

A Perspective in the Career of a Pavement Engineer

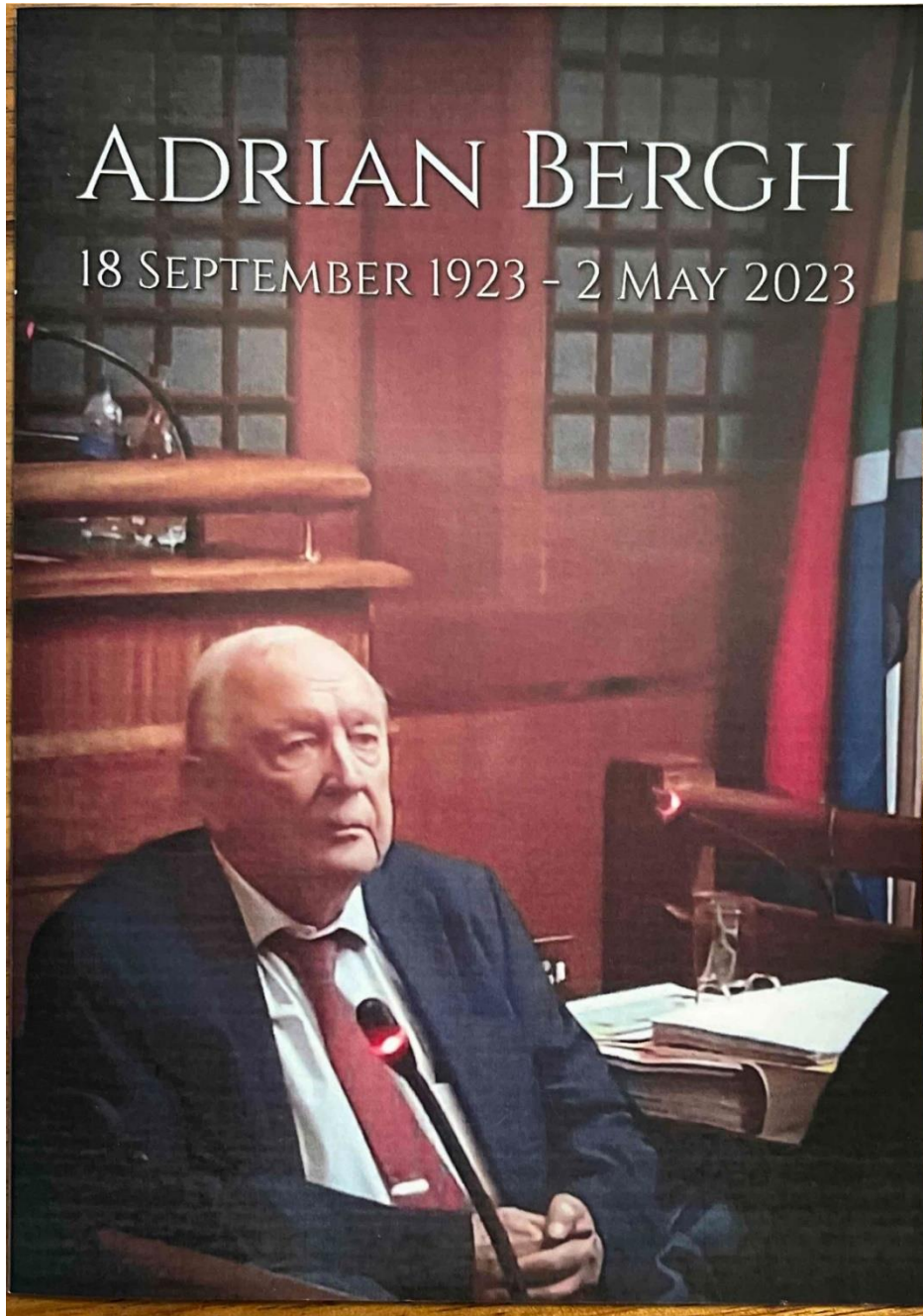
Douglas Judd. PrEng. FSAT

Outline

- A Tribute to Mr Adrian Bergh.
- Laying the Foundations
- Pavement Engineer – the dilemma
- Technical Highlights in the Consulting and later in a PPP Concession environment

ADRIAN BERGH

18 SEPTEMBER 1923 - 2 MAY 2023



Mr Adrian (AO) Bergh

- A gigantic contribution to the Civil Engineering fraternity.
- In particular Materials and Pavement Engineering
- A Pioneer of many techniques that we take for granted today
- A committed mentor.
- A man of innovation
- He was a materials man at heart. Very few interactions did not contain reference to PI, CBR or Spray Rate.
- Mr Bergh employed me in 1975 and sent me straight to the materials laboratory.

Mr Bergh Pioneered

- Use of **Lime as a stabilizing agent** when other engineers were focused on cement.
- Use of **Single Seals** as a preventative maintenance action in the 1970's.
 - In the 1970's thin asphalt layers with a single seal wearing course were a favoured rehabilitation option, long before the larger politically aligned companies even thought of reseal and rehab.
- Developing more appropriate seal design methods long before TRH 3 was a round.
- Use of **Bitumen Rubber in Asphalt and Seals** to enhance fatigue resistance.
 - With Les Davidson developed local techniques, favoring the dry blend method for asphalt
 - At the same time Ronnie Renshaw and Tosas were following the Arizona Refining methods of a wet blend.
 - The dry blend method allowed higher percentages of rubber crumb
 - Eventually the wet blend became dominant at 20-22% rubber crumb as it was easier to blend.
- Use of **Bitumen Emulsion in Emulsion Treated Bases**. ETB. 1% net bitumen.
 - Before the use of Road Recyclers. 1970.
 - Benefits. Lower water demand, Aided compaction, Reduced permeability.
- Use of **Gilsonite to modify bitumen**, a pure carbon black to increase stiffness.
- Developing an **alternative to traditional Ultra Thin Concrete Pavement** that worked using less steel.

Mr Bergh Pioneered

- Developing and implementing maintenance training programs for young engineers and Contractor development
- Developing test procedures for seal work including the ALD “monkey” and the pan & cylinder aggregate spread rate test.
- A mentor to many young engineers.
- He went into the office at CSIR daily well into his 90’s.
- Mr Bergh was well known for strong informed opinions.
- He did not tolerate non-practical engineers who offered uninformed opinions.

RIP Mr Bergh.

Foundations for a successful career

- Advice to young Pavement Engineers
- Materials
 - Pavement Engineering is an Art as much as a Science
 - The Artists tools is a sound knowledge of materials.
 - Work in a Laboratory
 - Do not observe. Do the tests
 - Learn and Understand the test methods and equipment
 - Most importantly understand what the test results mean
 - If you understand materials and how they behave you can make the materials work for you.

Foundations for a successful career

- Working in the Field. The best learning ground
 - There is no short-cut to being an expert Engineer
 - Switch the computer off. Be out on site
 - Spend quality time with the people actually doing the work
 - If you are faced with problems on site, the senior people will tell you what they think you want to hear.
 - Speak to the people on the ground and you will soon identify where the problems lie.

Foundations for a successful career

- **Contracts and Specifications**
 - Know the Contract that you are dealing with
 - Learn and Understand Standards.
 - Become familiar with best practice documents.
 - TMH
 - TRH
 - SABITA Manuals
 - South Africa is a world leader.
 - Learn and Understand Specifications.
 - COTO is a change. Embrace it.
 - Know how to measure the work done
 - Understand what is included in the Pay Items.
 - Attend Conferences and Seminars

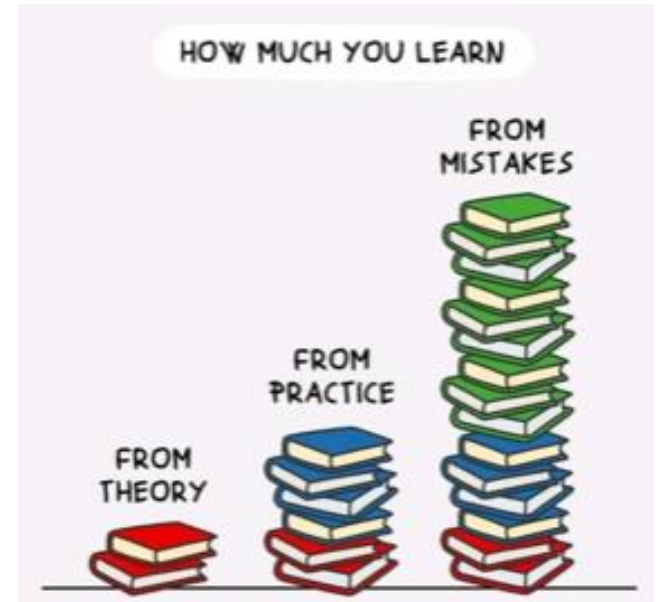
Foundations for a successful career

- The P in Pavement Engineer stands for
 - Passionnot
 - Payday
- In the 1970's & 80's if you wanted to work in a position of authority on a road construction site you needed to pass exams (TPA exams)
- Should this accreditation be re-introduced?

Foundations for a successful career

- Do not be afraid to make mistakes.
- Your development will depend on how you react to and remedy mistakes
- Mr Bergh always used a saying
 - *You can tell me I am wrong when I know that I am right, but please don't tell me I'm wrong when I know I am wrong*
- The famous quote is also relevant.

Insanity is doing the same thing over and over and expecting different results.



Pavement Engineer, the dilemma

- Civil Engineers are assessed by the monuments that they have created.
 - Great buildings
 - Massive bridges
 - etc
- Road engineers in SA generally do not build monuments.
 - There are few new opportunities for major highways, tunnels and mountain passes.
- Our monuments are well designed roads and rehabilitation projects delivering cost efficient solutions with good quality.

Pavement Engineer, the dilemma

- GFIP could have been a monument BUT
- Supposedly intelligent people thought it prudent to destroy a well planned concept.
- Imagine the User pay principle working in GFIP
 - An uncongested Gauteng freeway system
 - A thriving construction industry
- It is far easier to destroy than to build.
- Many of our colleagues have disgustingly supported the nay-sayers to all of our detriment!!!

Pavement Engineer, the dilemma

- Are we not prepared to learn from our mistakes?
- Are we prepared to share our failures?
- Why do we not share lessons learnt?
- Unfortunately has contractual and or liability consequences.
 - The same mistakes are being made.
 - Some asphalt placed in the past 5-8 years are examples. Many failures and many forensic investigations.
- This is a challenge for change.

Technical Highlights put to good use

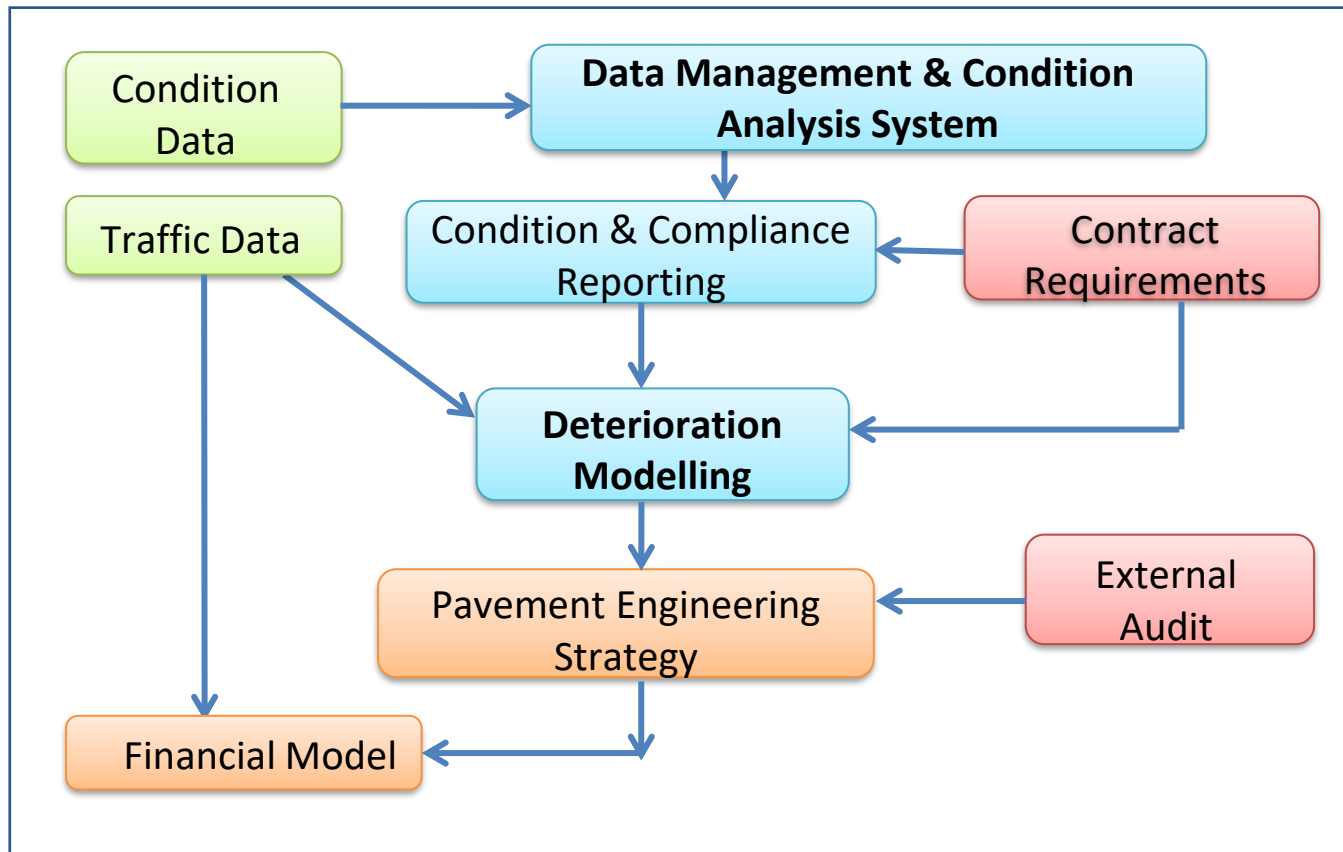
- Pavement Management Systems
- Single Seals-How far can you push the limits
- ETB's & BSM's
- Use of alternative materials – Steel slag
- Understanding pavement performance
- Developing Road Maintenance implementation strategies that benefit contractor development

Pavement Management Systems

- It remains inconclusive who developed the first municipal PMS in SA. 1983
- Mr Bergh wanted a simple system
- He needed a young engineer who had a faint idea about computer programming.
- The MBS system was born.
- Ongoing involvement in the management of road networks provides a great insight into how pavement perform
- TMH 9 is a fantastic document for recognizing defects.

Pavement Management Systems

- Typical PPP PMS



Single Seals – How far can you push the limits

- Single Seals-Part of my life since 1976.
- Their contribution to pavement life has been underestimated
- More recently Gerrie van Zyl et al have developed a means to quantify pavement life to bitumen rubber seals.
- If you have confidence in your design, you can use BR bitumen seals in uncommon applications.
- During 2008 – 2014, 100% of the flexible pavement sections of the N3 (360km) had a single seal surface dressing

Single Seals – the N3

- Traffic Volumes 12,000 vpd 35% heavy.
- TRH 3 elv design >100,000
- Off the the design scales.
- Use a well graded single size aggregate
- 16mm with 100% passing 20mm is ideal.
- ALD – 12,2+mm
- Beware of the new metric sieve sizes with single sized design envelope.
- In particular do not follow the 20mm single size specification. Max size 28mm?? This is not a practical size.

Single Seals – the N3

- TRH & COTO standards provide for Surfacing Seals under normal traffic conditions.
- TRH 3 issues warnings relating to sealing under HIGH TRAFFIC VOLUMES.
- HIGH VOLUME roads relates to HEAVY TRUCK TRAFFIC rather than many light vehicle's.
- There are major performance benefits in using SURFACING SEALS on HIGH (HEAVY) VOLUME ROADS
- SURFACING SEALS can compete head to head with UTFC and other WC asphalt mixes
- Trigger for use of SURFACING SEAL is PERFORMANCE and not only ECONOMICS

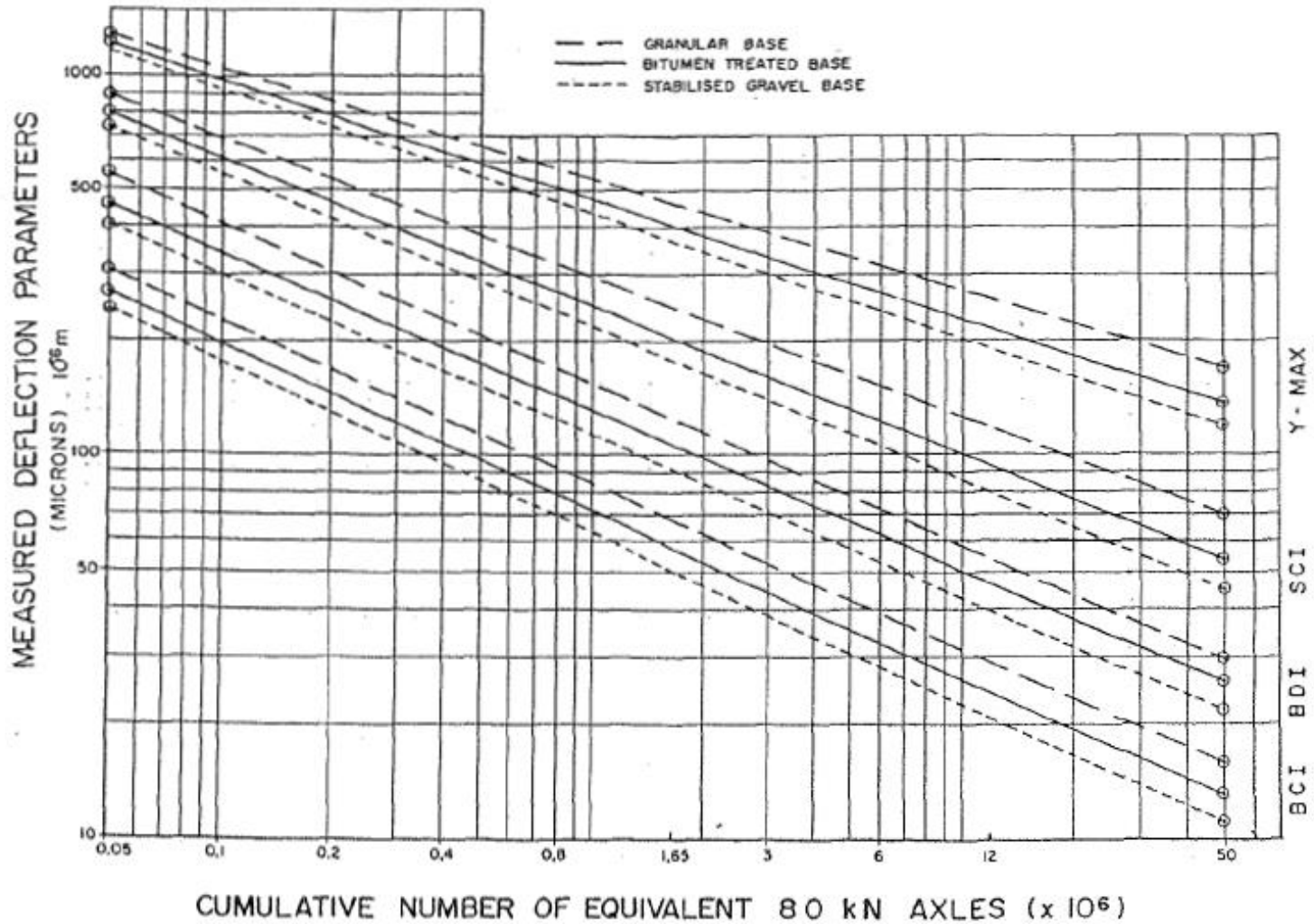
Single Seals – the N3



ETB's & BSM's

- I will reference this as an important part of the road rehabilitation arsenal, however.
- The concept is based on
 - A flexible system that is designed to deflect under loading
 - It assumes relatively thin asphalt layers
 - It needs a balanced pavement structure
 - Its failure mechanism is rutting
- All of the above do not fall into the strict requirements of a Concession Contract.
- Much work is being done to provide the analysis tools to prove that low deflection is not the only indicator of structural life.

ETB's & BSM's. Is TRH12 still relevant



Use of alternative materials-Steel Slag

- What is steel slag
- Not a “waste product
- It is a by product of the steel making process,
- It has a complex chemical structure, comprising oxides and silicates;
- The slag processing includes weathering, crushing, screening and de-metallising;
- CAUTION. Highly expansive if not weathered correctly.
- The weathering process is an essential part of the handling of steel slag, as it enables the hydration of any uncombined free lime (CaO) or free magnesia (MgO) present in the material.

Use of alternative materials-Steel Slag

- Use in Asphalt and Seals
- Particle shape and surface texture, stability and skid resistance;
 - Cubical shape;
 - Rough surface texture;
 - The Flakiness Index (FI) of the steel slag aggregate is markedly lower than those for the dolerite and quartzite aggregates;
 - A Polished Stone Value (PSV) of 63 for the steel slag aggregate indicates a high resistance to the surface of the aggregate polishing under the action of traffic.

Use of alternative materials-Steel Slag



Use of alternative materials-Steel Slag

Property	BOF Slag	Dolerite	Quartzite
Free Lime	1-15	N/A	N/A
pH	10	8	5
Particle Density	3.2	2.9	2.7
Water Absorption	1.5	0.8	0.3
Bulk Density	1800	1600	1500
Flakiness Index	7	20	23
Ten Percent Fines Value			
Wet	460	315	236
Dry	490	350	299
Aggregate Crushing Value			
Wet	7	13	20
Dry	-	11	15
Aggregate Impact Value	12	11-8	-
Polished Stone Value	63	52	55
Los Angeles Abrasion Value	10	18	21

Use of alternative materials-Steel Slag

- Not used extensively.
- DOE decided to classify Steel Slag a waste product and applied onerous conditions on its use. Restrictions lifted a few years ago.
- It should still be considered as an alternative aggregate.
 - High SG means tons/m² has an impact on cost per m² even though material cost is low.
 - Higher bitumen demand due to higher surface area.

Alternative materials-RUTTING PERFORMANCE

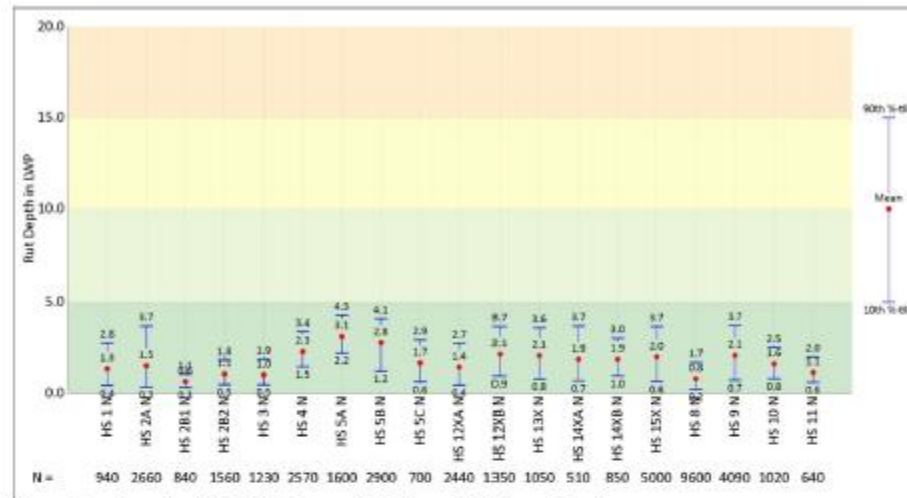


Figure 7: Rut depth distributions on Northbound Highway Sections

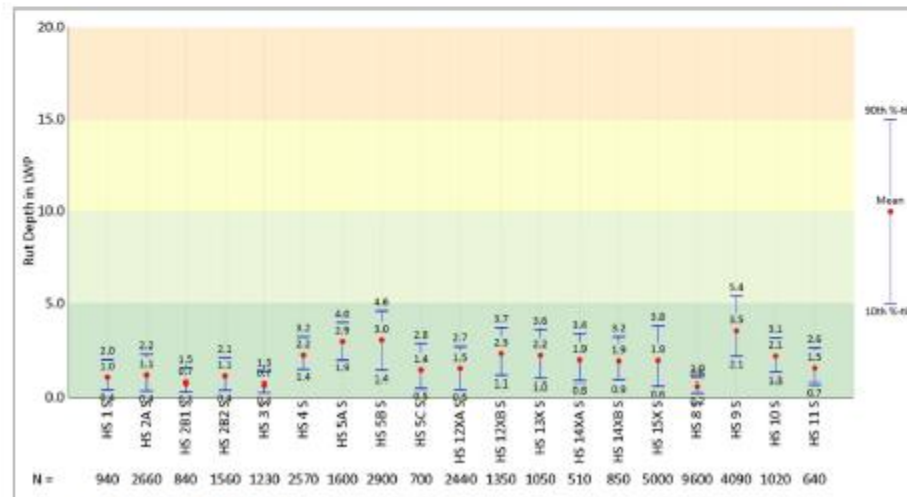


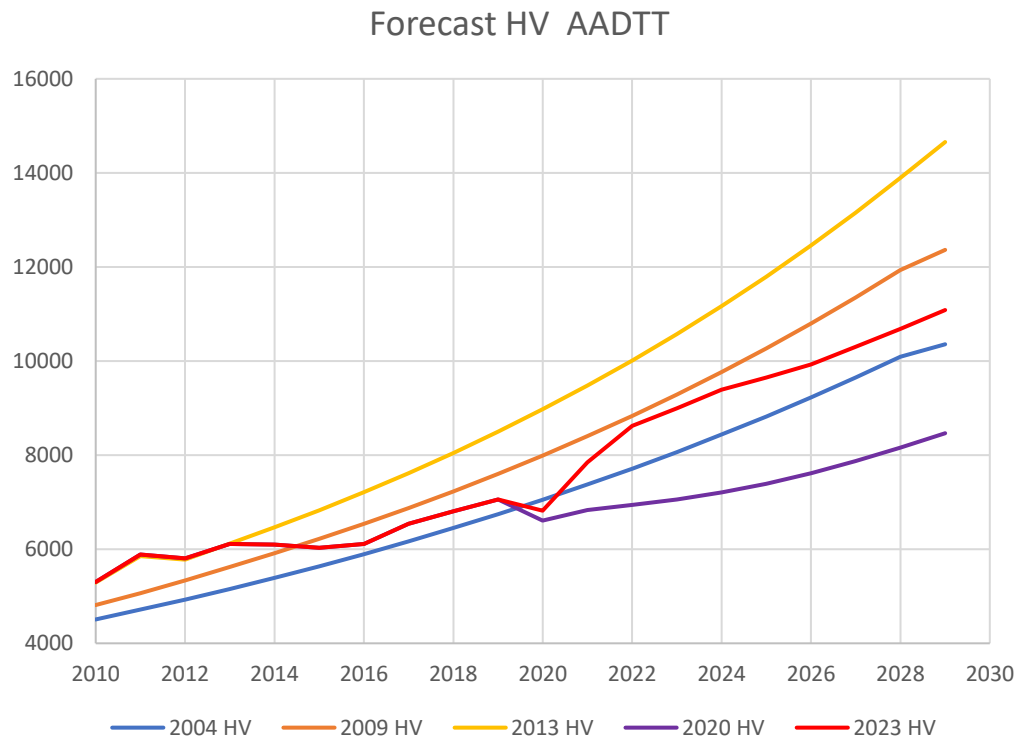
Figure 8: Rut Depth Distribution on Southbound Highway Sections

Long term Pavement Strategies and Understanding pavement performance

- A 30 year forecast.
- Predicting truck growth and behavior
 - There is no lane wander. Trucks drivers guide on the yellow line.
- Designing for 3,000 HV per day and 3,2 E80 per HV.
- Measuring Material Performance
- Predicting Pavement Performance

Long term Pavement Strategies and Understanding pavement performance

- Heavy vehicle growth
- Change in forecast growth.



Pavement performance

- Managing a pavement on a PPP project has many privileges.
- Accurate traffic data
- Regular pavement functional and structural data.
 - Good pavement records
 - Regular deflection data
 - Regular performance data (IRI & Rutting)
- Ability to analyse performance and deterioration in detail.
- Ring fenced maintenance funding

Upgrade, Rehabilitation and Periodic Maintenance

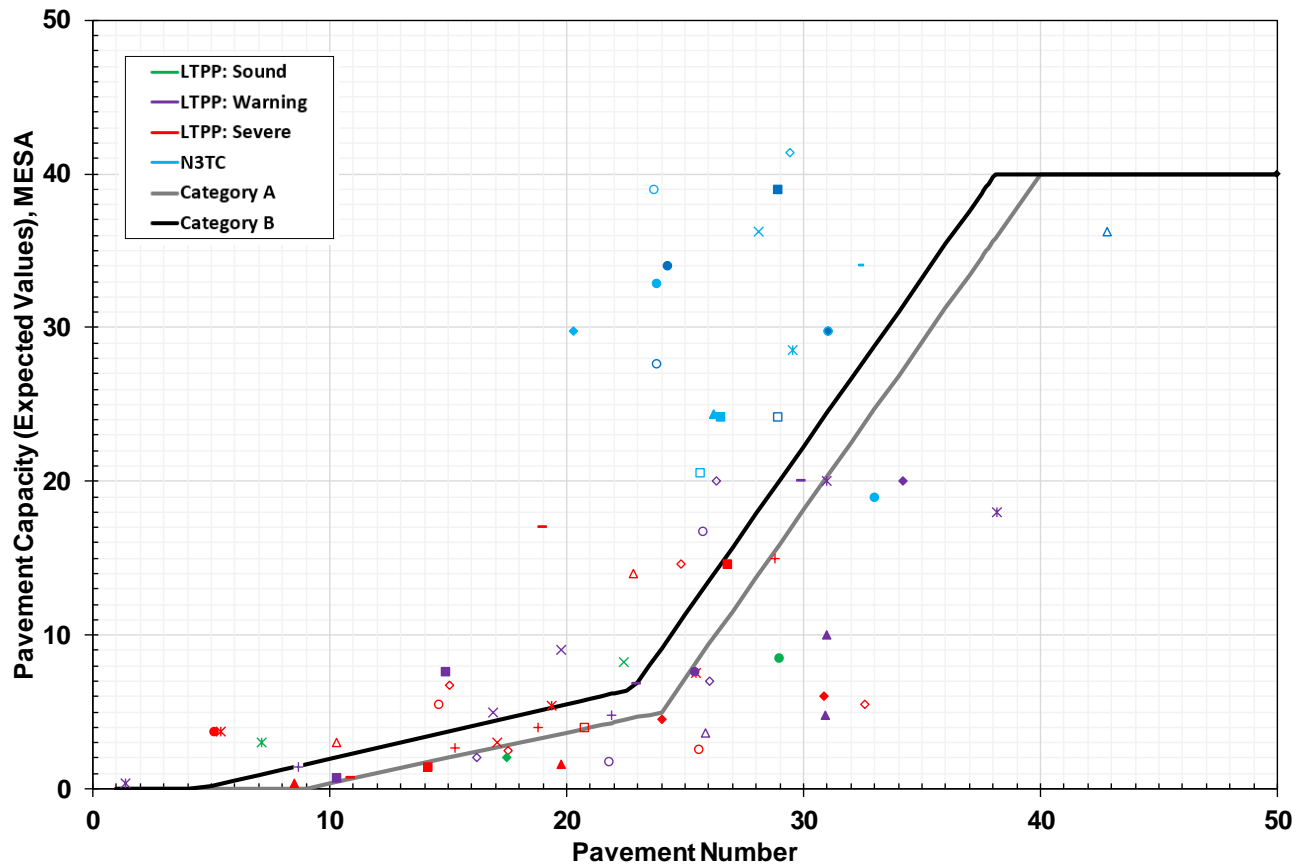


Pavement performance

- Analysis with the assistance of Fenella Johns
- Paper presented at ISAP 2019 and published in Journal 2020
 - “Toll Concessions: Management Strategy and Deflection Performance of the N3TC Network in South Africa”
- Conclusion.
 - Deflections are considered to be a good indicator of the structural capacity of pavements
 - Deflections, and are expected to increase with time and traffic carried.
 - This assumption underlies many available pavement design methods.
 - This paper shows that for 22 representative sections on the N3 Toll Route, the deflections do not increase with time, as is expected with most design methods

Pavement performance – Regular periodic maintenance

Actual performance vs Pavement Number



- Developing Road Maintenance implementation strategies that benefit contractor development
- Mr Bergh used to say.

If you want to look brilliant, surround yourself with brilliant people.

Developing Road Maintenance implementation strategies The A Team



Road Maintenance implementation strategies. Add Management



Routine Road Maintenance (RRM)

- Contractual Maintenance Obligation is viewed by N3TC as the absolute minimum standard.
- In order to achieve maintenance goals, N3TC appoints Contractors from adjacent local communities on long term contracts.
 - Grass cutting;
 - Alien removal;
 - Fire management
 - Drainage Maintenance;
 - Fencing
 - Litter Collection – Recycling
 - Road Sign and Road Furniture Maintenance

Routine Road Maintenance (RRM)

- Requires a long term approach. There is no quick fix.
- Requires on-going training programmes.
- Requires high level of financial assistance initially;
- Requires high level of management assistance initially;
- Requires gradual removal of assistance so that Contractors can develop confidence of responsibility and build up a credit track record.
- Establishment of Special Maintenance Projects for EME Development

Routine Road Maintenance (RRM)

- Projects previously let as Commercial Contracts because of need for costly specialist equipment.
- N3TC acquired the specialist equipment and hires it back to the Maintenance Contractors.
- Contractors attended in-depth training courses;
- N3TC assists with purchase of costly materials;
- Result –
 - Major increase in level of skills and capacity.
 - Enterprise Development
- Previous 5 year Contractor cycle. Four local contractors developed from CIDB 2/3 to 5/6
- Current 3 year Contractor cycle. Ten local Contractors will be able to grow from CIDB 3 to CIDB 5/6.

Acknowledgements

- Mr Bergh
- Hugh Thompson



- Special mention Basie Nothnagel
 - Ferocious auditor in his early days- 1970's
 - Set high standards for materials testing for National roads projects