Mending Our Ways: South African Experience

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bvi 50 YEAR CELEBRATION EST 1967-2017
• ENGINEERING • PROCUREMENT • MANAGEMENT

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Make today matter

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Narrative

- Transportation infrastructure experiences issues – since always?

Ancient Romans used molten iron to repair their stone-paved roads

Potholes have been causing humans headaches since ancient times.

- https://www.zmescience.com/science/news-science/ancient-roman-road-repair-0423/
- Poehler, E.E., van Roggen, J. and Crowther, B.M., 2019. The iron streets of Pompeii. American Journal of Archaeology, 123(2), pp.237-262.

Narrative

- Transportation infrastructure experiences issues – since always?

- Minding & Mending required
  - 1st understand - then do

    - ***Minding*** *- give stress to statement that one is making so that preceding or following statement will not be misunderstood*
    - ***Mending*** *- to begin to behave well, having until now behaved badly*

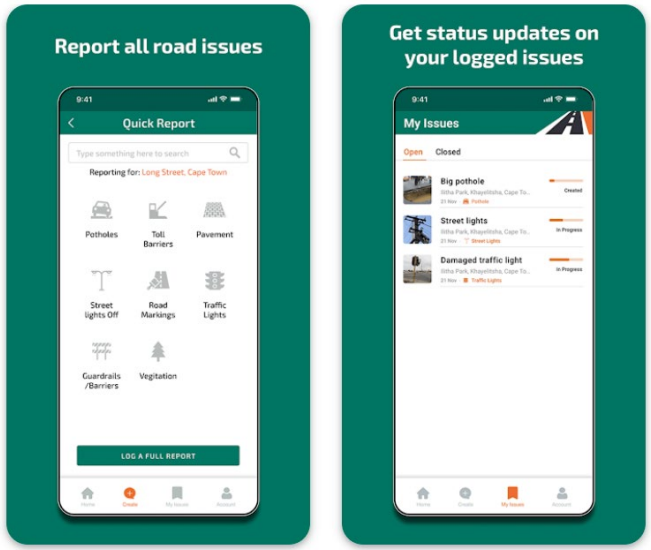
- Some South African experiences
- Co-author acknowledgement
  - André Greyling - bvi (Loudens International)

Minding & Mending our ways

- Minding
  - Observe & reflect
  - Build narrative – how to read a road
  - Develop actions
    - Technical, economical, social, etc.
- Mending
  - What?
  - Why?
  - Where?
  - Whom?
  - When?
  - **How?**

Symptoms & social media solutions

- Community / Social media solutions
  - Community efforts
    - Pros & Cons



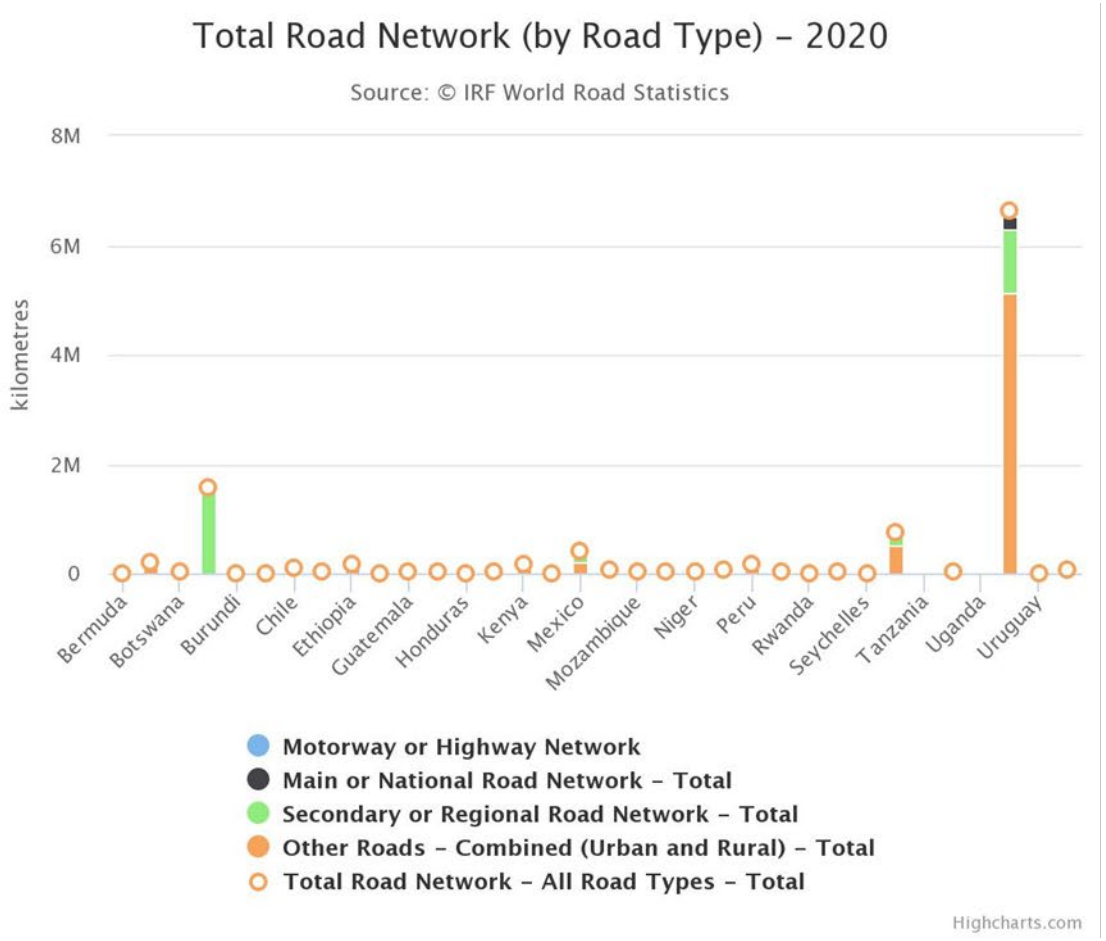
CAN DATA SOLVE THE POTHOLE PLAGUE?

With the recent wet weather creating havoc with our roads, the often-asked question is how potholes can be prevented in the first place. The power of data may hold the answers.

Our Gatvol Mix fills the gap: How potholes are building relationships

A not-for-profit movement that is helping to repair SA's roads and build relationships has expanded to finance township start-ups to produce its mix.

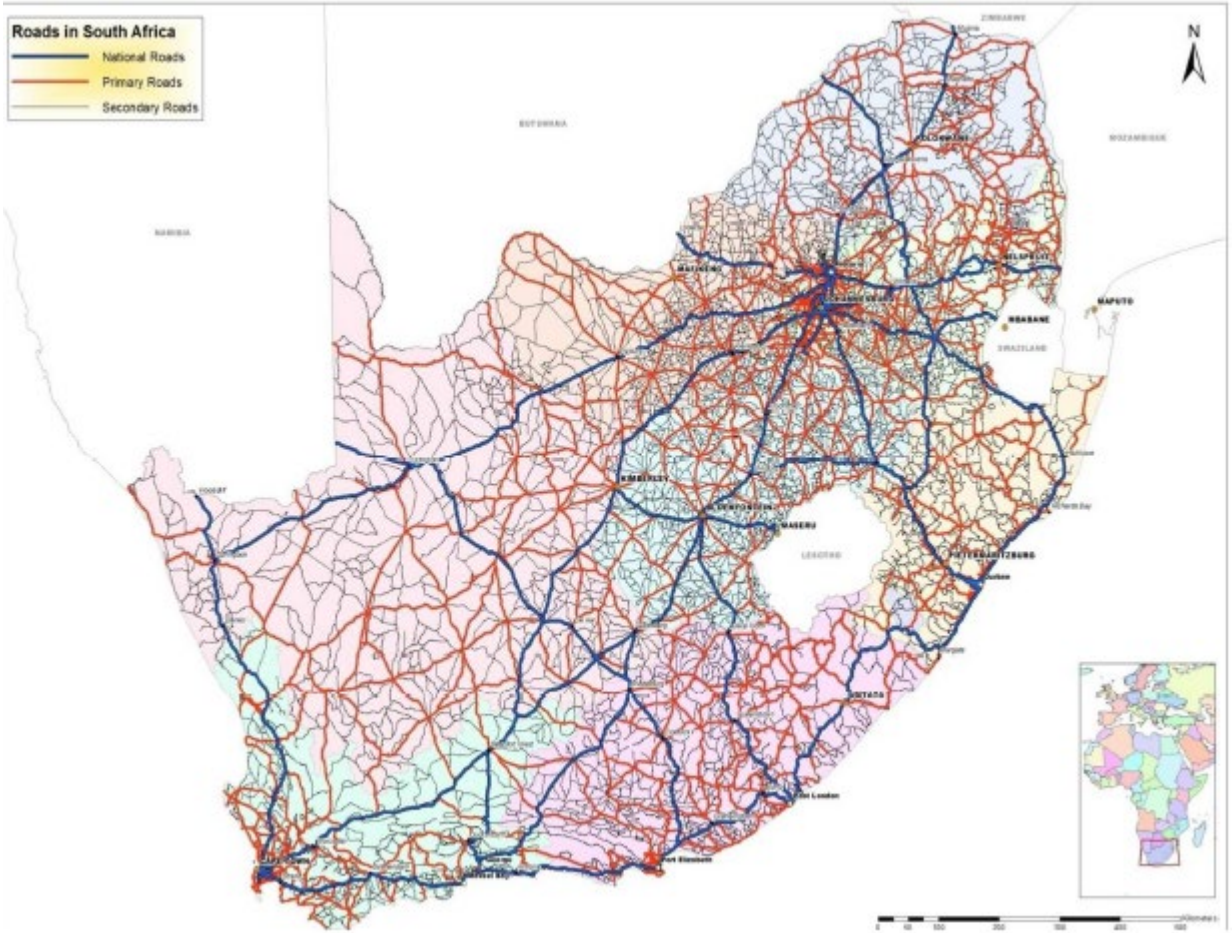
International Road Federation



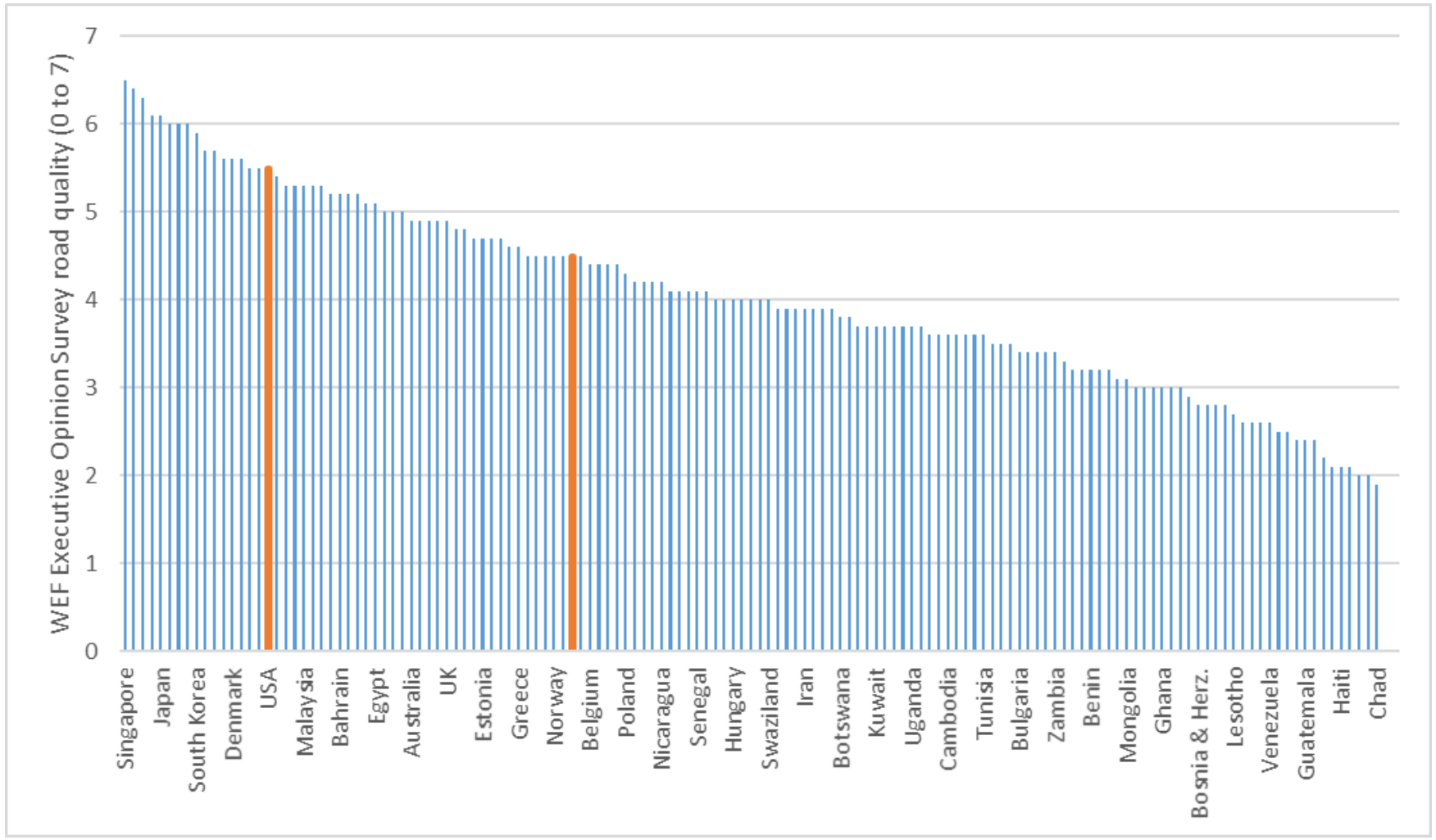
Rank	Country	Road length [km]
1	United States	6,650,000
2	India	5,603,293
3	China	4,859,500
4	Brazil	1,751,868
5	Russia	1,452,200
6	Japan	1,215,000
7	Canada	1,042,300
8	Thailand	1,004,310
9	France	965,446
10	Australia	920,217
11	South Africa	750,014
29	Nigeria	193,200
32	Kenya	161,415
34	Congo, Democratic Republic of	153,497
39	Egypt	137,430
44	Algeria	113,655
45	Ethiopia	110,414
46	Ghana	109,515
48	Libya	100,024
49	Zimbabwe	97,418

SA Network

Paved	Gravel	Total
153 719 km	593 259 km	746 978 km
20.6 %	79.4 %	

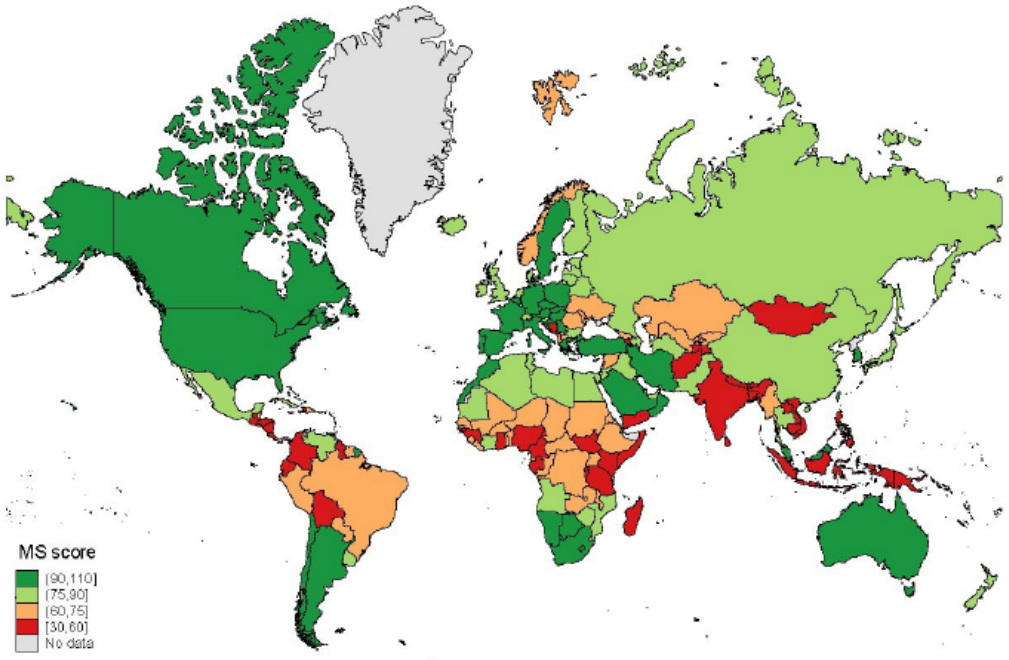


World Economic Forum (WEF) - Roads quality - 2019



International Monetary Fund (IMF)

- Road Quality & Mean Speed score
- Cross-country road quality based on travel mean speed between large cities from Google Maps

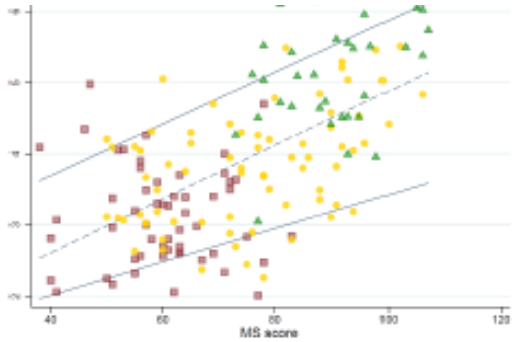


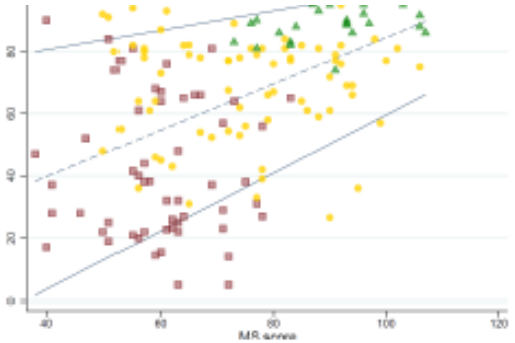
https://www.imf.org/en/Publications/WP/Issues/2022/05/20/Road-Quality-and-Mean-Speed-Score-518200

International Monetary Fund (IMF) view

- Why does it matter?

A good road is always better





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How to Mend

- Numerous options for mending
  - Maintenance & Rehabilitation
- Depends on
  - Condition
  - Traffic
  - Environment
  - Technology
  - Materials
  - Experience

Introduction – BSM in South Africa

- Developed foamed bitumen application with Wirtgen
- Prototype tested in South Africa in 1996
- Pioneers of technology
- Ongoing research & development

- **Technology manual**
  - TG2
  - BSM approach
  - Pavement investigation & evaluation
  - Mix design
  - Structural design
  - Construction

- https://www.sabita.co.za/non-members-manuals-and-dvds/

Fundamental differences

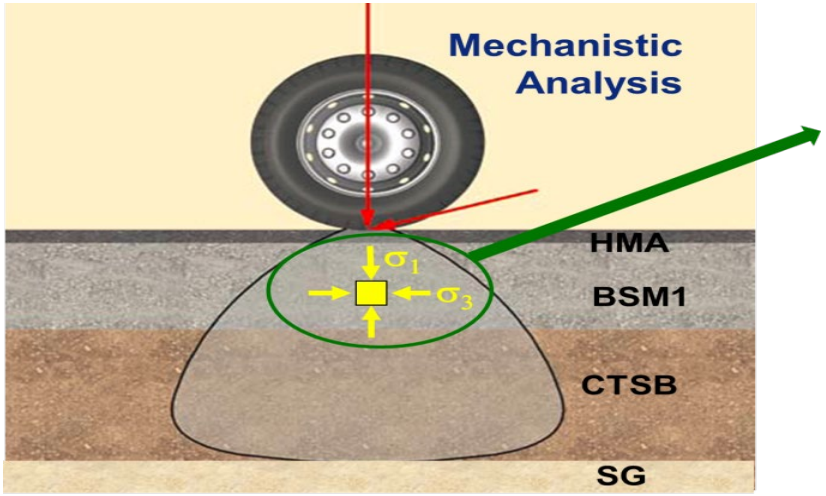
South African approach	USA approach
▪ Material-based ▪ Pavement design with BSM as material option ▪ No distinction between BSM foam or emulsion ▪ Depth & material mix does not affect classification	▪ Process-based ▪ Cold recycling as solution to pavement distress ▪ Distinction between process to produce BSM ▪ Recycling depth & mix of asphalt & aggregate affect process

Rehabilitation design – South Africa

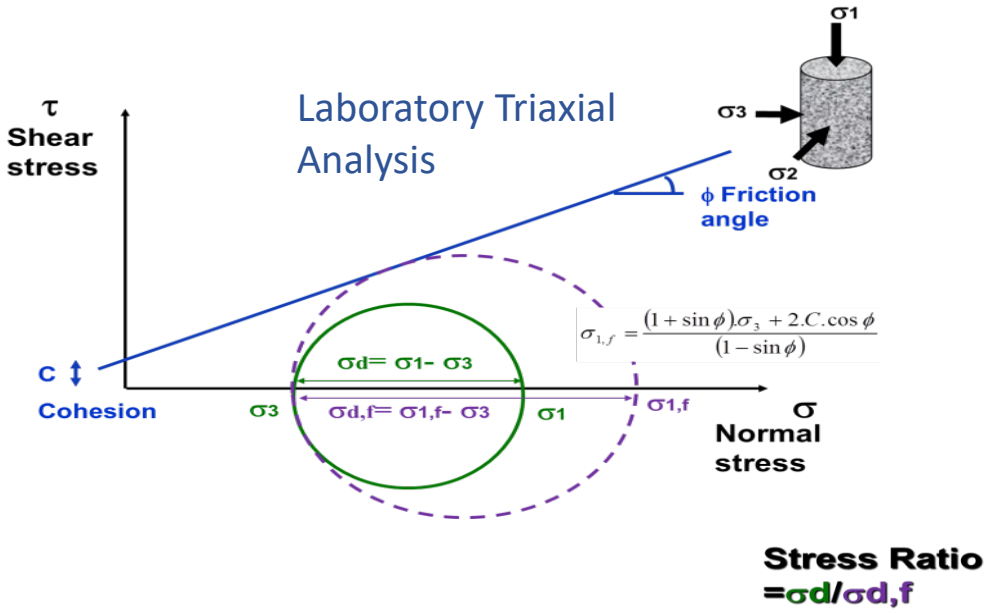
- SA design focusses on material behavior
  - BSM produced using foam or emulsion
  - Granular material, reclaimed asphalt or previously cemented material
  - Non-continuously bound material – no fatigue cracking
  - Material behaves like granular material – permanent deformation
  - Design for accumulation of shear strain

Rehabilitation design – South Africa

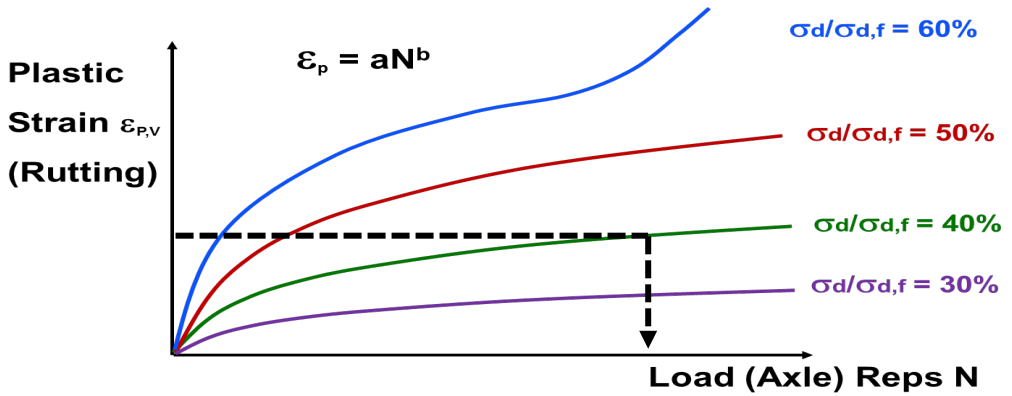
- Material behavior



Permanent deformation (rutting) design for granular material



Design Life for 10mm rut



Mix design - Bitumen content, active filler & strength

South African approach

- Sampled from various layers, *recombined according to milling depth*
- Reference density - Modified Proctor
- Produce specimens - *Vibrating hammer compaction*
- *Determine effect of active filler*
  - 1% cement, 1% lime, no filler
- Tested at *4 bitumen contents*
  - 1.8%, 2%, 2.2%, 2.4%
- ITS_{dry} > *32.6 psi* ITS_{wet} > *18 psi*
- *Shear properties (Triaxial)*

USA approach

- Sampled from each layer*, reconstituted to specific grading based on recycling method*
- Reference density - Modified Proctor
- Produce specimens - *Marshall or gyratory compaction*
- Active filler *only used if mix does not meet specifications*
- Tested at *3 bitumen contents*
  - Typically 1.5% to 3%
- ITS_{dry} > *45 psi* ITS_{wet} > *0.7 x* ITS_{dry}
- *No shear properties*

Construction

South African approach	USA approach
• Layer thickness 6 to 12“	• Layer thickness *depends on process* ▪ CIR – 3 to 4“ ▪ FDR – 4 to 12” ▪ CCPR – 3 to 5”
• Active filler *placed by hand* • Compacted to *100% modified Proctor*	• Active filler *placed by bulk spreader* • Compacted to *95% modified Proctor*

Quality control

South African approach

- Acceptance based on
  - Field density target: *100% modified Proctor*
- *Density tested at 6 set locations per day* with modified Proctor
- Field samples
  - *Moisture correction to OMC*
- Strength: ITS_{DRY} and ITS_{WET}

USA approach

- Acceptance based on:
  - Field density target: *95% modified Proctor*
- Rolling pattern *established on first day of construction* & if significant changes occur in mix
- Field samples
  - *NO moisture correction*
- *Regular testing of bitumen*
  - Penetration Grade
  - Foaming

Conclusions

- **South African & USA methods**
- Fundamental difference
  - SA starts with material, USA starts
  - Structural design
  - Mix design
  - Construction
  - Quality Control

Mind & Mend our ways

Thank you

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