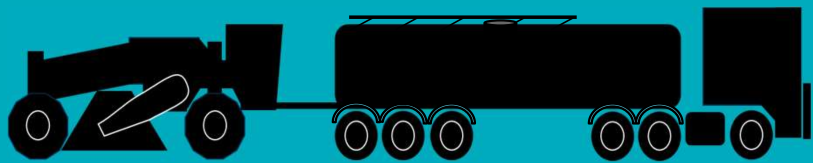
Implementation of Foamed Bitumen in Queensland – a 25-year journey



Damian Volker, Principal Engineer

Department of Transport and Main Roads (TMR)

Australian Pavement Recycling and Stabilisation Conference

Pavement Recycling for Sustainable Roads

Novotel Brighton Beach, Sydney • 10th August 2022

AustStab

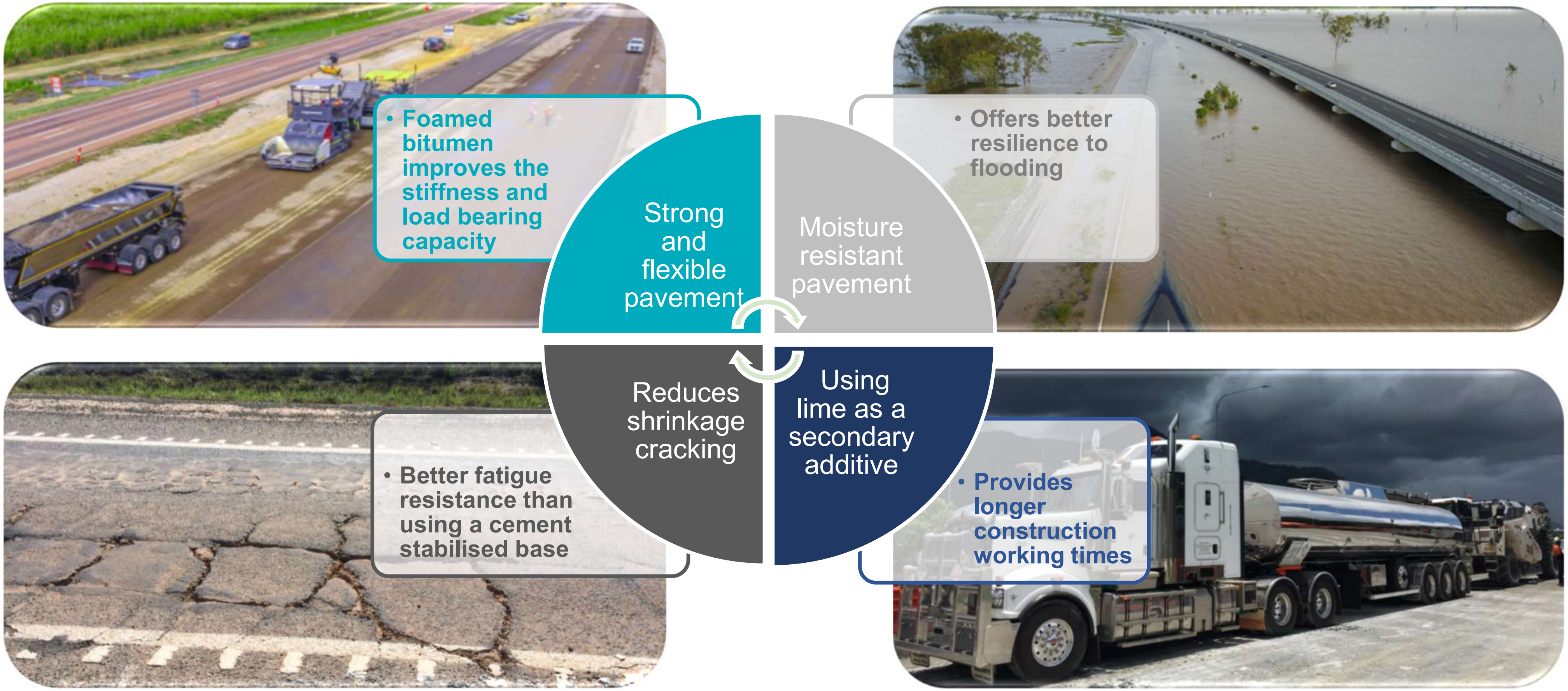
Pavement Recycling and Stabilisation Association

Traditional Owners Acknowledgement

TMR Artwork storyline Travelling by Gilimbaa.

About us

Implementation of Foamed Bitumen in Queensland



TMR early Foamed Bitumen projects

Border (Warwick) District
- -1997 – 1999: 3 projects

North Coast Hinterland District
- -1998: 1 project

South Coast Hinterland District
- -2000/01: 2 projects

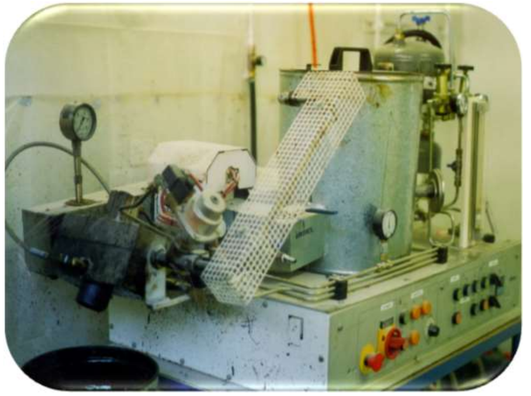
Redland Shire
- -2000: 2 projects

The first trial - Gladfield – Constructed 1997

- 250mm OWP + 200mm IWP stabilised with 4% bitumen and 1.5% cement
- CBR 3 (expansive) subgrade
- Pavement life (prior to fatigue) ~ 2.5 years
- Approx. traffic to failure ~ 2.5 x 10^6 ESA
- Site has been overlaid with 160mm granular material.

TMR foamed bitumen laboratory equipment

Herston
(Then)



Bulwer Island
(Now)

Inglewood – Constructed 1998

- 200mm stabilised layer with 4% bitumen and 1.5% quicklime.
- Insitu subgrade strength CBR 5 – 20
- 3 year prior to the onset of fatigue cracking (only in areas with insitu CBR 5 - 8)
- Calculated fatigue life similar to that achieved in the field




Rainbow Beach – Constructed 1998

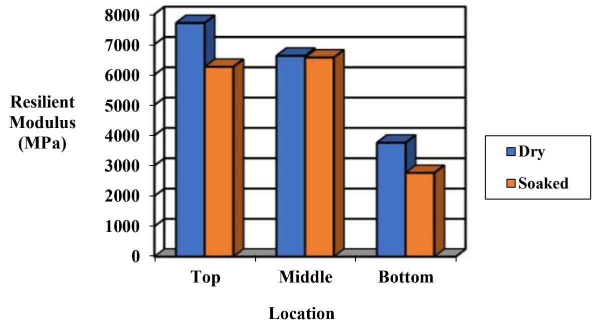
- Trial to assess foamed bitumen against bitumen emulsion stabilisation
- 3 x 200m sections of foamed bitumen stabilisation constructed using 3, 4 and 5% bitumen + 1.5% quicklime
- Still performing adequately and showing few signs of distress

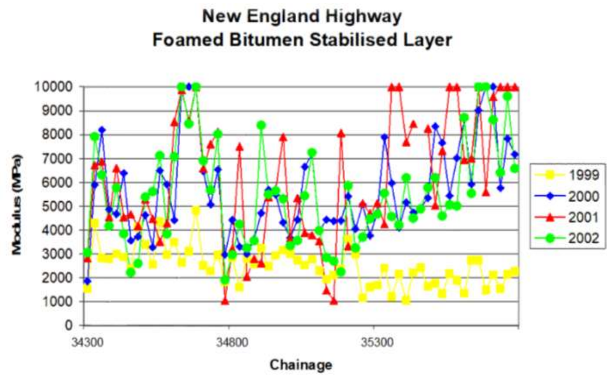
Allora – Constructed 1999

- 17km section stabilised 250mm OWP + 200mm IWP with 3.5% bitumen + 1.5% quicklime
- Originally design with a 50 – 120mm asphalt overlay (not constructed)
- Subgrade – expansive black soil
- 1.5km section tested for deflection at regular intervals

Allora - 2002

- Isolated signs of distress
  - Two minor rut / shove failures
  - Possibly material related
- Longitudinal cracking
  - Subgrade movement
  - IWP fatigue cracking (insufficient depth?)
- Seal Flushing





The foamed bitumen discovery – flood resilience

Staplyton-Jacobs Well Road – after prolonged 1m deep flood waters.

The foamed bitumen discovery – flood resilience

Bruce Highway Yeppen Floodway

Mt. Lindesay Hwy (Camp-Cable Rd)

Cunningham Highway Warrill View

Oakey-Pittsworth Road Mt. Tyson

These foamed bitumen pavements survived unscathed after flooding from natural disasters in Qld.

Flood resilience

RoadTek project: Yandina – Bli Bli Road (May 2022)

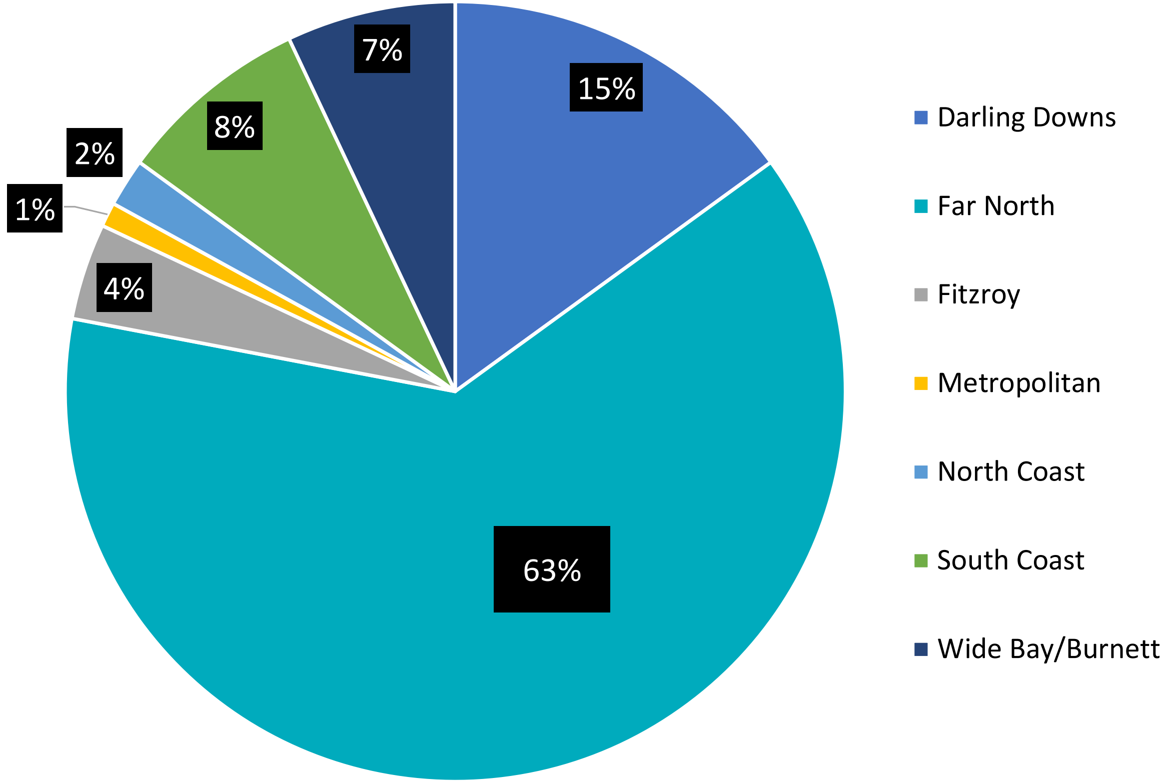
After flooding - untreated section

After flooding foamed bitumen treated section

Queensland Government's objectives for the community

TMR meets these objectives by delivering resilient and cost effective foamed bitumen pavement solutions in collaboration with the stabilisation industry.

Foamed bitumen regional distribution in TMR



(ARRB, 2015)

Plant-mixed foamed bitumen - 2012

Plant-mixed foamed bitumen - 2022

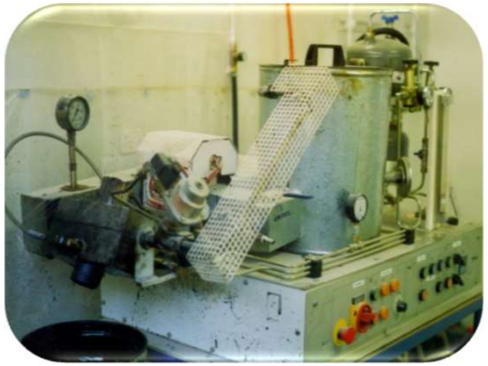
Image sourced from Hiway Stabilizers, 2018

Image provided by Fulton Hogan, 2021

Image provided by Quarry Solutions, 2021

Pugmill/plant-mixed foamed bitumen (typically located at a quarry).

The challenges along the way



TMR's first Foamed Bitumen trial was in 1997, performed by Stabilised Pavements Australia.

Pavement recycling for sustainable roads

https://www.tmr.qld.gov.au/Community-and-environment/Planningfor-the-future/Building-sustainable-roads

Recycled materials - gravel specification for foamed bitumen

Table 7.2.1(a) – Constituents in Type 2 materials

<table>
<tr><th rowspan="3">Subtype</th><th colspan="6">Maximum Limit of each Constituent (percent by mass)</th></tr>
<tr><th rowspan="2">Natural gravel or quarried material</th><th colspan="5">Recycled materials</th></tr>
<tr><th>Recycled concrete</th><th>RAP</th><th>Recycled brick</th><th>Recycled glass ^</th></tr>
<tr><td>2.1</td><td>100</td><td rowspan="5">100</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2.2</td><td>100</td><td>15</td><td>15</td><td>0</td></tr>
<tr><td>2.3</td><td>100</td><td rowspan="2">20</td><td>20</td><td rowspan="3">20</td></tr>
<tr><td>2.4</td><td>100</td><td rowspan="2">45</td></tr>
<tr><td>2.5</td><td>100</td><td>45</td></tr>
</table>

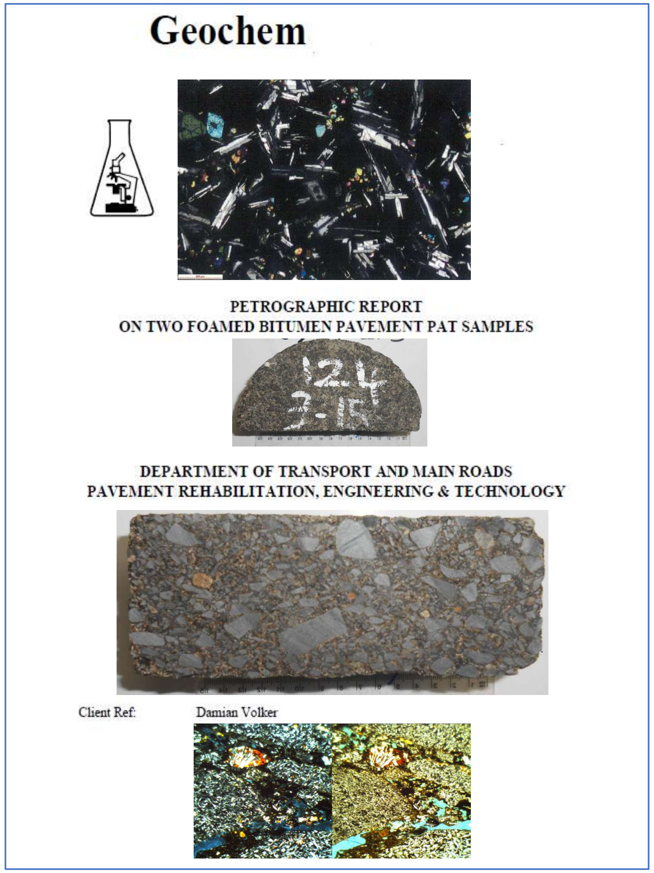
^ Recycled glass shall comply with the requirements of MRTS36 *Recycled Glass Aggregate*.

Subtypes	2.1 and 2.2
Test Sieve Size (mm)	
75.0	100
37.5	100
19.0	87 – 100
9.5	67 – 87
4.75	50 – 70
2.36	36 – 52
0.425	14 – 24
0.075	7 – 16

https://www.tmr.qld.gov.au/Community-and-environment/Planningfor-the-future/Building-sustainable-roads

Reference: MRTS05 March 2022

Petrographic analysis on materials for foamed bitumen

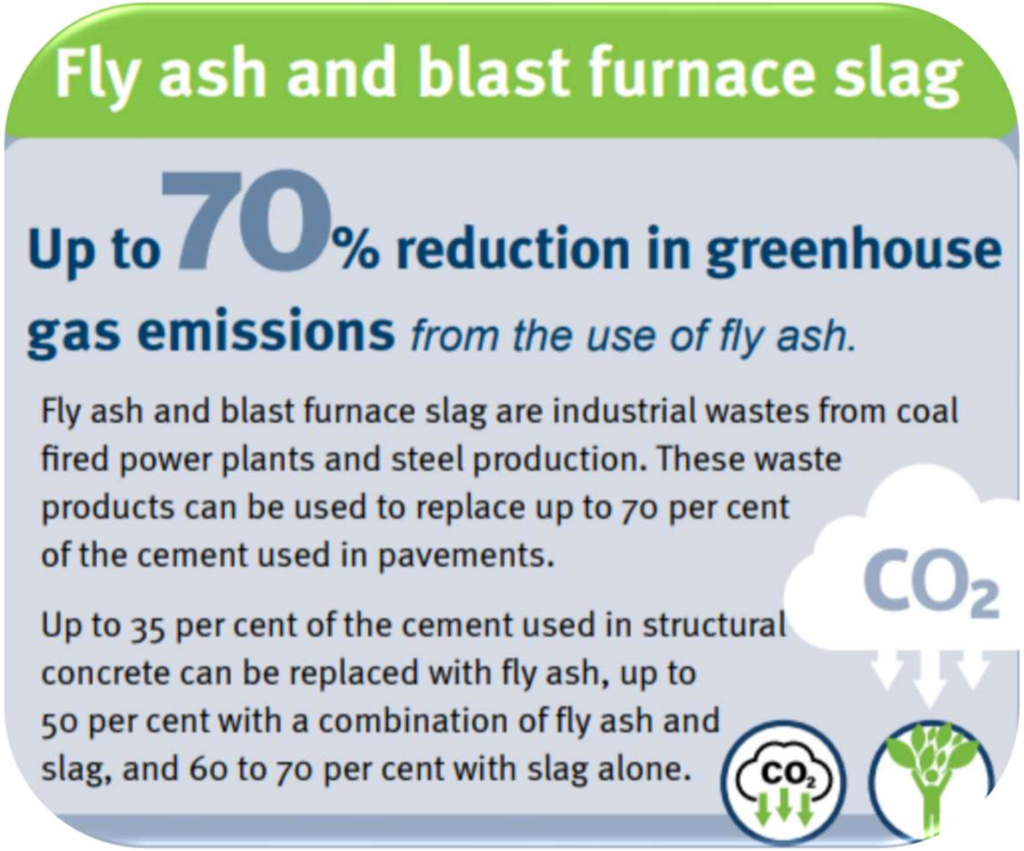


Geochem

PETROGRAPHIC REPORT
ON TWO FOAMED BITUMEN PAVEMENT PAT SAMPLES

DEPARTMENT OF TRANSPORT AND MAIN ROADS
PAVEMENT REHABILITATION, ENGINEERING & TECHNOLOGY

Client Ref: Damian Volker



https://www.tmr.qld.gov.au/Community-and-environment/Planningfor-the-future/Building-sustainable-roads

National Asset Centre of Excellence (NACOE)

Austroads

New project: APT6245 Develop design procedures for foamed bitumen stabilised pavements.

Reference: Austroads 2021

Follows on from:

- **APT6157 <u>Laboratory fatigue characterisation of foamed bitumen stabilised materials</u> and**
- **TT2046 <u>Improving the cost effectiveness of foamed bitumen stabilised pavements</u>**

How foamed bitumen is applied in Queensland

Floodways and areas of high rainfall

Yeppen Floodway Rockhampton South

Mt. Lindesay Highway – Camp Cable Road

April 2017

Mt. Lindesay Highway – Camp Cable Road

After April 2017

After February 2022

Australian Pavement Recycling and Stabilisation Conference
Pavement Recycling for Sustainable Roads
Novotel Brighton Beach, Sydney • 10th August 2022

AustStab
Pavement Recycling and Stabilisation Association

Motorways as a structural subbase in lieu of deep-lift asphalt

Logan Motorway 2007 – Westbound

Smith Street Motorway 2015 – Eastbound

New works (Greenfield) as well as rehabilitation

Airports and councils

Brisbane Airport

Scenic Rim Council

Rehabilitating old cement-treated pavements

Before

Bruce Highway 10E

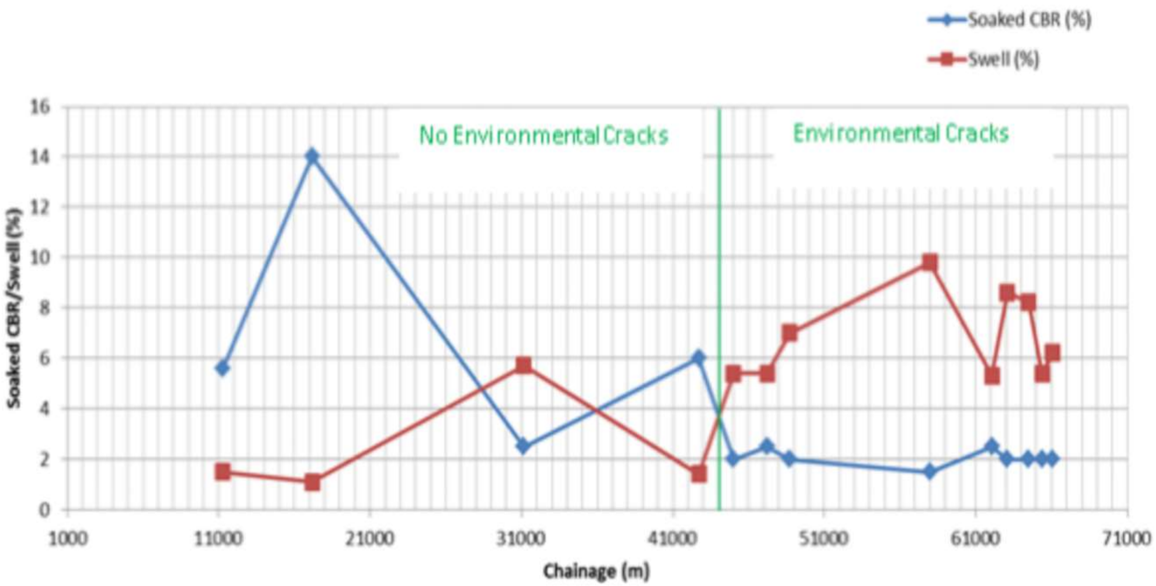
After

In combination with lime or triple blend subbase

Learnings: Geosynthetics are a must on reactive subgrades.

Risks of environmental cracking over expansive subgrades

Risks and use of geosynthetics – design considerations



Learnings: Geosynthetics are a must on reactive subgrades.

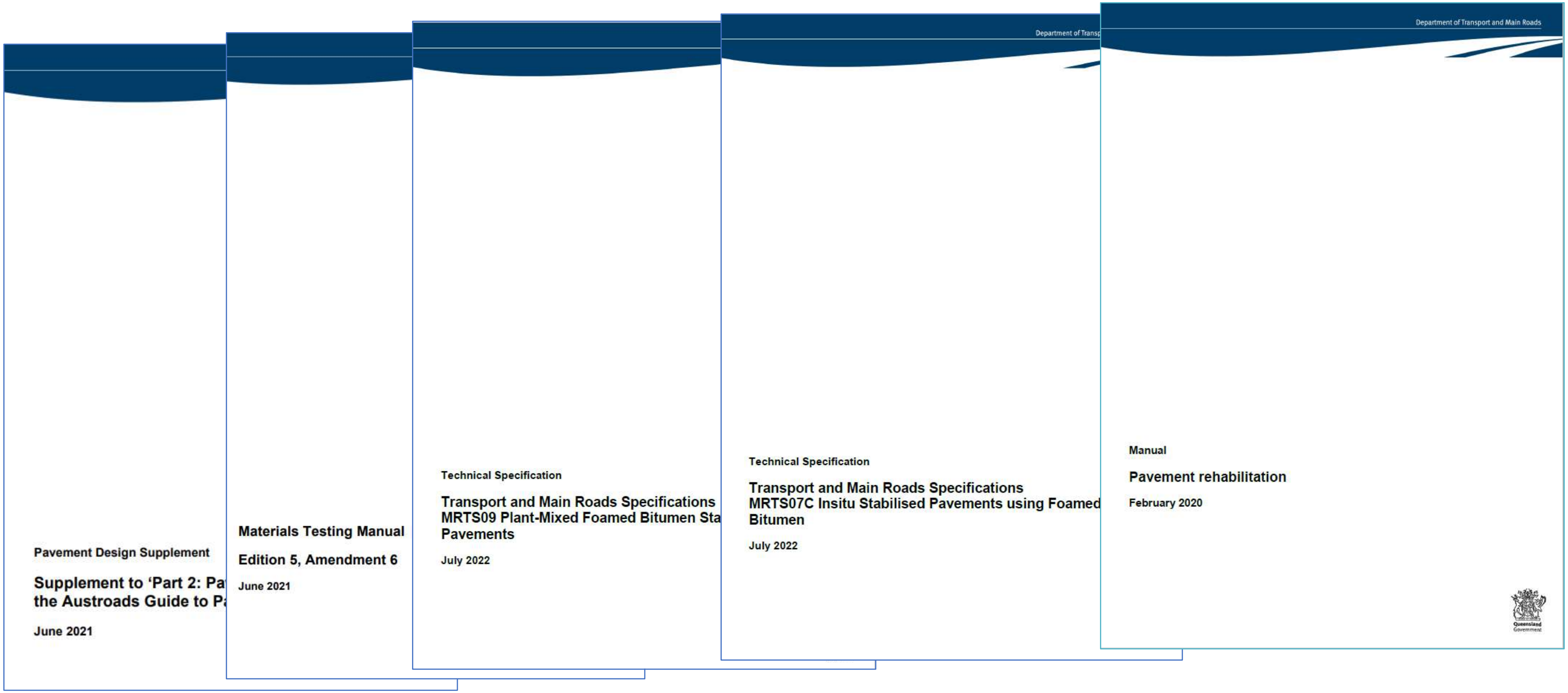
Plant-mixed offers the opportunity to place geosynthetics under the imported foamed bitumen base.

Geogrid reinforced sprayed seals

Australian Pavement Recycling and Stabilisation Conference
Pavement Recycling for Sustainable Roads
Novotel Brighton Beach, Sydney • 10th August 2022

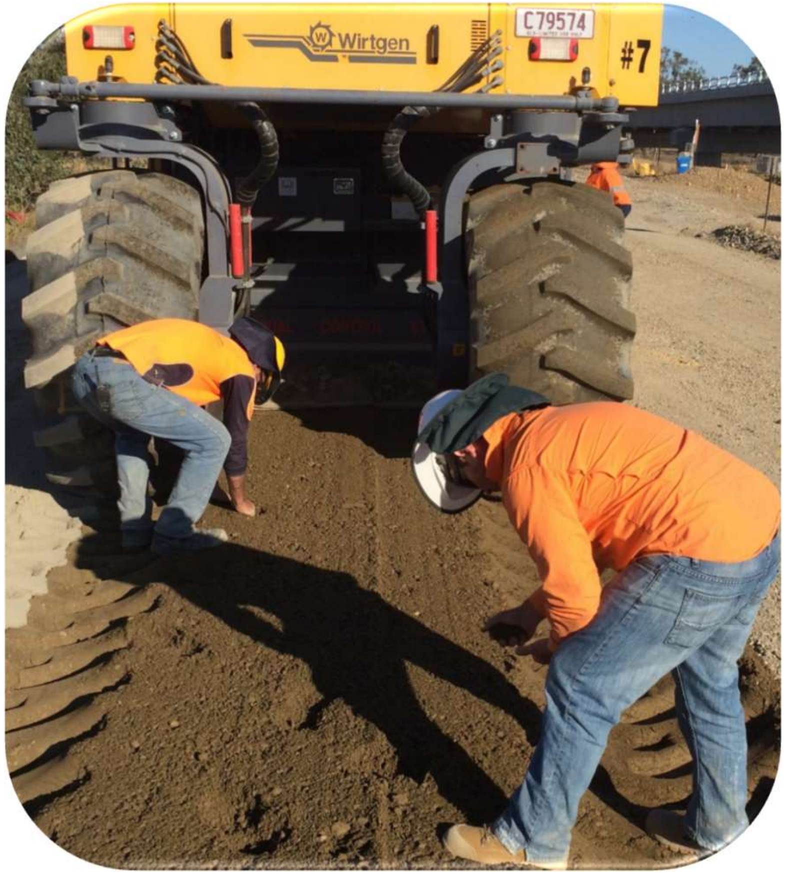
AustStab
Pavement Recycling and Stabilisation Association

Development of Foamed Bitumen design, testing and construction documents



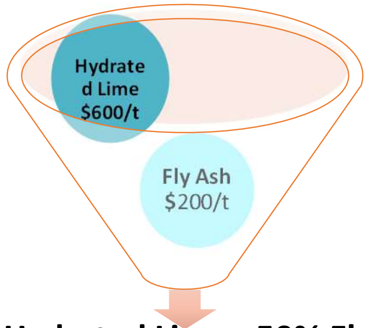
Promotion of Foamed Bitumen technology at local, state, national and international levels

Consultation, training courses and project-linked onsite training



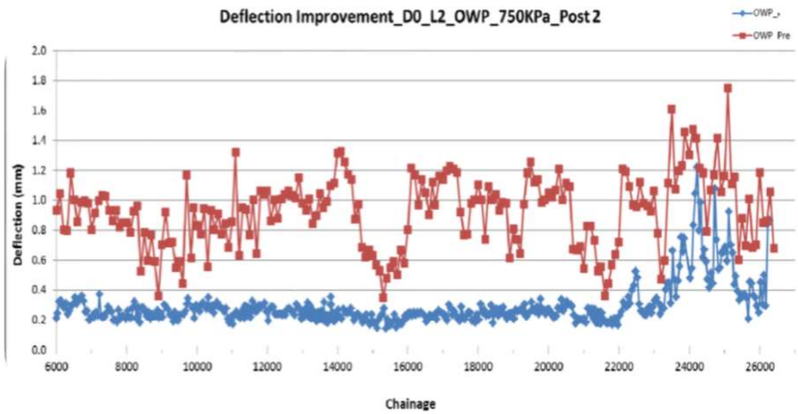
Emerging technologies and continual improvements to design and construction practices

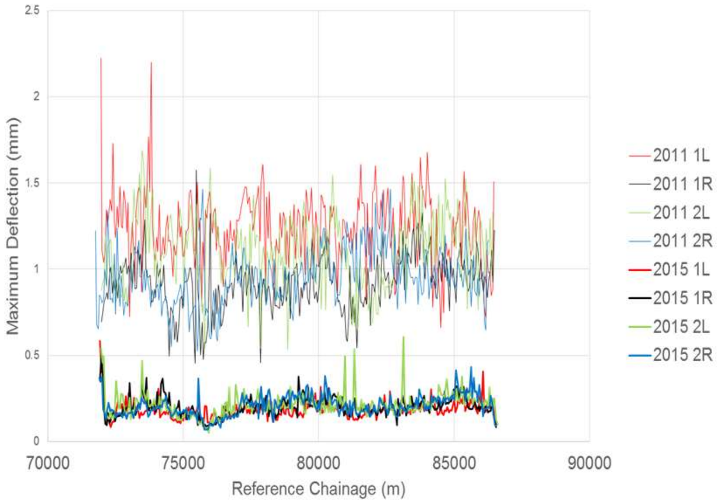
W 380 CR (Paver Laid Insitu Foamed Bitumen)



50% Hydrated Lime : 50% Fly Ash blend = $400/tonne

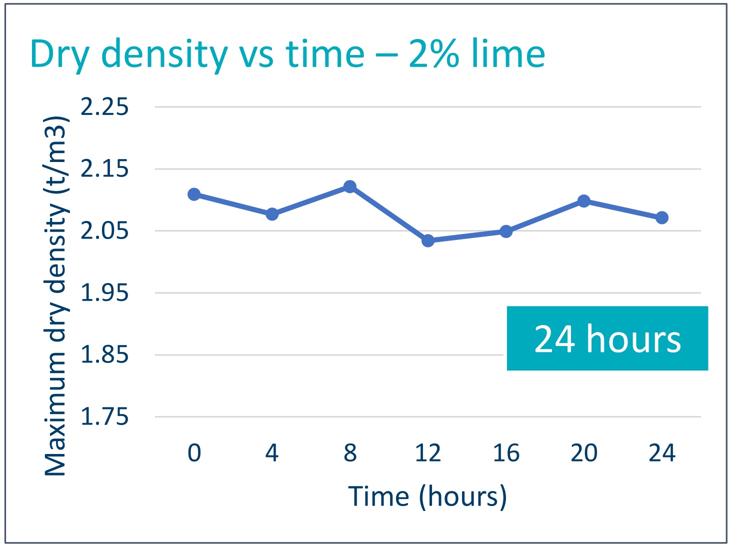
Research and Analysis - rigorous lab testing and field research

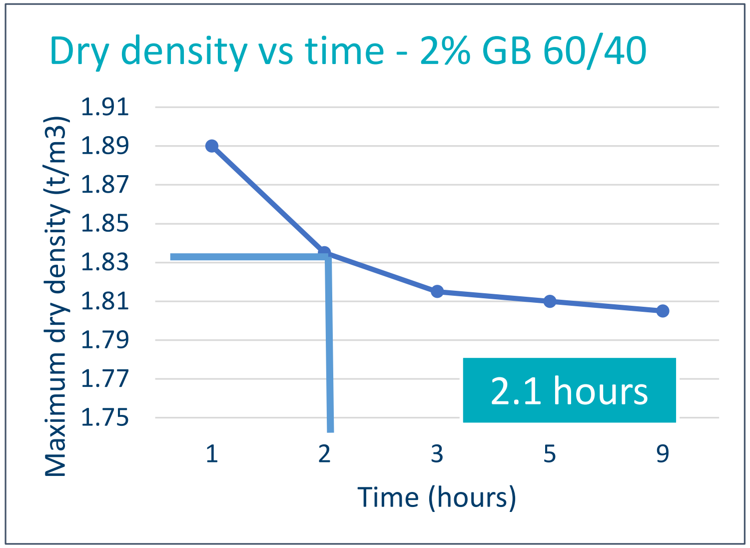




Foamed bitumen - workability

Foamed bitumen with: hydrated lime verses cement with regards to working time.





TMR research - with university students

Current and future challenges foamed bitumen faces in Qld

- **Costs and availability of stabilising agents – what are TMR doing to assist.**

Increasing the bitumen content to 3.5 per cent to increase fatigue resistance and reduce layer thickness.

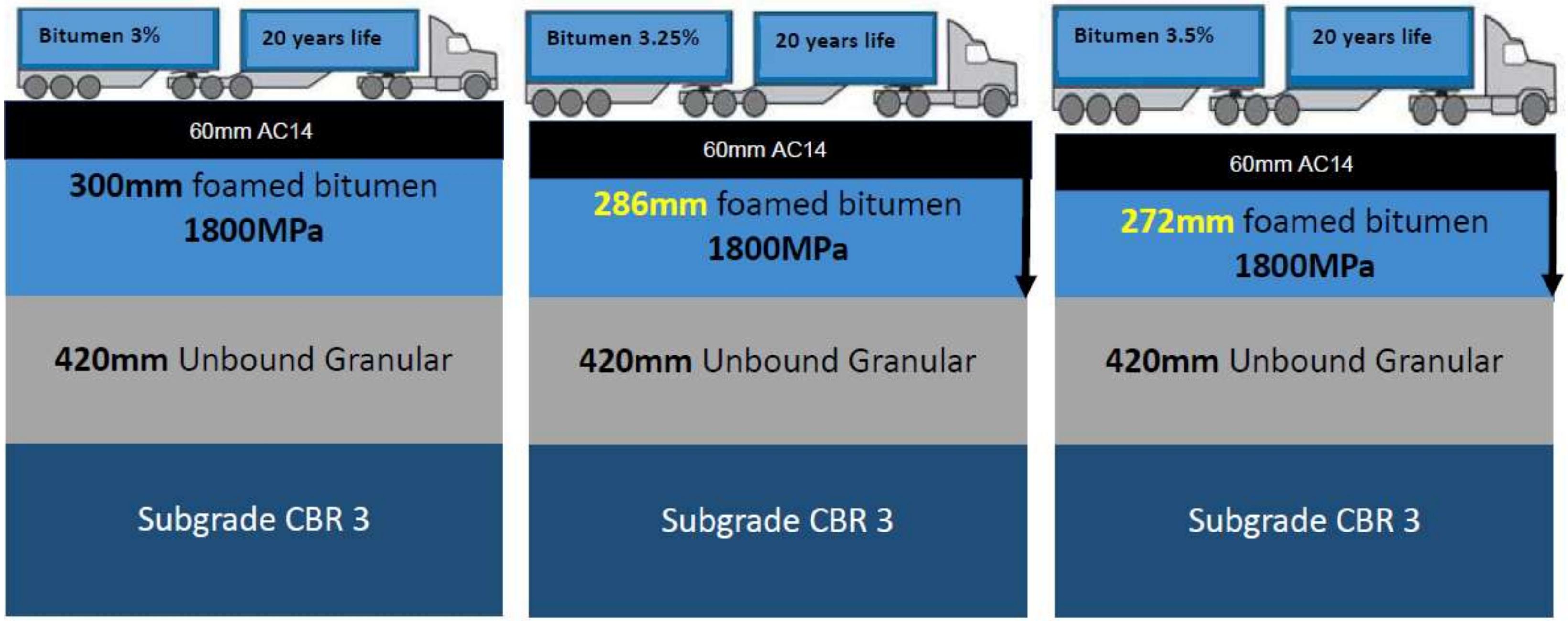
Secondary additive: Hydrated lime typically 1.25 – 2 per cent, or 50:50 hydrated lime : fly ash blend* – typically 1.25 – 2 per cent.

Increased the use of Quicklime on subgrade and triple blend subbase projects.

**Optional, but often essential to meet modulus requirements.*

Bitumen economy - 0.5% increase saving costs

Result of increased bitumen from presumptive 3% bitumen by mass to 3.5% bitumen by mass – Re-modelled design depths



Scenario:
A project already designed based on 1800 MPa and 3% bitumen by mass (7% by volume). The 300mm depth as per the original 3% bitumen design is remodelled. The relationship between increased bitumen content and fatigue life results in a reduction in Foamed Bitumen depth.
1800MPa - 300mm - 3% bitumen by mass (7.0% by volume) = 20-year life
1800MPa - 286mm - 3.25% bitumen by mass (7.5% by volume) = 20-year life
1800MPa - 272mm - 3.5% bitumen by mass (8.0% by volume) = 20-year life

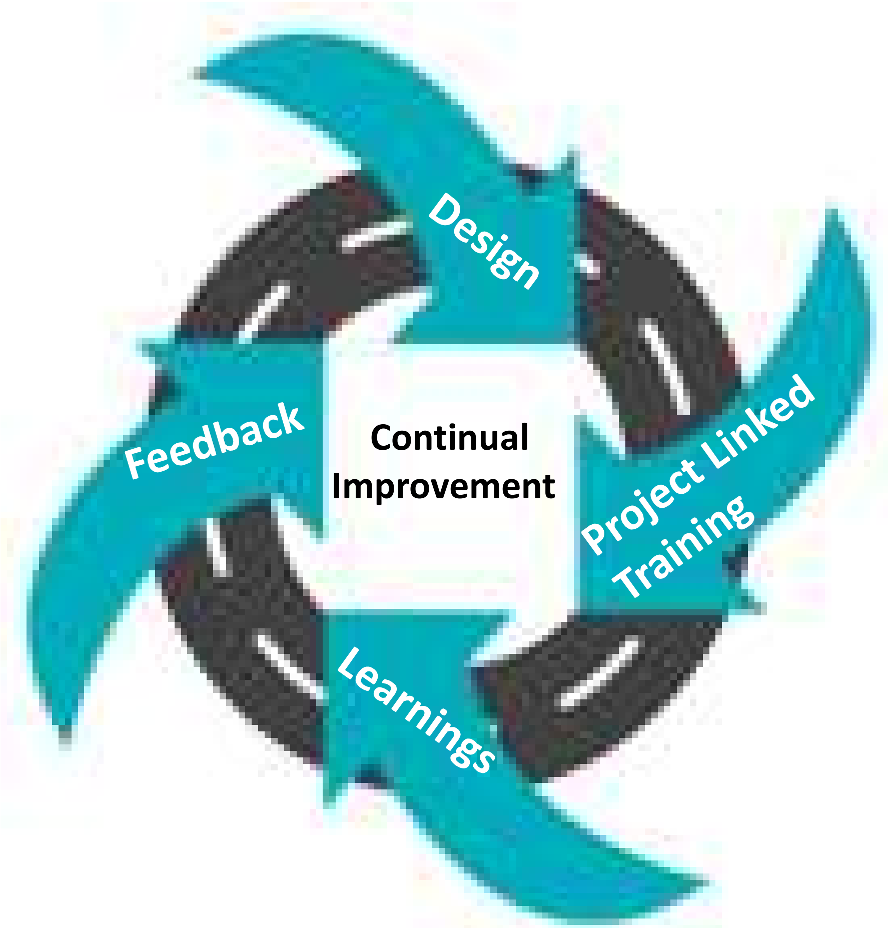
Stabilisation training modules on TMR specifications

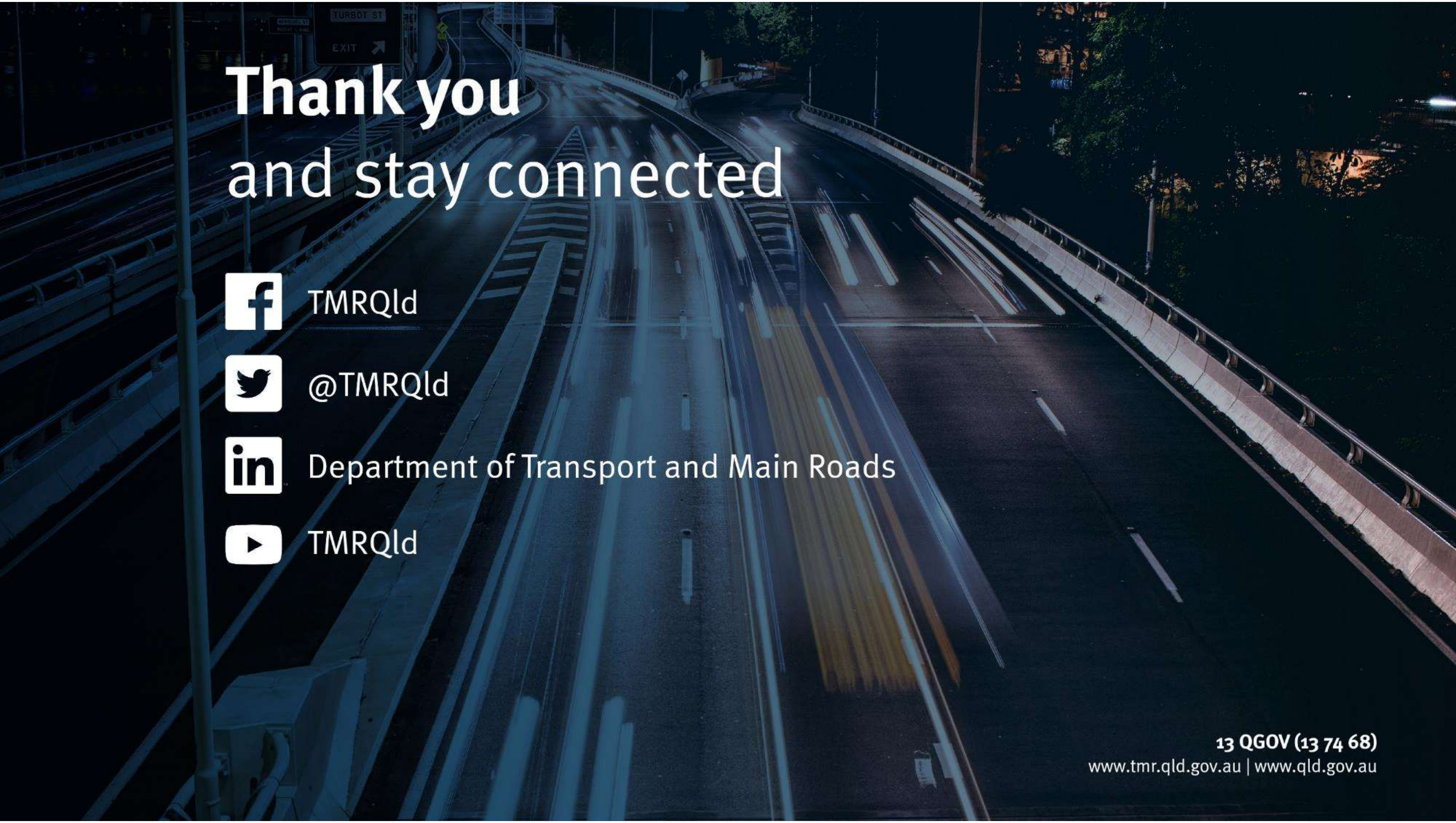
Similar concept to the TfNSW (Transport for New South Wales) Grey Card system for:

- B80 Grey Card Training - Concrete Work for Bridges.
- Finish Concrete - Concrete Road Paver Crew training.

Summary

- These innovations and savings arise from rigorous laboratory and field research, and justify ongoing research.
- Pavement Rehabilitation Unit extensively use and appreciate the great value that our TMR laboratories provide for the department.
- This ensures that the implementation of responsible innovation is based on sound laboratory research.




Thank you
and stay connected
TMRQld
@TMRQld
Department of Transport and Main Roads
TMRQld
13 QGOV (13 74 68)
www.tmr.qld.gov.au | www.qld.gov.au