South African Road Design System (SARDS)

Revision Status Report

33rd RPF Meeting

10 May 2017

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Definitions

- **SAMDM** – Old South African Mechanistic Design Method limited to flexible pavements only.
- **SAPDM** - South African Pavement Design Method include all pavements flexible / block /concrete.
- **SARDS** - South African Road Design System is the software portal incorporating revised SAPDM models

SAPDM Revision Process / Progress

Start

- CAPSA - 2004
- RPF Task Team - May 2005
- Research Requirement framework - November 2005

Phase 1

- Develop Detailed Project Briefs – November 2006

Phase 2

- Appoint Research Teams – January 2007
- Inception Phase Reports (22 Projects) – July 2007
- CAPSA 2007 Workshop
- Peer Review – Phase 2 Reports – November 2007

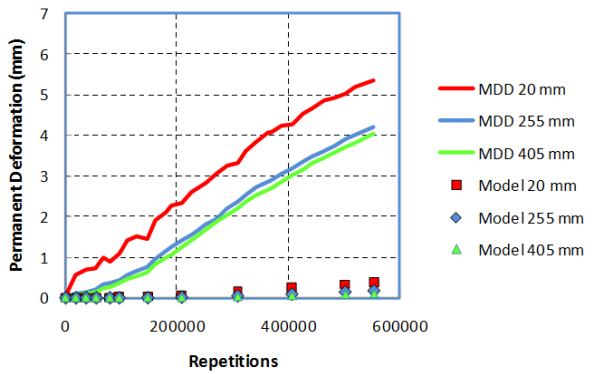
Phase 3

- Appointment of Principle Service Providers – September 2008
- 22 Research Teams – Quarterly Progress Meetings
- Basic Research Mostly Completed – 116 Reports
- 41 Environmental sites monitoring – complete
- Experimental Sections R35 (stabilisation) / R104 (10 Different Instrumented Pavements) – completed construction, monitoring ongoing
- Software Development – Main Focus Currently

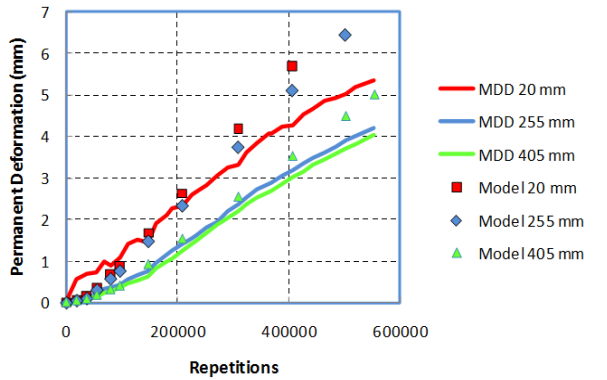
New Model Validation Procedure

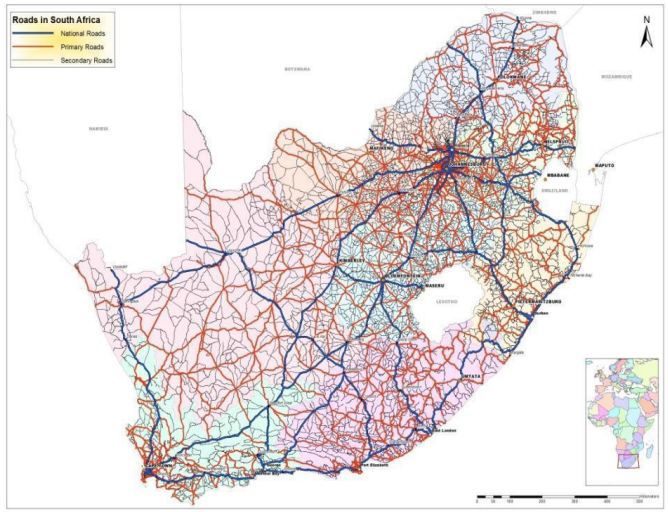
Phase 1 | Phase 2 | Phase 3

TRB'96 models



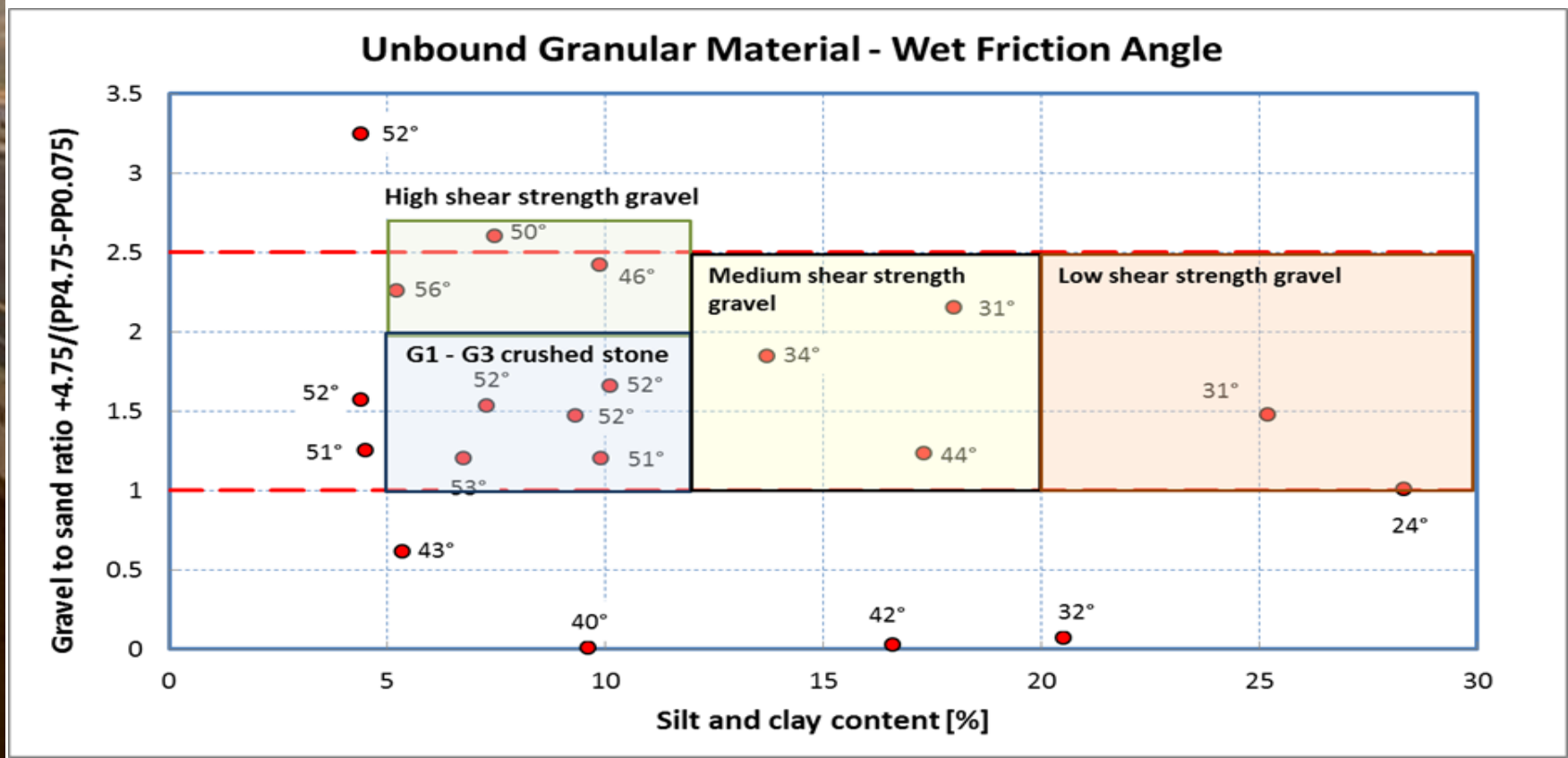
Current models





Phase 1 & 2 Validation – Unbound Materials

- Model formulation remain consistent with CAPSA 2015
- **BUT**
  - Strong correlation found between grading and Atterberg indicators and all aspects of unbound material behaviour
  - This enabled the development of predictive models using only the results from routine material tests to estimate the model coefficients



Phase 1 & 2 Validation – Stabilised Materials

- Model formulation remain consistent with CAPSA 2015
- **Mix composition dependent models developed for the following aggregate types**
  - Crushed stone, including new and recycled crushed stone
  - Coarse crushed gravel
  - Previously stabilised gravel
  - Sand
- Failure stress predicted for any realistic combination of cement and bitumen

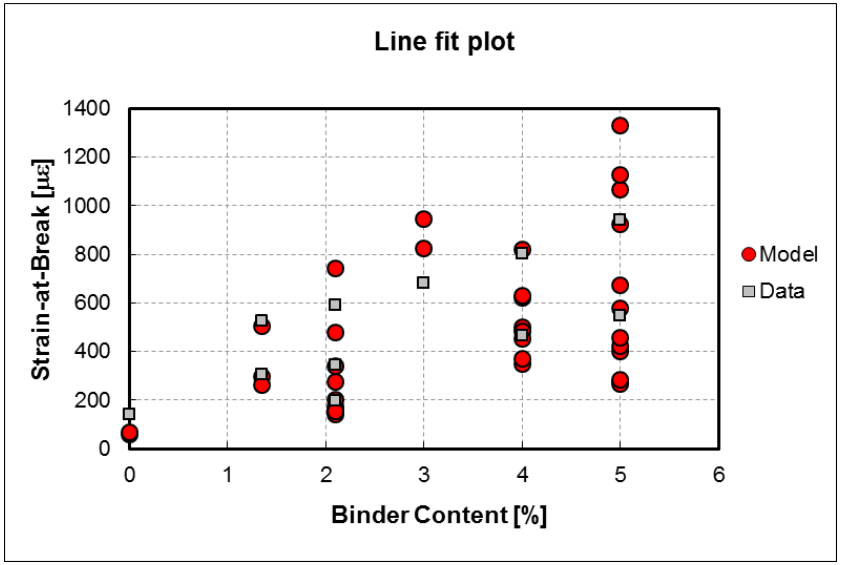
Recycled crushed stone

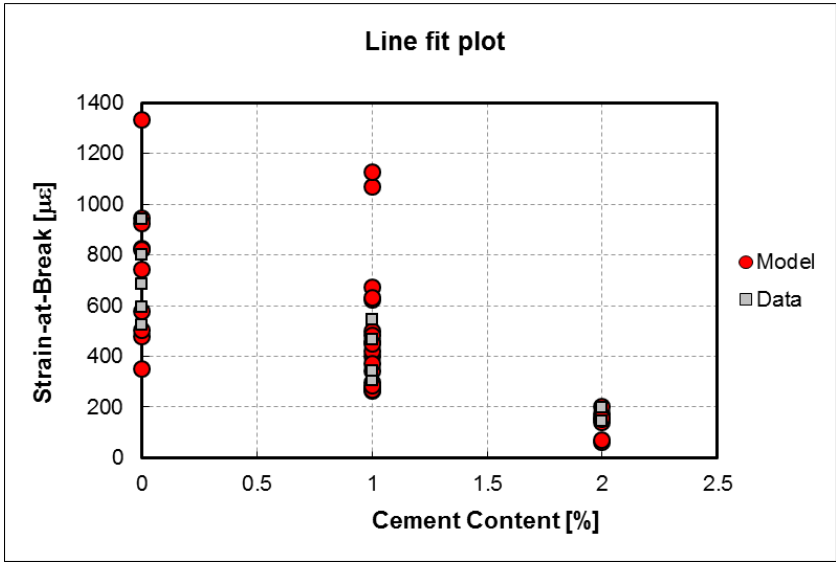
Aeolian sand

Phase 1 & 2 Validation – Stabilised Materials

- Strain-at-break predicted for any realistic combination of cement and bitumen

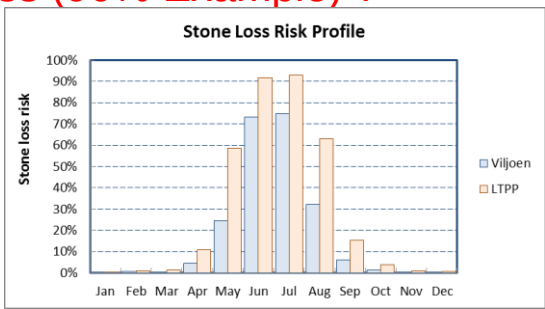
Aeolian sand





Surface Seals Models

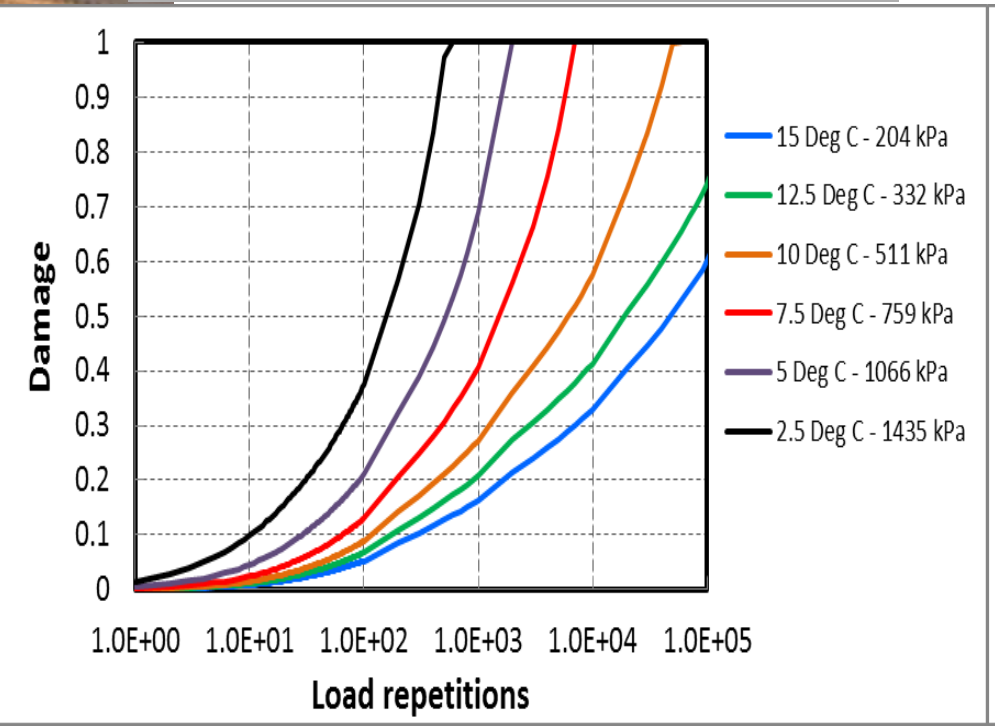
- Primary seal response model developed that incorporates
  - Aggregate spread rate
  - Aggregate ALD
  - Binder application rate
  - Binder age
  - Tyre contact stress
  - Vehicle speed
  - Seal temperature
  - Support conditions (base stiffness)
  - (Had to introduce thermal stress for results to make sense)
- Damage models
  - Stone-loss (adhesive failure)
    - Damage testing done at high temperature(?)
    - Had to extrapolate results to low temperature to be useful
    - Only possible to develop a temperature based stone-loss risk factor
    - What level of adhesive damage results in stone-loss (90% Example) ?
  - Binder fatigue (cohesive failure)
    - The results for double seals are encouraging
    - Cape and single seals require refinement
  - Embedment (not implemented yet)



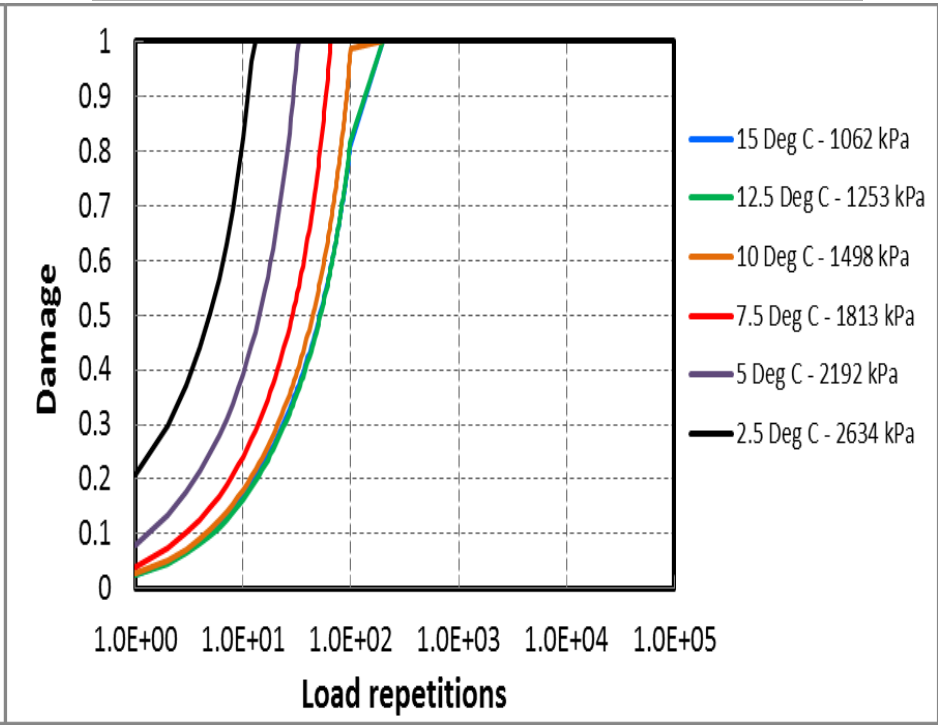
Seal Binder fatigue (cohesive failure)

- Effect of support and temperature on double seal fatigue

Base stiffness – 800 MPa

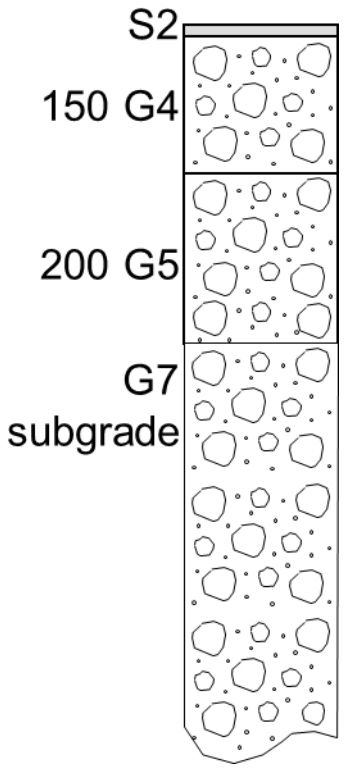


Base stiffness – 450 MPa



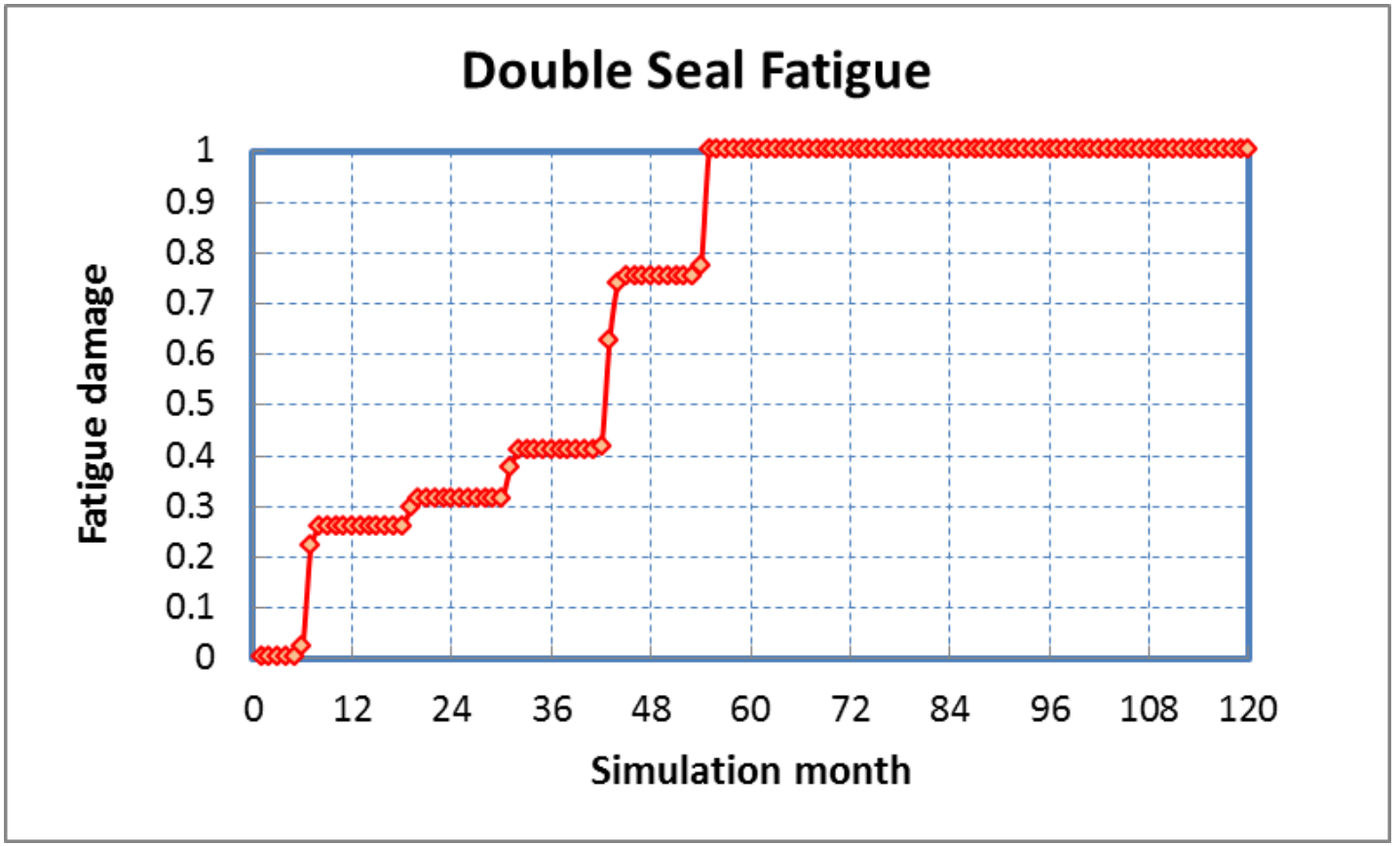
Phase 2 Validation – R104 Seal Damage

- Double seal on G4 base
- Heavy traffic loading
  - Equivalent to N1 Pietersburg traffic
  - Too heavy for R104 but selected to induce high levels of damage
- Simulation started in January



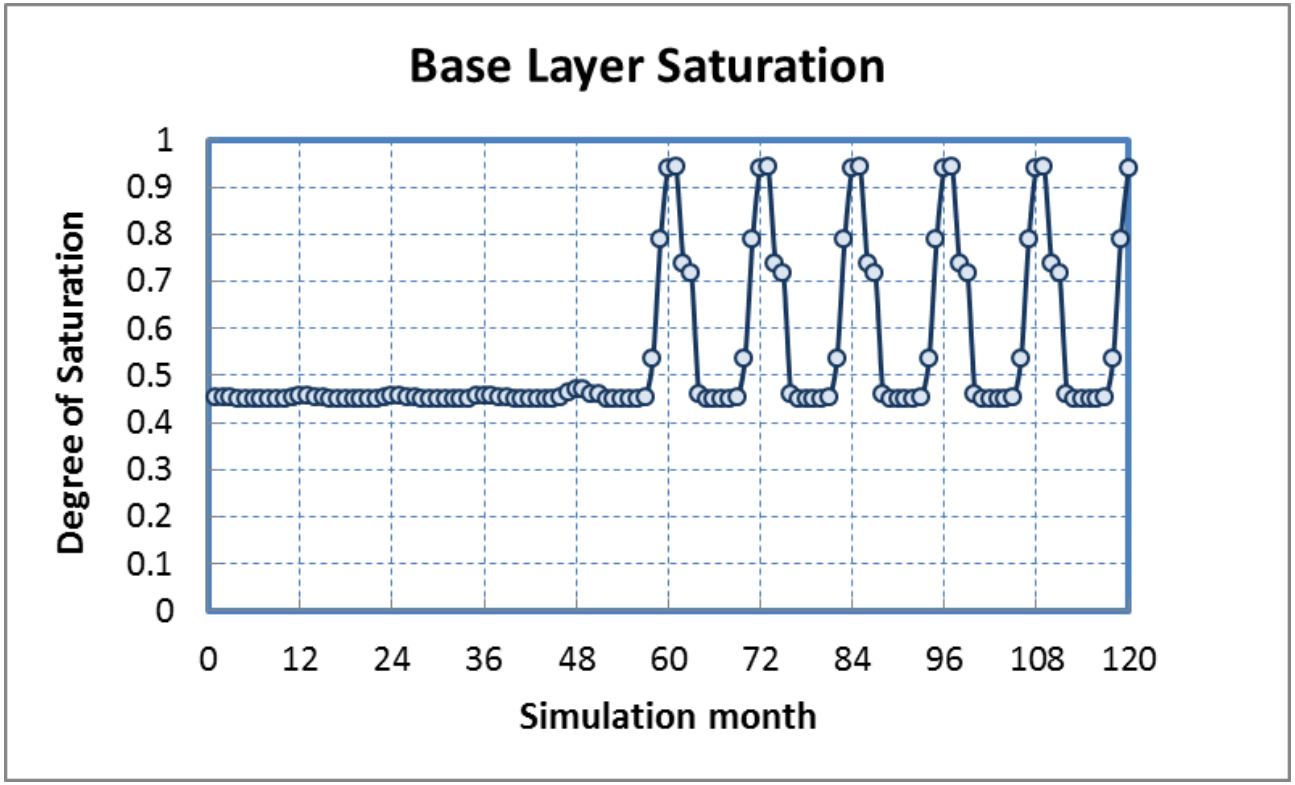
Step 1: Seal Fatigue Damage

- Fatigue damage = 1 represents cracked condition
- All fatigue occurs in winter months
- Seal fatigue failure in winter of 5th simulation year



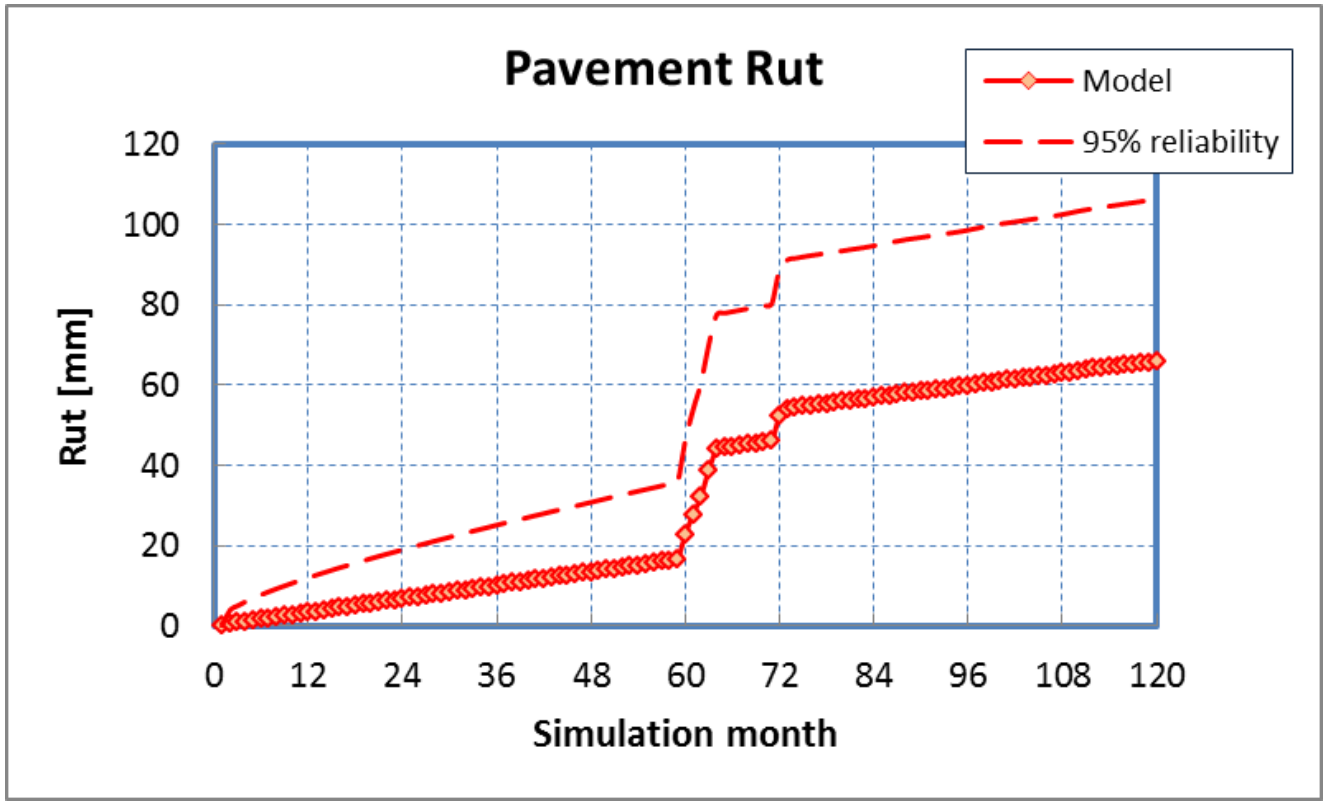
Step 2: Base layer moisture change

- Base layer saturation increases in summer months following seal fatigue
- Saturation levels
  - Equilibrium saturation from Emery model
  - Average base saturation level for summer months probably too high for the full duration of a month
  - Conceptual saturation model requires field calibration



Step 3: Pavement Rut Increase

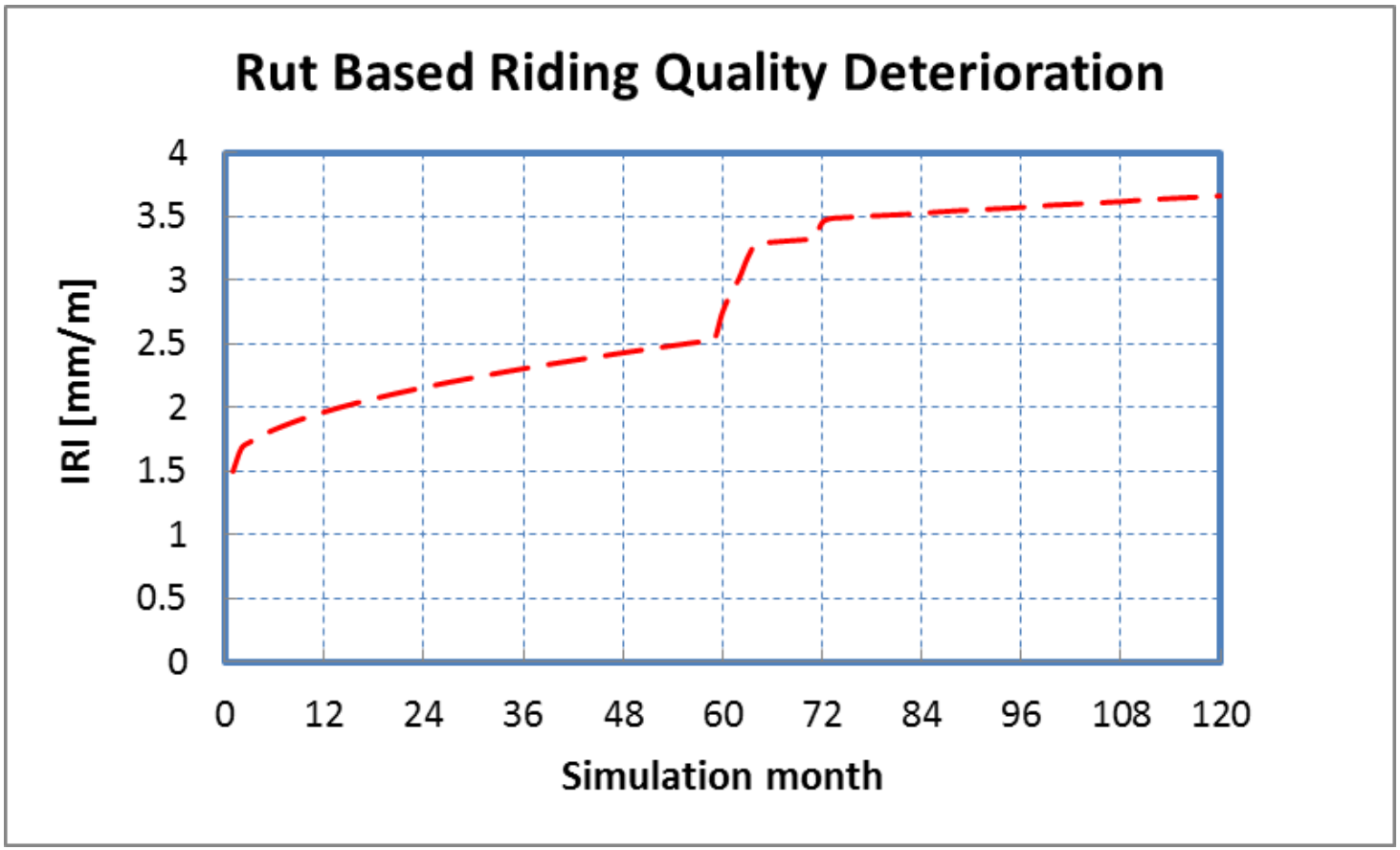
- Shear failure in first summer following seal fatigue (remember unrealistic N1 traffic used on R104)
- 95 % reliability is an upper bound



Step 4: Roughness Increase (User Costs)

- Only the HDM4 roughness deterioration resulting from rut variance
  - One of five components

$$\Delta RI_r = K_{gr} a_0 \Delta RDS$$



Phase 2 Validation: Major Frustrations

- Current SANRAL Server Constraints limiting Phase 2 Simulation Analysis (3 days)
  - Intel Xeon® Phi™ Processors (Knights Landing) only became available November 2016
  - Currently only have access to developer platform with 1CPU (64 cores) in USA
  - Currently conducting testing on “scale model "of proposed SANRAL production solution (3000 cores) in USA / France
  - Expected delivery in November 2017
- Current SANRAL Server Constraints limiting ability to provide access to SARDS Beta Software
  - New Enterprise Level Server and Storage Hardware Ordered February 2017
  - Expected delivery September 2017

SARDS BETA - 2.2.8.0 (itis.nra.co.za) - Update Projects

Modules

Project | Tender | Traffic Design | Pavement Investigation | Pavement Construction | Laboratory | Binder

Modules

Refresh Projects | Synchronize Lookups | Synchronize Workspaces

Sards Projects | Tender Projects

Drag a column header and drop it here to group by that column

Project Number	Project Description	End Date	Sync Type	Provisioned	Note	Exists Locally	Synchronize Project	Synchronize Video
N.003-030-2010/1	DICAL: Epworth to Athlone	2013/12/13	SARDS Project	Yes			Synchronize	
N.003-030-2017/1	DICAL: Ashburton I/C Murray Rd	2021/12/31	SARDS Project	Yes			Synchronize	
N.003-030-2017/2	DICAL: Murray Rd - Epworth	2021/12/31	SARDS Project	Yes			Synchronize	
N.003-030-2017/3	DICAL: Epworth - Twickenham Rd	2021/12/31	SARDS Project	Yes			Synchronize	
N.003-034-2017/1	DNND2: Realignment: Twickenham - Cedara	2021/12/31	SARDS Project	Yes			Synchronize	
R.104-010-2011/1	DSCPR: Simon Vermooten to Bronkhorstspr.	2015/03/21	SARDS Project	Yes			Synchronize	
R.104-010-2011/2	DIBBW: R104 Bridge Improvements	2017/03/31		No	Not provisioned			
Test DEMO	Testing		SARDS Project	Yes			Synchronize	0 / 0 Frames. Approximately 0 bytes

Synchronize Selected Projects

Point Selection Mode | Segment Selection Mode

Horizontal Alignment

24° 36' 14.96" S 28° 16' 40.42" E

synchronizing

downloading - preparing for synchronization

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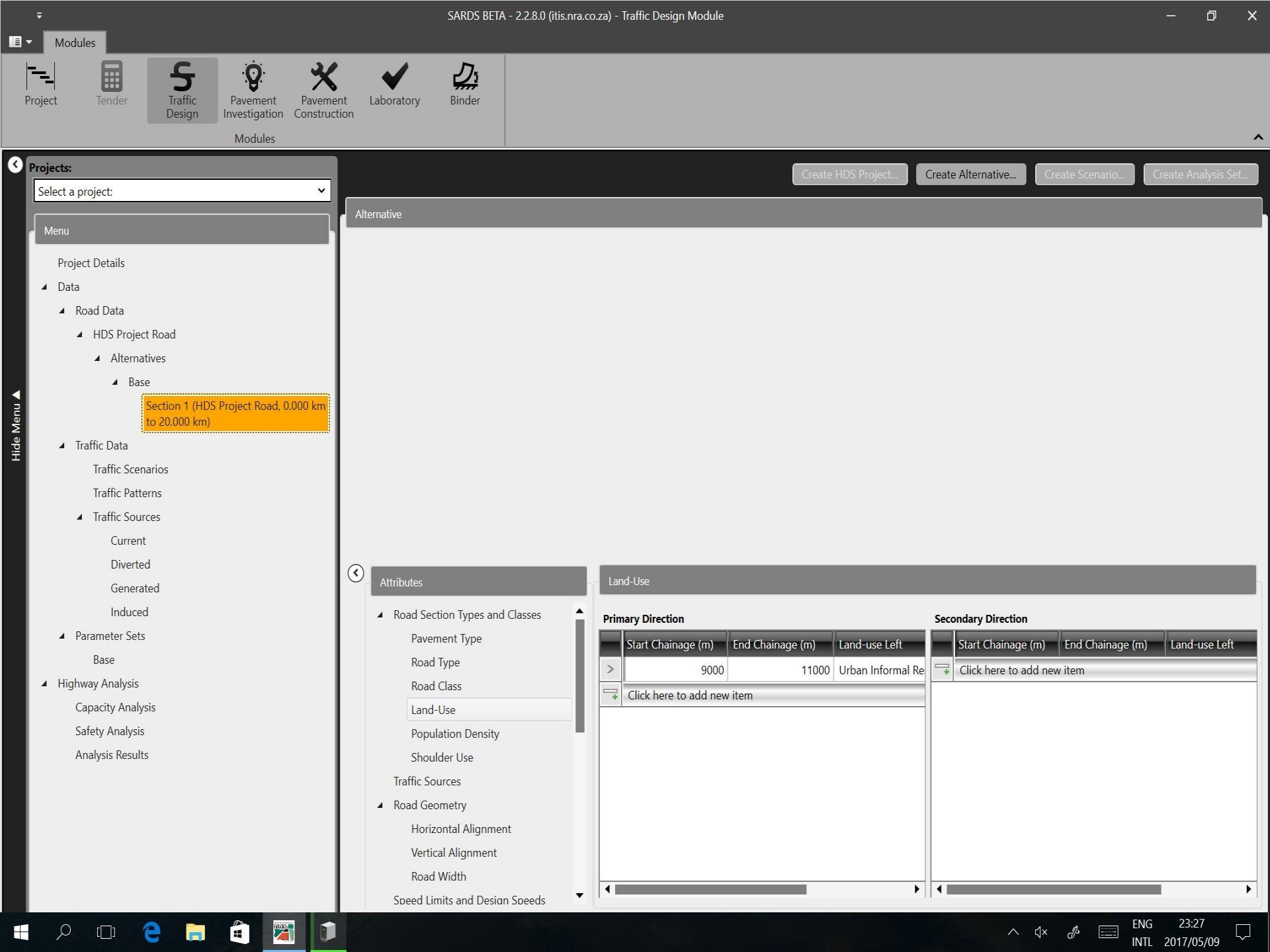
SARDS BETA - 2.2.8.0 (itis.nra.co.za) - Traffic Design Module
Modules
Project
Tender
Traffic Design
Pavement Investigation
Pavement Construction
Laboratory
Binder
Modules
Projects:
Select a project:
Create HDS Project...
Create Alternative...
Create Scenario...
Create Analysis Set...
Menu
Project Details
Data
Road Data
HDS Project Road
Alternatives
Base
Section 1 (HDS Project Road, 0.000 km to 20.000 km)
Traffic Data
Traffic Scenarios
Traffic Patterns
Traffic Sources
Current
Diverted
Generated
Induced
Parameter Sets
Base
Highway Analysis
Capacity Analysis
Safety Analysis
Analysis Results
Hide Menu
Alternative
Attributes
Road Section Types and Classes
Pavement Type
Road Type
Road Class
Land-Use
Population Density
Shoulder Use
Traffic Sources
Road Geometry
Horizontal Alignment
Vertical Alignment
Road Width
Speed Limits and Design Speeds
Land-Use
Primary Direction
Start Chainage (m)
End Chainage (m)
Land-use Left
9000
11000
Urban Informal Re
Click here to add new item
Secondary Direction
Start Chainage (m)
End Chainage (m)
Land-use Left
Click here to add new item
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SARDS BETA - 2.2.8.0 (itis.nra.co.za) - Pavement Construction Module

Modules

Project | Tender | Traffic Design | Pavement Investigation | Pavement Construction | Laboratory | Binder

Modules

Projects :

Test DEMO - Test Projects

Sections :

N00124NX-24-
20.87 km
25.62 km

N00124NX-24-
20.87 km
25.62 km

N00125NX-25-
0.00 km
71.29 km

Hide Menu

Lots | Design Specification | Test Schedules | Test Results

Show : All Lots | Filter by Trial Lot : All | Create

Created between 2016/11/09 and 2017/05/09 | Material : All | Layer Type: All

Step 1 : Describe how Lots should be generated

Trial Lot : Please Select One

How many Lots : 1.00

Quality Assurance Specification

Select test schedule : SANS3001

QA Scheme : Please Select One

Lot Details

Lift No. : 1

Paver Width :

Kerbed Constr ?

Start Peg : Please Select One

End Peg : Please Select One

Total road distance selected : 0m

No. Lanes : 1

C-L Offset of Lot origin (m) :

Constr. Width (m) :

Constr. Thickness (m) :

Layer thickness control : Please select one

Summary

Trial Lot Errors :
Please select a valid QA Scheme for the Trial Lot
Please provide a valid Start Peg
Please provide a valid End Peg
Please provide a valid Layer thickness control
A Paver Width of between 1m and 4m is required for Asphalt lots

Next | Cancel

INTL 2017/05/09

SARDS Software Release Strategy

Pre - Alpha Phase

- Software requirements analysis, software design, software development, and unit testing – Software Developers

Alpha Phase

- The alpha phase of the release life cycle is the first phase to begin software testing, first by developers and then selected users. Alpha software can be unstable and could cause crashes or data loss.
- **New Build every 2 weeks**

Beta Phase

- Software in the beta phase will generally have many more bugs in it than completed software, as well as speed/performance issues and may still cause crashes or data loss. The focus of beta testing is reducing impacts to users, often incorporating usability testing by users.
- **SARDS Demo Projects / User Feedback / Monthly Updates**

Release Candidate Phase

- A release candidate (RC) is a beta version with potential to be a final product, which is ready to release unless significant bugs emerge. In this stage of product stabilization, all product features have been designed, coded and tested through one or more beta cycles with no known showstopper-class bug.
- **Training / Recent Projects / Pilot Projects (November 2017, subject to server hardware)**

Release

- Released for general use on **all projects**
- **Ongoing Training / Support / Enhancements**

Creating wealth through infrastructure

Thank you!

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