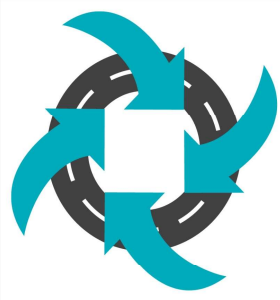


Sustainability Assessment Tool (SAT)

Brook Hall, Principal Transport Economist

Life Cycle & Economic Analysis Portfolio Leader

Australian Road Research Board (ARRB)



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Collaborative Research & Development



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Queensland Government

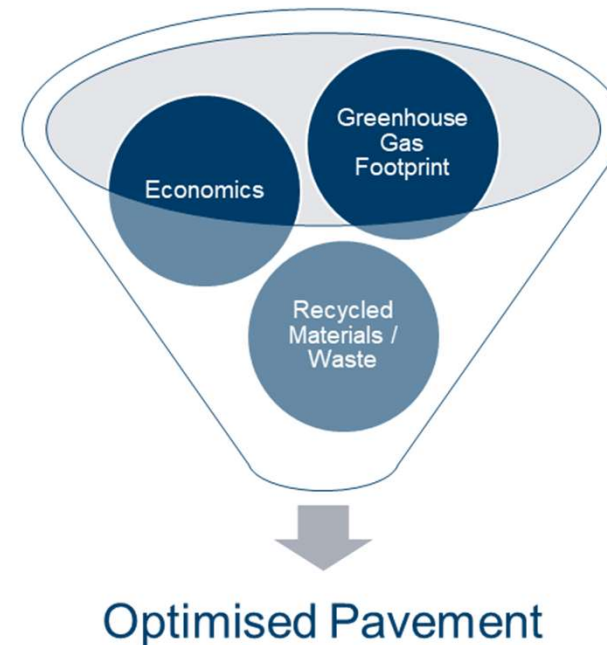
PROJECT SPONSORS



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Background

- NACOE and WARRIP research programs delivered innovations in pavement materials and technologies
- Poor uptake by industry
- Foundational research project (for NACOE) indicated pavement innovations provide both economic and environmental wins
- Sustainability could be one driver to increase uptake



Purpose

- Develop and release an online lifecycle analysis tool for the comparative assessment of pavement options
- Enhance the adoption of pavement technology research and innovation



Scope

Cradle-to-grave lifecycle assessment



Extraction and production of materials



Construction



Maintenance



Operations (including use phase)



End of life (emissions and waste outputs)



Material haulage



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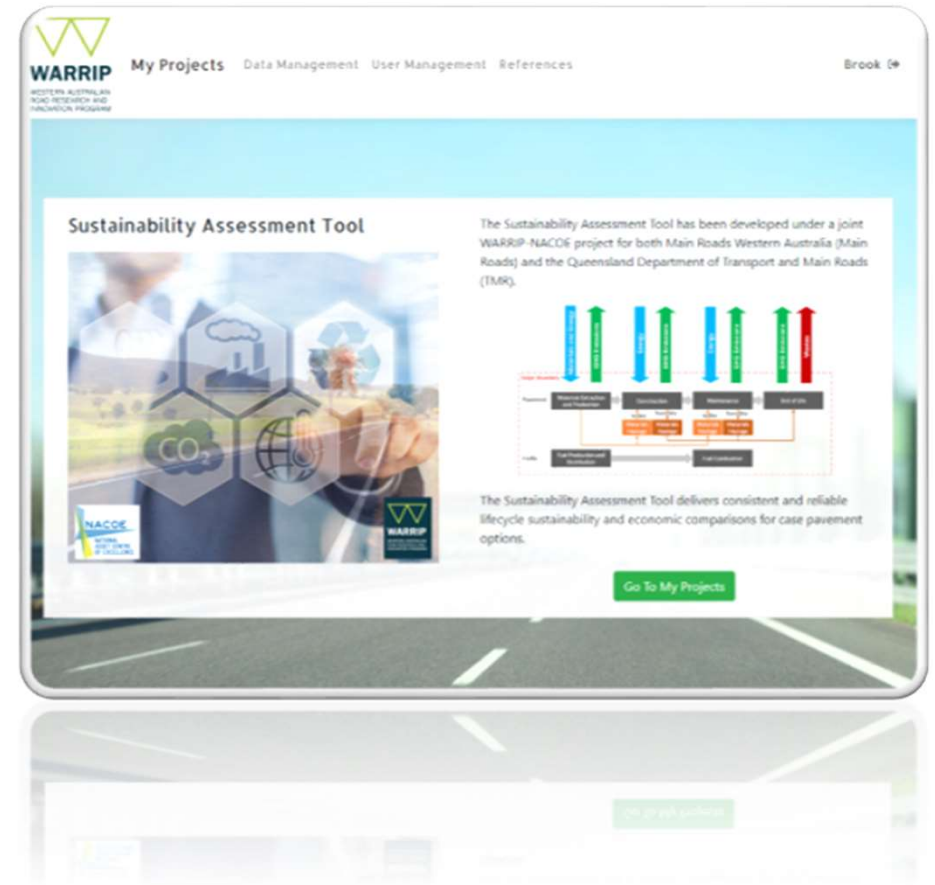
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Key features

- User-friendly web-based interface
- Tailored, flexible and customisable
- In-built guidance tips



Key features

- Build your own pavement layer by layer
 - Constituent materials (85+)
 - Pavement products (~120)
- Construction & maintenance
- Built-in/customisable maintenance data, incl. concrete placement and stabilisation
- Use phase
 - Built-in fuel use models.
 - Sensitive to traffic, alignment & deterioration

The screenshot shows a software interface for pavement design. At the top, there are seven numbered tabs: 1. Pavement Design (selected), 2. Construction, 3. Maintenance, 4. End of Life, 5. Transport, 6. Use Phase, and 7. Sensitivity. Below the tabs, the 'Pavement Design' section is active, showing 'Pavement Name: Dense Graded Asphalt'. The 'Layers' section contains a table with three layers, and the 'Visualisation' section shows a vertical bar chart of the pavement profile.

Layer	Description	Thickness	Pavement Products
1	Surface 50mm dense grade asphalt (AC14H(A15E))	50 mm	<ul style="list-style-type: none"> 14 mm Crushed Aggregate (94.5%) A15E (4.5%) Hydrated Lime (1%) <p>Target Density: 2325 kg/m³ Calculated Density: 1562.9 kg/m³ Density Adj. Factor: 148.8%</p>
2	Intermediate 50 mm dense grade asphalt (AC14H(A15E))	50 mm	<ul style="list-style-type: none"> 14 mm Crushed Aggregate (94.5%) A15E (4.5%) Hydrated Lime (1%) <p>Target Density: 2325 kg/m³ Calculated Density: 1562.9 kg/m³ Density Adj. Factor: 148.8%</p>
3	Base 195 mm dense grade asphalt (AC20H(C600))	195 mm	<ul style="list-style-type: none"> 20 mm Crushed Aggregate (94.7%) C600 (4.3%) Hydrated Lime (1%) <p>Target Density: 2325 kg/m³ Calculated Density: 1563.2 kg/m³</p>

The 'Visualisation' section shows a vertical bar chart representing the pavement profile. The y-axis ranges from 0 mm to 650 mm. The chart shows three distinct layers: a top layer (orange) from 0 to 50 mm, a middle layer (red) from 50 to 150 mm, and a bottom layer (dark blue) from 150 to 345 mm. A legend on the right identifies the layers: Layer 1: 50mm dense gr (orange), Layer 2: 50 mm dense gr (red), Layer 3: 195 mm dense g (dark blue), Layer 4: Single/single ag (purple), Layer 5: Single/single bit (green), Layer 6: ACM0 (light blue), Layer 7: 150 mm Type 2 (yellow), and Layer 8: 170 mm CBR 7 (grey).



Stabilisation products and processes

Construction Process:

In-situ Stabilisation (Bitumen)

In-situ Stabilisation (Bitumen) error based on diesel usage. Processes (57l/hr), one spreader truck (12.4 (12.47l/hr), one water truck (12.4 and one Class 110 grader (17l/hr (3.19l/m3) Assumptions: • Ongoing (10hrs/day) and no significant cost Excludes: • Emissions or by product Mobilisation and demobilisation pump/portable water tower, generator material to site.

+ Custom Process

Manufacturing Process:

+ Custom Process

Stabilised Material - Manufacture - Cement

-- SELECT --

Concrete - Manufacture

Hot Mix Asphalt - Manufacture

Stabilised Material - Manufacture - Bitumen

Stabilised Material - Manufacture - Cement

Warm Mix Asphalt - Manufacture

transportation • energy and plant use. Wastewater and some solid wastes are considered. Assumptions: • Concrete production is based on ready-mix concrete production in Australia • Amount of cement is adopted as per the Green Building Council of Australia (GBCA). Exclusions: • Administration, Site office, water pump/portable water tower, generators, etc. • Dust • Transporting concrete to the site.

Data Management - Product Library

Show 10 entries

Search: stab

Description

MRTS07A

In-situ stab using Lime (Unbound granular, modified granular and stabilised)

- Hydrated Lime (6%)
- In-Situ Material (94%)

MRTS07B

In-situ stab using cement (Unbound granular, modified granular and stabilised)

- Type GP Cement (1.5%)
- Fly Ash (1%)
- In-Situ Material (97.5%)

MRTS07C

In-situ stab using foamed bitumen (Unbound granular, modified granular and stabilised)

- C170 (3%)
- Hydrated Lime (1.5%)
- In-Situ Material (95.5%)



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









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Concrete pavement products and maintenance

MRTS40	
Jointed unreinforced concrete base (PCP) (Asphalt or Concrete - 2000 kg/m ³)	 
<ul style="list-style-type: none"> Type GP Cement (13%) Fly Ash (4%) Crushed Rock (55.3%) Natural Sand (27.7%) 	
Continuously reinforced concrete base (CRCP) (Asphalt or Concrete - 2200 kg/m ³)	 
<ul style="list-style-type: none"> Type GP Cement (13%) Fly Ash (4%) Crushed Rock (54%) Natural Sand (27%) Steel (Reo) (2%) 	
Jointed reinforced concrete base (JRCP) (Asphalt or Concrete - 2150 kg/m ³)	 
<ul style="list-style-type: none"> Type GP Cement (13%) Fly Ash (4%) Crushed Rock (54.7%) Natural Sand (27.3%) Steel (Reo) (1%) 	
Steel fibre reinforced concrete base (SFRC) (Asphalt or Concrete - 2200 kg/m ³)	 
<ul style="list-style-type: none"> Type GP Cement (13%) Fly Ash (4%) Crushed Rock (53.3%) Natural Sand (26.7%) Steel fibre (3%) 	

Data Management - Maintenance Schedules	
Show 25 entries	Search: <input type="text"/>
Maintenance Schedule	 
Full depth asphalt 20 year design life DGA or SMA surfacing	 
Full depth asphalt 20 year design life OGA surfacing	 
Full depth asphalt 30 year design life DGA or SMA surfacing	 
Full depth asphalt 30 year design life OGA surfacing	 
Lightly Bound 20 year design life DGA or SMA surfacing	 
Lightly Bound 20 year design life OGA surfacing	 
Lightly Bound 20 year design life spray seal surfacing	 
Unbound 20 year design life DGA or SMA surfacing	 
Unbound 20 year design life OGA surfacing	 
Unbound 20 year design life spray seal surfacing	 
Foamed Bitumen 20 year design life DGA or SMA surfacing	 
Foamed Bitumen 20 year design life OGA surfacing	 
Foamed Bitumen 20 year design life spray seal surfacing	 
Plain Concrete 30 year design life concrete surfacing	 
Continuously reinforced concrete 30 year design life concrete surfacing	 
Continuously reinforced concrete 30 year design life DGA and SMA surfacing	 
Steel-fibre reinforced concrete 30 year design life concrete surfacing	 
No maintenance	 
Custom	 



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Capability

Compare innovative pavement design options

Alternative Case 1 to Base Case Comparison

[Overview](#)
[GHG Emissions](#)
[Materials Overview](#)
[Economic Outputs](#)
[Pavement Design](#)

Overview

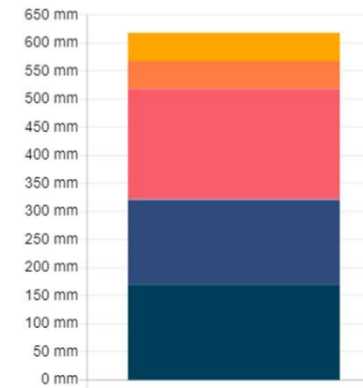
Lifecycle Emissions (tCO ₂ eq):	94,711	- 34
Lifecycle costs, including GHG emission costs (\$PV):	\$3,607,624	-\$2,976
Lifecycle GHG emission costs only (\$PV):	\$2,417,947	-\$1,866
Use Phase Emissions (%):	99.71%	+ 0.04%

[Overview](#)
[Materials Overview](#)
[Emissions by Scope](#)
[Pavement Design](#)

Pavement Design

Base Case Pavement Design: [🔗](#)

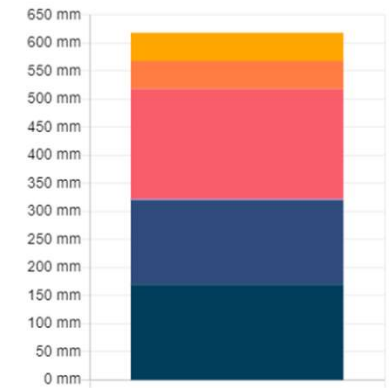
Total thickness: 619 mm



- Layer 1: 50mm dense grade asphalt (AC14H(A15E))
- Layer 2: 50 mm dense grade asphalt (AC14H(A15E))
- Layer 3: 195 mm dense grade asphalt (AC20H(C600))
- Layer 4: Single/single aggregate
- Layer 5: Single/single bitumen
- Layer 6: ACM0
- Layer 7: 150 mm Type 2.3 unbound granular material
- Layer 8: 170 mm CBR 7% select fill

Alternative Case Pavement Design: [🔗](#)

Total thickness: 619 mm



- Layer 1: 50 mm dense graded asphalt with 15% RAP
- Layer 2: 50 mm dense graded asphalt with 15% RAP
- Layer 3: 195 mm dense graded asphalt with 30% RAP
- Layer 4: Single/single aggregate
- Layer 5: Single/single bitumen
- Layer 6: ACM0
- Layer 7: 150 mm Type 2.3 unbound granular material
- Layer 8: 170 mm CBR 7% select fill



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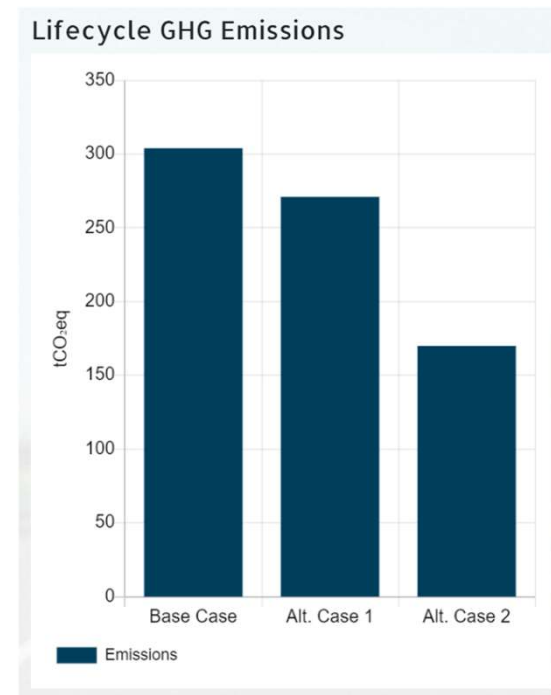


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Lifecycle assessment outputs

Sustainability

- Lifecycle GHG emissions (tonnes CO₂-e)
- Other air-pollutants
- Energy use
- Water use
- Material quantities (tonnes)
- IS Enviropoints



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Lifecycle assessment outputs

Economic

- Costs (\$ Net Present Value)
- Calculates the whole-of-life economics of pavement options
- Sensitivity analyses
- Costings based on materials, construction methodology, maintenance, residual asset value, carbon price.



Key messages

- Developed by TMR, Main Roads WA and ARRB to the benefit of industry to:
- Support adoption of new technologies and materials
- Reduce GHG emissions & other environmental impacts
- Achieve economic sustainability goals
- Improve their long-term investment decision-making
- Evaluate new and innovative pavement designs consistently and reliably.



Summary

The SAT is:

- Unlike any pavement assessment tool currently being used in the industry right now/ competitor products lack the precision and flexibility
- Assesses the environmental impacts and benefits of innovative pavement designs in a consistent and user-friendly way
- Aligned with Infrastructure Sustainability Council (ISC)'s ratings process and requirements



QUESTIONS





THANK YOU

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