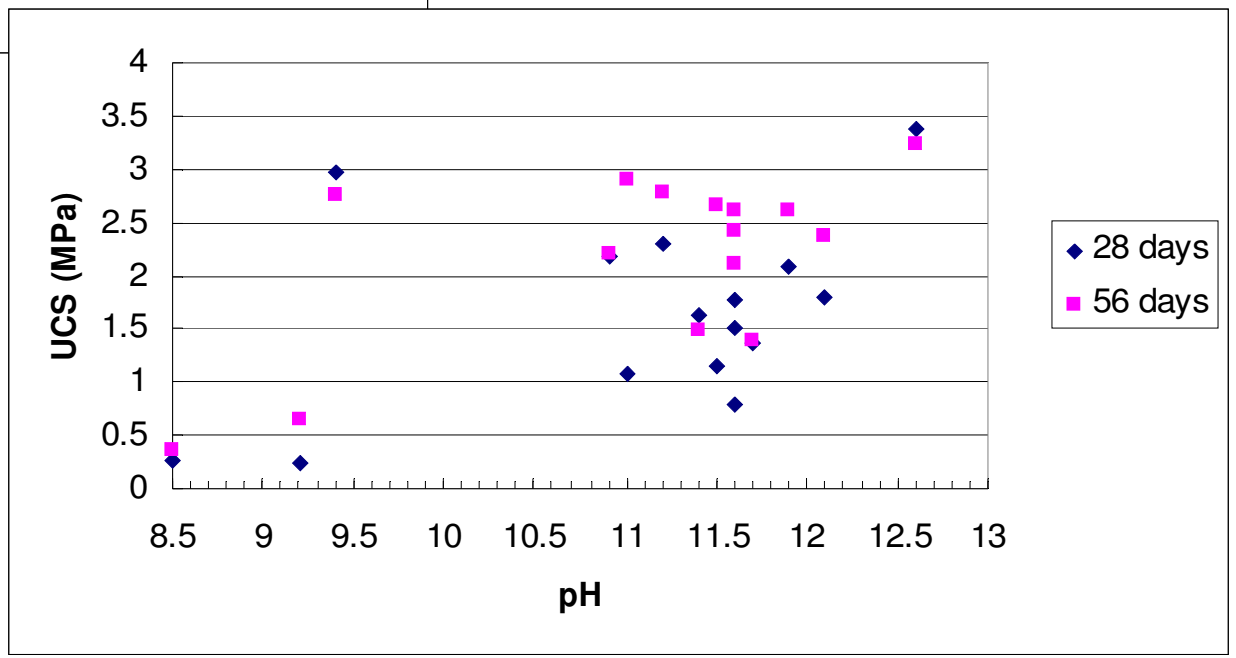
- Followed from the *re-cementation* caused by residual stabilizer observed on N12;
- 14 x samples collected from all over and tested without additional stabilizer:
  - Previously stabilized roads (> 25 years old);
  - Concrete rubble (30 to 54 years old);
  - Construction & demolition waste;
- Tested UCS after 28 and 56 days.

Some *Interim* Results….

Project Leader: Dr Phil Paige-Green:



Increase in UCS over time -Strong linked with pH



Conclusions

Project Leader: Dr Phil Paige-Green:

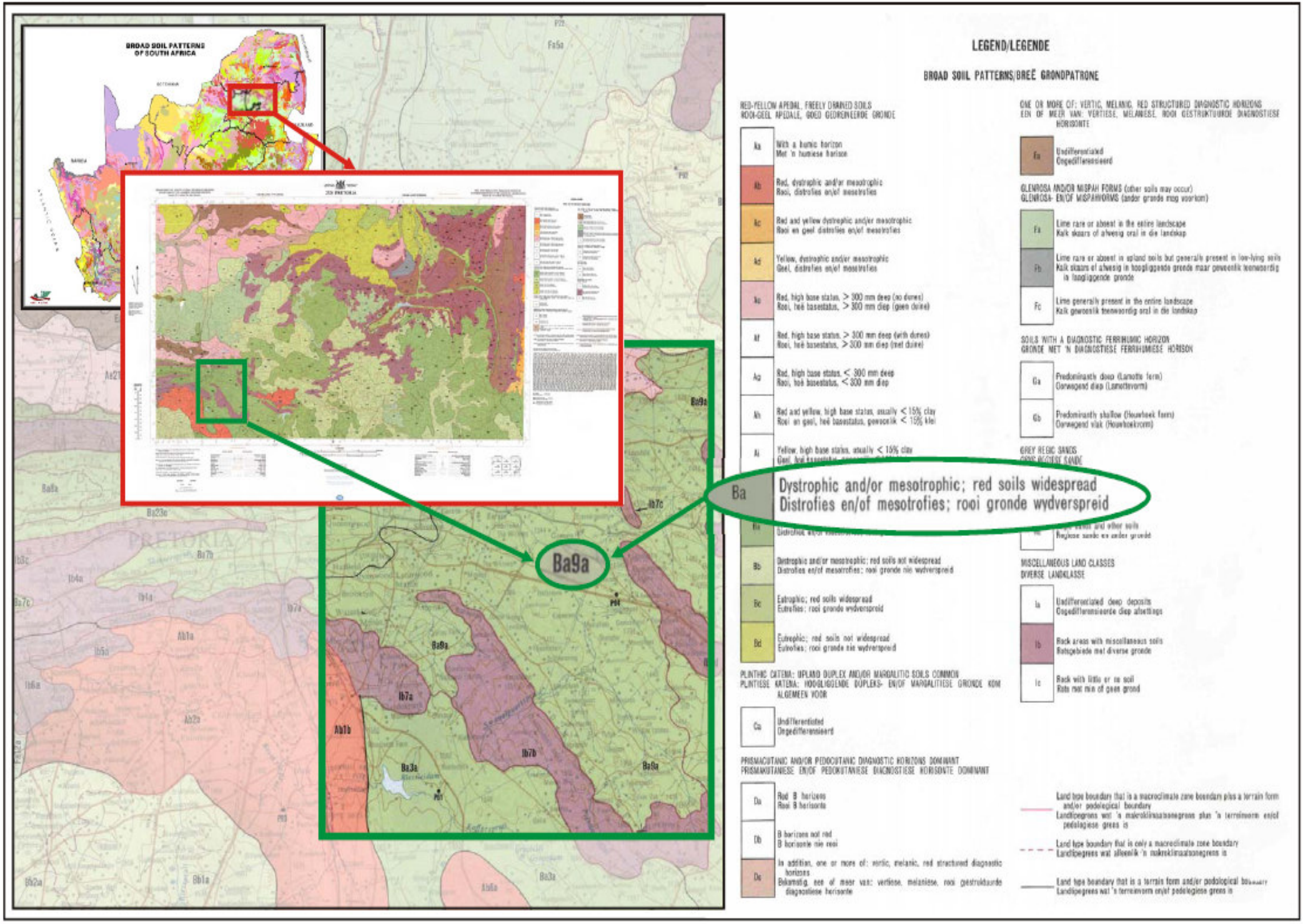
- Definite and strong reactions;
- pH > ±10.5 will “guarantee” 28 day UCS > 750 kPa;
- Important when looking at recycling and re-stabilization of failed road pavement sections:
  - Q: Do we add additional stabilizer and how many times can we do this ?

010: *Quantitative analyses*
Soil mapping: Geotechnical Engineering

Project Leader: Dr Phil Paige-Green:

- The entire area of South Africa has had soils mapped to a depth of about 1.2 m (Agricultural Research Council, (ARC));
- The maps are accompanied by test results (agricultural & engineering);
- BE developed techniques to use this information as preliminary identification of engineering; ;problems for road sub-grades and infrastructure
- Cross checked with field profiles – good agreement.

APPENDIX A 1: Overview example of the 1 : 250 000 Land Type Map 2528 Pretoria (1° x 2° size). The Land Type Ba9 and its legend description are highlighted, while background location is visible. A Broad Soil Pattern map is inset.



APPENDIX A 2: Overview example of the technical Land Type Inventory Ba9 (Ba = Plinthic Catena: Dystrophic and Mesotrophic soils; red soils widespread) listing terrain units, soil series, selected soil properties and a Modal Profile Number for associated laboratory analyses.

LAND TYPE / *LANDTIPE* ..... Ba9 ← Land Type Number

CLIMATE ZONE / *KLIMAATSONE* ..... 26S ← Climate Zone

Area / *Oppervlakte* ..... : 45310 ha

Estimated area unavailable for agriculture

Beraamde oppervlakte onbeskikbaar vir landbou : 500 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte :*

2528 Pretoria (45310 ha)

Inventory by / *Inventaris deur :*

J L Schoeman

Modal Profiles / *Modale profiele :*

P94 ← Modal Profile

Contact the ARC-ISCW for English description of the soil type

Terrain unit / *Terreineenheid*	1	3	4	5
% of land type /% *van landtipe*	15	50	30	5
Area / *Oppervlakte (ha)*	6796	22655	13593	2266
Slope / *Helling (%)*	3 - 8	4 - 15	2 - 6	0 - 1
Slope length / *Hellingslengte (m)*	100 - 300	200 - 500	100 - 400	50 - 150
Slope shape / *Hellingsvorm*	Y	Y-X	X	X
MB0, MB1 (ha)	0	10195	12234	2266
MB2 - MB4 (ha)	6797	12460	1359	0

← List of Soil Series

Soil series or land classes / *Grondseries of landklasse*	**Depth** / *Diepte* (mm)	MB	ha	%	ha	%	ha	%	ha	%	**Total** / *Totaal* ha	%	**Clay content %** / *Klei-inhoud %* A	E	B21	Hor	**Texture** / *Tekstuur* Class / *Klas*	**Depth limiting material** / *Diepte-beperkende materiaal*
Soil-rock complex																		
Grond-rotskompleks:																		
Rock/Rots		4	3398	50	4531	20					7929	17.5						
Mispah Ms10, Trevanian Gs17, Southwold Cv26	100-400	3	2718	40	4531	20					7250	16.0	15-25			A	meSaLm-SaClLm	R,so,lc
Msinga Hu26, Hutton Hu16	500-1200+	0			4531	20	1359	10			5890	13.0	20-30		20-35	B	fi/meSaClLm	so,hp
Mispah Ms10, Klipfontein Ms11, Trevanian Gs17, Williamson Gs16	150-400	3	680	10	3398	15	1359	10			5437	12.0	15-30			A	meSaLm-SaClLm	R,lc,hp
Doveton Hu27, Vimy Hu28, Argent Sd11, Richmond Sd12	450-1200+	1			1133	5	3398	25			4531	10.0	30-45		35-60	B	fiSaCl-ClLm-Cl	so
Longlands Lo21, Albany Lo22, Wasbank Wa21, Warrick Wa22	600-1200+	0					2719	20	227	10	2945	6.5	10-20	10-20		A	LmmeSa-SaLm	sp,hp
Southwold Cv26	300-750	0			2266	10	680	5			2945	6.5	20-30		20-35	B	fi/meSaClLm	so,R
Katspruit Ka10, Emfuleni Wo10, Willowbrook Wo11	350-750	0					1359	10	1360	60	2719	6.0	30-50			A	fi/meSaClLm-Cl	gc
Avalon Av26, Glencoe Gc26	450-900	0			1133	5	1359	10			2492	5.5	20-30		20-30	B	fi/meSaClLm	sp
Jozini Oa36, Dundee Du10	>900	0					1359	10	680	30	2039	4.5	20-30		20-35	A	fi/meSaClLm	gs
Swartland Sw31	750-1200+	1			1133	5					1133	2.5	20-35		35-50	A	fi/meSaClLm	so

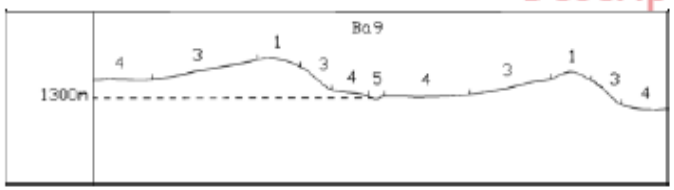
Total Occurence % ← Total ha / %

Clay Content % ← Clay content % A / E / B21

Depth Limiting Material ← Depth limiting material

Terrain type / *Terreintipe :* B3

Terrain form sketch / *Terreinvormskets*



Geology Description

For an explanation of this table consult LAND TYPE INVENTORY (table of contents)

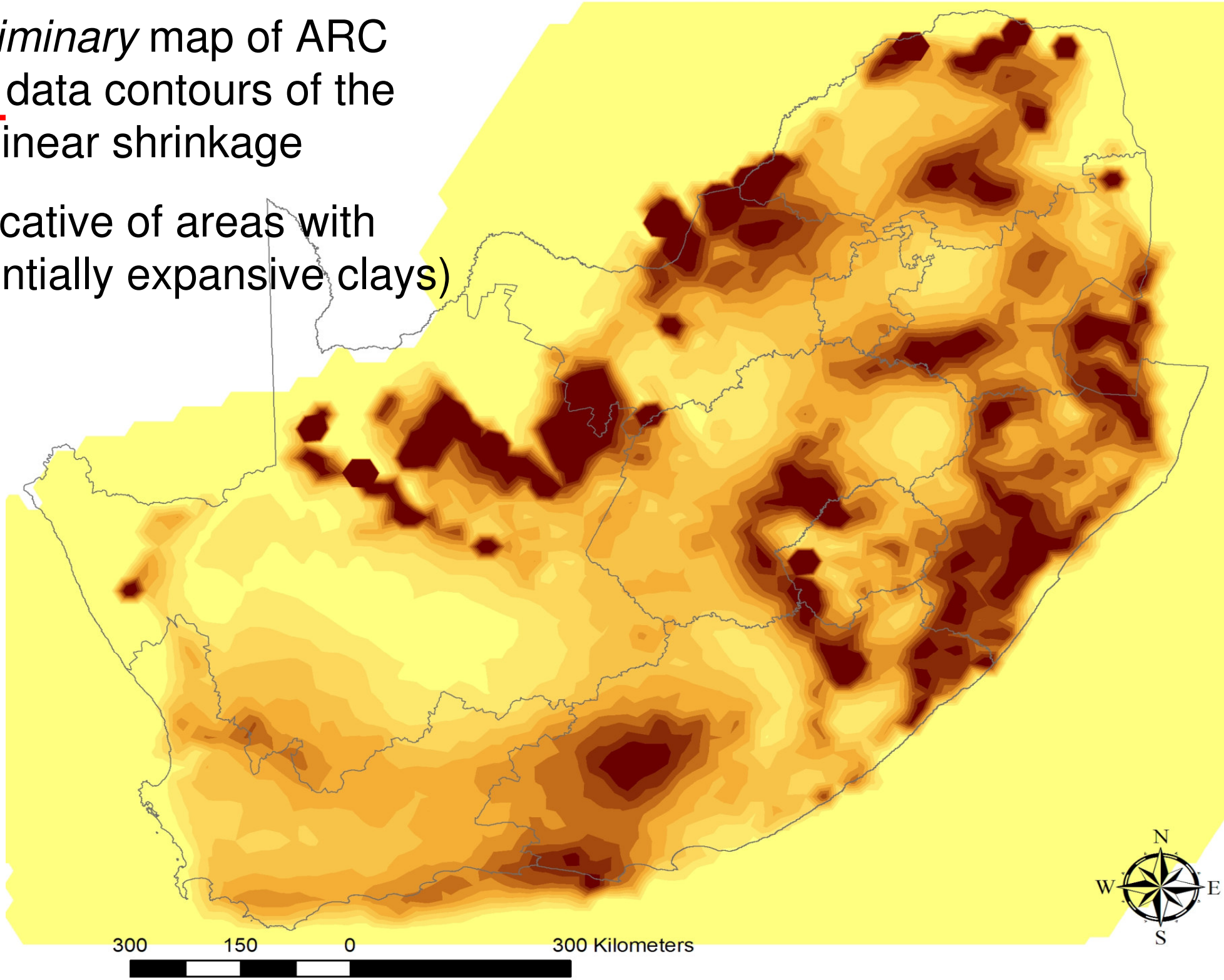
Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Shale, quartzite, hornfels and chert of the Pretoria Group; diabase; andesite of the Hekpoort Formation (Transvaal Sequence).

Geologie: Skalie, kwartsiet, horingfels en chert van die Groep Pretoria; diabaas; andesiet van die Formasie Hekpoort (Opeenvolging Transvaal).

Preliminary map of ARC with data contours of the bar linear shrinkage

(indicative of areas with potentially expansive clays)



012: Quantitative analyses

Project Leader: Mr Robert Leyland:

STRUCTURAL FAILURES OF THE ROAD ENVIRONMENT

Problem identification

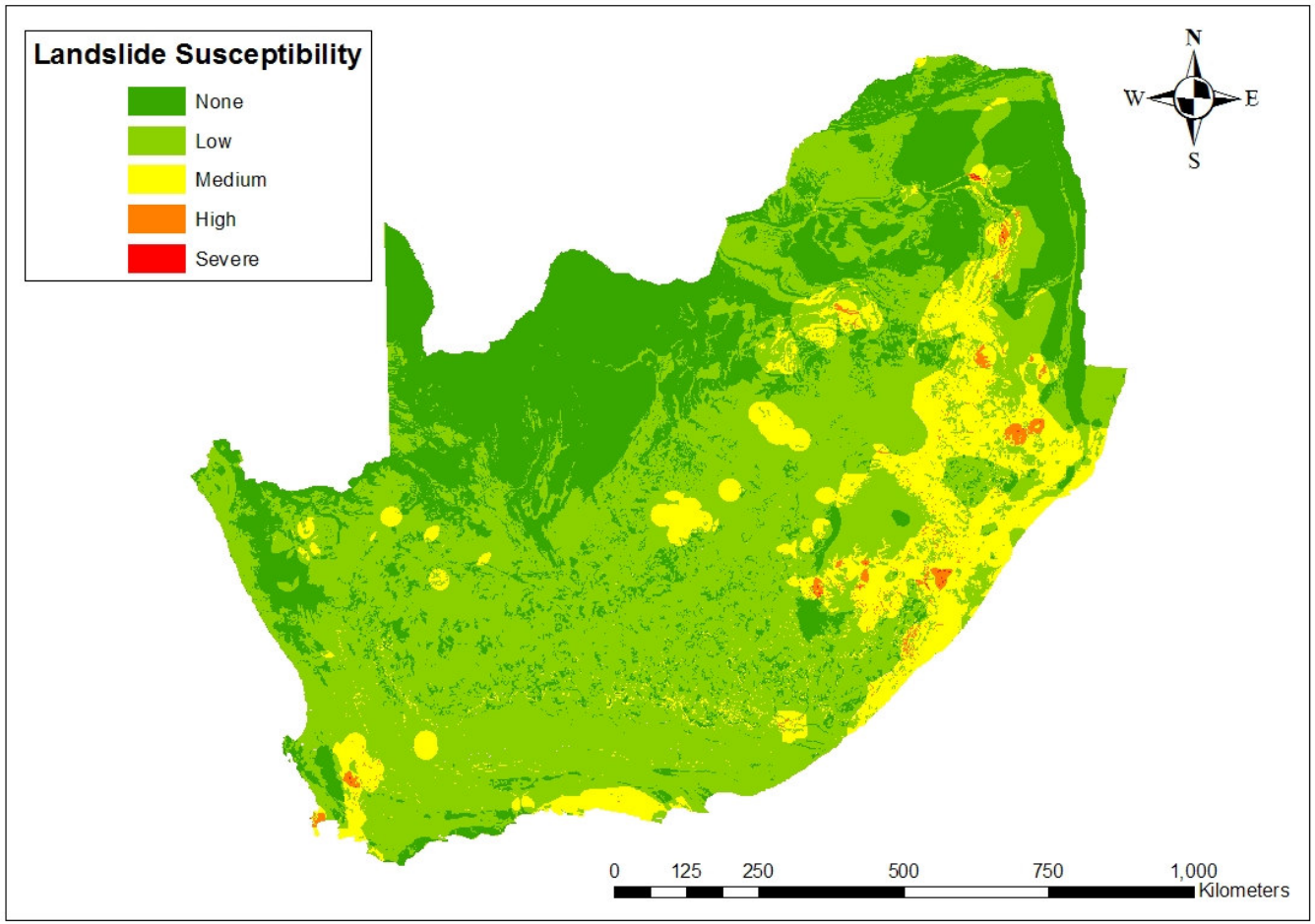
Project Leader: Mr Robert Leyland:

- Identified need for a ***Slope*** Management system in South Africa;
- Identified need for updated ***landslide susceptibility map.***

Research outcome

Project Leader: Mr Robert Leyland:

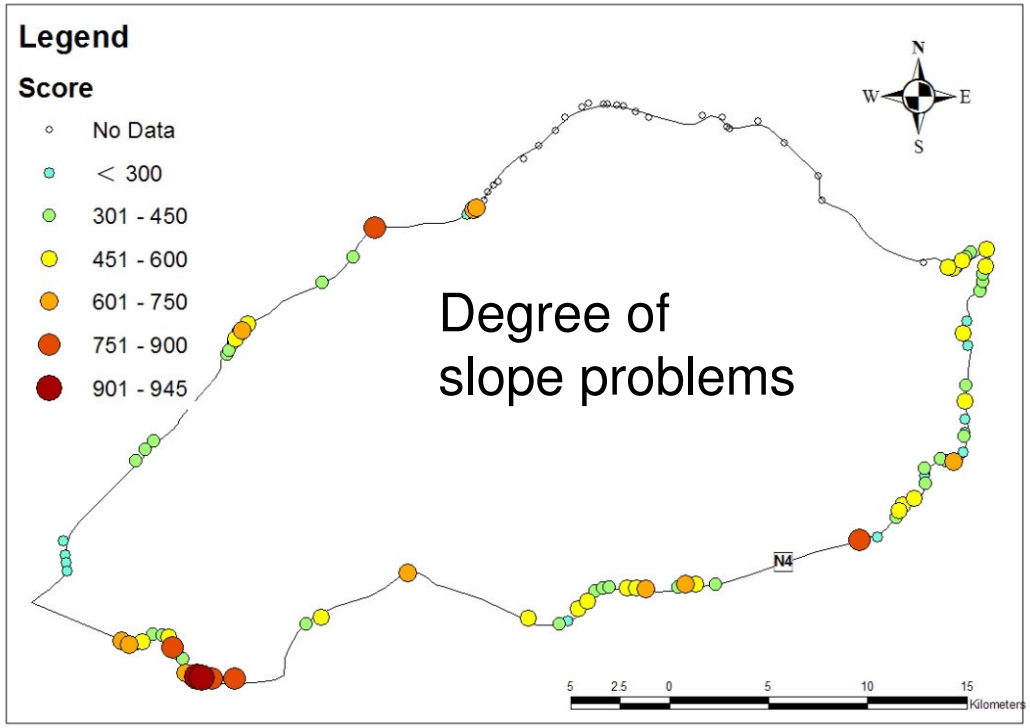
- Updated landslide susceptibility map;
- Preliminary slope management system for South Africa;
- Two day course on engineering geological aspects of slope stability;

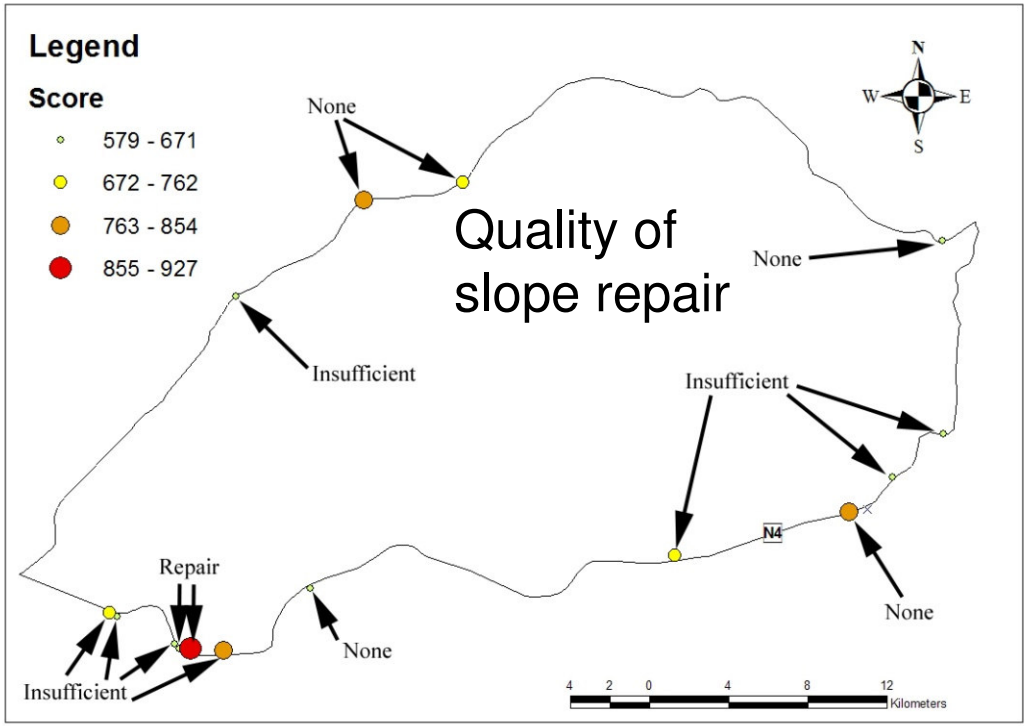


Outstanding issues

Project Leader: Mr Robert Leyland:

- Landslide susceptibility mapping using detailed Geographic information system (GIS) data;
- Completion of Slope Management System;
- Creation of complete GIS system;





Potential applications

Project Leader: Mr Robert Leyland:

Use by road authorities to:

- Monitor slopes *pro-actively;*
- To upgrade mitigation measures;
- Prevent disruptions on strategic national routes.

013: *Quantitative analyses*
Fundamental (Engineering) Soil Properties

Project Leader: Ms Amrita (Amy) Maharaj:

Problem Identification

- The objective of the project was to assess the current state of development in the field of ***Dielectric Constant (DC)*** application to roads
- Many fundamental chemical-physical properties of pavement materials are **not well understood;**
- The dielectric properties - material act as an ***electrical insulator***, or a measure of the ***electric permittivity*** of the material, i.e., the ability of the material to limit the flow of electrical current;.

Dielectric Sensor (for Dielectric Constant, DC)

Project Leader: Ms Amrita (Amy) Maharaj:

This study showed that the Dielectric Sensor (DS) primarily measures the **moisture content** in a material, with a compounding **interaction of density.**

Research Outcome

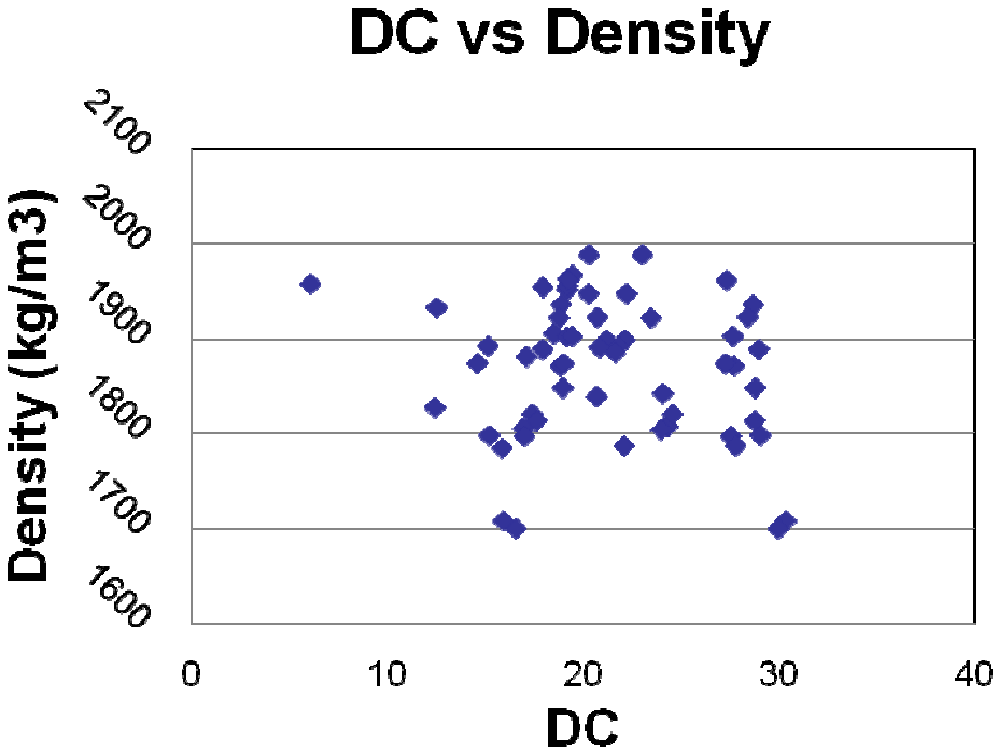
Project Leader: Ms Amrita (Amy) Maharaj:

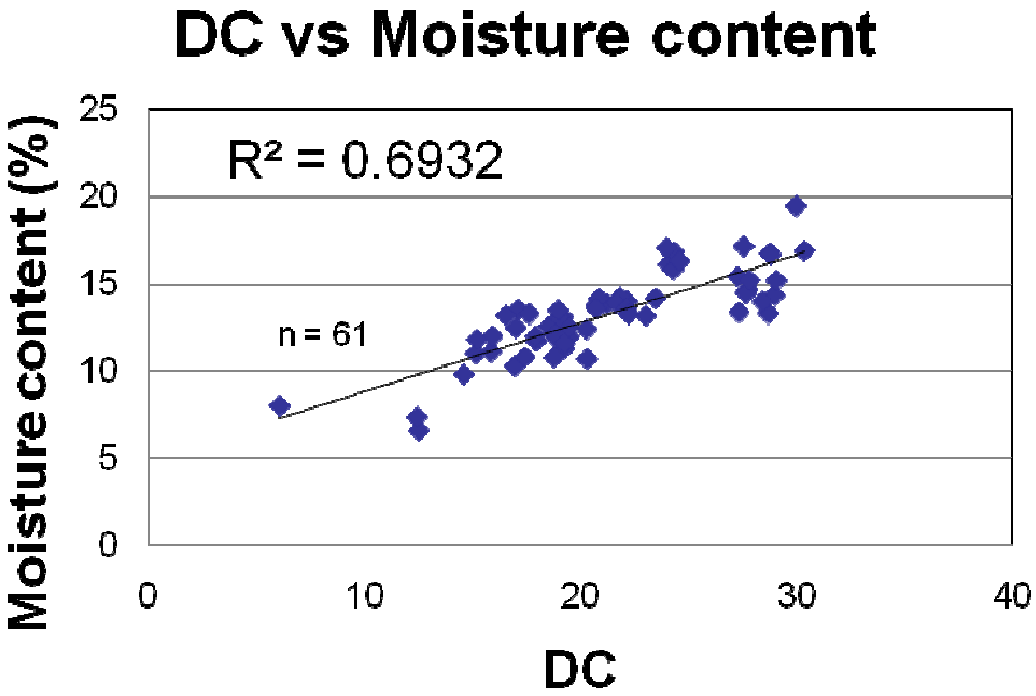
- The DC researched - focus was on **moisture content and density.**
- Dielectric Sensor (DS) may be useful as a tool to measure the moisture content;
- As a general material characterizing tool the dielectric sensor (DS) appears to be of limited use since too many variables affect it and extensive calibration is needed.;
- The use of the DC as an indication of stabilization durability and pavement design as applied in the USA **appears to be very tenuous;**

Some Results of Dielectric Constant (DC)…

Project Leader: Ms Amrita (Amy) Maharaj:

The distribution of DC readings in relation to (a): density and (b): moisture content (Material A with n = 61 values in data set)





Potential Application..?

Project Leader: Ms Amrita (Amy) Maharaj:

- The DS maybe be useful as a tool for measuring moisture content, however, for deeper measurements the DC sensor **will be impractical** for routine measurements - access pit needed;
- The DS may also be feasible for the determination of the ***density*** of material that has a ***known constant moisture content;***
- It is however, recommended that work on DS/DC for road materials be suspended.

CSIR - Potential Projects: – 2010-2013

SOLUTIONS (PROJECTS?)	ACTIVITY (POSSIBLE KEY SOLUTIONS)	DURATION
1. CREATING SUSTAINABLE ACCESS – TRIPLE BOTTOM LINE (SOCIO-ECONOMIC SUSTAINABLE (~ *BOOKLET ?*)	1. Pavement Management System (PMS) Lite / HDM IV (SANRAL ?) 2. NEW METHODOLOGIES / TECHNOLOGIES (GEOCELLS) + PACKAGING; 3. BLACK TOP PAVING BLOCKS; 4. THIN LAYER BLACK TOP;	3 YRS

SOLUTIONS (PROJECTS?)	ACTIVITY (POSSIBLE KEY SOLUTIONS)	DURATION
2. MULTILAYER ASPHALT PAVING BLOCKS	1. INCEPTION PLAN 2. R&D FOR BASIC COMPOSITION 3. MANUFACTURING , STORAGE AND TESTING (LAB & FIELD) 4. PAVEMENT DESIGN & EVALUATION 5. MANUALS, PROTOCOLS AND DISSEMINATION	3 YRS
3. THIN CONCRETE + POTENTIAL POTHOLE FILLER + AGRIBINDER + NANO-PHOSPHOROUS + SRP PROPOSALS + MICRO-FILLER + BITUMEN RUBBER		

The End….

Any Questions ..??...

Please do not hesitate to talk to us…