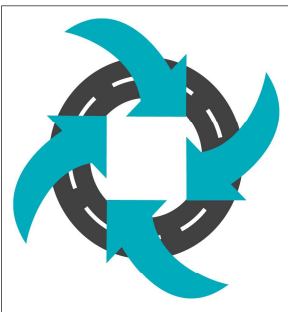




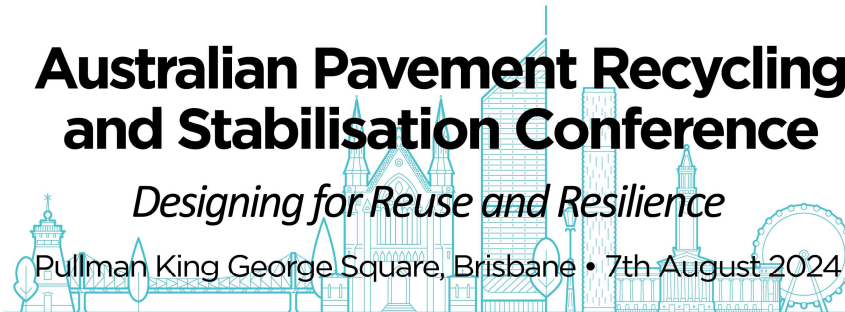
Recycled Material Blends for Stabilisation



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Presenters



Dr Negin Zhalehjo

Senior Technology Leader
Safer Smarter Infrastructure,
Pavement Research Leadership

NTRO | ARRB



Meera Creagh

Principal Engineer (Pavement Rehabilitation)

*Pavements, Materials and Geotechnical
Engineering & Technology Branch
Infrastructure Management and Delivery Division*

Qld DTMR



Dr James Grenfell

Principal Professional Leader
Sustainability and Materials Performance,
Portfolio Leader - Sustainable Infrastructure
Materials

NTRO | ARRB



PROJECT #1 OUTLINE

Using Recycled Materials in Stabilised Pavements (NACOE O24)

- **Key Contributing Staff:** Dr Negin Zhalehjoo (NTRO), Meera Creagh (TMR), Dr James Grenfell (NTRO), Dr Jaspreet Pooni (NTRO)
- **Project Timeframe:** July 2021 – June 2025
- **Project Objective:**
The main objective of this research project is to investigate the feasibility of the use of different recycled material blends as host materials for foamed bitumen stabilisation and cement stabilisation using a laboratory testing program and field trial.
- **Acknowledgements:**
NACOE Project O24: Undertaken by NTRO|ARRB and TMR through NACOE Program
TMR Bulwer Island Laboratory undertook the laboratory testing of this project



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

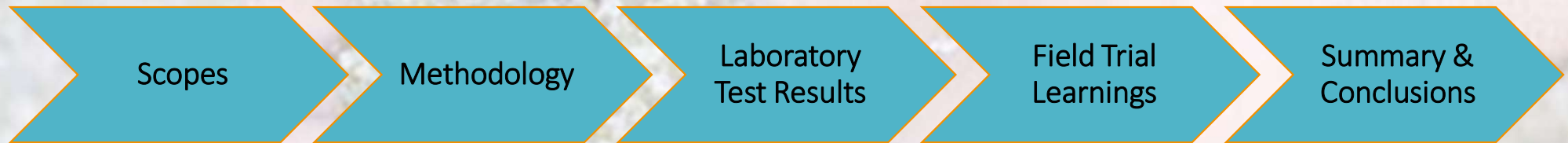
Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

OVERVIEW

NACOE Research Program



Australian Pavement Recycling and Stabilisation Conference

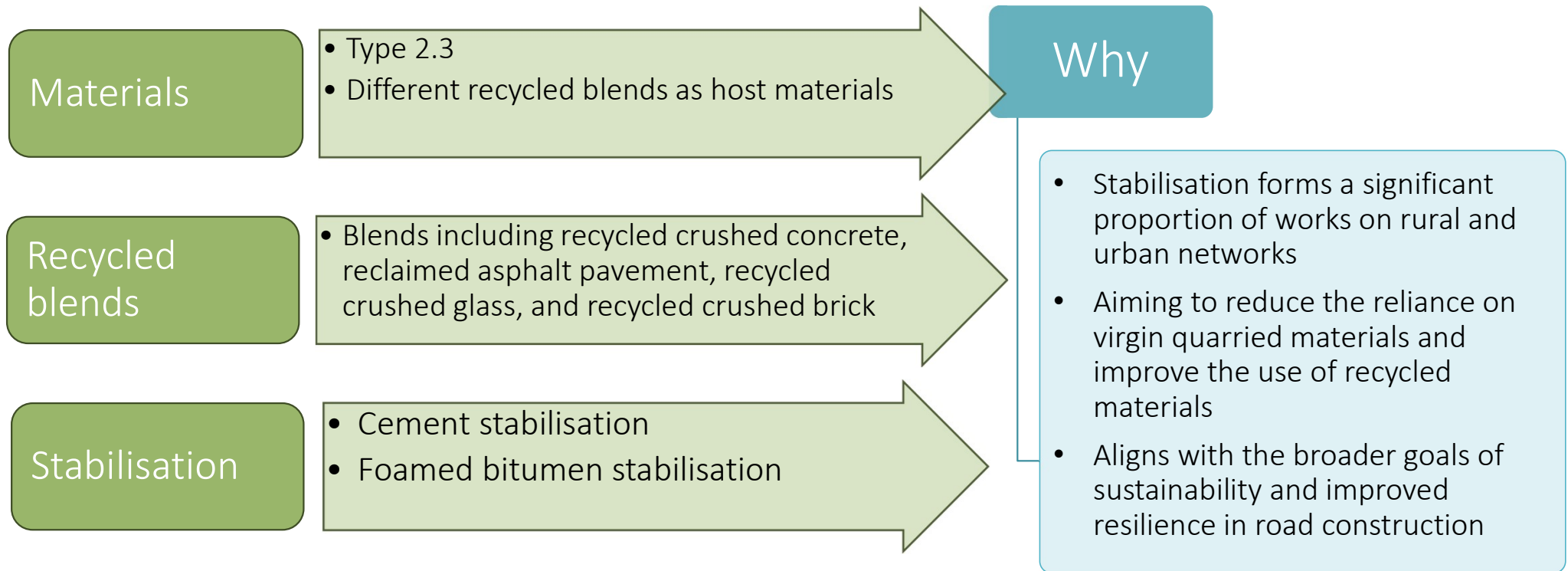
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Stabilisation of Recycled Material Blends



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Benefits of Foamed Bitumen Stabilisation (FBS) in Pavements

Creates strong and flexible pavements

Reduces moisture susceptibility and improves resilience to flooding

Can be opened early to traffic

Reduces shrinkage cracking

Environmentally-friendly & Cost-effective

Up to 100% of the existing pavements can be used – lower use of finite resources (sustainable solution)



ABC News
Floodwaters demolished pavements in Rockhampton, QLD



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Benefits of Lightly-Bound Cemented (LBC) Materials

Low cost treatment to improve performance of unbound granular pavements

Provides granular pavements with rut resistance and resilience to flooding

Provides excellent performance when used in combination with sprayed seals and thin asphalt surfacings

LBC bases have shown good performance (no block or crocodile cracking) if appropriately designed and constructed

The cracking mechanism in LBC is by diffuse cracking and therefore is not affected by the expensive to manage block cracking problems like heavily-bound cemented materials



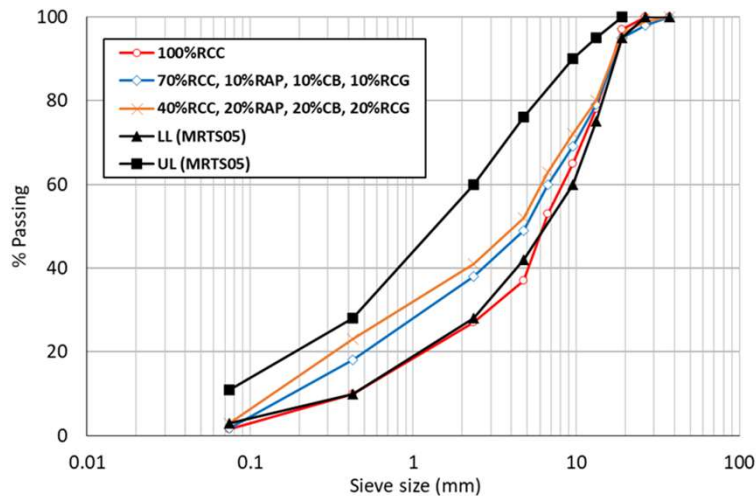
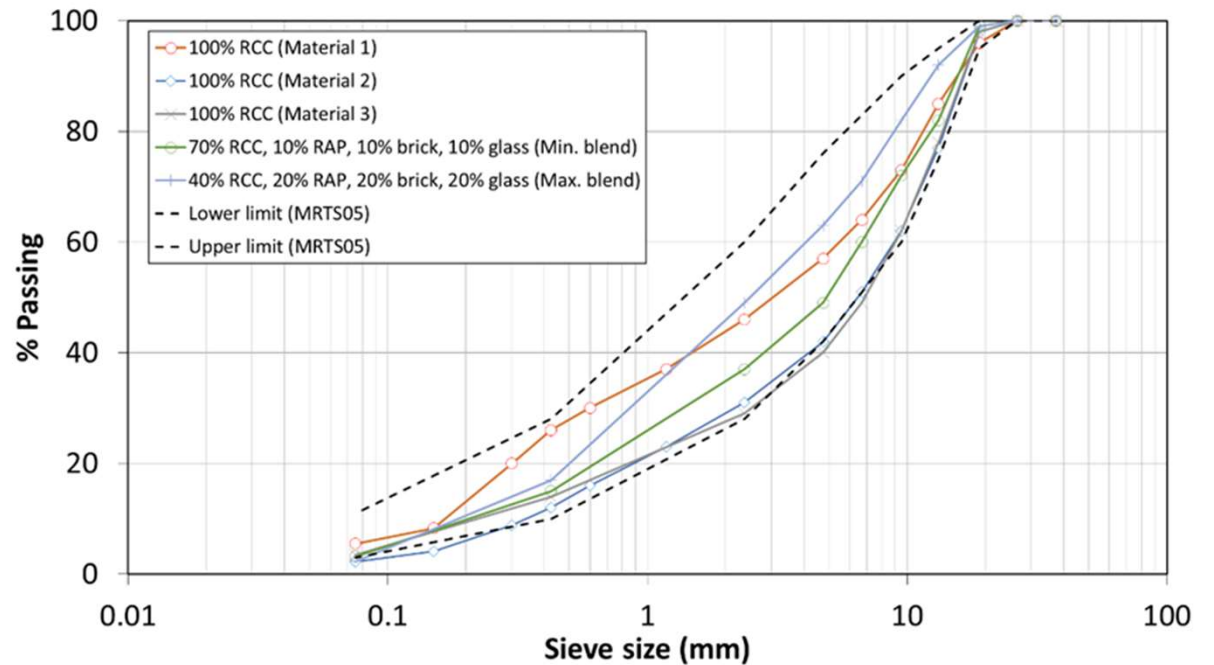
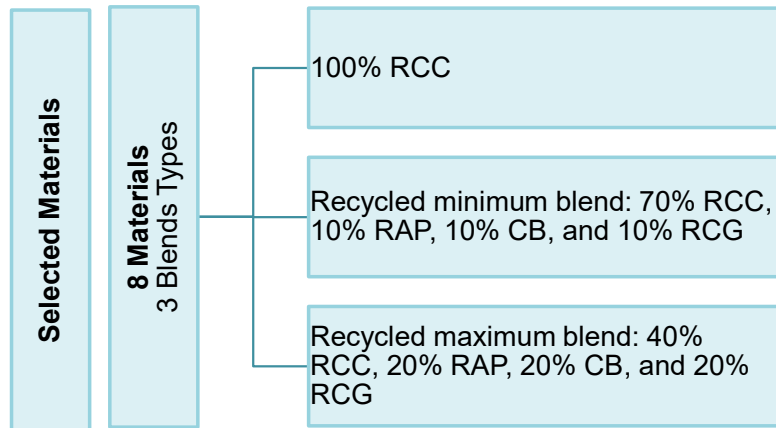
**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

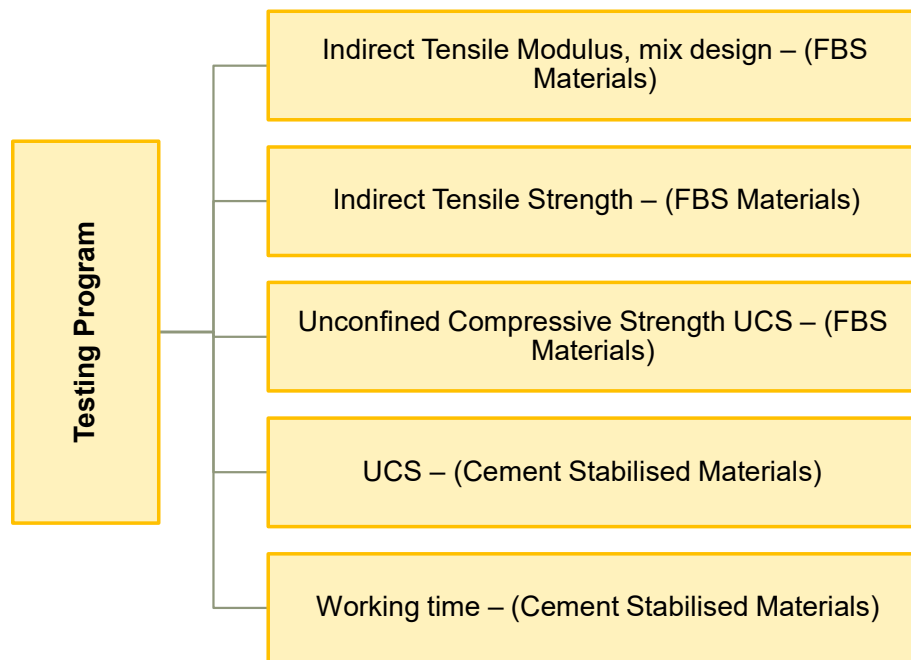


Recycled Host Materials Particle Size Distribution



- RCC: recycled crushed concrete
- RAP: reclaimed asphalt pavement
- CB: crushed brick
- RCG: recycled crushed glass

Phase 1: Comprehensive Laboratory Investigation



Mixing FBS material – Wirtgen apparatus



UCS testing



Indirect tensile modulus testing



**Australian Pavement Recycling
and Stabilisation Conference**

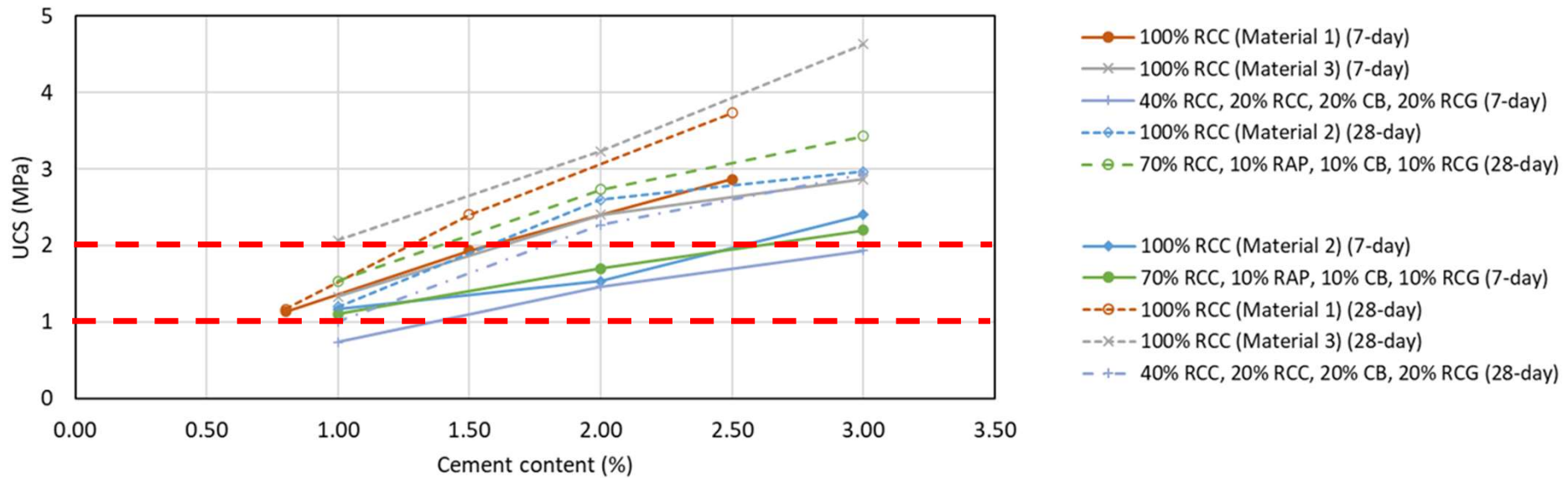
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Unconfined Compressive Strength (UCS) Test Results – Lightly Bound



Australian Pavement Recycling and Stabilisation Conference

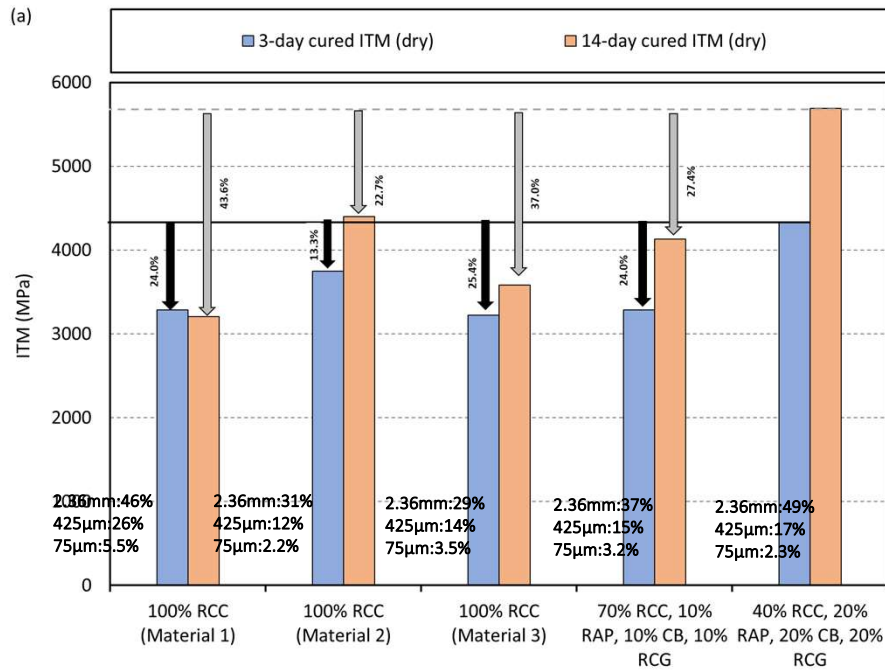
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

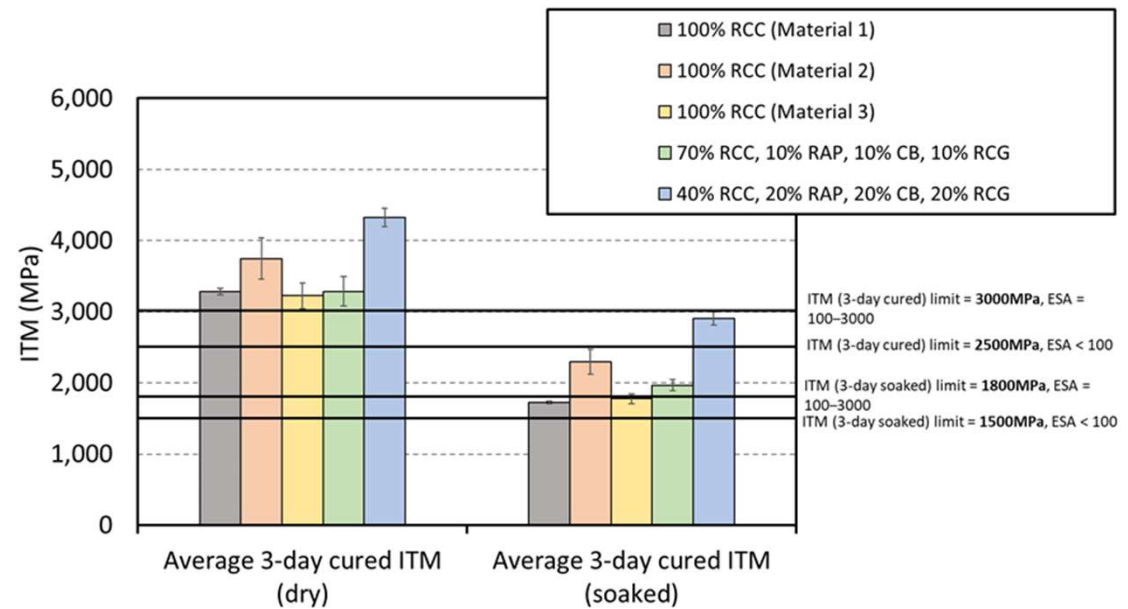


Pavement Recycling and Stabilisation Association

Indirect Tensile Modulus (ITM) Results



Effect of curing



FBS Mix Design



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Phase 1 – Summary of Findings

- Project investigated whether different recycled blends, including RCC, RAP, RCG, and CB, were suitable host materials for both cement and foamed bitumen stabilisation.
- TMR mix design procedures were used for both stabilisation treatments to assess whether recycled materials blends could achieve conformance.
- Conforming mix designs could be achieved with both treatments using recycled host materials.



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



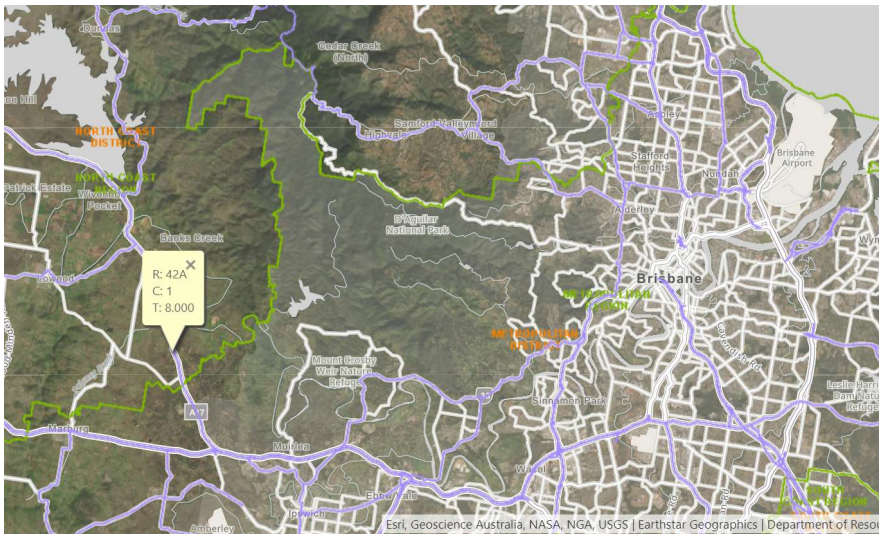
Pavement Recycling and Stabilisation Association

Phase 1 – Summary of Findings

- This means recycled material blends can be used in plant-mix stabilisation and as top-up material for in-situ stabilisation.
- This will reduce the reliance on non-renewable resources and align with the broader goals of sustainability and improved resilience in road construction.
- There is an opportunity to optimise recycled blends through materials engineering expertise, tailoring grading envelopes to the stabilisation method.

Phase 2: Field Trial – Brisbane Valley Highway

- Construction and monitoring of field trials to validate the findings and provides confidence to practitioners to increase the use of recycled materials within the pavement stabilisation sector.



- Partnering across TMR – Engineering and Technology, North Coast District and RoadTek.
- Brisbane Valley Highway - Between Ipswich and Wivenhoe Dam.
- Moderately loaded: 4350 vehicles , 15% heavy vehicles.
- Planned second field trial (2025) (TBC): Plant mixed lightly bound material



**Australian Pavement Recycling
and Stabilisation Conference**

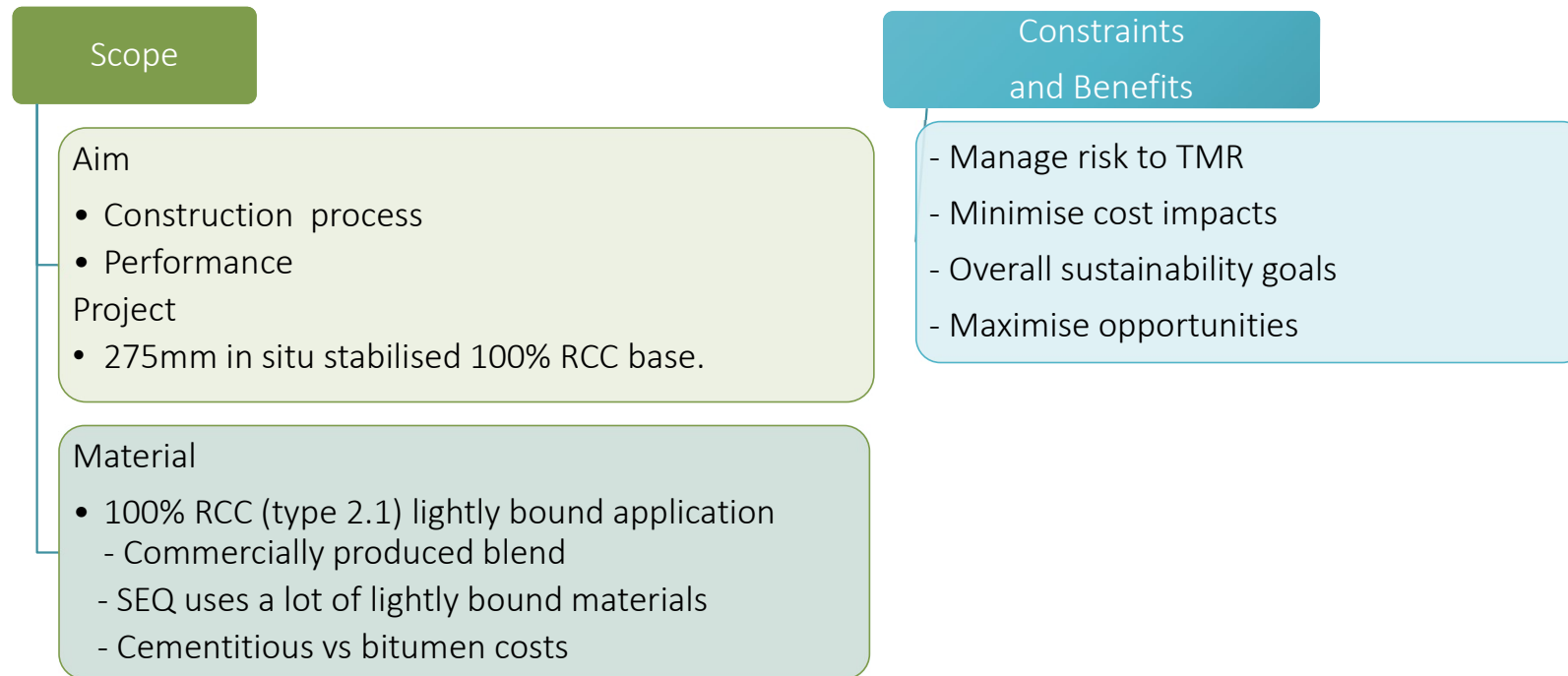
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Phase 2: Field Trial – Brisbane Valley Highway



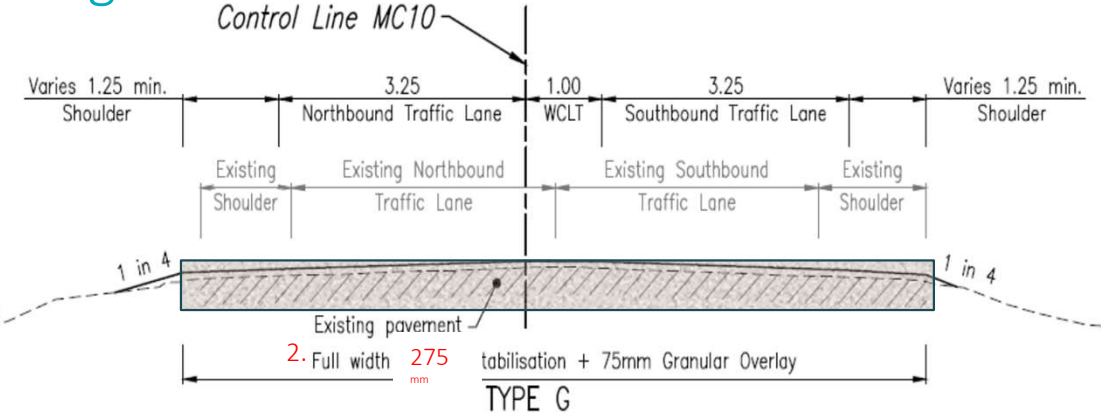
**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Design



Material



Site

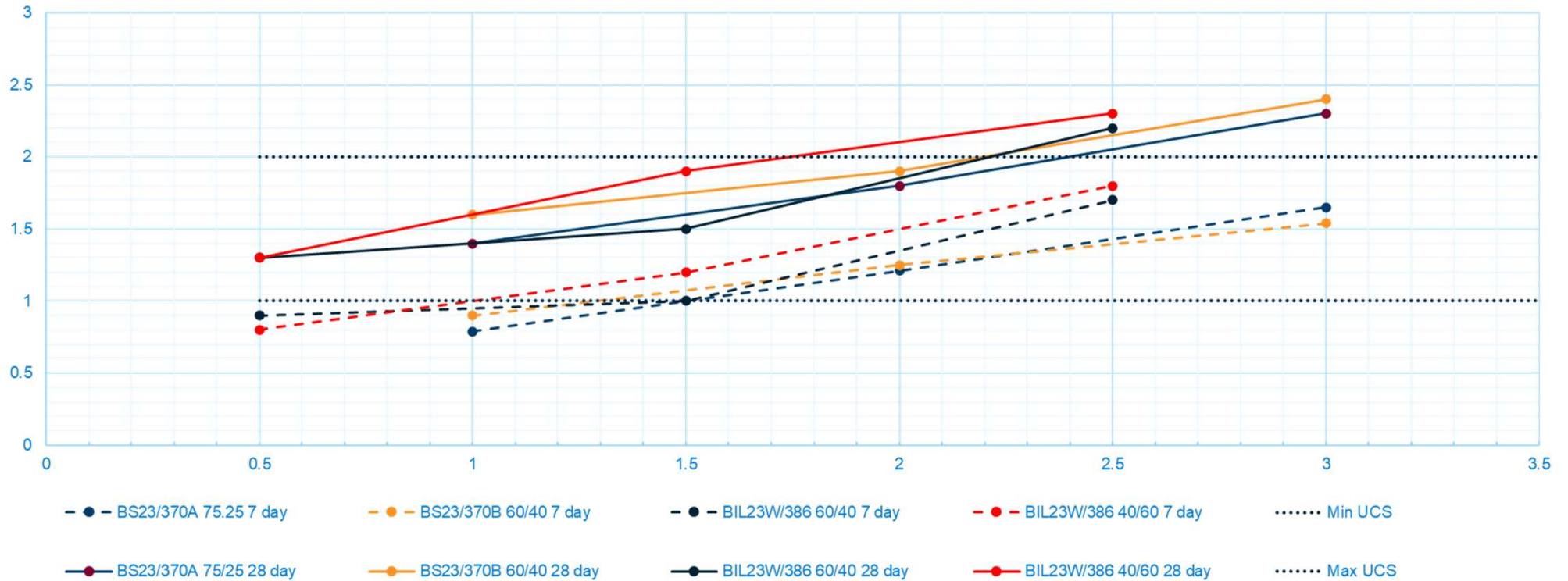


Australian Pavement Recycling and Stabilisation Conference
Designing for Reuse and Resilience
 Pullman King George Square, Brisbane • 7th August 2024



Phase 2: Field Trial – BVH Mix design

O24 BVH UCS



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Phase 2: Construction of Field Trial



Stabilising



Stabilising



Field UCS tests



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Phase 2: Construction of Field Trial



Stabilised 100% RCC



Final trim



Start of Final compaction with smooth drum



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Phase 2: Field Testing

- **Subgrade**

- Classification
- Soaked & unsoaked CBR
- Dynamic Cone Penetrometer (DCP).

- **Grading & Atterberg limits**

- Pre & Post compaction

- **Field UCSs**

- **Long term performance monitoring**

- Visual inspection
- Asset condition data
- Comparison with adjacent lane

- **Future Field Trials**

- Plant mixed
- Subbase; improved layers

- **For wider implementation, some challenges remain**

- Sourcing in-situ stabilisation sites close enough to Registered Recyclers
- Suitable support conditions
- Construction constraints around intersections
- Education of construction crews – Project Linked Training
- Weather
- Procurement requirements
- Field testing – time and distance constraints for field UCS testing



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Waste 2 Resource Strategy



1. Minimise disposal to landfill



2. Achieve resource efficiency through circular economy practices



3. Facilitate market growth



4. Reduce greenhouse gas emissions from waste generation and resource use

Source: TMR.



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

Department of Transport and Main Roads

TMR's Waste 2 Resource Strategy

Resource efficiency through circular economy practices to minimise waste generation and maximise resource recovery

The Department of Transport and Main Roads (TMR) plans, manages and delivers Queensland's integrated transport system for road, rail and sea.

The Queensland Government has committed in the *Waste Management and Resource Recovery Strategy* to a more sustainable future, with a focus on a circular economy. The *Waste 2 Resource (W2R) Strategy* is how TMR will achieve this commitment.

TMR recognises that reducing Queensland's waste and ensuring all products and materials are managed as valuable and finite resources are shared responsibilities between government, industry and the community.

TMR's W2R Strategy sets the strategic direction and intent to minimise wastes and achieve a more sustainable use of resources across the department. The W2R Strategy sits under TMR's *Environmental Sustainability Policy*.

Vision

TMR will become a zero waste organisation and transport industry leader through circular economy practices



Queensland Government

Source: TMR.



Pavement Recycling and Stabilisation Association

W2R Strategy pillars and NACOE024



1. Specifications – already permitted



2. Engagement & collaboration – ARRB; TMR E&T & Districts



3. Market engagement – understand processes and barriers



4. Procurement – encouraging use and fostering demand



5. Data collection and analysis – demonstrate performance



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

Source: TMR.



PROJECT #2 OUTLINE

Mechanical stabilisation of recycled crushed concrete with recycled crushed glass



Project initiation

Literature review

Scoping

Stakeholder
consultation



Laboratory study



Field
demonstration/
validation



Performance
monitoring



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Recycled crushed concrete

- The project was partially funded by the NSW EPA under the Civil Construction Market Program.
- Project uses two recycled materials:
 - Recycled crushed concrete
 - Recycled crushed glass
- Council receives large amount of C&D waste material from its own projects.
- Processed into DGB/DGS 20 under NSW EPA Resource Recovery Order 2014, Recovered Aggregate



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Recycled crushed glass



- Council collects approximately 8,500 tonnes of glass each year.
- Small pieces of glass are much trickier to recycle, potentially useable material that usually goes to waste.
- Potential to be incorporated into asphalt, concrete, etc.
- Great possible solution to the issue of wastage.
- Cost-effective option providing sustainable outcomes for our community.



**Australian Pavement Recycling
and Stabilisation Conference**

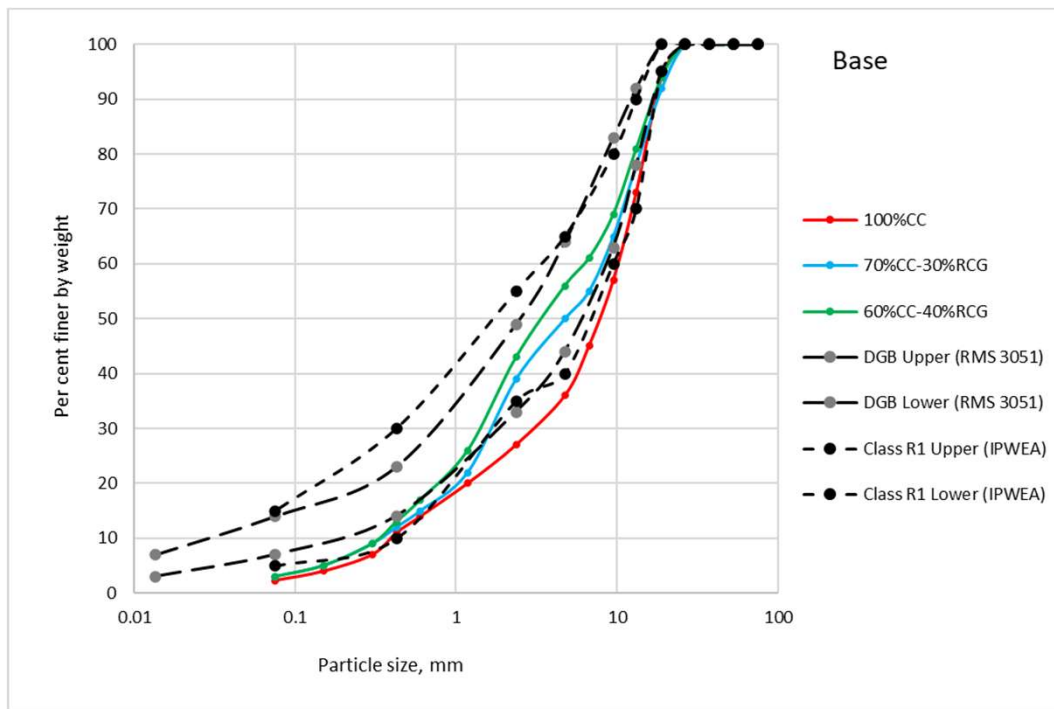
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Gradings from materials blending

Grading of raw materials



- 100 % recycled crushed concrete has poor grading
- Grading improvements with increased recycled crushed glass content
- Grading improvements lead to:
 - Compaction improvements
 - Performance improvements



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Permanent deformation testing

Assessment of granular material blends performance



Austrack (Extra-large Wheel tracker)



Sample preparation



Trafficking



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

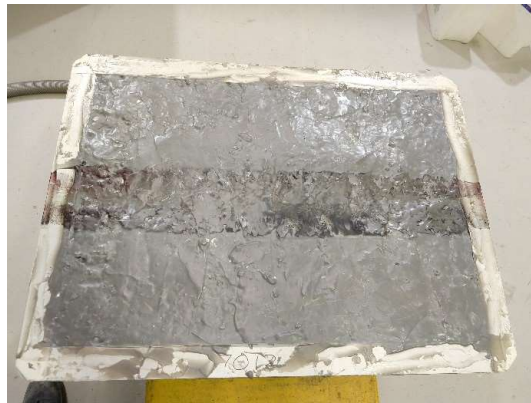
Pullman King George Square, Brisbane • 7th August 2024



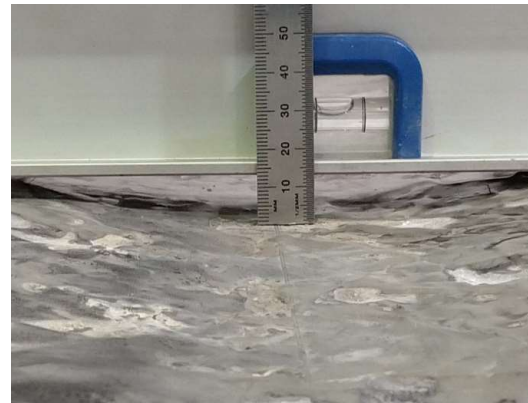
100% Recycled Crushed Concrete



Surface after compaction



Sealed surface after wheel tracking



Sealed surface after wheel tracking



View from the right side when unmoulding



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

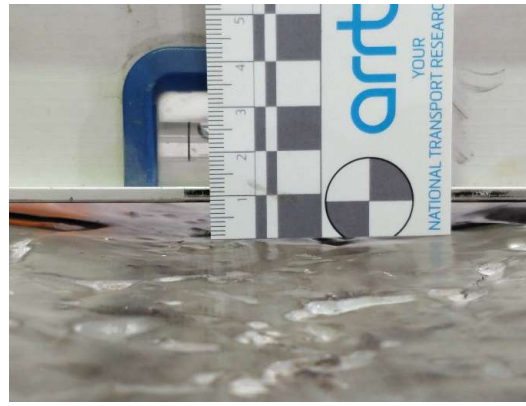
70% Recycled crushed concrete – 30% Recycled crushed glass



Surface after compaction



Sealed surface after wheel tracking



Sealed surface after wheel tracking



View from the right side when unmoulding



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

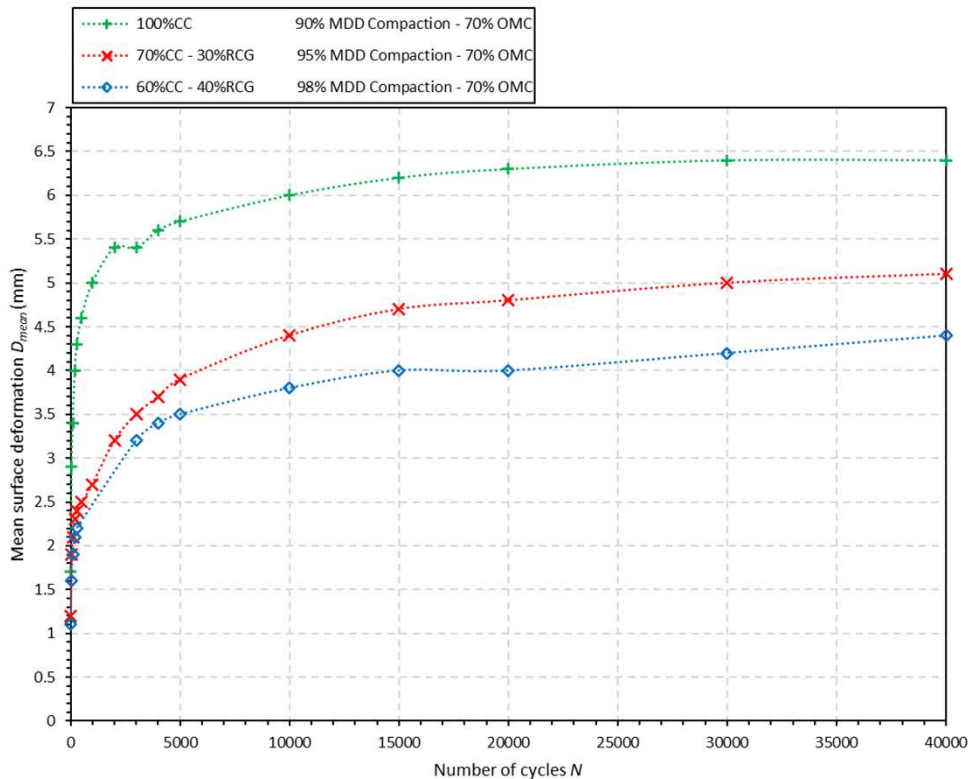
Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Permanent deformation performance

Rut Depth Comparison



- Samples tracked to minimum 40,000 cycles.
- Decreased rut depth seen with greater recycled crushed glass content.
- Increase recycled crushed glass content leads to improved compaction and improved rutting performance.
- All well within acceptable range.



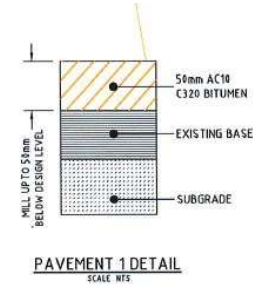
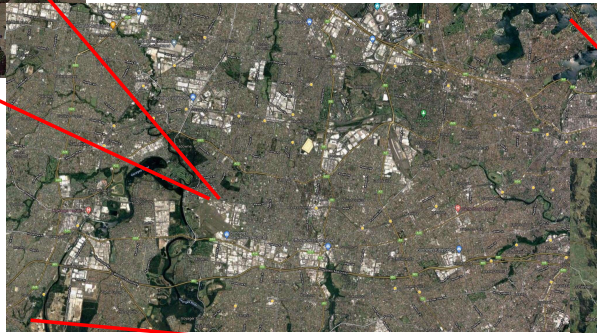
**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

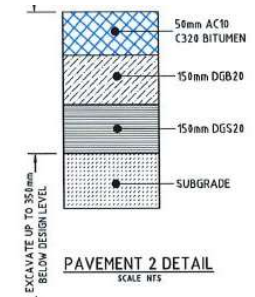
Pullman King George Square, Brisbane • 7th August 2024



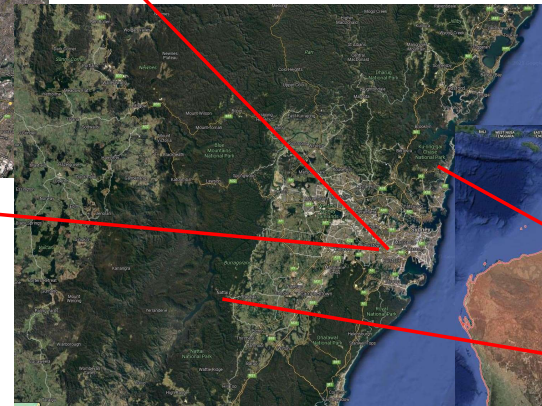
Field trials



Existing structure



New structure – incorporating recycled materials



- The move to sustainable materials solutions for Local Government Authorities



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

Construction of field trial

- Marion Street in City of Canterbury Bankstown on Sydney, NSW



**Australian Pavement Recycling
and Stabilisation Conference**

Designing for Reuse and Resilience

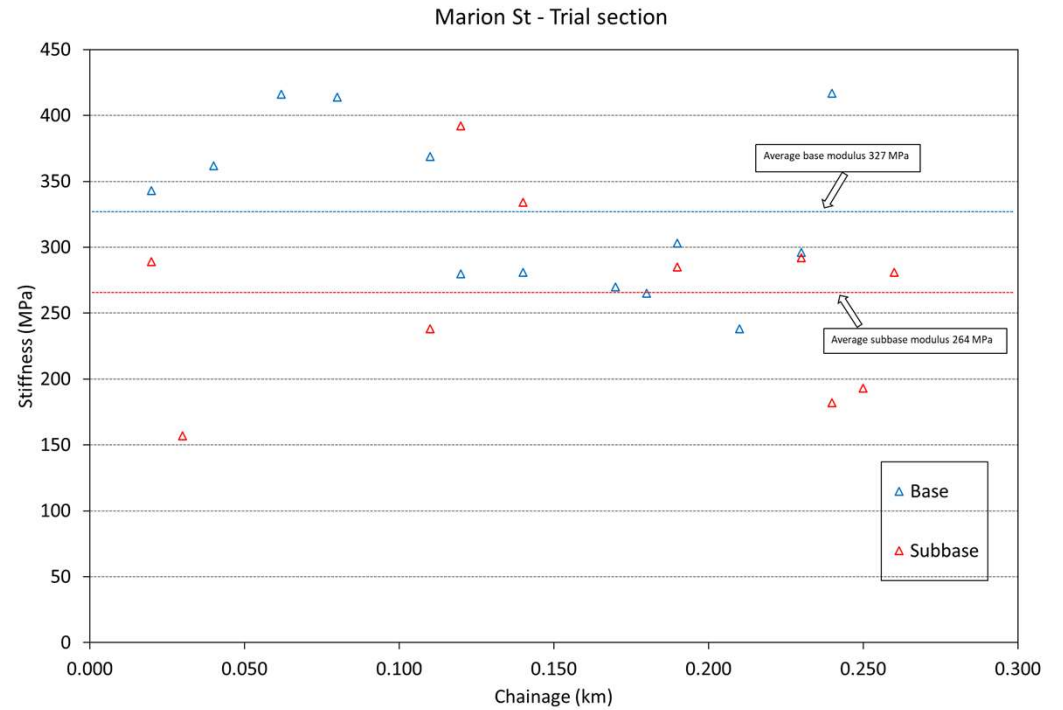
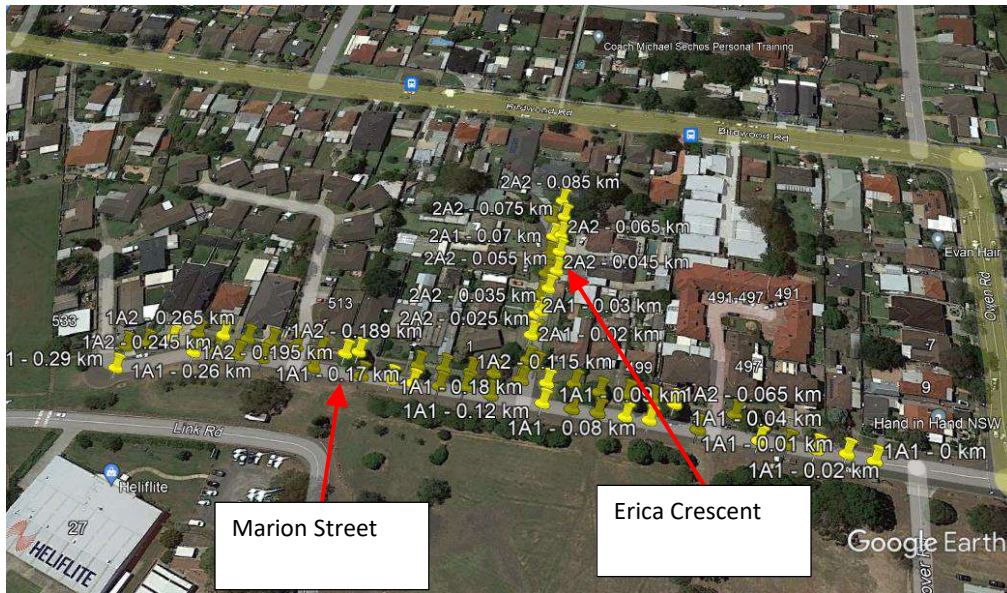
Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Performance monitoring

- Initial results of performance assessment



Australian Pavement Recycling and Stabilisation Conference

Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024



Pavement Recycling and Stabilisation Association

Acknowledgements



Peter Stephenson, Rutuza Patil
Canterbury Bankstown City Council

Paul Morassut
Fulton Hogan

Funding from New South Wales EPA

