

TG2 (2019)
Bitumen Stabilised Materials (BSMs)

Dr Fenella Johns

Road Pavements Forum RPF
November 2019



excellence in bituminous products

Project sponsored by

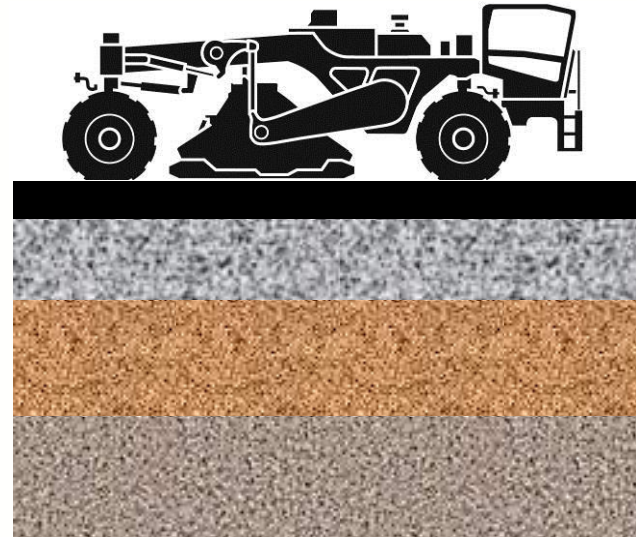
SABITA

Authors:

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Fenella Johns**



- New Chapter: Pavement Investigations
- Materials Classification update (DEMAC)
- Mix Design Revisions
- Pavement Design
 - PN updates
 - ME Design Method (new)
 - Comparisons
- Summary



VISUAL ASSESSMENT

Confirm/modify Uniform Sections

PAVEMENT INVESTIGATIONS

Excavate test pits / slots

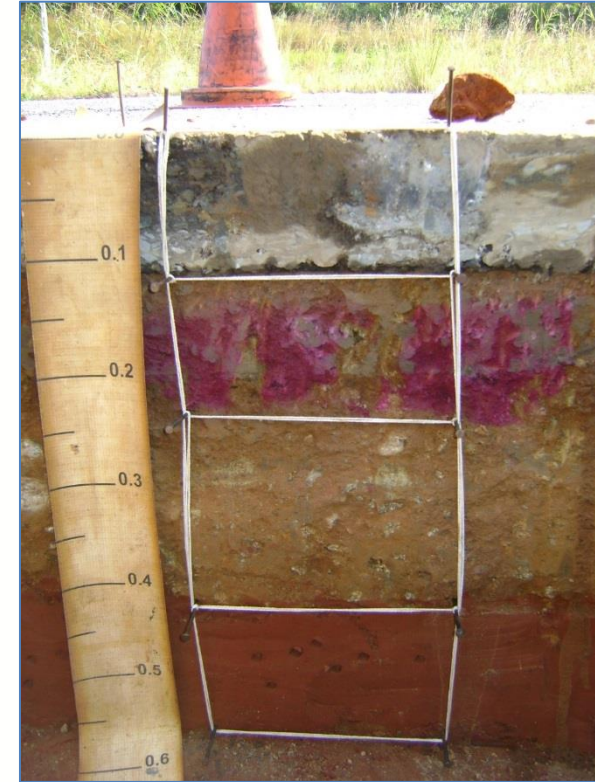
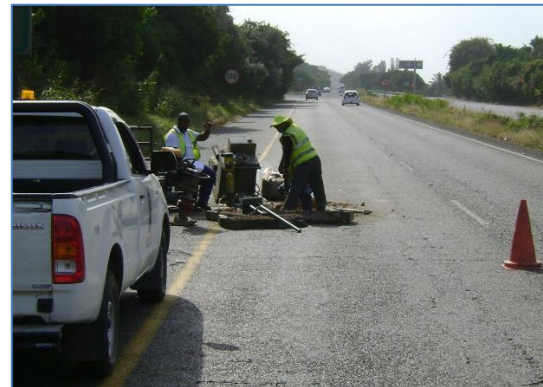
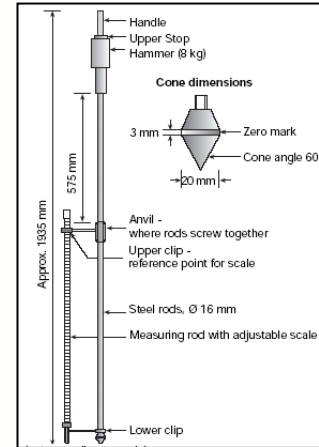
Core extraction

DCP survey

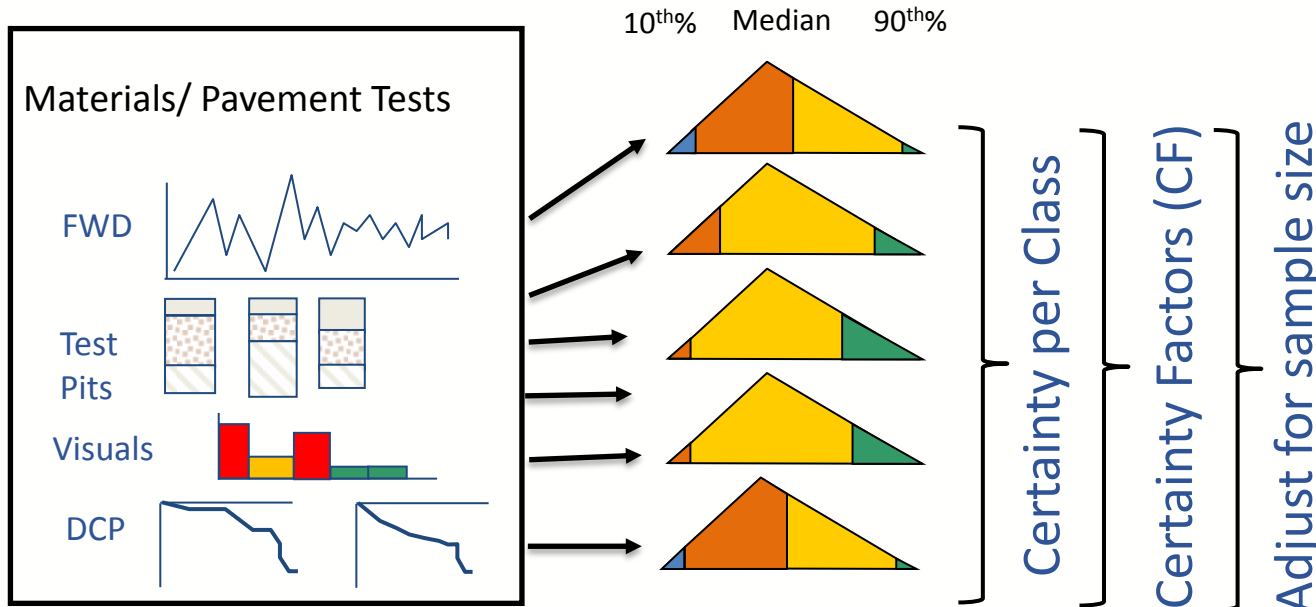
MATERIAL SOURCES

Existing road

Borrow pit/ quarry



MATERIALS CLASSIFICATION - DEMAC SYSTEM



Example output

Cumulative Certainty
DE-G7 with Certainty of 0.7

- UPDATE WITH LATEST PERFORMANCE STUDIES AND INDUSTRY STANDARDS
- VALIDATION OF CERTAINTY FACTORS

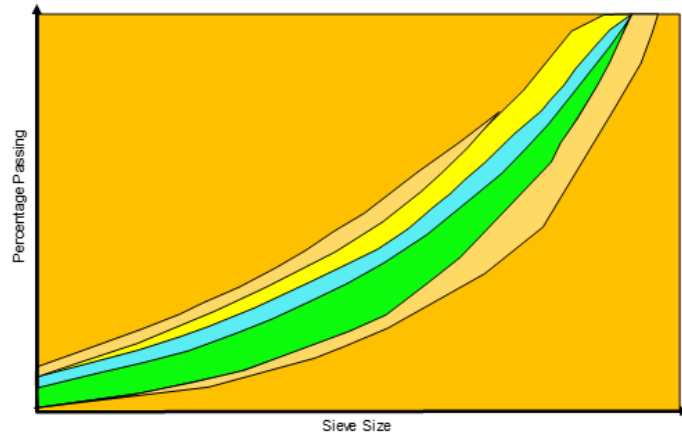
Bayes factor	Evidence Category	CF
> 100	Extreme evidence for H ₁	0.8 – 1.0
30 – 100	Very strong evidence for H ₁	0.6 – 0.8
10 – 30	Strong evidence for H ₁	0.4 – 0.6
3 – 10	Moderate evidence for H ₁	0.2 – 0.4
1 – 3	Anecdotal evidence for H ₁	0 – 0.2
1	No evidence	0



- UPDATED AND NEW MATERIAL CLASSIFICATION RULES

Crushed stone (COTO DS, 2019)
– Refined gradings, additional indicators

Cemented materials – Broader spectrum of parameters; refined DE-EG Class



Crushed Stone grading assignment

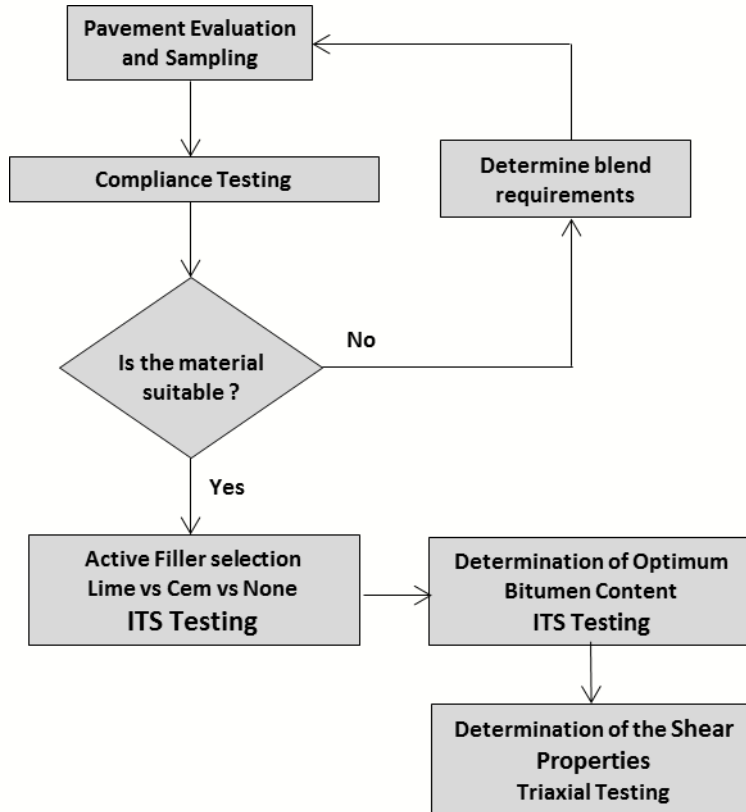
1 2 3 4 5



- RECOMMENDED DESIGN APPLICATION

DEMAC certainty associated with road category

Final Certainty	Recommended Application
< 0.3	Inadequate
0.3 to 0.5	Category D Roads
0.5 to 0.6	Category C Roads
0.6 to 0.7	Category B Roads
> 0.7	Category A Roads

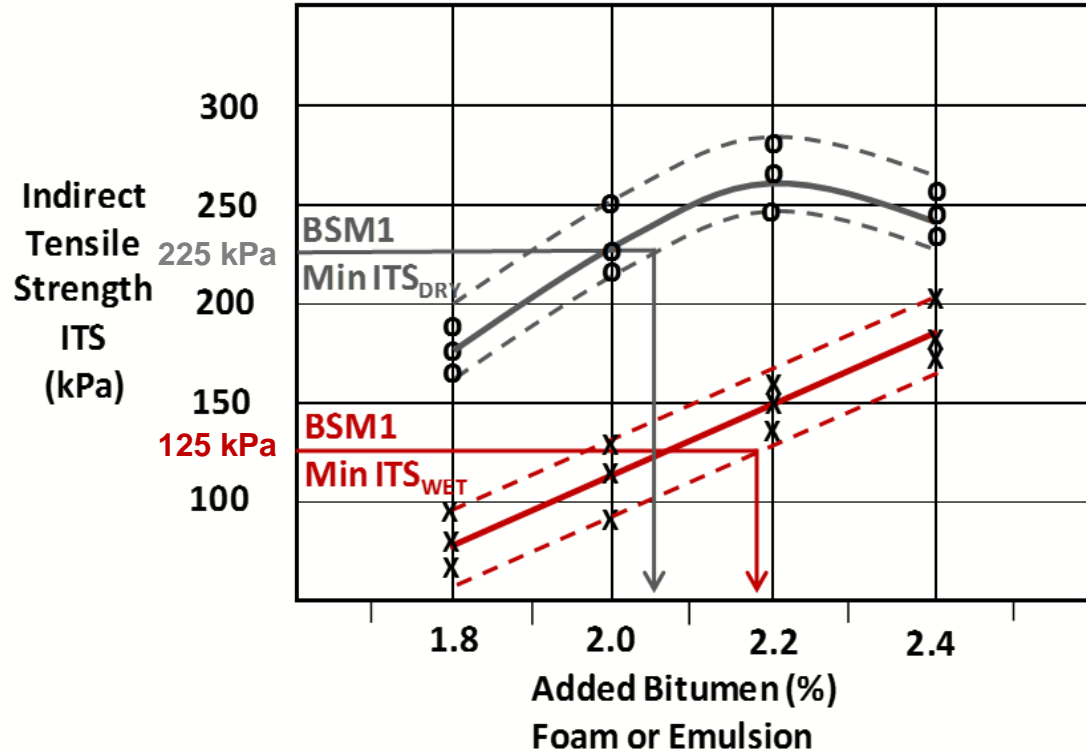


ITS

Triaxial



Class	ITS Limits	
	ITS _{DRY} (kPa)	ITS _{WET} (kPa)
BSM1	> 225	> 125
BSM2	> 175	> 100



NOTES

ITS standard method for BSM

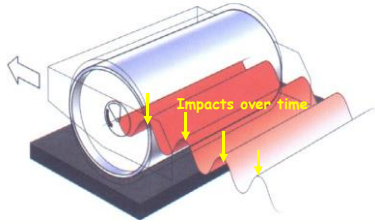
Updated limit for ITS_{wet}

Plot 90th & 10th Percentile

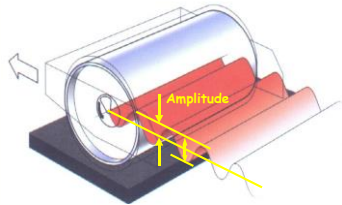
Stats for design BC \neq ave

MIX DESIGN – NEW EQUIPMENT₁

Frequency - vpm (hz)



Amplitude - mm



Vibrating Hammer Compaction

	Field	Lab
Frequency (Hz)	50 – 65	15 – 30
Amplitude (mm)	0.4 – 1	3 – 5

MIX DESIGN – NEW EQUIPMENT₂ (TRIAXIAL)



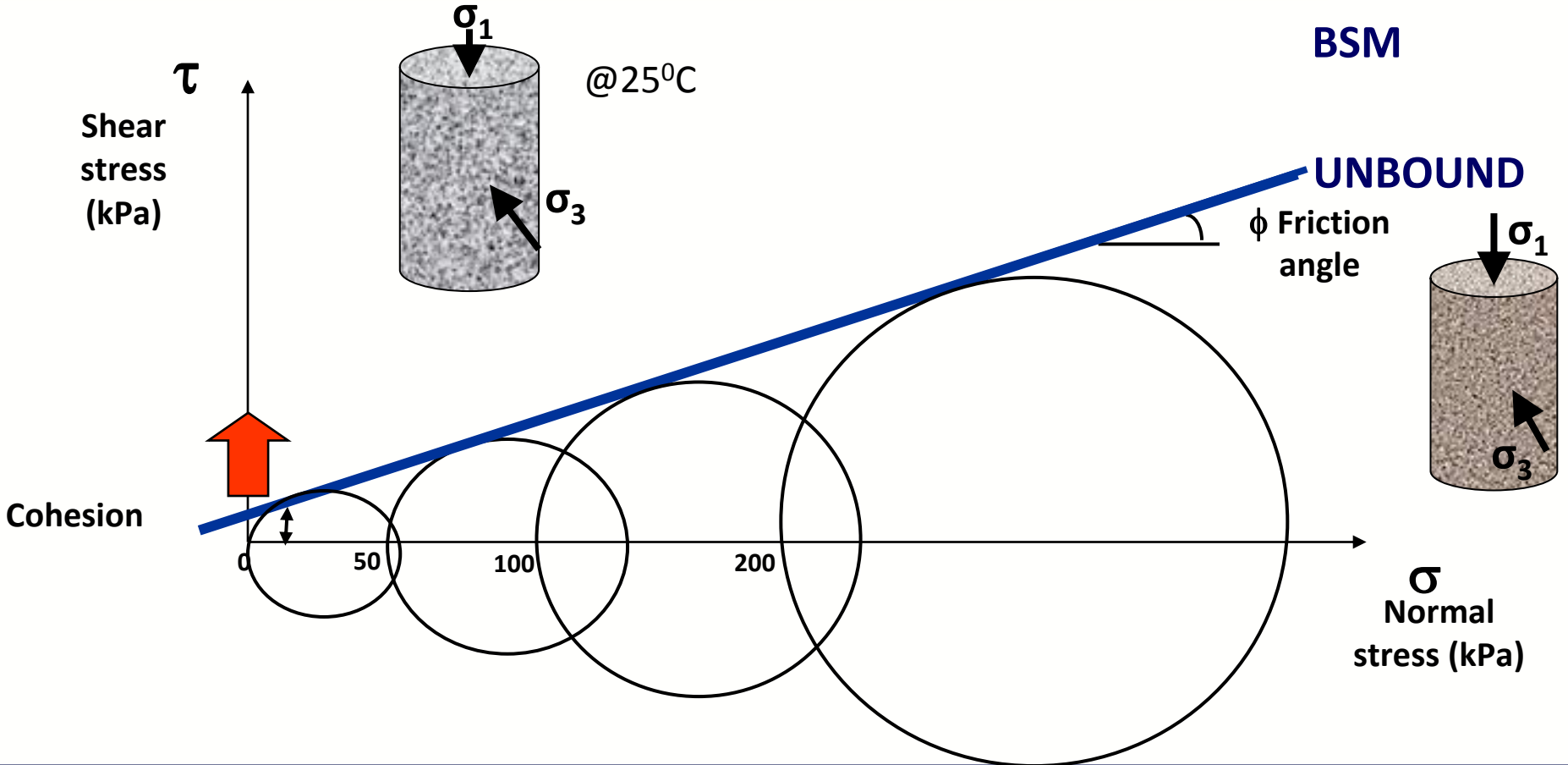
Test at 25°C

**Confining Pressure
0, 50, 100 & 200 kPa**

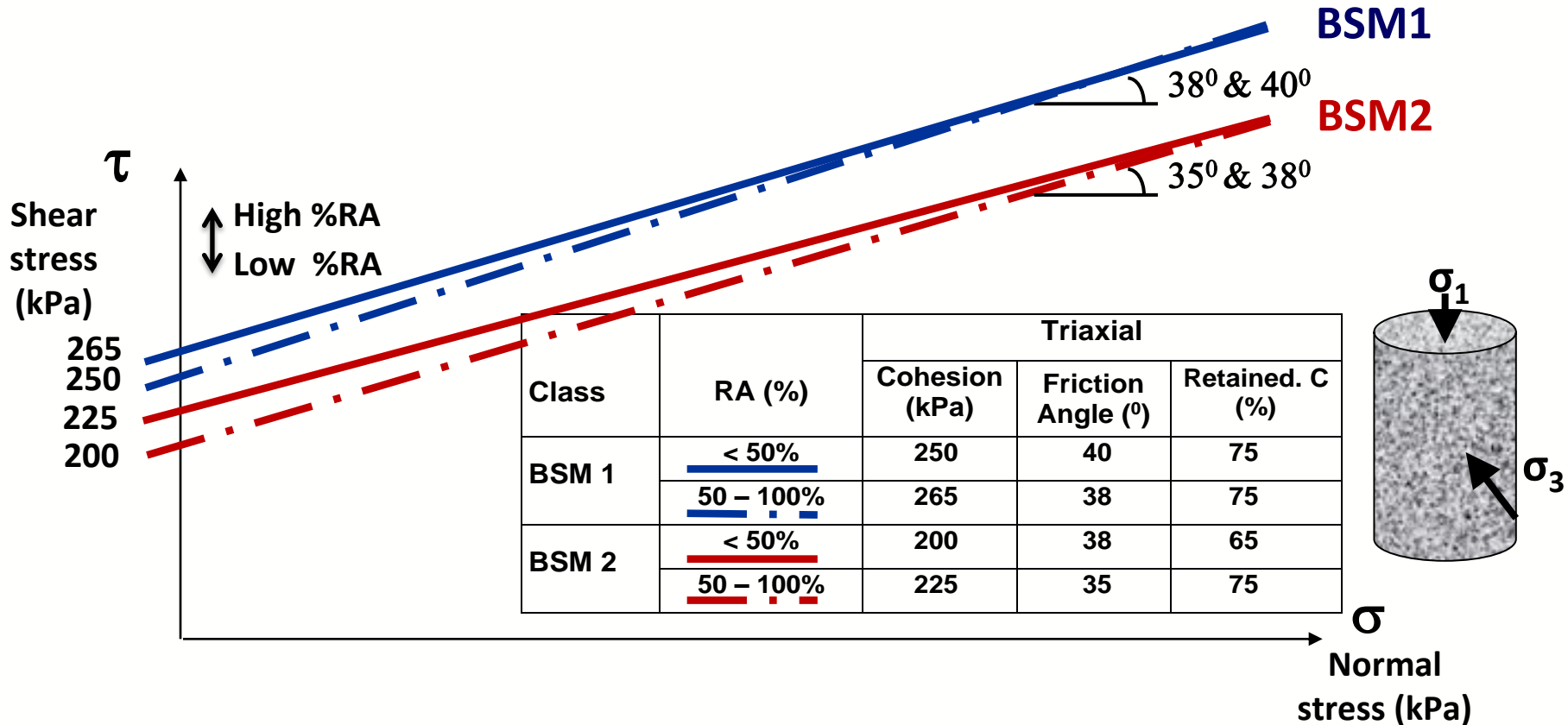
BSM

UNBOUND

ϕ Friction angle



TRIAXIAL LIMIT GUIDELINES (including RA%)



PAVEMENT NUMBER – WHAT'S NEW?

DATA

- 69 LTPP Sections
- TRH 4 Catalogues + SATCC Catalogues

STRUCTURAL ISSUES

- Over-contribution of asphalt & under contribution of CTB - recalibrated
- Asphalt layer max thickness increased to 100 mm
- Asphalt bases included, max thickness 200 mm

SOLUTIONS

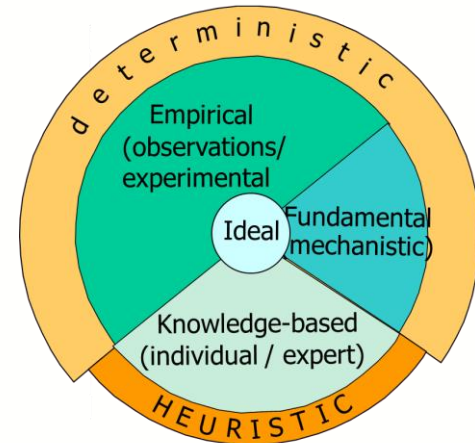
Thickness adjustment factor for stabilized layers

- Asphalt
- Cemented
- BSMs

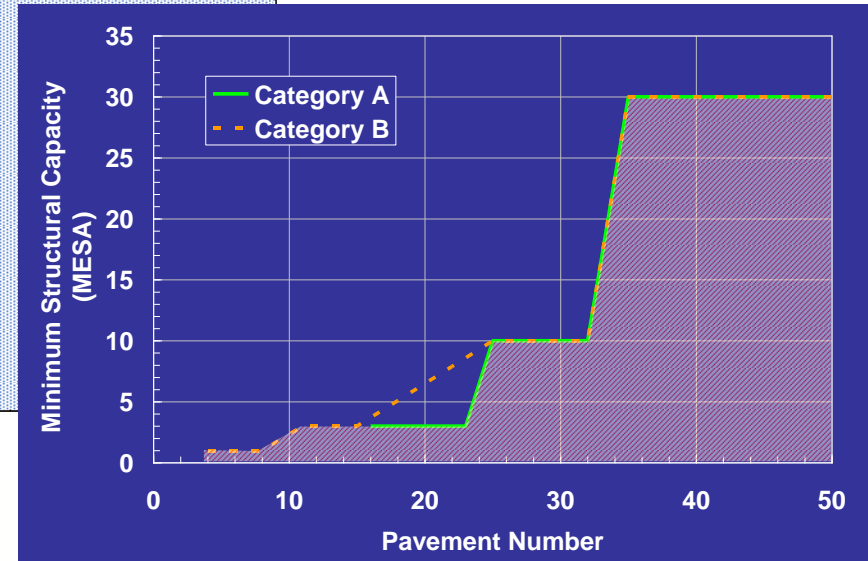
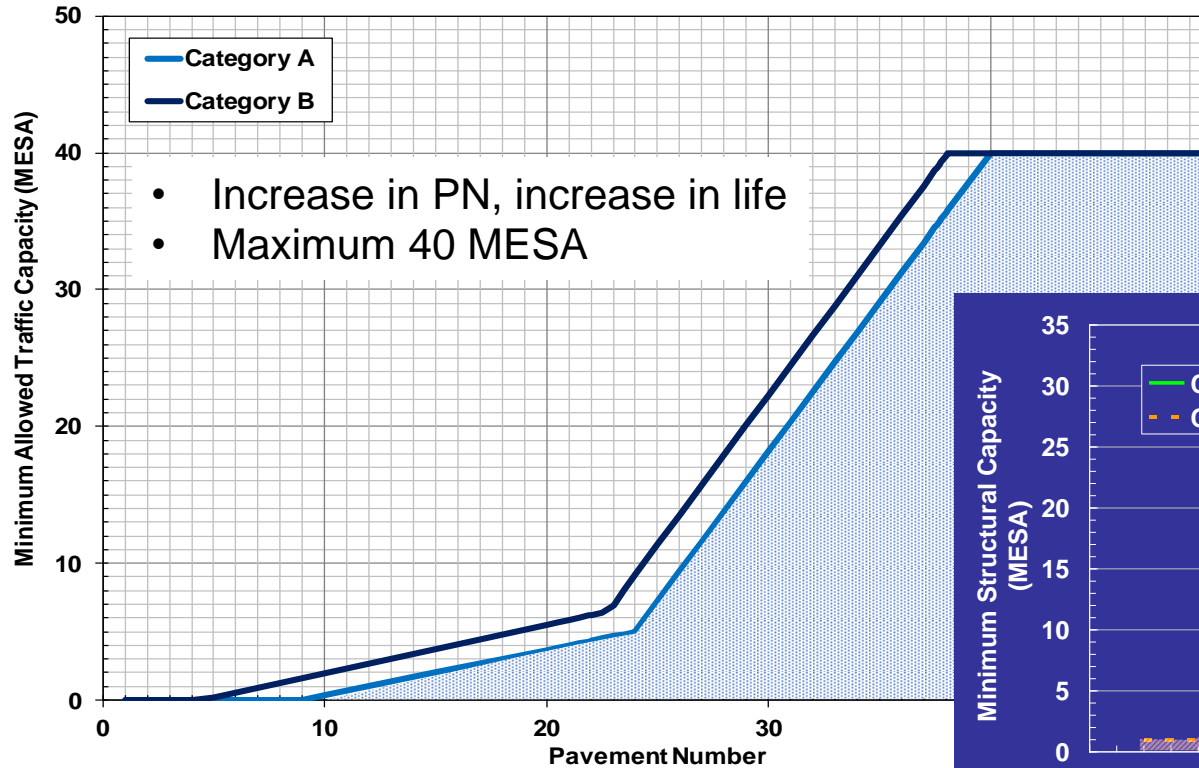
Materials

- EG 4 & 5

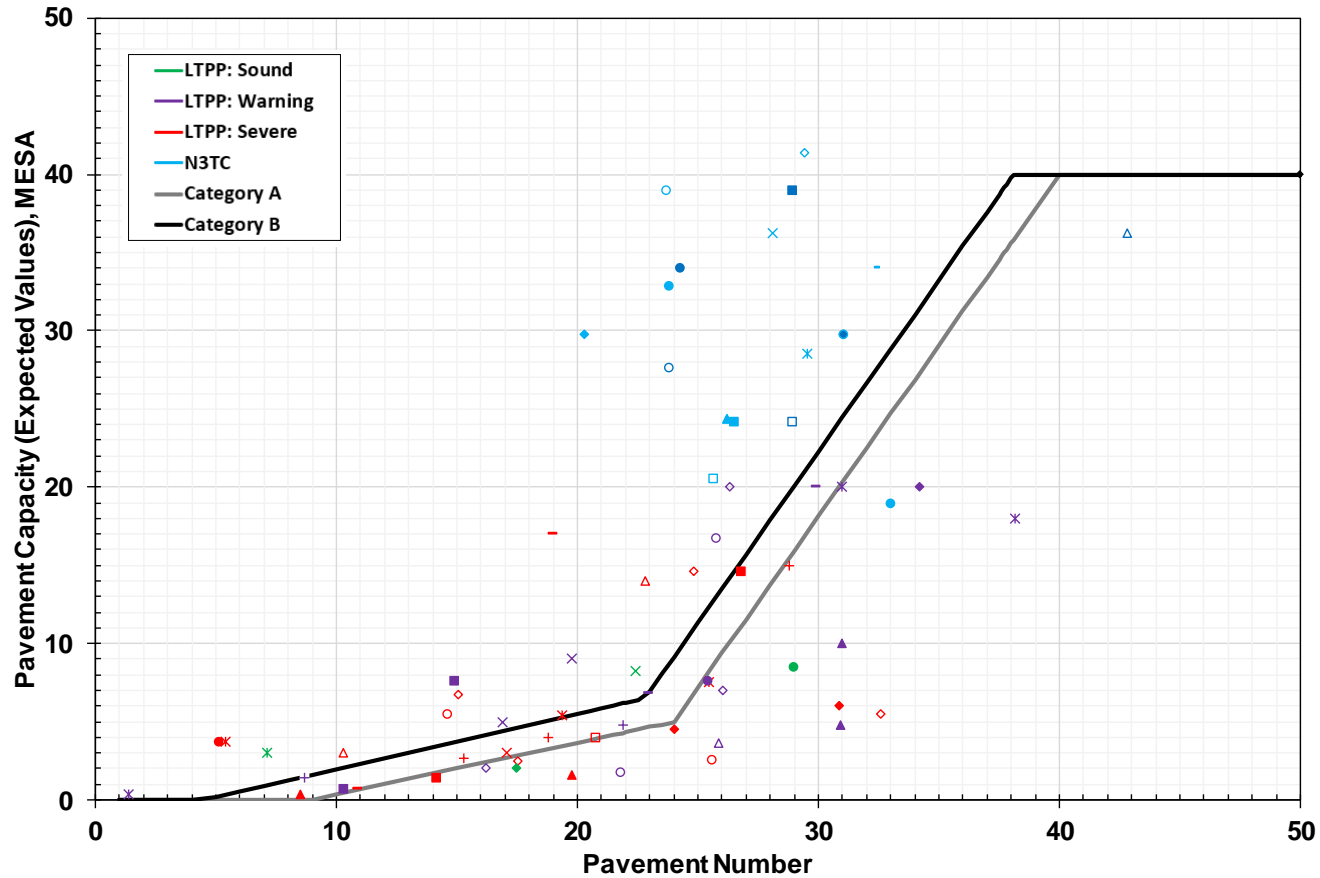
Seals 10 mm thick



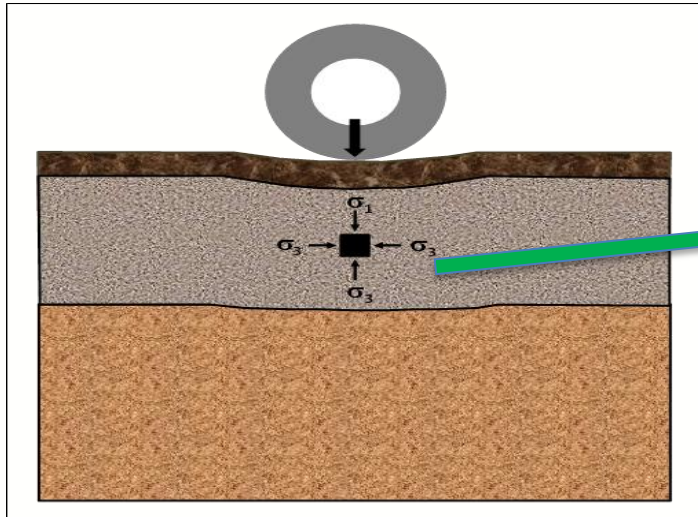
PN - FRONTIER CURVE UPDATE



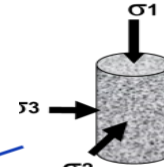
PN - FRONTIER CURVE UPDATE



Deviator Stress Ratio (DSR)



Lab Triaxial Analysis



τ
shear stress

c ↓
Cohesion

ϕ Friction angle

$$\sigma_{1,f} = \frac{(1 + \sin \phi) \sigma_3 + 2.C.\cos \phi}{(1 - \sin \phi)}$$

$\sigma_d = \sigma_1 - \sigma_3$

$\sigma_{d,f} = \sigma_{1,f} - \sigma_3$

σ
Normal stress

DSR

$\sigma_d / \sigma_{d,f} = 60\%$

Plastic Strain $\epsilon_{p,v}$
(Rutting)

$$\epsilon_p = aN^b$$

10mm rut

$\sigma_d / \sigma_{d,f} = 50\%$

$\sigma_d / \sigma_{d,f} = 40\%$

$\sigma_d / \sigma_{d,f} = 30\%$

Design Life

Load (Axle) Reps N

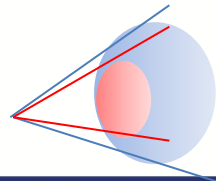
Reliability	A	Rut limit
95%	1.71113	10
90%	1.79873	15
80%	1.88733	20
50%	2.00443	25

$P_{mod} = \% \text{ Max Dry Density}$



$$\log N = A - 57.286 \cdot DSR^3 + 0.0009159 \cdot PM_{DD} \cdot RetC$$

Deviator Stress Ratio

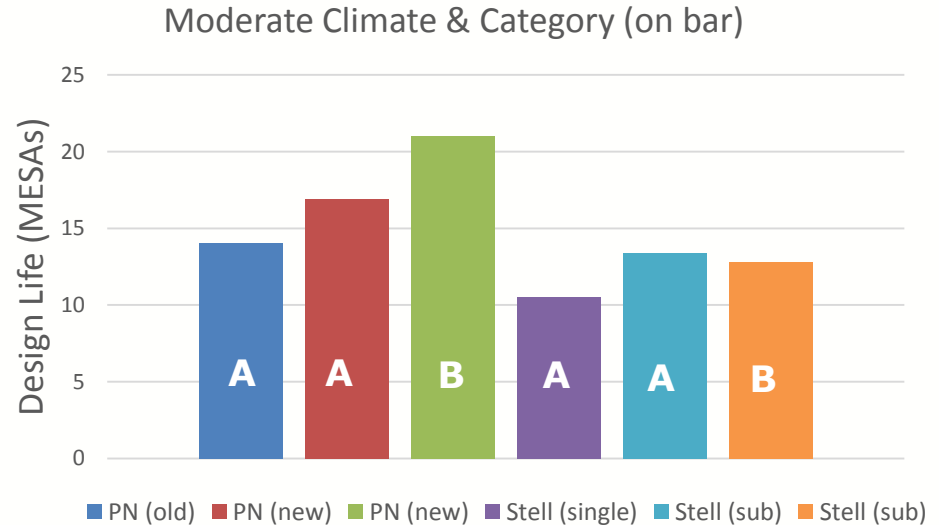
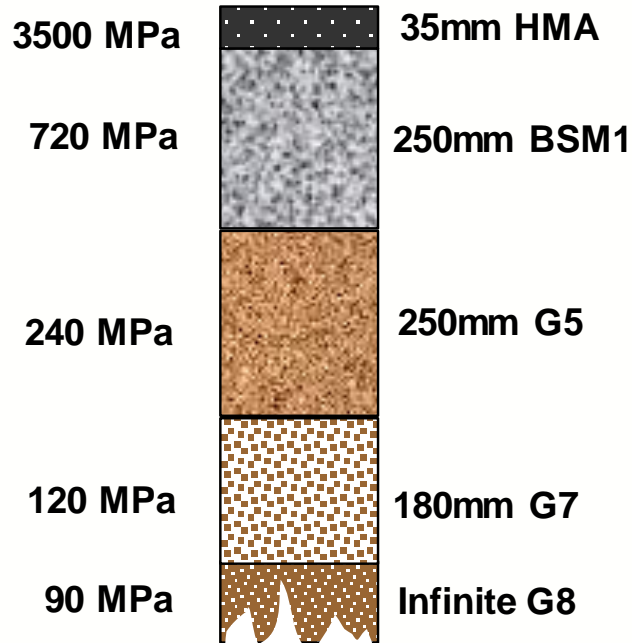


Retained Cohesion



(Biermann, Stell Univ)

MECHANISTIC EMPIRICAL DESIGN - PAVEMENT 5



Note: Single layer & Sub-layer Analysis at 1/4 depth

MECHANISTIC EMPIRICAL DESIGN - BSM2 DEFAULTS



BSM2

Applying the Guideline Limit (**lowest**) for **all 3** shear parameters, is **over-conservative**
Default values are recommended

Class	Percent of Reclaimed Asphalt	ITS (kPa)		Triaxial		
		ITS _{DRY}	ITS _{WET}	Cohesion (kPa)	Friction Angle (°)	Retained Cohesion (%)
BSM 1	< 50%	225	125	250 – 300 (250)	40 – 50 (40)	70-85 (75)
	50 – 100%	225	125	265 – 350 (265)	38 – 45 (38)	75-90 (75)
BSM 2	< 50%	175	100	200 – 250 (225)	38 – 40 (39)	65-75 (70)
	50 – 100%	175	100	225 – 250 (238)	35 – 40 (37)	70-85 (75)

BSM1

Adjustments to **NEW** Guideline limits (**more conservative**)

PAVEMENT INVESTIGATION

- **Insufficient rehab strategy**

MIX DESIGN

- **Performance based** needs
- Laboratory **testing skills**
- **Material** link to structural design

STRUCTURAL DESIGN

- **Bias** in PN design – HMA & CTB
- **Unrealistic** ME designs 2002

CONSTRUCTION

SOLUTIONS

Supplementary **evaluation procedures**
Synthesis of materials data (DEMAC)

ITS for prelim tests, then **triaxial** (shear)
Training and **certification** implemented
Shear properties used directly **in design**

Updated & additional **LTPP data** adjustment
New ME Method with updated data

In place **upgrade** + In place **update**

Thhhhhank youuuu !

