USC Airport Pavement Research Program

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Introduction

• What is the APRP?
• Why is there an APRP?
• Where is it up to?
• What has it done?
• How has this helped?
• What is the cost-benefit?
• What is the future?
What is the APRP?

• University-based research program
• Funded by the airport industry
• Airport pavements and associated topics
• Practice and technology upkeep
• Mandatory focus
  • Applied research
  • Implementation into practical
  • Education of the next generation
  • Represent the industry
What is the APRP?

• Director – Greg White
• Post-doctoral researcher – Ali Jamshidi
• Collaborators
• Students
  • Four PhD researchers
  • Eight Master of Science/Engineering researchers
  • Range of final year civil engineering undergraduates
• Industry partners
Why is there an APRP?

• Up to the 1990s
  – Department of Housing & Construction
  – Department of Civil Aviation
  – Federal Airports Corporation

• Since privatisation
  – No structured R&D
  – No centralised practice upkeep

• Everything else has changed
  – Aircraft wheel loads and tyre pressures
  – Bitumen and other materials
  – Performance expectations and legalities
Why is there an APRP?

• Who does the Research and Development?
  • Consultants?
    – Not paid to research
    – No return on investment
  • Government?
    – The ‘S’ in CASA is for ‘SAFETY’
    – Outside of their brief
  • Construction industry?
    – Conduct significant R&D
    – Only where there is commercial advantage
Where is it up to?

• Greg White started in 2016
• Official launch in 2017
• Sunshine Coast, Perth and Defence
• Others wanted evidence of success
• Others wanted a return on investment
• First five years of funding now ending
• Defence extension is imminent
• And we now have a track record and an RoI
What has it done?

• Representation
  • ICAO Airport Pavement Expert Group
  • ICAO Friction Task Force
  • Australian Standards committees

• Australian Airports Associations
  • Series of webinars
  • Pavement Working Group
  • MOS 139 review industry group
  • P&L Forums and Workshops
  • Practice Notes

• Students
  • Sean Jamieson – Stone mastic for runways
  • Tom Weir – Foamed bitumen characterisation
  • Roberto Espinosa – Marginal material use
  • Demi van den Heuvel – Sustainability (CPEE)
  • 36 USC final year engineering students

• Publicly available research outputs

<table>
<thead>
<tr>
<th>Calendar year</th>
<th>Journal articles</th>
<th>Conference papers</th>
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<tbody>
<tr>
<td>2016</td>
<td>8</td>
<td>7</td>
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<td>2017</td>
<td>6</td>
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<td>2018</td>
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<td>2019</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>2020</td>
<td>8</td>
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</tr>
</tbody>
</table>
What has it done?

- Dubbo airport
- Emerald airport
- Sunshine Coast airport
- Brisbane airport
- Whitsunday Coast airport
- Shellharbour airport
- Rockhampton airport
- Defence airfields
- Brisbane City Council
- Sunshine Coast Council
- Perth airport
- Western Sydney airport

- AAA
- Downer
- Boral
- Colas
- Fulton Hogan
- BMD
- LendLease
- CASA
- ATSB
- AfPA
- AustStab
- ARRB TR
- ICAO
- FAA
How has it helped?

• Performance-related asphalt specification
  • Dubbo airport
  • Whitsunday Coast airport
  • Rockhampton airport
  • Weipa airport
  • Cairns airport
  • Norfolk Island airport
  • Perth airport (taxiways)
  • Darwin airport (aprons extension)
  • Emerald airport
  • Shellharbour airport
  • Groote Eylandt airport
  • Cessnock airport (runway)

• Warranted protection against major failures
• Balance of risk with industry
• Practical and achievable tolerances
• Joint heaters
• Recycled asphalt
• Proprietary products
• Better surface bond
• National consistence
• Modern ‘best practice’ approach
How has it helped?
How has it helped?

• Sprayed sealing specification
  • Dubbo airport (cross runway)
  • Dubbo airport (taxiways)
  • Mudgee airport
  • Orange airport
  • Narrandera airport
  • Three ALAs near Roma
  • Archerfield airport
  • Parkes airport (runway)
  • Parkes airport (taxiway and apron)
  • Merimbula airport
  • Cessnock airport (taxiways)

• Collaborative with industry
• Reflects a ‘best practice’ approach
• Balance of performance and efficiency
• Commentary
• Standard design catalogue
• National consistence
How has it helped?
How has it helped?

• Ungrooved stone mastic asphalt for runways
  • Emerald airport
  • Shellharbour airport
  • Where next?

• Draft specification development
• Laboratory trials (7 mixes, four contractors)
• Field trial (RAAF Amberley taxiway)
• Pilot project at Emerald airport
• Costs ±2% but expected to last 4-6 years longer
How has it helped?

Surface texture

Runway Friction
How has it helped?

• Recycled asphalt for airports
  • Low risk recycled asphalt (RAP) sources
  • Better grading than new aggregate
  • Significant reduction in new aggregate
  • Small reduction in bituminous binder
  • No reduction in surface performance
  • Greatest sustainability benefit in asphalt surfacing
  • Around 5,000 tonnes of material savings to date
### How has it helped?

<table>
<thead>
<tr>
<th>Asphalt Property</th>
<th>Mixture P</th>
<th>Mixture D</th>
<th>Mixture R</th>
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<tbody>
<tr>
<td></td>
<td>No RAP</td>
<td>With RAP</td>
<td>No RAP</td>
</tr>
<tr>
<td>Marshall Stability (kN)</td>
<td>19.1</td>
<td>16.5</td>
<td>13.6</td>
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<tr>
<td>Marshall Flow (mm)</td>
<td>3.2</td>
<td>2.5</td>
<td>2.8</td>
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<tr>
<td>Resilient Modulus (MPa)</td>
<td>4,062</td>
<td>5,018</td>
<td>5,002</td>
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<tr>
<td></td>
<td>4,899</td>
<td>5,134</td>
<td>5,089</td>
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<tr>
<td></td>
<td>4,350</td>
<td>5,155</td>
<td>5,382</td>
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<tr>
<td>Fatigue life (cycles)</td>
<td>&gt;1,000,000</td>
<td>&gt;1,000,000</td>
<td>&gt;1,000,000</td>
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<tr>
<td></td>
<td>&gt;1,000,000</td>
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<td>&gt;1,000,000</td>
<td>&gt;1,000,000</td>
<td>&gt;1,000,000</td>
</tr>
<tr>
<td>Wheel track rutting (mm)</td>
<td>1.9</td>
<td>1.4</td>
<td>1.5</td>
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<tr>
<td>Tensile Strength Ratio (%)</td>
<td>97</td>
<td>96</td>
<td>97</td>
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How has it helped?

• Non-destructive testing
  • Laser scanner for sand patch texture – efficient for large tasks
  • Gauges for density cores – around 2,000 cores avoided to date
  • FWD for PCN – saving airports from erroneous strength rating
How has it helped?

Laser meter

FWD for PCN

5% ile value
PCN = 12

Gauge density
How has it helped?

• Better concrete pavements
  • Sahar Deilami – reflecting cracking when overlaid
  • Sean Jamieson – joints and their load transfer efficiency
  • Western Sydney Airport – post tensioned concrete aprons
  • Brisbane airport and BMD – alternates to flexural beams
  • Undergraduate students – recycled glass and plastic for sand
What is the cost-benefit?

- High return on investment
- Independent assessment by Cadre Capital Partners
- Based on
  - 40-year pavement lifecycle
  - 40 years of investment (cost)
  - But only 5 years of outputs (benefits)
- Monetised value of
  - Reduce cost to build/maintain
  - Longer life
- Intentionally conservative assumptions
- Whole of life cost with and without the USC APRP
- Average return of $19.50 (per $ invested)
What is the cost-benefit?

Available benefit per $ spent on APRP

- All of industry
- Capital city airport
- Major regional airport
- All civil airports
- Department of Defence

- $0
- $5
- $10
- $15
- $20
- $25
What is the future?

• Five year extension with Defence support
• Seek support from other major airports
  • Five years of track record
  • Significant outcomes
  • Demonstrated return on investment
• Construction of a specialist laboratory
• More students, More research, More outcomes, More benefit
What is the future?

• Ongoing research activities
  • Asphalt preservation trials – Defence
  • Microsurfacing for regional airports – specification with AfPA
  • Foamed bitumen for airports – specification with AustStab
  • Accelerated asphalt sample ageing – Ahmed Abouelsaad (PhD)
  • Sustainability in pavements – Defence and a PhD student
  • Evolution of runway friction
  • Proof rollers for crushed rock and thick sand fills – Hudson Anstee
  • Better asphalt joints and density testing
What is the future?

• Many PhD and Masters opportunities
• Available student research projects
  • Asphalt preservation trials
  • Recycled materials in concrete
  • Airport concrete pavement modernization
  • Recycled in airport concrete
  • Asphalt joints and density
  • Evolution of runway friction
  • Performance specification of crushed rock base course
Conclusions

• Airport Pavement Research Program is now four years old
• Filling the gaps left by Government
  – Specification of materials
  – Modernisation of practice
  – Low risk recycled for sustainability
  – Education of a new generation
• Reliant on ongoing funding by industry
• Range of opportunities to get involved
• Improving practice to shape the future
• Provide a return to the industry
QUESTIONS?