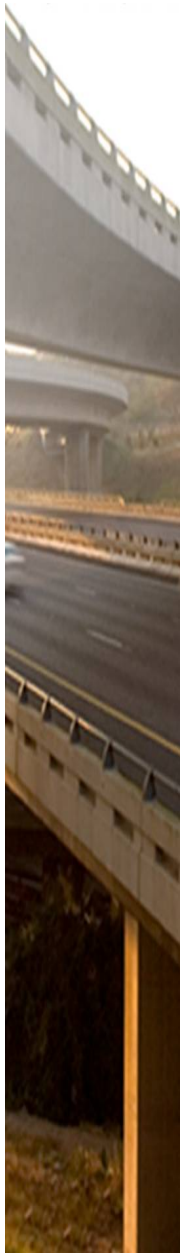


South African Pavement Design Method (SAPDM)

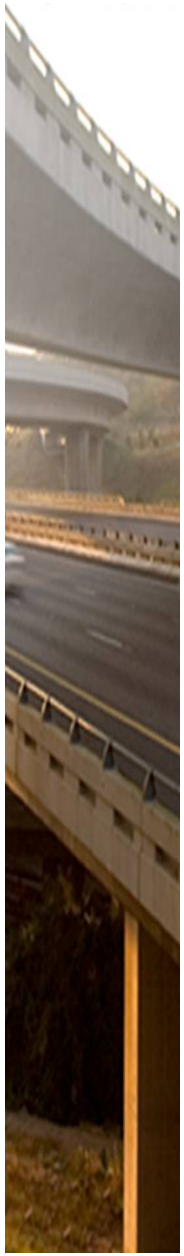
Status Report

18th RPF Meeting

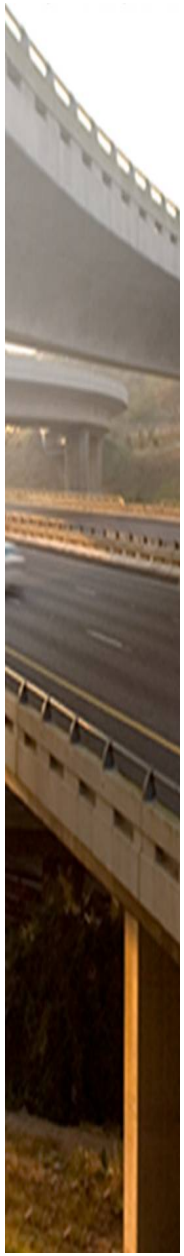
11 November 2009

L Kannemeyer

Aka GODZILLA



Historical Overview – SAPDM Revision



- Process initiated at RPF -May 2005
- R&R framework - November 2005
- Pavement Performance Information System (LTPP)
  - Material Classification Concept
  - Pavement Number Concept (PN)
  - 50 Projects Completed – February 2008
  - 15 Stabilized Projects Added – February 2008
- Mechanistic-Empirical Analysis System (MEAS)
  - Phase 1 – Develop Detailed Project Briefs – November 2006
  - Phase 2 - Inception Phase (22 Projects) – July 2007
  - Peer Review – Phase 2 Reports – November 2007
  - Additional SANRAL Requirements – December 2007
  - Appointment of Main Service Providers – September 2008
    - CSIR Built Environment
    - Pavement Modelling Corporation
    - SC Van As Traffic Engineering
- SAPDM Website (www.sapdm.co.za) – May 2009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Pavement Design Method
IMPROVING THE STRUCTURAL DESIGN MODEL
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Project Team Documentation
Frequently Asked Questions
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South African National Roads Agency Ltd. (SANRAL)
Council for Scientific and Industrial Research
CONTACT INFORMATION:
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welcome to the South African Pavement Design Method Website...
About the project
Mechanistic-empirical pavement design has been one of the primary pavement design tools in South Africa since the early 1970s. Although some improvements were made to the original method over the years, the main components of the current method are still based on research done during the 1970s and 1980s. The problems associated with the current method were highlighted at the Conference for Asphalt Pavements in Southern Africa held in 2004. These problems were again raised at the subsequent Roads Pavement Forum meeting held in May 2005 and a workgroup appointed to initiate the revision of the South African Mechanistic-Empirical Design Method.
Project sponsors
Currently two sponsors have approved funding for the revision of the flexible pavement design method, the South African National Roads Agency Ltd (SANRAL) and the CSIR. CSIR funding covers mostly research activities to establish the foundation from which the development and implementation activities will be launched. SANRAL is the main sponsor and largest client body to implement the revised design method.
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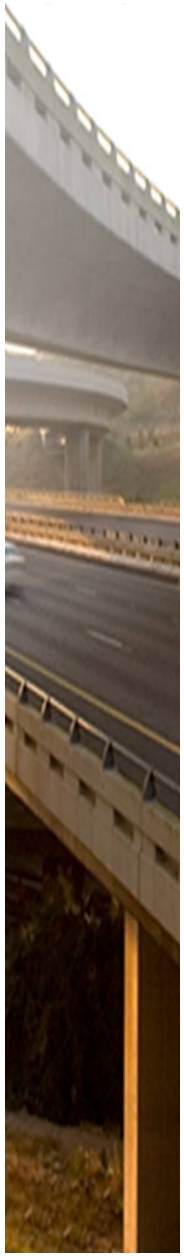


Draft Contract Report SANRAL/SAPDM/B-1a/2009-01
January 2009

Revision of the South African Pavement Design Method

Project Focus Area: Resilient Response Models for Unbound Material – B-1a

Restricted

Resilient Modulus Models for Partially Saturated Unbound Granular Material

Version: 1st Draft

Author:
HL Theyse

PREPARED FOR:
South African National Roads Agency Limited
P O Box 415
Pretoria 0001

PREPARED BY:
Pavement Modelling Corporation
1397 Starkey Ave
Waverley 0186

$$M_r = \frac{a\exp\left[\ln\frac{b}{a} + d(S-s)\right] + b}{1+\exp\left[\ln\frac{b}{a} + d(S-s)\right]} \quad (24)$$

$$\frac{M_r}{p_{atm}} = K_0 VD^{K_{r0}} \left\{\frac{a\exp\left[\ln\frac{b}{a} + d(S-s)\right] + b}{1+\exp\left[\ln\frac{b}{a} + d(S-s)\right]}\right\} \left(\frac{\sigma_3'}{p_{atm}}\right)^{K_C} \left(\frac{\sigma_1'}{\sigma_i'}\right)^{K_M} \quad (25)$$

with the variables as defined previously

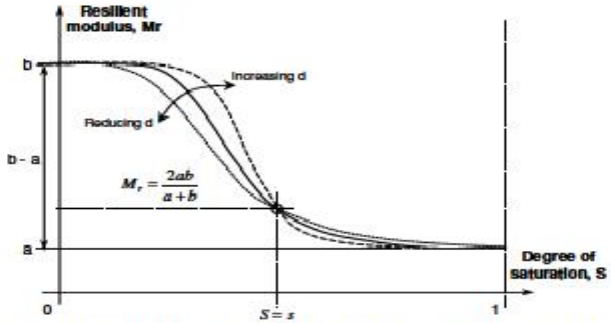


Figure 34 Schematic representation of the required relationship between the resilient modulus and degree of saturation

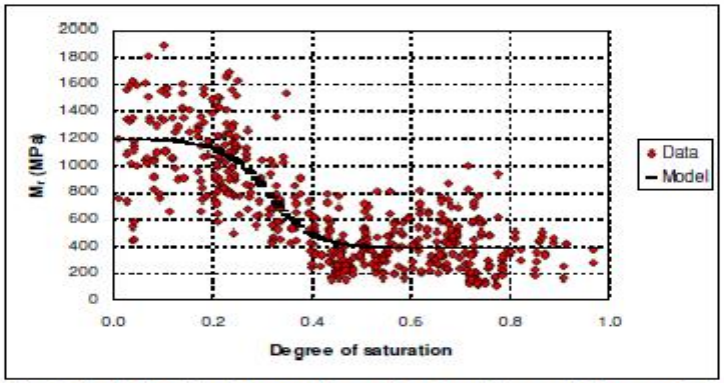
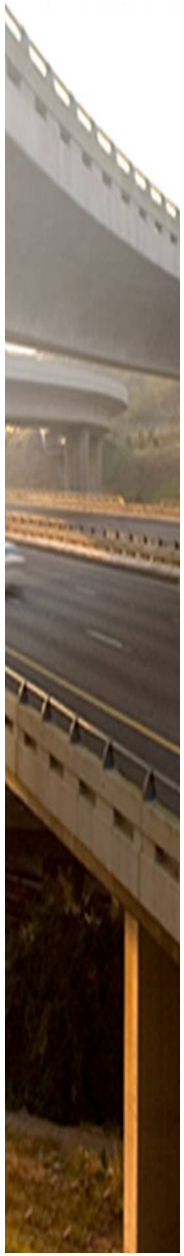


Figure 35 Calibrated relationship between the resilient modulus and degree of saturation



Draft Contract Report SANRAL/SAPDM/E-1/2009-01
April 2009

Revision of the South African Pavement Design Method

Project Focus Area: E-1
Environmental and Spatial Variables

Restricted

Climatic Zones: Identification of Climatic Zones

Version: 2nd Draft

Authors:
P Paige-Green
R Leyland
F Netterberg

PREPARED FOR:	PREPARED BY:
South African National Roads Agency Limited P.O.Box 415 Pretoria 0001	CSIR Built Environment P.O.Box 395 Pretoria 0001

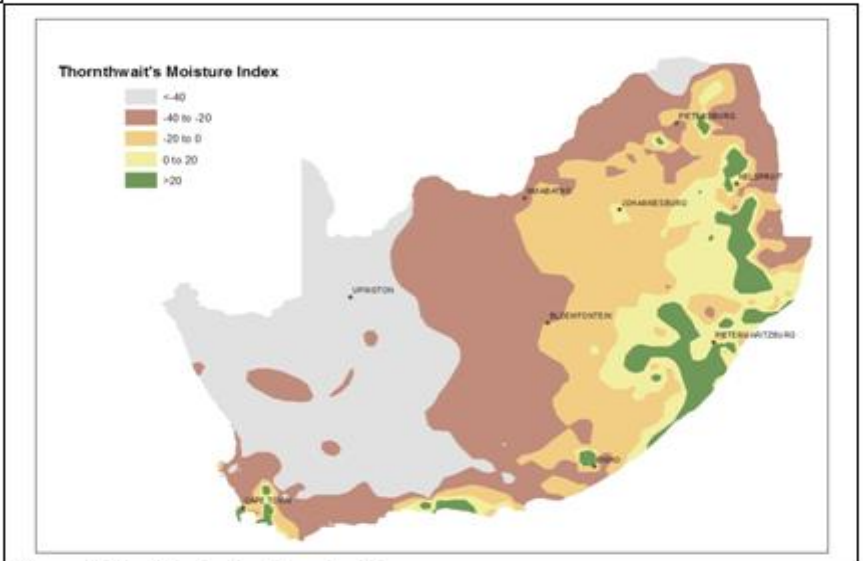
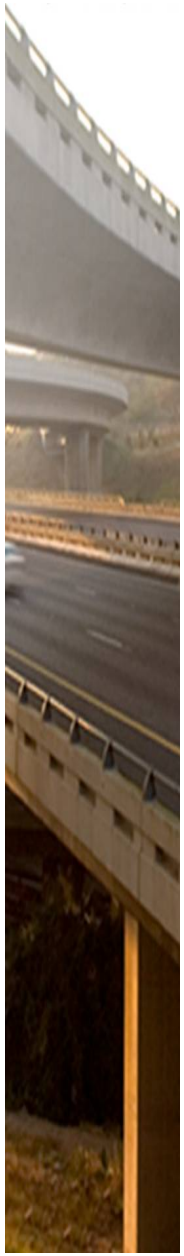


Figure 4 Simplified revised Thornthwaite map



Draft Contract Report SANRAL/SAPDM/D2/2009-02
March 2009

Revision of the South African Pavement Design Method

Project Focus Area: Damage Models for Unbound Material - D2

Restricted draft

Development of a general yield strength model for unbound material

Version: 1st Draft

Author:
HL Theyse

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Pretoria 0001

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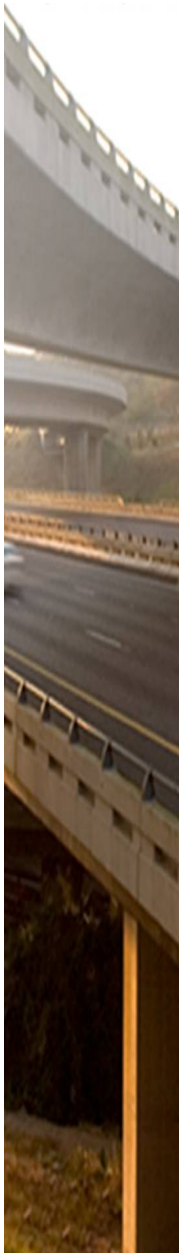
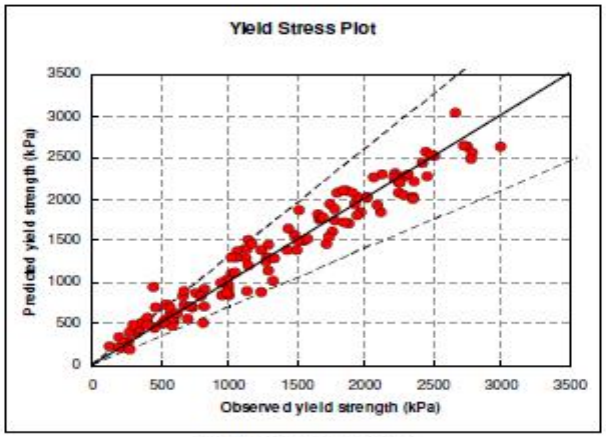
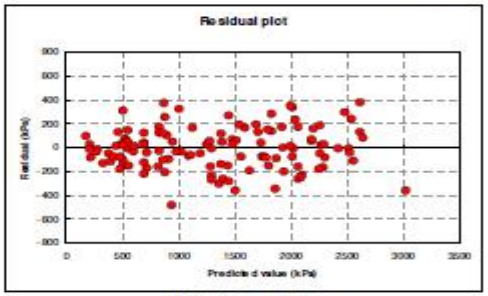
Pavement Modelling Corporation
1397 Starkey Ave
Waverley 0186

Pavement Modelling Corporation
CC 2007/005375/23

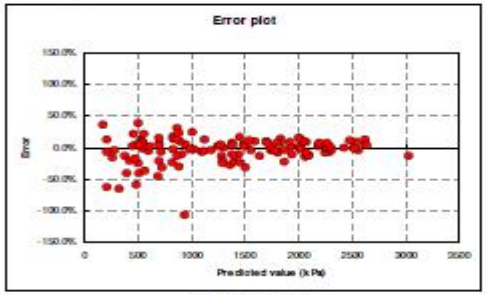




(a) Prediction accuracy

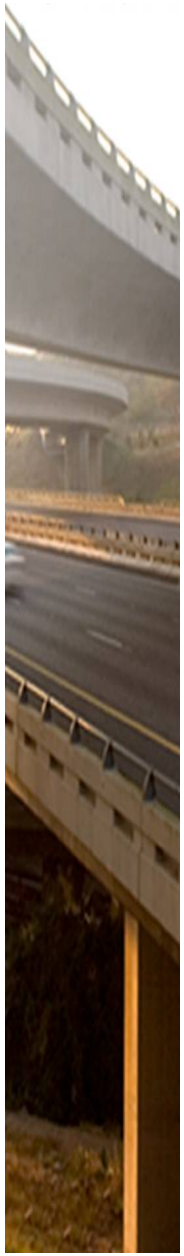


(b) Residual plot



(c) Error plot

Figure 30 Prediction accuracy and precision of the crushed stone general yield strength model



Draft Contract Report SANRAL-SAPDM-B1a-2009-02
August 2009

Revision of the South African Pavement Design Method

Project Focus Area: Resilient Response Models for Unbound Material – B-1a

Restricted

Density Estimates for Unbound Granular Material

Version: 1st Draft

Author:
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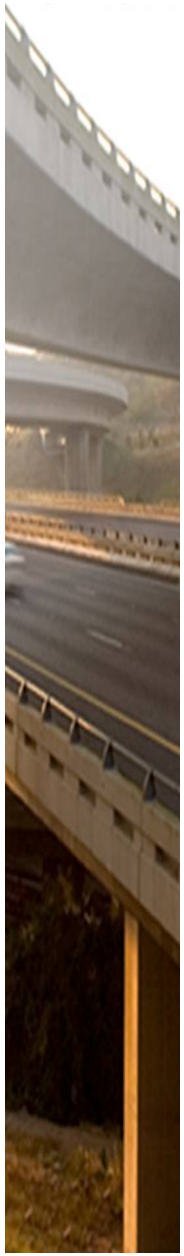


5.2.2 mod AASHTO volumetric density

The final model for mod AASHTO volumetric density estimates is given by Equation (16) with the model coefficients summarised in Table 19.

$$VD_{mod} = Y_0 + \alpha_1 TD + \alpha_2 TD^2 + \beta_1 (P_{0.425} \times LS) + \beta_2 (P_{0.425} \times LS)^2 + \gamma_1 P_{max} + \gamma_2 P_{max}^2 \quad (16)$$

Where VD_{mod} = mod AASHTO volumetric density (%),
TD = area deviation of the actual grading from the Talbot grading for the corresponding maximum particle size
$P_{0.425} \times LS$ = Product of the percentage passing the 0.425 mm sieve by mass and the linear shrinkage
P_{max} = maximum particle size (mm)
$Y_0, \alpha_i, \beta_i, \gamma_i$ = regression model coefficients

Table 19 Model coefficients for the mod AASHTO volumetric density model

Density estimate for	Regression results						
	Y_0	α_1	α_2	β_1	β_2	γ_1	γ_2
Fine material	76.05	-0.2339	0.0015	-1.4794	0.0522	0.6177	-0.0085

5.2.3 Loose volumetric density

The final model for the loose volumetric density estimates is given by Equation (17) with the model coefficients summarised in Table 20.

$$VD_{loose} = Y_0 + \gamma_1 P_{max} + \gamma_2 P_{max}^2 + \gamma_3 P_{max}^3 \quad (17)$$

Where VD_{loose} = loose volumetric density (%),
P_{max} = maximum particle size (mm)
Y_0, γ_i = regression model coefficients

Table 20 Model coefficients for the loose volumetric density model

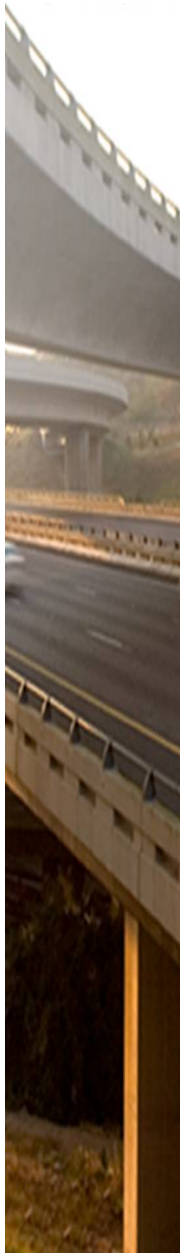
Density estimate for	Regression results			
	Y_0	γ_1	γ_2	γ_3
Fine material	55.55	-1.8274	0.1092	-0.0014

5.2.4 Vibratory table optimum compaction moisture content

The final model for the vibratory table optimum compaction moisture content estimates is given by Equation (18) with the model coefficients summarised in Table 21.

$$OCMC_{vib} = Y_0 + \alpha_1 P_{0.425} + \alpha_2 P_{0.425}^2 + \beta_1 P_{max} + \beta_2 P_{max}^2 + \gamma_1 LS + \gamma_2 LS^2 \quad (18)$$

Where $OCMC_{vib}$ = vibratory table optimum compaction moisture content (%),
$P_{0.425}$ = percentage passing the 0.425 mm sieve by mass
P_{max} = maximum particle size (mm)
LS = linear shrinkage
$Y_0, \alpha_i, \beta_i, \gamma_i$ = regression model coefficients



Draft Contract Report SANRAL/SAPDM/A2/2009/02
September 2009

Revision of the South African Flexible Pavement Design Method

Project Focus Area A2

Traffic volume and axle load information system

Restricted Draft

Research Traffic Data Preparation

Version: 1st Draft

Author:
Dr SC van As

PREPARED FOR:
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P.O.Box 415
Pretoria 0001

PREPARED BY:
SC van As Traffic Engineer CC
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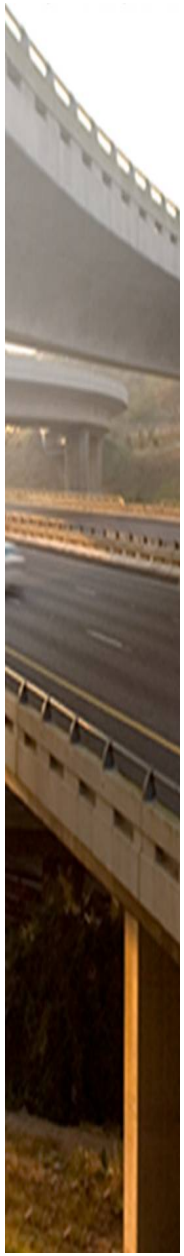

Draft Contract Report SANRAL/SAPDM/A2/2009/03
September 2009

Revision of the South African Pavement Design Method

Project Focus Area A2

Traffic volume and axle load information system

Restricted Draft

Traffic Data Verification and Replacement

Version: 1st Draft

Author:
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Mr C Schildhauer

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Pretoria 0001

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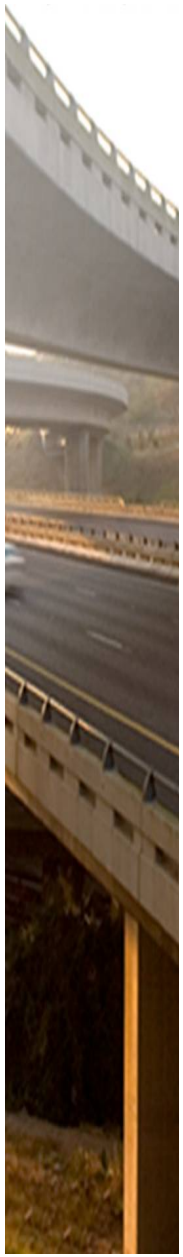
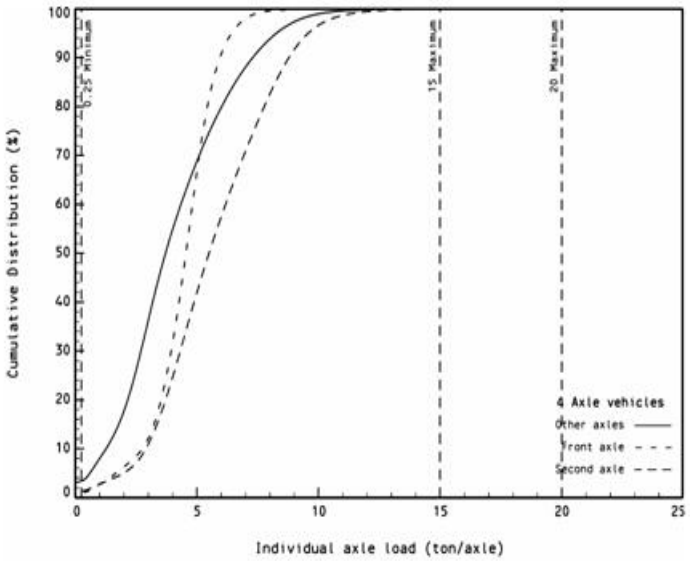
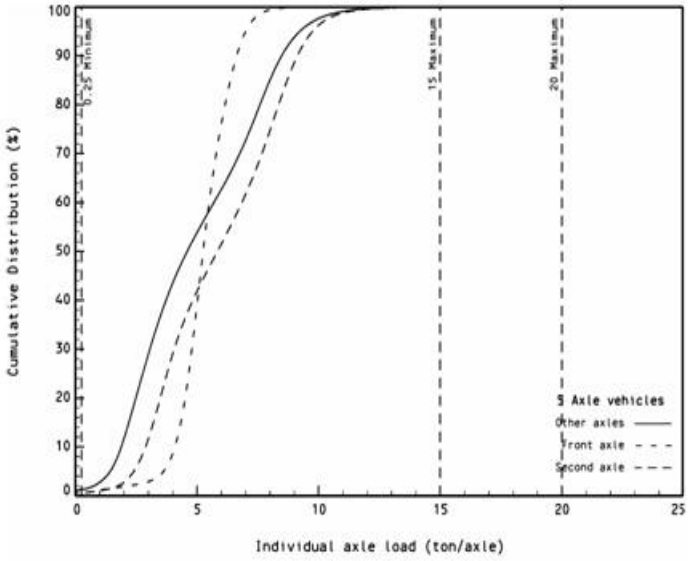
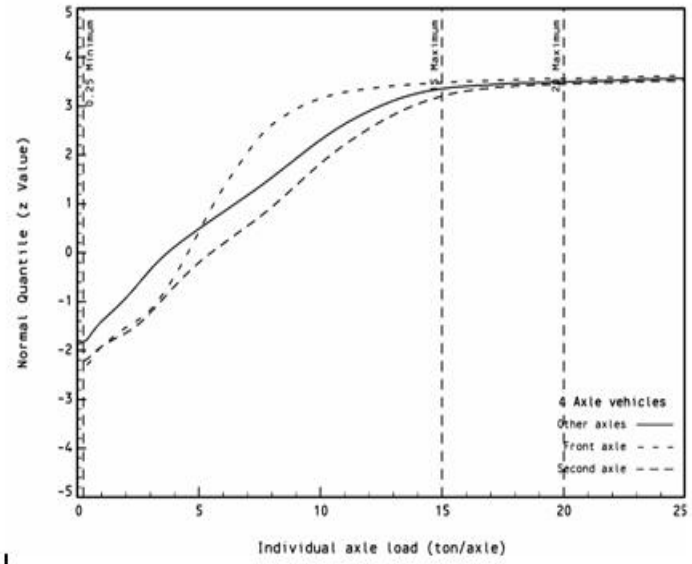
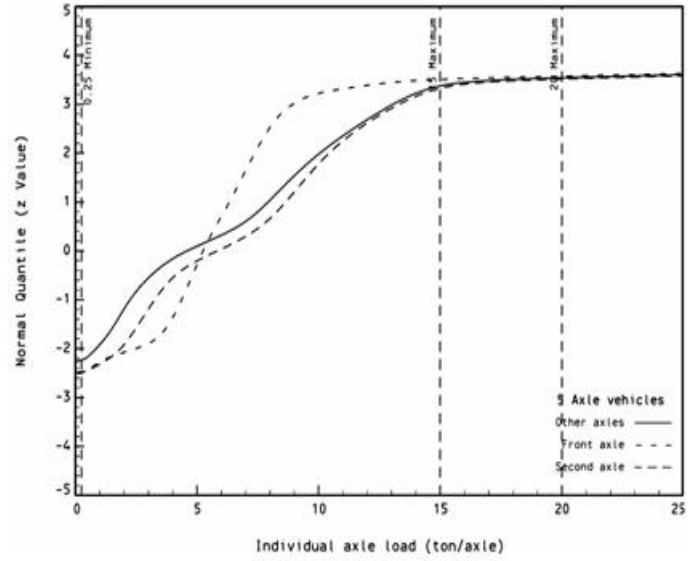
PO Box 36204, Menlo Park 0102
Mikros Systems
Fascia Street 116, Silvertondale



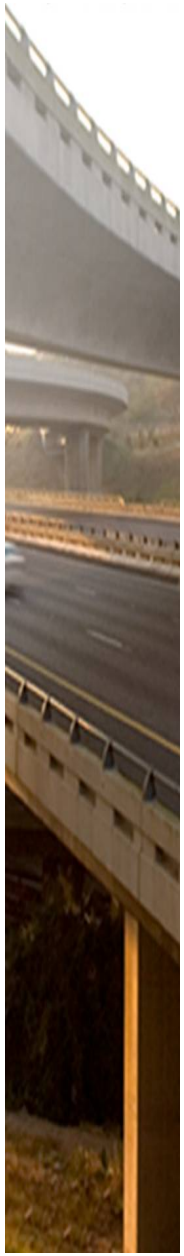








Figures A6.3 and A6.4 Cumulative distribution of individual axle loads – 4 and 5 Axle vehicles



Draft Contract Report SANRAL-SAPDM-ILP-2009-01
October 2009

Revision of the South African Pavement Design Method

Project Focus Area: Integration Level Project – ILP

Restricted

System Design: Mechanistic-Empirical Pavement Deterioration Modelling

Version: Interim 1st Draft

Author:
HL Theyse

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South African National Roads Agency Limited
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Waverley 0186

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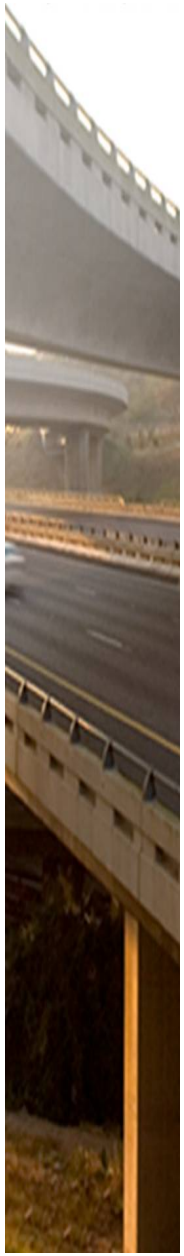


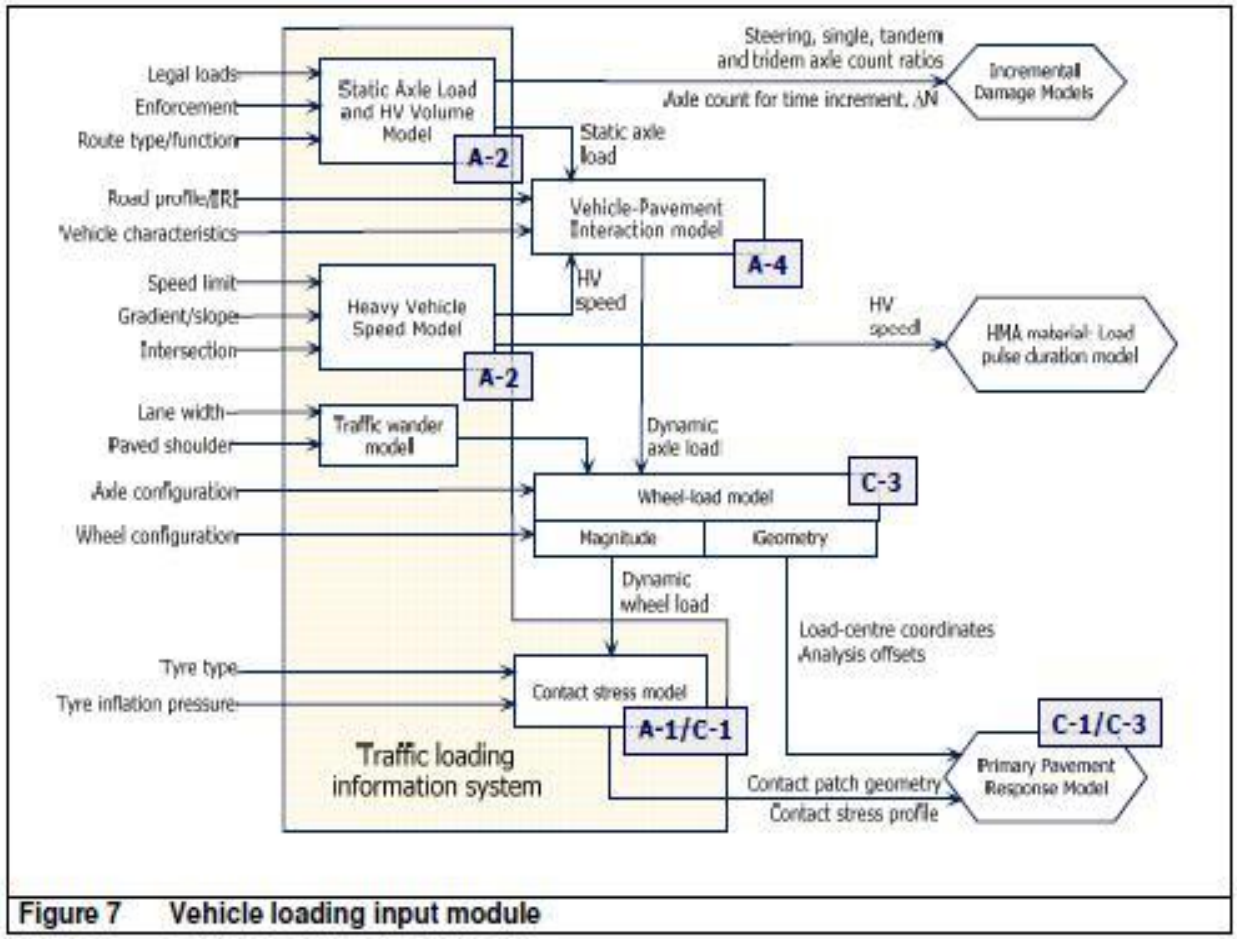
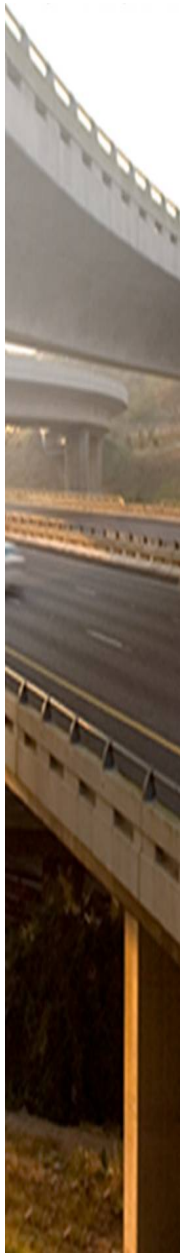


Figure 7 Vehicle loading input module



Draft Contract Report SANRAL/SAPDM/E2/2009/01
Oct 2009

Revision of the South African Pavement Design Method

Project Focus Area E2
Guidelines on collection and interpretation of statistical information

Restricted Draft

Regression Analysis with R and RStat

Version: 2009.3(1)

Authors:
Dr Z Kimmie
Ms S Khuluse
Dr SC van As

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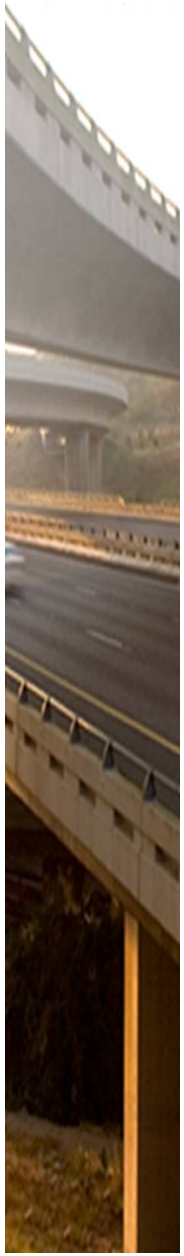
South African National Roads Agency Limited
P O Box 415
Pretoria 0001

PREPARED BY:
CSIR Built Environment
PO Box 395, Pretoria, 0001

SC van As Traffic Engineer CC
PO Box 36204, Menlo Park 0102



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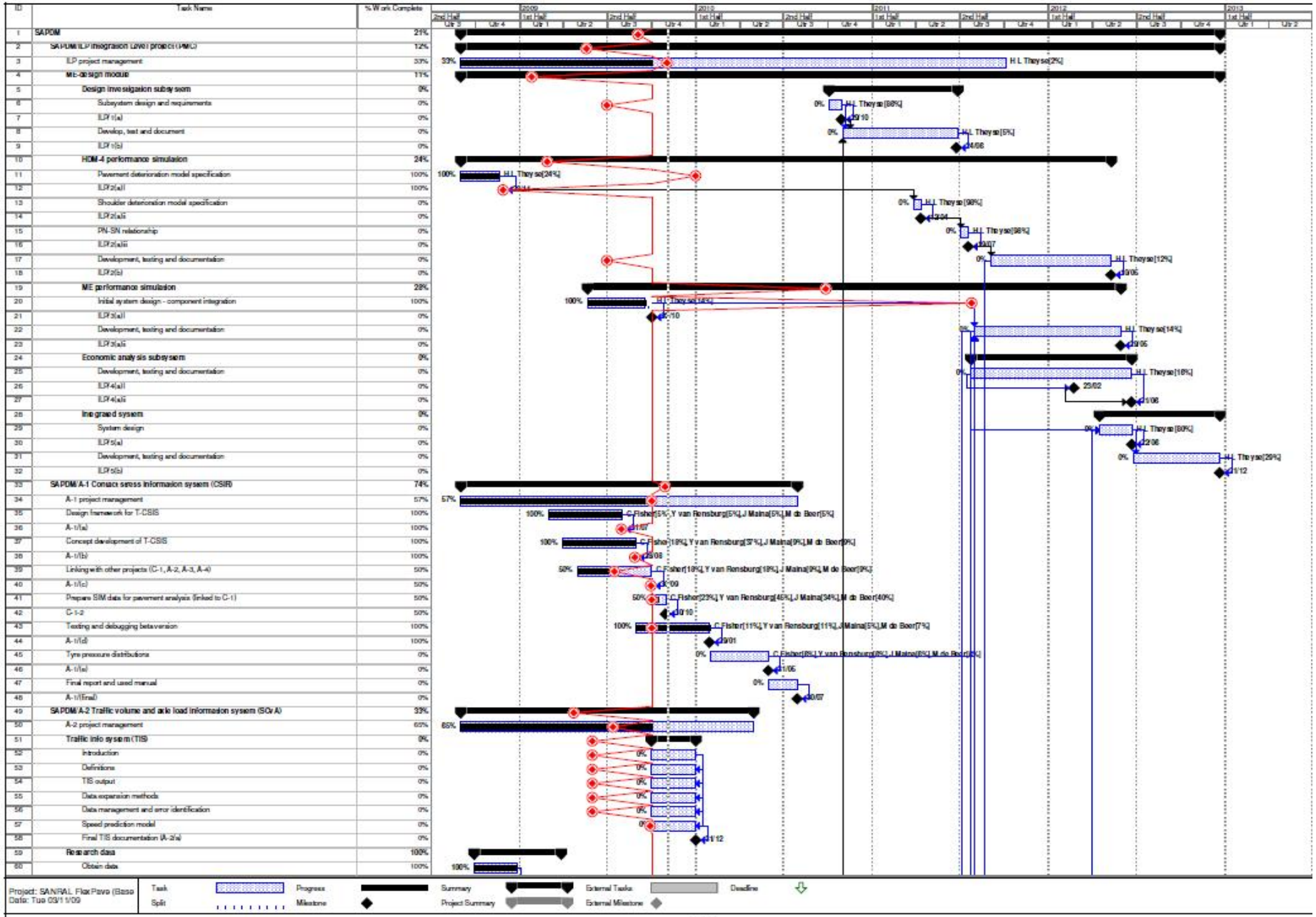
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3 ILP project management 33%
4 ME-design module 11%
5 Design investigation subsystem 0%
6 Subsystem design and requirements 0%
7 ILP1(a) 0%
8 Develop, test and document 0%
9 ILP1(b) 0%
10 HDM-4 performance simulation 24%
11 Pavement deterioration model specification 100%
12 ILP2(a)I 100%
13 Shoulder deterioration model specification 0%
14 ILP2(a)S 0%
15 PN-SN relationship 0%
16 ILP2(a)ii 0%
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18 ILP2(b) 0%
19 ME performance simulation 28%
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21 ILP3(a)I 0%
22 Development, testing and documentation 0%
23 ILP3(a)ii 0%
24 Economic analysis subsystem 0%
25 Development, testing and documentation 0%
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27 ILP4(a)ii 0%
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40 A-1(c) 50%
41 Prepare SIM data for pavement analysis (linked to C-1) 50%
42 C-1-2 50%
43 Testing and debugging beta version 100%
44 A-1(d) 100%
45 Tyre pressure distributions 0%
46 A-1(e) 0%
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48 A-1(final) 0%
49 SAPDM A-2 Traffic volume and axle load information system (SCrA) 33%
50 A-2 project management 65%
51 Traffic info system (TIS) 0%
52 Introduction 0%
53 Definitions 0%
54 TIS output 0%
55 Data expansion methods 0%
56 Data management and error identification 0%
57 Speed prediction model 0%
58 Final TIS documentation (A-2/a) 0%
59 Research data 100%
60 Obtain data 100%
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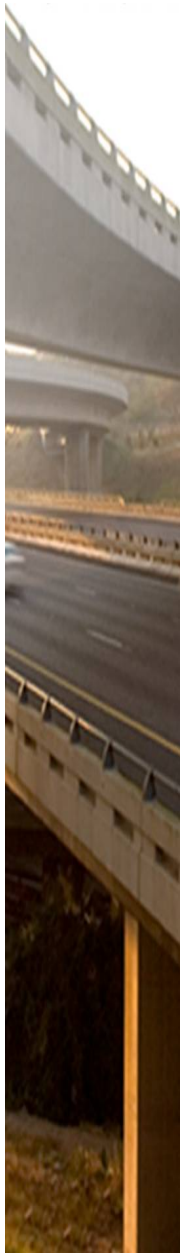
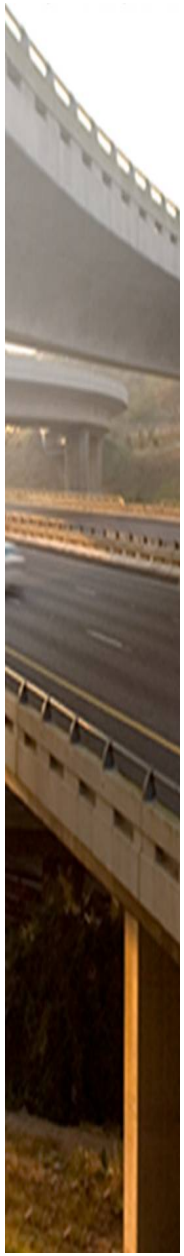
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 1

Issues



- Field Trials – Getting it Going
  - Environmental, Material, Instruments
- Stabilised Materials – Getting it Going
- Surface Seals
  - Rejuvenating the Subgroup Again
- Concrete / Block
  - Starting Subgroup
- Involvement of Students
  - Phd / M.Eng
- Funding
  - Under Estimation of Work / New Work

Thank You



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