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Alternative Surfacing for Low Volume Rural Roads

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- Objectives of AFCAP
  - Improve all year access to rural poor
  - Local resource-based rural road improvement
  - Identify cost effective community based methods of rural road construction
  - Introduce previously trialled surfaces under SEACAP and other methods
  - Extend the knowledge of rural road construction in Tanzania by constructing demonstration pavement sections

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- Benefits to Tanzania
  - Construction techniques and lessons from other countries appropriately applied to the Tanzanian context
  - The investigation of the practicalities of constructing appropriate local-resource based durable surfacing

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- Background
  - Recent road engineering research has shown that, in general, most earth and gravel roads are uneconomical and practically unsustainable
  - The largely earth and gravel based rural networks in Africa are imposing huge maintenance burdens on poorly-resourced Authorities and Governments

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- Background
  - Gravel is becoming increasingly scarce and expensive, only available at long haulage distances thus further increasing the cost of gravelling and regravelling
  - This is particularly true in Tanzania which has a large earth and gravel road network spread across a vast area

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- Background
  - It is suggested that an answer to this problem is to provide more durable road surfaces including sealed roads
  - This will dramatically reduce the demand for gravel, produce a smoother running surface to reduce vehicle operating costs, reduce maintenance costs, reduce travel times, and reduce dust pollution

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- Project Description
  - To identify suitable rural access roads in order to use for the demonstrations
  - To identify specific problematic locations along the access roads which prohibit basic access during the rainy season using Environmentally Optimised Design (EOD)/Spot Improvement Design (SID) techniques
  - To construct appropriate surfaced pavements at the problematic locations to replace the standard gravel pavements

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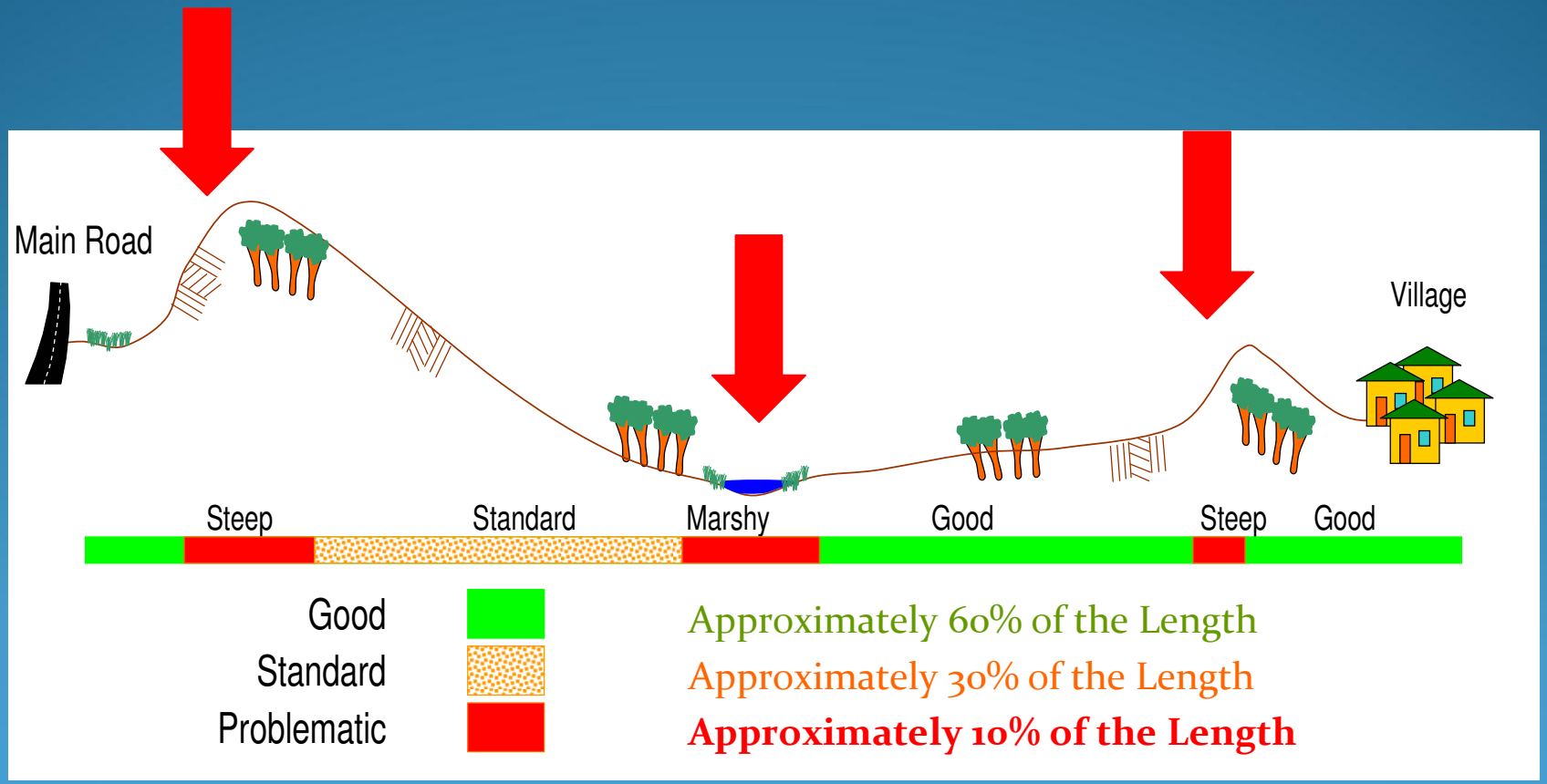
- Environmentally Optimised Design (EOD)



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- Design Approach
  - The construction cost of appropriate surfaced pavements is significantly higher than a standard gravel pavement
  - Therefore it is recommended the pavements along the roads are implemented using the EOD approach

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- Selection Criteria
  - Accessibility to the sites and proximity to proper utilities so that it is possible for practitioners to visit the roads
  - The roads should connect communities with regional and trunk roads – community access roads
  - A likelihood for an increase in the traffic volumes on the roads after construction
  - A single road in each region

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- Selected Districts
  - Pwani Region - Bagamoyo District
  - Kilimanjaro Region - Siha District
  - Tanga Region - Muheza District
  - Dodoma Region – Kondoa District
  - Morogoro Region – Morogoro District
  - Iringa Region – Iringa District

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- Selected Project Roads
  - Due to budgetary constraints the two highest scoring roads were selected:
    - Bago to Talawanda (Road No. 21.01-1) in the Bagamoyo District
    - Lawate to Kibongoto (Road No. 13.02-1) in the Siha District

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- Bago to Talawanda

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- Bago to Talawanda

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- Lawate to Kibongoto

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- Lawate to Kibongoto

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➢Comparison of Project Areas

Parameter	Bagamoyo	Siha
Subgrade	Sandy Soils Expansive Clays	Red Clayey Soils
Traffic	Low Volume	Higher Volumes
Gradient	Flat	Steep
Alignment	Straight	Winding
Climate	Hot, Humid, Dryish	Cool, Wet
Construction Materials	Quartzitic Gravel Decomposed Granite Soft Limestone Gneiss	Volcanic Tuff

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- Design Approach
  - The EOD/SID approach involves locating the most problematic sections along the road which prohibit basic access during the rain season and applying
    - Durable pavement structure at these specific problematic locations
    - Less expensive pavements in areas which are perfectly satisfactory all year round

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- Identifying Problem Sections
  - Steep Gradients
  - Sharp Bends
  - Muddy Tracks
  - Erosion Channels
  - Slippery Surface
  - Poor Subgrade
  - Loose Sand
  - Soft Wet Areas

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- Identifying Problem Sections
  - Visual assessment during the wet and dry seasons
  - Local knowledge
  - Route alignment and spot location identification using a handheld GPS
  - Alignment trial pits to test the in-situ soils to define subgrade strength
  - Drainage assessment
  - Combined these investigations into a strip map to show problematic areas

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- Strip Map
  - Vertical Gradients
  - Subgrade Bearing Capacity
  - Drainage System
  - Visually Assessed Poor Sections
  - Photographs
  - Potential Impassable Sections

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- Impassable Sections

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- Impassable Sections

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- Impassable Sections

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- Impassable Sections

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- Gravel Pavement

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- Double Sand Seal

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- Otta Seal

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- Slurry Seal

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- Penetration Macadam

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- Double Surface Dressing

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- Concrete Geocells

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- Concrete Strips

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- Unreinforced Concrete

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- Lightly Reinforced Concrete

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- Concrete Paving Blocks

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- Hand Packed Stone

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Pavement Type	Local Materials	Flat terrain	Steep Terrain	Populated Areas	Marshy Areas	Low Strength Subgrades	Small Contractor Suitability	Likely Cost Advantage	Maintenance Reduction
Gravel Pavement	+	+	-	-	-	+	+	+	-
Unreinforced Concrete	-	+	+	+	+	-	+	+	+
Reinforced Concrete	-	+	+	+	+	-	+	+	+
Concrete Geocells	-	+	+	+	+	+	+	+	+
Concrete Strips	-	+	+	+	+	+	+	+	+
Concrete Paving Blocks	-	+	+	+	+	-	+	-	+
Hand Packed Stone	+	+	+	-	+	+	+	+	-
Single Otta Seal with a Sand Seal	-	+	-	+	+	-	+	-	+
Double Otta Seal	-	+	+	+	+	-	+	-	+
Double Sand Seal	-	+	-	+	-	-	+	-	+
Slurry Seal	-	+	-	+	+	-	+	-	-
Double Surface Dressing	-	+	+	+	+	-	+	-	+
Bitumen Penetration Macadam	-	+	+	+	+	-	+	-	+
Engineered Natural Surface	+	+	-	-	-	-	+	+	-

Note: + indicates a positive advantage; - indicates a probable disadvantage

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- Design Issues
  - Each pavement structure was designed using the Tanzanian Pavement and Materials Design Manual
  - Minimum layer thicknesses and material quality were specified
  - Minimum carriageway width (3m) was specified with no shoulders
  - The road will be a single lane with frequent passing bays

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- Design Issues
  - The Tanzanian Pavement and Materials Design Manual classifies the subgrade bearing capacity in four categories (S15, S7, S3, CBR<3%)
  - The method requires that the subgrade to be brought up to a minimum CBR>15% by using of one or more improved subgrade layers (CBR>7%, CBR>15%)

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- Design Issues
  - The Manual specifies for low volume roads that:
    - Natural gravel base material has a CBR>60%
    - Natural gravel subbase material has a CBR>25%
    - Natural gravel improved SG1 material has a CBR>15%
    - Natural gravel improved SG2 material has a CBR>7%

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Pavement Types		Bitumen Pavement	Unreinforced Concrete	Reinforced Concrete	Concrete Paving Blocks	Concrete Strips	Geocells	Hand Packed Stone
Surface Layer	Type	Bitumen Surface	Concrete	Concrete	Blocks	Concrete	Concrete	Stone
	Thick	Varies	75	75	65	100	75	200
Bedding Sand	Thick				15			15
Base	Type	Natural Gravel CBR>60%	Natural Gravel CBR>60%	Natural Gravel CBR>60%				
	Thick	150	100	100				
Subbase	Type	Natural Gravel CBR>45%			Natural Gravel CBR >45%	Natural Gravel CBR>45%	Natural Gravel CBR>45%	Natural Gravel CBR>45%
	Thick	100			150	150	150	150
Improved Subgrade	Type	Natural Gravel CBR>15%	Natural Gravel CBR>15%	Natural Gravel CBR>15%	Natural Gravel CBR>15%	Natural Gravel CBR>15%	Natural Gravel CBR>15%	Natural Gravel CBR>15%
	Thick	150	150	150	150	100	100	100
Improved Subgrade	Type	Natural Gravel CBR>7%	Natural Gravel CBR>7%	Natural Gravel CBR>7%	Natural Gravel CBR>7%	Natural Gravel CBR>7%	Natural Gravel CBR>7%	Natural Gravel CBR>7%
	Thick	150	150	150	150	150	150	150
Subgrade	Type	CBR<7%	CBR<7%	CBR<7%	CBR<7%	CBR<7%	CBR<7%	CBR<7%

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- Sections Selected for Bagamoyo
  - Single Otta Seal with a Sand Seal
  - Slurry Seal
  - Double Surface Dressing
  - Double Sand Seal
  - Concrete Geocells
  - Concrete Strips
  - Hand Packed Stone Blocks

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- Sections Selected for Siha
  - Double Otta Seal
  - Penetration Macadam
  - Double Surface Dressing
  - Unreinforced Concrete Slabs
  - Lightly Reinforced Concrete Slabs
  - Concrete Geocells
  - Concrete Strips
  - Concrete Paving Blocks

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- Whole Life Cost Analysis
  - After construction the different pavement types will be compared using a whole life cost analysis
  - This will assist in the selection of an appropriate pavement type
  - Highlight the long term benefits of more durable pavements when compared to the standard gravel pavement

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- Local Materials
  - The project has a philosophy to 'use what you have' with regards to local materials and were considered as much as possible in the design and selection of the different pavement structures

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- Local Materials - Bagamoyo
  - Quartzitic River Gravel
  - Decomposed Granite Gravel
  - Soft Limestone Gravel
  - Gneiss

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- Quartzitic River Gravel

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- Decomposed Granite Gravel

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- Soft Limestone Gravel

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- Gneiss

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- Local Materials - Siha
  - Volcanic Tuff

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- Volcanic Tuff

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- Volcanic Tuff

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- Construction and Monitoring
  - Construction is underway in Bagamoyo and is expected to finish next April
  - The Siha Contract is to be tendered soon
  - The pavements will be monitored by the Consultant for 2 years at 6 monthly intervals
  - The District Engineers will continue to monitor the demonstrations for a further 8 years

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- Conclusions
  - It is important for skilled engineers to spend significant time in the field, particularly during the rainy season, to clearly identify the problematic areas along the road and assess where basic access is being lost – EOD/ SID

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- Conclusions
  - It is important to incorporate local materials as much as possible in the design and selection of the different pavement structures

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- Conclusions
  - During the selection process of the different pavement structures, if more than one option is suitable for a particular section then construction cost tends to lead to a decisive result

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THANK YOU