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
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
Environmentally Optimised Design (EOD)

Approximately 60% of the Length
Approximately 30% of the Length
Approximately 10% of the Length
Design Approach

- The construction cost of appropriate surfaced pavements is significantly higher than a standard gravel pavement.
- Therefore, it is recommended that the pavements along the roads are implemented using the EOD approach.
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
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
## Comparison of Project Areas

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<thead>
<tr>
<th>Parameter</th>
<th>Bagamoyo</th>
<th>Siha</th>
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<tr>
<td>Subgrade</td>
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<td>Red Clayey Soils</td>
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<td>Expansive Clays</td>
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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
Identifying Problem Sections

- Steep Gradients
- Sharp Bends
- Muddy Tracks
- Erosion Channels
- Slippery Surface
- Poor Subgrade
- Loose Sand
- Soft Wet Areas
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
AFCAP - Tanzania

Impassable Sections
AFCAP - Tanzania

- Impassable Sections
AFCAP - Tanzania

Gravel Pavement
AFCAP - Tanzania

➢ Double Sand Seal
AFCAP - Tanzania

Otta Seal
AFCAP - Tanzania

- Slurry Seal
AFCAP - Tanzania

Penetration Macadam
AFCAP - Tanzania

➢ Double Surface Dressing
AFCAP - Tanzania

Concrete Geocells
AFCAP - Tanzania

➢ Concrete Strips
AFCAP - Tanzania

Unreinforced Concrete
AFCAP - Tanzania

- Lightly Reinforced Concrete
AFCAP - Tanzania

Concrete Paving Blocks
Hand Packed Stone
<table>
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<tr>
<th>Pavement Type</th>
<th>Local Materials</th>
<th>Flat terrain</th>
<th>Steep Terrain</th>
<th>Populated Areas</th>
<th>Marshy Areas</th>
<th>Low Strength Subgrades</th>
<th>Contractor Suitability</th>
<th>Likely Cost Advantage</th>
<th>Maintenance Reduction</th>
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Note: + indicates a positive advantage; - indicates a probable disadvantage
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
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 one or more improved subgrade layers (CBR>7%, CBR>15%)
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%
<table>
<thead>
<tr>
<th>Pavement Types</th>
<th>Bitumen Pavement</th>
<th>Unreinforced Concrete</th>
<th>Reinforced Concrete</th>
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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
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.
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
AFCAP - Tanzania

- Quartzitic River Gravel
AFCAP - Tanzania

- Decomposed Granite Gravel
AFCAP - Tanzania

Soft Limestone Gravel
AFCAP - Tanzania

- Gneiss
AFCAP - Tanzania

- Local Materials - Siha
- Volcanic Tuff
AFCAP - Tanzania

Volcanic Tuff
AFCAP - Tanzania

- Volcanic Tuff
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
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
Conclusions

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