Project Selection and Mix Design Guidelines for Road Rehabilitation using Full-Depth Reclamation with Foamed Asphalt

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16th Annual TERRA Pavement Conference
Minneapolis MN, February 2012
Summary

Ø Introduction
Ø Project selection overview
Ø Desktop study
Ø Preliminary site investigation
Ø Detailed site investigation
Ø Mix design
Ø Conclusions
Introduction

Ø FDR-FA
   + Growing interest
   + Not a "fix-all" solution

Ø Project investigation is essential

Ø Existing guidelines
   + Wirtgen Manual
   + South Africa TG2
   + California FDR-FA Guide
   + Other
      • RMRC
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Ø Introduction
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Ø Performance related to:
+ Materials
+ Strength of underlying layers
+ Drainage
+ Mix and structural designs
+ Construction procedures

Ø Project selection based on
+ Desktop study
+ Preliminary site investigation
+ Detailed investigation
  • Field testing
  • Preliminary laboratory testing
  • Analysis
Introduction
Project selection overview
Desktop study
Preliminary site investigation
Detailed site investigation
Mix design
Conclusions
Desktop Study

- Collect all relevant data
  - As-built plans
  - Photolog and pavement condition reports
  - Traffic data
  - Climate data
  - Maintenance records
  - Land-use plans

- Desktop study report
  - Project information, road information, potential problems, fatal flaws, decision
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Preliminary Site Investigation

Ø Who
  + Project engineer and maintenance superintendent

Ø When
  + Early in project scope, rainy season

Ø What
  + Windshield survey
    • Cracking and pumping
    • Rutting
    • Previous maintenance
    • Height of road above subgrade
    • Drainage efficiency
    • Land use adjacent to road
    • Cause of failure
  + Subgrade sampling and testing
  + Report
    • Results
    • Fatal flaws
      – Structure
      – Drainage
      – Subgrade failure
      – Excessive deep patching
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Detailed Site Investigation

Ø Who
  + Project engineer, district staff

Ø When
  + Rainy season

Ø What
  + Subgrade stiffness assessment
  + Visual assessment
  + Pavement layer thickness assessment
  + Material sampling
  + Indicator tests
  + Analysis and report
  + Life-cycle cost analysis
Subgrade Stiffness - FWD

Ø Why
  + Evaluate subgrade
  + Identify variability and weak areas
  + Identify locations of test pits

Ø When
  + Rain season

Ø What
  + Worst lane
  + Between wheel paths
  + 20m interval (1 km/h)
Subgrade Stiffness - FWD

Ø Analysis

+ Pavement layer modulus backcalculation not appropriate
+ Subgrade deflection modulus

\[ E_{\text{def}}(r) = \frac{(1-v^2) \times P}{\pi \times r \times d} \]

+ Plot results against distance
  - > 45MPa – no subgrade problems
  - 25 – 45MPa – subgrade problems likely
  - <25MPa – more detailed survey
Subgrade Stiffness - FWD

Zone A: >45MPa, no improvement necessary
Zone B: 25MPa - 45MPa, improvement required before recycling
Zone C: <25MPa, detailed study and improvement before recycling
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks
Visual Assessment
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks

Ø Rutting
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks

Ø Rutting

Ø Previous maintenance
Visual Assessment
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks
Ø Rutting
Ø Previous maintenance
Ø Areas with subgrade modulus <45MPa
Visual Assessment

- Cracking
  - Extent and nature
  - Pumping
  - Loose blocks
- Rutting
- Previous maintenance
- Areas with subgrade modulus <45MPa
- Drainage
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks
Ø Rutting
Ø Previous maintenance
Ø Areas with subgrade modulus <45MPa
Ø Drainage
Ø Road side activity
Visual Assessment
Visual Assessment

Ø Cracking
  + Extent and nature
  + Pumping
  + Loose blocks

Ø Rutting

Ø Previous maintenance

Ø Areas with subgrade modulus <45MPa

Ø Drainage

Ø Road side activity

Ø Test pit and core locations
  + Test pits – each uniform section + problem areas
  + Cores – every 500m + where required
  + DCP measurements through core holes
Layer Thickness Assessment

Ø GPR
  + Continuous
  + Calibrated with cores

Ø Core
  + Measure and photograph
  + Record special characteristics
    • Rubber, stripping, fabrics, etc

Ø Analysis
  + Plot results against distance
Subgrade Stiffness - DCP

Ø Test in core holes
   + Beware effect of core drill water

Ø Analysis
   + Various calculations available
   + Suggest DCP number
     • (Rate of penetration [mm/blow])
   + Plot DCP number against distance
   + Compare to FWD
Test Pits

Ø Number of purposes
  + Pavement cross section
  + Subgrade moisture conditions
  + Source of material for mix design
    • 1m x 1m x 1m

Ø Remove asphalt with milling machine
Test Pits
Laboratory Testing

Ø Indicator tests
  + Grading analysis
    • Top 250mm – 300mm + underlying layers + subgrade
  + Subgrade Atterberg Limits
  + California Bearing Ratio
    • Underlying layers + subgrade

Ø Analysis
  + 5 to 12% passing 0.075mm (#200) in top layer
  + Subgrade PI <12
  + Subgrade CBR ≥ design requirement
  + Consider adding base material if necessary
Analysis Summary

Ø FWD and DCP Analysis
  + % of project falling into different zones
  + Prefer <10% of project in Zone C
  + Consider costs of improving weak areas

Ø Visual and test pit assessment
  + Extent of problems
  + Life of repairs
  + Effect of road side activities

Ø Layer thickness
  + Sufficient material to recycle?
  + Pre-milling on thick pavements if necessary
    • Not pre-pulverization!
Life-Cycle Assessments

Ø Life-cycle cost assessment
  + Quantify economic benefits
  + E.g. Realcost

Ø Environmental life-cycle analysis
  + No guidelines available for FDR-FA
  + Will be important on future projects
Project Investigation Report

Ø Summary of findings
Ø Recommendation
+ Flow chart
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Mix Design

Ø Nine part process
Ø Asphalt and active filler contents determined separately
  + Determine the grading of the pulverized material
  + Select the active filler type
  + Determine the compaction curve of the pulverized material
  + Select the asphalt binder and determine the foaming parameters
  + Determine the mixing moisture content (MMC)
  + Determine the asphalt binder content
  + Determine the active filler content
  + Determine the reference density for field compaction & ITS for QA
  + Determine the tensile strength retained and temperature sensitivity of the mix design (optional)
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Conclusions

Ø FDR-FA is a viable rehabilitation option
Ø Not a "fix-all" solution
Ø Project investigation is required to determine if FDR-FA is appropriate
Ø Combination of FWD, Visual assessment, coring, DCP, test pit and indicator testing required
Ø Decision based on results
Ø Proceed with mix design after decision is taken
Ø California FDR-FA Guidelines
  + www.ucprc.ucdavis.edu
Thank you!

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