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A typical concrete bridge superstructure. Corrosion of reinforcing or pre-stressing steel is one of the main durability problems affecting concrete pier caps, beams and decks.

Your views

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Halting reinforcement corrosion in concrete bridges

A project on the use of surface treatments to prevent or slow the corrosion of reinforcing and pre-stressing steel will help extend the service life of New Zealand's ageing coastal bridges.

More than 30 percent of New Zealand's state highway concrete bridges and 15 percent of local authority controlled concrete bridges are over 50 years old. Corrosion of reinforcement and pre-stressing steel is one of the key ways that these bridges deteriorate over time, with recent research revealing that in coastal areas corrosion of pre-stressing steel was beginning in bridges that were only 35–40 years old.

The ramifications of this corrosion are serious, as not only is repair costly, but pre-stressed elements may fail structurally as a result, potentially with little warning.

For asset owners and managers, the situation has been a tricky one, with monitoring and repair as needed the favoured approach. While many may have been aware of surface treatments to slow or prevent the corrosion, there has been insufficient guidance available about these treatments' performance, selection, use and potential benefits to encourage their use.

The current report draws on a literature review conducted from 2007 to 2010 to fill that gap, providing comprehensive guidance for owners and managers about why, when and how to use selected surface treatments on bridges exposed to saltwater splash and spray.

What are the treatments?

The project focused on using surface treatments to slow or prevent corrosion in reinforcing and pre-stressing steel (in beams and other bridge superstructure elements) that are exposed to seawater splash or spray (as opposed to surfaces exposed to traffic, or tidal or ponding conditions).

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It also focused on the risk of chloride-induced corrosion and, as a result, considered surface treatments that reduce the ingress of moisture and chloride ions, rather than those that create a barrier to carbonation (the other main cause of reinforcement corrosion).

The project considered only those surface treatments that penetrate the concrete surface to line or block pores and voids (often called penetrating or impregnating sealers). Such treatments are of particular interest because they are less susceptible to damage and weathering than barrier coatings (the other main form of surface treatment), and hence require less maintenance to remain effective and retain the appearance of the surface. Some are also breathable, which reduces corrosion risk by allowing the treated concrete to dry.

Penetrating surface treatments looked at included hydrophobic pore-lining treatments based on silanes and siloxanes, and pore-blocking treatments based on cementitious materials or alkali silicates.

The bridges most likely to benefit from treating concrete surfaces to prevent or slow the corrosion of reinforcing and pre-stressing steel are those exposed to splash or spray from seawater, such as this bridge near a surf beach.

Treatments to extend service life

Drawing on extensive international research on surface treatment use, the project found that the degree of protection, and extension of bridge or bridge element service life, that a treatment can afford depends on the exposure conditions, concrete quality, cover depths and reduction of water or chloride ingress that is achieved by the treatment. It also depends on the treatment being maintained effectively, as without this the benefits will be relatively short lived.

When applied (and maintained) in a correct and timely manner though, the benefits from silane and siloxane pore-lining surface treatments are many.

Such treatments may:

- significantly reduce the ingress of moisture and chloride ions in concrete exposed to seawater splash, spray and ponding
- reduce corrosion activity in un-cracked concrete
- reduce corrosion activity in cracked concrete (depending on the concrete's moisture content, the depth of impregnation, the cover depth and whether the concrete cracked before or after treatment).

Evidence from the literature review suggests that silicate-based pore-blocking treatments are less effective than silane and siloxane treatments in reducing the ingress of moisture and chloride ions, and generally less effective than silane and siloxane in reducing corrosion activity. They may, however, be more effective than silane and siloxane treatments in reducing carbonation, although carbonation-induced corrosion is not common in New Zealand bridges.

Cement-based pore-blocking treatments are used for waterproofing, and so may be more effective than silane and siloxane treatments for concrete exposed to water under pressure.

Close-up of rusty strand and rebar.

When to treat

The first line in corrosion prevention should always be ensuring that the bridge has effective durability design and good-quality construction to begin with. With this in place, bridges constructed in compliance with current standards should achieve 100-year service lives without the need for treatment.

For older bridges, silane and siloxane treatments can potentially extend the service life of reinforced and pre-stressed concrete bridges if they are applied before corrosion damage occurs. This is also the most cost-effective time to apply them, as they need to be reapplied regularly throughout the bridge's life.

Treatments should generally not be applied to new bridges because they may not be able to penetrate the surface sufficiently, may cause the concrete to dry prematurely (and hence not achieve its ultimate performance) and will need to be reapplied regularly, adding extra maintenance costs. The exception is where remedial work is required to address shortcomings in construction.

Bridges in NZS 3101 exposure classifications B2 (coastal frontage) and C (tidal/splash/spray) are those most likely to benefit from silane or siloxane surface treatments, as these are most at risk from corrosion induced by chloride ions from seawater. Bridges in exposure classifications A2 and B1 are unlikely to require treatment, unless they exhibit signs of corrosion of non-structural steel, or localised corrosion of structural steel suggesting a more widespread problem.

What's in the report?

The full research report provides guidance on when and how to apply surface treatments, including the optimum time for treatment, and their use on particular ages and classifications of bridges.

Guidelines are also provided for authorities to identify bridge populations that would benefit from surface treatments, and within these to prioritise individual bridges that would benefit: 'It is recommended that corrosion risk be addressed in a similar way to current seismic and scour risk-screening projects, whereby groups of bridges most at risk are identified, and then the needs of individual bridges within those groups are assessed in more detail to identify an appropriate means of addressing them'. The guidelines are based on a series of principles that together provide a process for making an informed decision on whether or not to treat.

Recommendations are also given in the report for changes to national policy that would facilitate the inclusion of surface treatments in bridge owners' and managers' repair and maintenance regimes.

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The influence of surface treatments on the service lives of concrete bridges
NZ Transport Agency research report 403

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From bike to bus (or train or ferry) and back again

Providing an interface between cycling and public transport makes sound economic sense and would be popular with urban travellers, according to recent research.

Research team leader Matt Ensor of Beca Infrastructure says that, by looking at examples around the world, the team was able to develop a model for forecasting demand here in New Zealand.

'Our objective was to assess international experience in providing storage for bikes at public transport stops, stations and terminals, and facilities for cyclists to take their bikes on public transport. We looked at various examples from around the world, but in the end we drew on data from the United States and Canada as those countries' contexts were the most applicable to our own.

'We used this data to create guidance for forecasting the use and benefits of various cycle–public transport schemes in New Zealand cities. The results were very positive and will sit alongside New Zealand-based trials of the various initiatives.'

Two main means of integrating cycling and public transport were looked at.

- Bike-and-ride, where cyclists use bikes to get to public transport facilities, then park bikes there and use public transport to continue their trip. Examples are cycle storage lockers or other secure storage at train and bus stations, or ferry terminals.
- Bike-on-board, where cyclists use bikes to get to public transport facilities, then carry them onto public transport, potentially using them at the end of the service to reach their destination. Examples include purpose-designed racks fitted on buses, and dedicated cycle parking areas set aside on trains and ferries.

Predicted benefits from cycle–public transport schemes include providing travellers with additional and more flexible transport choices, especially for those people who do not live within easy walking distance of public transport, or who prefer to use bikes to get around. Other benefits include a predicted increase in cycling trips (and a reduction in car trips), greater patronage of public transport, reduced congestion, better health for patrons (from greater use of active modes of transport) and a reduced environmental impact from transport.

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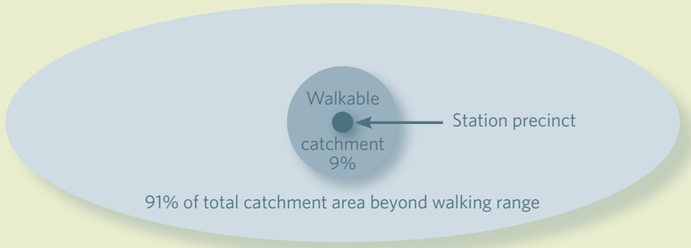
Expanding the catchment

One of the key benefits of providing cycle–public transport schemes is the ability to increase the patronage on public transport services. Research overseas has shown that the time required to reach a public transport service is one of the main factors influencing whether people consider it viable to use that service. Typically, this time is 10 minutes – patrons are prepared to spend 10 minutes walking or cycling to their public transport stop. Because cycling is (by and large) quicker than walking, it significantly increases the catchment area within which people will consider using a public transport service, provided there is some way to store or transport their bike when they arrive.

Catchment area example



Source: Martinovich (2008)

In practical terms, this means that the catchment area for a particular public transport service could increase 10-fold, if a cycle–public transport scheme is provided.

Matt says, 'This is the area that could theoretically be covered by bike in 10 minutes, but we still need to determine how many patrons within this would be attracted to cycling to public transport services, if bike facilities were provided. This data is not available in New Zealand, which is one reason the study focused on long-term observed cycle–public transport rates from overseas.

Cycle–public transport summary by option scenario (bus only)

	Auckland	Wellington	Christchurch	Hamilton	Tauranga	Dunedin
SCENARIO 1: BoB ONLY (BUS)						
Annual cycle–PT trips	634,130	316,450	241,980	47,130	17,570	27,220
Annual cycle–PT trips from cars	317,450	158,590	121,490	29,450	8,650	13,610
Secure locker supply	–	–	–	–	–	–
Benefit to cost ratio	8.9	8.6	8.9	10.4	9.2	7.2
SCENARIO 2: BaR ONLY (BUS)						
Annual cycle–PT trips	131,370	65,820	50,480	12,380	3,460	5,690
Annual cycle–PT trips from cars	84,120	42,060	32,410	7,420	2,230	3,460
Secure locker supply	390	195	150	37	11	17
Benefit to cost ratio	N/A					
SCENARIO 3: BoB AND BaR (BUS)						
Annual cycle–PT trips	663,810	331,290	253,860	61,860	18,570	28,950
Annual cycle–PT trips from cars	347,630	173,700	132,870	32,410	9,650	14,840
Secure locker supply	390	195	150	37	11	17
Benefit to cost ratio	4.6	4.3	3.7	3.3	2.0	2.3

Note: PT = public transport; BoB = bike-on-board; BaR = bike-and-ride

Developing the model

A major outcome of the project is a model to forecast demand for cycle–public transport schemes in particular areas. The model is based on:

- overall demand for a cycle–public transport scheme as a portion of public transport patronage
- the number of cycle–public transport scheme users who would shift away from the private car
- the demand for secure locker storage.

A simulation is then used to model the range of values for each of these variables. Forecasts were produced from these values, which transport practitioners could adjust to reflect their local context.

Matt says, 'The next step was to use the information from the forecast models to perform an economic evaluation of particular initiatives. Six urban areas in New Zealand were assessed for their potential to integrate cycle–public transport schemes into their existing public transport services.'

The six areas looked at were the Auckland, greater Wellington, Christchurch, Hamilton, Tauranga and Dunedin regions. Residents' normal means of travel to work were different in each region, as were the public transport services available. Limited bike-on-board and bike-and-ride facilities were already available in Auckland, Wellington and Christchurch.

How the figures stack up

When the model developed in the research is applied to the six urban areas studied, 1.7 million cycle–public transport scheme trips are forecast each year across bus, rail and ferry.

The table at left breaks this down, with respect to buses, into daily forecast weekday trips in the six studied urban areas, for three different scenarios of scheme provision:

- bike-on-board (BoB) only
- bike-and-ride (BaR) only
- both BoB and BaR.

Matt explains that each demand variable in the model used to produce the forecasts has a range associated with it. 'What we found is that, with a highly successful cycle–public transport system, the demand could double from that forecast. Conversely, for a poor-performing scheme, demand could be almost halved.'

The table also shows:

- the forecast number of current private car drivers who would make use of cycle–public transport schemes, thereby removing car trips from the road
- the demand for lockers forecast for bus services (when combined with rail and ferry in Auckland and Wellington, demand could reach 800 and over 600 lockers respectively)
- the potential economics of implementing schemes (based on indicative costs and assumed usage rates similar to those observed overseas).

For all six of the urban areas studied, the economic analysis shows that the benefits of providing cycle–passenger transport schemes exceed the costs. However, Matt cautions that, because of the range of factors used in the model and because the costs used in the evaluation are only indicative, practitioners will have to calculate funding cost–benefit ratios on a project-by-project basis.

Making it local

Although pilots are already underway in New Zealand to provide cycle–public transport facilities, Matt explains that these were not taken account of in the research.

'The model was purposefully based on international information about long-term use of cycle–public transport interfaces, because short-term rates available from New Zealand trials are unlikely to be the same. One of the main things that the research showed us is that, without good promotion and a high level of fit-out on services, then the usage rates will continue to be low.'

With this in mind, the report contains a series of recommendations for transport providers to successfully introduce cycle–public transport schemes in regions. These include a review of public transport services in the major centres to assess whether vehicles and contracts can be altered to allow bikes on board, and a review of public transport stations and terminals to see whether the forecast demand for secure bike storage can be provided.

Matt says that New Zealand can benefit by learning from the more successful schemes internationally. These show that it is critical for there to be a comprehensive and collaborative process between marketing, education and engineering when introducing a scheme. This could include activities such as:

- bringing a bus with bike-on-board to events around the city
- setting up example racks at stores and bike-friendly places for people to try loading and unloading bikes
- providing discounts for lockers and fold-up bikes
- going into workplaces and schools to discuss the programme
- using technology and real-time monitoring of behaviour to optimise the system once it is in place.

Other recommendations for the public transport system include:

- no additional fare charged for passengers taking their bikes on board services
- a re-examination of some operators' current refusal to carry bikes on board services at peak time
- potential retrofitting of trains to provide flexible areas capable of accommodating both bikes and people, and more secure storage at stations
- an extension of the research to cover demand from cyclists who need to avoid areas not capable of being cycled, such as harbour bridges and tunnels
- long-term data collection in New Zealand on current cycle–passenger transport scheme trials, previous travel patterns of scheme users, and the attractiveness of secure storage options over bike-on-board ones.

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Forecasting the benefits from providing an interface between cycling and public transport
NZ Transport Agency research report 418

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One eye on the land, the other on the road: improving integrated transport assessments in New Zealand

Guidance on when and how to carry out an integrated transport assessment, plus what should be included in assessments of varying complexity, is contained in a recent report facilitated by the Trips Database Bureau.

New research has produced guidelines to improve practice on undertaking integrated transport assessments in New Zealand.

Although transport assessments are happening, and some guidelines are already available, it is generally acknowledged these assessments produce variable results and quality. This is a problem, because it may mean that valuable resources are being under-used or over-used, and important decisions are being made without the benefit of fully understanding the transport effects.

The new guidelines seek to rectify this by drawing on best practice here and overseas to explain how integrated transport assessments should be conducted, with particular reference to the requirements for integrated and sustainable management of resources contained in New Zealand legislation.

What's in the guidelines?

Steve Abley of Abley Transportation Consultants, one of the principal authors of the research with Malcolm Douglass of Douglass Consulting Services and Paul Durdin also of Abley, says that in developing the integrated transport assessment guidelines there was a need to reconcile the sometimes conflicting needs of decision-makers and practitioners. 'A uniform methodology was required for carrying out an integrated transport assessment and, with this in mind, we developed the guidelines to improve understanding of the process and the relevant inputs as well as the fit and context for integrated transport assessments within the New Zealand regulatory structure.'

The level of detail covered by a transport assessment, and the nature of the assessment for a particular issue or project, depend on the particular circumstances of each site. Factors such as the statutory planning framework that applies, the degree of traffic impact or adverse effects indicated from a preliminary assessment, and the sensitivity of adjacent networks to changes in travel demand will all influence the type of assessment required.

The guideline outlines the scope and content required for four types of integrated transport assessments, namely simple, moderate, broad and extensive, with decisions about which level of assessment is required based on two dimensions: the geographic effect and the policy effect.

Steve explains that this approach differs from what has occurred in the past. 'Guidelines in the past have either limited themselves to full integrated transport assessments, or allowed for varying levels of assessment based purely on the expected transportation effects within a particular geographic area. In the current guidelines, we've added another dimension, so that decisions about which type of assessment is required now also take into account policy considerations.'

ITA scope definitions

ITA scope	Geographic	Policy
Simple	Expected to have an effect within the site and at the interface with the transport network	Expected to be compliant with statutory rules
Moderate	Expected to have an effect over a small area or neighbourhood	Expected to align with local policies
Broad	Expected to have an effect over a larger area, eg part of or a whole suburb	Expected to align with local and regional policies and objectives
Extensive	Expected to have impacts over a wide area, district or region	Expected to align with regional and national policies, objectives and visions

What is an integrated transport assessment?

The term 'integrated transport assessment' was first used in New Zealand by the Auckland Regional Transport Authority, and refers to a particular method of assessing transport issues and effects in New Zealand.

Integration in this context means the integration of land use and transport, which is a key outcome sought through the New Zealand Transport Strategy 2008 and the Land Transport Management Act 2003. Integrated transport assessments are seen as a key mechanism for delivering successful environmental outcomes from transport projects. The Resource Management Act 1991 requires regional and local authorities to achieve 'integrated management of the natural and physical resources' in order to promote their sustainability. The transport system is considered a physical resource and therefore critical to integration issues.

The current project has widened the scope of what is meant by an integrated transport assessment to encompass five dimensions:

- consideration of national, regional and local transport and growth strategies
- discussion of land use control policies and district plan zoning objectives
- recognition of varying thresholds for assessments both on and off the site
- greater emphasis on person-trips by all modes
- consideration of travel demand management techniques for larger sites with high trip generating developments.

In the guidelines, the consideration of geographic issues relates to the spatial distribution of the expected effects, and the area over which the effects of the proposal will be noticed or deemed important. The consideration of policy and planning issues relates to district, regional and national strategies and plans (with the issues concerning the interactions between transport, land use and community under these documents). The larger an integrated transport assessment's scope, the greater the range of policies and strategies that will need to be addressed.

The guidelines outline the process to follow in developing an integrated transport assessment, and the typical contents for assessments of each type. In general, the content for simple assessments will be modest (because small projects will typically have limited impacts) and may only include consideration of such impacts as site access, on-site provisions and safety issues. Moderate integrated transport assessments will add to this a consideration of the project's impact on adjacent streets and nearby intersections. This may incorporate consideration of the land use characteristics and zoning provisions in the relevant district plan, and some local site modelling for pedestrian effects, and on-site and off-site vehicle movements.

Broad assessments will pull in adjacent blocks and could require strategic assessment of the location, evaluation of neighbouring land uses, consideration of a range of travel modes, surveys and more extensive modelling. Extensive integrated transport assessments have the widest consideration of issues, and will require more extensive and complex transportation modelling, and consideration of district and regional effects in the context of longer-term planning objectives.

Technical assessment methodologies for the various aspects of an integrated transport assessment can vary significantly, so the report also provides four practice notes for practitioners to use (on vehicle-trip generation surveys, estimating design trip generation rates for retail activities, relevant case law, and discussion of the permitted baseline), with recommendations for more to be developed in the future.

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Integrated transport assessment guidelines
NZ Transport Agency research report 422

Freely available online at www.nzta.govt.nz/research

Hard copy $20 – order from email research@nzta.govt.nz

Walk this way, at night and in comfort

A review of pedestrian lighting guidance that focuses on lighting needs from a pedestrian viewpoint and aims to make walking at night not only safe, but also attractive, will complement existing standards.

A number of initiatives are currently being implemented to encourage people to walk more in New Zealand's urban areas. Some of these, such as the New Zealand Transport Strategy, target increasing total trips by active means (including walking) in urban areas for environmental, infrastructure and sustainability reasons. Others, such as those being driven by the Ministry of Health, are focused on people's health. Either way, the numerous benefits of adopting more active means of getting around are widely recognised.

In the past, most lighting in public urban areas has been provided primarily for motorists, and only incidentally for pedestrians. However, pedestrians' lighting needs are very different from those of motorists. Tiffany Lester of Opus Central Laboratories explains that little guidance seemed to be available on 'What aspects of lighting are particularly important to making walking after dark safe? And how could lighting make the walking after dark experience more pleasant?'

Opus set out to provide guidance on how to consider public lighting specifically for pedestrians. New Zealand already has comprehensive standards governing this type of lighting: for example, in the form of AS/NZS 1158.3.1:2005: Lighting for roads and public spaces, part 3.1: pedestrian area (category P) lighting – performance and design requirements. The current guidance will complement, not replace, those standards, because the purposes of the documents are different.

Tiffany says, 'The standards, by their nature, describe how to provide adequate and acceptable lighting, but they are not intended to change people's transport choice. If you are seeking to encourage people to walk, then you also need to consider how to make areas appealing, so that people want to use them at night. Competent pedestrian lighting design requires an understanding of how people respond to lighting, as well as technical lighting knowledge.'

The guidelines are based on a wide literature review and information from across the lighting industry. The following key elements emerged and are discussed in more detail in the full report.

- The presence of shadows within a pedestrian lighting environment needs to be balanced, in order to avoid areas of strong shadow but at the same time create three-dimensionality for objects in the environment. The extent of shadows can be managed through the angle of light incidence, or the number and intensity of light sources.
- Lighting uniformity is important. It can be managed through luminaire output, apparent light size, mounting height and spacing.
- Lighting colour can optimise colour rendering, eg by recreating natural daylight conditions. Lighting colour can also be used for effect, eg by combining and enhancing the colours of the pedestrian environment.
- The visibility field for physical safety should be related to the likely speed of pedestrian movement. The visibility field required for feelings of personal security is likely to be larger than that required for physical safety. While recommendations vary and the particulars of the pedestrian situation should rule this decision, the visibility field for personal security appears to be approximately 10m.
- Pedestrian lighting can influence people's perceptions of personal security. This effect needs to be considered to ensure that the pedestrian lighting scheme communicates the appropriate message to pedestrians about the use of particular areas after dark.
- Throughout a pedestrian lighting scheme, the illuminance needs to be reviewed from the perspective of likely pedestrian activity types and locations, and potentially matched to desired activities and locations for these.

Lighting based on how we see

One of the important things that the guidelines do is make recommendations for public lighting based on how human night vision works (as opposed to relying purely on the readings and calibrations of instruments).

Parts within the human eye provide various aspects of vision and those parts perform differently under different lighting

conditions. This means that the visual experience during the bright light of the day is not the same as that under the levels of illumination typical of pedestrian lighting. As the light decreases, visual sharpness declines, and sensitivity to different colours changes.

The natural working of human vision affects pedestrians' experience of lighting. So while an illuminance meter might detect that lighting levels are fine, this might not be how pedestrians, operating on night vision, experience the situation. For example, past research has established that while an illuminance meter registered that a white light source and a yellow light source provided identical levels of illumination, in fact the light source with the greater amount of blue light in it provided people with better vision (as a result of the human eye being more sensitive to blue-green at low light levels).

In addition, it is recognised that people feel most comfortable when their interpretation of the world around them feels natural, including their spatial orientation. In daylight, this occurs naturally, with the sun providing logical patterns of shadow and light. The impression of the pattern of lighting created through light meter readings and the parameters given in formal standards may not, however, reflect how well a lighting scheme delivers on the aspects of lighting that are significant for pedestrian comfort.

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Public lighting for safe and attractive pedestrian areas
NZ Transport Agency research report 405

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Evidential-based guidelines for temporary speed limits

Research report 407

Opus Central Laboratories

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Hard copy $20

A study was conducted to examine whether the New Zealand code of practice for temporary traffic management guidelines for the implementation of temporary speed limits (TSL) results in driver speeds that match safe travelling speeds. Site approach and site entry speed data were collected at eight sites around Wellington, New Zealand, where TSLs were in place. Four TSLs (100 to 70km/h, 100 to 50km/h, 100 to 30km/h and 50 to 30km/h) and two visibility conditions (continuous and non-continuous) were used. Surveys were sent to 100 drivers at each site, asking about their risk perceptions and attitudes to speeding and roadworks. While drivers did reduce speed at the approach to the entry of a roadworks site, the reduced speeds, both the mean speeds and 85th percentile, were higher than the TSL.

These findings indicate that improvements are needed regarding site design and TSL estimation to reduce the crash risk. Drivers' subjective risk perceptions, either site specific or general, were not related to their site entry speeds. Drivers also tended to underestimate the speed at which they would drive through a site. The survey results suggest that drivers' subjective perceptions do not influence their objective behaviours. Recommendations are made for improving the setting of TSLs based on estimates of driver speeds.

Improving school travel systems

Research report 420

Transport Engineering Research NZ (TERNZ)

Freely available online at www.nzta.govt.nz/research
Hard copy $40

The purpose of this research, carried out between 2008 and 2010, was to investigate the evidence for prioritising school travel initiatives, and to develop an evidence-based toolkit for the design of school travel systems to supplement existing school travel initiatives.

There are tangible economic, safety, health and environmental reasons for giving greater priority to school travel initiatives, and a more coordinated approach to optimising school travel systems could be adopted. This would also help the government address its *Government policy statement on land transport funding* (GPS) theme of economic growth and productivity, although further work is needed to balance the impacts of school travel initiatives against other projects, such as state highway development, which might also have a positive impact on the wider transport system.

This report clearly demonstrates that a number of areas such as cycling to school, bus safety and access, road environments around schools, rural schools, and road safety education and training for young people need to be systematically addressed if New Zealand is to realise the benefits of an optimised school travel system.

The proposed school travel system toolkit is intended to supplement existing school travel planning processes, and includes a status diagram to help evaluate different parts of the school travel system and track improvements. The toolkit and status diagram are intended for school travel planners and other personnel who are involved in the provision of school travel systems or infrastructure.

Attitudes and behaviour in relation to public transport in New Zealand's non-metropolitan regions

Research report 419

Massey University, Palmerston North

Freely available online at www.nzta.govt.nz/research
Hard copy $35

During the last decade, New Zealand's non-metropolitan regions have undergone significant demographic and economic changes as a result of migration and changing employment trends. These changes are not widely recognised or understood, let alone addressed in land use and transportation planning.

This research analyses the demographic trends in three non-metropolitan regions and, through data gathered from a questionnaire and interviews, explores the residents' attitudes and behaviour in relation to shared transport. The aim was to build understanding about how to improve transport access for people in these regions in a way that best uses existing infrastructure. This would support current government goals for transport, which include providing more transport choices, lowering the costs of transportation, making the best use of existing infrastructure, and ensuring that investment in land transport contributes to economic growth and productivity.

The research identifies clear scope for, and interest in, having a greater range of transport options, including shared or flexible transport services. Because shared transport contributes to reduced single-occupant vehicle trips and fewer vehicles coming into larger urban centres from adjacent smaller settlements, the wider land transport system and economy would benefit from its use, with improved effectiveness and value for money in the development and operation of networks.

Screening bridges for potentially high dynamic loads using profile variance

Research report 416

Opus Central Laboratories

Freely available online at www.nzta.govt.nz/research
Hard copy $20

Profile variance, which is already listed in the NZTA's RAMM database, is a measure of the difference between the actual road profile and its moving average over selected moving average lengths. The relationships between measured dynamic bridge deflections, and road profile variance and roughness values derived from raw road profiles for short, long and medium wavelengths, were examined during 2008–2009. These relationships between profile variance and bridge response were used to investigate the potential use of profile variance as a predictor of dynamic vehicle loads and as a means of screening New Zealand bridges for mitigation of damage, and for targeted and proactive maintenance.

Auditing public transport accessibility in New Zealand

Research report 417

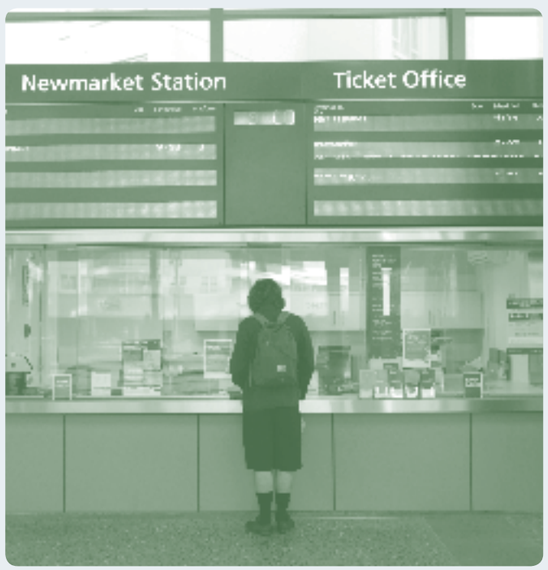
Pinnacle Research & Policy Ltd

Freely available online at www.nzta.govt.nz/research
Hard copy $50

This research project, conducted in 2007–2009, reviewed international best practice for auditing public transport (PT) accessibility, and developed and piloted a New Zealand-specific PT accessibility audit methodology. The accessibility audit and report card takes a 'whole-of-journey' approach to accessibility, thus including: service coverage; accessing information about the services; getting to the service; paying for the service; getting on board; enjoying the ride; getting to the final destination (where people want to go, when they want to get there); and making the return trip. Affordability of the service has been excluded from the current audit and report card.

The audit uses a simple yes/no checklist to assess accessibility factors and summarises these in a report card which tallies the number of 'barriers to access' rated as 'severe' (3), 'moderate' (2) and 'slight' (1) on the route/corridor for each of six PT user categories. The audit and report card were piloted on three routes in the greater Wellington region.

The audit and report card are supplemented with a best practice guide to the factors that contribute to making a PT journey accessible to any or all categories of PT user. Possible future improvements include: developing a web-based assessment tool; including ferry, Total Mobility and long-distance services; and exploring other rating scales and options.



Design moisture condition guidelines for pavement design and material assessment

Research report 424

Opus Central Laboratories

Freely available online at www.nzta.govt.nz/research
Hard copy $10

A pavement design model developed in the United States (US) is used to estimate the equilibrium degree of saturation in pavement subgrade and basecourse materials. The model is applicable to all the mainland US states, including areas with similar climatic conditions to New Zealand. The research on which this report is based, which was carried out in 2008–2009, indicates that the US-based model is appropriate to New Zealand conditions, where typical equilibrium moisture conditions are in the range of 50–60 percent for granular basecourse and typically greater than 85 percent for fine-grained subgrade soils.

Failure probability of New Zealand pavements

Research report 421

Opus Central Laboratories

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The risk involved in pavement design is that the pavement life will be shorter than the design life. While the literature reveals that statistical methods can be used to estimate the risk (or reliability) of a pavement design, researchers do not appear to have demonstrated the rigour of their analysis by comparing their results with the performance of actual pavements.

This research project, carried out in 2008 on four state highway networks in New Zealand, studied how the interaction of all the variables relating to pavement life combine to influence pavement performance.

The probabilities of failures were investigated through the available RAAM data. The study examined the rutting and roughness performance of unbound granular pavement and full-depth asphalt pavement.

Based on these findings, it is proposed that thin-surfaced granular pavements have a bimodal distribution of life. The first peak is in the first one to two years, when shallow shear and potholing can occur. After this period, the pavement settles down and the average life will approximate 45–50 years under moderate traffic. It is also concluded that, although the pavements have not been failing through rutting or roughness, the Austroads *Pavement design guide*'s proposed risk of a five percent probability of not achieving the pavement's design life appears to be correct.

The NZTA's 2011/12 research programme

In order to ensure that funding for the research programme meets the objectives of the *Government policy statement on land transport funding* (GPS), the NZTA undertook a review of its research programme in 2009. The review outcome signalled a change of approach to the research programme through a new research programme framework to guide the NZTA's investment in research. The framework lists the NZTA's research priorities and criteria for investment and is available at www.nzta.govt.nz/resources/research/docs/research-programme-framework-2011-12.pdf.

Right now, the NZTA is taking the first steps in preparing its research programme for 2011/12. Requests for proposals (RFPs) for research topics will be advertised on the Government Electronic Tendering Service (GETS) as from June 2011.

For more information, view www.nzta.govt.nz/resources/research/index.html.

Value of research reports to end users

The NZTA has commissioned a research project to look at how valuable Research Programme reports and findings are to end users.

The project, which is currently underway, is focusing on reports published between 2005 and 2009 which are available on the NZTA's website. As well as looking at how the reports and findings are used, the project will identify the most effective ways to promote the reports and findings to end users.

The research report will be available mid year, and the NZTA will publish the report and implement the findings, as appropriate, so as to enhance the value for money of its investment in transport sector research.

Supplementary issues of the *NZTA research* newsletter

A significant number of research reports have recently been published, resulting in the need for two supplementary issues of *NZTA research*. It is anticipated these will be released in May and wAugust 2011.

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

NZTA research

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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.

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.

Advertisements of forthcoming conferences and workshops that are within this publication's field of interest may be published free of charge, when space permits.

Inquiries on specific articles should be made to the author. Otherwise, all general correspondence and queries related to conference notices and mailing list requests should be made to: research@nzta.govt.nz.

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New Zealand Government

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