

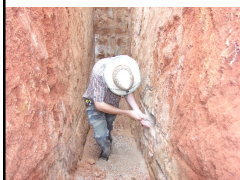
Course content

- 1 Introduction
- 2 Performance
- 3 Design
- 4 Construction
- 5 Maintenance
- 6 Management
- 7 Investigation & maintenance measure selection
- 8 **Safety aspects**
- 9 Rehab, improvement and upgrading



8 SAFETY ASPECTS

- Construction and maintenance of unsealed roads includes operations defined as “construction work” under Construction Regulations (2003 – section 43) of Occupational Health and Safety Act (1993)
- References to use of plant, labour resources, work in excavations and trenches, etc
- Need to comply with the act



8 SAFETY ASPECTS

- Document is not a safety guide
- Certain issues of recent importance raised
- Safety problems will always occur during the construction and maintenance of unsealed roads
 - Dust
 - Lack of deviations
 - High windrows often with “large” stones
 - Slow moving equipment
 - Potholes
 - Large stones and boulders on the road, etc



8 SAFETY ASPECTS

- Important to fully sign post with correct warning signs
- Quality of signs needs continuous checking – dust, flying stones, etc
- Graders and other plant with high visibility “rotating” lights – keep clean and working
- Windrows left on the road should not be higher than 100 mm – leave for as short as possible
- Graders working in tandem or tridem minimise this time



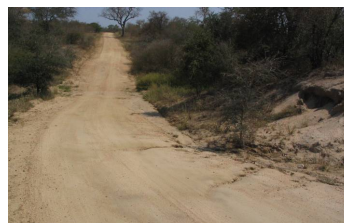
8 SAFETY ASPECTS

- All labour should have high quality safety vests
- Must be kept clean and operative
- Sign boards are not routinely used for warning on unsealed roads (slippery, speeds, unsafe conditions, etc.)
- Problems complying with statutes (after each junction, distance from road edge, etc.)
- Cannot account for periodic episodes of extreme weather
- Increase in future



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9 REHABILITATION, IMPROVEMENT & UPGRADING

9.1 Rehabilitation

Different definitions for sealed and unsealed roads

- Sealed road – “measures to improve, strengthen or salvage existing deficient pavements so that they continue, with routine maintenance, to carry the traffic with adequate speed, safety and comfort”.
- Usually towards the end of the design life
- This is done routinely on unsealed roads
- Regravelling (almost the equivalent) is done routinely

9 REHABILITATION, IMPROVEMENT & UPGRADING

9.1 Rehabilitation

- Rehabilitation of unsealed roads is probably restricted to betterment (realignment, raising of the formation, improved drainage, etc)
- Usually a policy decision from a regional level or higher
- Normally based on high traffic counts, improved safety requirements or political decisions



9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Even with the best materials, construction and maintenance, gravel roads are still subject to the environment and traffic
- They will continue to deteriorate, generate dust and lose gravel
- Numerous proprietary soil stabilizers are currently available that may improve some of these materials and slow the deterioration.
- Famous “snake oils”



9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Conventional stabilization
 - Lime, cement, bitumen (not discussed in the document)
- Proprietary stabilizers
 - Well known internationally
 - Afghanistan to Zambia
 - China to Ghana
 - Perhaps not for the right reasons
- Two types of Product
 - Surface fines retention
 - Strengthen soils (stabilizers)
 - Some overlap but have primary purpose

9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

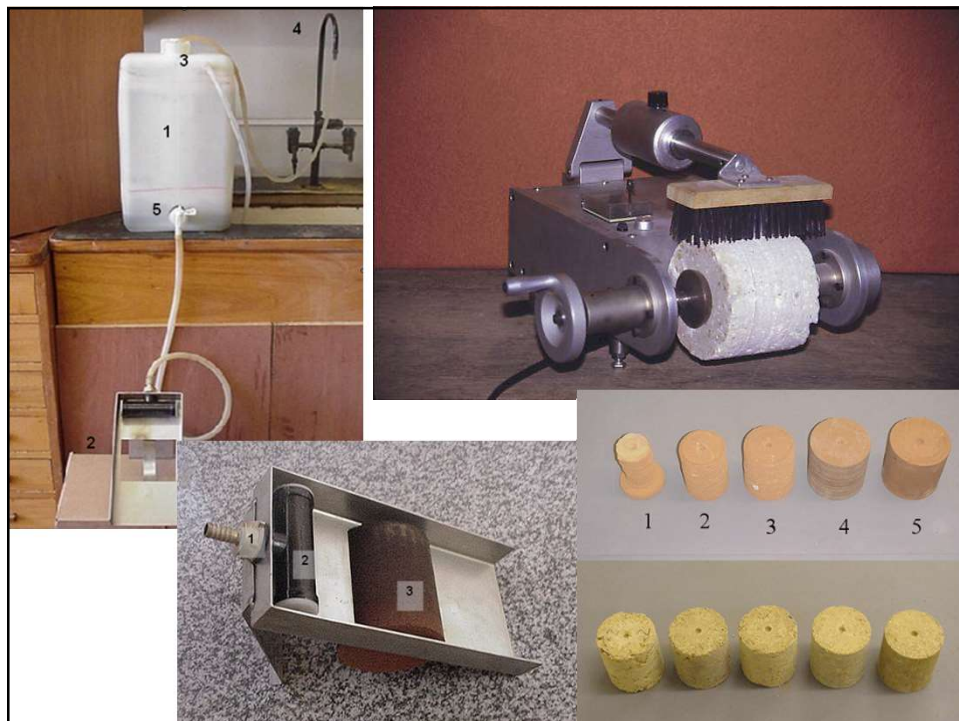
- Many of the products can have beneficial effects
- No single product that consistently improve all materials
- Therefore require extensive test programs
- If they produce the required properties, no practical reason why they can't be used
- **Must be economical !!**



9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Recent developments have led to an Agrément certification process
- This determines whether a product fulfills certain criteria related to its potential use. These include :
 - Resistance to abrasion
 - Resistance to water absorption
 - Increased density for single compactive effort
 - Sensitivity to moisture
 - Increased shear strength
 - Change in plasticity
- Two standard materials
 - Non plastic sand
 - 70% of sand and 30% black clay mixture



9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Specification criteria for results
- Certification does not necessarily guarantee that the product will perform with all materials in all cases
- New “light certificate” – high probability of success
- Products can either be sprayed on or mixed in
 - Sprayed on tend to not last as long – better for dust palliation
 - Mixing in best for “stabilizers”

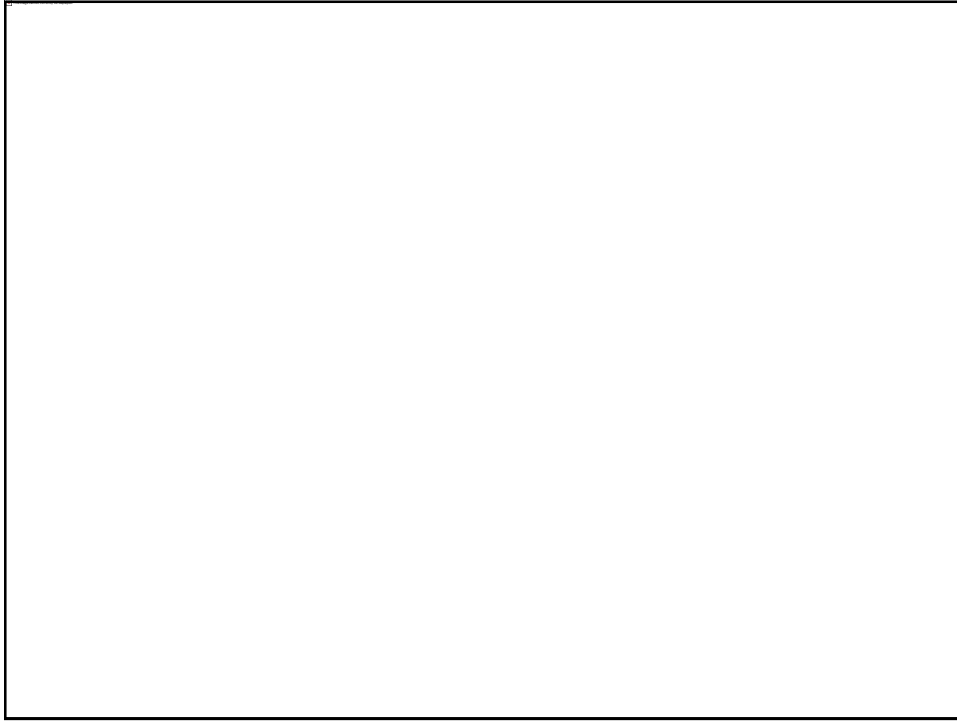


9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Dust palliation
- Number are available
- Each need to be tested
- Ligno-sulphonates and hygroscopic salts (chlorides) shown to be effective
- First indication can be obtained from Table





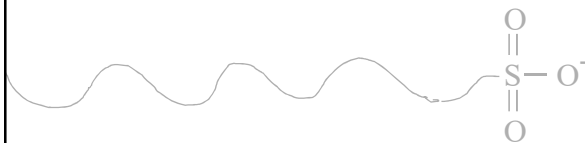
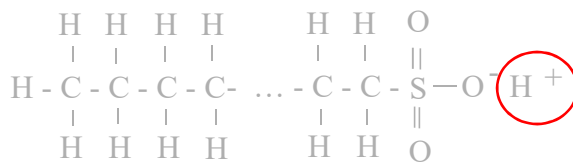
9 REHABILITATION, IMPROVEMENT & UPGRADING

9.2 Improvement

- Stabilization
- Many of the products can stabilize certain soils
- Range of products – at least 40 in SA
- Most commonly used:
 - Sulphonated petroleum products (SPPs)
 - Enzymes
 - Petroleum resins
 - Synthetic polymer emulsions
 - Cement based
 - Bitumen or bitumen based
- A lot of work on SPPs

SULPHONATED OILS

- Surfactants (surface active agents)
- Dodecyl sulphonic acid ($\text{CH}_3(\text{CH}_2)_{11}\text{SO}_3\text{H}$) – Anion in water



CLAY MINERALS

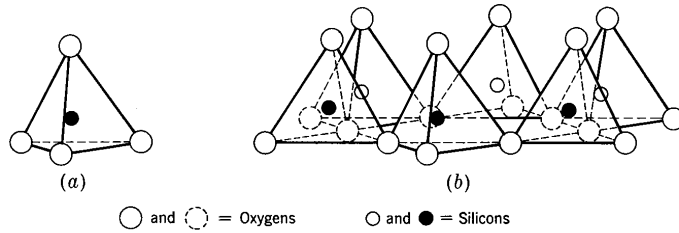


FIG. 2-2. Diagrammatic sketch showing (a) single silica tetrahedron and (b) the sheet structure of silica tetrahedrons arranged in a hexagonal network.

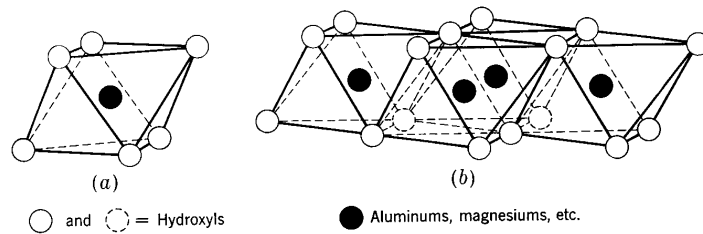
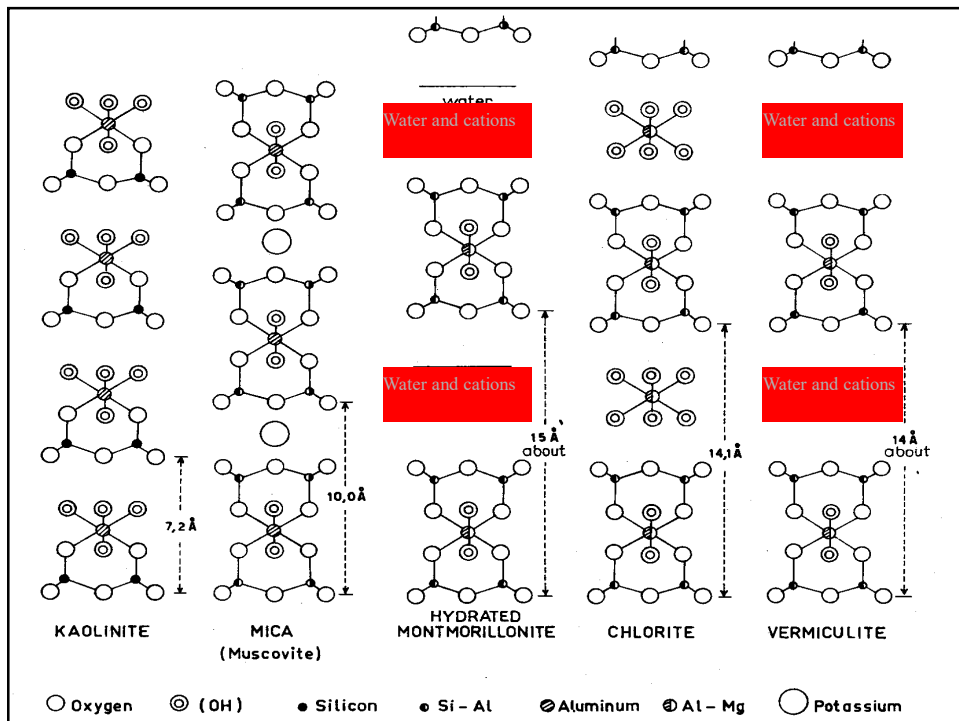
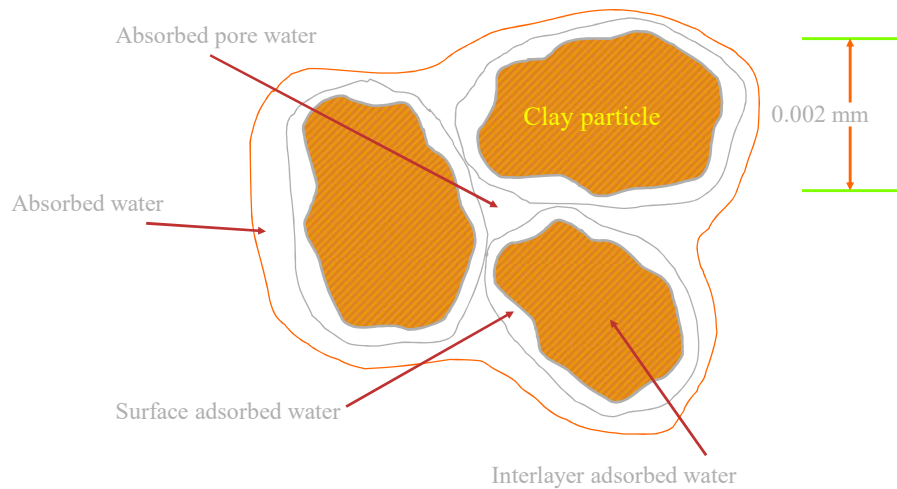


FIG. 2-1. Diagrammatic sketch showing (a) single octahedral unit and (b) the sheet structure of the octahedral units.

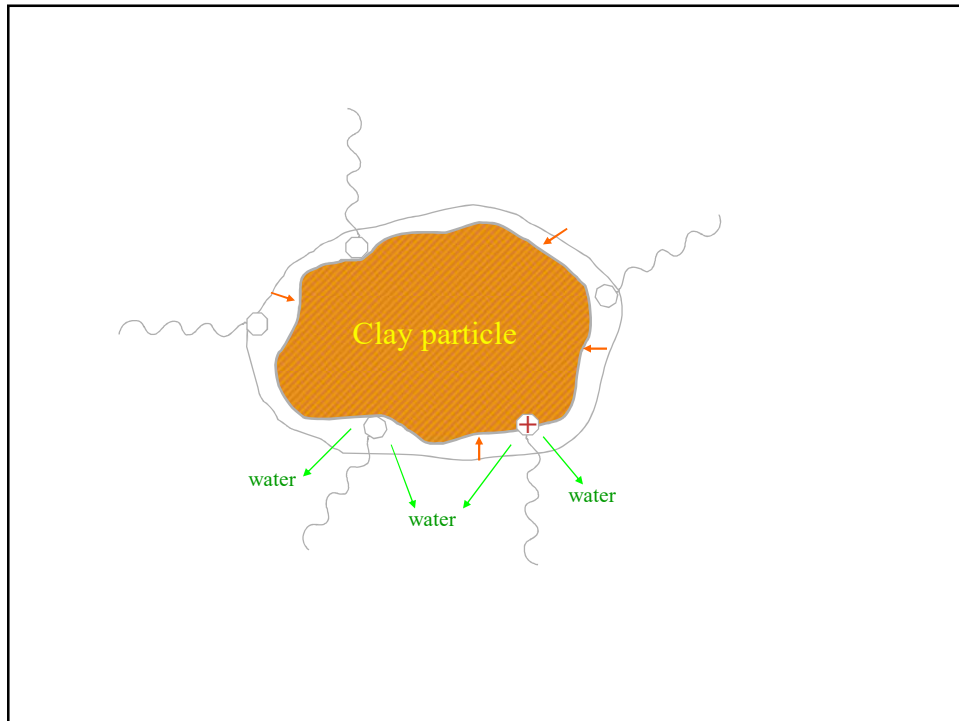


CLAY WATER SYSTEM



ACTION OF SULPHONATED OILS ON CLAYS

- Theoretically:
 - Attach to clay particles (ionic exchange)
 - Water expulsion
 - "Water proofing" through hydrophobic action
 - Better compaction (lubrication and less water to compress)



TESTING FOR SUITABILITY

- Need plasticity and correct clay mineralogy
- Grading (% < 0.075 mm)
- Do they improve the soaked CBR?
- Normal CBR test with different products and application rates
- If the required CBR is produced, then go ahead.
- Carry out regular testing – reactivity changes !



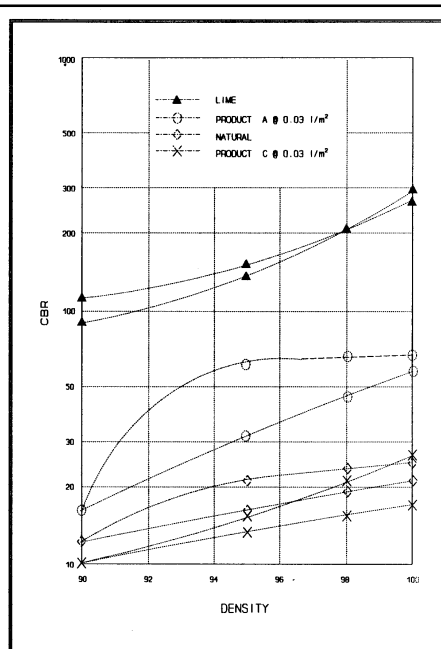


FIGURE 4 : THE EFFECT OF TREATMENT OF SOILS WITH LIME AND DIFFERENT SPP's AT 0.03 l/m³

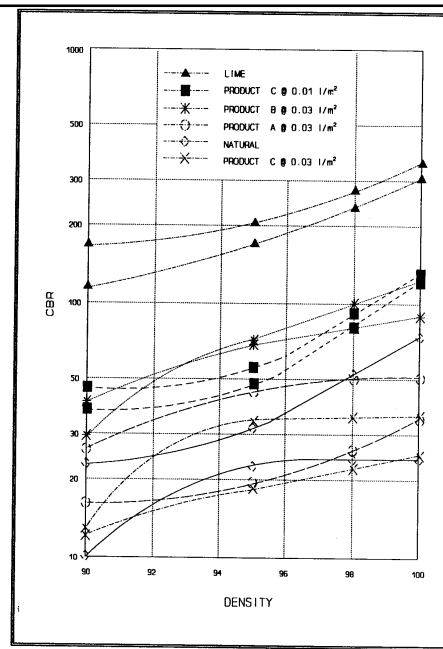


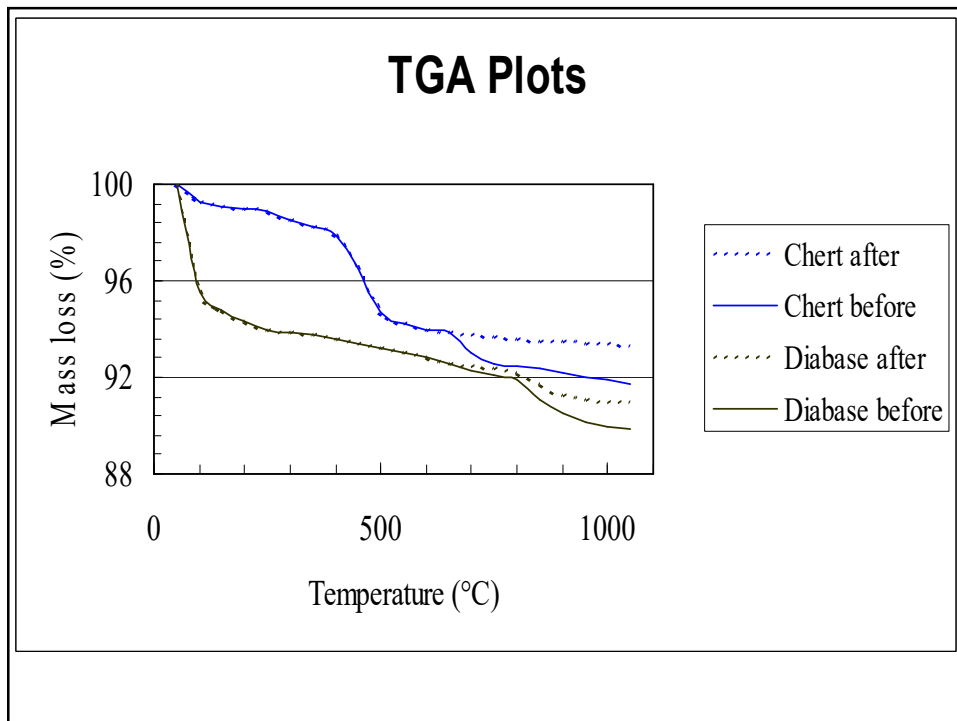
FIGURE 5 : THE EFFECT OF TREATMENT OF SOILS WITH DIFFERENT SPP CONCENTRATIONS

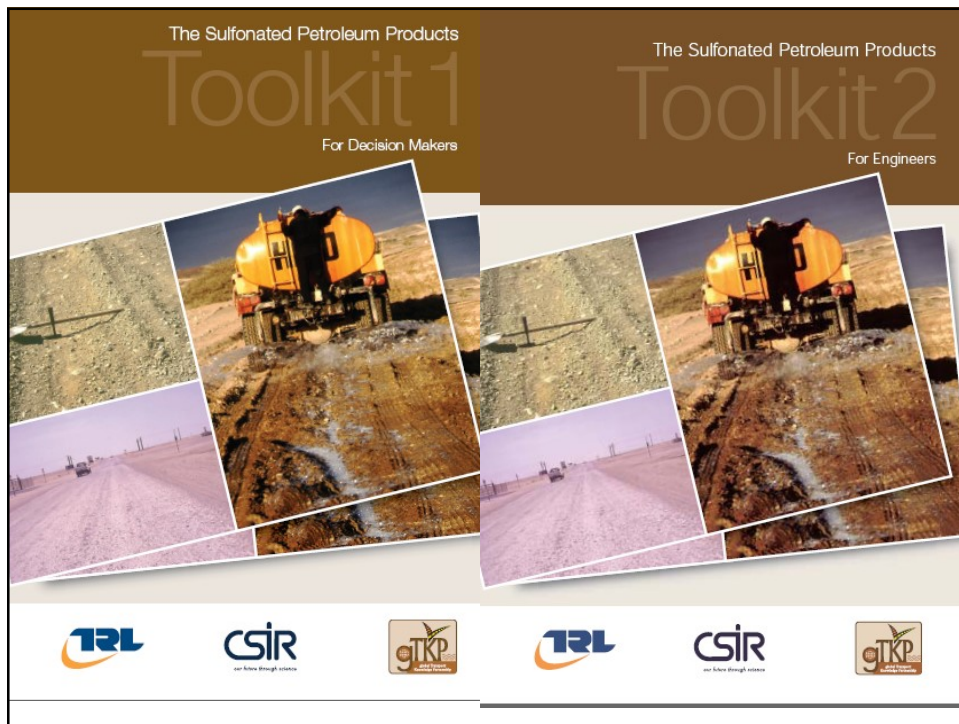
EFFECTIVENESS OF SPPS

- Yes - erratic

Material	Diabase	Black clay	Ferricrete	Chert	Shale
Treatment					
None	32	2	181	51	33
Product B	76	2	137	39	42
Product G	65	2	144	41	37
Product C	72	-	-	85	45
Product D	69	-	-	46	38





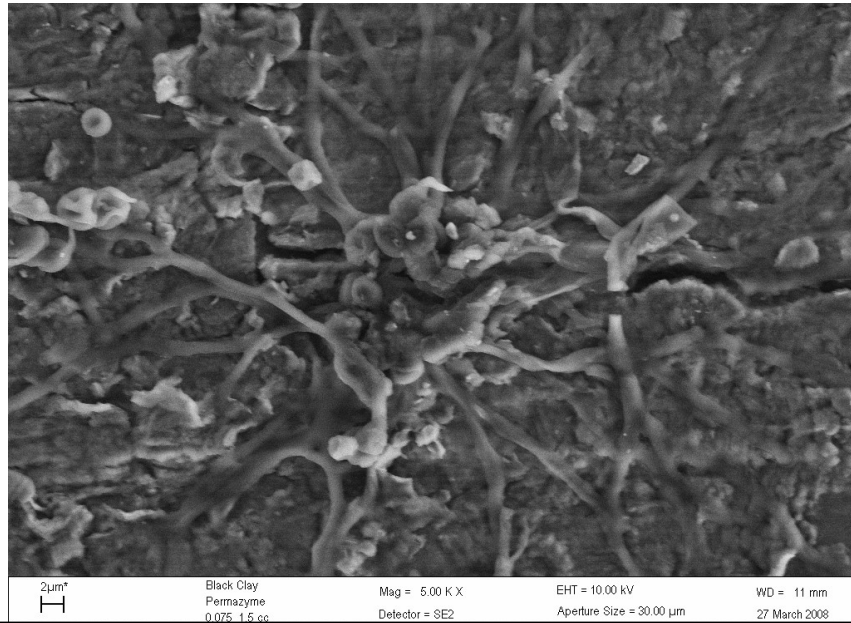


ENZYMES

- Whole bunch available locally
- No really good experiences in the field
- Many trials carried out
- Signs of activity in the laboratory



Action of Enzyme-based product on clay



CEMENT-BASED PRODUCTS

- Should be more effective (or have specific characteristics) than ordinary cement to be cost effective
- Number around – one recently obtained first Agreement certificate
- Trials underway with some



CEMENT-BASED PRODUCTS

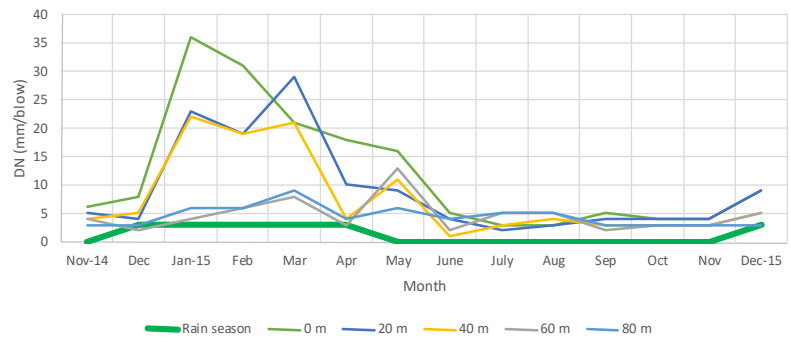
- Not for unpaved roads
- Dust



POLYMERS

- Tried a few on unpaved roads
- Expensive and little effect

- KNP
- Tanzania



DCPs on a polymer trial section Monitored over more than a year

- Tested (Jan 16) in light rain and after about 91 mm of rain had fallen in the previous 72 hours (170 mm in the previous 18 days)
 - In situ CBR values in the top 150 mm = 6 - 8%
 - 10 – 23% in the underlying 150 mm layer
- DCP in the adjacent "control" section.
 - 30% in top 150 mm
 - 48% in underlying 150 mm layer

ARE CHEMICAL STABILIZERS ANY USE?

- Perhaps – provided that:
 - The correct combination of material and product is used
 - The correct application rate is used **and the product is cost-effective**
 - The standard soaked CBR is increased during laboratory testing to the required value
 - Application is closely controlled
 - Normal construction quality requirements are fulfilled
 - A PPGS should be implemented
- Maintenance may be difficult

OTHER OPTIONS

- Reduction of gravel loss specifically
- Problem with borrow pits in conservation areas
- Bitumen emulsion stabilization !!



9. REHABILITATION, IMPROVEMENT & UPGRADING

9.3 Upgrading

- Generally involves improvement at any stage
 - eg, from track to earth road
 - Earth to gravel road
 - Gravel road to sealed LVR
 - Each responding to a certain need
- Upgrading can be facilitated by “Stage construction”
- Appropriate material selection (WC = Subbase)
- Regravelling versus mobilization for construction
- Techniques fairly well summarised (SATC 2003)
- All related to cost of sealed alternative
- Some can be low cost

INTERESTING CASE

- Regravelled with RA



INTERESTING CASE



SUMMARY

- Covered the full document content
- Number of points repeated over and over
- Hopefully you have all learnt something new or useful
- Thanks for attending and

“Happy gravel road building”

Thank you

