

Bituminous Stabilized Materials: Structural Design and Materials Classification

**APT Steering Committee Feedback
February 2008**

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Today's Presentation

- *Brief overview of methods*
 - *Pavement number*
 - *Materials classification*
- Software
- Validation
 - Software user statistics
 - Some validation results
 - User comments

Software

- www.bitstab.roadrehab.com
- Software runs on website
- Background info
 - Descriptions
 - Download backup reports

Review Needs

- Need industry representatives to review:
 - Structural design method
 - Approach to material classification
 - Material class limits
 - “Reasonableness” of results

Website Users: Statistics

- 48 registered users
 - Widely represent industry
- Number of time accessed sites:
 - > 5 logins: 10
 - 2 – 4 logins: 14
 - 1 logins: 9
 - 0! logins: 15

Website users

User	Company	Logins
Joe Grobler	Gautrans	20
Rennie Shunmugam	Loudon International	15
Deon Hyman	Vela VKE	11
Arno Hefer	MAS	9
F Le Roux	Nyeleti Consulting	8
Otto Schnitter	BKS(Pty) Ltd	7
Anton Botes	Vela VKE	6
Andre Greyling	BVi Consulting Engineers	6
Juergen Gentz	Jeffares & Green (Pty) Ltd	5
Mzimkhulu Nduna	VelaVKE Consulting Engineers	5
Dave Collings	Loudon International	3
Marshall Thompson	University of Illinois	3
Theo La Grange	EFG Engineers	3
Gerhard Fourie	PD Naidoo & Associates	2
Carlos Seara	BKS Consulting Engineers	2
Dewald Hutten	V&V Consulting Engineers	2
Corne Roux	SANRAL	2
Andries Bester	WSP	2
Marius Prinsloo	Lidwala	2
Rob Archibald	Vela VKE	2
Eric Lathleiff	eThekwini Municipality	2
Qhubekani Mtimkulu	eThekwini Municipality	2
Mynhardt Augustyn	VelaVKE	2

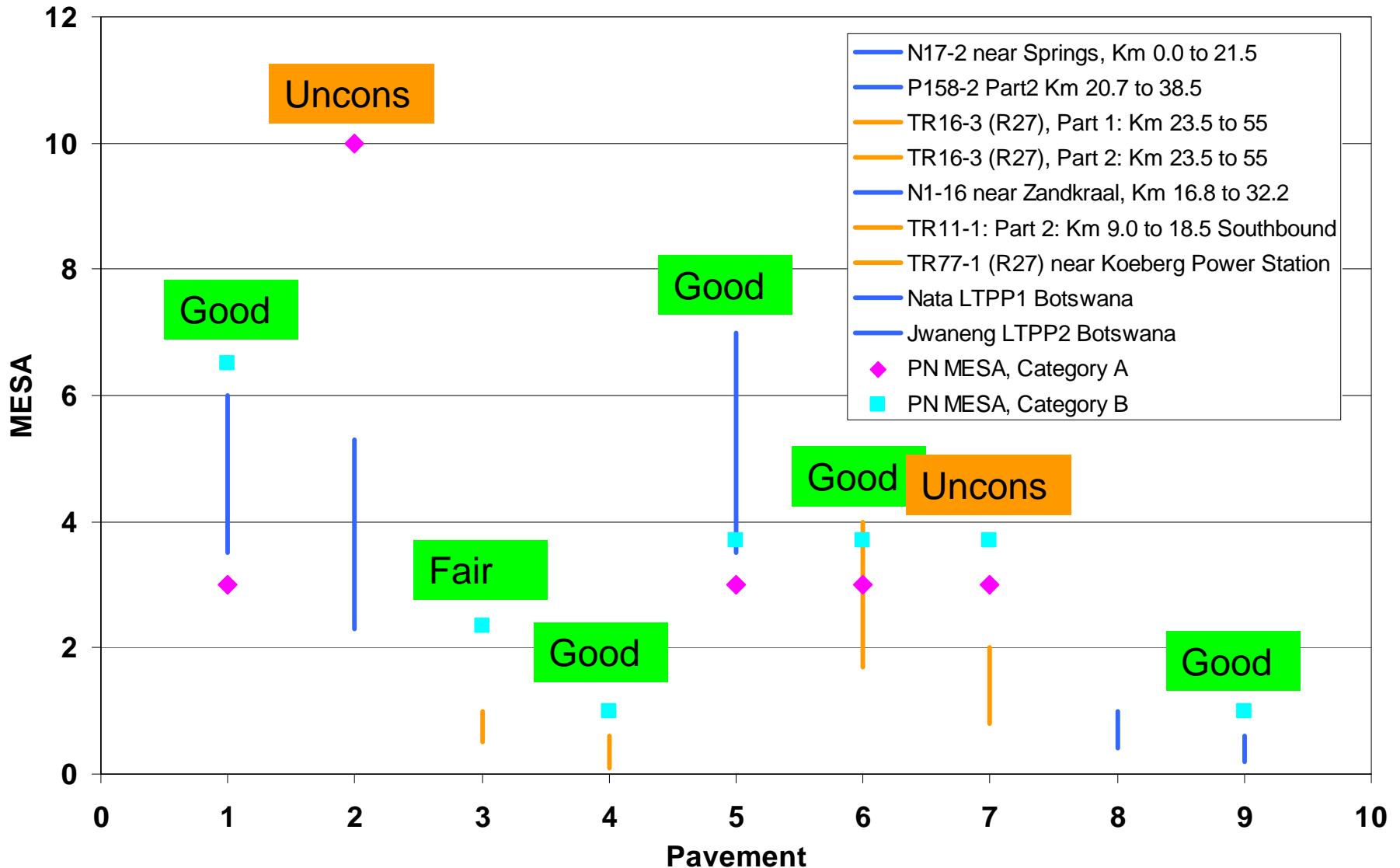
Website users

Daniel Mtimkulu	eThekwini Municipality	2
Pierre Barkhuizen	Kantey&Templer	1
Hendri Schoonraad	Mosomo Consulting Engineers	1
Pieter Botha	PHi	1
Seelan Naidoo	Ethekwini Municipality	1
John Onraet	Much Asphalt (Pty) Ltd	1
Philip Joubert	SSI	1
Peter Nganjo	BKS (Pty) Ltd	1
Riaan Burger	PD Naidoo and Associates	1
Mike Bouwmeester	WSP SA Civil and Structural Engineers	1
Mike Yu	Wirtgen	0
Shaheen Nackerdien	ASCH	0
Steph Bredenhann	WSP SA Civil & Structural Engineers	0
Wynand Steyn	CSIR BE	0
PW de Bruin	Tshepega	0
Johan Opperman	SNA Civil & Structural Engineers	0
Gerhard van Blerk	Transit	0
Jacques van Wyk	Soillab PTY LTD	0
Sandile Gqoboka	Knight Piesold	0
Arthur Taute	Vela VKE	0
Wimpie Janse van Rensburg	Siyenza Engineers	0
Ridwaan Ghany	Madan Singh & Associates	0
MC Barnard	BKS (Pty) Ltd	0
Qhubekani Mtimkulu	eThekwini Municipality	0
Matthew Houston	Atkins	0

Validation of PN

- Compared PN estimated pavement capacity with actual capacity using LTPP pavements in PPIS database
 - Granular on granular pavements
 - Granular on cemented pavements

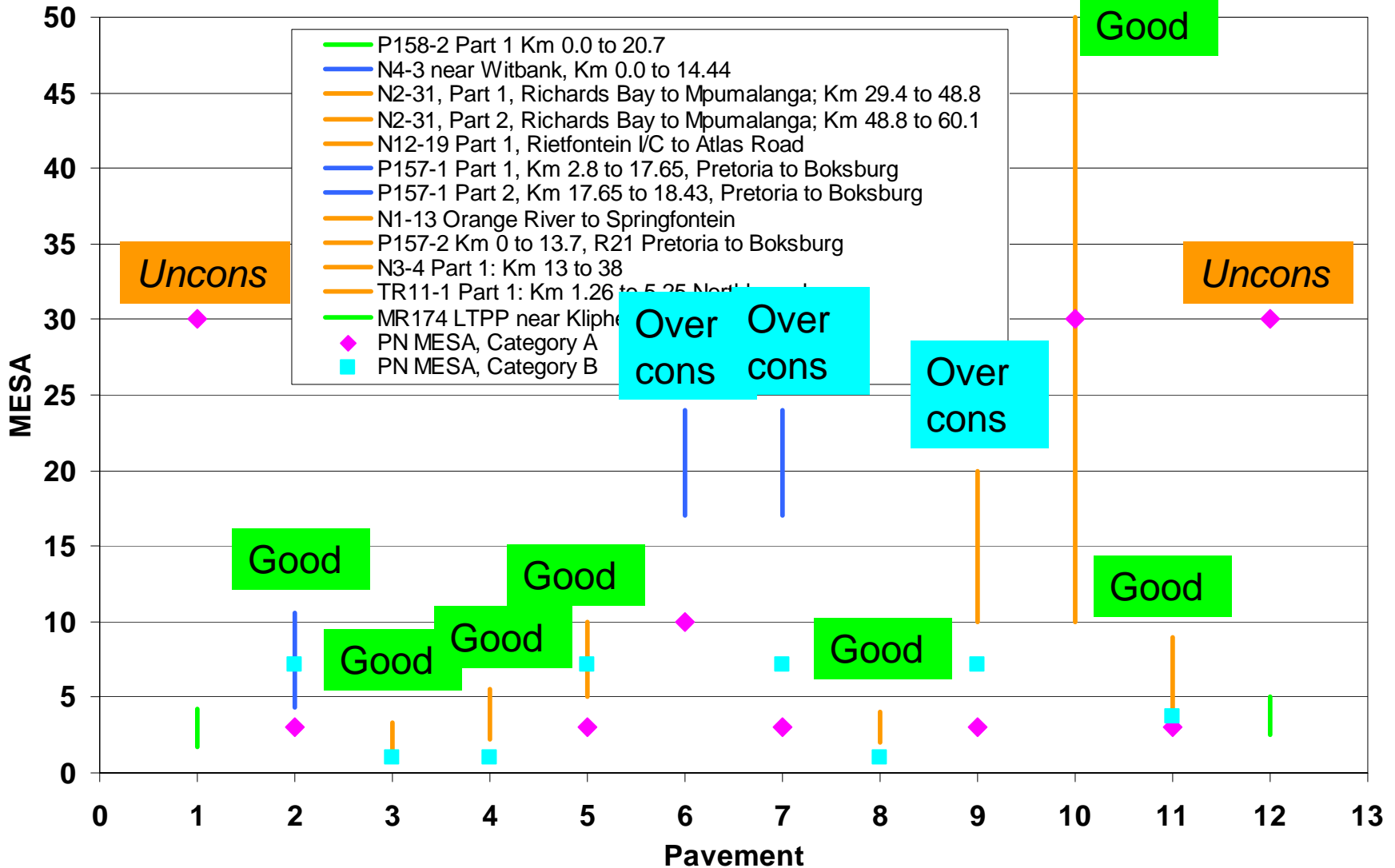
PPIS: Granular over Granular



Validation (Unbound subbase)

Road	Climate	Traffic	Condition	Validation
N 17-2	Mod.	3.5 – 6	Warning	Good
P158-2 (2)	Mod.	2.3 – 5.3	Warning	Unconservative
TR16-3 (1)	Dry	0.5 – 1	Severe	Fair
TR16-3 (2)	Dry	0.1 – 0.6	Severe	Good
N1-16	Dry	3.5 – 7	Warning	Good
TR11-1	Mod.	1.7 – 4	Severe	Good
TR77-1	We	0.8 – 2	Severe	Slightly unconservative
Nata (Botswana)	Mod.	0.4 – 1	Warning	N/A
Jwaneng (Botswana)	Dry	0.2 – 0.6	Warning	Good

PPIS: Granular / Cemented



Validation (Cemented subbase)

Road	Climate	Traffic	Condition	Validation
P158-2 (1)	Moderate	1.7 – 4.2	Good	Unconservative
N4-3	Moderate	4.3 – 10.6	Warning	Good
N2-31 (1)	Wet	1.3 – 3.3	Severe	Good
N2-31 (2)	Wet	2.2 – 5.5	Severe	Good
N12-19 (1)	Moderate	5 – 10	Severe	Good
P157-1	Moderate	17 – 24	Warning	Over conservative
P157-1	Moderate	17 – 24	Warning	Over conservative
N1-13	Dry	2 – 4	Severe	Good
P157-2	Moderate	10 – 20	Severe	Over conservative
N3-4	Wet	10 – 50	Severe	Good
TR11-1	Moderate	3.5 – 9	Severe	Good
NR174	Moderate	2.5 - 5	Good	Unconservative

User Comments (PN Method)

Validation of Material Classification

- Compared design equivalent material classes with those determined by engineer
 - TR16-3 (Nieuwoudtville to Calivina)
 - N1-13 (Orange River to Springfontein)

Validation: Material Classification

- TR16-3 (Nieuwoudtville to Calvinia)

Layer	Materials class (relative certainty)	Original SNA report	Comment
Base	G3 (0.67 certainty) [G4 (0.62 certainty)]	G5, with some G4	Unconservative
Subbase	G6 (0.56 certainty)	G5, with some G6	Appropriate
Subgrade	G6 (0.79 certainty)	G5, with some G6-G8	Appropriate

Validation: Material Classification

- N1-13 (Orange River to Springfontein)

Layer	Materials class (relative certainty)	Original report	Comment
Base	G2 (0.66 certainty)	G3 or G4	Unconservative
Subbase	G6 (0.69 certainty)	G6	Appropriate
Subgrade	G6 (0.73 certainty)	G6	Appropriate

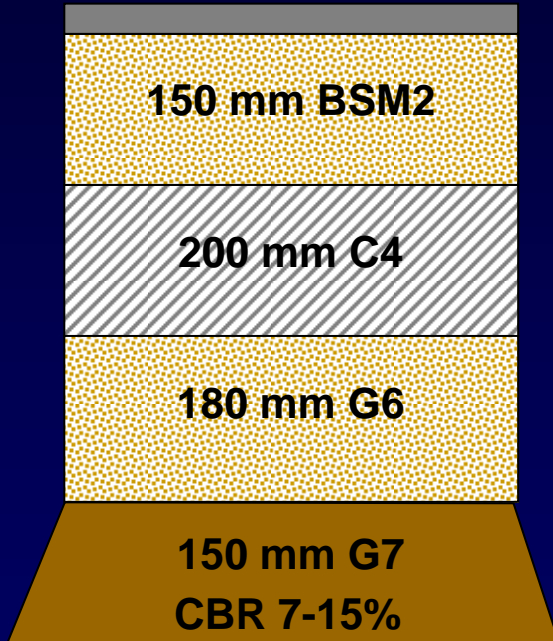
User Comments (Material Classification)

What's next?

- Further validation
- Solicit comments from users (if possible)
- Make adjustments if deemed necessary
- Strategy for continued population of databases
- Finish by end March

Example, Moderate Region

1. Material Classes



2. Determine subgrade stiffness (140 MPa)
3. Adjust for CBR (26 MPa)
4. Adjust for climate (118 MPa)

5. Assign modular ratio's and max stiffness

MR = 2, $E_{Max} = 450$
MR = 3, $E_{Max} = 400$
MR = 1.8, $E_{Max} = 180$
118 MPa

6. Calculate Layer ELTS Values

ELTS = 450 BCF = 0.7
ELTS = 400 Thickness Adj = 0.4
ELTS = min(212, 180) ELTS = 180
118 MPa

6. $ELTS = \min(E_{support} * MR, E_{max})$

7. Layer PN = thickness * ELTS

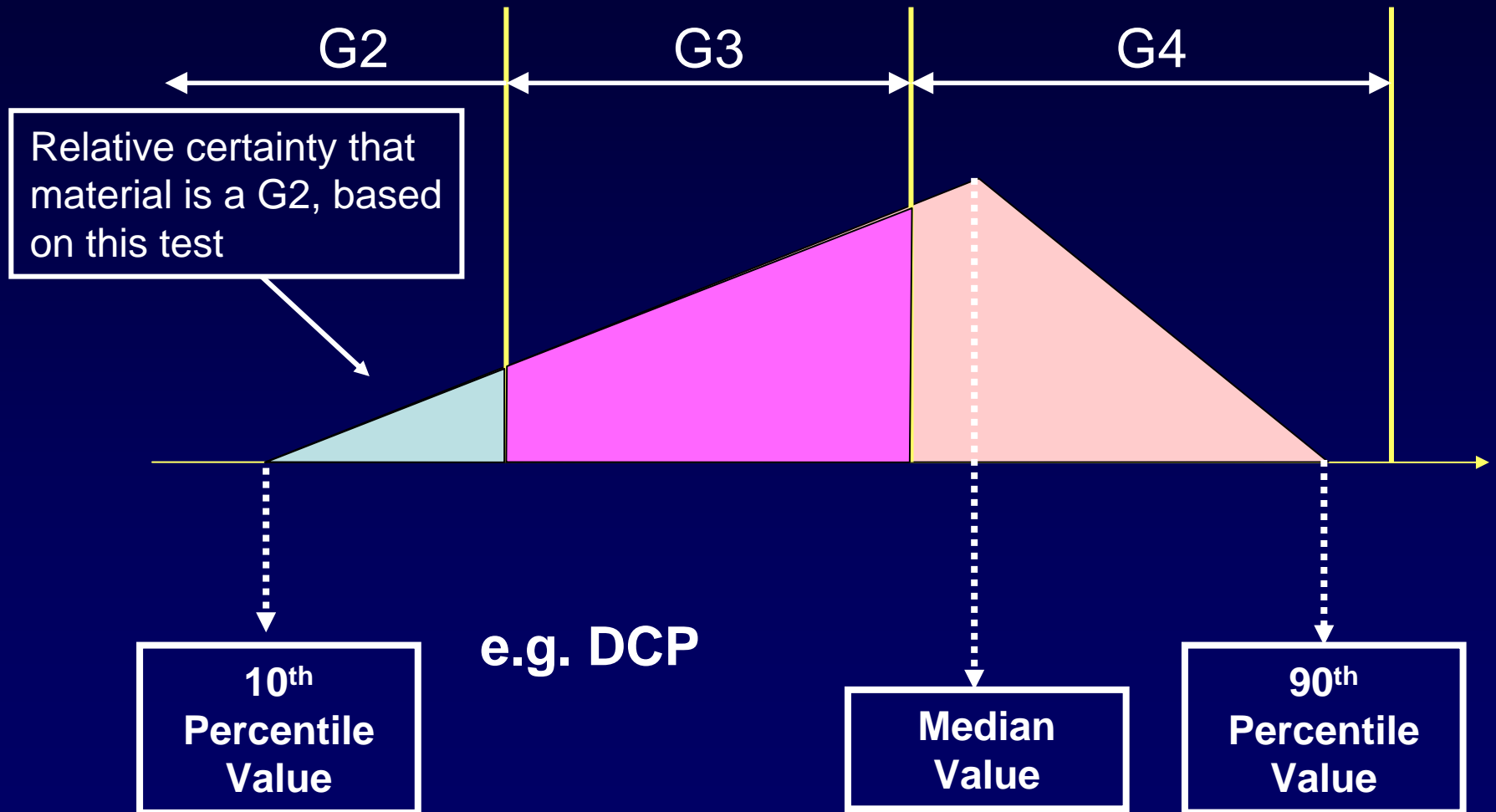
8. $PN = \sum \text{layer PN}$

Classification Parameters and Certainty Factors: Granular and Cemented Materials

- Soaked CBR (0.4)
- Grading, % passing 0.075, GM (0.4, 0.3, 0.2)
- Relative density (0.3)
- DCP penetration (0.4)
- FWD stiffness (0.3)
- Consistency (0.2)
- Plasticity Index (0.4)
- Moisture content (0.3, 0.2)
- Aggregate crushing value (0.3)
- Number of fractured faces (0.3)
- Historical performance (0.4)
- Evidence of active cement (0.3)

- Also adjust for sample size

Assigning Material Class Confidence for Specific Indicators



Synthesis of Results

- Sequentially process data to obtain cumulative certainty that material is a G1, G2, etc.

	Design Equivalent Material Class			
Available Information	G3	G4	G5	G6
Grading	0.1	0.2	0.0	0.0
Plasticity Index	0.1	0.35	0.1	0.0
	Refusal	1.5	3.0	6.0
Rule certainty = 0.3				
C(Hypothesis DCP Info)	0.1	0.47	0.23	0.0
Backcalc. Stiffness	0.1	0.59	0.30	0.0