Foamed Bitumen – 6 x Case Studies
Mechanistic Design & Evaluation of Pavements
2006 Workshop

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Purpose & Introduction

(i) To review 6 x foamed bitumen projects completed over the last 4 months

(ii) To identify key elements at each project
Hiway Stabilizers NZ Ltd

- Foam Bitumen Recycling since 2002
- Purchased WR200 & WR2500 Late 2005
- 65,000m² Foamed in last 4 months
  - 40,000m² Rural & 25,000m² Urban

- Briefly discuss key elements of 6 x recent projects

What is Foamed Bitumen Recycling?

Water for producing foam

Hot bitumen

Water for compaction

Working direction
Material Requirements

- **Optimum grading curve**
  - Critical factor is at least 5% fines

![Sieve Analysis Diagram]

Optimising Foamability

- Intersection of Expansion Ratio & Half Life shows optimum bitumen / water ratio

![Foamability Diagram]
Case Studies – Waitakere Road (RDC)

- Waitakere Road, Rodney:
  - Area: 10,000m²
  - Client: Rodney District Council
  - Traffic: 2.7 x 10⁶ ESA
  - Design: 0.5% cement, 0.5% fly ash, 3.5% bitumen, 200mm
  - Construction time: 2 weeks (including 60mm overlay)
  - Offer: Alternative design/build accepted by Rodney District

- Quality Assurance includes strength determination:
  - Design modulus FBR Base 750 MPa
  - 850 – 1350 MPa achieved in Matta test

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**Waitakere Road Benkelman Beam Deflections**

<table>
<thead>
<tr>
<th>Chainage (m)</th>
<th>Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate beams - right lane</td>
<td>2 month beams – right lane</td>
</tr>
<tr>
<td>Maximum Deflection (mm)</td>
<td>2.84</td>
</tr>
<tr>
<td>Minimum Deflection (mm)</td>
<td>0.52</td>
</tr>
<tr>
<td>Average Deflection (mm)</td>
<td>1.25</td>
</tr>
<tr>
<td>95th Percentile (mm)</td>
<td>1.93</td>
</tr>
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Case Studies – Waitakere Road (RDC)

- **Area:** 27,500m²
- **Client:** Queenstown Lakes District Council
- **Traffic:** 6 x 10⁵ ESA
- **Design:** 1% cement, 3.5% bitumen, 200 mm
- **Construction time:** 2 weeks
- **Offer:** Design/build tender accepted by Queenstown Lakes DC

Existing upper aggregate layers were deep; in places 300mm+ to an old chip seal layer
- FWD predicts substantial remaining pavement life
- Not consistent with site observations; shallow shear and comprehensive freeze-thaw damage to existing pavement.
  - Temperature range from -15°C to 20°C

Case Studies – Coronet Peak (QLDC)

- **Coronet Peak Road, Queenstown**
  - **Area:** 27,500m²
  - **Client:** Queenstown Lakes District Council
  - **Traffic:** 6 x 10⁵ ESA
  - **Design:** 1% cement, 3.5% bitumen, 200 mm
  - **Construction time:** 2 weeks
  - **Offer:** Design/build tender accepted by Queenstown Lakes DC

- Existing upper aggregate layers were deep; in places 300mm+ to an old chip seal layer
  - FWD predicts substantial remaining pavement life
  - Not consistent with site observations; shallow shear and comprehensive freeze-thaw damage to existing pavement.
    - Temperature range from -15°C to 20°C
Case Studies – Coronet Peak Road (QLDC)

- All QA requirements met
- Density 97 to 99% MDD
- Total Voids 12 - 18 %
- Clegg Hammer - early strength increase
- Briquettes
  - Nominal 7-day curing
  - $E = 900$ to 1750MPa
Case Studies – Settlement Road

- **Settlement Rd, Papakura**
  - Area: 4,200m²
  - Client: Blacktop Construction (Papakura DC)
  - Traffic: 1 x 10⁷ ESA
  - Design: 2% lime, 1% cement, 3.5% bitumen, 240mm
  - Construction time: 10 days to seal
  - Offer: Blacktop D&B accepted - PDC trial
- **High PI (25) & poor shape (crossfall 7%)**
- **Hiways provided:**
  - 4% max crossfall
  - -30mm level from channel

Completed in ~1 week
Conventional design = 700 – 800mm undercut & 7 – 8 weeks construction
Case Studies – Rimu Road SH2 (Transfield)

- Rimu Road, State Highway 2
  - Area: 7,800m²
  - Client: Transfield Services Ltd
  - Traffic: 13,600 veh/day, 12% HCV
  - Design: 1% cement, 3.5% bitumen, 200mm
  - Construction time: 6 days to seal
  - Offer: Hiways D&B accepted

Case Studies – Rimu Road SH2 (Transfield)

- Traffic
  - Immediately
- Water Resistant
  - No pumping of fines
- Degree of
  - Saturation – dries quickly
Case Studies – Walmsley Road

- **Walmsley Rd, Manukau**
  - **Area:** 5,900m²
  - **Client:** Blacktop Construction (Manukau CC)
  - **Traffic:** $1.4 \times 10^7$ ESA (10,000 AADT)
  - **Design:** 3% KOBM pretreatment
    - 1% cement
    - 3.5% bitumen, 200mm
  - **Construction time:** 11 days to seal
  - **Offer:** Client specified treatment

- **Case Studies – Walmsley Road**
  - 600m³ of aggregate removed
  - 110mm rainfall (100mm historical May average)
  - No drainage path

All design / contract criteria met
Some pre-seal work required for smoothing
Case Studies – SH16 Coatesville Riverhead

- SH16, Old North Road to Coatesville Riverhead Highway
  - Area: 8,000m²
  - Client: Transit New Zealand (MWH Consultants)
  - Traffic: $1.0 \times 10^7$ ESA (9,000+ AADT)
  - Design: 1% cement, 3.5% bitumen
    - 180mm depth
  - Construction time: 8 days to seal
  - Offer: Client specified treatment

Case Studies – SH16

- K&C 75% of section & finished to channel level
- 50mm rainfall
- 30 to 60mm existing surfacing
- Level 2 Closure – 7:30pm - 05:00

All design / contract criteria met
2-coat Grade 3/5 PME surfacing – followed by AC in 4 to 6 months
Advantages of FBR compared to other treatment options

- **Strength:**
  - Similar to a cemented pavement

- **Flexibility:**
  - A visco-elastic material that resists permanent plastic deformation

- **Uniformity:**
  - Can provide uniform base from a heterogeneous or patched pavement

- **Temperature susceptibility:**
  - Superior resistance to freeze-thaw cycles

- **Lower permeability medium is created:**
  - Massive improvement in resistance to pumping of fines due to coated fines, tensile capacity & lower permeability
  - Treatment in conditions where granular construction is not possible
  - Dries to level of saturation required for sealing much quicker than conventional granular

- **No shrinkage cracking:**
  - Small volumes of powder binders & water

- **Rate of gain of strength:**
  - Pavement can be trafficked immediately
  - Can be controlled - cement can be used if required
Advantages of FBR compared to other treatment options

- Reduced road user inconvenience – can be trafficked immediately
- Environmental (Last year 30K m3 cut to spoil pavement materials for Blacktop)
- Fully recycled pavement
- Faster construction time
- Possible cost savings

When is FBR the most suitable treatment option?

- Where uniformity is required
- Where upper pavement layer strength is inadequate
- To provide high strength and flexibility
- Urban pavement rehabs
- Heavily trafficked pavements
- Tight construction programme
- Limited traffic disruption
Design Philosophy

- Foamed bitumen pavements typically designed by using Austroads/CIRCLY and modelled as a phase 2 modified aggregate with enhanced resilient modulus.

- Impending TNZ NZ Supplement – Recommends FBR Design methodology matching that is currently utilised.

- Design modulus determined and confirmed from laboratory testing.

- Grading and optimum bitumen & water content from laboratory testing.

- Up to 2% of other binders can be used:
  - Lime to eliminate plasticity
  - Cement for early strength gain.

Design Principals

- Briquettes determine appropriate binder volume and pavement design strength:
  - Prepared using specific procedures
  - Tested in Materials Testing Apparatus and/or Indirect Tensile.
Design Principals

- Accepted best practice procedures are used
  - Density / Moisture relationship relative to MDD (adjustment to NDM is made to account for the bitumen)
  - Plateau testing
  - Benkelman beam or FWD – consistency and stiffness
  - Clegg hammer – early strength

- Design values confirmed with samples collected on site and design briquettes with heavy compaction to replicate field conditions. Testing undertaken for ITS, UCS & RM

- Construction practice varies from conventional granular