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## Rural crash prediction models a step closer

A recently published NZTA report - on phase two of a three-phase research project - sets out the key variables and preferred model to be used in predicting crashes on rural roads.

This report includes a pilot study that covers the second stage of the research project. The study aims to quantify the impact of key road features, including road alignment and cross-section, and the roadside environment, on the safety of two-lane rural roads.

In New Zealand, a high proportion of fatal and serious crashes happen on two-lane rural roads. However, historic crash data is not always sufficient to understand the safety issues on many sections of the rural road network, especially the significant proportion that is low-volume and generally has insufficient crashes to allow a full diagnosis of safety problems. Yet, despite the low number of crashes,

there may still be good potential to improve safety, especially along a route or across an area.

In this context, crash prediction models become particularly useful for evaluating crash risk by crash type for individual sections of the network. They are also valuable for assessing the potential benefits from proposed changes to improve safety.

Shane Turner of Beca Infrastructure says, 'Crash prediction models have become increasingly popular since the 1990s when they were initially applied to intersections and links. Since then, we've seen a number of detailed models being developed with respect to specific

road features or policies. These models have limited application, because they typically take into account only a limited number of the variables needed to accurately predict crashes. For example, they may look only at the type of terrain, or road surface condition, or even purely traffic volumes.

'The purpose of the current research project is to build models capable of taking into account the majority of the important predictor variables when assessing the safety of a given section of road. Some road features, particularly advanced delineation treatments, are not included in the models, but can be factored in using other research.'

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### Your views

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### Variables in multi-variable models

Type	Variable
Traffic volume	Traffic volume (V)
Shoulder environment	Unsealed shoulder (U)
	Seal width (S)
Point hazards	Combined point hazards (H)
Accesses	Combined accesses (Ca)
Roadside - other	Distance to non-traversable slope/perpendicular deep drain (N)
Road geometry	Absolute curvature (C)
	Absolute gradient (G)
	Skid resistance (Sr)
	% reduction in curve speed (Vc) <sup>1</sup>

<sup>1</sup> The results of the two-variable models indicated that horizontal geometry was not a significant variable. However, horizontal geometry is widely considered to have a significant effect on crash rate. A horizontal alignment variable (percentage reduction in curve-negotiation speed of the section compared with the preceding 500m section) was thus later introduced into the best-performing four-, five- and six-variable models.

The first stage of the research project (completed in 2006) involved scoping what the important variables might be, and also the data collection and sampling requirements for the phase two pilot.

The pilot phase being reported on has narrowed down the key variables to be used in the final models, and identified the data collection options and issues for those variables. Preliminary crash prediction models were also developed and a preferred model identified.

Phase three - the main study stage of the research - is in progress and will develop the final crash prediction models using a larger sample set. The overall purpose of the study is to quantify the impact that the key road features or variables identified in phase two have on the safety of New Zealand's rural roads, including the interactions between these variables.

### Building the models

The pilot study collected road alignment, roadside environment, traffic flow and crash data for 200 400m-long sections of rural roads throughout the Waikato region. After exclusion of certain sections, 148 sections were included for input into the preliminary models.

Shane says, 'We used generalised linear regression model techniques to develop the preliminary models. Initially, we had 28 predictor variables that we had data for and could potentially use in the models. They fell into 5 broad categories of: road geometry, road cross-section, roadside environment, road surfacing and accesses.

'Traffic volume was included as a default variable in all the preliminary models we developed, so we started with a single-

variable model based on this, then added extra variables, one at a time, to determine which set of variables were most representative and performed the best. This enabled us to identify a final set of eight variables, which we incorporated into the models alongside traffic volume.'

From this process a preferred model emerged, which showed that for a given section of road the crash rate was most influenced by:

- traffic volume
- distance to non-traversable hazards (such as a row of trees or a deep ditch)
- absolute gradient
- skid resistance
- number of accesses.

Shane says, 'The preferred model gives us a good starting point for the final modelling in phase three. Because of the small size of the sample data set we were working with in the pilot, the final model developed cannot be used for crash prediction at this stage. However, the modelling does demonstrate the importance of the roadside environment and road geometry on crash occurrence.'

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Next generation of rural roads crash prediction models, NZ Transport Agency research report 437

Freely available online at [www.nzta.govt.nz/resources/research/reports/437/index.html](http://www.nzta.govt.nz/resources/research/reports/437/index.html)

# Roadside crucial influence in crashes

The pilot study clearly demonstrated the importance of the roadside environment and hazards in predicting crash rates for rural roads. The following variables of particular relevance emerged through the research:

- **Seal width** - data was collected on both seal width and unsealed shoulder width. Although seal width is recognised as affecting crash rates, the relationship between the two is complex and unclear; narrower seals decrease the separation between lanes, potentially increasing the number of head-on crashes, while wider seal can increase drivers' speeds, but give them more opportunity to regain control should they lose it.
- **Slope width** was broken down into the recoverable slope (adjacent to the seal, from where drivers, if they go on to it, can steer back on to the roadway) and the transversable slope (one step beyond the recoverable slope, and from where motorists can safely stop or slow once they leave the road). Slope width is important as it affects the ability of drivers who have lost control of their vehicle to regain control and either safely stop or re-enter the traffic.
- **Point hazards** are roadside hazards at particular points on the road shoulder, such as wooden and concrete poles, light columns, signs, trees, culverts and the end of bridges. Previous research has established a relationship between the density and type of roadside point hazards and the severity of loss-of-control crashes.
- **Driveway accesses** - the number of driveway accesses on rural roads influences the number of driveway crashes, rear-end collisions and crashes that involve collision with an object (such as a roadside point hazard). Data was collected on the type of accesses onto a given section of road and their use.

# Walk this way to more walking

Following a recent increase in the 'value' of walking, a research project has looked at whether creating new pedestrian facilities, or improving existing facilities, increases the number of people who walk.

The NZTA revised its procedures for developing and evaluating pedestrian improvement projects in January 2010. Part of this revision was to increase the value of the benefit attributed to new pedestrian trips dramatically, from \$0.50/km to \$2.70/km. This increase reflects the need to quantify the benefits of walking as a transport option, especially for shorter trips.

Walking has a part to play in achieving the government's current transport objectives (as set out in the Government Policy Statement 2012, covering the period 2012/13 to 2021/22), including improving journey times, easing congestion, creating more efficient freight supply chains and making use of existing capacity.

The practical effect of the increase attributed to walking's economic value is to make it even more important to be able to estimate and monitor the increase in pedestrian activity flowing from pedestrian improvement projects. The current research project sought to inform this by looking at the various factors that influence people's willingness to walk, investigating pedestrians' perceptions of their environment and expectations from facilities and identifying the benefits that can result from new facilities.

Shane Turner of Beca Infrastructure who headed the research project says, 'Walking has many obvious economic, physical and environmental benefits yet, despite this, it is in decline worldwide as a mode of transport. In New Zealand, research has estimated a one-third reduction in the number of walking trips being made between 1990 and 2004, which pretty much reflects trends elsewhere in the world.

'However, for numerous reasons, including peak oil and the health benefits of a more active life, it is imperative that people are encouraged to walk, and one way this can be done is by providing safer and more inviting pedestrian environments. Our goal in the study was to demonstrate that pedestrian numbers would increase at a certain location, or with respect to a particular facility such as a crossing, if pedestrians believed that factors such as safety and delay had improved at that location.'

## Overview of the study

The research analysed case studies from eight sites where new or improved pedestrian facilities were planned and then implemented. Analysis focused on whether pedestrian use of the sites increased and pedestrian perceptions of the sites improved, following implementation.

The study also developed an expected pedestrian-usage model for planners and funders to use when planning or evaluating new or improved facilities, and a monitoring database for facilities for future use.

Three types of pedestrian facilities were selected for monitoring – pedestrian refuges, zebra crossings and signalised crossings – at eight different sites in Auckland, Christchurch and Hamilton. All of

the sites were due to have new or improved pedestrian facilities installed within the two years covered by the study.

## Selected study sites

Site	Location	New/improved facility
Moorhouse Ave (at Science Alive!)	Christchurch	Pedestrian signal
Hereford St (at Westpac Lane/ National Mutual Arcade)	Christchurch	Zebra crossing with slightly raised median and warning light system
Hoon Hay Rd	Christchurch	Kea crossing
Sparks Rd	Christchurch	Zebra crossing (school patrol)
Ensors Rd	Christchurch	Refuge island and kerb build-out
Collingwood St, East of Tristram St	Hamilton	Kerb extension
Tristram St (at Gary Keith Motors)	Hamilton	Refuge island
Margot St, Grey Lynn	Auckland	Kea crossing

Data was collected on the sites' characteristics and influences (including the quality of the footpaths and lighting, surrounding environment, signs, resting places, other crossing points nearby, types of pedestrians, local land use, traffic flows, weather and crash statistics for the location), and pedestrian count surveys were conducted before and after the implementation.

Pedestrians were also surveyed about their perceptions of the crossing locations before and after the implementation, with the questions designed to gather views about the safety, delay and directness of the facility in question.

The results showed consistent increases in pedestrian flows at all but one of the sites surveyed, after the pedestrian facility had been installed or improved. At five of the sites this increase was significant, and it could be concluded that the implementation had positively affected pedestrian numbers. Kerb extensions and refuge islands generated the largest increases in pedestrian usage, followed by kea crossings.

Pedestrian desire lines (pedestrians' preferred point and route for crossing at a particular site) remained more or less the same before and after implementation, although a greater proportion of people changed their actual crossing point to make use of the new or improved facilities.

Shane says, 'What this shows is the importance of understanding pedestrians' desire lines when planning a facility, because the facility's use will be maximised when it is placed along pedestrians' most desirable crossing path. We saw this with the Collingwood Street kerb extensions in Hamilton, where the facility did not lie on pedestrians' preferred routes. Although pedestrian crossings increased at this particular site, the facility was still not used by a large proportion of the pedestrians in the area.'

With respect to pedestrians' perceptions, safety was rated as the most important factor influencing where pedestrians chose to cross the road. Pedestrians at all the study sites reported feeling

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### Changes in numbers of pedestrians crossing at the surveyed areas

Location	Type of improvement	'Before' survey (ped/hr)	'After' survey (ped/hr)	% change	Significant change?
Moorhouse Ave at Hoyts 8/Science Alive!, Christchurch	Signalised crossing	75	80	7%	No
Hereford St, Christchurch	Raised zebra crossing with warning light system	628	607	-3%	No
Sparks Rd, Christchurch	School-patrolled zebra crossing	148	228	54%	Yes
Hoon Hay Rd, Christchurch	Kea crossing	43	64	49%	Yes
Ensors Rd, Christchurch	Refuge island and kerb extension	7	8	14%	No
Collingwood St, Hamilton	Kerb extensions	30	57	90%	Yes
Tristram St, Hamilton	Refuge island	25	46	84%	Yes
Margot St, Auckland	Kea crossing	69	98	42%	Yes

safer after the new or improved facility had been implemented (although only five of the eight facilities were rated by respondents as providing an 'extremely safe' crossing environment). Interestingly though, a perceived increase in safety did not necessarily guarantee greater pedestrian numbers, as other factors such as waiting times and location in relation to desire lines also played a part.

At three-quarters of the sites, the new facilities were perceived as reducing waiting times, although delay was ranked as having reduced importance where pedestrians felt the safety of the particular facility had improved. Overall, zebra

crossings were given the highest average ratings for reducing delays and improving directness, while kea crossings were considered the best performing in terms of improving safety.

#### Monitoring and evaluation database

One of the project's objectives was to develop a database for evaluating a proposed facility's benefits, estimating its impact on pedestrian activity before implementation and monitoring it afterwards. To this end, the study team developed a template that allowed site-specific information to be loaded about location, road classification, traffic

volumes, local schools, surrounding land use, crash history, type of pedestrian facility, survey dates, pedestrian counts, costs and promotion. The database can be accessed online at [www.levelofservice.com](http://www.levelofservice.com).

Shane says, 'The database can be easily modified to include any future data fields that may be required. Although so far we've only got the limited data from the study stored in it, our hope is that over time local authorities will populate it with the details of their pending pedestrian facility improvement projects. This would provide us with a comprehensive record of implementations, and eventually allow us to identify trends in use, safety, delay and directness for the various types and locations of pedestrian facilities.'

Other recommendations included the need for research into the effects of wider-area treatments for pedestrians, the use of crash prediction models to identify sites that are unsafe for pedestrians, and better overall monitoring of pedestrians, including at locations where no pedestrian facilities are in place.

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*Benefits of new and improved pedestrian facilities – before and after studies, NZ Transport Agency research report 436*

Freely available online at [www.nzta.govt.nz/resources/research/reports/436/index.html](http://www.nzta.govt.nz/resources/research/reports/436/index.html)



A signalised crossing

# Sticks and carrots bring land use and transport closer

Current government strategy emphasises the need for greater integration between land use and transport planning. However, recent research has discovered that local and regional policies may be having the opposite effect: they seem to be unwittingly promoting individual vehicle use, as opposed to more sustainable modes of transport, in relation to large retail and commercial developments.

Carried out between 2009 and 2010, the study selected Sylvia Park in Mt Wellington, Auckland as a case study. By gathering data about a single development, the study sought to understand the factors that influence decision-making in the private sector, and hence whether local and regional policies were influencing those decisions in ways that promoted integration.

The study showed that, left to its own devices, the private sector is unlikely to pursue greater integration of land use and transport. Moreover, many policies and strategies are unwittingly having the opposite effect, either preventing or discouraging the private sector from promoting alternative modes of transport.

From these findings, the study was able to make four recommendations, which local and regional government agencies and

authorities can implement to achieve greater integration.

## The case study

Sylvia Park is one of New Zealand's largest retail developments. Opened in 2006, it covers a gross floor area of 72,525m<sup>2</sup>, with resource consent for a further 18,500m<sup>2</sup> of commercial office space (the overall site area is 200,000m<sup>2</sup>). Located 11km from Auckland's central business district, Sylvia Park is adjacent to both State Highway 1 and the North Island main trunk railway. It boasts its own train station, with covered waiting areas, pedestrian lifts, ramps and stairs linking the station to the centre. Bus stops are located between, and close to, the station and the centre's western entrance.

Sylvia Park was selected for the case study because it is a relatively recent development that can be reached through

## The research questions

The study explored five key research questions. The full report highlights how the results garnered from these questions lend themselves to more general interpretations, which were then used as the basis for recommendations.

1. How do people travel to Sylvia Park? How does retail expenditure vary by access mode and other socio-economic factors?
2. What are the transport and land use characteristics of similar retail developments in cities comparable with Auckland?
3. What are the capital and operating costs incurred by the developers to accommodate different transport modes? What is the average transport cost per user by mode?
4. How does the profitability of different transport modes vary across time? How should the developer manage future travel demands?
5. What are the implications for transport and land use policy? What are the recommended priorities for regulatory reform and further research?



The train station at Sylvia Park is located close to bus stops and the mall's western entrance

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various transport modes (car, train, bus, cycle and foot). By focusing on a particular development, the research sought to use it as a 'lens' through which to examine current policy settings and identify ways in which they can be improved.

With this in mind, the study posed five research questions designed to shed light on the costs and revenues associated with the different transport modes through which people accessed the centre. Analysis of the answers to these questions formed the basis for four main recommendations:

- managing the location of major developments
- removing minimum parking requirements
- levying development contributions using shadow tolls
- replacing transport rates with an annual parking levy.

The recommendations' combined impact is to effectively reduce the private sector's upfront capital costs and risks, while providing ongoing incentives for it to manage traffic demands. Ultimately, the recommendations should serve to better align private and public sector interests, thereby supporting greater integration between land use and transport.

## Manage location

The study's first recommendation, capable of immediate implementation, is that local authorities should use their district plans to manage the location and configuration of major retail developments. A four-layer hierarchy of integration is suggested (urban form and land use, general site access, internal site configuration, and travel demand management) to be incorporated within plans. The result will be clearer communication by authorities of their expectations for where and how major developments should proceed and, as a result, greater certainty for the private sector.

## Eliminate minimum parking requirements

The second recommendation for immediate implementation is that local authorities should eliminate minimum parking requirements from district plans and instead allow developers to determine the level of parking they will provide onsite. The study found that minimum parking requirements lead inevitably to low-density developments and excessive vehicle use. Eliminating them would mean the value of land used for parking would provide at least some incentive for developers to manage the demand for vehicle travel.

## Use shadow tolls

A recommendation requiring further investigation was that regional and local authorities should levy development contributions by way of shadow tolls. Shadow tolls would charge developers a fee based on the actual travel demands generated by the project, and would reduce their upfront capital costs and create a lower risk profile for projects. Like the abolition of parking requirements, shadow tolls have the potential to encourage the private sector to manage vehicle travel (by making alternative modes of travel more cost effective from the developer's point of view) and as a result stimulate more integrated land use and transport outcomes.

## Adopt an annual parking levy

The final recommendation was that authorities should replace their transport rates with an annual parking levy. A levy based on the number of car parks would be a more accurate indicator of a development's traffic-generating potential, than a rate based on property value which would penalise centrally located (and accessible) properties.

Despite separating out its recommendations, the study concluded that a 'coordinated but diverse mix of regulatory reforms', comprising both 'regulatory sticks' and 'financial carrots', was more likely to achieve the government's goals of greater integration 'than one single measure'. This was particularly the case given that some of the recommendations could influence only new developments, such as shadow tolls, while others could potentially affect both new and existing developments, such as the removal of minimum parking requirements.



Pedestrian walking zones around Sylvia Park

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*Integrated transport and land use: Sylvia Park as a case study*, NZ Transport Agency research report 444

Freely available online at [www.nzta.govt.nz/resources/research/reports/444/index.html](http://www.nzta.govt.nz/resources/research/reports/444/index.html)

# New design strain criteria for granular layers

Current pavement design in New Zealand is based on Austroads' *Pavement design – a guide to the structural design of road pavements* (2004). The Austroads method uses the pavement design software programme CIRCLY to compute strains within the pavement. These strains are then used in equations to check the fatigue life of the bound pavement layers, and the rutting life of the subgrade soils.

However, while Austroads includes a design criterion to limit subgrade strain values, it is silent when it comes to calculating rutting in the granular pavement layers. This is despite the fact that recent investigations into early failures in granular pavements have revealed that most surface rutting could be attributed to deformation in the granular layers. In contrast, very little deformation was evident in the subgrades, indicating that the Austroads design criteria for the subgrade was adequate.

Given the number of early and other pavement failures that can be attributed to rutting and shoving in the granular layers, the lack of a design method for these layers is an obvious gap. The current research project sought to fill this gap by developing a simple method for calculating design strain criterion for basecourse and sub-base aggregates, which could then be used in CIRCLY to predict pavement life. The design strain criterion is derived from repeated load triaxial (RLT) tests.

Greg Arnold from Pavespec explains that the research follows on from a parallel research project that used RLT tests to predict rut depths and determine lives for granular pavements.

Greg says, 'The rut depth predictions derived from our other project were used in the current research to validate the method we used. The aim was not to produce a generic design strain criterion that could be used for all basecourses and sub-bases. Rather, we wanted to provide a simple method that pavement designers could use to develop strain criterion specific to the aggregates they are using in their projects, based on RLT testing of those aggregates.'

'This will give more accurate results, because we know from Pavespec's own database of RLT tests that basecourses and

sub-bases that conform to the same specifications can nonetheless return a wide range of performance results.'

CIRCLY allows users to define new strain criteria for any pavement material. Using the new method proposed in the research, designers will be able to input their specific design strain criterion into CIRCLY, and because the programme will then also reflect the likelihood of rutting in the granular layers, it will generate a more accurate prediction of pavement life.

Initial analysis using CIRCLY, carried out as part of the project, shows that applying a strain criterion to basecourse and sub-base aggregates results in a prediction of pavement life the same as that derived from full rut depth models. The research report recommends that these proposed strain criteria should be tested on a range of pavement designs, including stabilised materials, with the results then presented to the industry to consider their adoption.

Greg says, 'Adopting the strain criteria would reduce the risk of early pavement failure by limiting the use of fully unbound granular pavements to low-traffic-volume roads, and requiring structural asphalt pavements or pavements using granular materials modified with cement or lime for higher-volume roads. In practice, designers have already started moving away from full depth granular materials, but the proposed design criteria would give them the tools they need to support their use of alternatives.'

## About repeated load triaxial (RLT) testing

An RLT testing apparatus applies repetitive loading on cylindrical materials for a range of specified stress conditions. The output is deformation (shortening of the cylindrical sample) versus number of load cycles (usually 50,000) for a particular set of stress conditions.

Multi-stage RLT tests are conducted to obtain deformation curves for a range of stress and strain conditions to develop models for predicting rutting. Recent research has shown that even with good quality aggregate, pavements can still fail before the end of their design life, due to rutting of the granular layers, especially if they get wet or traffic volumes are high.

RLT testing can quickly identify aggregates where there may be a risk of this occurring, as often the sample fails before the completion of all the stress stages. It is also a useful performance test for determining if alternative materials like recycled crushed concrete are suitable for use in pavement construction.

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Development of a basecourse/sub-base design criterion, NZ Transport Agency research report 429

Freely available online at [www.nzta.govt.nz/resources/research/reports/429/index.html](http://www.nzta.govt.nz/resources/research/reports/429/index.html)

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# How slow will they go?

## The impact of slow zones on travel choices

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The safety improvements created by traffic management measures designed to slow vehicle speeds on urban roads have now been well established. Recent research attempted to look at the other, less well-documented impacts of these measures, including their effect on people's travel behaviour and choice of travel mode.

However, due to the mixed nature of the available evidence, the study was unable to conclude whether or not treatments to create slow zones on roads could also effectively influence other travel behaviour.

Carolyn O'Fallon of Pinnacle Research and Policy says, 'Initially we set out to develop an evidence-based model for best practice for slow zone treatments that influenced aspects of travel behaviour other than speed.

'We had seen the often dramatic effect that establishing slow zones can have on city streets, in terms of reducing driver speed and hence enhancing safety, but we wanted to explore if these impacts extended to other aspects of travel behaviour. The type of thing we had in mind was whether or not the slow zone also increased walking and cycling, decreased traffic flows or caused people to change their choice of transport mode.

'However, there wasn't sufficient evidence available, internationally or locally, to develop a model. Safety through speed reduction has been the primary objective where slow zones have been created, and any monitoring has focused on this. Due to the lack of evidence, we instead developed a less detailed monitoring framework that can be used to collect outcome and impact data from slow zone treatments. With time, the findings from that monitoring may enable a model along the lines we originally envisaged to be developed.'

Because none of the studies looked at during the research had specifically taken into account changes in mode use or travel behaviour as a result of slow zones, the researchers had to focus on other data that may be indicative of these things. But while some studies suggested an increase in walking, a substantial number showed the opposite, with less or the same number of people choosing to walk in areas where slow zones had been created. Similarly inconclusive results were returned with respect to cycling (six studies showed more cycling activity, and seven showed a decrease or no change), and while several studies showed reductions in traffic flows, there were numerous other studies where flow hadn't been measured or reported on, and so could not be assessed.



Slow zones have been implemented extensively in the UK, through a combination of physical modifications and lower speed limits

### Taking it slow

The concept of slow zones has come about in New Zealand as a result of legislation passed in 2004 that enabled local authorities to set a wider range of speed limits. A slow zone treatment (as defined in the research report) is 'any programme that modified the physical road environment in such a way that it would moderate driver behaviour, slow vehicle traffic, and/or improve the



environment of the neighbourhood'. Treatments can be anything from traffic calming and road capacity reduction installations, to area-wide speed limitations.

In New Zealand, slow zone implementation has tended to be rather patchy and restricted to small areas. In Wellington, suburb-wide 40km/h speed restrictions have already been implemented, some through the use of traffic management measures that have the effect of slowing traffic, others through actual lower limits. A four-year plan to introduce 30km/h limits around suburban shopping centres has recently begun. Likewise, Christchurch has installed traffic calming measures and lowered limits to 40km/h along several of its streets.

In the UK by contrast, where slow zone treatments have been used for rather longer, treatment areas tend to cover larger areas, with some cities designating nearly all of their residential roads as 30km/h zones.

In a quest to build a picture of best practice slow zone treatments (particularly those that affected transport behaviour or mode choice), the research looked at examples and data from treatments both at home and abroad. Specific treatments investigated included:

- traffic calming
- 30km/h zones and limits
- home zones (residential streets where the road space is shared between vehicles and people 'safely and on equal terms')
- mixed priority routes
- sharing the main street (Australian initiative that aimed to manage main streets and sub-arterial roads to improve their safety and quality for all users)
- neighbourhood access planning
- road capacity reduction
- shared space
- complete streets (street planning that takes a multi-modal approach, catering for the needs of 'drivers; cyclists; transit vehicles and users; and pedestrians of all ages and abilities').

### The monitoring framework

The evaluation framework proposed by the study focuses on collecting evidence of the impacts that particular slow zone treatments have on people's travel behaviour.



More examples of slow zones in the UK

Carolyn says, 'The evaluation framework is quite straightforward. It involves measuring pedestrian, cycling, public transport and vehicle activity in the area to be treated, both before the treatment is installed and after. Surrounding areas should also be measured in case users divert to them to avoid the slow zone.'

Ultimately, it would be beneficial to also collect data for a non-treated control area, and for different types of treatments. Having access to such information would help build a clearer picture of which measures are most effective in influencing travel behaviour, although Carolyn acknowledges that this level of evaluation may not be feasible.

'In the report we caution that implementing an evaluation framework in New Zealand to

reliably estimate effects on mode choice on its own may not be good value for money,' Carolyn says. 'The small areas treated here, and the relatively low reductions in speed they are designed to achieve, when compared to overseas, mean the impacts of treatments are going to be harder and costlier to detect.'

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*Slow zones: their impact on mode choices and travel behaviour, NZ Transport Agency research report 438*

Freely available online at [www.nzta.govt.nz/resources/research/reports/438/index.html](http://www.nzta.govt.nz/resources/research/reports/438/index.html)

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## ***The variability of road traffic noise and implications for compliance with the noise conditions of roading designations***

**Research report 446**

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*Freely available online at [www.nzta.govt.nz/resources/research/reports/446/index.html](http://www.nzta.govt.nz/resources/research/reports/446/index.html)*

Many road designations have conditions with respect to noise, requiring that when the road is completed measurements will be undertaken to prove that the performance standards of those conditions have been fulfilled. However, all measurements are subject to variability, and the designation conditions do not address either the expected nature of this variability or how it should be accounted for in establishing compliance with the conditions.

This research was carried out in New Zealand between 2006 and 2008. It sought to quantify the variability in noise measurement and, in light of this identified variability, develop a recommended approach to establishing compliance.

The report first discusses the evolution of current practice, and then examines in detail the expected variability that can occur in both noise generation and noise propagation. The impact on noise levels of factors such as traffic volume, heavy goods vehicles, traffic speed, road type, road deterioration, wind speed and direction, ground type and vegetation is examined. Recommendations to improve measurement consistency are made.

The recommended method of compliance is based on noise modelling, supplemented by measurement, to validate the overall model, followed by testing the performance of noise mitigation elements that are incorporated in the modelling.

## ***Trips and parking related to land use***

**Research report 453**

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*Freely available online at [www.nzta.govt.nz/resources/research/reports/453/index.html](http://www.nzta.govt.nz/resources/research/reports/453/index.html)*

The objective of the research detailed in research report 209 was to produce a comprehensive national database of information on trips and parking related to land use in New Zealand, and to identify historic trends since the 1970s. This research has revised the original report, updating it to 2010 and comparing

New Zealand results with those reported in the UK, USA and Australia. It also reviews trip generation surveys and databases from these four countries.

The research indicated a general equivalence and consistency in the travel patterns seen in New Zealand to those reported in UK, USA and Australia.

Drawing on parallel research based on the Ministry of Transport's New Zealand Household Travel Survey, there is a chapter devoted to daily trips by all modes and purposes.

The research considered surveyed seasonal traffic and parking variations, and identified the practical parking design demand for a whole year as the 85th percentile satisfaction, which is also the 50th highest hour. This is the upper design limit suggested for the site being considered. At selected locations there may be a variety of specific reasons to reduce this design figure. The report also recommends undertaking further multi-modal trip generation and parking demand surveys for more land uses.

## ***Determination of personal exposure to traffic pollution while travelling by different modes***

**Research report 457**

**Simon Kingham, Woodroe Pattinson, Kreepa Shrestha**

**– Department of Geography, University of Canterbury**

**Ian Longley – National Institute of Water and Atmospheric Research**

**Jenny Salmund – School of the Environment, University of Auckland**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/457/index.html](http://www.nzta.govt.nz/resources/research/reports/457/index.html)*

The purpose of this research was to assess the comparative risk associated with exposure to traffic pollution when travelling via different transport modes in New Zealand cities. Concentrations of the key traffic-related pollutants (particulate matter (PM): PM10, PM2.5, PM1; ultrafine particles (UFPs) and carbon monoxide (CO)) were simultaneously monitored on pre-defined routes in Auckland and Christchurch during the morning and evening commute for people travelling by car, bus, on-road bike, train (Auckland only) and off-road bike (Christchurch only) from February to May 2009.

The key results of this research are:

- car drivers are consistently exposed to the highest average levels of CO
- on-road cyclists are exposed to higher levels of CO, PM1 and UFPs than off-road cyclists

- car drivers and bus passengers are exposed to higher average levels of UFP than cyclists
- at some parts of their journeys, travellers are exposed to very high levels of pollution, often for short periods of time
- locating cycle paths just a short distance from roads can reduce pollution exposure significantly
- one hour of commuting could contribute up to 20% of total daily CO and UFP
- PM10 and PM2.5 are inappropriate indicators of exposure to vehicle emissions.

## **A social responsibility framework for New Zealand's land transport sector**

### **Research report 458**

**Carolyn O'Fallon - Pinnacle Research & Policy Ltd**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/458/index.html](http://www.nzta.govt.nz/resources/research/reports/458/index.html)*

Since the implementation of the Land Transport Management Act 2003, public sector land transport organisations in New Zealand have been obliged to be socially and environmentally responsible, either as one of their organisational objectives (NZ Transport Agency) or in terms of the activities and combinations of activities approved for payment from the National Land Transport Fund (regional councils and road controlling authorities). While most organisations had a strong sense of what was meant by environmental responsibility, less was known about what was required to be socially responsible.

In November 2010, after five years of extensive work involving 99 member countries and approximately 450 experts, the International Organisation for Standardisation's (ISO) Guidance on social responsibility (ISO 26000) was published. The ISO 26000 is intended to guide organisations to translate the concept of social responsibility into action. However, because the ISO 26000 was developed for use by a wide range of organisations across many countries, it is a complex and involved document. We analysed the ISO 26000 guidance standard in order to develop a practical guide for implementation within local and central government organisations in New Zealand's land transport sector.

## **Extending pavement life: investigation of premature distress in unbound granular pavements**

### **Research report 459**

**David Stevens and Graham Salt - Tonkin & Taylor Ltd**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/459/index.html](http://www.nzta.govt.nz/resources/research/reports/459/index.html)*

Premature distress in unbound basecourses has occurred regularly in New Zealand. In 2008, the NZ Transport Agency (NZTA) commissioned the assembly of an inventory of problem basecourses and subbases. Study of the inventory found that the long-term degree of saturation of basecourse was highly significant in the case histories of premature distress, ie the pavements failed through shear instability (shoving) in the basecourses. A common feature in basecourses with a high degree of saturation was gap grading in the sand fraction.

Existing basecourse specifications limit gap grading through grading shape control requirements, but the case histories demonstrate that tighter control is required.

The basecourse inventory was used to establish regression equations for predicting the in situ long-term degree of saturation of a basecourse. This approach appears to be very promising. Timely decisions can now be made on acceptance or the need for corrective measures prior to sealing.

The above considerations have been used for preparing revised drafts of the NZTA basecourse specification and subbase specification notes, as well as a set of recommendations for the compaction specification and the New Zealand supplement to the document *Pavement design - a guide to the structural design of road pavements* (Austroads 2004) (Transit NZ 2007a) to implement practical solutions to premature distress in unbound basecourses.

## **Characterisation and use of stabilised basecourse materials in transportation projects in New Zealand**

### **Research report 461**

**W Gray - Opus International Consultants**

**T Frobel - Fulton Hogan**

**A Browne - Hiway Stabilizers**

**G Salt and D Stevens - Tonkin & Taylor**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/461/index.html](http://www.nzta.govt.nz/resources/research/reports/461/index.html)*

The stabilisation of near-surface granular pavement materials is accepted practice in transportation maintenance and capital development projects in Australasia. Stabilisation in this context involves the mechanical introduction of reactive agents, including cement and foamed bitumen, into existing or manufactured granular materials, with or without existing seal inclusion.

Present-day design guides characterise stabilised granular materials as either modified or bound, depending primarily on the amount and type of reactive agent used in the stabilising process. Modified materials are modelled as unbound granular materials in a pavement.

Bound (cemented) materials are modelled as layers with tensile load-carrying capacity within the pavement. Cracking in the bound pavement layer is governed by 'fatigue relationships'.

This research has shown that stabilisation with smaller reactive agent contents (<3% by dry mass) can deliver materials that should be modelled as lightly bound, delivering cost-effective pavement solutions.

This research report describes the collection and interrogation of performance data from New Zealand road pavements that utilised stabilised granular materials. The research, carried out from December 2009 to August 2011, compared actual stabilised pavement performance with the expectations in published design guidelines. A conceptual pavement performance model for near-surface 'lightly bound' stabilised granular pavement layers that better matches observed pavement behaviour is proposed.



## **Multigrade bitumen for chipsealing applications**

### **Research report 460**

**P Herrington, M Gribble and G Bentley – Opus International Consultants**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/460/index.html](http://www.nzta.govt.nz/resources/research/reports/460/index.html)*

Research was undertaken in 2009–2011 to evaluate the potential benefits of multigrade bitumens in chipsealing in New Zealand. A field trial demonstrated that multigrade bitumen seals could be constructed without significant modifications to existing practice, except that higher spraying temperatures are required and adhesion agent choice is limited. Experimental measurements of bitumen–tyre adhesion temperatures were made using a rolling wheel apparatus. The cohesive energy of bitumen in artificial seals at 60°C under impact loading was studied using a pendulum device. In both tests, the results for multigrade bitumens were found to be similar to standard bitumens of similar 25°C penetration, even though the 60°C viscosity of the multigrade materials was 2–3 times higher.

## **Lifetime liabilities of land transport using road and rail infrastructure**

### **Research report 462**

**N Mithraratne – Landcare Research**

*Freely available online at [www.nzta.govt.nz/resources/research/reports/462/index.html](http://www.nzta.govt.nz/resources/research/reports/462/index.html)*

The aim of the project was to establish the whole-of-life environmental performance of passenger and freight movement that uses roads and rail. The performance indicators selected were life cycle energy consumption, life cycle stormwater contamination and life cycle greenhouse gas emissions. This study was based on process assessment and considered material use, transport requirements, on-site machinery use and fuel use. The impacts of traffic delays and rolling resistance were not considered. The study was undertaken in New Zealand between October 2009 and March 2011 using data for the year beginning July 2007 and ending June 2008.

The results suggest that the environmental impact of pavements can be altered by earthworks (especially in hilly terrains), choice of construction system, and wearing-course construction. Rail emissions can be influenced by the source of the steel rails used. For passenger transport, fuel use is the dominant factor; for freight transport, infrastructure, vehicles and fuel are equally important. However, the use of rail for passenger and freight transport leads to far greater reductions in energy and carbon emissions when compared against all modes of road transport.

The results derived using New Zealand data are significantly different from those using European data. It is therefore essential to use local data in evaluations of transport policies and actions.

## **Other NZTA publications you might be interested in...**

*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 [www.nzta.govt.nz/about/newsletters/index.html](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).

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