TRB AFD40 FEEDBACK

Feedback on current and future HVS activities:

CSIR / Gautrans programme Aug 08 – Oct 09

Ultra Thin Concrete evaluation

Louw du Plessis

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Contents

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Background

- Extensive surfacing backlogs of surfacing of township roads (>2500km)
- Environmental issues – scarcity of road building materials
- Limited funding available for roads
- Expanded Public Works Programme (EPWP) very high priority:
  - Job creation
  - Training
- Innovative new technologies and construction methods required
- CSIR approached by Gautrans to assist in the development and designing of a possible solution
- CSIR suggested the use of a lightly reinforced concrete pavement

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Benefits of Ultra Thin Reinforced Concrete Pavements (UTRCP)

- Increase of labor content by an estimated 350%
- Training and skills acquired, e.g. concreting can be applied in other sectors
- Reduced layer works required, which reduces amount of work to be carried out by plant
- Less maintenance required, and more durable
- Investment in equipment fairly low (no barrier to entry)
- Environmental benefits – fly ash, waste product is used
- Reduced the reliance on imported material (bitumen and aggregates)
- Reduced construction costs and contract period
- Less energy required for illumination (street lights)

UTRCP Mix

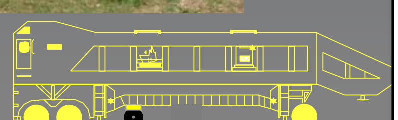
- Aggregate: 2 stone size matrix: 13 & 9mm quartzite
- CEM 1 (42.5) cement
- Reinforced steel mesh 5.6mm diameter placed on neutral axis
- Grid size: 200 x 200mm
- PCC thickness: 50mm
- Cured for 7 days under plastic sheets
- HVS testing started after 28 days
- Ave Compressive cube strength was 37.5 MPa (28days)

Base construction


UTRCP Construction

Environmental effects on slab curling and warping

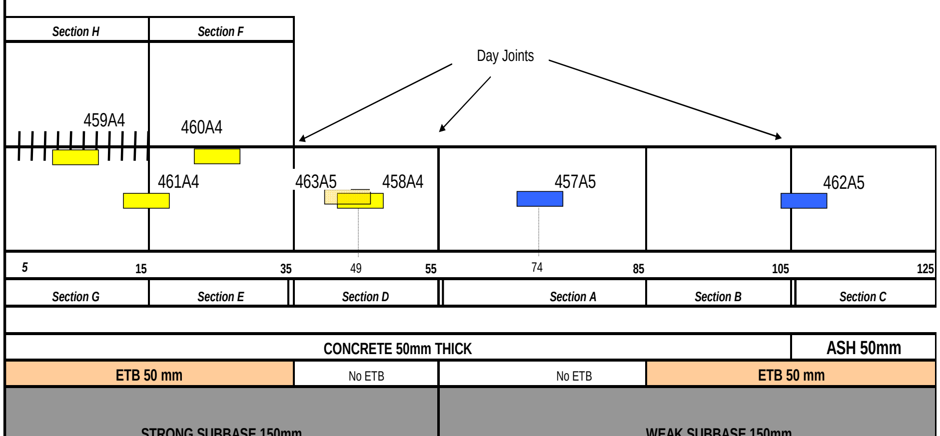
Accelerated pavement testing with the Heavy Vehicle Simulator (HVS)



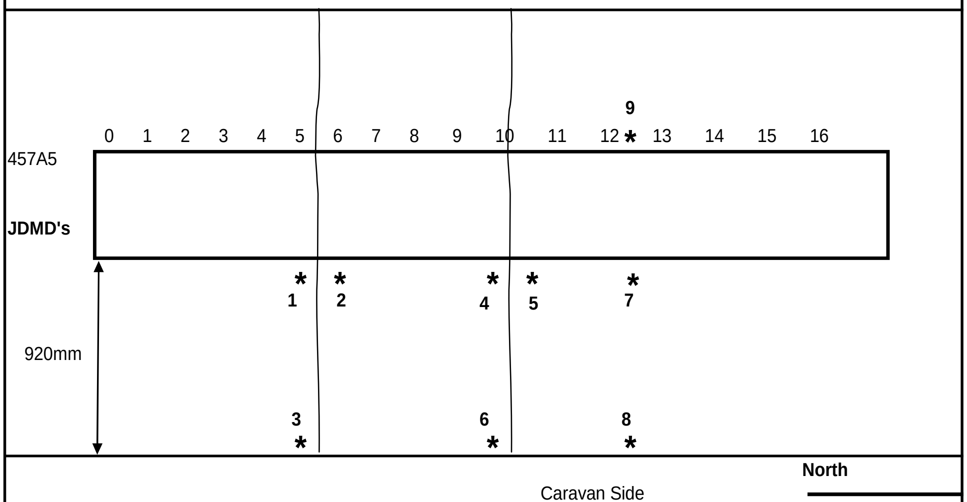
Main Testing Objectives

- To assess the effects of various input parameters (i.e. type of aggregate, support conditions, longitudinal joints, traffic loading) on the structural integrity and performance of the UTRCP layer;
- To determine the structural strength across joints and transverse cracks, as these are believed to be the weak areas in the UTRCP system; and
- To establish the success of repair and rehabilitation options in the event of trenches and early UTRCP layer failure.

Testing Areas

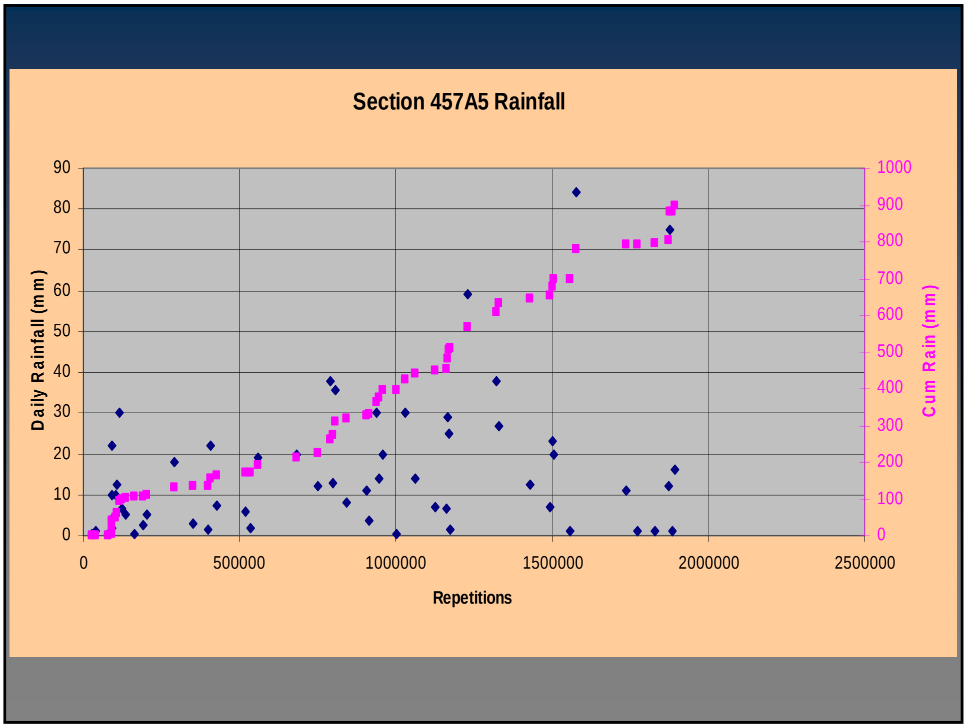


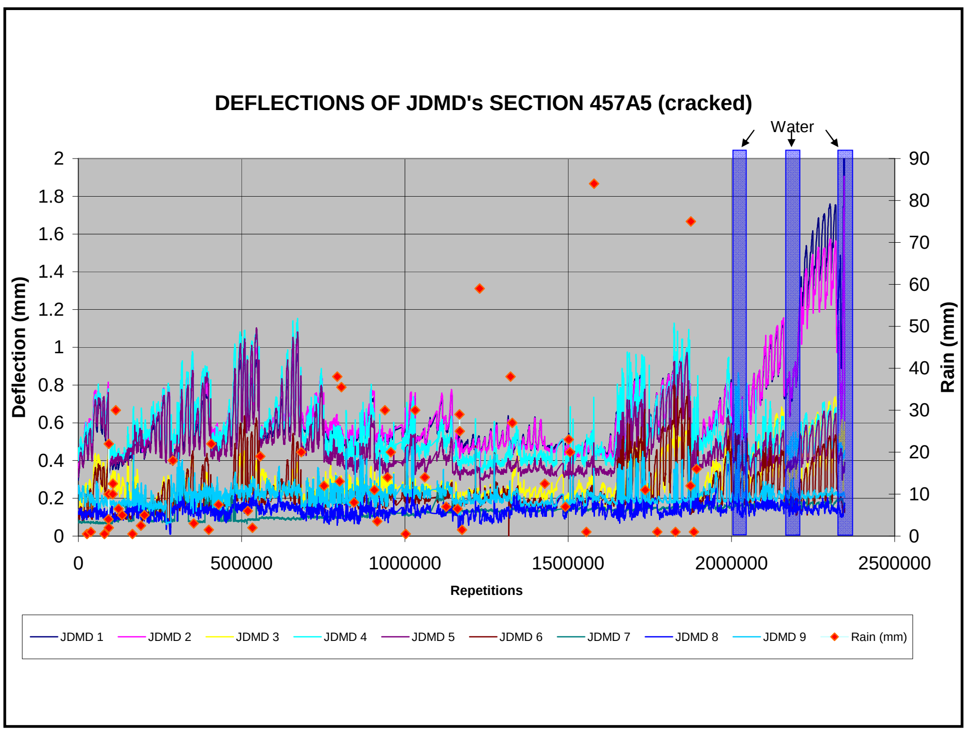
457A5: Test on weak base (no ETB): Dry test, centre slab loading, 40kN



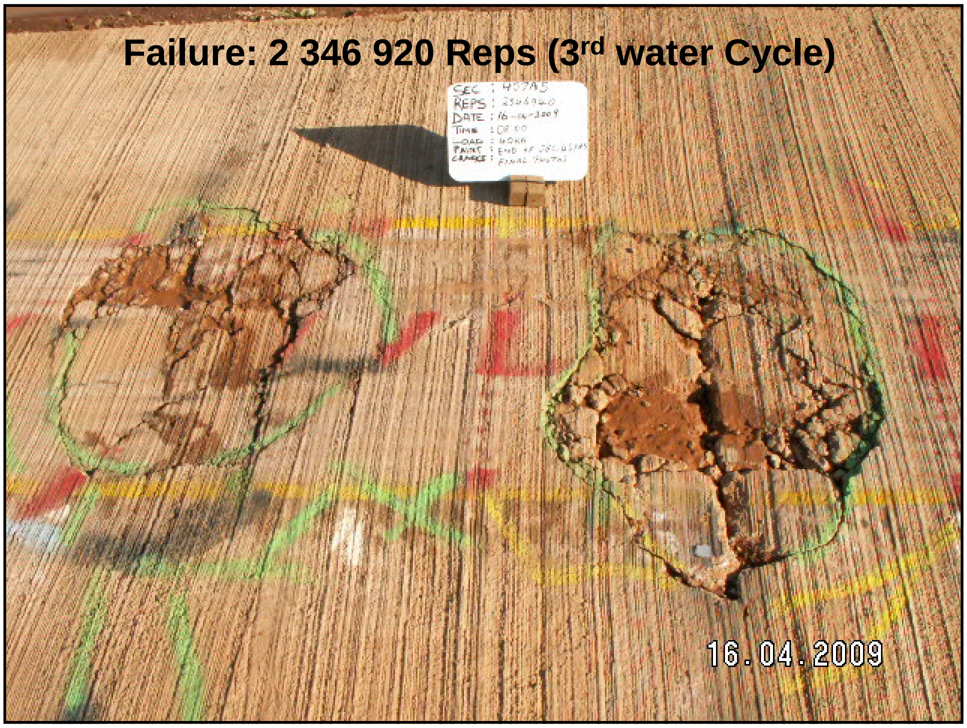
457A5: Centre slab loading Weak base (no ETB)

- Section lasted 2 346 920 repetitions
- 2m dry, 40k wet, 120k dry etc.
- Section failed in its 3rd watering cycle
- Starting date: 31 Oct 08, end 15 April 09 (166 days)
- Ave slab thickness: 55mm
- 900 mm of rain fell during testing period


Section 457A5 Rainfall
Daily Rainfall (mm)
Cum Rain (mm)
Repetitions
0
10
20
30
40
50
60
70
80
90
0
100
200
300
400
500
600
700
800
900
1000
0
500000
1000000
1500000
2000000
2500000

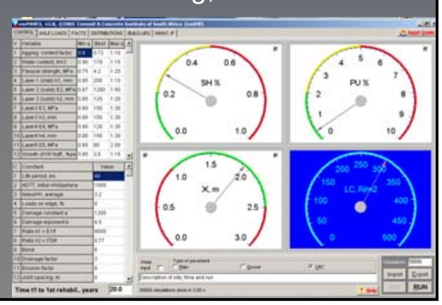

DEFLECTIONS OF JDMD's SECTION 457A5 (cracked)
Water
Deflection (mm)
Rain (mm)
Repetitions
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
10
20
30
40
50
60
70
80
90
0
500000
1000000
1500000
2000000
2500000
JDMD 1
JDMD 2
JDMD 3
JDMD 4
JDMD 5
JDMD 6
JDMD 7
JDMD 8
JDMD 9
Rain (mm)

Failure: 2 346 920 Reps (3rd water Cycle)



Modeling of UTRCP with cncPAVE

- cncPAVE is South Africa’s mechanistic Concrete Pavement design Software Package
- Is based on models developed from finite element and multi-layer evaluations.
- The design method has been calibrated against actual performance of different concrete pavement sections (roads and streets) under normal traffic loading, as well as under the HVS.



Significant Results from the analysis

- Critical stress is the tensile stress at the bottom of the slab approximately 450mm from a crack (or joint)

Failure mechanism

- After crack development the stiffness of the slab is reduced, resulting in an increase in deflection and higher vertical stress at the top of the supporting layer.
- At the same time high compressive stresses develop at the top of the slab in the crack, resulting in spalling
- With increased crack width water can easily enter the pavement which will cause pumping.
- The loss of support and induced loads from the top causes the slab to be overstressed which results in failure.

Conclusions

- Initial results indicates that even in the wet state, the pavement sections should be able to carry the anticipated traffic on a residential township road for its design life (20 + years)
- Proper curing techniques are important to control shrinkage cracks and slab warping.
- Base materials with a high resistance to water penetration to improve the erosion potential will improve the life of the pavement even further (Cement, lime or bituminous treated materials)

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