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Ongoing road trials on State Highway 1 are demonstrating the satisfactory performance of EMOGPA surfacing 'in the field'

# Seeking longer-life solutions for open-graded porous asphalt surface

Laboratory and field tests of epoxy-modified open-graded porous asphalt surfaces (EMOGPA) have shown that they offer far superior cohesive properties, lifetimes and fatigue lives than surfaces constructed using conventional bitumen binders.

Even though they are more costly to construct - the cost of an EMOGPA surface is likely to be around 2.3 times that of a standard open-graded porous asphalt one (OGPA) - the better performance of the epoxy-modified model makes it an attractive option for road authorities seeking long-life pavements. What is more, research has established that EMOGPA surfaces can be manufactured and constructed without any significant modification to existing plant or operating procedures.

The research, carried out by Opus International Consultants with support from Fulton Hogan Ltd, is part of a broader collaborative research project being spearheaded by the OECD's and European Conference of Ministers of Transport's joint transport research centre.

The larger project (which involves research agencies and organisations from eight countries) is investigating the potential for epoxy-modified asphalts of various designs, and a thin cementitious material especially formulated for

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## Your views

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the project, to provide pavement surfaces with very long lifetimes (greater than 30 years).

The New Zealand arm of the research focuses on the potential benefits of EMOGPA and follows on from earlier laboratory investigations of OGPA manufactured using an epoxy-modified bitumen. The current research report also includes results from a concurrent project examining the effects of diluting the epoxy binder composition as a way of reducing costs.

Phil Herrington of Opus explains how, although OGPA is widely accepted as a safe and environmentally friendly surfacing, its use in New Zealand is undermined by issues associated with binder oxidation.

'Binder oxidation is the principal factor affecting the ultimate life of an OGPA surfacing,' says Phil. 'Because of the material's very open nature, oxidation is more rapid than with conventional mixes. Oxidation leads to the binder becoming brittle, which in turn leads to the mix failing through loss of material from the surface under traffic-shearing stress. As a result, OGPA surfaces develop rough, uneven riding surfaces, and their average lifetime is relatively short at 10 to 11 years. This, of course, adversely affects their benefit-cost ratios and inhibits their more widespread use.'

'We wanted to investigate the potential for EMOGPA to improve the lifespans of open-graded surfaces. EMOGPA uses the same mix designs as conventional OGPA, but with the bitumen component replaced by a binder that also incorporates a reactive epoxy resin and curing agent. Such binders tend to cure over time to a hard, slightly rubbery consistency, which is more resistant to oxidation and abrasion.'

## The research

The research used laboratory testing to investigate the curing behaviour and durability properties of EMOGPA, and a road trial to monitor its ongoing performance.

The epoxy-bitumen used in the research was a two-part solvent-free product designed to be blended just before use: part A was an epoxy resin formed from epichlorhydrin and bisphenol-A; part B was a fatty acid curing agent in approximately 70 penetration grade bitumen.

Asphalt specimens were compacted by Marshall Hammer, and the effect of oxidation on them was then studied by

measuring changes in their moduli and abrasion resistance using the Cantabro Test.

A standard 20% air void mix design was tested, as was a 30% mix. Also tested (in the concurrent research) were mixes where the epoxy binder had been diluted with standard bitumen to 25% and 50% of the full epoxy binder composition.

The road trial laid sections of both the 20% and 30% air void EMOGPA surface, and a control surface of 20% air void OGPA constructed using 80-100 penetration bitumen, on a stretch of State Highway 1 in Christchurch that carries more than 15,000 vehicles per day.

## The outcomes

Phil says, 'The results confirmed the findings from our earlier research that show that EMOGPA is resistant to oxidation. The material was essentially unaffected, in terms of abrasion loss, even after being subject to oxidation approximately equivalent to what it would experience after 20 years in the field.'

'With conventional OGPA you would expect the surfacing to have failed long before then, but with EMOGPA, although the modulus continues to increase over time, this does not lead to increased abrasion loss. Nor does it lead to reduced fatigue life, which was found to be at least 25 times better than that of the control.'

'By extrapolating the abrasion data from heavily oxidised specimens, the research predicted a potential field life of around 144 years for EMOGPA surfaces. Even for the diluted mixtures, lifetimes of around 93 years were predicted. Similar results were returned, with respect to fatigue testing the full EMOGPA mix, with lifetimes improved by over 25 times. The diluted mixes showed no significant improvement in this respect. However, even for the diluted mixtures, the material did not become excessively brittle or likely to crack prematurely when subject to fatigue.'

Phil says, 'So even though diluting the epoxy binder with standard bitumen produced an OGPA mix with inferior properties to the undiluted mix, we're still seeing a surface that has markedly superior abrasion resistance, and equivalent fatigue life, to conventional OGPA. When you add cost into the equation, the cost of a full EMOGPA surface, in place, is likely to be in the order of 2.3 times that of a conventional OGPA surface, but with a vastly extended lifetime. For the diluted

mixes, the cost is likely to be around 1.3 to 1.6 times more.'

The field trials, which are still running, also support the satisfactory performance of EMOGPA surfacing, with no significant difference noted between the sections in terms of rutting, skid resistance or traffic noise.

Phil says, 'The trials are only three years old and still need to be monitored to establish EMOGPA surfacing's durability over time. What they have already demonstrated though, is that a full-scale EMOGPA surface can be manufactured and constructed using standard plant and equipment. Only very minor changes are needed to practices too – mainly greater control of the time that the mix is maintained at high temperatures, and the need to ensure that the epoxy binder is not under-cured or over-cured at compaction. Other than that, we noted no unusual fumes or smells (which had been a concern) and the trial sections were opened to traffic the same afternoon.'



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*Epoxy-modified porous asphalt*  
NZ Transport Agency research report 410

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# Public transport trends build picture of future demand

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Understanding the factors that influence public transport patronage, so that transport operators and funding agencies can better estimate future demand, was the objective behind a recent research project carried out for New Zealand's three largest cities.

Conducted by Booz & Company in 2008 and 2009, the study applied econometric analysis to model bus and rail service patronage in the Auckland, Wellington and Canterbury regions, covering the three largest cities in the country.

Judith Wang, who headed the research team, says the study flowed from earlier research, which had successfully applied econometric analysis to understand the impact of petrol price changes on petrol consumption and traffic volumes.

'What came out of the previous study was that, although petrol prices had some influence on public transport patronage, there were other more significant factors at play. In the current study, we were seeking to identify and explore those influences, so that we could better understand how they affected demand,' says Judith.

Accordingly, the research set out to:

- identify the key factors affecting public transport patronage
- estimate the elasticities with respect to each of the factors identified
- develop forecasting models for use by transport operators and funding agencies to estimate future demand.

## What the models said about patronage

Judith says, 'As was to be expected, the models showed that the three cities all had different characteristics, and as a result the drivers behind the long-term and short-term trends were also different.'

Major findings included that fluctuations in fuel prices in recent years have had a positive impact on public transport patronage in all three cities, although not on all modes. In particular, although fuel prices had a significant influence on bus patronage in both Auckland and Christchurch, the substitution effect (with people electing to take the bus rather than drive their car) was more pronounced in Christchurch, due to higher per capita levels of car ownership and better bus service levels.

Of the five determining factors considered, service was identified as the key factor driving increased patronage in all the cities and all the modes (except Wellington buses). Judith says, 'This is a very encouraging result, as it shows that the investment in public

transport infrastructure, and the new and improved services introduced over the past decade, have had a tangible, positive, influence on patronage in all the cities. This is the type of information agencies and authorities need to have to hand when making investment decisions for the future.'

Fare also had a significant influence, albeit a negative one, on patronage in all of the cities, although interestingly not on all of the modes. The latter finding was most evident in Auckland where, unlike the other two cities, fare levels did not appear to affect bus patronage. Judith says, 'With Auckland being the biggest city, a higher proportion of the population depends on public transport to get around. As a result, fares have less influence because for some residents, taking the bus isn't a matter of substitution or choice.'

Other significant findings included:

- in Auckland, service and fare elasticities were higher for rail services than for bus services (which could be attributed to recent improvements in the city's rail system)
- income was also found to have a positive effect on Auckland's rail patronage, which was contrary to a negative influence on patronage in Wellington and internationally (again, this unusual positive effect can be explained by recent infrastructure investments and service improvements, which have changed the Auckland rail market by attracting a greater proportion of commuters with higher incomes)
- car ownership had significant negative influences on demand for Auckland bus and Wellington rail services, and was among the most elastic of all the factors identified
- increased fuel prices were more significant than increased fares as a result of the increased prices (in other words, public transport was still considered relatively cheap compared to driving)
- Wellington has a more mature commuter market than either Auckland or Christchurch, creating the highest rate of public transport use among the three cities. In addition, it has the highest walking mode share (due to its compact CBD) and its council has a committed parking restraint policy in the central area, rendering its elasticity estimates generally lower (less elastic) than those for Auckland and Christchurch.

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### Developing the models

As an initial step, the project looked at historical trends in public transport patronage in Auckland, Wellington and Christchurch for the past decade, examining the stories behind the trends to understand what factors might have had significant influence on the observed changes.

Six variables emerged, which were then used to develop short- and long-term forecasting models for the major transport modes in each region.

The dependent variable for each model was patronage (measured in trips per capita). This was influenced by three economic and two structural factors:

- economic determinants
  - service level (in bus/train kilometres per capita)
  - real fare (in real revenue per passenger)
  - real income (in real disposable income per capita)
- structural determinants
  - car ownership (in cars per capita by region)
  - real fuel price.

Estimates were then calculated for demand elasticity with respect to each of the factors that were found to have significant influence, as they applied to bus and rail services, in the three regions.

Judith explains, 'The feasibility of econometric analysis depends on data availability, which means that meaningful forecasting models can only be built if we have access to all the relevant data. We had been hoping to develop both regional and national short-term and long-term forecast models, but as it turned out, differences in the data we collected for the three regions meant we were only able to take a regional approach. We applied dynamic econometric models so that changes over time could be captured in the model, which also meant that the short-term and long-term elasticities for each of the factors could be determined simultaneously by the one model for each mode in each region.'

Model forms used for each of the public transport modes in the three regions are set out in the full research report.

SUMMARY OF FACTORS INFLUENCING PUBLIC TRANSPORT PATRONAGE IN NEW ZEALAND

	Auckland		Wellington		Christchurch
	Bus	Rail	Bus	Rail	Bus
Service	positive	positive	n/a	positive	positive
Fare	n/a	negative	negative	n/a	negative
Car ownership	negative	n/a	n/a	negative	n/a
Income	n/a	postive	n/a	negative	n/a
Fuel price	positive	n/a	n/a	positive	positive

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*Appraisal of factors influencing public transport patronage,*  
 NZ Transport Agency research report 434  
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# Double-take on walking and cycling yields interesting results

Over the past decade, active transport has been promoted by agencies in the transport, health and physical activity sectors.

Examining the crossovers and differences between data collected by each of these sectors was the aim behind a recent project with a particular focus on the Active New Zealand Survey.

Sport and Recreation New Zealand's Active New Zealand Survey (ANZS) was conducted over 12 months in 2007 and 2008. Over 4000 adults took part in face-to-face interviews about their sport and recreation activities and levels of physical activity in general. A feature of the survey of interest to the transport sector was that it

recorded walking and cycling for recreation purposes, separately from a means of transport.

The potential of this data to add to existing transport-focused data was explored in a recent NZ Transport Agency-funded research project. Charles Sullivan, formally of Capital Research Ltd, who led the research, says that the project's broad objective was to improve active transport measurement and monitoring, and collaboration over data collection and analysis between the various agencies in New Zealand.

'The Ministry of Transport has had a strategy to increase walking and cycling for several years,' says Charles. 'But there has also been growing interest from the health and physical activity sectors about how active transport can be incorporated into, and counted as part of, people's daily activity levels.'

'There are obvious opportunities, both in terms of cost-savings, and with respect to the breadth and depth of data available, in agencies from different sectors collaborating over the data they collect. The Active New Zealand Survey was a particularly far-reaching and high-quality survey, easily overlooked by the transport sector, so we took a particular focus on what it could tell us about active transport. A secondary aim was to compare walking and cycling results from that survey, with results from the Ministry of Transport's ongoing New Zealand Household Travel survey.'

Findings of interest included that active transport is relatively common. Over one-third (38%) of adults had walked, jogged, run or cycled for transport purposes in the past week (for at least 10 minutes at a time). Fully 370 million hours were spent walking each year, with 37% attributed to transport and the remainder to sport and recreation. Similarly, 34 million hours per year were spent cycling, 29% for transport and 71% for sport and recreation.

Charles says, 'What the survey provides us with, for the first time, is sound quantification between time spent walking and cycling to get around, and time spent predominantly for leisure. There is a qualification, in that only stretches of activity lasting 10 minutes or more were recorded in the Active New Zealand Survey, in line with its health and physical activity focus. One particular implication is for the New Zealand Household Travel Survey, where cycling results have often been reported as being 'for transport'. From the Active New Zealand Survey, we can see that this is not the most common motivation for people cycling, even if they are cycling on the road, rather than mountain biking. It is natural for users to assume that cycling results from a major Ministry of Transport

survey are mainly about cycling done for transport reasons, but that's probably not the case.'

Other findings of interest included:

- walking for transport decreases with age, whereas walking for recreation increases (see Figure 1)
- far more women walk for recreation than men, but there are no major differences in the genders of those using their feet to get around (see Figure 1)
- relatively few adults meet the Ministry of Health's '30x5' guideline for physical activity (at least 30 minutes of moderate physical activity on five or more days a week) through active transport alone
- active transport does make an important contribution towards the 30x5 goal, with around one-fifth of adults engaging in active transport at a moderate level on at least one day per week. More than half (57%) of active transport was carried out at a moderate or vigorous intensity level, highlighting its potential to form part of a healthy lifestyle.

Note: The lines extending above and below each plotted point show margins of error (95% confidence intervals).

The second aim of the research, to compare results in the Active New Zealand and New Zealand Household Travel surveys (and explain the reasons for any differences), also produced some interesting findings. In particular, the estimate for the amount of time that adults spent walking, jogging and running in the former survey was much higher (over double) than in the latter.

Charles says, 'The message for users of results from the surveys is to be aware that the two surveys may report very different results for things with similar labels, such as 'total walking' or 'total walking/jogging'. The surveys in fact record very different types of activities and users need to allow for this when attempting comparisons between them.'

Figure 1 Time spent walking during previous seven days (Active New Zealand Survey 2007/08)



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While the research was wary about suggesting changes or additions to the two major surveys looked at ('Because maintaining consistency over time is central to their value,' says Charles), it did recommend that trends in transport-related walking and cycling should be monitored separately from walking and cycling done for recreational purposes, and that the Ministry of Transport should look at alternative ways to do this. Other recommendations flowed from analysis of, and comparisons between, the two surveys' approaches and data.

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*Walking and cycling: improving combined use of physical activity/health and transport data, NZ Transport Agency research report 435*  
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# Psychology meets engineering to improve work site safety

## A recent study has combined traffic psychology with traffic engineering to better understand the factors that influence driver speeds around roadworks.

Roadworks are recognised road safety hot spots. Crashes between vehicles and other vehicles, road works infrastructure and site workers more common than is desirable. A recent project, carried out by Opus Central Laboratories, aimed to minimise the number of crashes occurring at roadwork zones in New Zealand by developing a model to set appropriate speed limits for specific sites.

Stephen Murray, formerly of Opus Central Laboratories, says that, although there is already a code of practice for setting speeds for work zones, this is relatively straightforward, without a lot of flexibility to take into account the various factors that can affect risks at specific sites.

'Crashes at work zones tend to occur due to interactions between vehicles, the environment, and driver factors,' says Stephen. 'The main causes can be categorised as:

- driver distraction, which can happen when drivers are looking for directions or activities on the side of the road
- conflicts between construction activities and traffic
- site workers whose lives are in constant danger due to the risk of crashes, and reduced vehicle-flow capacity and speed.

'The latter factor in particular is one of the major concerns associated with work

zones. Congestion and queues caused by works create a huge hazard in terms of rear-end crashes, especially where the road configuration at a particular site means that drivers may be unaware of the queue before they reach its tail, or misjudge the time required to slow down. All of these factors need to be adequately taken into account if we are to set safe speeds around work zones.'

The research combined traffic engineering and traffic psychology in an effort to better understand the factors that influence drivers' speeds. Eight work zones were studied where temporary speed limits had been set using existing guidelines. Sites covered a range of speed limits and visibility conditions, and data about drivers' speeds was collected from two locations within them. One hundred drivers were then selected from each site, and sent surveys about what they estimated their speed to be, their general attitudes to roadworks and driving speeds, and their perceptions of risks at roadwork sites.

Stephen says, 'What we found is that, although drivers did reduce their speeds as they approached roadworks, their speeds were still consistently higher than the temporary speed limits that had been set for the sites. From the surveys we found that drivers' attitudes to roadworks and speeding in general are more closely

related to what they estimate their speeds to be, than to their actual speeds. In addition, drivers' subjective perceptions of risk had no measurable effect on their driving speeds through roadworks.'

As a result, the research recommended that work sites should be designed to either reduce driver speed further or be safer at higher operating speeds (the actual speed that drivers use through the site). A model was developed that enabled the safe speed limit for a site to be accurately assessed and the actual operating speed to be estimated; the two speeds are then compared, enabling adjustments to the speed or site to be made.

Stephen says, 'Applying the model during the site design phases will enable any necessary changes to be made before work begins. There is still room to improve the model, particularly with respect to estimating driver speeds and understanding the factors that influence them, but overall the model works well.'

# How to set safe speed limits at work sites

The full research report sets out a detailed model that can be used to set temporary speed limits and design traffic management plans for roadwork sites.

The model involves estimating an appropriate safe speed for the site (based on an assessment of various factors or conditions) and comparing this to the actual operating speeds of vehicles passing through the site. The relationship between the two speeds (ie whether the actual speed of vehicles is less than, the same as or greater than the identified safe speed) will indicate whether improvements are needed to the site's traffic management plan to bring the two speeds more in line.

Conditions that need to be taken into account when estimating a safe speed for a work zone include:

- danger to the public and site workers
- skid resistance
- loose material on the surface that could harm workers or vehicles
- restrictions to visibility
- surface friction
- objects or equipment that could be dropped onto the live lane or otherwise affect traffic flow
- reductions in lane numbers
- emergencies (eg floods, slips, accidents)
- changes to vehicle stability caused by the roadworks
- temporary roadways
- roadside devices, such as cones or barriers
- traffic being directed to cross the median line and lane shifts
- weather conditions
- narrow shoulder and lane widths
- new seal.

These conditions are then used to estimate a safe speed limit for the site. As a basic guide the model recommends that the limit can be any multiple of 10 within the range 20 to 80km/h, but must be at least 20km/h less than the existing speed limit on the road. 'Stop and go' or 20km/h should be posted in an emergency or an unavoidable situation (in general, if limits are set too low, motorists tend to ignore them), and that:

- if all the conditions are safe, then use the existing speed limit
- if one or more of the conditions are unsafe, then reduce the speed limit by 10km/h for each condition
- if one or more of the conditions are severe, then reduce the speed limit by 20km/h for the first condition and 10km/h for each subsequent condition
- if all the conditions are rated as low risk, then reduce the speed limit by 20km/h.

Existing models developed by previous research were adopted to work out actual operating speeds at work sites. These were then compared with the identified safe speed limit to set a reasonable temporary speed limit for the site.

Essentially:

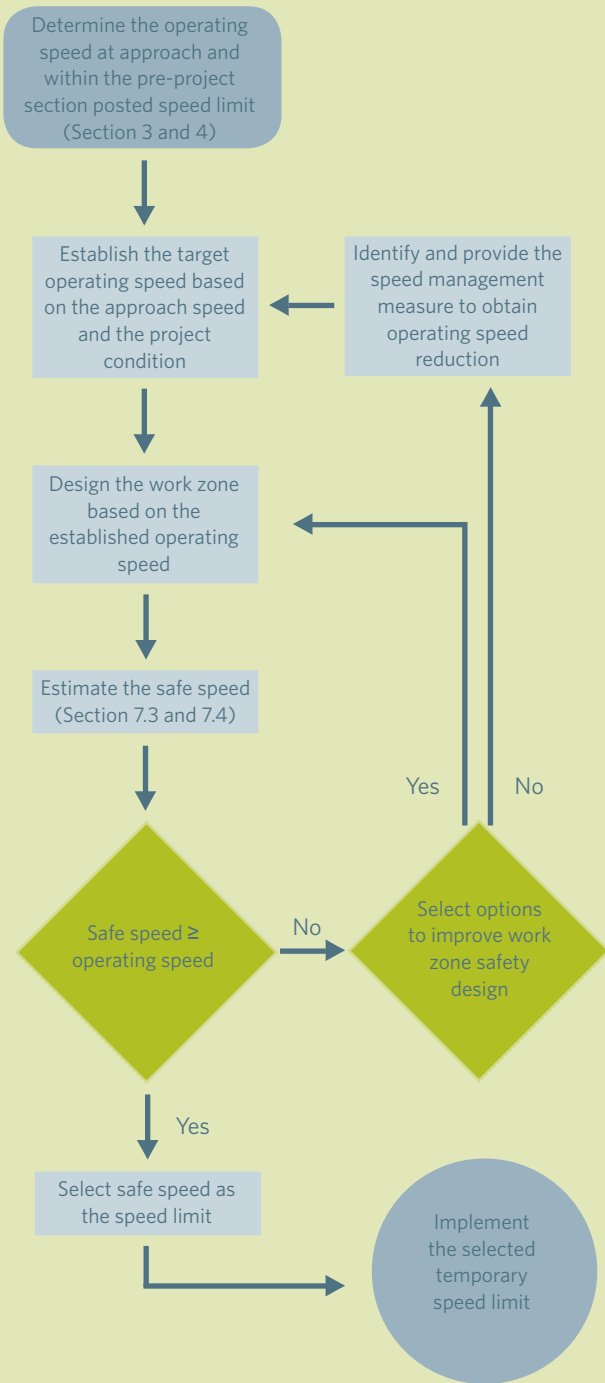
- if the safe speed is greater than the actual operating speed, then the safe speed should be selected as the temporary speed limit
- if the safe speed is less than the actual operating speed, then site safety conditions should be improved and the safe speed re-estimated (with the process continued until the operating speed is the same as or less than the safe speed). If it is not possible to improve site safety, then traffic management measures (such as speed trailers, warning devices and lane narrowing measures) need to be used to reduce operating speeds until they are the same as or less than the safe speed.

The flowchart on the next page gives an indication of the overall process.



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**Flowchart for establishing a reasonable work zone site-specific speed limit**



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 NZ Transport Agency research report 407  
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# New research publications

***'I'll just take the car' Improving bicycle transportation to encourage its use on short trips***

Research report 426

Massey University and Otago Polytechnic

Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)

Hard copy \$45

Cycling for transport in New Zealand is a minority activity, yet the recreational cycling market is growing. The car is the most popular choice of travel mode by far. There is a clear desire to encourage more practical cycling in New Zealand, but limited understanding of who will be the next practical cyclists and how to encourage them. This research, from July 2008 to June 2010, applied the affective design methodology to the goal of increasing practical cycling in New Zealand. A literature review revealed that overseas best practice is for integrated local cycling policies. Theories of diffusion of innovations and contemplation of change were highlighted and used to inform the project. A review of the New Zealand cycling market showed limited choice of and access to practical cycling tools. A survey of 234 New Zealand cyclists and non-cyclists demonstrated differences between the groups in perception of bicycles and cyclists, with more agreement for unfamiliar practical cyclists and bicycles. Practical workshops explored the effect of direct cycling experience on perceptions. A 'practical cycling system design model' was proposed, along with recommendations for its implementation.

***The mechanisms and types of non-motor vehicle injuries to pedestrians in the transport system and indicated infrastructure implications***

Research report 431

Opus Central Laboratories

Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)

Hard copy \$20

Research carried out in 2008–2010 examined the quantum and causes of non-motor vehicle injuries to pedestrians through a structured interview survey. Pedestrians sustaining injuries in locations away from the road network (eg in parks) were excluded, as the emphasis was on the role of road and footpath features. The highest proportion of trips and falls (34%) were sustained while stepping over a kerb. A further 18% were caused by irregularities in the path or road surface. Factors that amplified the severity of injuries included the road or path surface, pedestrians' inattention, type of footwear worn, and whether walking or running. Two main issues were identified from the study. These were:

- (1) people tripped and fell more often on poorly maintained surfaces as opposed to poorly designed areas, and
- (2) the severity of the injuries is directly related to the surface.



The study recommends improving the definition of kerbing in key pedestrian areas and improving the maintenance regime of footpaths and roads used by pedestrians, eg crossings. The study also found that it is necessary to instigate research to provide improved data and analysis tools to prioritise such countermeasures in relation to other uses of road safety funds and improved data for input into such analysis tools. Further, a national guide is needed for pedestrian road safety audits and inspections covering both motor vehicle and non-motor vehicle risk.

### ***Benefits of new and improved pedestrian facilities - before and after studies***

**Research report 436**

**Beca Infrastructure Ltd**

**Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)**

**Hard copy \$65**

Walking is an essential mode of transport. New and improved pedestrian facilities promote walking and provide greater access and mobility within our communities.

The NZ Transport Agency has recently updated the procedures for the evaluation of pedestrian improvement projects. The benefit factor applying to new pedestrian trips was increased from \$0.50 to \$2.70/km, making pedestrian facility improvement projects more economically viable. Thus, estimating the increase in pedestrian flows (as opposed to simply recording existing pedestrian flows) is now important in the economic evaluation of new or improved facilities.

This research analysed case studies at eight New Zealand sites where the implementation of new pedestrian facilities (or the improvement of existing facilities) led to increased pedestrian usage and improved perception of the sites. The study recorded pedestrian rates both before and after facility implementation, and analysed accompanying factors such as safety, delay and directness. It also tried to develop an expected pedestrian-usage model, based on before and after data analysis, for planners and funding agents to use when planning new or improved facilities, and for use in project evaluation.

Finally, a monitoring database containing before and after pedestrian count data for various new and improved pedestrian facilities, along with a list of the accompanying factors mentioned above, was developed for future use.

### ***Reducing pedestrian delay at traffic signals***

**Research report 440**

**Beca Infrastructure Ltd**

**Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)**

**Hard copy \$30**

Since 2000, the benefits of walking as a mode of travel have been recognised by the New Zealand government in a raft of policy statements and strategies. However, the Ministry of Transport acknowledges that there are a number of issues to overcome to encourage more walking. This research focuses on one of the key issues: namely, the delay experienced by pedestrians at traffic signals.

Historically, New Zealand's approach to pedestrian delay has been minimal, with pedestrian issues considered primarily from the point of view of safety, rather than level of service or amenity. At traffic signals, pedestrians are often accommodated in a way that causes the least amount of interruption to motorised traffic, and signal cycle times can be long, leading to excessive pedestrian waiting times. This can lead to frustration, causing pedestrians to violate the signals and use their own judgement to cross, resulting in safety risks.

This research, which was carried out between 2007 and 2010 in Auckland, Wellington and Christchurch, used techniques such as pedestrian attitude surveys, micro-simulation modelling and a literature review of international best practice to identify methods of reducing pedestrian delay at signalised intersections in these cities. The recommendations developed during the course of the research provide both technical and policy mechanisms for improving pedestrian delay in New Zealand's central-city areas.

### ***Are the harmful emissions from New Zealand's light duty vehicle fleet improving?***

**Research report 441**

**NIWA**

**Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)**

**Hard copy \$30**

Vehicle emission reduction technologies are continually improving. In theory, as new vehicles replace old ones in the fleet and as fuel quality improves, the amount of pollutants discharged on a per vehicle basis should (on average) be reducing. However, it is unclear how much influence new technology and improved fuel is actually having on the 'real-world' emissions from the light duty vehicle fleet as a whole.

This project used remote sensing to measure real-world vehicle emissions in Auckland in 2009. Results were then compared with measurements taken at the same sites in comparable campaigns undertaken in 2003 and 2005. The main objective of the project was to address the question: Are the harmful emissions from New Zealand's light duty fleet improving under the current 'business as usual' scenario?

Emissions measurements (carbon monoxide, nitric oxide, hydrocarbons and uvSmoke as an indicator of fine particulate matter) were stored together with vehicle information (such as fuel type, age, odometer reading and emission standard) enabling the effect of each parameter and any trends to be assessed.

The results confirmed that New Zealand's light fleet emissions are indeed generally improving with current trends. However, three trends of concern were identified and require on-going monitoring.

## ***The effect of better road delineation on driving: a new method of assessment***

Research report 442

Opus Central Laboratories

Freely available online at [www.nzta.govt.nz/research](http://www.nzta.govt.nz/research)

Hard copy \$20

In this research project, the innovative 'hands-on' method, first developed by Walton and Thomas in 2005, was tested in its ability to evaluate the effects of improved road delineation on driver behaviour. The method uses hand positions on the steering wheel as an indicator of drivers' perceived risk, with drivers being more likely to place both their hands on the top half of the steering wheel when driving through a more difficult environment.

Specialist night-vision equipment and infrared floodlights were used to observe a total sample of 2896 drivers at three sites in the Greater Wellington region in 2009–2010. Other intermediate measures of perceived risk (speed and headway acceptance) were also recorded, in order to assess how drivers' risk perceptions changed with variation in the driving conditions (daytime/night-time, wet/dry) and road delineation (faded/upgraded road markings).

The results showed that the 'hands-on' method was an effective and reliable tool to measure the impact of improved line markings on drivers, and to quantify the size of this effect compared with daylight driving. The method was sensitive to subtle changes in the road context, which makes it a useful instrument for road engineers to evaluate the relative improvement or change in drivers' responses to changes in road contexts.

## **Supplementary issues of the NZTA research newsletter**

The significant number of research reports recently published has resulted in the need for supplementary issues of *NZTA research*. The first supplementary issue was published in May 2011. This current issue is the second. There will be a third supplementary issue published in November 2011.

The supplementary issues will be published in addition to the regular quarterly publication of *NZTA research*.

### **NZTA has a number of other publications you might be interested in.**

The NZTA's quarterly newsletter *Pathways* keeps the transport sector up to date with what we are doing.

*NZTA Connect* provides a snapshot of the NZTA's projects and initiatives that are relevant to the work approved organisations are doing in the area of land transport in New Zealand.

*Exchange* is the Public Transport Leadership Forum's quarterly e-newsletter. It informs transport sector leaders and rail, bus and ferry operators across New Zealand about the forum's vision, synergies, and planned initiatives to improve the effectiveness of public transport in New Zealand.

For more information about these newsletters go to <http://www.nzta.govt.nz/about/newsletters/index.html>

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*NZTA research* is published quarterly by the NZ Transport Agency. Its purpose is to report the results of research funded through the NZTA's Research Programme, to act as a forum for passing on national and international information, and to aid collaboration between all those involved. For information about the NZTA's Research Programme, see [www.nzta.govt.nz/resources/research/index.html](http://www.nzta.govt.nz/resources/research/index.html).

Contributed articles are welcome, and should be typed in double spacing and not exceed 1000 words. Illustrations may be either black and white or colour, and must be of high quality. *NZTA research* reserves the right to edit, abridge or decline any article.

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### **Disclaimer**

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### **Do we have your correct details?**

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Email [research@nzta.govt.nz](mailto:research@nzta.govt.nz)

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Are available on the NZTA website [www.nzta.govt.nz/resources/nzta-research/](http://www.nzta.govt.nz/resources/nzta-research/)

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