



FUTURE-PROOFING TRANSPORTATION INFRASTRUCTURE

Pothole in chip seal road surface

WATERPROOF ROADS - A NEW RESEARCH PROJECT IS DEVISING IMPROVED METHODS FOR PROVIDING AFFORDABLE, OPTIMISED AND FUTURE-PROOFED TRANSPORTATION INFRASTRUCTURE.

New Zealand is absolutely dependent on maintaining a high quality road transport network for economic growth, travel safety and social wellbeing through community connectivity. Yet we're also a pluvial country with many areas receiving in excess of 2,000mm of rainfall annually – and water and roads do not mix well. As much as one third of the \$1.3 billion spent annually by the NZ Transport Agency and regional roading authorities on road maintenance can be related, directly or indirectly, to water damage.

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Water rising through first coat seal

That's why Opus is undertaking a new research project. It's aiming to significantly reduce the annual maintenance and construction costs to NZ roading authorities, caused by water damage to road surfaces.

This large research project is being funded by the Ministry of Business, Innovation and Employment, and also has significant support from the NZ Transport Agency.

With freight volumes growing by 2.5% annually and extreme rainfall events predicted to become the future norm, roading authorities need new innovations in order to future-proof and maintain the affordability of NZ's road infrastructure.

The project will research and develop novel waterproofing materials and innovative road construction methodologies, with the aim of becoming the accepted industry standard by the NZ Transport Agency and other roading authorities overseas. These new products will reduce domestic road construction and maintenance costs, freeing up resources and allowing roading authorities to further optimise and modernise the network.

The project team includes researchers from Opus, the University of Auckland and the Australian ARRB Group. Together, the team combines the leading road science and engineering researchers in Australasia and is led by Phil Herrington, a scientist in our Petone office.

THE STATE OF NZ ROADS

Almost 90% of the NZ road network is highly susceptible to water damage. It consists of a compacted gravel (aggregate) basecourse layer over which multiple chip seal layers are constructed. The purpose of the seal is to provide a skid resistant surface for traffic and prevent water entering the basecourse.

However, research has confirmed that seals are in fact not effective in their waterproofing function - that is, they leak. Water damage manifests itself in two ways: deformation and potholing of the basecourse, and 'flushing' of the seal (i.e. the riding surface becomes slick with bitumen and unsafe for drivers).

FINDING NOVEL WAYS TO PREVENT WATER DAMAGE

The goal of the project is to find novel, cost-effective methods to counteract the effects of water damage on NZ roads. The work has two key components:

- Novel water-impermeable membranes that prevent water from entering the basecourse at its upper surface.
- Methods to modify the sealing chip surface to prevent water disbonding of bitumen that leads to flushing.

MONETARY BENEFITS AND MORE

The benefits of this project to NZ are varied and far reaching. Net cost reductions to the NZ Transport Agency and local authorities from this research project are estimated at \$81m p.a. within 5-10 years of completion of the research. Additionally, the waterproofing technologies developed will at least double average pavement and surfacing lives, resulting in longer-lasting infrastructure that doesn't need frequent costly repairs.

The research has the potential to revolutionise the way in which pavements are constructed, leading to significant and immediate economic benefits. Expensive premium basecourse materials and current cement and foamed bitumen stabilisation techniques could be replaced with much cheaper 'marginal' materials and designs. Large tonnages of quarried material (currently considered waste) could also be efficiently utilised.

To find out more about this waterproof roads project and our progress, please get in touch.

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ASSESSING ROAD SEAL PERFORMANCE IN THE LAB



Circular Accelerated Surfacing Tester (CAST)

OPUS HAS DESIGNED AND CONSTRUCTED A NEW CIRCULAR ACCELERATED SURFACINGS TESTER (CAST). FOR THE FIRST TIME, ROAD SEAL BEHAVIOUR CAN BE STUDIED UNDER REALISTIC TRAFFIC SPEEDS AND IN A TEMPERATURE-CONTROLLED ENVIRONMENT.

Developments in road seal design and binder performance have long been hampered by the difficulty in assessing road seal performance in a controlled laboratory environment. Up until now, the only real options for the study of road seals have been either simple plate impact type tests or expensive field trials.

To address this gap, Opus Research has designed and constructed CAST (Circular Accelerated Surfacing Tester) which is a machine that can be used to study road seal behaviour under realistic traffic speeds and in a temperature-controlled environment.

HOW CAST WORKS

The machine consists of two 300mm diameter, 70mm wide treaded tyres loaded with up to a 200kg deadweight. These tyres rotate around a 2.35m diameter track at speeds of up to 50kmph. The vertical stress on the seal surface is up to 400kPa.

Four test samples are positioned around the track. The samples are temperature controlled (from -7°C to 55°C) by fluid circulating through the base plate. The entire machine is inside an insulated

enclosure - the air in which is also temperature controlled (from 0°C to 40°C). The test road seals can be up to 150mm thick (allowing for the testing of field samples or asphalt mix) and can be constructed onto smooth or textured steel plates, or compacted base course as needed.

The 2.5m radius of the machine results in substantial shear forces to the road seal surface. Damage and texture changes to the surface are monitored using stereo-photography. Software records changes to the x, y and z coordinates of mesh points overlaid on the surface image (Figure 1).

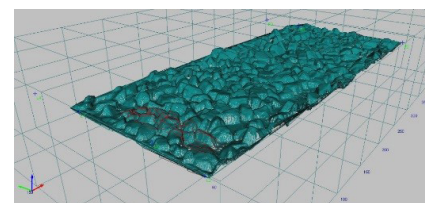


Figure 1

RESEARCH PROJECTS

CAST is currently being used to validate new bitumen performance tests.

Future work includes proposed studies on the relative strength of two-coat and racked-in road seals, and the benefits of polymer modified bitumen on chip retention. CAST also has the potential to investigate the durability of road markings and the effect of surface texture on noise generation from road surfaces.

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SHARROWS: A SHARED SPACE SOLUTION?

RESULTS FROM AN OPUS RESEARCH OBSERVATIONAL STUDY REVEALED A SIGNIFICANT EFFECT ON DRIVER BEHAVIOUR BY SHARROW ROAD MARKINGS. THE AVERAGE FREE VEHICLE SPEED REDUCED FROM 42KMPH TO 36KMPH.

As outlined in Wellington City Council's long term plan and annual plan, significant investments are being made into improving Wellington's cycling infrastructure, with the aim of making cycling a more 'safe and convenient' experience. As a step towards achieving this aim, Opus Research evaluated the



effectiveness of sharrow road markings. Sharrows are distinctive stencil-style road markings used on shared traffic lanes. We examined whether these road markings promoted better road sharing through improved road user understanding and behaviour.

UNDERTAKING THE STUDY

Through direct observation and survey methodologies, road user behaviour was observed pre- and post-sharrow markings at a 50kmph site on Featherston Street in Wellington CBD. Using 280 cyclist video observations, the study was able to assess behaviours such as cyclist lane position, numbers travelling within car door zones, and overtaking distance.

Additionally, an online survey of 479 Wellington drivers and cyclists captured the perspectives of these road users as well as any reported shifts of the desired behaviours.

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SHARROWS HAVE A SIGNIFICANT EFFECT ON DRIVER BEHAVIOUR

Results from the observational study revealed a significant effect of the sharrow road markings on driver behaviour, with the average free vehicle speed reducing from 42.18kmph to 36.16kmph. This finding suggests that sharrows have the potential to create safer road speed environments for all road users. However, no significant effect was found for sharrows on cyclist behavior. This possibly indicates that the 50kmph speed limit may have restricted cyclist behaviour change.

Positively, cyclist survey respondents reported that sharrows appeared to have some impact on the caution and space drivers gave to them as they drove past. They also felt that sharrows increased their sense of belonging on the road.

However, a number of respondents felt that sharrow markings are difficult to see, with some respondents reporting that they found it difficult to understand the meaning of the marking without explanation.



TAKING INTO ACCOUNT RESPONDENTS' FEEDBACK

As a result, Opus recommended that appropriate complementary information, such as roadside signage,

be used alongside sharrows. We also recommended the use of educational and public marketing campaigns that enhance driver and cyclist awareness and understanding of sharrows and the behaviours they are intended to elicit.

Lastly, when sharrow road markings were positioned in the centre of the lane, driver respondents were more likely to think cyclists should be cycling in the middle. Therefore, in order to encourage cyclists to "own the road", Opus recommended that the marking should be positioned in the centre of the road. This is supported by the finding that the majority of participants chose the centre of the lane as the preferred location for the sharrow markings, and also by overseas observational results.

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CONDITION ASSESSMENT OF CONCRETE INFRASTRUCTURE ASSETS

OPUS HAS LONG BEEN INVOLVED WITH CONDITION ASSESSMENT WORK. AMONG OTHER BENEFITS, THIS VITAL WORK HIGHLIGHTS ANY REMEDIAL WORK REQUIRED TO ENSURE THE CONTINUED SAFETY AND LONGEVITY OF INFRASTRUCTURE ASSETS.

Opus carries out condition assessment work of concrete infrastructural assets such as bridges, wharves, buildings, water and wastewater pipes, treatment plants, chimneys, and reservoirs. This work allows us to assess the durability, remedial requirements, and remaining life of these assets. From here, recommendations can be made to ensure the assets remain functional and safe.

CONDITION ASSESSMENTS IN ACTION

The photo shows a condition assessment we undertook of the New Plymouth Power Station chimney. As an example of the sometimes difficult conditions we encounter, our team worked from a man cage, suspended from a 100m mobile crane.

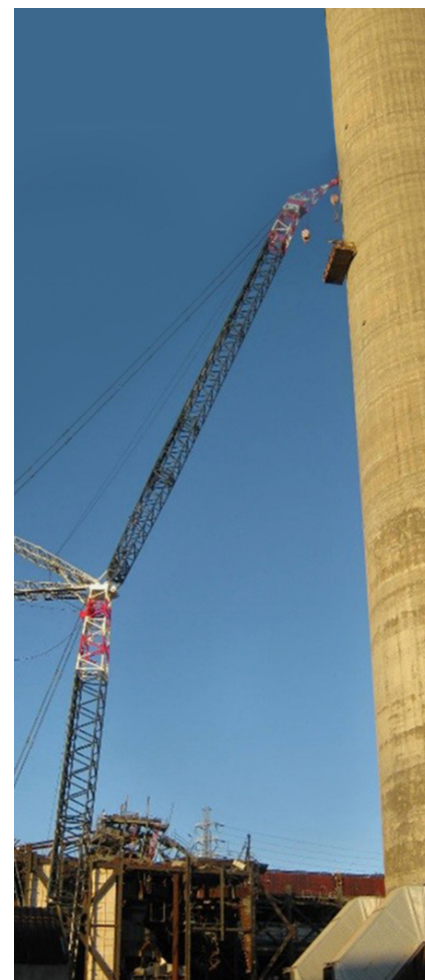
Although the power station has been decommissioned and the 200m high concrete chimney is no longer in use, the chimney needs to be maintained into the future to address potential structural and safety issues.

The assessment allowed us to define the future reinforcement corrosion risk, the likely residual life and the preferred maintenance strategy.

Recent assessment projects highlight our experience across a broad range of infrastructure assets, including some of New Zealand's most high profile projects. We've undertaken assessments of trunk sewer mains in Auckland, Golden Bay Cement's jetty in Portland, Tiwai road bridge and wharves in Invercargill, and multiple road bridges for the NZ Transport Agency, including the 144-span Rakaia River bridge in Canterbury.

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New Plymouth Power Station chimney

CITIES OF THE FUTURE



because they have invested in the right technology, people and businesses to improve life for the people who call their city home.

One aspect of Opus' work around smart cities includes a project led by Louise Baker, Principal Transportation Consultant. She is leading a team of researchers who are writing three strategic research papers for Auckland Council to set the scene for a 'Smart Auckland'; the third paper is titled 'Smart Transport: Opportunities for Auckland'.

Louise has developed a strong track record in research relating to smart cities, with a particular focus on transport and technology. She has also made several recent conference presentations, including presenting 'A Travel Demand Management Digital Safari' at the Association for Commuter Transport conference in Baltimore, Maryland USA. You can connect with Louise's progress and thoughts on smart cities and transport on Twitter: @digital_TP



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A NUMBER OF CITIES AROUND THE WORLD ARE BECOMING 'SMART CITIES' – WHAT DOES THIS MEAN FOR THE FUTURE OF CITIES AND HOW IS OPUS HELPING TO EXPLORE SMART CITIES?

Urban population accounts for 54% of the total global population – up from 34% in 1960, and growing. As urban population grows, so do urban problems – from congestion and pollution to resource scarcity and energy inefficiency. Worldwide, interest has grown in exploring the use of smart cities approaches to address issues, grow jobs and to improve citizens' quality of life.

WHAT IS A SMART CITY?

Smart cities can be viewed as a broad, integrated approach to improving the efficiency of city operations, its citizens' quality of life, and growing the local economy.

This results in innovative, sustainable, efficient and liveable urban centres. Ultimately, smart cities are about improving people's lives.

SMART CITIES AND OPUS

Opus recognises that the cities around the world that are getting 'smart' right are doing so not because they have invested in a wide range of technology to run and monitor all aspects of day-to-day life, but

DEVELOPING NEW METADATA STANDARDS

OPUS HAS RECENTLY WON A SIGNIFICANT PROJECT WITH AUSTRROADS TO DEVELOP A NEW METADATA STANDARD FOR ROAD ASSET MANAGEMENT AND INVESTMENT.

Opus has been successful in winning a significant and technically exciting project with Austroads (the association of Australasian road transport and traffic agencies) to develop a metadata standard for road asset management



and investment which will define the framework for asset management data for road controlling agencies in Australia and New Zealand.

The project is a joint initiative by Opus staff located in both Australia and NZ, along with specialist inputs from several sub-consultants. An exciting aspect of the project is that it will contribute to Austroads' strategy around data harmonisation, to improve the efficiency

of road asset management and the effectiveness of investment decisions.

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CANADIAN ADVENTURES

OPUS RESEARCH'S ACTIVITIES EXTEND BEYOND NEW ZEALAND, AS OUR RECENT ADVENTURES IN CANADA HIGHLIGHT.



Opus Research Manager Behavioural Sciences, Jared Thomas

Jared Thomas visited Canada in July 2015 to present work at the 11th Canadian Conference on Earthquake Engineering. He shared some of our New Zealand learnings and new techniques to encourage building owners to seismically retrofit their buildings. This was based on work we had done for the Natural Hazards Research Platform.

WORKING WITH OPUS OFFICES WORLDWIDE

During the week-long trip he also met key Opus staff and clients which led to some opportunities to add value to existing and potential work streams in British Columbia. This was mostly around intelligent questionnaire design, better techniques to gain stakeholder feedback, and improved methods to measure suppressed demand for new infrastructure.

Jared Thomas

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CITY OF KELOWNA CAPITAL INVESTMENT STRATEGY - PUBLIC ENGAGEMENT

A team of Opus staff, including Anna Robak, Technical Principal Global Asset Management, Matthew Rodwell, Senior Asset Management Consultant, and Jean Beetham, Urban Studies Researcher, has recently completed a capital strategy public engagement project with the City of Kelowna (the City) in Canada.

The City had a long list of capital investment projects that staff and the community believed would improve their lives, but the budget wouldn't cover them all. Our team helped the City

develop a survey that would engage and educate their communities, and help the City understand which services the communities wanted to invest more in. The survey provided the perfect opportunity to educate the public about the type and extent of services provided by the City, as well as the household-level costs related to providing, improving or reducing them. The survey will help the public better understand how their rates are used, and how changes in their household rates can directly affect the local services they use.

Opus' innovative approach to public engagement resulted in multiple benefits:

- The City now has a robust methodology for understanding how their communities would prioritise capital funds.
- The ability to get a wider, more locally representative view of the public's preferences.
- A reduction in public opposition to rising costs, such as rates increase. This transparent approach typically reveals that citizens are willing to pay more if they understand and have input into what they are getting.

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NEW TO THE TEAM



RUSSELL STEELE

Russell Steele has recently joined the Opus Research Testing Services team. With his science degree in chemistry from Massey University, he will be undertaking a range of laboratory and field project work including playing a key role in our testing work for the Wellington highway management contract.

Russell has an extensive background in road contracting services and laboratory work, and spent the past 10 years working for Higgins Contractors. His hobbies include alpine and bush tramping, and caving.

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