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WSP Opus Research Issue 14 - July 2018

We are now WSP Opus

Welcome to our new-look newsletter!

Since our last edition of InTouch, our company has undergone significant change. We are excited to announce that, as of December 2017, Opus International Consultants was acquired by a leading global infrastructure consultancy firm WSP – we are now WSP Opus.

As part of an organisation of 43,000 minds operating across 40 countries, we are now better placed than ever to benefit our clients through increased ease of access to international best-practice skills, technologies and innovations across the spectrum of professional infrastructure expertise.

Our focus has been to build strong relationships with the various specialist divisions within WSP – in particular their Digital team (WSP's Software Engineering Division), who are an Amazon AWS and Telstra applications development partner. Headquartered in Melbourne this team of 40 software engineers design, develop and manage web, mobile, and Internet of Things (IoT) applications, and systems integration for major corporations and governments in Australia, New Zealand and globally.

Our New Zealand research and instrumentation teams are working with WSP Digital to deliver remote infrastructure monitoring solutions for various clients. They are also supporting our behavioural and social sciences teams' development of human-centred infrastructure, with the use of bespoke software solutions, based on open-standards and open-source software code and platforms.

Together we provide a unique service offering for clients with the capabilities and experience of both WSP Opus Research and WSP Digital to draw on. We look forward to working on some exciting and innovative projects with you soon.

In this issue

We hope you enjoy the stories we've included about what our teams have been up to. We'd love to hear what you think!

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Resolving motorist–cyclist conflict at driveways

Original entrance, Hutt Road, Wellington

The recent New Zealand-wide surge in investment in urban cycleways has introduced a significant new challenge for cyclists. Cycleways in commercial areas are often interrupted by multiple, busy driveways, where interactions and conflicts between exiting/entering motorists and cyclists on the cycleway negatively impact cyclists' comfort and enjoyment, and – more importantly – their safety.

Many commercial owners are installing an array of solutions, including signage, road markings and – in some cases – technology. But it has been difficult to assess the effectiveness of these installations because only limited guidance, and little or no consistency or evaluation of driveway treatments, has been in place.

To reduce or avoid these conflicts, an innovative design approach was developed by members of the 'motorist-cyclist conflict at driveways' project team and the wider steering group made up of individuals from WSP Opus, the NZ Transport Agency, and Wellington City Council. The design and its iterations, which integrated human psychology factors with smart traffic engineering, was trialled during a recent observational study.

A behavioural success framework was developed to monitor key behaviours in this controlled, before-and-after trial, where cyclist and driver behaviours were coded and analysed using video footage.

Modified entrance, Hutt Road, Wellington

The project team developed, implemented and tested each intervention, or combination of interventions, to determine which one most effectively reduced conflict between cyclists and motorists at driveways.

Feature	Cue to motorists
Zebra crossing style marking	Signal that motorist must yield
Limit line	Signal that motorist must yield and identifies ideal stopping location
Green colour	Raises expectation of a high cyclist presence
Cycle symbol	Indicates cyclist priority use of the space
Speed hump	Reinforces the need to stop at the limit line

Totara Road, Tauranga. Before/after design simulation by WSP Opus Christchurch

The findings indicate that a combination of cost-effective pavement treatment, supported by a physical reinforcer (speed hump), produced a 28% improvement in behaviour change in motorists' exiting behaviour. Cyclists' approach speeds were also significantly improved.

The success of the design is evident as it has been readily adopted in other locations throughout New Zealand.

Want to find out more?

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Upper Hutt Cycleway

Rubberised cycleways

The ultimate in (re)cycling

Cycleways are big news right now, with many new urban and off-road projects either installed or underway across the country. At WSP Opus Research, our pavement materials and behavioural sciences teams are in the final phase of a three-year project to trial an exciting and innovative alternative pavement material to make cycleways even more attractive for the general public to use. Funded by the Ministry for the Environment via the Waste Minimisation Fund and the NZ Transport Agency, with contracting assistance from Fulton Hogan and PCL, our project team recently completed a successful rubberised asphalt trial on a cycleway in Upper Hutt, provided by the Upper Hutt City Council. The asphalt was specially mixed with bitumen that had devulcanised tyre-rubber added to it.

Since the rubberised asphalt surface was laid down, our behavioural scientists have been collecting data by way of intercept surveys to capture feedback on the trial from the local community. The response so far has been extremely positive. WSP Opus has also been using our instrumented bike as a quantitative tool to demonstrate that not only is ride quality for the rubberised pavement comparable to that for standard asphalts, it is also far superior to the ride quality experienced on chip seal and gravel alternatives. Although surface monitoring of the rubberised asphalt is not yet complete, indications are also positive that the modified material will have improved resistance to both fatigue and oxidation – factors that traditionally undermine asphalt pavement durability longer-term.

Our researchers are currently quantifying the levels of chemical compounds that are emitted as gases under manufacturing conditions with assistance from AsureQuality. The aim is to confirm what findings are so far indicating – that there will be no unintended negative side-effects from using rubber waste in this useful way.

What do our pavements people do?

- **Understand behaviour of road and pavement materials**
- **Use advanced techniques to improve the performance and durability of road materials, surfacings and pavements**
- **Develop non-standard and modified pavement materials**
- **Develop sustainable solutions: renewable biomass raw materials, recycling, extreme long-life pavements.**

Want to find out more?

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Lowered speed limits deliver unexpected benefits

Lowering speed limits has been a hot topic of discussion since a recent landmark report – Speed and Crash Risk by the International Transport Forum (an intergovernmental organisation of 59 member countries) – recommended reducing open road speed limits to 70km/h. The report explored the impact of reduced average speeds on road crash and fatality rates in 10 countries and estimates that a 10% decrease in mean (average) speed leads to a 20% decrease in injury crashes and a 40% decrease in fatal crashes.

The report also recommended a speed limit of 70km/h on rural roads without a median barrier.

The relevance for New Zealand is that, across the nation's roading network, over 70% of roads fall into this category. But the Forum's recommendations also raise an important question – are there any benefits to be had from reducing speed limits, in addition to the looked-for reduction in crashes?

WSP Opus Research has recently undertaken research on behalf of the NZ Transport Agency that considers whether reduced speed limits could compensate for the current inability to achieve recommended skid resistance levels on state highways . This inability has been brought about by the local scarcity of natural aggregates capable of providing high levels of friction throughout a road surface's life.

The research resulted in development of an analysis framework to facilitate assessment of the impact of lowering both wet friction levels (which state highways are managed to) and speed limits on crash risk and road user costs. This framework has been based on vehicle speed-related procedures incorporated within the NZ Transport Agency's Economic Evaluation Manual, including travel times, vehicle operating costs, carbon dioxide emissions and crash severity. New Zealand-specific relationships between road surface skid resistance levels and crash risk were also employed, and relationships for all vehicle types, including motorcycles were factored in.

Application of this framework has shown that, should the open road speed limit be lowered in line with recommendations, the following **significant road user benefits** are anticipated:

- **reduced vehicle operating costs** through lower wear and tear on mechanical components and fuel consumption
- **reduced crash risk and severity**
- **reduced CO2 emissions** through lower fuel consumption
- **prolonged useful life for road surfacings** through reduced tyre forces.

All of which provides good supporting evidence that reduced open road speed limits will not only result in increased journey times, but also in a range of positive longer-term benefits.

To provide a snapshot of savings possible, the framework was applied to a 10km section of State Highway 58, with a 100km/h speed limit. This showed that if the maximum permitted speed was reduced by just 10km/h to 90km/h, the following benefits would result:

- Skid resistance could be relaxed by 20% to 30% for curves without a resultant increase in the risk of a loss of control crash occurring. This means that lower-cost local aggregates could be used, or alternatively, if more expensive polishing-resistant aggregates have been brought in, these would last longer.
- Significant cost savings in the order of $2.8 million per annum for motorists, including reduced vehicle operating costs through a reduced need for speed changes at curves. By comparison, the 0.7 minute increase in journey time is costed at $1.8 million per annum, meaning that, for this situation, the reduction in vehicle operating costs more than compensates for the increase in journey time.

"... a 10% decrease in mean (average) speed leads to a 20% decrease in injury crashes and a 40% decrease in fatal crashes."

What do our road safety people do?

- Solutions development to prevent injury in transport and built environment situations
- Statistical crash modelling, slip and skid testing, structural integrity, human factors evaluations
- Active participation on safety-focused review panels
- Expert reviews for safety-focused journals
- Research activities include road crash reconstruction modelling, pedestrian slip testing, instrumentation and data capture, evaluation of safety interventions, structural integrity testing, human factors evaluations.

Want to find out more?

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Novel solution to assess road seal performance

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

To address this gap, the WSP Opus Research teams designed and constructed the CAST (Circular Accelerated Surfacings Tester) machine, which enables laboratory-based studies of road surfacing and road marking materials under realistic traffic speeds and temperature-controlled conditions.

The CAST machine's wheels can travel at speeds of up to 50km/hr, with controlled acceleration and deceleration. Cooling/heating fluid is circulated through an aluminium plate to control the temperature of the test specimen, and the air temperature within the chamber is also controlled. This helps to ensure that results are achieved under consistent conditions.

The machine's circular nature enables it to effectively simulate pavement stresses at bends. In combination with photogrammetry which is an image analysis technique, the machine allows the team to quantify damage incurred and also to explore damage mitigation options for future real-world benefits.

The CAST machine is now two years old, and it has enabled us to investigate the effect of temperature on binder performance, the strength of different seal designs, and how road materials in general behave under high horizontal stresses.

Want to find out more?

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Inside the CAST machine
Photo by Lance Lawson Photography

Standing the test of time: Analysis and interpretation of Long-Term Pavement Performance (LTPP) data

Our pavement research specialists recently undertook a comprehensive statistical analysis and review of the Long-Term Pavement Performance (LTPP) dataset for the NZ Transport Agency. The analysis demonstrated that the numerical dataset was not sufficiently robust to discover useful or significant correlations in its existing form.

Despite this apparently considerable limitation, there is however still a significant wealth of information contained in the visual observations, records and photographs stored within the LTPP database. Perhaps surprisingly, this has the very positive potential to contribute to a greater understanding of distress and maintenance activities at each site.

The purpose of the research project was to examine the LTPP database to determine:

- Maintenance strategies with proven ability to achieve optimum pavement life
- Any maintenance strategies that result in undesirable pavement performance outcomes
- Impact of surfacing conditions on pavement life
- Effectiveness of different maintenance interventions (including intervention timing)
- Scope to improve LTPP experimental design.

The team also investigated whether LTPP data could, in its current form, help to:

- Identify trends
- Identify key factors leading to pavement failure
- Determine whether pavements that display cracking are at a higher risk of failure than other pavements.

Our research included a manual investigation to identify sites highlighted by the statistical analysis, as well as interpretation of supplementary site photographs, site notes and construction records. The team was unable to identify any reliable data to confirm that pavements that display cracking are at higher risk of failure than other pavements.

The research did, however, determine that some current maintenance treatment types, and the quality of maintenance/reconstruction practices, could lead to worsening levels of service following maintenance, compared with sterilised sites where maintenance is restricted to emergency repair work only. The maintenance practice of water cutting, for example, was identified as needing careful consideration before use, as it appears to contribute to more rapid condition deterioration than other interventions.

Our research has resulted in various recommendations around how the dataset could be restructured to provide additional, and more accessible, benefits, given the considerable scope to improve the quality of the data in the LTPP and the road assessment and maintenance management (RAMM) database.

Want to find out more?

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Application of a proprietary binder bandage crack seal
Photographer unknown

Remote crack monitoring

Cracking is one of the most common defect types captured during the structural inspection process. Crack movement is usually recorded using gauges or crack cards; however, the downside of this approach is that results can be very subjective. These gauges are unable to record the history of crack movement, which is potentially far more useful than simply knowing that a crack has occurred. They are also unable to capture details around when crack movement has occurred (for example, as the result of an earthquake, or daily movement caused by diurnal temperature fluctuations). Not all cracks will impact on an asset's viability, but understanding when and how actively structural cracks are propagating provides key information for asset owners to better manage their assets over the longer term.

To address this issue, the WSP Opus Research team has developed new innovative electronic gauges that can read both size and movement of cracks to an accuracy of 0.001mm. Depending on the sampling rate, theses gauges have standalone power of 6-12 months (~12months' life can be achieved when data is collected at a rate of one reading per hour). The gauges are inexpensive and easy to install, and are currently in operation on several strategic road tunnels and bridges around New Zealand.

The new gauges have proved so successful that they have now been configured to measure and record movement (as opposed to cracks per se). These second edition gauges are being used to measure the movement of bridge bearings and other structural movements.

The gauges work by either storing collected data on an SD card, or by bundling and transmitting the collected data via text message to engineers for analysis. From June 2018, collected data from these gauges will be available in near real-time, depending on frequency of sampling and transmission.

Electronic movement/crack gauges enable significant asset management cost savings to be made. Propagation of cracks and other asset defects can be accurately measured and used to demonstrate movement history and trends. This in turn provides asset owners and managers with tangible justification for Forward Works Plans. Data findings from a gauge installed at the Johnsonville Hill Road Tunnel, for example, demonstrated that annual inspections are probably not required as per the O&M manual, resulting in an estimated saving of over $10,000 across a six-year inspection cycle.

Want to find out more?

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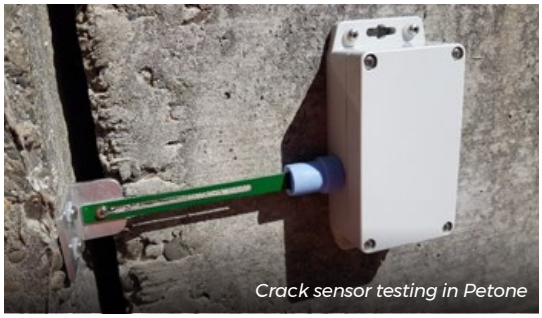
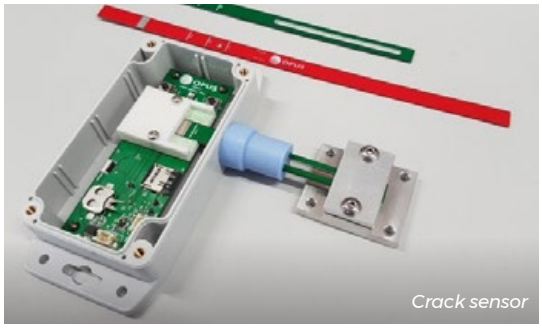
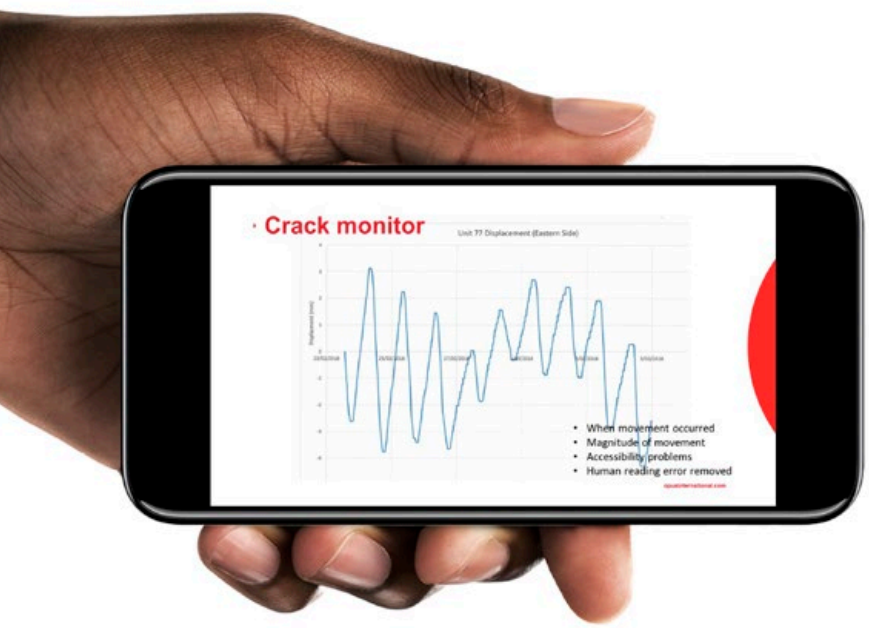


Crack sensor testing in Petone



Crack sensor



Crack sensor on Johnstone's Hill Tunnel

Structural testing and steel compliance capability

Over some five years the Structural Testing Laboratory has significantly developed its steel testing capabilities. The laboratory was IANZ accredited for tensile testing of steel reinforcing materials in December 2017, in accordance with the New Zealand, Australian and international industry standards.

Thanks to the cutting-edge instrumentation and computer-controlled testing machines we have invested in, which are calibrated for forces of between one and 200 tonnes, we are now able to offer our clients testing to meet compliance with all of the referenced standards in AS/NZS 4671:2001 Steel reinforcing materials for tensile testing (namely, ISO 6892-1:2016 Metallic materials – Tensile testing – Method of test at room temperature, ISO 15630-1 2010(E) Steel for the reinforcing and pre-stressing of concrete – Test Methods and AS 1391:2007 Metallic materials – Tensile testing at ambient temperature). Our accreditation is valid for conventional and seismic reinforcing bars ranging in size from 6 to 50mm in diameter. We also offer the complete suite of testing for reinforcing material as detailed in AS/NZS 4671:2001 – for example, bending testing and geometric checks.

Tensile testing of 6mm steel mesh reinforcing bar - Instron machine

Want to find out more?

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Tensile testing of 50mm seismic reinforcing bar - Servotest machine

To seal beside or to seal over? Best-practice rumble strip management

Rumble strips – or audio tactile profiled (ATP) roadmarkings – are lines with raised ribs designed to 'rumble' and be heard and/or felt when driven over. The effective life of ATP roadmarkings can be six to eight years, possibly even longer, depending on climatic conditions and levels of road use and wear.

Of most interest to road asset managers, ATP roadmarkings sometimes still have effective life remaining when the road they are on needs resealing. This led the NZ Transport Agency to commission research into practical options to retain the noise and vibration benefits of ATP roadmarkings through resealing cycles.

There was little in the way of existing literature or experience relating to the retention of ATP roadmarking benefits when roads are resealed. Two innovative techniques are currently being piloted or are in actual use on roads:

- In-lane resealing, where the road surface of the trafficked lane adjacent to existing ATP roadmarkings is resealed, but the non-trafficked shoulder and the ATP roadmarkings themselves are not resealed.
- Sealing over existing ATP roadmarkings, with the intention that the noise and vibration benefits will be retained through the reseal layer.

Our team designed a research project to examine the effectiveness of both techniques, including field measurements of in-vehicle noise and vibration levels while driving on ATP roadmarkings.

Our recommendation from this research is that in-lane resealing is the preferred option in situations where resealing is required and ATP roadmarkings still have effective noise and vibration life remaining. Our research has found that in-lane resealing offers the most certainty of the two trialled techniques that noise and vibration effects of the ATP roadmarkings will remain effective after a road is resealed.

Other recommendations to have come out of this research project include:

- ATP roadmarkings should be considered an asset and managed as such, including performance monitoring.
- Best-practice ATP roadmarkings management approaches could include regular subjective assessment of the roadmarkings' noise and vibration effects and visibility (given that objective measurement techniques are more complex and less readily available).

Want to find out more?

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Understanding why people do what they do

Understanding the motivation behind public behaviour is a key aspect in identifying and prioritising possible mechanisms for change. In the natural hazard space, we work closely with emergency managers, planners, policy makers, business community organisations, and infrastructure owners to undertake research that makes an important contribution to strategies and policies to build and strengthen New Zealand's resilience to hazard events. Our work covers more traditional topics – such as wind loads and liquefaction – and extends to topical issues including the use of social media in emergency management, improved public response to earthquakes and floods using emerging technologies (including virtual reality training tools), and the acceptance of the risk posed by older commercial and heritage buildings.

In the smart mobility and cities space we capture new behavioural insights and social data to better understand what people want and need. To optimise our safe use, enjoyment and access to our vibrant cities, places and spaces we capture unique data to understand:

- How are people using these environments now?
- What motivates this behaviour?
- How would we like to do things differently?

This ensures our infrastructure, design solutions and policy direction are people-centred and future ready.

• How are people using these environments now?
• What motivates this behaviour?
• How would we like to do things differently?

Our work here covers strategic direction – such as social infrastructure solutions for the Welsh government, smart mobility initiatives for Auckland Transport, and meeting the multi-modal needs of the next generation of travellers. As well as innovative monitoring and design solutions – such as improved safety in design for our more vulnerable travellers, especially pedestrians, cyclists, motorcyclists, and visiting drivers.

Want to find out more?

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