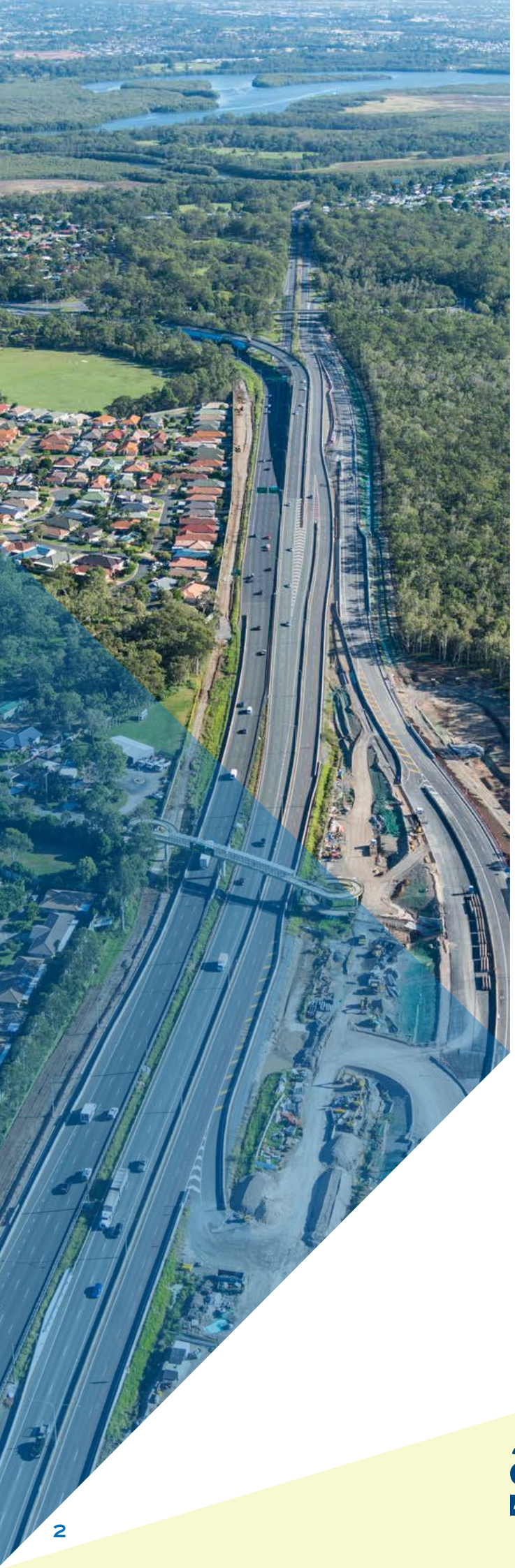
NACOE

NATIONAL ASSET CENTRE OF EXCELLENCE

HIGHLIGHTS REPORT

2016-2017

AN INITIATIVE BY: Queensland Government arrb AUSTRALIAN ROAD RESEARCH BOARD



To contribute to lower-cost, quality infrastructure through knowledge and research

arrb
AUSTRALIAN ROAD RESEARCH BOARD

Queensland Government

OUR MISSION

NACOE will drive savings and enhance national technical capability in transport and roads asset engineering through:

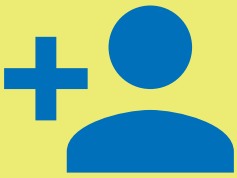
- unlocking innovation
- implementing international best practice
- translating new knowledge into practice

STRATEGIC OBJECTIVES

COST SAVINGS

Delivering economic benefits to the Queensland network through cost-effective innovation and higher performing pavements, refined asset management practices, efficient management of structures and by optimising road safety and network operation outcomes

COLLABORATION



Working in partnership with industry, universities and government bodies to leverage research and resources, helping to deliver mutually beneficial outcomes

DEVELOPMENT

Developing the capabilities of staff and disseminating learnings to regions

IMPLEMENTATION

Facilitating demonstration projects, establishing research tools and infrastructure to help implement new technologies and practices in Queensland

FOREWORD BY NACOE BOARD

NATIONAL ASSET CENTRE OF EXCELLENCE (NACOE)

The NACOE Board

Miles Vass

Julie Mitchell

This report outlines the considerable progress that NACOE is continuing to make in delivering applied research in Queensland.

The board has now changed its governance arrangement to rotating the chair between Queensland Department of Transport and Main Roads and ARRB. However, the strong focus on project benefit realisation, both in initial project selection and implementation, which was ingrained by the previous independent chair, Mr Neil Doyle, has continued under the new governance arrangements.

The board has also continued its strong focus on collaboration, and is now working closely with Main Roads Western Australia and Austroads to develop programs of complementary projects for NACOE.

Now that the program is in its fifth year, the strong focus is on implementing the findings of the completed projects from its first four years, to realise on the benefits of the investment.

Some of the notable implementation highlights which benefited from NACOE research include:

- The placement of ever increasing quantities of high modulus asphalt – EME2 – on significant projects in Queensland. Use of this asphalt on the Gateway Upgrade North (GUN) project involved the placement of 10,000 T of EME2, representing the largest use of this innovative product in Australia to date. Also, a current project on the Brisbane Port Access Road is using 50,000 T of EME2, and further large scale applications are currently being planned. We now expect that EME2 will rapidly take over as the main structural asphalt in Queensland.
- Increased use of recycled crumbed rubber in reseals in Queensland. The use of crumbed rubber reseals in South West Queensland involved cartage of considerable volumes of binder up to 1000 km away from Brisbane. This

project was honoured with an award for the best innovation at the National Australian Asphalt Pavement Association awards in Melbourne in 2017. As well as improving the durability of bitumen seals, use of crumbed rubber in sealing and asphalt work provides a beneficial application for waste tyres, which are otherwise stockpiled or burnt.

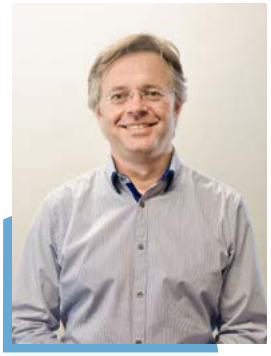
- Increased use of innovative foam bitumen stabilisation to improve pavement resilience when subjected to flooding.

The investment in NACOE research by the Department of Transport and Main Roads is a rolling program with a five year commitment. This investment, which is growing at $200,000 per year, reached $3.6M in 2016/17. This report demonstrates that this investment has been well targeted and effective, and the realised savings are increasing. It is notable that of the 109 projects which have commenced, over 59 have been completed, with many of these now fully implemented and delivering value for Queensland.

We would finally like to acknowledge the contribution of the departing board member, Garry Warren as well as the departing Agreement Manager, Carlos Rial from the Australian Road Research Board.

The NACOE Board

Peter Damen



Arjan Rensen

BENEFITS OF NACOE

90%
Projects completed

>10
Agency Benefit/cost ratio

35
Publications developed
including Technical Notes and Specifications

NACOE is continuing to deliver strong economic and sustainability benefits to the department and broader Queensland community. The program has delivered many high value research projects since it started in 2013. Some of the key benefits of NACOE to-date include:

- a significant reduction in the thickness of heavy-duty asphalt pavements that has led to savings in construction costs, construction time and material, which in turn has sustainability benefits to the community
- environmental benefits through the increased use of crumb rubber in sprayed seals
- reduced ongoing agency costs as a result of improved whole-of-life transport solutions
- improved asset management practices that have resulted in reduced agency and road user costs
- improved risk management practices for the planning, design and maintenance of transport infrastructure
- an improved understanding of the behaviour of bridges under live traffic loading, resulting in possible cost savings due to the deferment of strengthening or replacement projects
- improved guidance to the department for reducing crash risks on Queensland roads.

An economic analysis undertaken in year three of the NACOE research program suggested that a number of key projects delivered to-date have the potential (depending on implementation) to save the department between $130 million and $290 million. The same study estimated a benefit/cost ratio greater than 10, which is typically in the upper range of similar international programs.

However, the key to realising these savings is ensuring that the findings of NACOE are widely implemented across Queensland. The department has therefore placed an emphasis on implementation and is currently exploring ways to facilitate rapid uptake of the research findings.

The benefits of NACOE will continually be monitored in future to ensure that the department allocates its research funding in areas that will continue to make a real difference to Queensland.

FUTURE DIRECTION

The early years of the NACoE program focussed on projects with strong prospects of direct cost savings to the department and community and achieving 'quick wins'. As the program matures, more emphasis will be placed on:

- implementing research into practice
- collaborative research with external partners, such as other road agencies and industry organisations
- knowledge dissemination through workshops, seminars/webinars and technical papers
- capacity building and development of research talent through retention of expert personnel, further education, secondment opportunities and student internships.

The department has relocated its Pavements and Geotechnical teams, together with a 'world-class' material laboratory, to Pinkenba in Brisbane. ARRB is currently exploring opportunities to co-locate its Accelerated Loading Facility with the department, which will truly transform this facility into a National Centre of Excellence for pavements research. This facility will be open to industry and universities and facilitate innovation across the pavements industry.

CLIENT FEEDBACK

The 2016-17 client feedback survey indicated strong levels of ongoing support for the program with all the respondents indicating that the projects continue to deliver value for money to the department. The survey results also highlighted the excellent communication within project teams, which is believed to be a major contributor towards the success of the program.

The feedback received highlighted the importance of delivering practical outcomes that are tailored to the department's needs.

100%
Believe projects delivered value for money

100%
Satisfied or very satisfied with project communication

85%
Satisfied or very satisfied with the responsiveness of the project team

85%
Satisfied or very satisfied with the level of knowledge of the project team

AWARDS AND ACHIEVEMENTS

Simon Harrison - The Queensland Department of Transport and Main Roads and Ann Turner - ARRB Board member

Thierry DeFrene - COLAS Australia, Cameron Nisbett - SAMI Bitumen Technologies and Carlos Rial - Australian Asphalt Pavement Association CEO.

HIGH RISK ROADS

The Queensland Department of Transport and Main Roads initiated the Higher Risk Roads process for developing project proposals for safety improvement projects that will reduce fatal and serious injury crash rates in Queensland.

The process for identifying and treating high risk road sections involve a network analysis, safety risk assessments, options analysis and a business case for the preferred options. As a result, this project improved the Queensland Department of Transport and Main Road's road engineering capability by improving road safety and developing strong relationships between regional staff and the central Safer Roads team in Brisbane.

This project won the Implementing Agency Applied Research Award at the Inaugural Australian Road Research Board Award Gala Dinner, held at the Melbourne Aquarium.

LONG HAUL S1.8R CRUMB RUBBER BITUMEN

The modification of bitumen with crumb rubber from truck tyres improves the bitumen properties so that sprayed seals are more durable and less prone to bleeding, cracking and stone loss. SAMI Bitumen Technologies and SRS Roads (COLAS) produced a crumb rubber bitumen which complied with Queensland Department of Transport and Main Road's S1.8R specification using crumb rubber extracted from old truck tyres. The "preblended" crumb rubber bitumen was formulated so that it would be storage stable during prolonged heating and transport. SAMI supplied the S1.8R bitumen from their Brisbane facility to various resealing sites across the South Western district of Queensland. The binder was transported up to 1100km without the rubber particles dropping out of suspension or the binder properties degrading during transport. The development of long haul crumb rubber bitumen means that more use can be made of these binders in resealing the rural road network outside Brisbane which in turn will lead to sustainable, performance and economic benefits to the Department of Transport and Main Roads. This new development is because of an ongoing NACOE project aimed at promoting the increased use of crumb rubber modified binder in Queensland.

This innovative product won the Australian Asphalt Pavement Association National Innovation award in 2017.

CAPABILITY DEVELOPMENT

The NACOE program has supported a number of important capability development opportunities and knowledge transfer activities, including:

- mentoring of a number of undergraduate pavements thesis, with Queensland University of Technology
- one secondment between ARRB and Queensland Department of Transport and Main Roads, with further secondments proposed for 2017-18
- two pavements webinars disseminating new knowledge outcomes achieved through NACOE
- multiple papers and presentations at conferences across Australia and overseas including the Queensland Department of Transport and Main Roads Engineering Technology Forum 2016, ARRB Conference 2016, International Conference on Managing Pavement Assets, World Congress in Intelligent Transport Systems 2016, Australian Asphalt Pavement Association Conference 2017
- 40 reports, presentations and papers available on the NACOE website

NACOE RESEARCH PROGRAM IMPLEMENTATION

The outputs of the NACOE research program are implemented in various ways by including the following outputs into departmental and national documents:

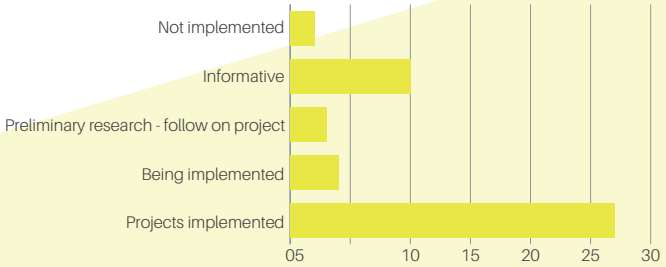
- technical notes
- design guides
- specifications (including supplementary specifications)
- implementation through demonstration road projects
- dissemination of learnings through presentations, seminars and webinars
- technical papers
- validating existing practice

The changes to technical notes, design guides and specifications may be minor or major, depending on the research outcomes. Where minor changes are required, issuing of the revised document may be withheld until a number of changes have accrued to warrant a new release. In addition, the release of revised documents may be conditional upon the synchronised release of other companion documents to avoid confusion and inconsistencies.

To date, of the 46 projects completed, 27 projects have been implemented in some form.

Many of the research findings can affect the way industry operates, hence before the release of revised documents, extensive consultation is often required. This involves internal agreement within the Queensland Department of Transport and Main Roads at all levels. Changes to industry might entail changes to work practices, new equipment purchases and training of personnel. During this consultation process, the documents may undergo further modification to incorporate the needs of industry. This consultation process can take some time, however it is a process where many of the barriers to adoption are removed before documents are released. Additionally, uptake of research is improved if stakeholders have been involved in the development process.

The Queensland Department of Transport and Main Roads is a member of Austroads, which undertakes research to develop nationally consistent guidelines. The work of NACOE and Austroads is often complementary to each other, whereby NACOE research further develops the Austroads findings to ensure that Queensland conditions and materials are fully considered and implemented. In many instances, the outputs from NACOE research have been fed through the various Austroads task forces and working groups, which then filter down into national documents. In some instances, an explorative study (typically comprising of a desktop study only) is undertaken to better understand the research need, benefits or application prior to progressing with a more in depth study. Where there is confidence in achieving a positive result, a follow-on project is often initiated.



COLLABORATION AND DISSEMINATION OF LEARNINGS

Collaboration with industry, universities and government bodies is one of the key strategic objectives for NACOE. The board believes that ongoing collaboration will allow the department to leverage off research and resources from other organisations, which in turn will deliver mutually beneficial outcomes to everyone involved. In 2016-17, NACOE worked closely with a number of external organisations, including:

- *The Queensland Department of Environment and Heritage Protection and Tyre Stewardship Australia* - to transfer crumb rubber modified technology to Queensland
- *The University of Queensland* - to undertake moisture monitoring of a trial pavement in South East Queensland
- *The Queensland University of Technology* – to undertake advanced laboratory testing of granular materials incorporating geosynthetic reinforcement layers
- *The University of Queensland (Queensland Alliance for Environmental Health Sciences)* – to undertake asphalt emissions monitoring during a demonstration project
- *The Central Queensland University* – to develop an innovative video analysis technique that allows vehicle paths to be tracked
- *The Western Australia Road Research and Innovation Program* – to transfer crumb rubber modified open graded asphalt and EME2 to Western Australia
- *The University of Queensland Structures Laboratory* – to undertake advanced laboratory testing on bridge deck and kerb units.
- *University of the Sunshine Coast* – to undertake advanced asphalt testing on EME2 samples.
- *The University of Queensland* – to explore potential applications for spinifex (a locally available nano-fibre) in road construction

It is believed that these collaborations are one of the key success factors of the NACOE research program and will continue in future years.

Another important strategic objective of NACOE is ongoing development through the dissemination of learnings to industry and the regions. Some key dissemination actives undertaken in 2016-17 include multiple presentations at the department's Technology Forum, a pavement webinar and seminar to present the new approach for designing heavy duty asphalt pavements in Queensland, as well as preparing technical papers for local and international conferences.

PAVEMENTS

The Pavements Program represents the largest proportion of the NACOE program, with approximately half the total projects and half the total investment. This program is focused on delivering engineering best practice across:

- asphalt
- road surfacings
- unbound granular and marginal materials
- stabilised/modified pavements
- several sustainability and innovative technology projects (including alternatives to traditional pavement materials).

When implemented, findings from this research have the potential to deliver significant cost savings to Queensland and potentially other states, which will allow more road projects to be constructed.

The major outcomes from the NACOE pavements program to date include:

- reduced depth of asphalt structural layers through:
  - adoption of EME (high modulus) pavement, and
  - refinement of thickness design based on improved temperature modelling
- improved understanding of the full implications of using non-standard and/or marginal granular materials through performance validation and evaluation guidelines. These pavements are widely used in western Queensland, due to non-availability of conforming materials. While they offer significant savings, they can involve increased risk of poor performance, so these risks need to be understood
- upgrading of many department specifications, based on the review of world's best practice, and laboratory research
- increased use of recycled and natural products in bituminous products across the network, to deliver environment benefits enhancing sustainability.

As the program evolves, the Agreement Managers are increasing emphasis on implementation. To achieve this, project teams will be increasingly involved in program development, and will remain involved in the project right through the implementation stage, to ensure success.

The program also has a strong focus to collaborate with industry and universities.

STABILISATION PRACTICES IN QUEENSLAND

The stabilisation of otherwise unsuitable road construction materials is an economically and environmentally beneficial alternative to importing base course, sub-base course, and/or select fill materials. A number of stabilisation technologies are currently available, each with distinct benefits and limitations. In Queensland, the selection of a stabilisation treatment for a given application is heavily influenced by traditional local practice. Approximately 15% of the state-controlled road network is stabilised with a range of materials. The purpose of this ongoing project is to deliver significant cost savings by providing state-wide consistency in the selection of the appropriate stabilisation method and aligning design to international best practice.

The research, to date, revealed that increased resilience in high-exposure environments can be achieved at a fraction of the cost of full depth asphalt when plant-mixed cementitiously modified base (CMB) and in situ mixed foamed bitumen stabilised base (FBB) are utilised in accordance with best practice. Ideal conditions for CMB include moderate to heavy traffic, wet climatic conditions, non-reactive sub-grade soils and where a high-quality surfacing is planned. FBB is selected where additional structural capacity is required and existing granular materials conform to standard specifications. Ideal conditions for FBB include moderate to heavy traffic volumes and a variety of climatic conditions and sub-grade types.

The study also found that stabilisation practices adopted by the Queensland Department of Transport and Main Roads are in line with best practice nationally. Furthermore, based on this Queensland research, an Austroads national project is harmonising foam bitumen stabilisation practices across Australia. Current research has shown that a 0.5% reduction in the foam bitumen application rate can reduce construction cost by $20K per kilometre.

As an outcome of this research, five new Technical Notes are currently being developed, which cover the different stabilisation practices in Queensland. These notes will provide guidance to practitioners regarding best practice for the investigation, design and construction of these technologies.

- Technical notes currently being developed are:
  - Pavement Stabilisation Overview and Appropriate Additive Selection
  - Pavement Investigation and Analysis for Rehabilitation Projects
  - Plant Mixed Cement Stabilisation, In situ Cement or Cementitious Stabilisation and
  - Foamed Bitumen Stabilisation.
- Stabilisation provides increased resilience to high moisture at a fraction of the cost.

Camp Cable Road intersection on the Mount Lindsay Highway:
Foam bitumen base successfully withstood inundation on the existing pavement and widened sections

PAVEMENTS

EVALUATE THE PERFORMANCE OF TRANSPORT NETWORK REHABILITATION PROGRAM (TNRP) FLOOD REPAIR WORKS

Between 2010 and 2013, Queensland experienced widespread flooding over most of its road network. Repairs to the resulting damage cost $6.4 billion and were constructed under the Transport Network Reconstruction Program (TNRP).

This four-year research project aims to identify best practices and lessons learnt from the TNRP, particularly in pavement design and repair techniques. The findings from this project will be used for the improvement of the design guidelines for future flood recovery works. Given the scale of the area affected, considerable variations of the pavement works undertaken and the construction techniques adopted in each region, the TNRP research project provides the department an excellent opportunity to identify optimal reconstruction practices to manage extreme weather events.

This project combined the most recent ARMIS condition data and information from ARRB's Intelligent Pavement Assessment Vehicle (iPAVe) surveys to assess the condition of the TNRP network. Field and laboratory testing have also been conducted at selected sites to gather additional data. The large pool of data provided a comprehensive tool for evaluation of the TNRP pavements.

The findings of this project will be used to optimise the TNRP Guidelines for future use after disaster events.

- This study has analysed a large pool of data collected from most recent ARMIS condition data, Traffic Speed Deflectometer (TSD) surveys, and field and laboratory testing for the TNRP works. It allows a high quality evaluation of the works for suggesting future design and construction guidelines.
- This project will continue to monitor the TNRP works and conduct a review of the effect of Cyclone Debbie 2017.

COST-EFFECTIVE DESIGN OF ASPHALT PAVEMENTS AT QUEENSLAND PAVEMENT TEMPERATURES

The project aimed to reduce the cost of asphalt pavements through two key areas; firstly, by improving the prediction of asphalt fatigue damage at higher temperatures; and secondly, by implementing a special high modulus asphalt (EME2) with a reduced thickness compared to conventional asphalt.

A significant outcome of the project was publication of Technical Note TN167: A New Approach to Asphalt Pavement Design in February 2017. It introduces improvements in asphalt pavement thickness design, an upper limit on design traffic and an improved method for considering heavy vehicle axle loads. Asphalt thickness reductions of around 7 to 10% are already being realised on several major projects, resulting in significant cost savings to the Queensland Department of Transport and Main Roads.

This project and earlier work done on transferring EME2 to Australia also accelerated the implementation of EME2 in Queensland, with the largest EME2 project to date in Australia. This was completed on the Deagon Deviation in April 2017 as part of the Gateway Upgrade North Project (GUN), where a 25% reduction of asphalt thickness was achieved compared to conventional asphalt. The NACOE project has assessed the production and placement, and early-life performance of the EME2, and has developed a long-term performance monitoring plan for the Deagon Deviation site.

Project outcomes have been disseminated widely through technical seminars, a series of webinars, project-specific training and papers presented at the Australian Asphalt Pavement Association conference, the Australian Road Research Board conference, and the Transport and Main Roads Engineering and Technology Forum.

- Technical Note TN167: A New Approach to Asphalt Pavement Design published in February 2017.
- Asphalt thickness reductions of around 7 to 10% are already being realised on several major projects, resulting in significant cost savings to Queensland Department of Transport and Main Roads.
- Implementation of EME2 on the Deagon Deviation of the Gateway Upgrade North shows a 25% reduction of asphalt thickness compared to conventional asphalt.

QUEENSLAND TRIAL OF HIGH-STANDARD GRANULAR BASE – TRACKSTAR ALLIANCE PROJECT

In 2013, a heavy-duty unbound granular pavement, using a high standard granular (HSG) base was constructed on the Centenary Motorway to demonstrate the suitability of this pavement type as a low-cost alternative to heavy duty pavements, which have traditionally been constructed in Queensland. HSG pavements can have lower upfront costs, but potentially come with increased long-term maintenance and performance risks. Queensland Department of Transport and Main Roads trialled these pavements in the past with varied success, however this project showcased how they can be used successfully.

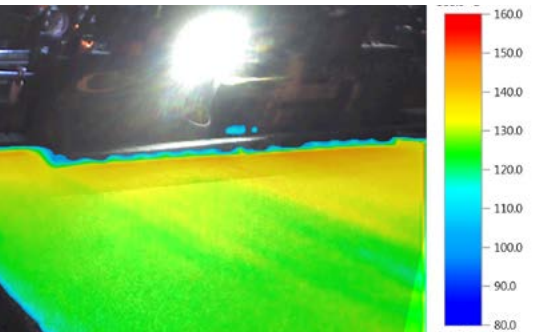
- High standard granular (HSG) base can be a low-cost alternative to heavy duty asphalt or cementitious pavements traditionally been constructed in Queensland. A 10 year design life heavy-duty trial pavement using HSG base was constructed in 2013 on the Centenary Motorway under this project. Performance assessment shows that the pavement is performing well after three years of service.
- Updated Queensland Department of Transport and Main Roads specification MRTS05: Unbound Pavements and Technical Note 171: Use of High Standard Granular (HSG) Bases in Heavy Duty Unbound Granular Pavements were published in August 2017.

PAVEMENTS

This project monitored the construction and subsequent performance of the pavement over a period of three years. It was found that the pavement was constructed to a high standard, and the pavement in general is performing well after three years of service (with an intended design life of 10 years).

As a result of this project, Queensland Department of Transport and Main Roads specification MRTS05 Unbound Pavements, has been updated to include an HSG material specification to help facilitate the construction of heavy duty unbound pavements. In addition, Technical Note 171: Use of High Standard Granular (HSG) Bases in Heavy Duty Unbound Granular Pavements has been published to provide design and construction guidance on the appropriate use of this material and managing associated risks.

TRANSFER OF CRUMB RUBBER MODIFIED ASPHALT AND SEALING TECHNOLOGY TO QUEENSLAND



Millions of vehicle tyres reach their end-of-life every year in Australia and pose a significant environment concern as these mostly ended up in landfill. The addition of processed tyre rubber granules to a conventional bitumen at high temperatures produces crumb rubber modified (CRM) binders with enhanced elastic and durability properties. The CRM binders have been used in sprayed sealing works in Australia and other countries for a long time, but have limited application in Queensland. Tyre Stewardship Australia, together with the Queensland Department of Environment and Heritage Protection and Queensland Department of Transport and Main Roads, jointly funded this project to maximise the use of recycled tyre rubber in asphalt and sprayed seals throughout Queensland.

The project was divided into two phases. The first phase explored the barriers to the use of the CRM binders, while the second phase was aimed at increased use of the CRM binders in Queensland Department of Transport and Main Roads roads. It included extensive literature reviews, a comparative binder testing program to demonstrate the ability to manufacture CRM binders locally, and a demonstration project to assess the constructibility and performance of open graded asphalt (OGA) using locally manufactured CRM binder. The demonstration project also included emissions monitoring to assess the potential health impacts of using CRM binders in asphalt.

The project recommended amendments to the Queensland Department of Transport and Main Roads binder and sprayed sealing specifications. The proposed amendments to MRTS11 (Sprayed Bitumen Surfacing) are substantial and will change the way Queensland Department of Transport and Main Roads will specify sprayed seals in the future. The proposed amendments to MRTS18 (Polymer Modified Binder) will align Queensland Department of Transport and Main Roads with current Austroads practice for the specification of polymer (including crumb rubber) modified binders, particularly with regards to nomenclature and binder properties. A new supplementary specification for crumb rubber modified OGA was also developed as part of this project.

The testing program showed that local suppliers can successfully manufacture tyre crumb rubber modified binders to meet the specifications. Besides, the

demonstration project in North Coast District in February 2017 showed the industry's ability to supply and construct open graded asphalt with crumb rubber. This project is being monitored and if found to be performing adequately may lead to wider implementation of crumb rubber modified asphalt.

Future work will address some remaining issues, including the variability of crumb rubber modified binder test results between different laboratories, determining accurate crumb rubber binder content, knowledge dissemination of the proposed changes to specifications and the design of crumb rubber asphalt mixes.

- A new supplementary specification for crumb rubber modified open graded asphalt (OGA) was developed.
- A demonstration project showed that local industry can successfully manufacture tyre crumb rubber modified (CRM) binders to meet specifications and construct open graded asphalt with crumb rubber.
- Updates to MRTS11 (Sprayed Bitumen Surfacing) and MRTS18 (Polymer Modified Binder) to facilitate the increased use of CRM binders in QLD.

QUANTIFYING THE BENEFITS OF GEOSYNTHETICS FOR THE MECHANICAL STABILISATION OF SUB-GRADE SOIL

The current value of earthworks on the Queensland Department of Transport and Main Roads road network is approximately $16 billion. A significant proportion of the Queensland road network is constructed over natural soils subject to moisture-induced strength loss and volumetric change. Traditionally, geosynthetics have been used as a sub-grade treatment to bridge over soft sub-grade areas to provide access for construction equipment or to improve the bearing capacity of the sub-grade. The objective of this multiple-year project is to assess whether the use of geosynthetics can lead to a significant reduction in granular pavement thickness.

This research will monitor trial pavements constructed on sub-grades that are reinforced (mechanically stabilised) with various geosynthetic products, as well as conducting laboratory tests under controlled conditions. Significant work has been completed to identify field trial sites, as well as commencing laboratory tests at the Queensland University of Technology (QUT) to improve Queensland Department of Transport and Main Roads understanding of the use of geosynthetics for granular pavement construction.

Preliminary laboratory results are encouraging as it was found that the use of geosynthetics in granular pavements increases the peak strength and pavement stiffness. The current laboratory testing equipment limits the accurate representation of field conditions. To remedy this shortcoming, new equipment will be designed, constructed and undergo testing at the QUT laboratory.

- Preliminary laboratory results show that the use of geosynthetics in granular pavements increases pavement strength and stiffness.
- Development of new testing equipment is being undertaken to assess the effectiveness of geosynthetics in the laboratory.

PAVEMENTS

USE OF SPINIFEX GRASS NANO-FIBRES IN CONSTRUCTION MATERIALS

DSR resizing of spinifex modified binder.

This is the second year of a three-year Advance Queensland funded research program for the University of Queensland to investigate the possible application of nano-fibres collected from spinifex grass for use with bitumen or cement in road construction. Queensland Department of Transport and Main Roads is contributing research funds towards this program to keep Queensland Department of Transport and Main Roads and ARRB abreast of and provide expert assistance to the research.

The research to date has found that there may not be any commercial benefits to be gained from using nano-fibres in bitumen-based products. The research is now re-directed to exploring their possible use in enhancing the physical properties of concrete for use in bridge structures.

It is important to explore the potential applications of these nano-fibres that are unique to arid Australia. This leading research has not been conducted elsewhere in the world. Common to most 'blue sky' research projects, the outcome may be uncertain but the potential rewards could be high, particularly if this results in new sustainable employment opportunities for indigenous people.

- Nano-fibres collected from spinifex grass, which grows widely in central arid region of Australia, may have potential in enhancing the physical properties of road infrastructure assets.
- Queensland Department of Transport and Main Roads is the first in the world to explore the use of spinifex grass in road infrastructure.
- Potential to provide sustainable employment opportunities for indigenous people.

WIDE CENTRELINE TREATMENT (WCLT) AND IMPACT ON PAVEMENT PERFORMANCE

In recent years, Queensland Department of Transport and Main Roads has implemented wide centre line treatment (WCLT) to provide additional separation between vehicles travelling in opposite directions to improve safety and, in particular, to reduce the potential for head-on crashes. An interim technical note TN155: Wide Centre Line treatment has been issued to provide geometric guidelines to designers.

The purpose of this research project was to investigate whether there are any adverse impacts of the WCLT on pavements and to understand whether outer wheel path or shoulder damage on some WCLT sections was due to this treatment.

In collaboration with researchers from the Central Queensland University (CQU), a video analysis technique was developed and deployed at six different test sites in the Mackay and Warwick districts. The imagery data collected from the test sites were used to track the lateral wheel positions on the pavement. This study has

identified a portable, cost-effective and accurate method to track the wheel paths of heavy vehicles, which would find applications in other transportation research projects in the future.

This study did not find significant impact of WCLTs on the short-term performance of the pavements. Updates to TN155 have been proposed based on the project findings.

- Innovative video analysis techniques were used to track the wheelpaths of heavy vehicles.
- Proposed updates to Technical Note TN155: Wide Centre Line treatment.

EFFECTIVE EXPANSIVE SUB-GRADE TREATMENTS ACROSS QUEENSLAND

Expansive sub-grades are a major cause of pavement distress across Queensland. While the treatment of expansive sub-grades is routinely undertaken, there is very little published guidance for design engineers to deliver practical design outcomes. The primary objective of this project was to document a systematic approach to the selection, design and construction of the most appropriate expansive sub-grade treatments for the contextual aspects of Queensland roads.

The project team consulted with key Queensland Department of Transport and Main Roads districts to capture previously undocumented knowledge on a range of treatments that are being routinely adopted in Queensland. It was found that design outcomes are often based on specific local area practices, or the individual experiences of designers. It was also found that there is very limited documented long-term performance history on the effectiveness of the various expansive sub-grade treatments in use.

The project concluded that there is an opportunity to optimise expansive sub-grade treatments through increased knowledge sharing and better understanding of actual performance through long-term performance monitoring. Documenting key guidance for designers would improve consistency and ensure that appropriate treatments are being considered for the influencing factors in place.

A technical webinar will be published in 2017/18 to disseminate project learnings to the key regional stakeholders.

- There is a shortage of published guidance for the design of expansive sub-grades in Queensland.
- The project has documented a technical report, which includes details of various routinely adopted treatments, district experiences, long-term performance assessment, and guidance on the selection of treatment options.

PAVEMENTS

IMPLEMENTING THE USE OF RECLAIMED ASPHALT PAVEMENT IN QUEENSLAND DEPARTMENT OF TRANSPORT AND MAIN ROADS REGISTERED DENSE GRADED ASPHALT MIXES

The incorporation of reclaimed asphalt pavement (RAP) materials into new asphalt mixes has many benefits including reduction of cost, reduction of greenhouse gas emissions, and conservation of natural resources such as bitumen, sand and crushed rock.

Historically, most of the asphalt manufacturing plants in Queensland were not capable of incorporating RAP into asphalt mixes. However, Queensland Department of Transport and Main Road's pre-qualified asphalt contractors have invested in new asphalt plants capable of incorporating RAP into the mixes. Many of these plants can incorporate more than 15% RAP originally specified by the Queensland Department of Transport and Main Roads specification.

This project has been investigating how Queensland Department of Transport and Main Road's asphalt specifications (and associated documents) can be modified to facilitate increased use of RAP in asphalt mixes whilst ensuring quality outcomes. The first year of this research project focused on asphalt manufacturing plant requirements and RAP stockpile management practices.

This project found that there were many plant configurations and methods of incorporating RAP into asphalt mixes. As a result, adoption of an 'outcome' based approach was found most appropriate in determining the allowable RAP percentages for particular plant types. To achieve this objective, the contractors would need to demonstrate that they are capable of producing conforming asphalt at the maximum RAP content they propose to use.

In addition, RAP stockpile management practices were also investigated. The findings of this investigation will be incorporated into a national RAP management guide that is being prepared by the Australian Asphalt Pavement Association (AAPA).

The remaining years of this project will identify and propose changes to the Department's specification MRTS30 and MRTS102 that are aimed at facilitating accelerated approval of asphalt mixes containing high percentages of RAP. These requirements will be based on the outcomes of Austroads Project TT1817 Maximising the use of replaced asphalt pavement in asphalt mix design.

- Use of reclaimed asphalt pavement (RAP) materials can reduce pavement construction cost, greenhouse gas emissions, and conserve natural resources.
- Many Queensland asphalt plants are capable of incorporating more than 15% RAP allowed by Queensland Department of Transport and Main Roads specification, and this gives an opportunity for increasing RAP use in Queensland Department of Transport and Main Roads works.

BEST PRACTICE NON-DESTRUCTIVE TESTING FOR QUALITY ASSURANCE OF ASPHALT

To improve quality assurance during the asphalt laying process, the world's best practice non-destructive density test methods were reviewed. Improved test methods would increase production rates, reduce rework of substandard asphalt, prevent early failure and overall, ensure that Queensland Department of Transport and Main Roads is obtaining value for money.

A review of local and international practices found that asphalt core tests are still the preferred method for the acceptance of density measurements during construction. Density measurements with nuclear gauges are also widely used within the asphalt industry, both locally and internationally.

The Queensland Department of Transport and Main Roads currently allows both of these methods, both have some disadvantages. International research suggests that electromagnetic devices could be a suitable alternative to nuclear density gauges, and a number of road agencies in the USA already allow these devices for quality control during construction.

A number of contractors in Queensland already use electromagnetic devices (particularly the PQI device) as a quality control tool during construction. Future research will assess the use of these devices for acceptance control using local materials and construction practices.

- Use of modern technology in quality assurance during the asphalt laying process could increase production rates, reduce rework of substandard asphalt, prevent early failure and overall ensure that Queensland Department of Transport and Main Roads is obtaining value for money.
- The study found that 'electromagnetic devices' could be a suitable alternative to 'nuclear density gauges' currently used in Queensland Department of Transport and Main Roads works.

BEST PRACTICE IN COMPACTION QUALITY ASSURANCE FOR PAVEMENT AND SUB-GRADE MATERIALS

When constructing road pavements and embankments, the level of compaction of both granular and sub-grade materials has conventionally been verified using density measurements. Over the past two decades, alternative methodologies such as the lightweight falling weight deflectometer (LFWD), Briaud Compaction Device (BCD), Soil Stiffness Gauge (SSG) and intelligent compaction have been developed.

The purpose of this research is to update Queensland Department of Transport and Main Roads processes for the quality assessment of compaction. Under this project, the compaction methods being researched range from historical earthwork practices to new technology's.

The current practice is to compact 200 mm thick layers, which are controlled by

PAVEMENTS

a sand replacement test and nuclear density gauge. On the other hand, modern compaction equipment can compact pavement layers up to 500 mm thickness (depending on material) and modern testing methods can verify compaction up to 400 mm thickness. There is therefore an opportunity to reduce construction cost by increasing productivity significantly.

Research to date concluded that a number of new quality assurance methods can be used to replace the current density-based methods. This will result in a more accurate measurement of the in situ modulus value without the need for long time delays before results become available, minimising the need to rework sections with non-conforming earthworks that were not identified early during construction.

- Current practice is to compact 200 mm thick layers, and use of sand replacement test and nuclear density gauge for the quality assurance.
- Modern compaction equipment can compact layers up to 500 mm thickness and modern testing methods can verify compaction up to 400 mm thickness. This project is investigating a number of new quality assurance methods that can be used to replace the current density-based methods to increase productivity on site.

COMPARISON BETWEEN HAMBURG WHEEL TRACKER AND MODIFIED LOTTMAN TESTS

Queensland's road network consists of several thousand kilometres of asphalt pavements, with around 150 km of new asphalt pavements being constructed each year. In addition, there is considerable expenditure on maintenance and rehabilitation of these pavements due to premature failure or poor performance. In many cases, these failures are due to a poor resistance of the materials to moisture-induced damage and stripping.

There is an opportunity to find efficiencies in asphalt pavement design and specifications through investigative testing of several potential failure mechanisms, particularly in terms of the ability to predict resistance to stripping in thin asphalt pavements (less than 30 mm thick).

Queensland Department of Transport and Main Roads commissioned its Hamburg Wheel Tracking Device (HWTD) in 2013. It has since been used to assess asphalt mixes for stripping potential and their general stability under submerged conditions at temperatures of up to 60 °C.

A previous project found that the HWTD can identify the relative performance of a range of mixes in terms of the ability to resist moisture-induced damage, and recommended it as a suitable tool for mix design and performance-based research in the future.

Currently, Queensland Department of Transport and Main Roads uses the modified Lottman test to determine susceptibility to moisture induced damage. It has limited ability to distinguish between the performances of different mix designs. The Hamburg wheel tracker more closely mimics traffic conditions than the Lottman test. This research project compares the two different methods to determine whether the Hamburg wheel tracker is a better assessment tool to predict in-service performance of different mix designs to resist moisture-induced damage and stripping. A positive outcome of the Hamburg wheel tracker as a better predictor of stripping and moisture-induced damage would reduce ongoing performance risks.

- Failure of asphalt layers due to moisture damage is a big concern for Queensland Department of Transport and Main Roads.
- The modified Lottman test currently being used to determine moisture susceptibility has limited ability to distinguish between the performance of different asphalt mix designs.
- The Hamburg Wheel Tracking Device (HWTD) could be used as an alternative to the modified Lottman test to better assess the risk of moisture damage between different mixes.

ASSET MANAGEMENT

The NACOE Asset Management Program is focusing on advancing asset management modelling practice and the underlying assumptions within these models.

In addition, the program includes research into new funding strategies that explore life-cycle costing implications, particularly in light of the risk of major weather events and flooding across Queensland.

It is expected that the program will deliver benefits to the department in terms of:

- more robust and accurate asset management tools and models, which will enable the department to better prioritise maintenance and rehabilitation spending, through informed decision making
- life-cycle costing of asset management strategies, with a focus on how to improve resilience of the network to rain and flood events with a limited budget and against increasing climatic threats, and
- assisting the department and regions with the implementation and optimisation of private-sector road asset management contracts

IMPROVED MODEL TO PREDICT THE REMAINING LIFE OF SPRAYED SEAL SURFACE

On an annual basis, Queensland Department of Transport and Main Roads spends more than $200 million on its road resurfacing program. Of Queensland's state-controlled road network, approximately 80% comprises of sprayed seal surfacing over granular pavement. Although sprayed seals do not provide structural strength, they prevent moisture ingress into the pavement, which is critical in maintaining the structural integrity of the road. Queensland has a range of climates varying from equatorial to desert with often widespread flooding. It is critical to ensure road pavements are effectively waterproofed.

The research work has focussed on detection and measurement of oxidisation of the bitumen to determine the optimal timing for resurfacing. Whilst the initial phase of the project did not identify any automated, non-destructive means of collecting this information, significant progress was made in identifying test methods that can predict the deterioration rate. Dynamic Shear Rheometer testing is being used to develop a relationship between surface stress and seal age. The research is striving to develop this relationship to enable improved risk management of the sprayed seal network. By providing a better understanding of the in situ performance of sprayed seals, resurfacing works can be more effectively programmed. It would optimise cost of resurfacing program through better seal age life prediction, while ensuring better pavement performance through effective water proofing for the reseal design life.

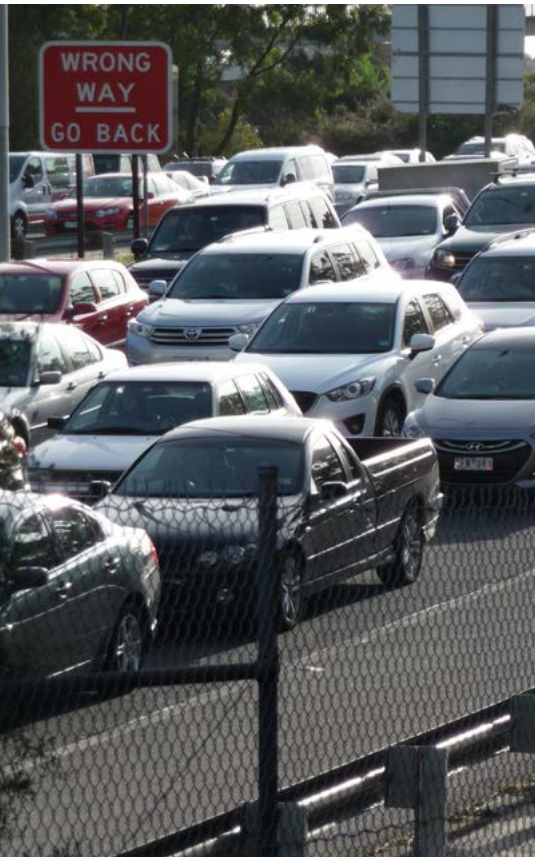
- Staging of resurfacing works are often determined based on the service life of sprayed seal surfaces.
- There is a need to develop improved models to predict the remaining life of sprayed seal surfaces.

INCORPORATION OF THE PAVEMENT RISK SCORE INTO THE PAVEMENT CONDITION INDEX

For many years, Queensland Department of Transport and Main Roads has calculated a Pavement Risk Score (PRS) in order to reflect the relative risk of pavements. This indicator relies on measured road condition data and information on the operating environment to assess the likelihood and consequence of an event in terms of road user safety. Without network-level pavement strength data, the PRS relied on measured surface characteristics to infer an overall level of pavement risk. Since the initial implementation of the PRS, a number of new approaches have been adopted, requiring Queensland Department of Transport and Main Roads to rethink how it assesses and uses pavement risk to manage the network. These developments include:

- A new approach to prioritisation of surface/pavement preservation works within its Pavement Management System (PMS) utilising a complex pavement condition index (PCI).

ASSET MANAGEMENT



- Routine collection of network-level strength data utilising the Traffic Speed Deflectometer (TSD).

The key output of this work is a revised PCI that incorporates pavement strength data that has been validated against field condition. This indicator will begin to be presented in annual asset condition reports and will be a key criterion to develop road surfacing and pavement rehabilitation investment programs. Its implementation is expected to yield cost savings through more efficient direction of constrained funding to the areas of highest risk.

- Queensland Department of Transport and Main Roads calculates Pavement Risk Score (PRS) based on road condition and operating environment data to prioritise road sections for preservation programs.
- The advancement of road science allows the improvement of process with the addition of pavement strength data.
- This project has delivered a validated pavement condition index (PCI) that incorporates pavement strength data and pavement risk factors.

STRUCTURES

The structures program seeks to deliver benefits to the network in a number of ways, including:

- destructive testing and analysis of vehicle interactions on load-limited and critical bridges to gain a better understanding of the capacity and performance of these structures
- development of staff capacity in the use of advanced assessment technologies and instrumentation of structures
- improving bridge monitoring and management through the use of advanced systems and by adopting world's best practice in asset and risk management
- introduction of advanced materials and technologies into structures across the network.

MEASUREMENT OF BRIDGE-VEHICLE INTERACTION UNDER LIVE LOAD

In Queensland, the Queensland Department of Transport and Main Roads is responsible for approximately 3,000 bridges and 4,000 major culverts, with a gross replacement asset value in excess of $11B. Several of these bridges are subject to load and permit restrictions, with an estimated cost of $120M to upgrade or maintain. The dynamic interaction between bridges and vehicles is a key criterion in the assessment process. This project found that the dynamic load allowance (DLA) factor of 0.4 used for assessing Queensland Department of Transport and Main Roads bridges can be reduced for the superstructure components with positive economic outcomes, realised by potentially increasing the freight capacity of bridges on freight routes. A higher DLA factor usually leads to more expensive maintenance and strengthening works. Therefore, Queensland Department of Transport and Main Roads initiated this project to investigate the scope for using reduced DLA factors in the assessment of load restrictions.

The investigation process included load testing of three representative bridges of different substructure types. It specifically focused on interactions between vehicles and bridges, and the degree of variance that occurs with different parameters such as structure type, road profile conditions, vehicle and suspension type.

The project findings supports consideration for the reduction of DLA factors for the superstructure components (e.g. girders under operational network conditions), subject to certain conditions. However, no reduction in DLA factors is recommended for the substructure components e.g. headstocks and columns. Further research may be considered to determine whether the research findings could be applied more widely to other similar structures.

STRUCTURES

- Several Queensland Department of Transport and Main Roads bridges are subject to load and permit restrictions, with an estimated cost of $120M to upgrade or maintain.
- This project found that the dynamic load allowance (DLA) factor of 0.4 used for assessing Queensland Department of Transport and Main Roads bridges can be reduced for the superstructure components with positive economic outcomes.

DECK UNIT BRIDGE DECK ANALYSIS UNDER LIVE LOAD

This research project has investigated the performance of deck-unit bridges. Deck-unit bridges have simply-supported spans with a superstructure that consists of rectangular prestressed-concrete hollow deck units (DU) tied together with transverse stressing bars (TSB). Standard numerical analysis of DU bridges has flagged an under-capacity for operational loads. However, regular bridge inspections have found no major concrete cracking or other significant signs of superstructural distress. This research project addressed the disparities between theoretical assessments and the actual behaviour of this bridge type.

The structural response of Canal Creek Bridge, located on Flinders Highway (east of Cloncurry), was assessed via load testing and short-term condition monitoring. Canal Creek Bridge is a two-span simply supported DU bridge built in the 1970s, with decks that consist of 13 DUs, 8.3 m long between supports. The results showed that when tested, the bridge superstructure performed better than that predicted by state-of-the-art numerical models. These results are critical to calibrate existing numerical models, mostly based on grillage analysis, as well as to refine standard capacity assessment procedures.

A testing program was conducted in the Structures Laboratory at the University of Queensland. Deck and kerb units 9.1 m long were salvaged from decommissioned Queensland Department of Transport and Main Roads bridges. The test beams provided a significant sample of 1960s DUs. The laboratory investigations included testing of individual units, both in bending and shear, up to structural failure. These older designed bridges were deemed below standard because of limited section depth (~300 mm) of the inner DUs and the inadequate shear reinforcement. All the salvaged deck and kerb units exhibited bending and shear capacities higher than what was estimated based on the original design specifications. The concrete and steel cores also yielded material strengths higher than the design values assumed for structural assessment.

Additional testing was conducted on a partially re-assembled DU bridge at the Structures Laboratory at the University of Queensland. The re-constructed bridge portion comprised 6 - 8.3 m long DUs and one KU. Serviceability load tests provided results consistent with the site tests conducted on the Canal Creek Bridge.

To investigate the effects of TSB deterioration on the performance of deck unit bridges, additional testing was performed on a redundant bridge across Sandgate Road on the Gateway Motorway. The testing indicated that this type of bridge has more reserve capacity than originally thought. Hence, the need for capital

upgrading, maintenance and inspections costs on a proportion of these at-risk structures will be significantly reduced.

Queensland Department of Transport and Main Roads is committed to incorporating the learnings from this project into the existing assessment/design guidelines as well as the permit process to ensure that learnings are applied to all transversely stressed deck unit bridges on the whole of the network.

- Laboratory testing indicates that existing deck units exhibit higher strength capacities than theoretical estimates.
- These findings will reduce the need for upgrading, maintenance and inspection costs on a proportion of Queensland Department of Transport and Main Road's existing bridge network.

ROAD-TRAIN AND B-DOUBLE NETWORK BRIDGE STRUCTURAL ASSESSMENT

The project identified several bridges on Queensland's freight network which are carrying as-of-right multi-combination vehicles, but exceed their theoretical capacities based on current assessment methods. Hence, these bridges are a priority for further investigation under the Priority Bridge Management Project (PBMP) to determine Queensland Department of Transport and Main Road's management approach. In the interim, the priority bridges are being managed on the basis of satisfactory past performance in accordance with AS ISO 13822-2005 Basis for design of structures – Assessment of existing structures until the department's management approach is determined.

In accordance with current procedures, this requires the establishment of a Structure Management Plan (SMP) for each priority bridge in order to document formal measures to manage a defective or sub-standard structure pending its rehabilitation or replacement. The PBMP has confirmed that 262 bridges will require SMPs from the preliminary list of 364 bridges. Some degree of consistency is expected in the management of interventions across issues/structure families.

The purpose of this project was to review and update the department's current guidelines for developing SMPs and develop some generic SMPs that can be tailored for various situations. The main focus is to provide a clear direction to operational staff so that interim measures can be readily applied to keep the structures safe and serviceable. Documented intervention thresholds and decision criteria are also compiled to enable effective risk management.

- Queensland Department of Transport and Main Roads has developed a list of 364 priority bridges on the Queensland freight network which are carrying as-of-right multi-combination vehicles in excess of their theoretical capacity.
- The purpose of this project is to review and update the department's current guidelines for developing SMPs, and develop some generic SMPs that can be tailored for various situations. These will provide clear guidelines for operational staff so that they can safely and consistently manage risks.

OTHER

A number of projects are funded under NACOE in the fields of Network Operations, Road Safety and Heavy Vehicle Management, totalling roughly 15% of the total program investment.

Current departmental initiatives include:

- targeted efforts to reduce the road toll through investigating key crash types and cost-effective techniques to minimise serious and fatal injuries
- assessing multi-model transportation costs, driving savings through improved network efficiency and adopting best practice modelling
- streamlining heavy vehicle policy to remove barriers to industry while delivering the best outcomes for the network as a whole

Through NACOE, a number of projects will also be looking to advocate the use of smarter technology and sustainable solutions on Queensland roads.

EVALUATION OF IN-SERVICE COMPLIANCE OF ROAD FRIENDLY SUSPENSIONS (RFS) USING EMERGING TECHNOLOGIES

Heavy vehicles fitted with road-friendly suspensions (RFS) are permitted to operate on selected routes at higher mass limits (HML). This productivity benefit is afforded on the basis that an approved RFS causes less pavement damage than one without it. New suspensions are tested and certified as road-friendly, however despite evidence that the performance of a suspension degrades over time, there is no in-service compliance requirement or test protocol for RFS.

This project reviewed the requirements for in-service testing of suspensions to confirm their road-friendly characteristics. This included identifying technologies that offered solutions that are both accurate and repeatable for on-road testing of vehicles.

Research by others has shown that poorly maintained vehicle components such as shock absorbers have a significant impact on vehicle maintenance costs. These worn-out components also adversely affect the road friendly characteristics of suspensions that subsequently increase road damage.

To confirm the in-service RFS characteristics during testing, three key elements are required: sufficient excitation of the suspension, accurate measuring systems and finally, technical analysis of the results. The detailed technical requirements of each of these elements must be defined.

It was found that the on-board vehicle scales have sufficient measurement accuracy but the lack of a suitable excitation method prevents this being a viable solution. Other technologies lack the ability to isolate the effects of variations in

the road surface, vehicle dynamics and environmental factors. A preferred RFS test method that limits these variations to an acceptable level has been identified. However, this project revealed that there are consistency issues with existing certifications that must be overcome first.

- Heavy vehicles fitted with road-friendly suspensions (RFS) cause less pavement damage than vehicles without it.
- This project has identified a suitable RFS test method that can limit the effect of variations of road surface condition, vehicle dynamics and environmental factors to an acceptable level.

REVIEW OF QUEENSLAND DEPARTMENT OF TRANSPORT AND MAIN ROADS GUIDANCE FOR HEAD-ON, RUN-OFF-ROAD AND INTERSECTION CRASHES IN QUEENSLAND

A review of historical crash data has identified three basic crash types on Queensland roads namely – intersection crashes, run-off-road crashes and head-on crashes. As these crash types account for the majority of the fatal and serious injuries, the research focused on these crash types in order to reduce their numbers.

The three-year project undertook a literature review, crash analysis, and prepared a number of treatment options for head-on, run-off-road injury crashes and intersection crashes. The project reviewed existing Queensland Department of Transport and Main Roads guidelines and practices relevant to the three key crash types to identify revisions and develop guidance based on the research findings. The project also provided a greater understanding of road safety engineering based measures that can be applied to address serious injury crashes so that the most effective treatments can be used in future projects. This will enhance crash cost savings and improve value-for-money on road infrastructure projects. It will also improve the effectiveness and economic returns on investments from safety programs such as Safer Roads Sooner.

Outcomes from this project are being used to provide guidance through a technical note as well as updating relevant Queensland Department of Transport and Main Roads standards, practices and guidelines.

- Intersection crashes, run-off road crashes and head-on crashes are the three main crash types on Queensland roads that account for a majority of the fatal and serious injuries.
- This project provided a greater understanding of road safety engineering based measures to address serious injury crashes through most effective treatments in future projects.

OTHER

REVIEW AND UPDATE OF ARRB/QUEENSLAND DEPARTMENT OF TRANSPORT AND MAIN ROADS METHODOLOGY FOR MEASURING EXCESSIVE CONGESTION COST AND EMERGING DATA SOURCE CONSIDERATIONS

In estimating traffic congestion cost, previous research made certain assumptions about the actual speed of vehicles on arterial roads. The project aimed to check the accuracy of these assumptions on side streets that tend to have shorter and variable length links. The project undertook sensitivity tests to identify alternative reference speed thresholds that could optimally define congestion on side streets.

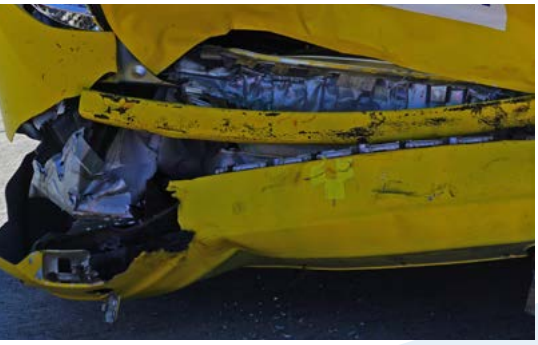
A section of Gympie Road in the north of Brisbane and an associated selection of intersecting side streets were considered in the case study. The project utilised Bluetooth technology and a special probe vehicle to provide more accurate travel time data. The project compared the results of the key performance indicators generated by three different data sources.

It was found that these more advanced methods for collecting data could increase the department's confidence in the congestion analysis. This has provided the potential to automate the analysis process. The project has shown that more accurate results could be obtained by using these modern techniques. The Bluetooth and probe vehicle data were found to align very well with each other on motorways, and probe data was able to capture the peak hour travel times to a higher level of accuracy than loop detectors in both motorways and arterial roads.

While excess congestion cost on side streets represented less than 10%, more accurate predictive tools such as this play a vital role in building a more accurate predictive system which would provide higher confidence in the analysis results.

- Use of advanced methods such as Bluetooth technology and special probe vehicle for traffic data collection can give improved congestion analysis.

REDUCING REAR-END CRASHES ON STATE-CONTROLLED ROADS



Rear-end crashes have always been the most frequently occurring crashes. The severity of these crashes has worsened in recent years. Rear-end injury crashes comprise 25% of all injury crashes on Queensland roads.

This project identified the characteristics of rear-end crashes on Queensland roads and helped define the scope of the rear-end crash problem. The research explored high rear-end crash locations in Queensland and determined the relationship between road features, and rear-end crash risk.

This project has a further year before finalisation, however it has revealed some interesting statistics which include:

- Approximately 25% of rear-end injury crashes on Queensland roads result in a fatal or serious injury. This figure is higher than for all other states and territories, except Victoria.
- The majority of rear-end injury crashes occurred on state-controlled roads. In all, 58% of the rear-end injury crashes and 81% of fatal rear-end crashes occurred on state-controlled roads.
- On state-controlled roads, rear-end crashes comprise 31% of all injury crashes, and 19% of fatal accidents.
- Rear-end crashes were more likely to be caused by young drivers (under 30) and elderly drivers (over 75).
- Passenger cars were more commonly the struck vehicle rather than the striking vehicle and larger vehicles are more likely to be the striking vehicle in a rear-end collision.

This research has allowed better guidance for engineering based treatments to address and/or reduce rear-end crash risk. The research learnings will improve processes and practices for managing road safety risk.

- Approximately 25% of rear-end injury crashes on Queensland roads result in a fatal or serious injury.
- Rear-end injury crashes are more frequent at signalised intersections.
- Rear-end crashes are more likely to be caused by young drivers (under 30) and elderly drivers (over 75).

IDENTIFYING HIGHER RISK STATE-CONTROLLED ROADS FOR SPEED RELATED CRASHES

Speed remains a significant contributing factor in fatal and serious injury crashes in Queensland. It is important that speed limits are compatible with the intended road use, road users and the road features. This research has identified speed-related issues on the state-controlled road network and linkages between speed-related crashes and road infrastructure.

When this ongoing research is finalised, a range of treatment options will be proposed that will assist in reducing crashes caused by speed. Safety-specific recommendations will be made to improve state practice to manage and mitigate the risk caused by excessive speed.

- This research has identified linkages between speed-related crashes and road infrastructure.
- Various treatment options are being studied for selecting the suitable ones in reducing crashes caused by excessive speed.

GET INVOLVED

HOW TO GET INVOLVED

The NACOE program runs on a rolling four-year basis, with projects generally spanning 1 to 3 years.

The program relies on the input and collaboration of ARRB, the Queensland Department of Transport and Main Roads and industry personnel to develop ideas for projects across the four key discipline areas of pavements, asset management, structures and other (network operations, road safety and heavy vehicle management).

Any suggestions for projects can be submitted through the NACOE website, at NACOE.com.au or through the NACOE email address info@NACOE.com.au

FEEDBACK AND CONTACT DETAILS

The NACOE Agreement Managers can be contacted with any feedback or to make enquiries regarding the program or specific projects.

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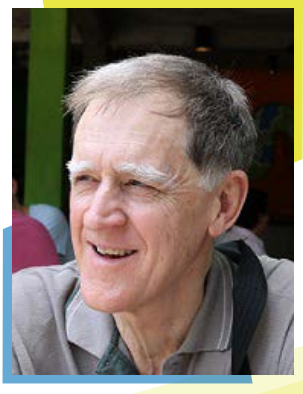

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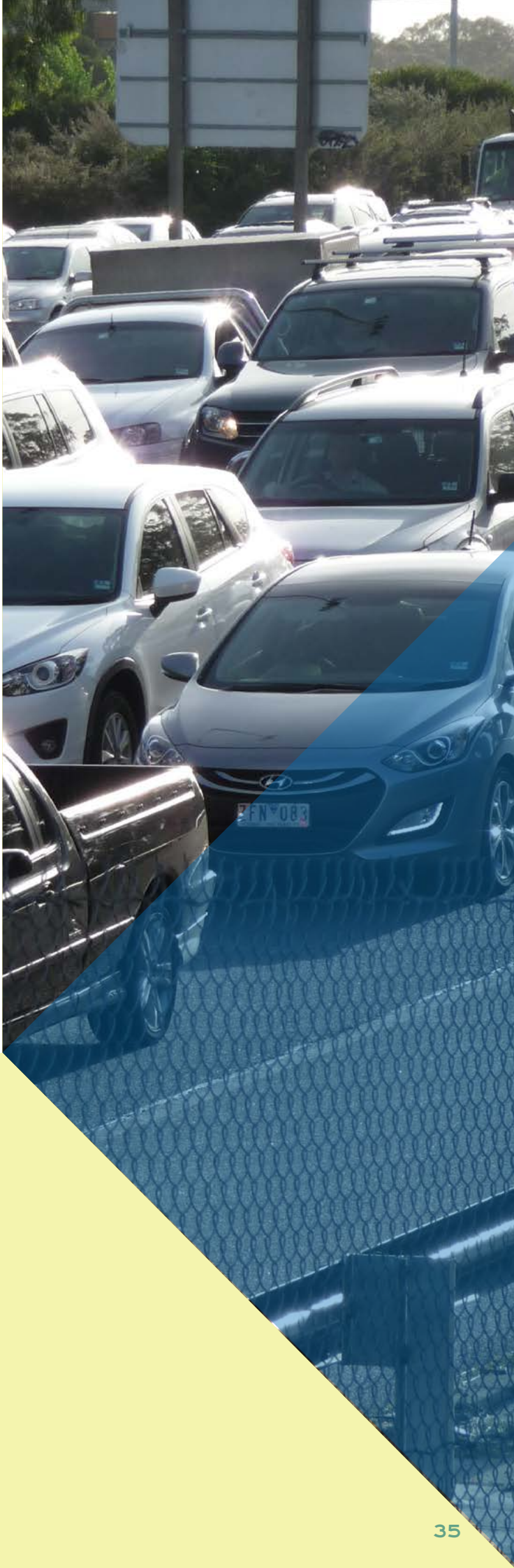

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