Course content

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3 Design
4 Construction
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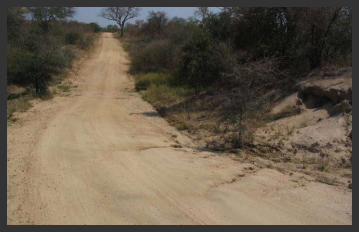


Gravel Road Maintenance & Selection of Appropriate Measures

Gerrie van Zyl

Presentation Outline

- Combined (Chapters 5 & 7)
- Maintenance (Definitions)
  - Routine
  - Periodic
  - Upgrading
- Investigation
- Selection of appropriate measures

Typical defects on gravel roads

Levels of Serviceability

	Required standards		
Level of Serviceability	Max Roughness[a]	Dustiness[b]	Impassability
5	15	5	Frequently
4	11	3	< 5 days/yr
3	9	3	Never
2	8	3	Never
1	6	1	Never

a International Roughness Index (IRI) in m/km
b See Jones and Paige-Green (2000)

How do we maintain at specific LOS

- Total maintenance strategies
- Combination of activities
  - Construction level
  - Routine maintenance
  - Periodic maintenance

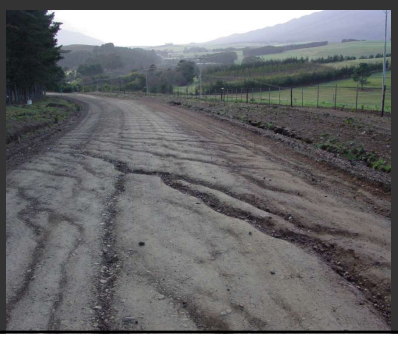
Routine maintenance

- Light and heavy blading
- Maintain drainage systems
- Vegetation control
- Fence repair
- Signage maintenance
- Patching

Periodic/ Scheduled Maintenance

- Forming / upgrading/ construct
- Gravelling/ Regravelling
- Spot gravelling
- Reshaping
- Reworking

- Combination of activities



Blading

- Dry blading
- Rain blading
- Wet blading

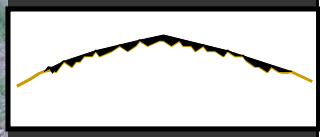
Grading/ Blading

- Dry, Rain, Wet
- Light blading/ Skimming/ Smoothening
  - Surface protection
    - Sand cushioning
    - Fines replacement
- Hard blading/ Grading/ Shaping

Effect of light blading

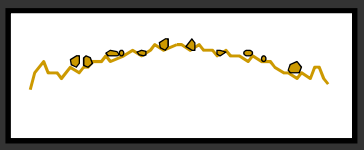




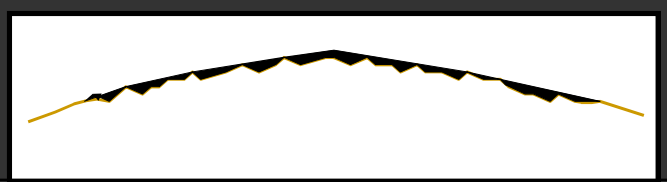



Additional material for maintenance

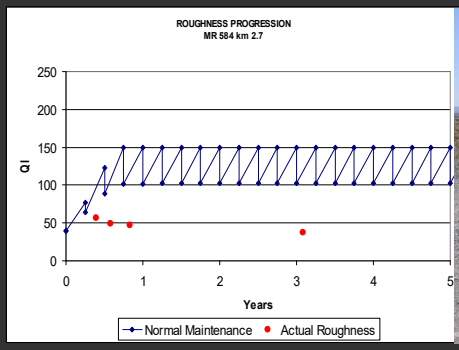
- Light blading
  - Remove cohesionless material



  - Spread fine material (moist & slightly plastic)
    - (provided during construction)



Effect of regular light blading



Sand Cushioning

- Spread 25 – 40 mm sand (passing 2mm sieve)

Grading/ Hard Double Blading

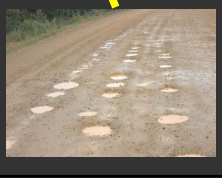
- Grading/ Heavy Blading
  - Typically < 50 mm distress/ deformation
  - Moisten
  - Loosen
  - Restore shape
  - Roll

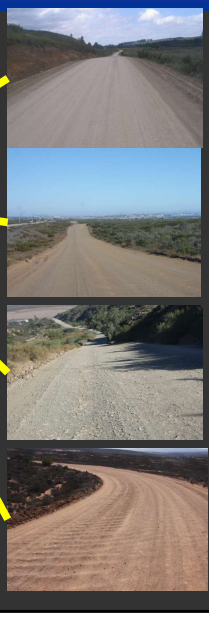
Crossfall

Understanding Road Roughness

	Comfortable Speed	IRI
	100 km/h	< 5
District distributors	80 – 100 km/h	7.5 - 5
District collectors	60 - 80 km/h	10 - 7.5
Minor Roads	45 – 60 km/h	12.5 - 10
	< 35 km/h	15

Level of Serviceability	Max Roughness[a]
5	15
4	11
3	9
2	8
1	6



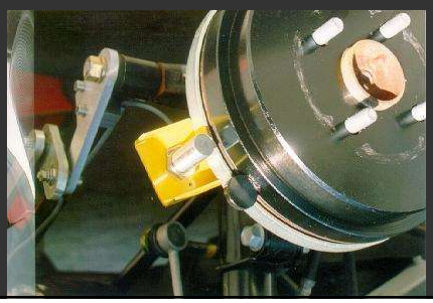


Roughness measurement

- Instruments
  - Response type (Suitable for gravel roads)
  - Lazer profilometers
- Calibration

Linear Displacement Integrator LDI

- Sums of displacements between the rigid axle and body of vehicle
- Used for QI (quarter-car index) I.e. one wheel
- Smart phones now – calibrate !

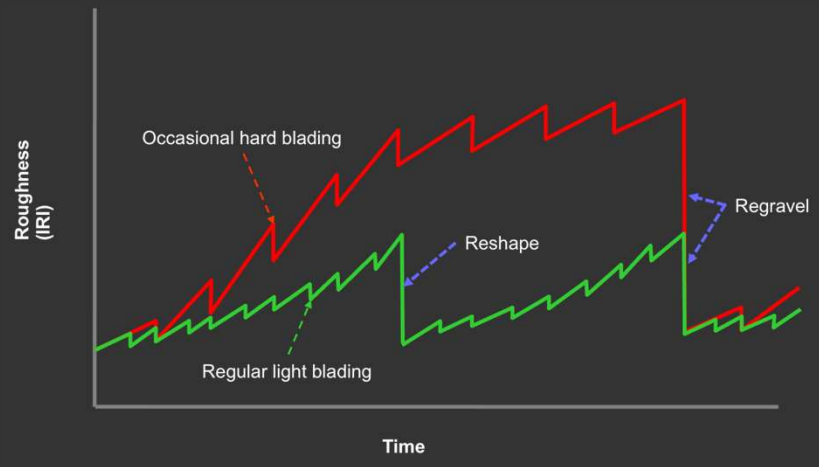


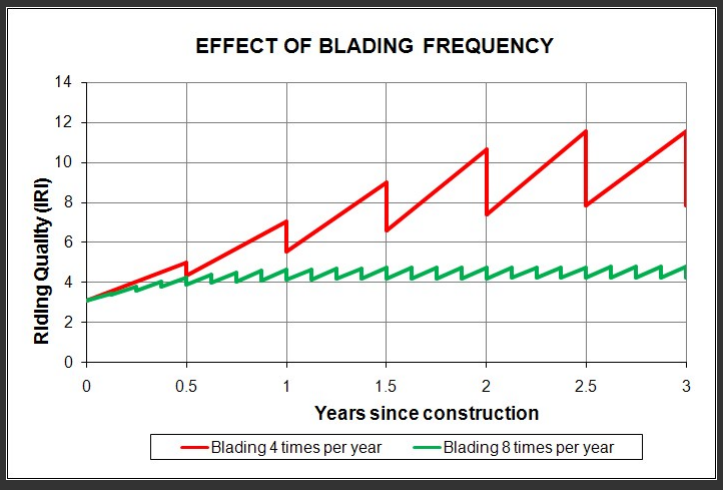
Optimum blading cycles

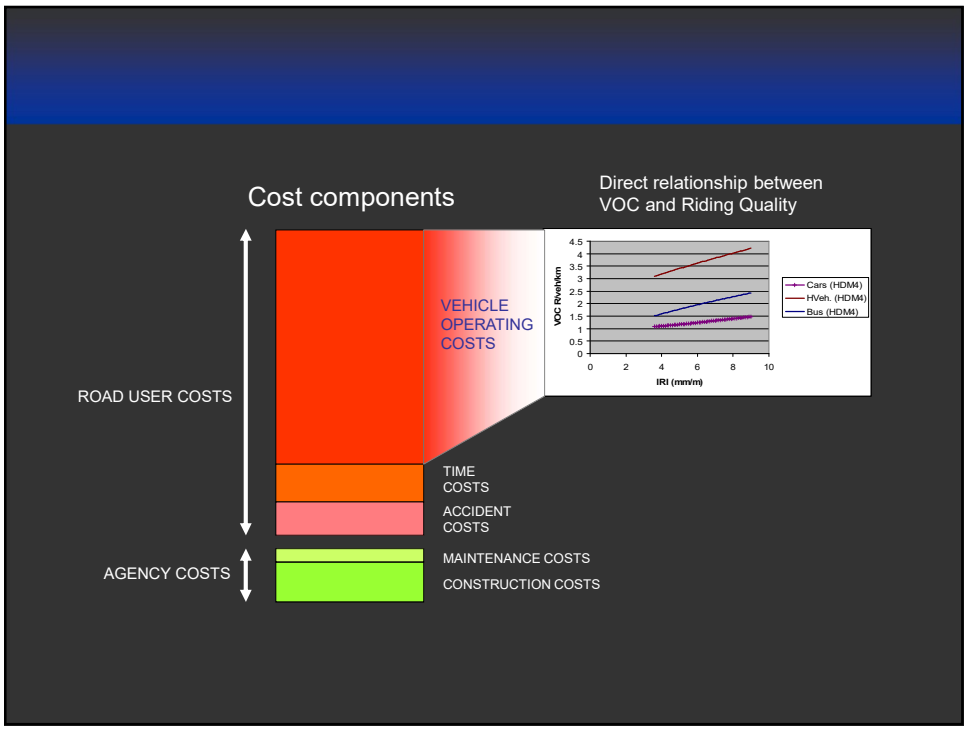
ADT	BRAZIL	GABON (MIN)	NAMIBIA
<10			4
20			6
50	5	3	12
100	10	4	24
150	14	6	34
200	19	8	44
300	23	10	52

Note: Type of bladings differ

Different maintenance strategies





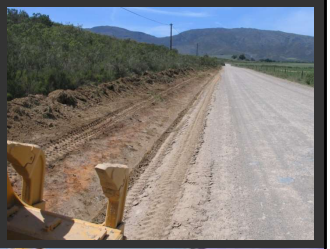


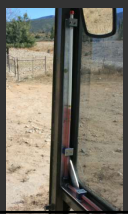
Forming

- Main purpose
  - Shape
  - Drainage
  - Safety
  - Maintainability

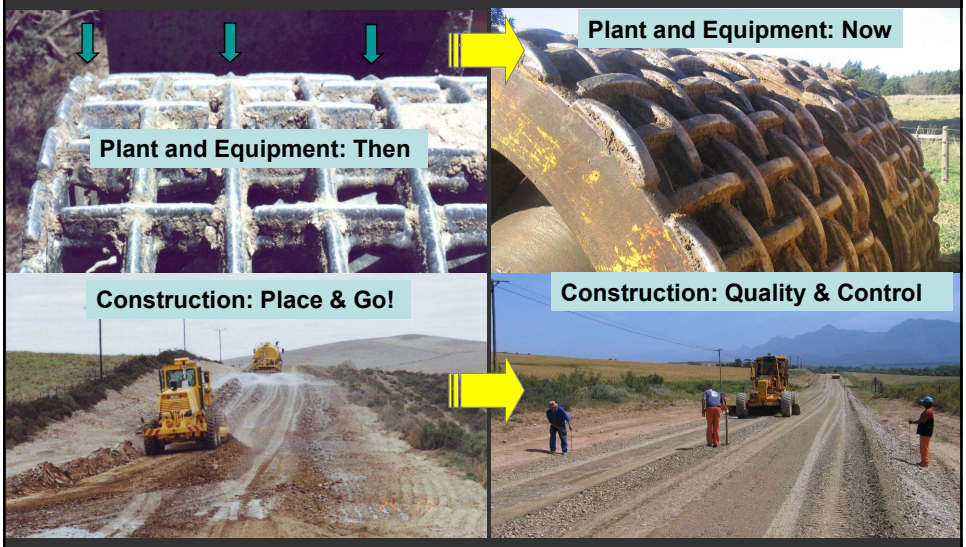
Reshape/ Rework

- Reshape/ Rework i.e. reconstruct wearing course layer using the existing material
  - Drainage
  - Rip
  - Moisten
  - Break down/ remove oversize
  - Shape





Reworking: Effect of equipment and QA



Controlled Construction Processes

Wearing Course Finish

Drainage

Rework: No re-mixing after grid rolling

Rework: Mobile crushers

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Regravel

Gravel Road Performance

… what can we improve on ?

- Factors influencing deterioration:
  - Material properties (Selection)
  - Traffic
  - Climatic conditions
  - Road geometry
  - Compaction effort
  - Routine Maintenance
    - Blading frequency
    - Drainage
    - When, what and how ?

Gravel Road Performance

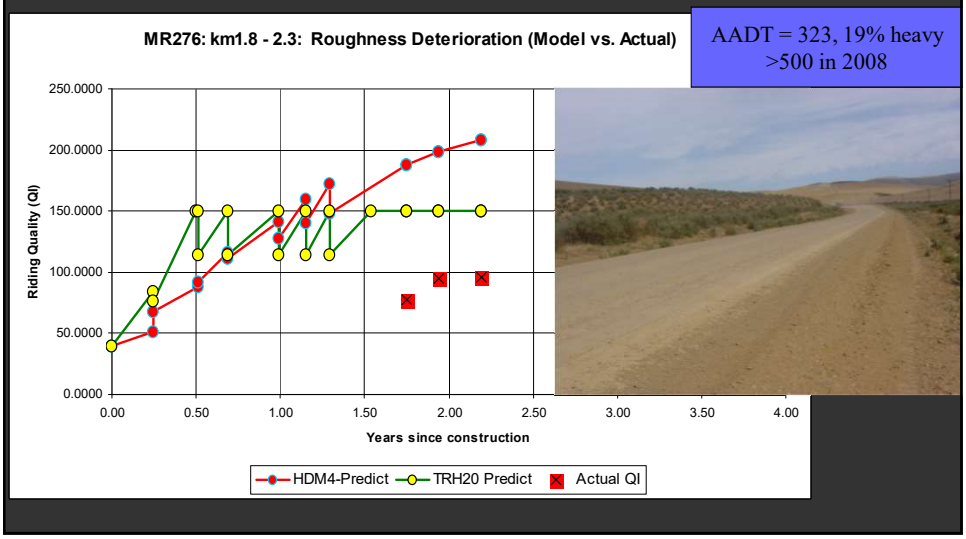
… continued

- Factors influencing deterioration:
  - Material properties
  - Traffic
  - Climatic conditions
  - Road geometry
  - Compaction effort
  - Routine Maintenance
    - Blading frequency
    - Drainage
    - When, what and how

Results

Slow Roughness Deterioration

(Bladed section)



AADT = 323, 19% heavy
>500 in 2008

Results

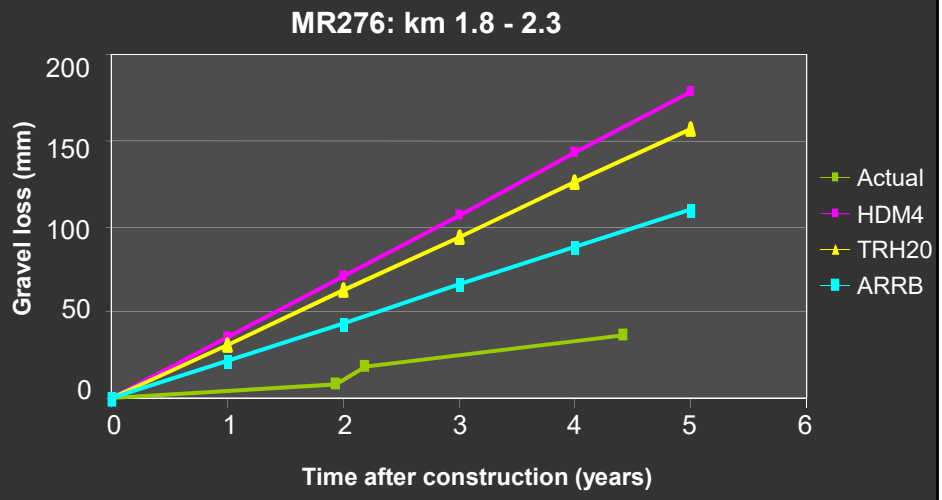
Slow Roughness Deterioration

(No Maintenance section)

AADT = 66, 17% heavy

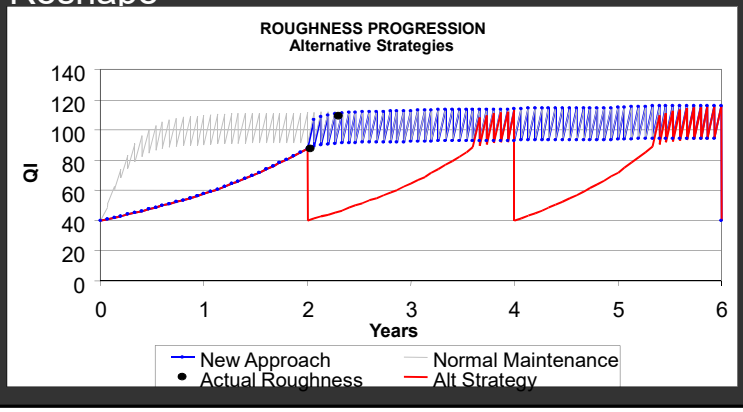
Study Results

Comparison of Actual vs Predicted Gravel Loss (AADT<350)



Alternative Strategies

- Proper design and construction
- Frequent blading
- Emphasis on drainage maintenance
- Reshape



Summary

- Surfacing at higher traffic volumes
- Vehicle operating costs – changes to maintenance strategies
- Reshaping of road at regular intervals – more economic than continuous blading at high roughness levels

Vegetation – Safety ?

Patching/Repair

Drainage

Drainage

Drainage

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Drainage

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Safety

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Conclusions

- Information
  - Regular inspections
  - Complaints/ requests
  - Understand impact of strategies
- Planning
- Training
- Control

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7 Measure Selection

- Investigation
  - URMS
  - Locals
  - Centre line survey
  - Etc
- Design summary

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Design Summary

PROVINCIAL ADMINISTRATION: WESTERN CAPE

DEPARTMENT OF TRANSPORT & PUBLIC WORKS — ROAD INFRASTRUCTURE

GRAVEL ROADS PERIODIC MAINTENANCE DESIGN SHEET

Local Authority		Project Code			
Road Authority		Project Name		From km	to
Road Number		DRE Area		Page	of

Existing Situation		
Landmarks		
km		0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0
Landmarks		
Traffic		
Width		
Shape		
Gradient		
Curves		
Low level		
Accident black spots		
Subgrade deficiencies		
Existing Material quality	Wearing Course	
	Base	
	Support/ In -situ	
Existing Strength DCP (CBR)	0-150 mm	
	150 - 300 mm	
	300 - 450 mm	
Recommended Actions		
Borrow pits	Position	
	Volume	
	TRH 20 class	
Geometric & level improvement	Horizontal	
	Vertical	
	Width	
	Cross fall	
	Raise level	
Drainage improvement	Culverts	
	Entrance pipes	
	Other	
Pavement structure	Road bed prep	
	Support layer	
	Wearing course	
	Mix in	
	Reshape	
	Special treatment	
Road side furniture		

Recommended maintenance strategy

Depth of distress

Slight defects e.g. loose corrugations and < 25mm deformation	Defects close to threshold e.g hard corrugations, ruts, shape loss (25 – 50 mm)	Defects past threshold e.g hard corrugations, ruts, shape loss (50 – 100 mm)	Defects past threshold e.g hard corrugations, ruts, shape loss **and** insufficient material to protect base, cover rocky areas and to provide sufficient drainage
Light blading (10 - 25mm)	Medium blading Watering and Compaction (50mm)	**Road cannot be maintained effectively with a grader but sufficient material thickness exists**	**Road cannot be maintained effectively with a grader and material not suitable**
		Heavy blading Watering and Compaction (100mm) Possible addition of gravel to protect base or to retain gradeability Rework/ breakdown of oversize if necessary	Road bed preparation, drainage and regravelling
Light blading	Heavy blading	Reshape Rework	Gravel, Regravel or Spot gravel

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Alternative thinking

Can we maintain

Can we utilise in-situ

Do we adhere to minimum stds

ASSESSMENT						
WEARING COURSE/ SURFACE						
GRADEABILITY		VERY GOOD	GOOD	WARNING	POOR	VERY POOR
	PROBLEM	DEEP SAND	HARD CORRUGATION	OVERSIZE MATERIAL	FIXED STONES	ROCK OUTCROP

SUBGRADE						
EXPOSED SUBGRADE		NONE	ISOLATED	FREQUENT	GENERAL	CONTINUOUS
SUPPORT STRENGTH		VERY GOOD	GOOD	WARNING	POOR	VERY POOR
	PROBLEM		Clay / Mud	Sand	Wet	

FUNCTIONAL ASSESSMENT							
ACCESSIBILITY		VERY GOOD	GOOD	WARNING		POOR	VERY POOR
	PROBLEM	Skid	Sand	Clay		Rocky	Drainage/ Erosion
RIDING QUALITY		VERY GOOD	GOOD	WARNING		POOR	VERY POOR
	PROBLEM	Corrugations	Stoniness	Potholes	Erosion	Deep sand	Deformation
SAFETY		VERY GOOD	GOOD	WARNING		POOR	VERY POOR
	PROBLEM	Geometry	Dust	Slippery		Drainage	Drifts
SURFACE DRAINAGE		VERY GOOD	GOOD	WARNING		POOR	VERY POOR
	PROBLEM		Road Level	Road Shape		Rutting	Windrow
SIDE DRAINAGE		VERY GOOD	GOOD	WARNING		POOR	VERY POOR
	PROBLEM		Culverts	Side Drains		Mitre Drains	Road level

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Alternative thinking

- Only regravel if
  - Cannot maintain effectively with grader
  - Other measures are not more cost effective e.g.
    - Rework/ rockbusting
    - Thin semi-plastic material on coarse surface (from side drains)
    - Sand cushion not effective/ not available
- Only improve accessibility and safety if
  - Below minimum standards for traffic/ purpose of road

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Appropriate measures

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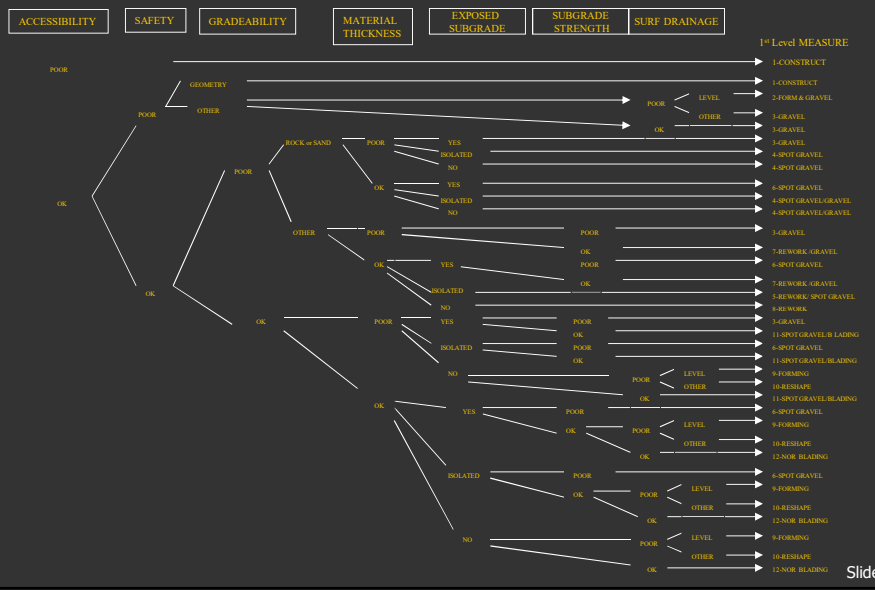
SIMPLIFIED DECISION TREE FOR REMEDIAL MEASURES



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