~~Intelligent~~ Compaction Management

SAT Report Back

Road Pavement Forum – CSIR Pretoria

5 November 2013

Krishna Naidoo

THE SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LTD
Reg. No.1998/009584/06

AMMANN

SASOL
reaching new frontiers

FAYAT

UWP CONSULTING
enhancing the quality of life

WIRTGEN GROUP

SPECIALISED ROAD TECHNOLOGIES

33 - 19

Background

- Compaction is a fundamental requirement for road-building
- Compaction has evolved significantly - better physics, electronics, understanding of materials.
- Specifiers have also evolved their approach to compaction - partial payment and bonuses for achievement
- Now technology and knowledge that combines many, if not all the aspects that affect compaction, analyses and optimises these aspects and makes them work together to achieve better than previous benchmarks.
- It provides dynamic and real time intelligence (data) that have spatial attributes as well, making it possible to adjust certain inputs during processes – compaction management.

National road-show (workshops)

Date	Region	No of attendees
15 October 2013	Gauteng	95
16 October 2013	KwaZulu Natal	120
17 October 2013	Cape Province	45

R150 – members
R300 – non-members

Sponsors

- Wirtgen
- SRT
- Osborne (Astec)
- Bell
- Ammann

Level of interest

Krishna,

Sounds like a good theme and important for getting the best value out of our pavements.

Make sure that the uniformity / homogeneous characteristics are also covered for all materials and the differences in typical performance from the product classes as their variability changes. Not all the same and the critical aspects differ.

Kindest regards,

Rob Vos

Robert Vos *State Executive Officer - Queensland*

Australian Asphalt Pavement Association

Level of interest

Morning Krishna

This is a very interesting and timely topic. Would it be presumptuous of me to ask for a copy of the presentation material and notes that will be used at the workshop.

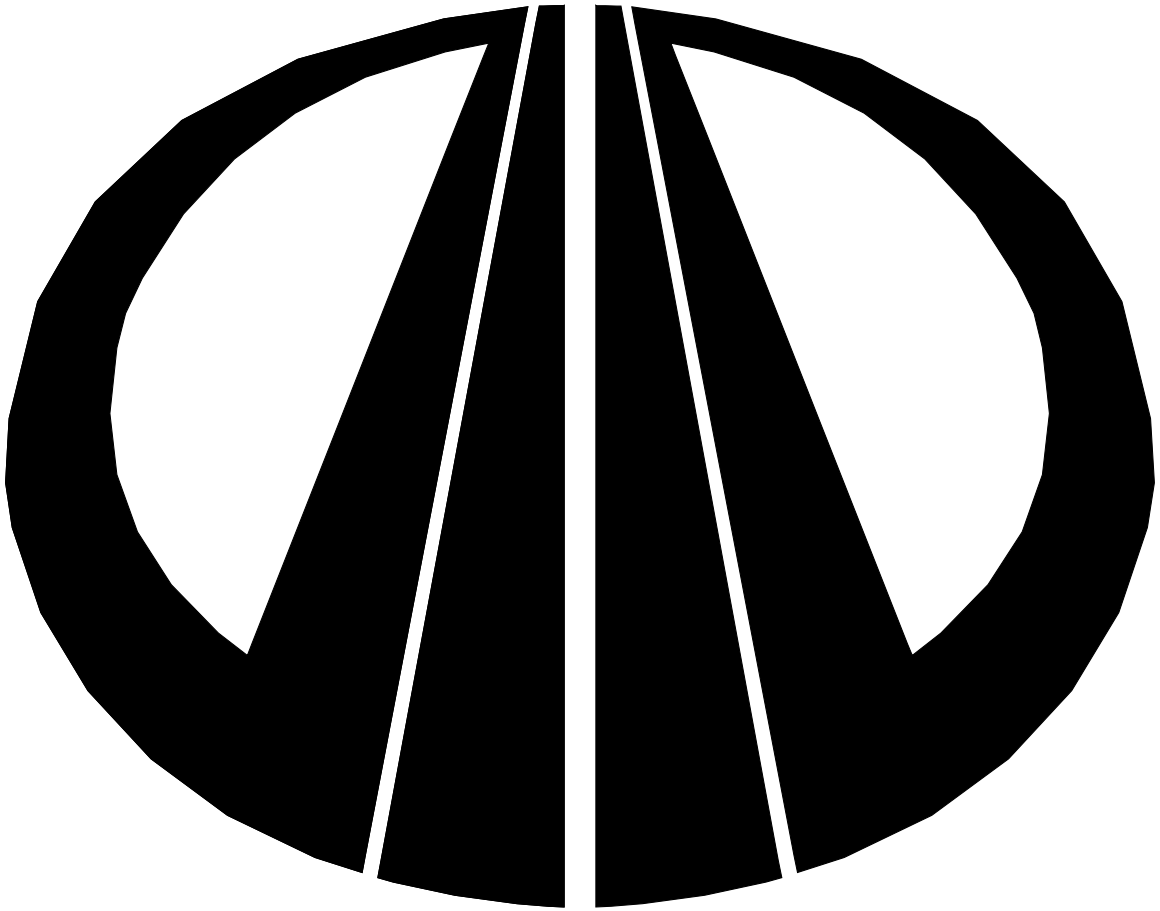
Regards

Robert Busuttil
Australian Asphalt Pavement Association

Programme

- Pavement Materials (granular & crushed stone) – Eric Lathlieef (eThekwini)
- Pavement Materials (asphalt) – Hennie Loots (SRT)
- Pavement Materials (in-place and recovered/BSM) – Dr Biederman - Ammann
- Specifiers perspective on compaction - Dumi Nkabinde (SANRAL)
- Pavement failure (network economics) – Shaun Moodley (eThekwini)
- Physics of compaction – Eric Lathlieef.
- Importance of Compaction – Mike White – UWP/SARF
- Compaction management: Sasol – William Honiball
- Compaction Management: Ammann – Dr Biederman
- Compaction Management: Wirtgen – Jens Ruprecht
- Compaction management: Bomag – Christophe Gaigoinet
- 4:00 **onwards – Cocktails**

Pavement materials



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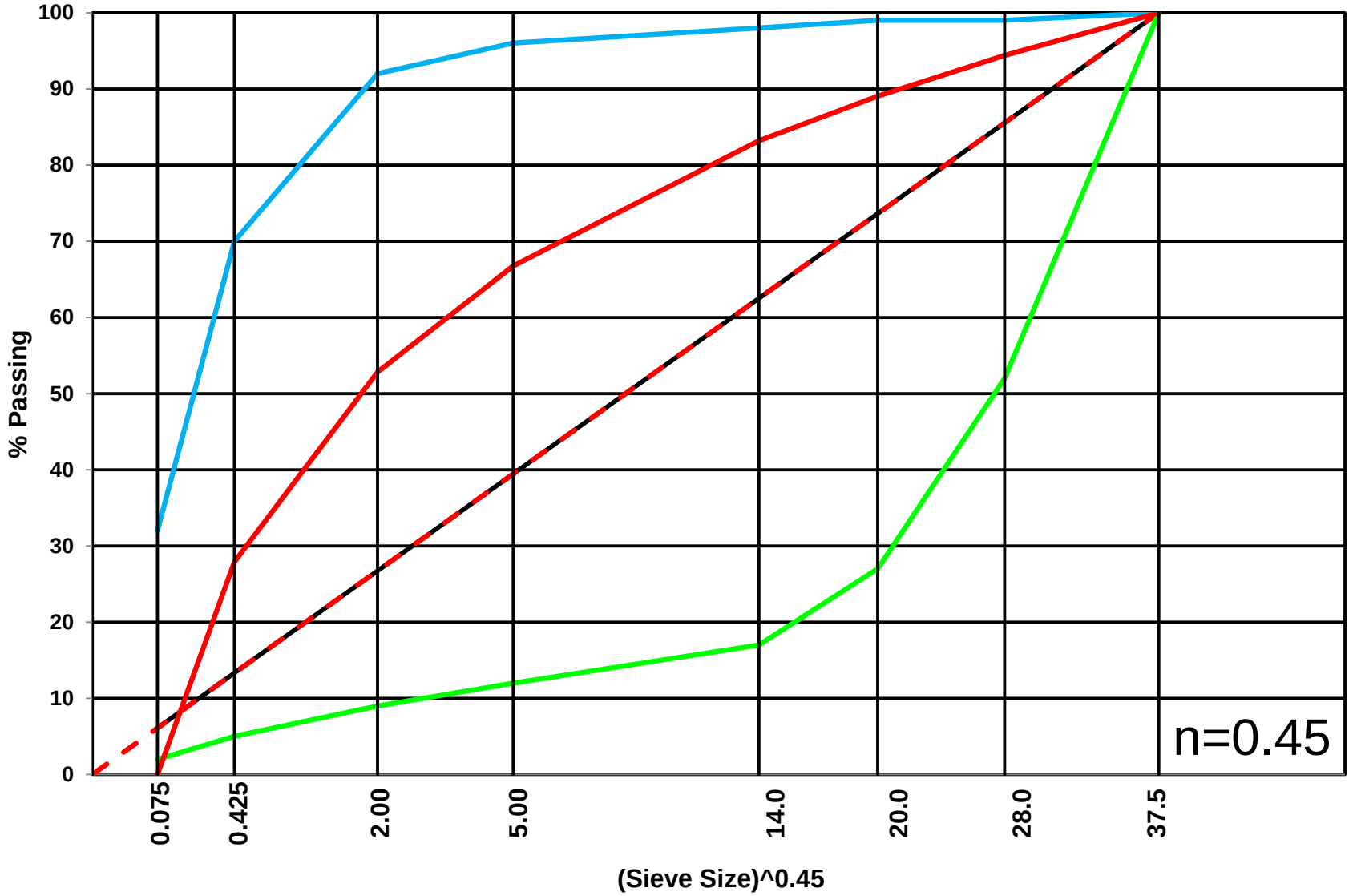
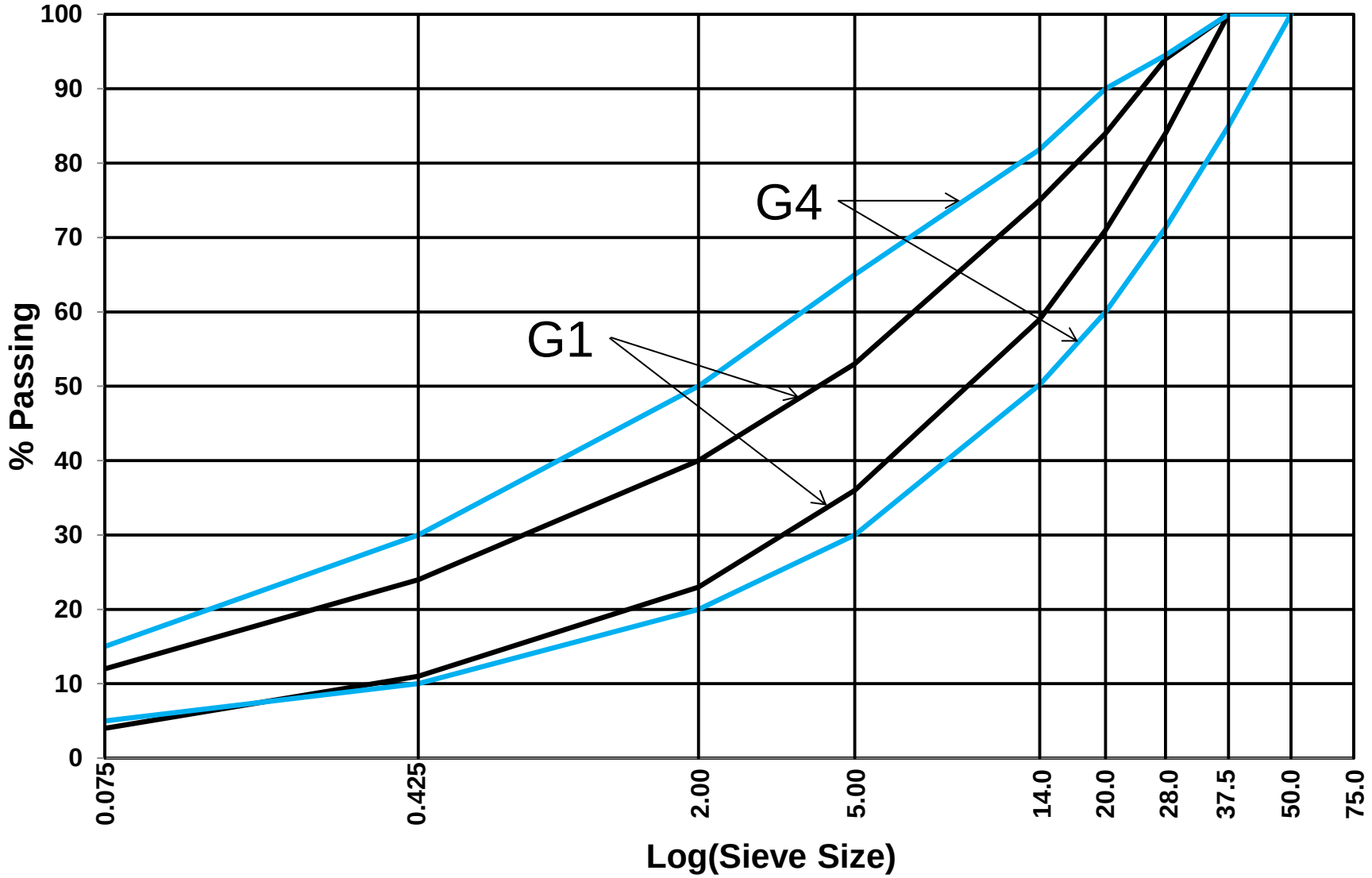

100
90
80
70
60
50
40
30
20
10
0
% Passing
0.075
0.425
2.00
5.00
14.0
20.0
28.0
37.5
(Sieve Size)^0.45
n=0.45


100
90
80
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60
50
40
30
20
10
0
% Passing
G4
G1
0.075
0.425
2.00
5.00
14.0
20.0
28.0
37.5
50.0
75.0
Log(Sieve Size)

Aggregate Volumetric Properties

Sieve Analysis

Flakiness Index

Loose and Rodded Bulk Density

ARD and BRD of Aggregates

Particle Index

Elongated Particles

Fractured Faces

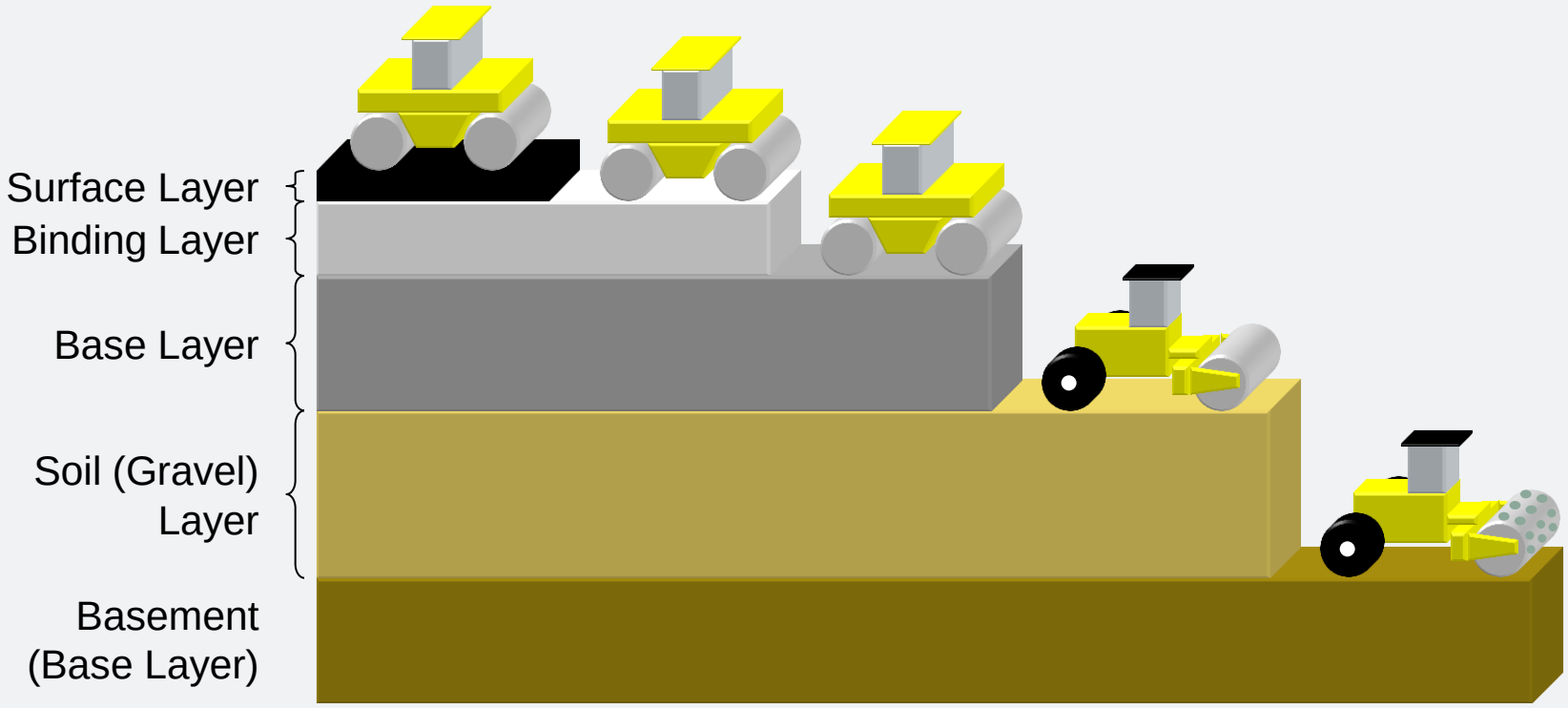
Aggregate Packing

- Bailey Method
- Loose and Rodded Density
- Sieve Analysis
- Primary Control Sieve 0.22 x NMPS
- Base Mixes 4.75mm
- Surfacing Mixes 2.36mm

Workability

- Currently
  - Voids after 300 Gyrations
- In Future
  - Voids of 4% at N_{design}
  - Warm Mix Technology
    - Chemical Agents
    - Foam Technology

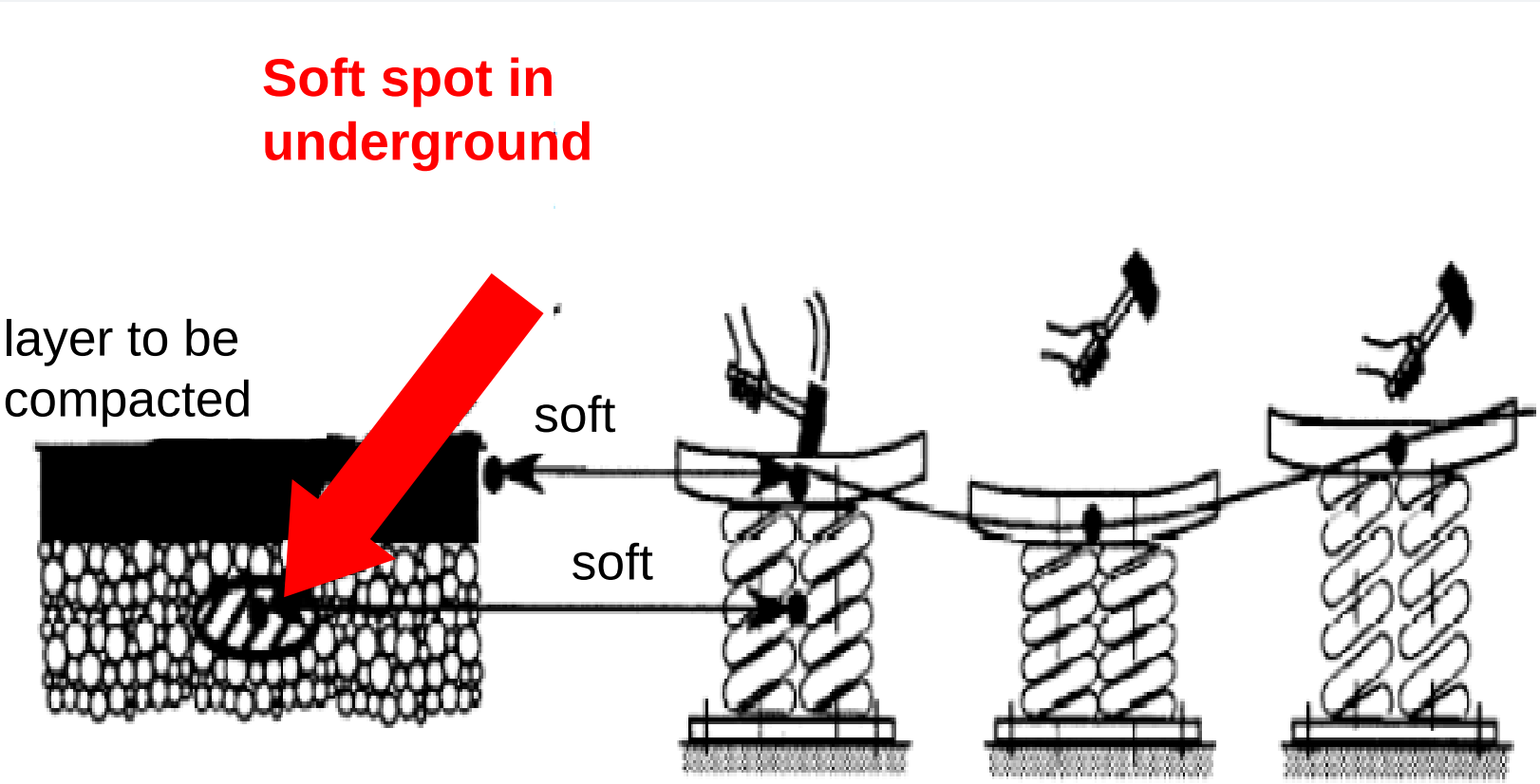
Asphalt Road – Every Layer has to be Compacted



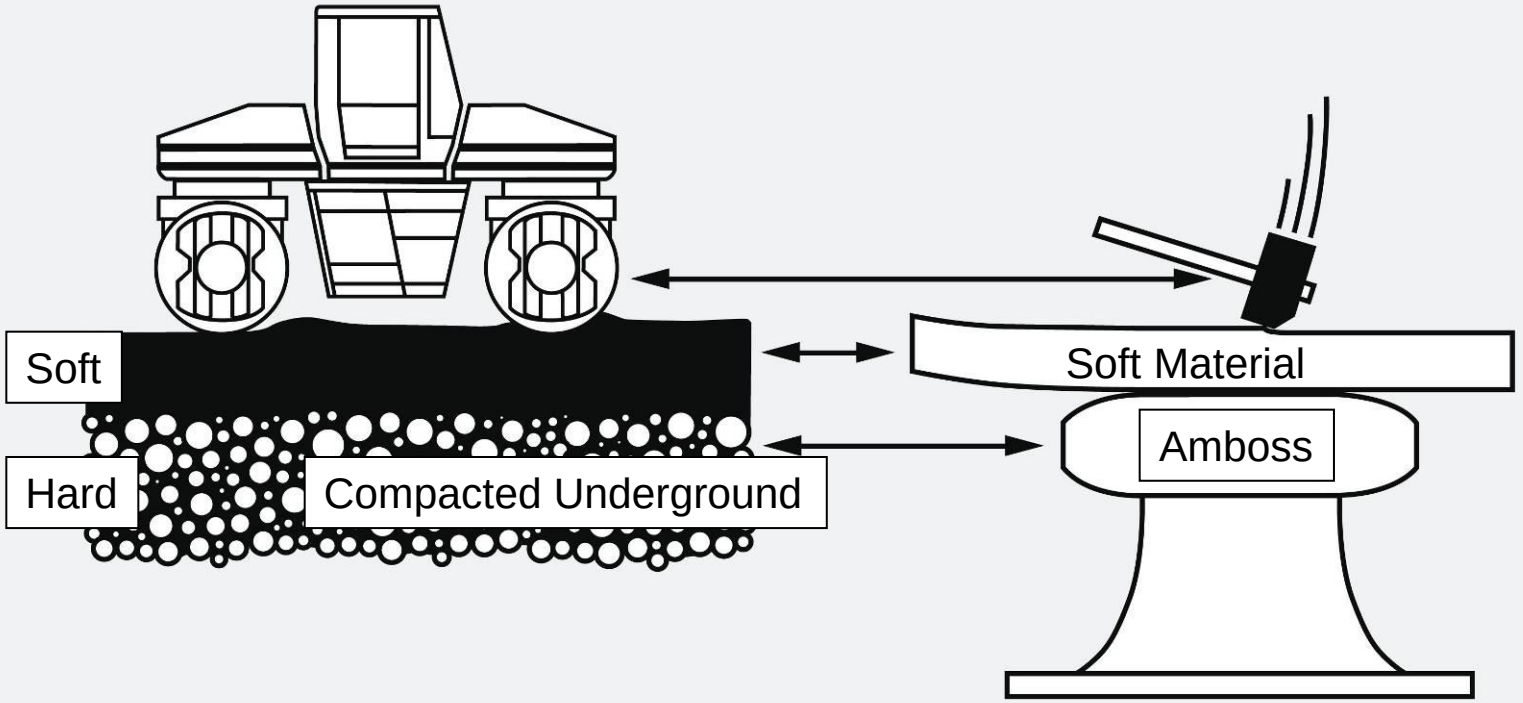
Importance of Load-Bearing Capacity is Known

… but it often looks like this.

Soft Underground = Bad Compaction

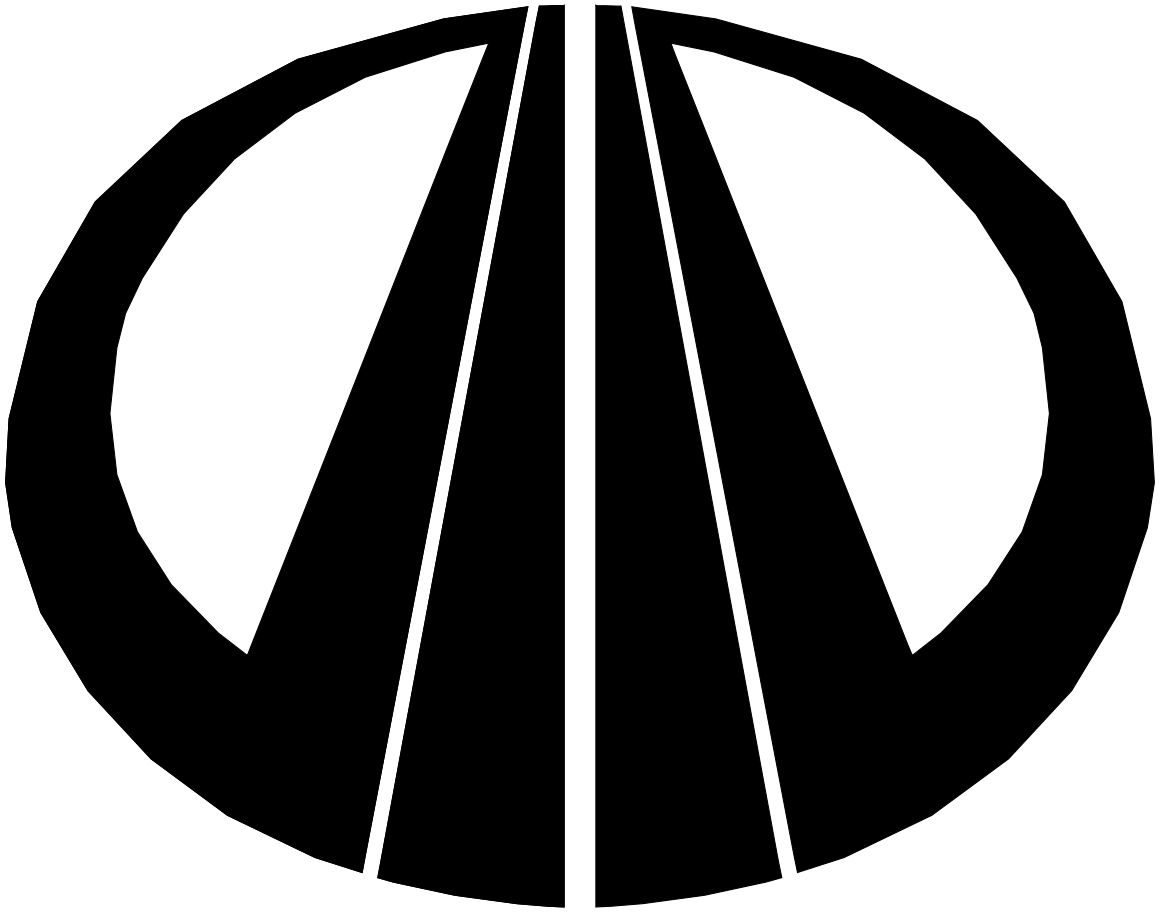


Hard Underground = Optimal Compaction



Anderegg, 1997 with reference to Odemark 1949

Physics of compaction



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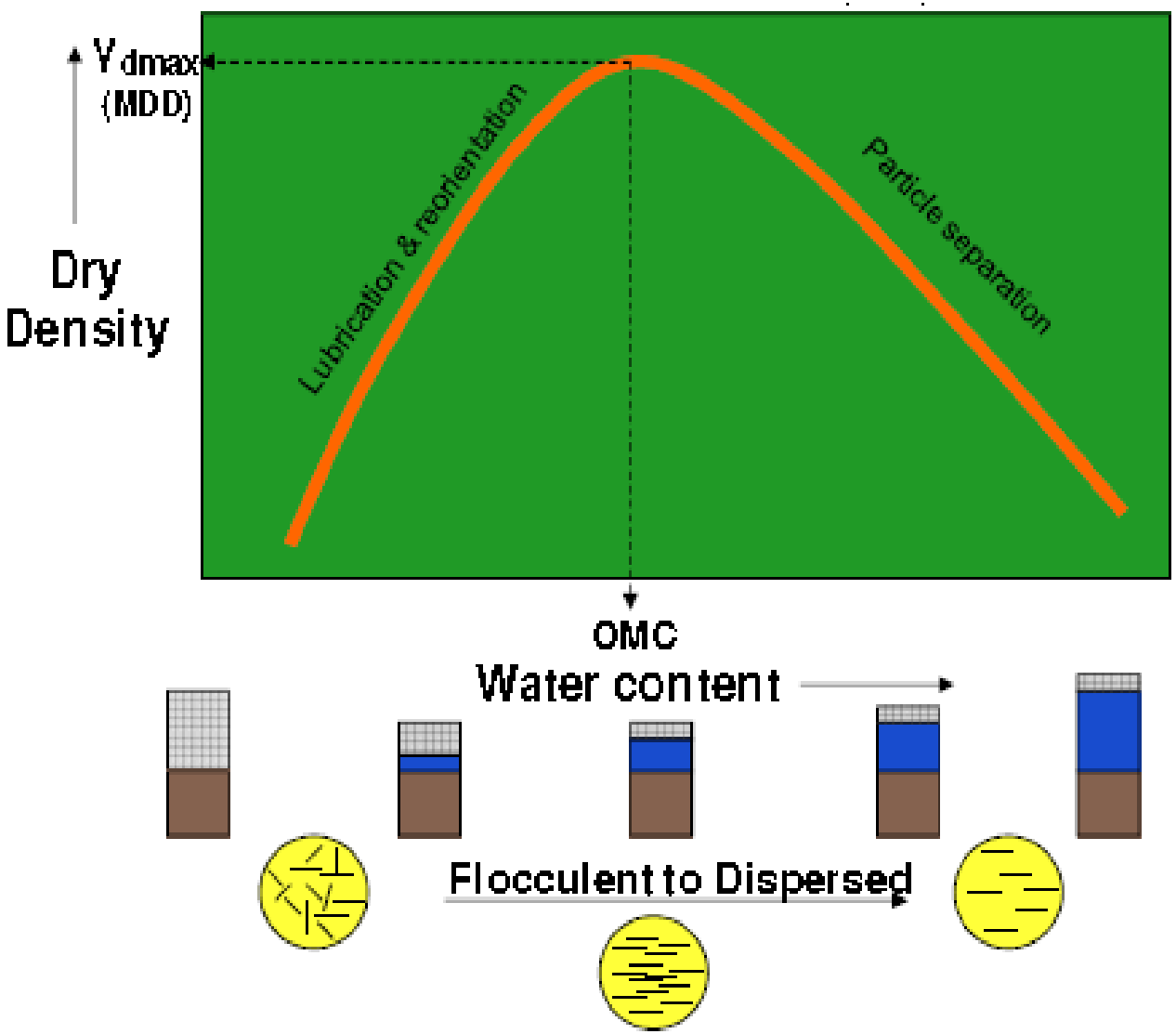
Ydmax
(MDD)
Dry
Density
Lubrication & reorientation
Particle separation
OMC
Water content
Flocculent to Dispersed

Importance of Compaction

In 1928 the California Highway Department undertook a study of their road network to assess the types of distress and the causes. From these studies it was determined that :

- Variable compaction was the primary cause of distress.
- The degree of compaction had a greater effect on the performance than any other factor.
- High clay content materials swelled and lost strength significantly when they got wet.
- Insufficient pavement thickness to support the wheel loads led to deformation.

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enhancing the quality of life

Importance of Compaction

Given all these variables can we continue to manage the compaction process in the traditional manner by just carrying out a few random density tests and relying on statistics to compensate for the variables ?

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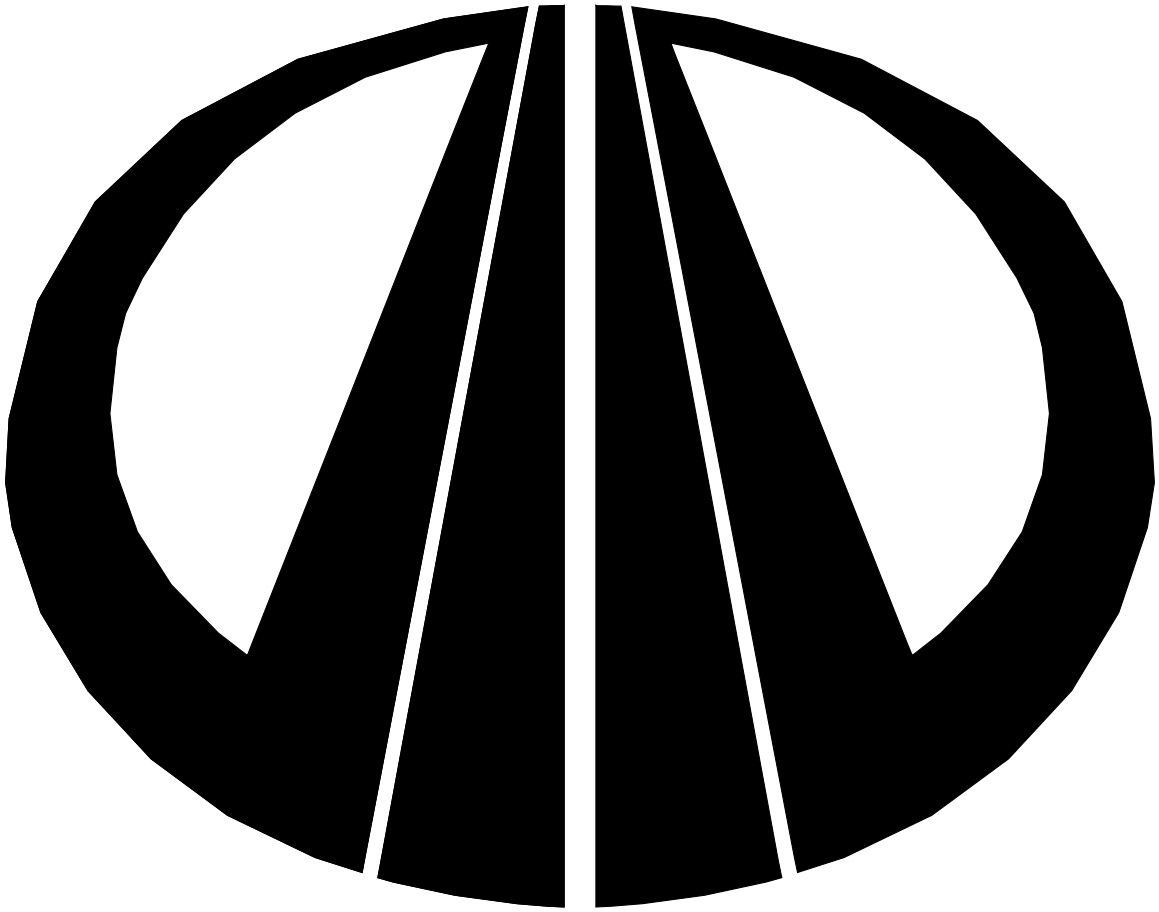
enhancing the quality of life

Specifiers



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Compaction Management: SUCCESS

Particle Shape

Material

Grading

Moisture

Substrate

Equipment

Operator

Temperature

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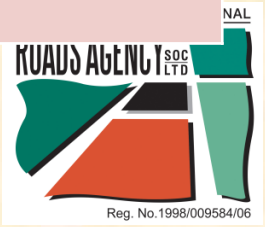
SANRAL SPECIFICATION VS. COLTO

CLAUSES	COLTO	SANRAL
3604(c)(i)	Engineers' choice to slush after density is achieved	Slushing is compulsory within 48 hrs
4204 Vehicle (f) & (h)	Canvas Does not specify how discharging onto paver is done (by haul vehicles)	Thermal cover. Strictly transfer vehicle ("shuttle buggy") for continuous paving. Fitted with anti-segregation auger



SANRAL SPECIFICATION VS. COLTO

TABLE B4213/2: PAYMENT ADJUSTMENT FACTORS FOR ASPHALT SURFACINGS

Target $IRI_{100m\ Ave}$ (m/km)	PAYMENT ADJUSTMENT FACTORS							
	Payment Bracket 1	Payment Bracket 2	Payment Bracket 3	Payment Bracket 4	Payment Bracket 5	Payment Bracket 6	Payment Bracket 7	Payment Bracket 8
< 0.80	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050
0.81 to 0.90	1.025	1.050	1.050	1.050	1.050	1.050	1.050	1.050
0.91 to 1.00	1.010	1.025	1.050	1.050	1.050	1.050	1.050	1.050
1.01 to 1.10	1.000	1.010	1.025	1.050	1.050	1.050	1.050	1.050
1.11 to 1.20	0,990	1.000	1.010	1.025	1.050	1.050	1.050	1.050
1.21 to 1.30	0,975	0,990	1.000	1.010	1.025	1.050	1.050	1.050
1.31 to 1.40	0,955	0,975	0,990	1.000	1.010	1.025	1.050	1.050
1.41 to 1.50	0,930	0,955	0,975	0,990	1.000	1.010	1.025	1.050
1.51 to 1.60	0,900	0,930	0,955	0,975	0,990	1.000	1.010	1.025
1.61 to 1.70	0.865	0,900	0,930	0,955	0,975	0,990	1.000	1.010
1.71 to 1.80	Reject	0.865	0,900	0,930	0,955	0,975	0,990	1.000
1.81 to 1.90	Reject	Reject	0.865	0,900	0,930	0,955	0,975	0,990
1.91 to 2.00	Reject	Reject	Reject	0.865	0,900	0,930	0,955	0,975
2.01 to 2.10	Reject	Reject	Reject	Reject	0.865	0,900	0,930	0,955
2.11 to 2.20	Reject	Reject	Reject	Reject	Reject	0.865	0,900	0,930
2.21 to 2.30	Reject	Reject	Reject	Reject	Reject	Reject	0.865	0,900
2.31 to 2.40	Reject	Reject	Reject	Reject	Reject	Reject	Reject	0.865
>2.41	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject

QUESTION:

Should we pay extra to get what is specified in any case??

Why accepting work not meeting spec and pay % ??

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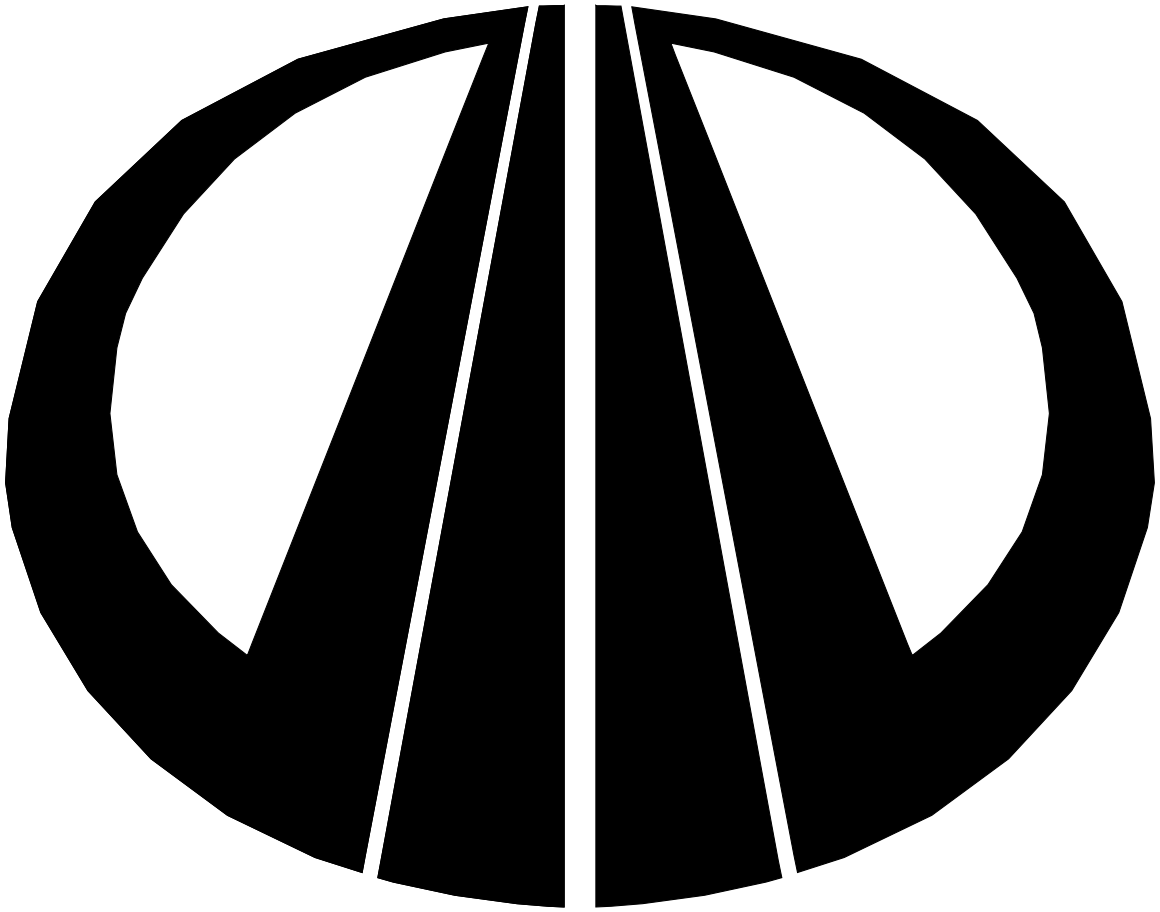
Compactonomics



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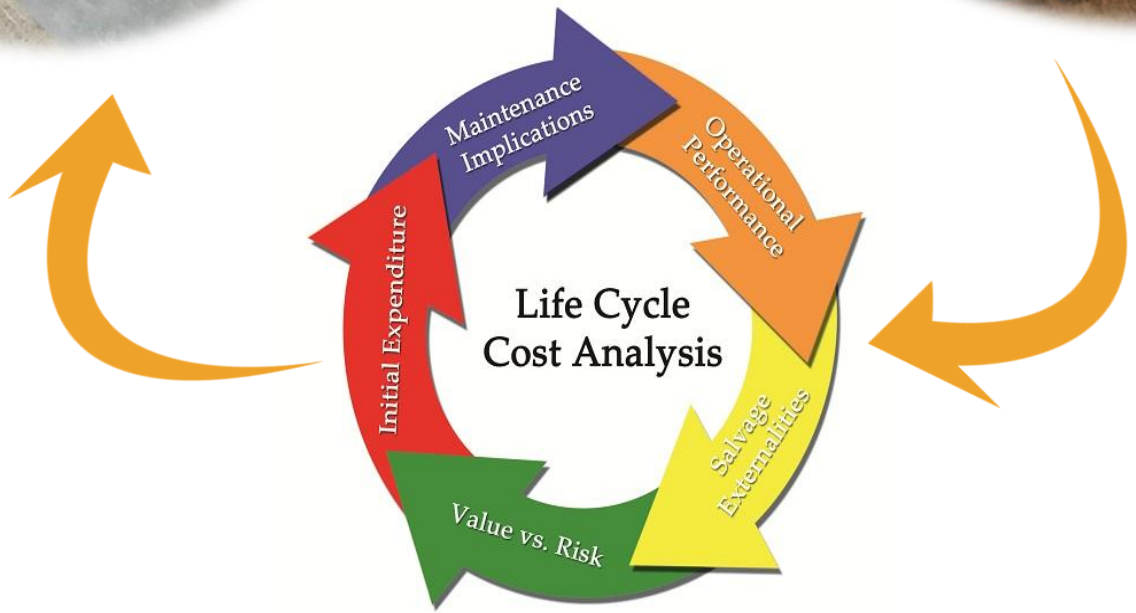
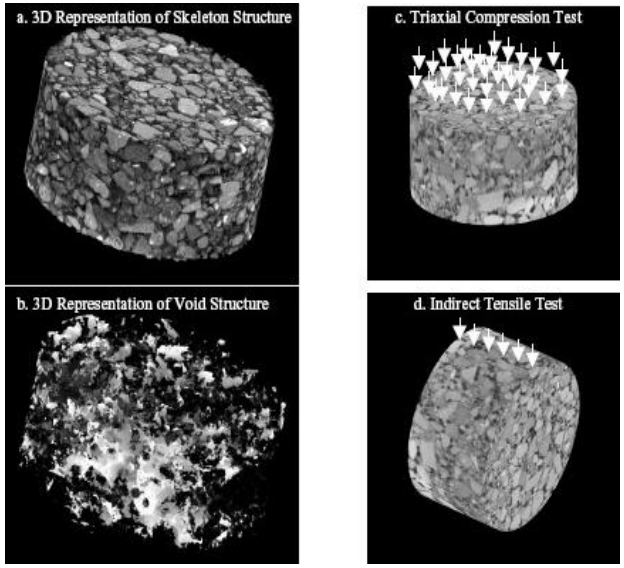
DYNAPAC
COMPACTION

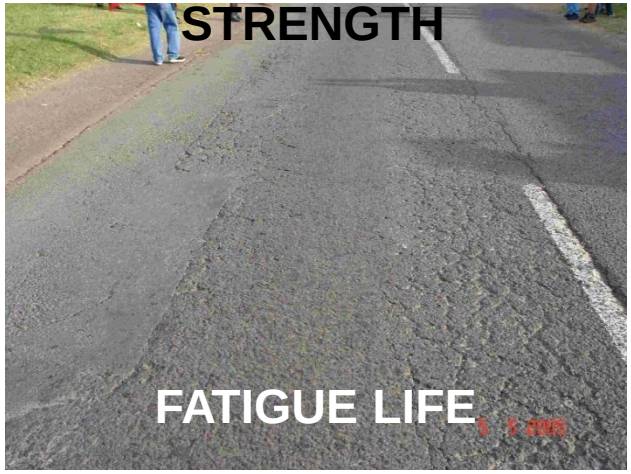

PAVEMENT PERFORMANCE
Road Survey Vehicle
www.nra.co.za


Maintenance Implications
Operational Performance
Salvage Externalities
Value vs. Risk
Initial Expenditure
Life Cycle Cost Analysis

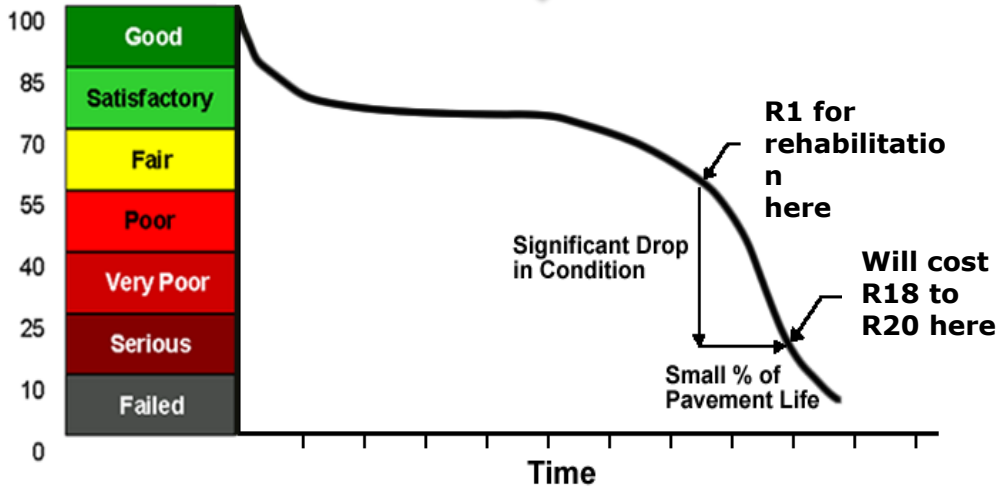
Poor compaction = low density & correlating high permeability



STRUCTURAL STRENGTH



Compaction & density achieved by the contractor on site



Joint cracks….an arthritic problem!!

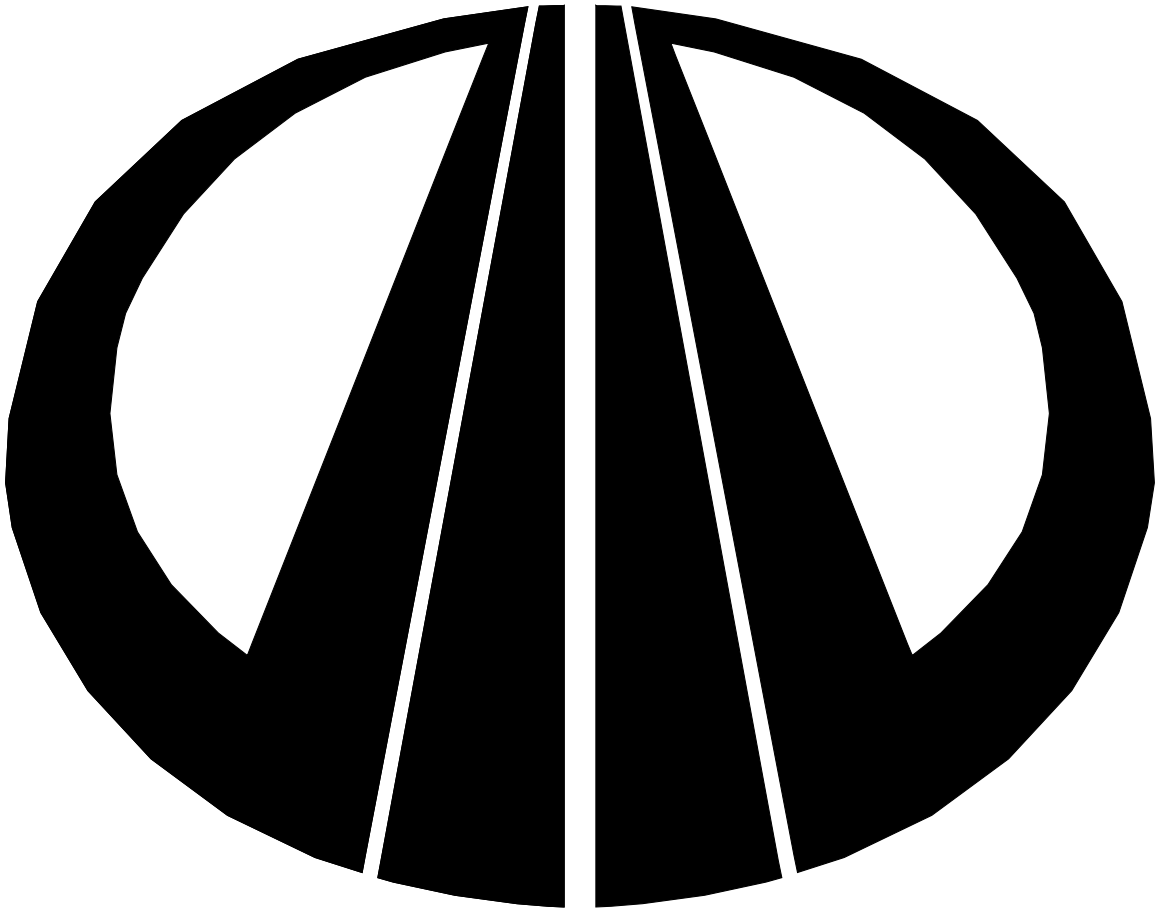
Poorly constructed joint

In a study to estimate the deviation in pavement performance life resulting from the deviations in the "as constructed" degrees of compaction of pavement layers from the "specified" values, it was observed that…

…every 1 % reduction in the specified degree of compaction of the asphalt layer results in a reduction of 12 % in pavement performance life.

(QUANTIFICATION OF VALUE OF COMPACTION TO ASPHALT PAVEMENT DESIGN LIFE, Dr. A.Samy Noureldin, Paper prepared for presentation at the " Pavements " session of the 1997 XIIIth IRF World Meeting, Toronto, Ontario, Canada)

Compaction management - Sasol



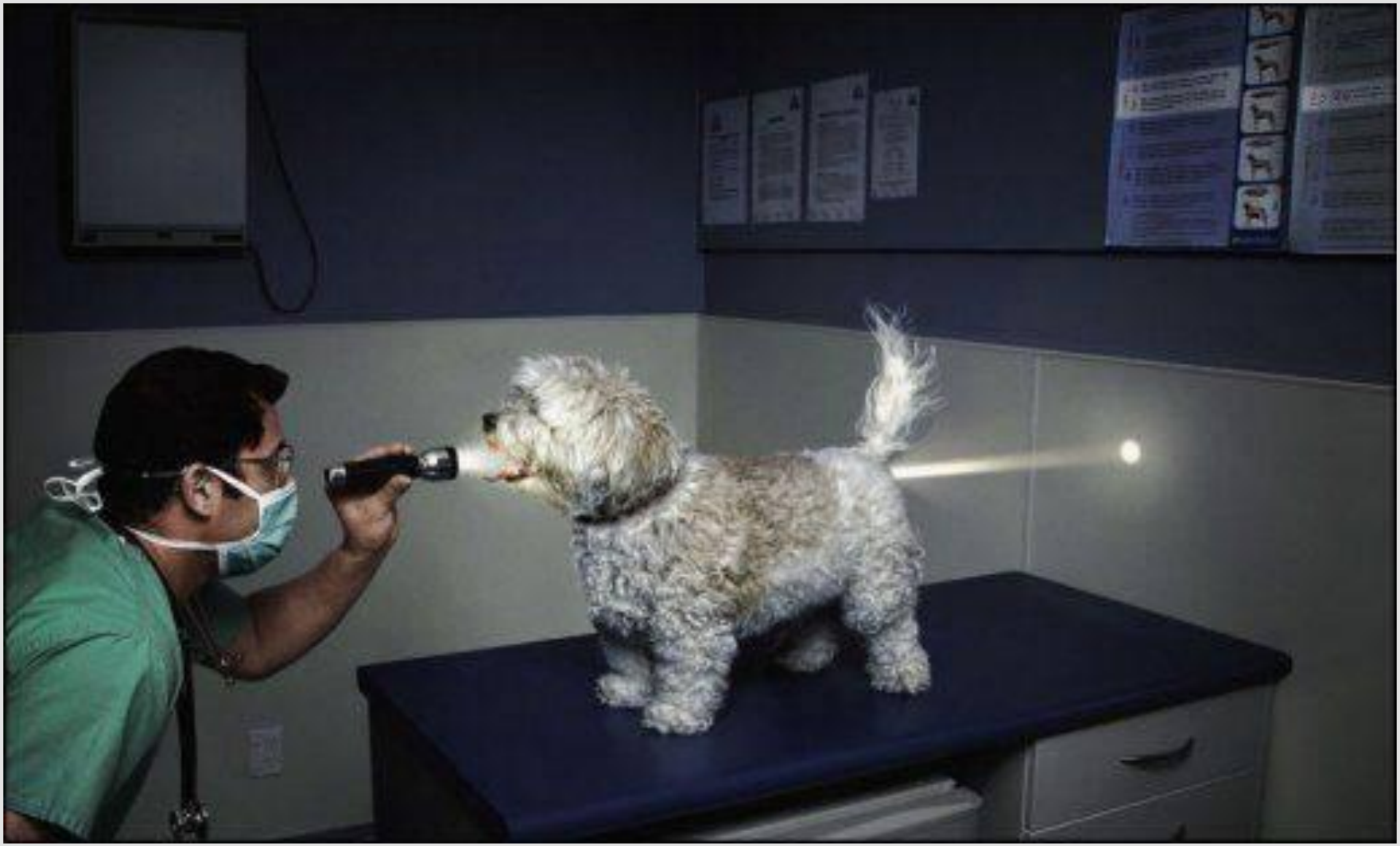
http://www.socsat.co.za/

Problem Statement

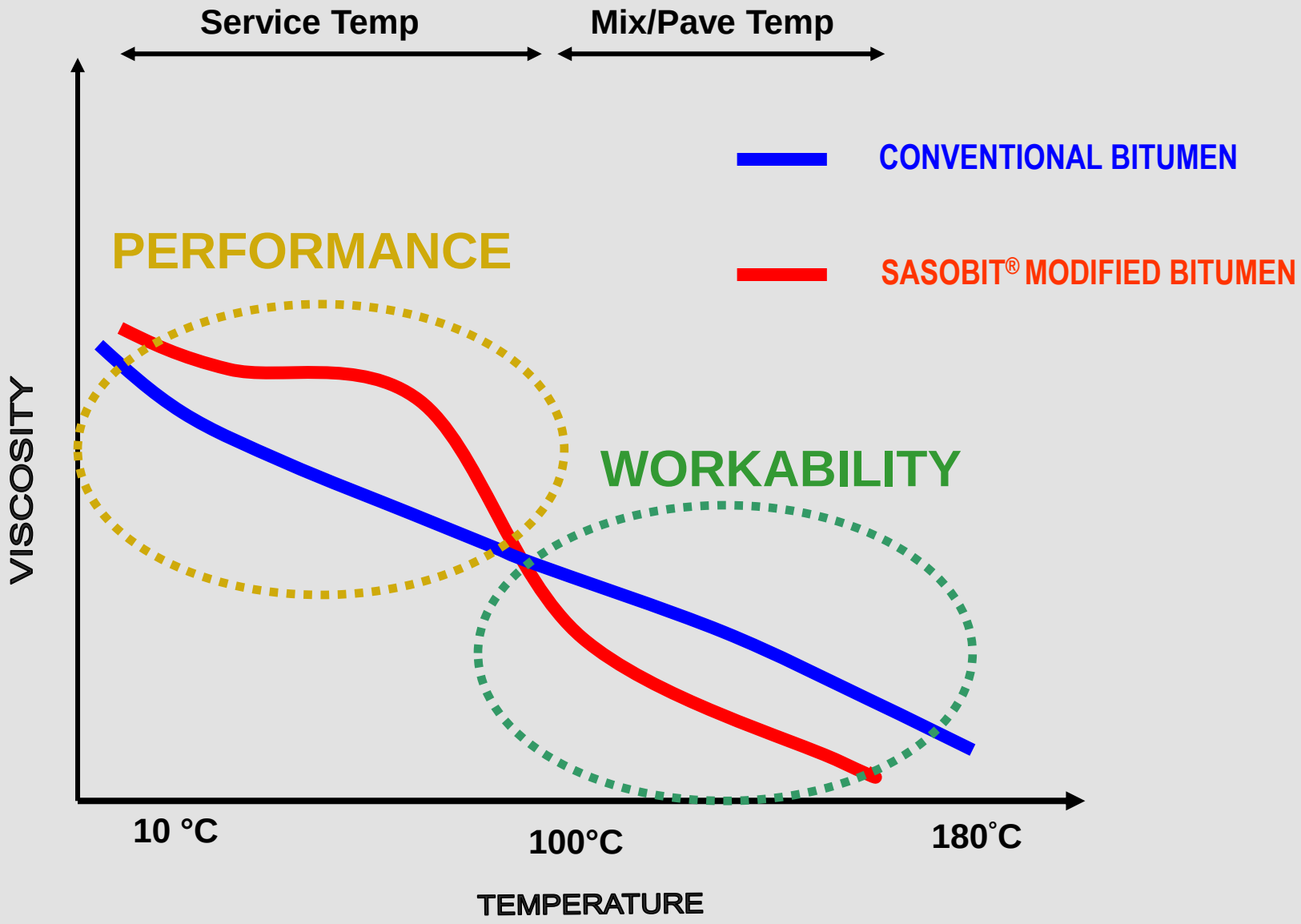
- In Europe, the single most important contributor to road failure has been identified as **non-optimal compaction**

But, as I have shown before …

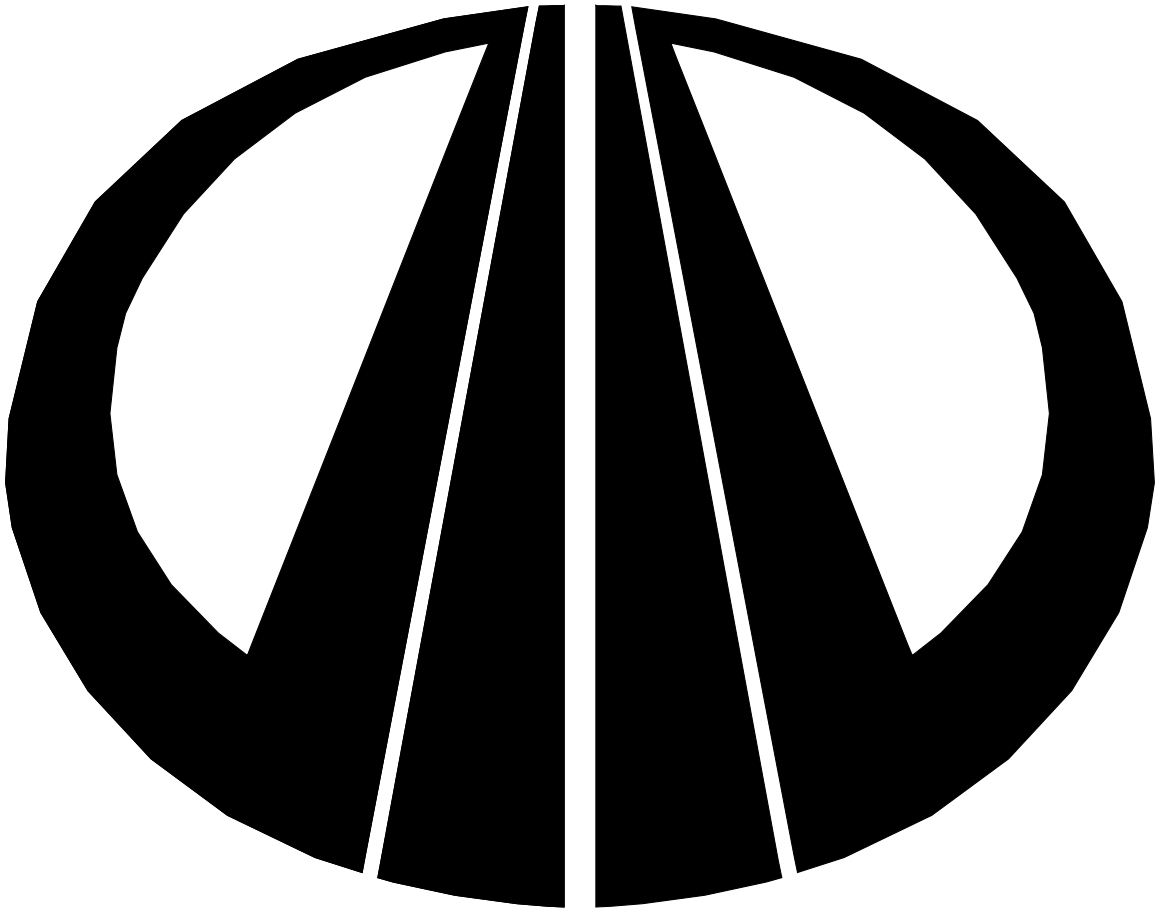
… there is indeed light at the end of the tunnel !!



Effect on Binder Properties: Viscosity



Compaction management - Ammann



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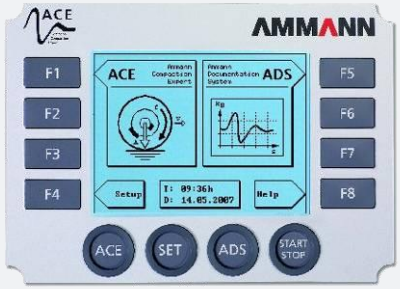
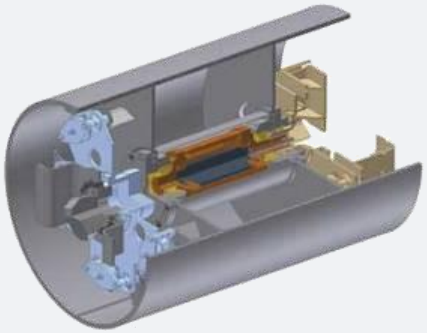
ACE - Compaction System

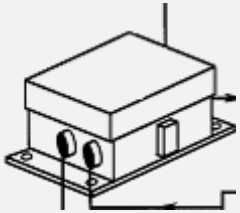
Display & Control



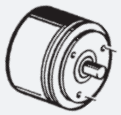
Variable Excitation



Control-
Unit



Sensors



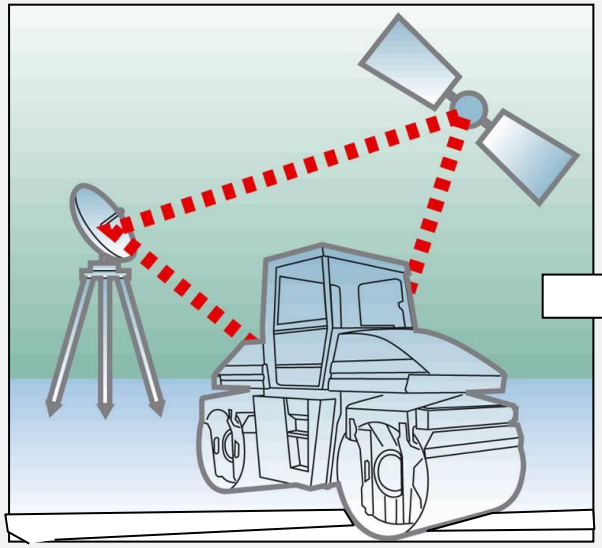
Imbalance Rotation Acceleration Temperature

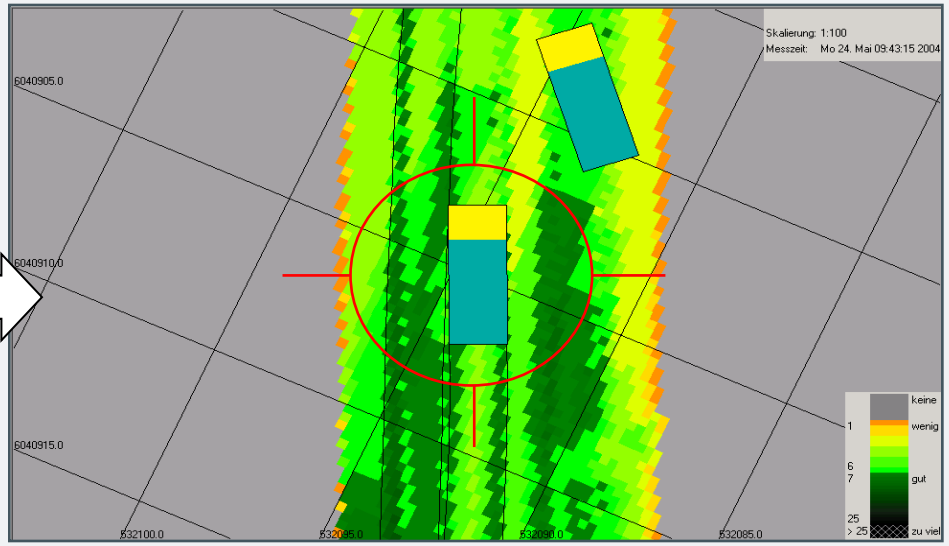
Mapping und Process Quality

Measure and Document = **Process Security**

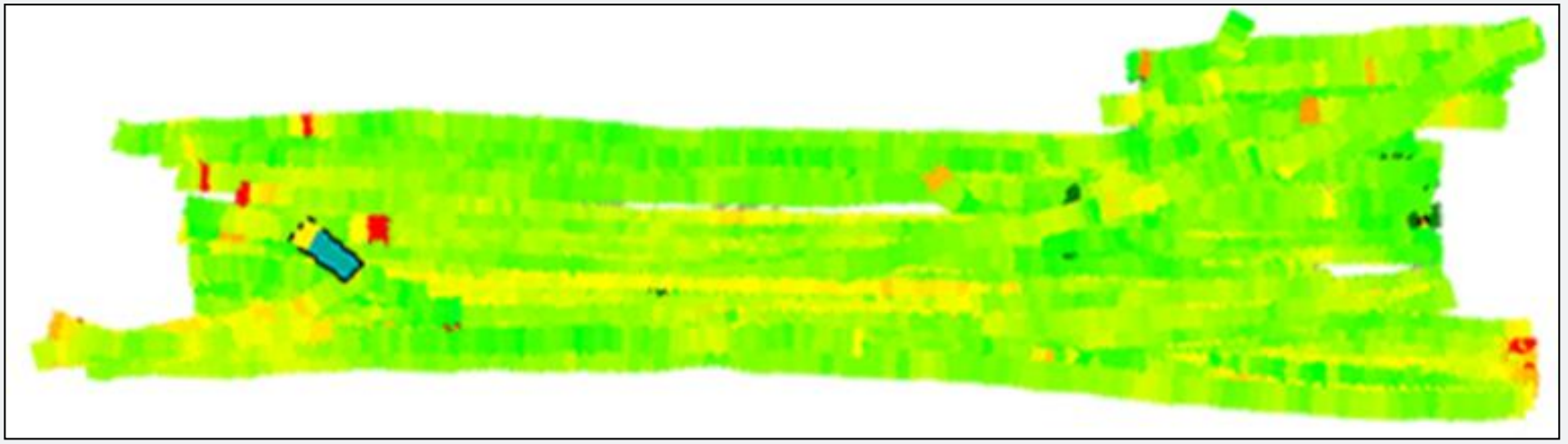
User Guidance & Visualization = **Process Efficiency**

Area-wide Compaction Control (FDVK)





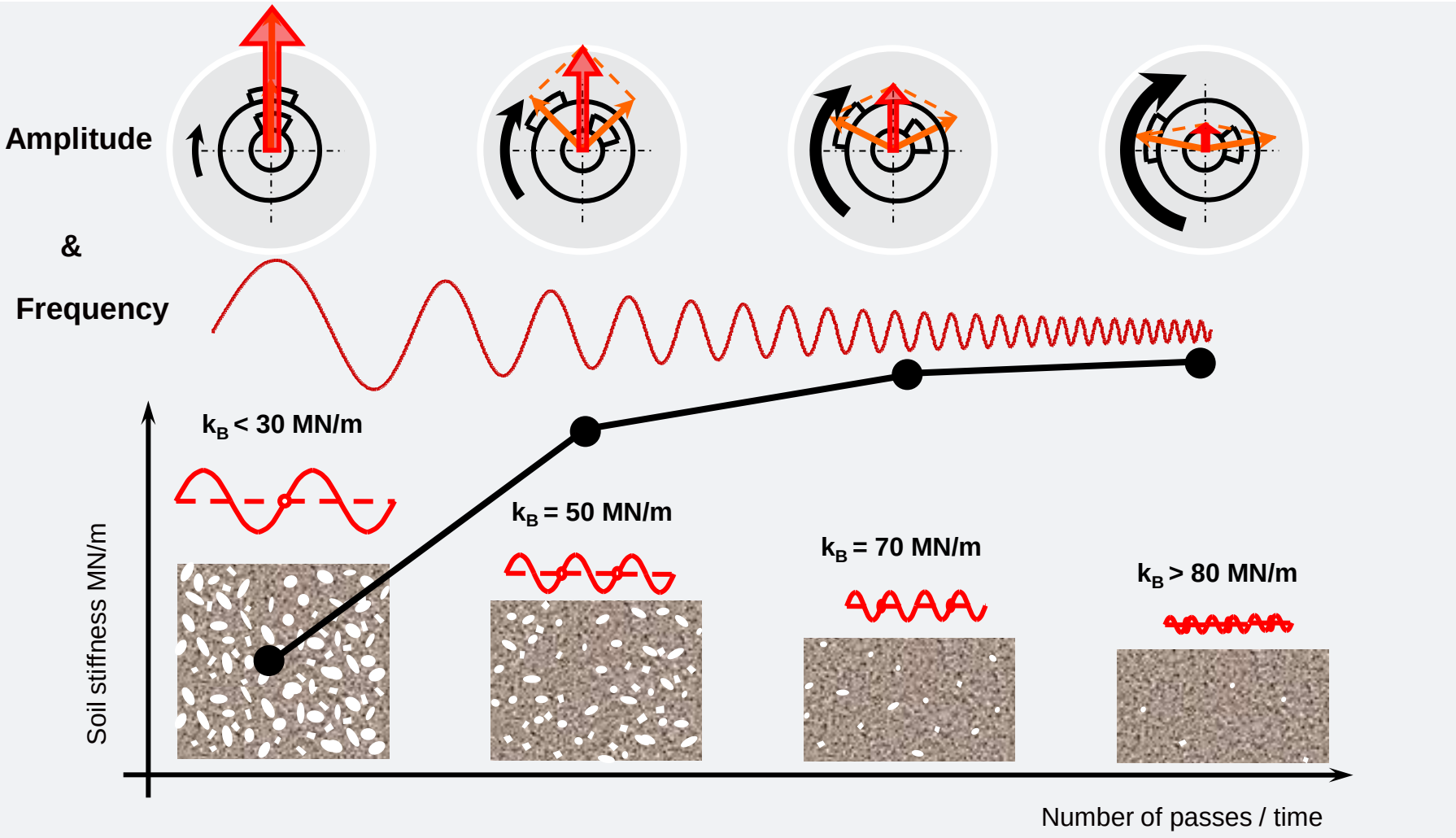
Control Measurement with Asphalt Rollers



→ No paving on badly compacted underground

Quality of compaction Correlated load-bearing values

ACE (feedback control system)



ACE Frequenzregelung – Reaktivität & „Finishing“

Verdichtung von 70 cm sandigem Kies

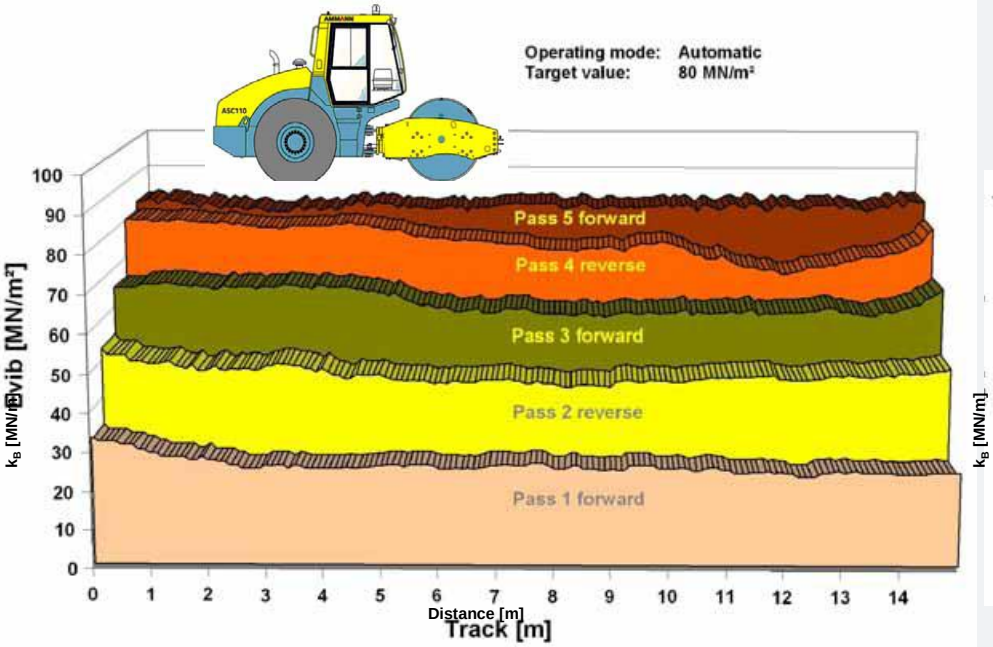
mit ASC110 ACE im Automatik Modus

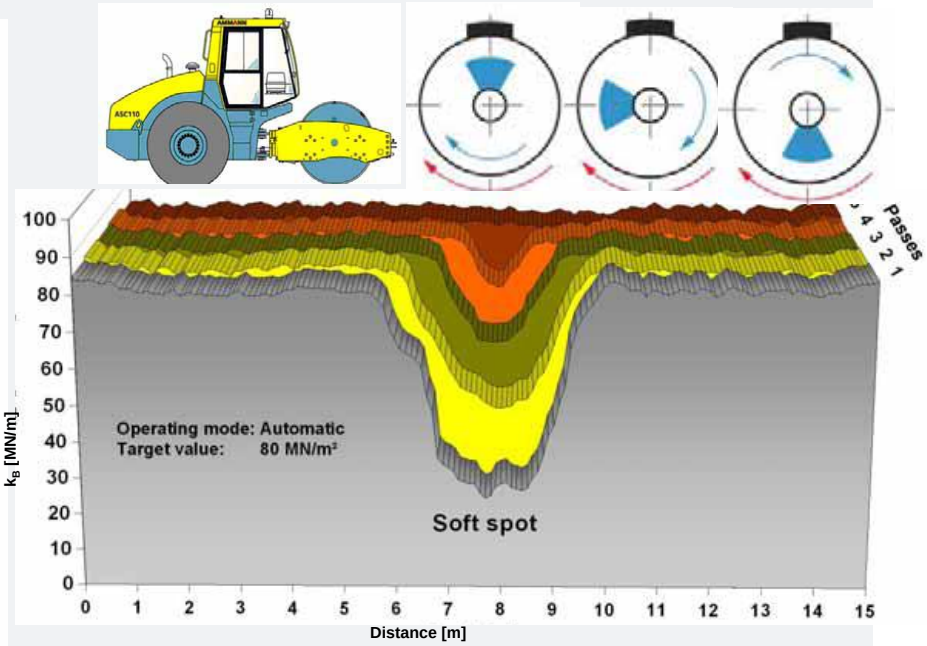
Zielwertvorgabe k_B = 80 MN/m

Nachverdichtung eines “Soft Spots”

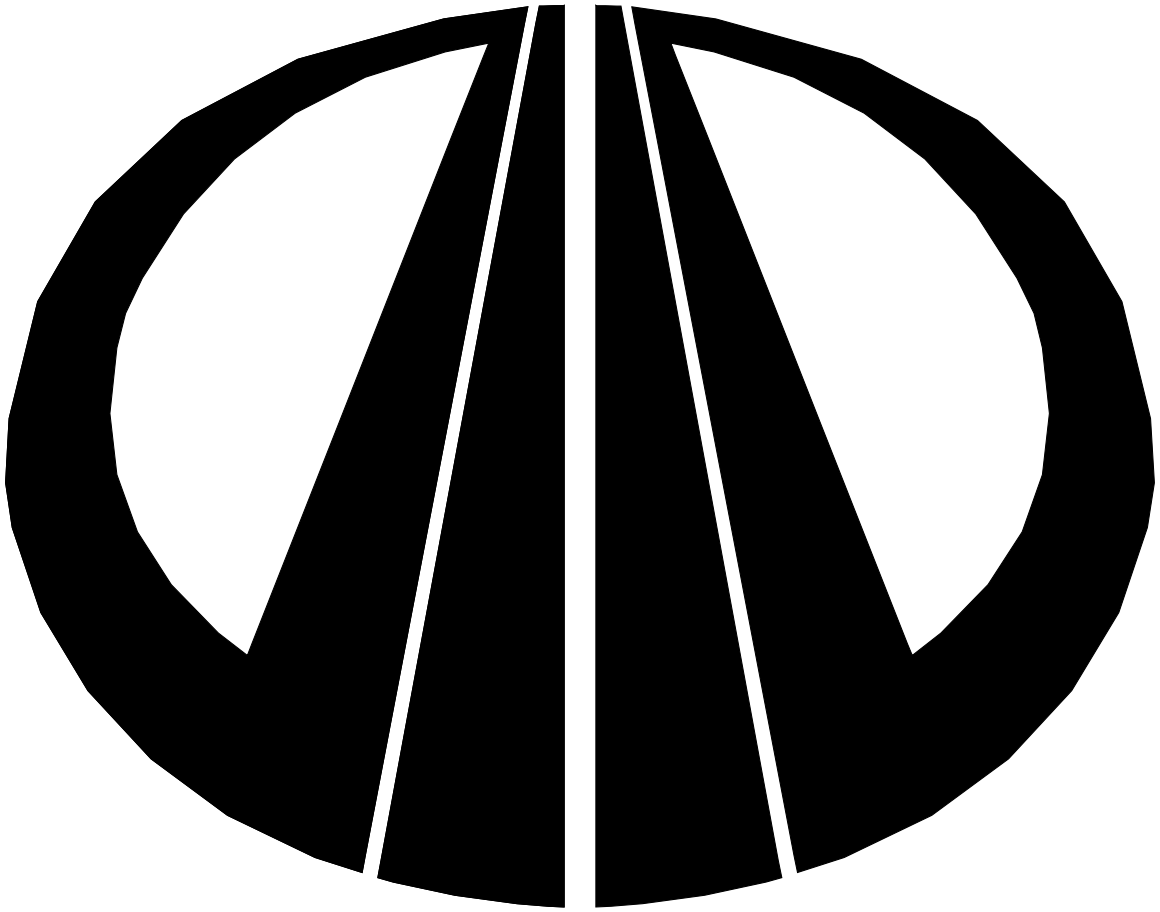
ASC110 ACE Automatik Modus

Zielwertvorgabe k_B = 80 MN/m





Compaction management - Wirtgen



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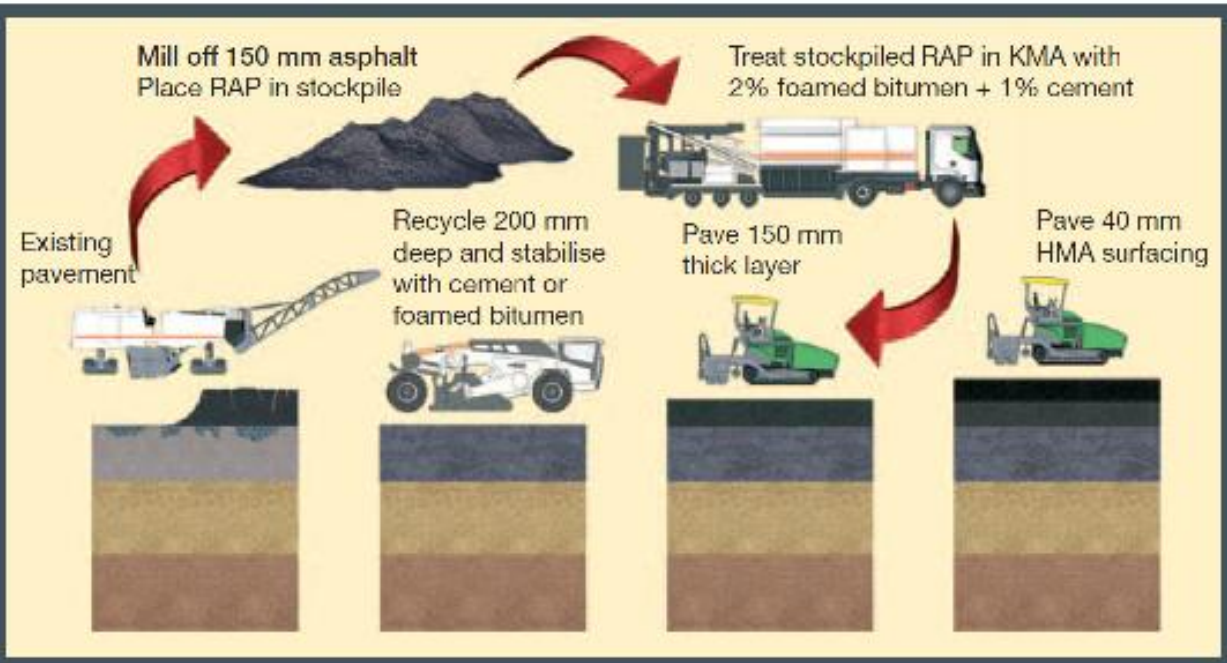
SOIL STABILIZER, COLD RECYCLER

Total Reconstruction

e.g. by Two Part Recycling – in-place & in-plant

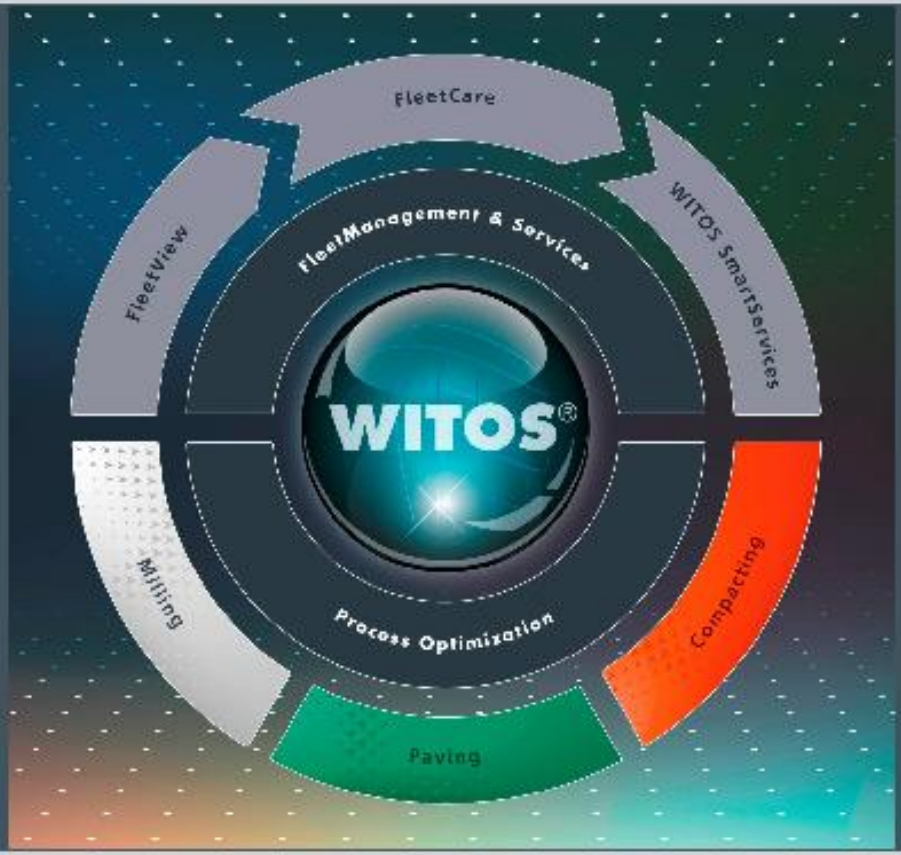


WITOS

WITOS

Wirtgen Group Telematics & On Site Solutions

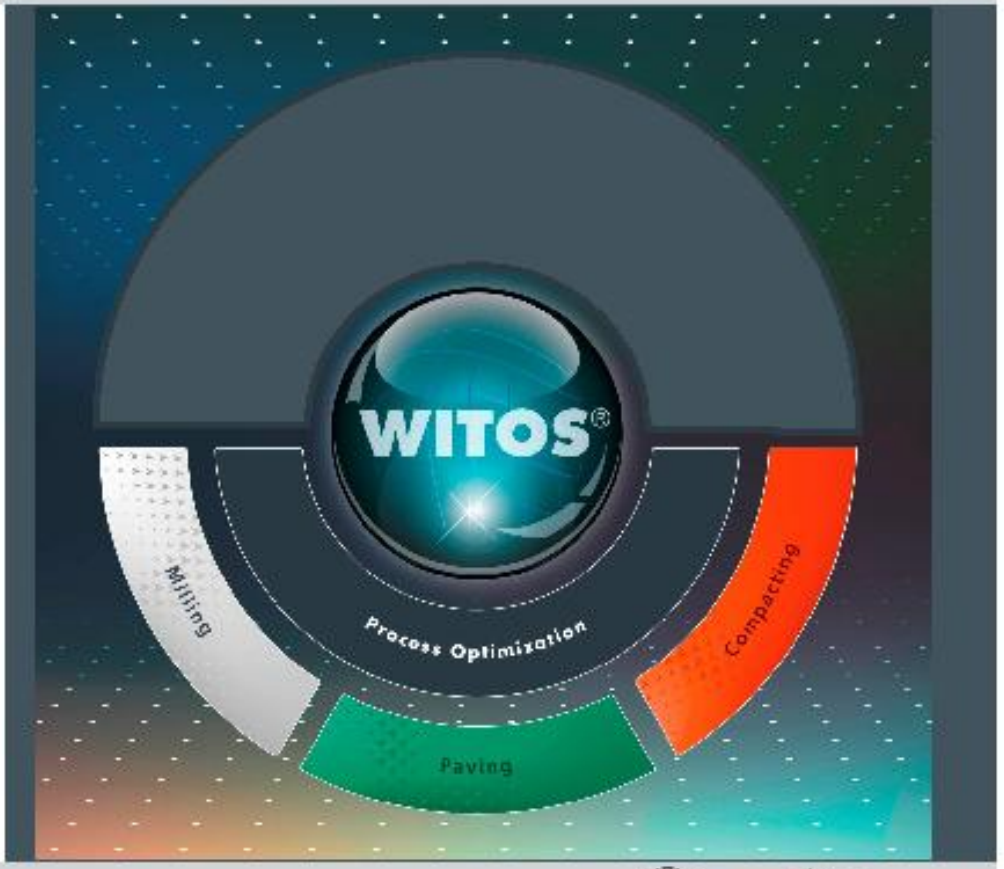
- FleetManagement & Services
- Process Optimization



WITOS

WITOS Process Optimization

- Process planning & control from mixing plant through paving and compaction
- Dynamic cycle for mix supply, just-in-time
- Immediate detection of deviations in work progress
- Common data basis in real time
- Analysis and statistics tool



WITOS

All persons involved in the process are integrated for optimized planning and management.

Roles in construction companies


Administrator


Site manager, Planner


Paving supervisor, Paving team


Roller operators

WIRTGEN GROUP / JOSEPH VÖGELE AG


Support, Service staff

Asphalt mixing plant


Mixing supervisor

Transport


Drivers

WITOS

WITOS Paving consist of five modules:

The Five Modules of WITOS PAVING

"Control" module

Establishes a consistent plan of operations for the job site and supports the monitoring of the work progress.

"Materials" module

Calculates the arrival times and loading times for the mix lorries and automatically performs a target/actual comparison.

"Transport" module

Informs the lorry drivers about target arrival times and makes available status reports on transport.

"JobSite" module

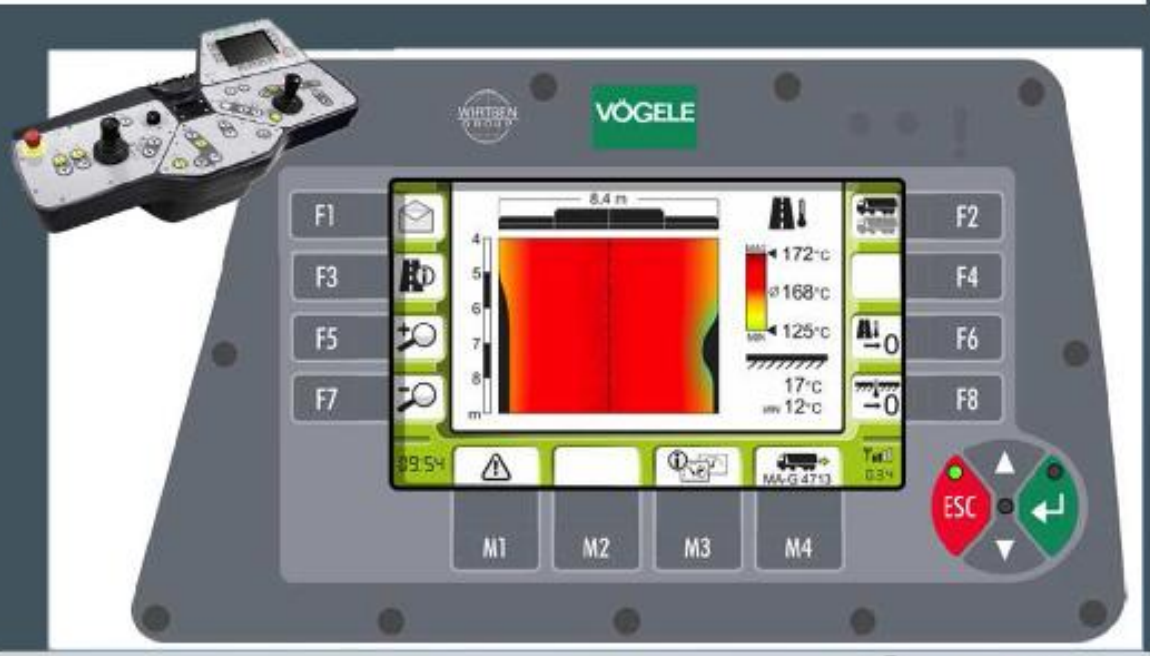
Provides transparency on the work progress, the material supply and the paving quality to the site manager and the paving crew.

"Analysis" module

Analyzes and visualizes all data determining the construction process, as well as the paving quality.

WITOS

WITOS Paving – Road Scan for temperature measurement pavement through infra-red camera. Data integration into WITOS and Hamm HCQ Navigator.



HCQ NAVIGATOR

Satellite based, area-wide

- Measurement
- Display
- Documentation

Of quality relevant parameters <u>during</u> compaction

- Stiffness
- Number of Passes
- Asphalt temperature
- Position data
- Change of compaction
- Driving speed
- Frequency, amplitude

HCQ NAVIGATOR

Quality

- CCC- Continuous Compaction Control for area-wide control
- Avoidance of over- and undercompaction

Cost-Effectiveness

- Avoiding of unnecessary passes
- Modular system

Documentation

- Area-wide data storage
- Data transfer via USB-stick

OSCILLATION

Oscillation –HAMM technology for more than 30 years

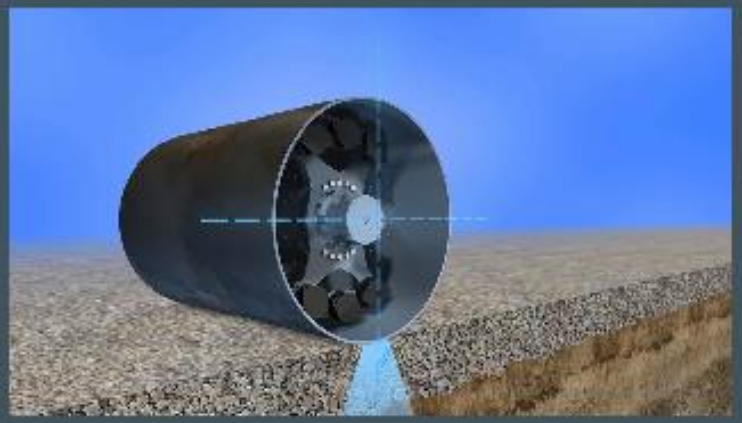
- Customer approved - more than one third of all HAMM tandem rollers with oscillation
- Available for all earth and asphalt rollers

Why oscillation?

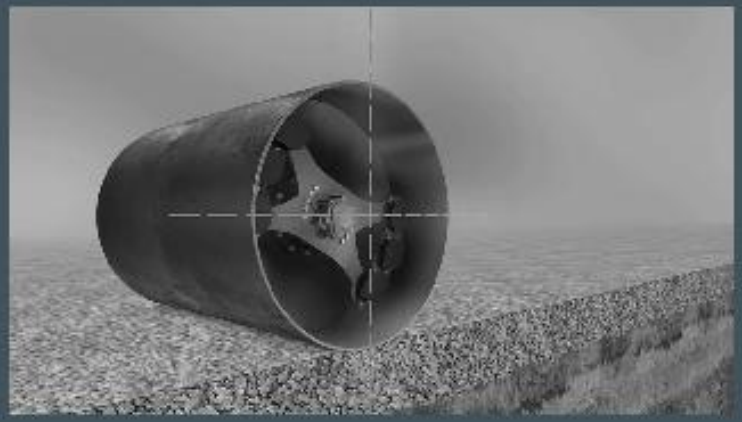
- Broader range of application
- Compaction of asphalt at lower temperature
- No overcompaction, no damage
- Minimal vibration stress
- Smooth surface
- Self adjusting compaction
- Easy operation

OSCILLATION

Comparison between Oscillation and Vibration

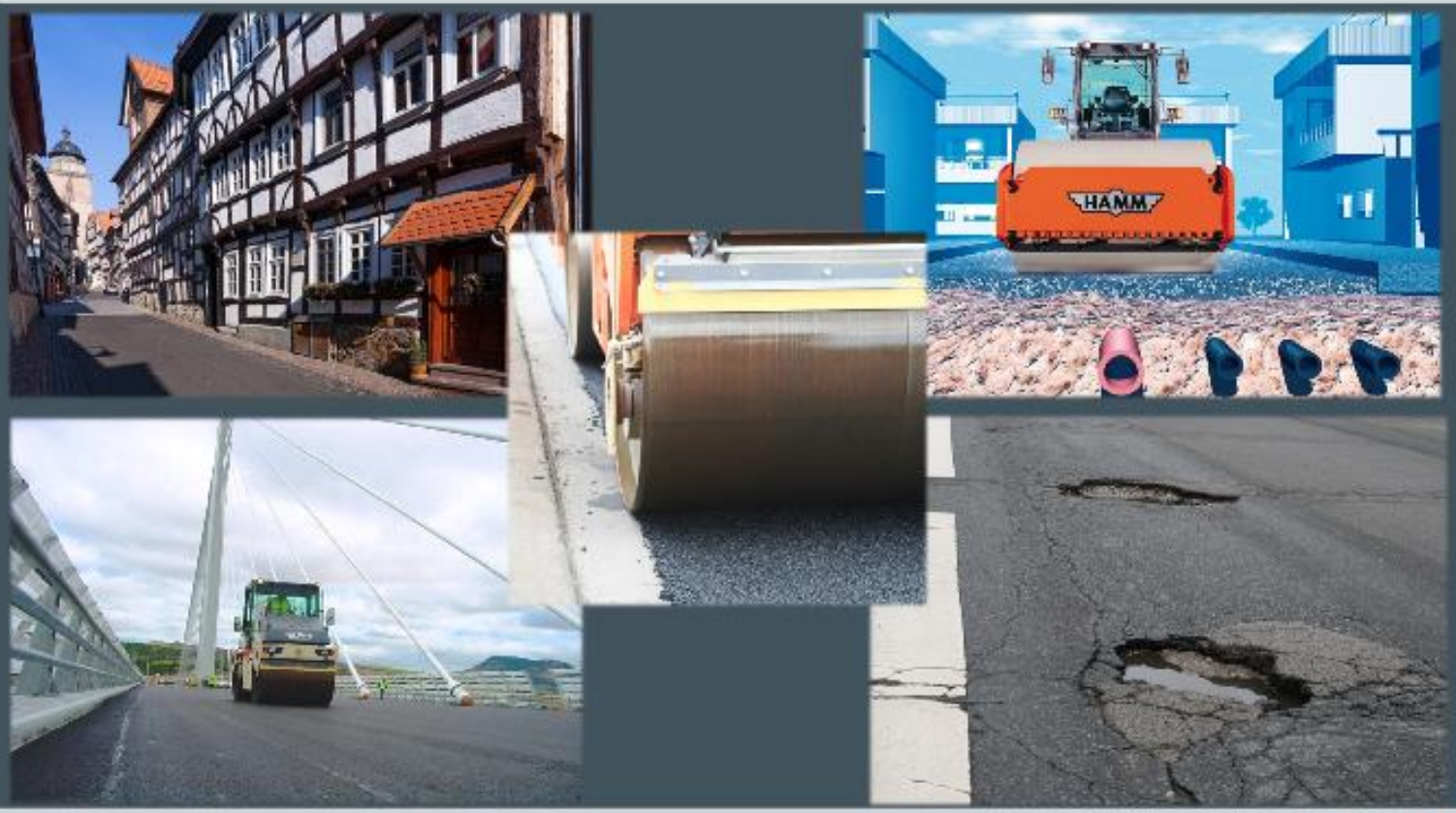


Oscillation

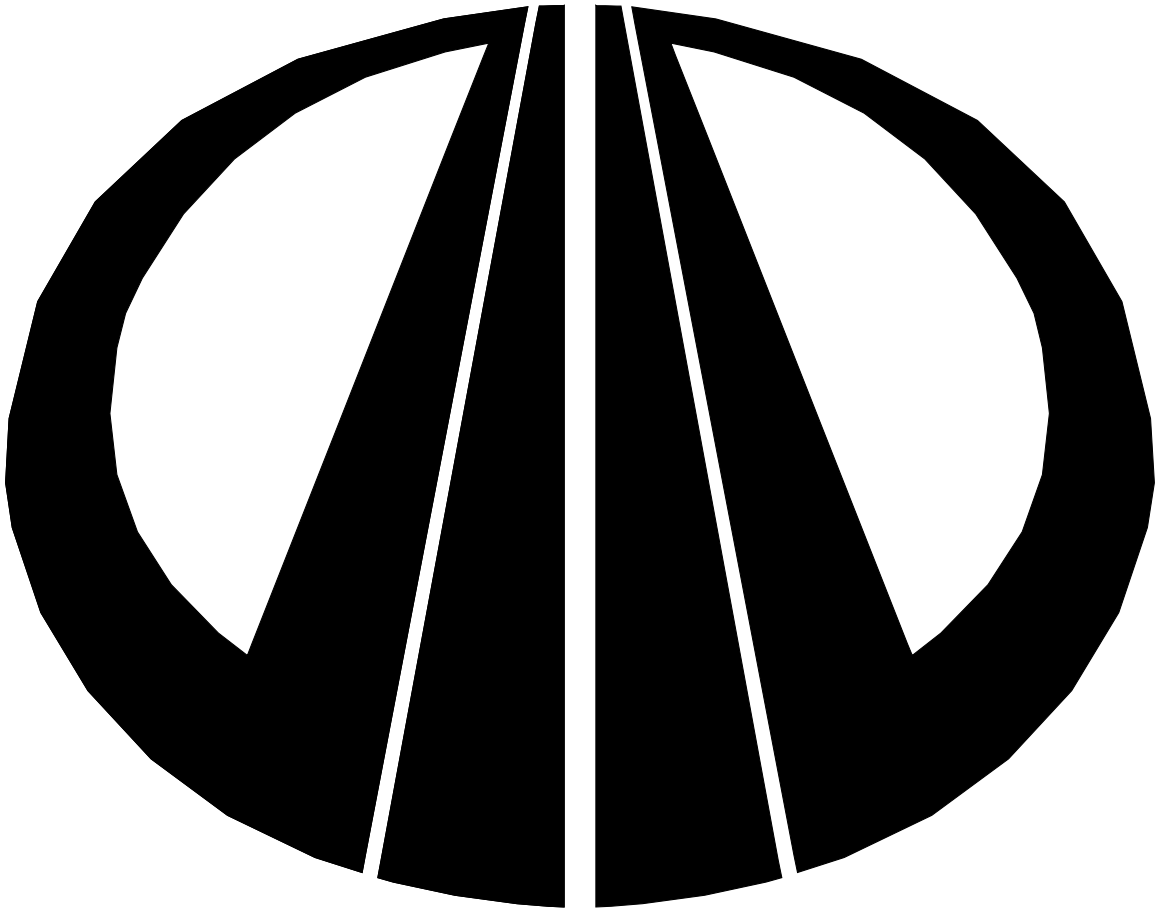


Vibration

OSCILLATION – TYPICAL APPLICATIONS

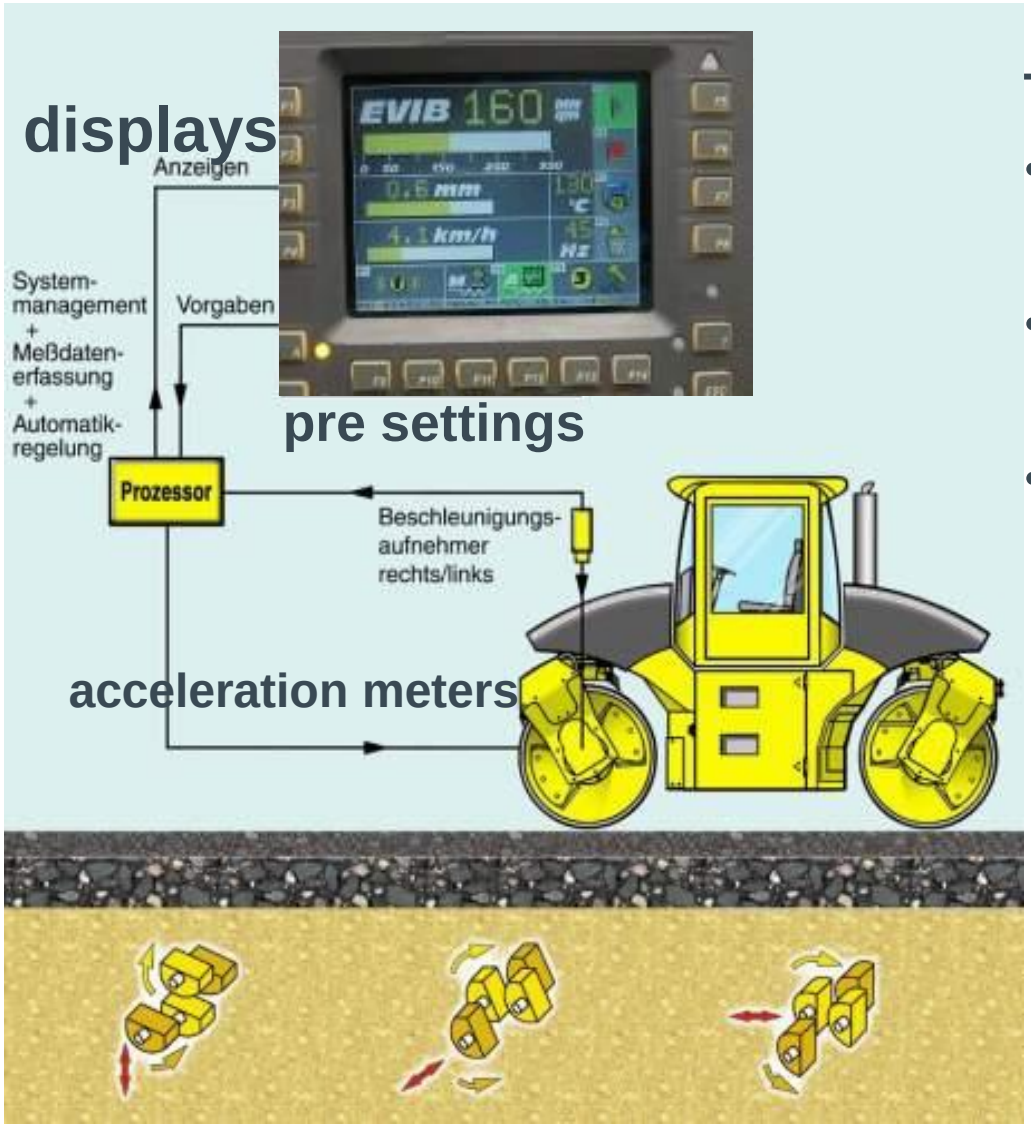


Compaction management - Bomag



http://www.socsat.co.za/

What is the Asphalt Manager?



Tandem roller with :

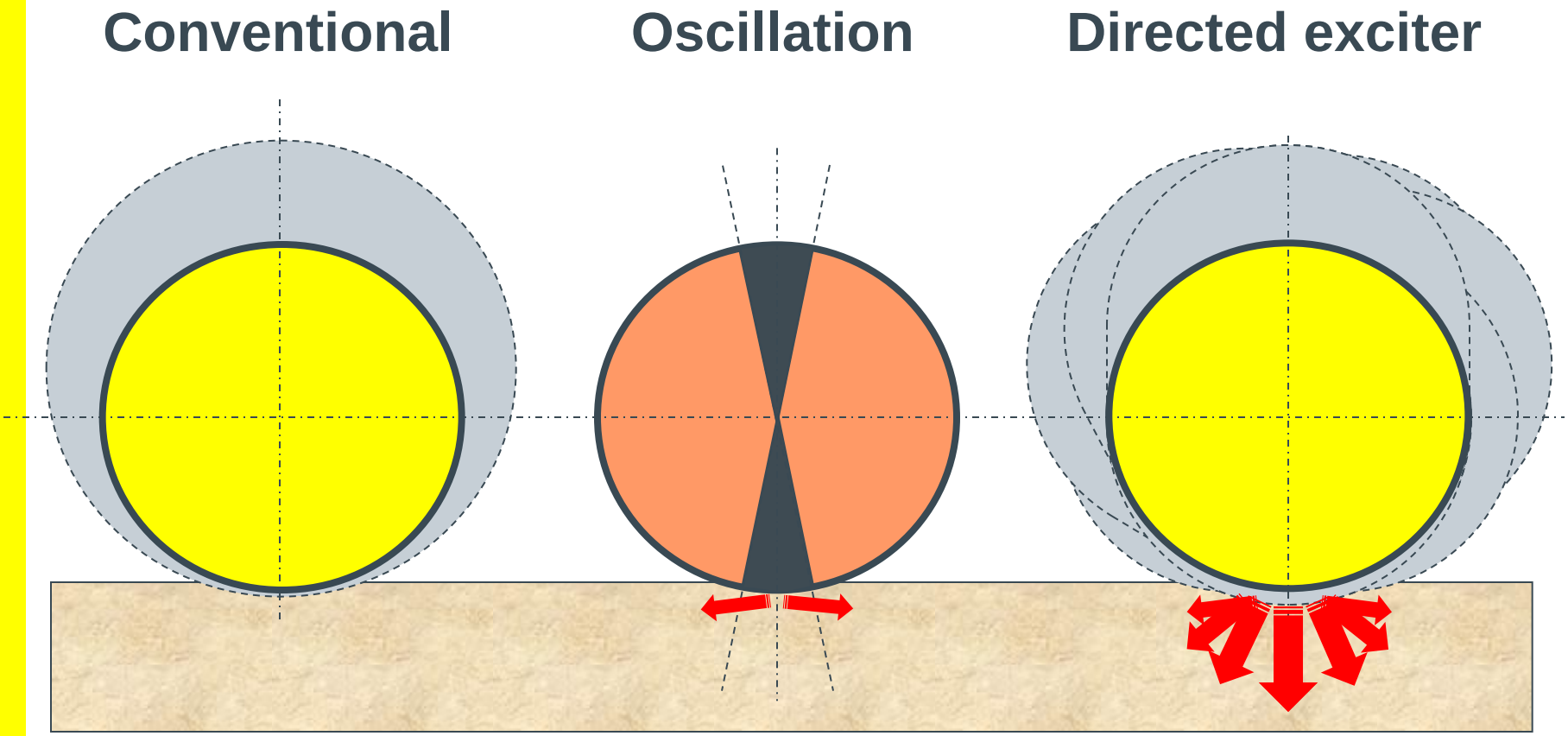
- Directed exciter in the front drum (variocontrol)
- Conventional Exciter in the rear drum
- On board continuous compaction measurement

E_{VIB} (MN/m²)

Dynamic stiffness value

Continuous indication of compaction progress

Exciter systems



Benefits of Asphalt Manager

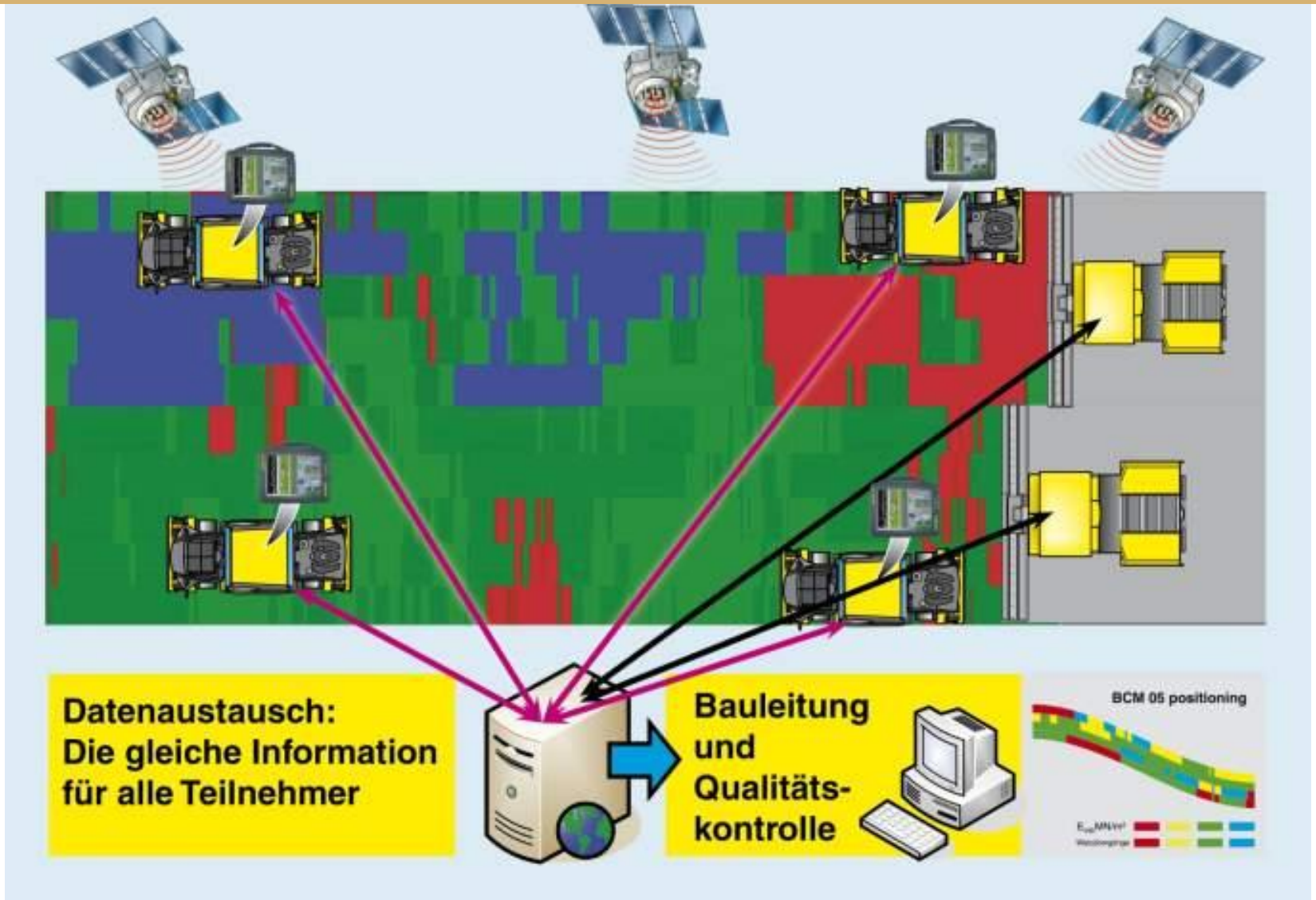
- very effective but smooth compaction because of amplitude reduction
- much less aggregate cracking problems
- better surface finish compared to standard machines
- wide range of applications (variable amplitude)
- continuous asphalt temperature measuring and presentation
- Continuous Compaction Control on board

Advantages of Asphalt Manager

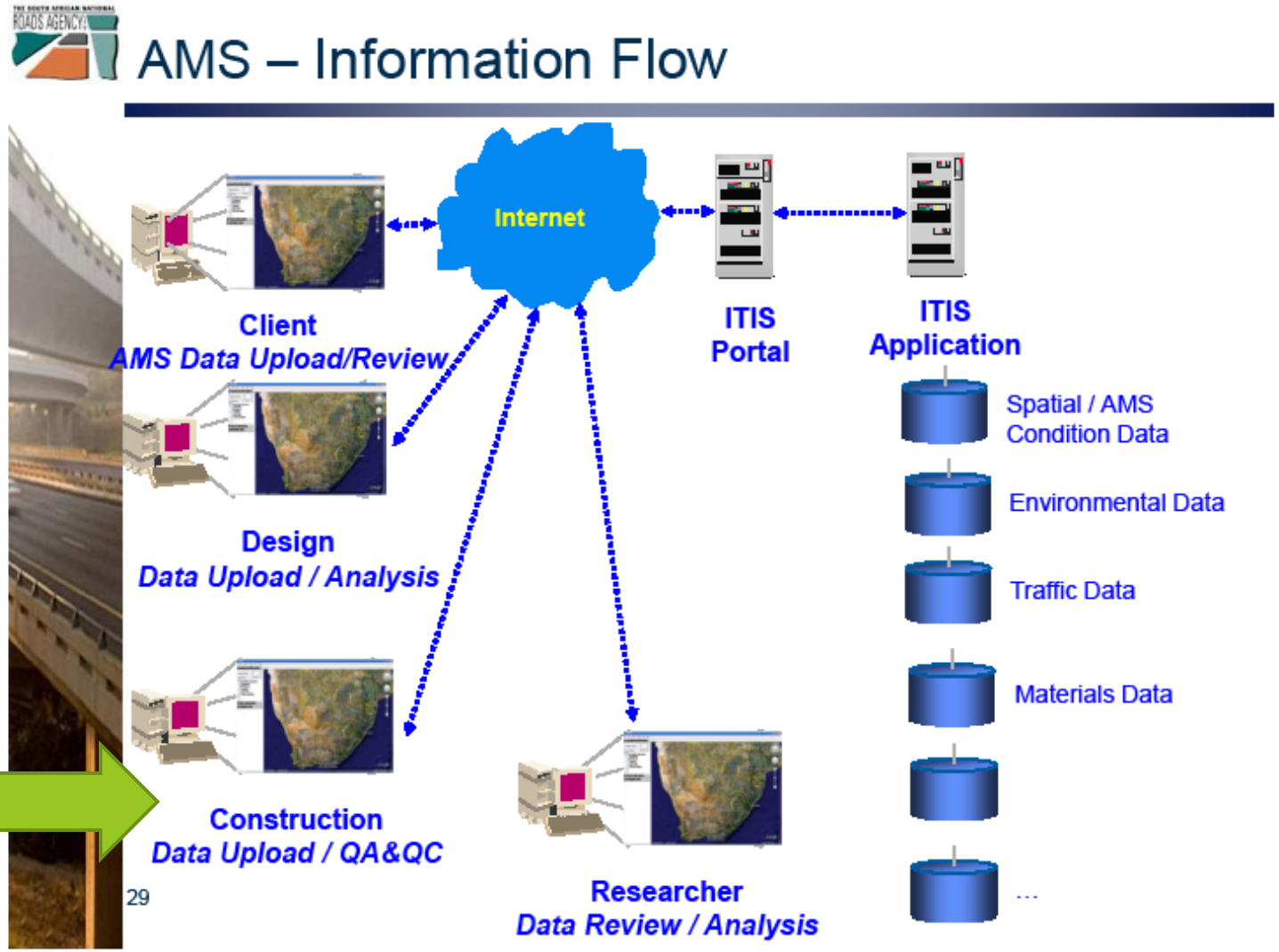
- Cost saving: Less passes, less fuel cost, less operating hours less machine wear
- Quality assurance: No under or over compaction Documentation

BCM Net

BCMNET – Data management between rollers and pavers



Going forward: #BigData



Ammann??
Wirtgen??
Bomag??
You??

Time for Compaction Management Plan?

- Is compaction complex – Yes
- Can compaction be more considered – Yes
- Will there be positive outcomes to more considered compaction– Yes
- Can compaction generate more data – Yes
- Can compaction data analysis improve compaction – Yes
- Can compaction data increase confidence of work done – Yes
- Can considered compaction increase pavement quality - Yes

PIARC – Rural Roads Maintenance

- 27 – 29 November 2013
- Hilton Hotel, Durban
- Partners:
  - National Department of Transport
  - SANRAL
  - SAICE
  - SARF
  - World Road Association
  - eThekwini Municipality

PIARC – Rural Roads Maintenance

- Fees – R2500
- Enquiries – Dumi Nkabinde nkabinde@nra.co.za
- Web – http://www.sanral.co.za
- http://www.piarc.org/en/

- CPD – 2,5 points

33 - 19