NZTA research

Supplementary issue
November 2011

ISSN 1174-0523 (print)
ISSN 1174-0566 (online)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Laying down asphalt

Your views

NZTA research welcomes letters from readers. Letters should be addressed to:

The Editor, NZTA research
NZ Transport Agency
Private Bag 6995
Wellington 6141
New Zealand

www.nzta.govt.nz

Is cooler better? Examining the case for warm asphalt

Research into the costs and benefits of using warm asphalt has been completed. It concluded that, at this stage in the technology's development, it is not possible to recommend that it should be adopted.

However, a watching brief was recommended, alongside a new performance-based specification for asphalt, to ensure that quality is maintained once the new technology is ready to use.

At present, approximately 1 million tonnes of hot mix asphalt is produced in New Zealand every year. Production consumes considerable fuel and energy, and produces substantial greenhouse gas emissions (in particular carbon dioxide). With both these factors currently in the spotlight, locally and internationally, attention has turned to the potential for warm asphalts to be used as an alternative.

Warm asphalt has been used overseas since the 1990s. It is produced (and sometimes placed and compacted) at significantly lower temperatures than those typically needed to produce hot mix asphalts (approximately 160°C). Proponents of warm asphalt technologies claim numerous advantages to their use, including:

- reduced heating fuel requirements
- reduced carbon dioxide and other greenhouse gas emissions
- reduced emissions of volatile organic compounds

continued on page 2

continued from page 1

- increased time available for their transport, laying and compaction
- ability to pave satisfactorily at lower temperatures (for some technologies)
- increased safety for operators
- longer surface life, due to reduced binder oxidation and improved compaction.

Two asphalt producers in New Zealand already have a plant capable of producing warm asphalt mixtures. For the others, it may be a matter of investing when the cost–benefit ratio of using warm asphalt indicates that this is warranted.

A recent NZ Transport Agency (NZTA) funded research report will help this decision-making process, by looking in depth at four of the main technologies associated with the manufacture of warm asphalt, including the costs, temperature reductions, plant modifications and typical energy needed to produce a tonne of mix for each process.

Weighing warm against hot

George Ball of Opus International Consultants explains that one of the principal purposes of the research was to evaluate, as far as possible, the energy consumption and emissions for each of the warm mix methods, then compare these with each other and with figures for hot mix production.

George says, 'This proved difficult because there is such a wide range of published results for the energy expended in hot mix manufacture – values ranging from 23 to 3400MJ per tonne of mix have been cited. The variation is probably because different studies are taking into account different factors when they calculate the energy consumed during the process. However, what the studies did show is that the energy expended in heating the aggregate and bitumen during the asphalt's manufacture represents only around 44 percent of the total energy involved in its production, transport, laying and rolling. So that automatically places an upper limit on the amount of energy that we can expect to save by adopting warm asphalt manufacturing processes.'

Calculated figures for the warm mix processes were used for the comparisons (measured data was not yet available for many of them), which indicated that many of these processes could potentially provide energy savings of around 20 percent, and a couple substantially more.

Lower manufacturing temperatures would also result in reduced emissions of carbon dioxide and other greenhouse gases.

The technologies behind warm mixes

Not only is warm asphalt produced at lower temperatures than its hot mix counterparts but, depending on the technology used, it may also be laid and compacted at significantly reduced temperatures.

Many warm asphalt technologies are still in the developmental stage, with their benefits and long-term performance yet to be verified. However, in general, they tend to be based on at least one (and sometimes a mix) of the five principles below.

The current research report looked in depth at the first four principles (no published material is yet available on the fifth), in an effort to give a clearer picture of what costs and benefits each may present for asphalt manufacturers and users.

1. Technologies based on modification of the asphalt mixing process (without changing the mixture's components). Significant plant modifications are necessary. Paving is completed at similar temperatures as for standard hot mixes.
2. Technologies based on adding substances that decrease the viscosity of the bitumen at high temperatures. Various waxes are added to enable mixing at lower temperatures. In general, paving cannot be carried out at reduced temperatures (unless a softer grade of bitumen is used). Minor adjustments may be needed to plant to enable the wax to be added in controlled amounts.
3. Technologies based on modifying the interaction between the bitumen and the aggregate. Proprietary chemicals have been developed to improve the workability of the mix and aggregate coating, without significantly changing the bitumen's viscosity. Mixing and paving can both be carried out at lower temperatures. The only plant modification required is apparatus to inject the additive into the bitumen.
4. Technologies based on introducing water to foam the bitumen. Ways of doing this include:
   - foaming the bitumen in the asphalt plant before it is applied to the aggregate – modified plant required
   - using zeolite additives that slowly release water above 100°C
   - adding warm bitumen emulsion to heated aggregate – enables paving at significantly lower temperatures
   - adding water to the aggregate to promote foaming when the bitumen is added – allows mixing and paving at lower temperatures, but requires significant modifications to plant and payment of a large royalty on set-up.
5. Technologies using low viscosity vegetable binders.

George says, 'For a typical warm asphalt process we could, if it was adopted throughout New Zealand, be looking at an annual carbon dioxide reduction of around 4700 tonnes. That's a significant reduction for the asphalt production industry, although obviously in the context of New Zealand's total emissions a variety of other control strategies are still needed. There's also potential to double the amount saved by the industry if one of the low-energy half-warm processes is uniformly adopted. However, the considerable costs involved for manufacturers in modifying their plant means that that's unlikely to happen at present.'

Other purposes of the research included comparing the set-up and production costs of the various processes, and investigating whether any of them were particularly suited to adoption in New Zealand.

It was discovered that currently it costs more to manufacture warm mixes than hot mixes, although projected increases in energy costs in the future may change this situation. It was also determined that, at this stage in the development of the various warm asphalt technologies, none of them stood out as especially suited to New Zealand conditions.

George says, 'We needed to balance the environmental advantages arising from reduced fuel consumption and emissions against the costs of producing any additives and of making necessary modifications to plants, and against the maturity of the various technologies.

'As a result, we were unable to make any blanket recommendation about adopting one or other of the technologies at present. However, we are recommending a

watching brief on the use and development of the anhydrous chemical additives and low-energy half-warm processes. These processes look to have the greatest long-term potential because of the energy savings associated with their reduced temperatures, and we would support any proposals to trial and apply these technologies here.'

The research report also recommends that provision should be made to enable warm asphalt technologies to be adopted as they mature and prove themselves in the field. This includes developing a performance-based specification for asphalt, based on the ultimate properties of the finished pavement, which could be applied to all mix processes – hot, warm and cold. At present, asphalt quality control is usually carried out under Transit New Zealand's *TNZ M/10: Specification for asphaltic concrete* (2005), which specifies a mix design method inappropriate for warm mix asphalts.

Contact for more information

John Patrick
Opus International Consultants
04 587 0600
john.patrick@opus.co.nz

Environmental and financial costs and benefits of warm asphalts
NZ Transport Agency research report 404

Freely available online at www.nzta.govt.nz/resources/research/reports/404/

Risk in the frame: effective risk management for New Zealand road networks

The Local Government Act 2002 emphasises the need for local authorities to take a holistic approach to risk management. Yet recent reviews and current opinion reveal that risk management practices are still lacking with respect to the management of road networks.

A research project to develop a 'comprehensive yet simple' best-practice guideline for risk management for road networks looked in depth at the current risk management practices of nine local transport authorities (councils) throughout New Zealand.

Although the study revealed clear shortfalls in authorities' current practices, it was able to draw on these, and information from a literature review, to set out the minimum requirements for an integrated risk framework, plus some practical tips for overcoming common obstacles in the risk management process.

The role of risk management

Risk management is essentially about identifying the risks that an organisation faces, and developing plans to mitigate and manage them. The aim is to ensure that the risks, should they occur, do not prevent the organisation from achieving its goals.

Risks can range from day-to-day operational challenges to major events that jeopardise how and whether an organisation can function. In the context of transport, this spectrum might range from risks associated with specific construction projects, to potential non-compliance with legislation, to failure of critical assets, which will in turn undermine the availability of civil defence emergency lifelines.

How the councils fared

A 2007 review of the asset management plans of 74 road controlling authorities identified that most were performing poorly

continued on page 4

continued from page 3

in terms of risk management (and very few were performing well). Specific issues included poor identification of risks and a lack of integration of transport risks into corporate risk policies. Actual and potential flow-on effects from these failures were poor decision-making about transport assets (because all the options were not being taken into account), lack of management awareness about risks that needed addressing, avoidable failure of critical assets, and the costs of risks not being taken into account in programmes and projects.

These types of risks were mirrored in the pilot study of the nine local authorities in the research project. (The authorities, representing approximately 10 percent of all authorities, were selected to provide a cross-section of population size, road network length, type and geographical spread, and included one that had not yet started developing a risk management process.)

Research team member Theuns Henning of the University of Auckland says, 'The study clearly demonstrated that road network risk management practices are still not being well implemented by local authorities in New Zealand. Although most councils understand the theory of risk management, very few are implementing the associated strategies, such as developing risk registers and keeping them up to date, and taking steps to reduce identified risks.

'What the study also showed is that there are specific difficulties or barriers that deter authorities from putting in place effective risk management frameworks. By identifying these and extracting examples of best practice from the case studies and from existing local and international guidelines, we were able to develop targeted guidelines for risk management in transport. The guidelines are practical and relatively simple, and we're recommending that they should be adopted at a national level.'

Towards a national guideline

The project's key recommendation is that all councils should be provided with a standard risk register to use with respect to transport. This could be done through the Road Information Management Steering Group and Road Controlling Authorities Forum, which will be releasing guidelines in a future publication.

These guidelines are set out in full in the research report and include an overview of the generic risk management process, plus suggested steps for establishing organisation-wide risk management (and linking this to transport or road risks) and for developing a risk management framework (including defining the asset manager's role, getting buy-in from the top, and getting started).

SUMMARY OF CASE STUDY COUNCILS

(* = risk framework is designed for these elements, but not currently populated)

Council	A	B	C	D	E	F	G	H	I
Population	206,000	69,000	57,000	55,500	46,000	28,500	27,500	18,000	10,500
Km roads operated	684	1,260	357	762	289	4,961	2,629	1,555	1,445
Corporate risk policy in place	✓	✓		✓					
Corporate guidelines in place	✓	✓							
Corporate risk roles defined	✓	✓		✓					
Similar RMF across activities	✓	✓	✓	✓	✓	*			
Transport/roading risk guidelines in place	✓	✓	✓	✓	✓	✓	✓	✓	
Transport/roading risk roles defined	✓	✓	✓	✓	✓		✓	✓	
Risk register established	✓	✓	✓	✓	✓	✓	✓	✓	
Gross/inherent risks evaluated	✓					✓			
Current risk evaluated	✓	✓	*	✓	✓	*	✓	✓	
Target risk nominated	✓					*		✓	
Current practices identified	✓		✓		✓	*	✓	✓	
Proposed actions identified	✓	✓	*		✓	*	✓	✓	
Risk actions prioritised			*	*				✓	
Actions assigned/monitored	✓	✓		✓	✓	✓		✓	
Actions costed/resourced									
Risk incorporated into AMP	✓	✓	✓	✓	✓	✓	✓	✓	✓

RISK MANAGEMENT GUIDELINES CURRENTLY BEING USED IN NEW ZEALAND

Agency	Standards New Zealand
Paper title	*Risk management guidelines, HB436:2004 – companion to AS/NZS 4360:2004*
Summary/synopsis	This handbook provides generic guidance for establishing and implementing effective risk management processes in any organisation. It demonstrates how to establish the proper risk context, and then how to identify, analyse, evaluate, treat, communicate and monitor risks.
Agency	Standards New Zealand
Paper title	*Risk management for local government, SNZ Handbook 4360:2000*
Summary/synopsis	This handbook provides risk management guidelines that can be applied specifically by local authorities to meet their obligations. The handbook divides council activities into seven broad categories, including 'built assets'. It also suggests organisational structures to implement and coordinate risk management in a local authority.
Agency	National Asset Management Steering Group
Paper title	*International infrastructure management manual – section 3.4 Risk assessment and management*
Summary/synopsis	This section outlines a process to ensure that organisations understand their risk exposure and critical assets, and have plans in place to manage risk to acceptable levels. The framework is based on Australia/NZ Standard 4360. An overview of the risk management process is provided, with a range of infrastructure risk case studies. The section also covers risk-based decision making and risk management applied to emergency management.

Detailed sections are included on identifying, evaluating and prioritising transport and road activity risks (including planning, management, delivery and physical asset risks). Also included is guidance on how to identify (and improve) practices that help avoid or mitigate these risks. It also looks at reporting, monitoring and reviewing risks and improvement actions, as well as integrating risk management with asset management, and evaluating the effectiveness and suitability of the risk management process.

Contact for more information

Theuns Henning
University of Auckland
09 923 8181
t.henning@auckland.ac.nz

Case studies and best-practice guidelines for risk management on road networks,
NZ Transport Agency research report 415

Freely available online at www.nzta.govt.nz/resources/research/reports/415/

Project supports equal status for pedestrian injuries

Around 700 pedestrians are admitted to hospital each year due to slips, trips and tumbles on or around our roads.

A recent project looking at the circumstances of these accidents showed that the unsatisfactory condition of the sites where the accidents occurred contributed substantially to their incidence, as did pedestrian distraction.

Pedestrian injuries form a significant proportion of the injuries sustained on the nation's road networks each year. However, because most of the accidents causing these injuries do not involve a motor vehicle, they are not reported as part of traffic crash data and very little is known about the circumstances in which they occur.

Opus Central Laboratories conducted research from 2008 to 2010 to fill in this knowledge gap. Using ACC data about claims for pedestrian injuries that did not involve motor vehicles, a literature search and an interview-based survey of injured pedestrians, the researchers were able to build up a more complete picture of how, when and why accidents happen.

Bill Frith of Opus says, 'Walking is an increasingly important mode of transport, especially in urban areas where it can help reduce congestion and emissions, and improve people's health and quality of life. This research has enabled us to make recommendations to improve the pedestrian environment, so that pedestrians can use urban streets with greater confidence.'

The New Zealand approach

New Zealand takes a Safe System approach to road safety. Under this approach, road controlling authorities are responsible for minimising injuries on their road networks, irrespective of whether motor vehicles are involved or not. Road networks include the actual roads, and areas near roads used by pedestrians such as footpaths and walkways.

Bill says, 'Even putting the current high levels of non-motor-vehicle-related pedestrian injuries on the road network aside, if walking is set to increase as a means of transport in the future, then it makes sense that injuries will also increase, unless the pedestrian infrastructure is improved to prevent them.

'In New Zealand, road controlling authorities have this responsibility for mitigation, so they need to understand how their road network infrastructure is contributing to accidents. Infrastructure in this context includes walking surfaces, road crossing points, service covers, and obstacles like bollards, seats, trees and signs.'

Survey findings

Using ACC data for non-motor-vehicle-related pedestrian injuries from accidents near or on roads in the Wellington region as a starting point, the final survey canvassed just under 500 people about their perceptions of their accidents. Topics covered included where the accident occurred and the environmental characteristics, such as lighting, weather, type of walking environment, visibility of any hazards, type of walking surface and whether respondents felt it was slippery or rough. They were also asked whether they believed that the surface they slipped, tripped or fell on influenced the severity of the accident.

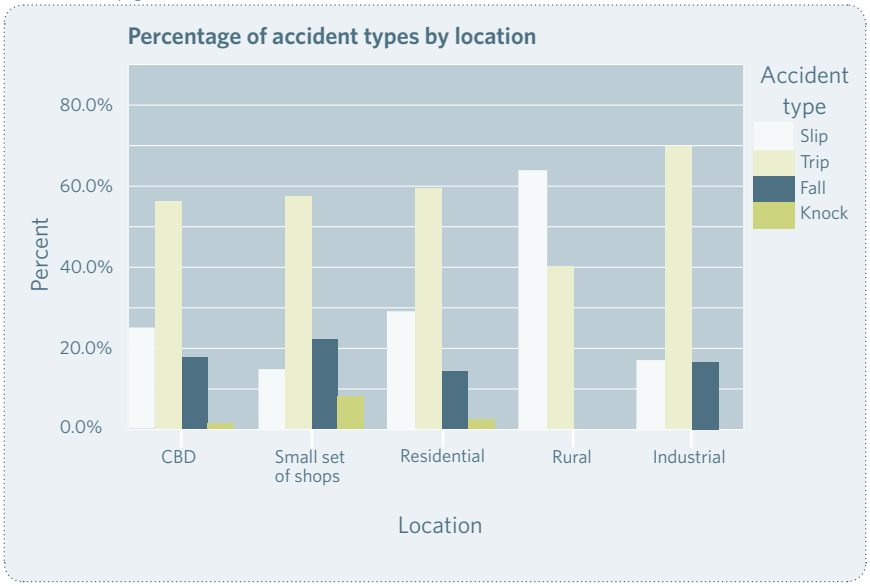
Questions were also asked about personal characteristics that may have made the respondent more vulnerable to an accident (such as footwear, health, fatigue, vision, what they were carrying and whether they were in a hurry) and whether they were distracted (for example by a cellphone, music, another person, signs or motor vehicles). Finally, respondents were asked their opinions on who was responsible for the accident and how it could have been prevented.

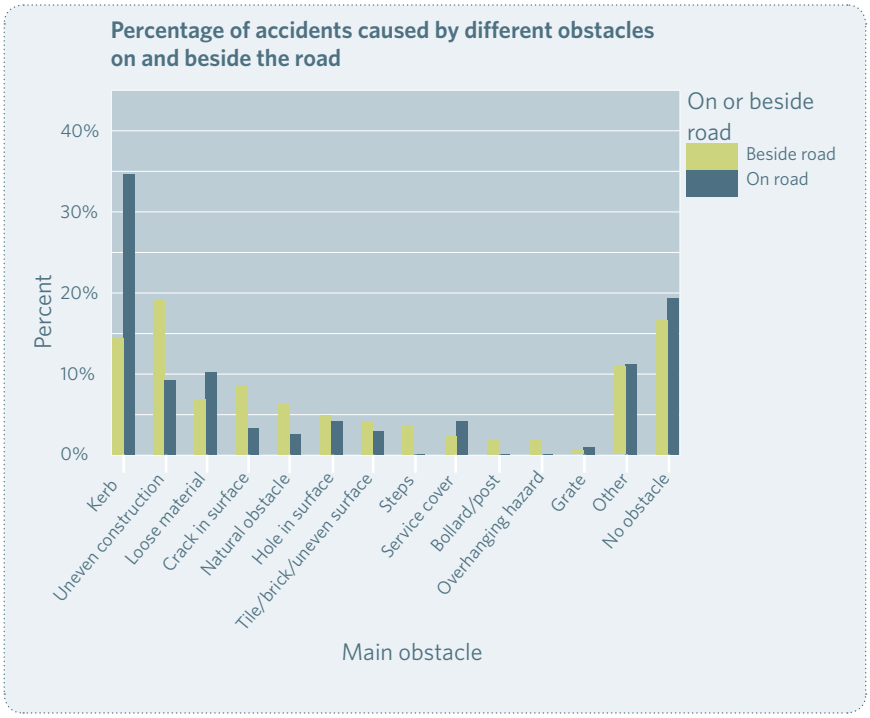
Major findings were:

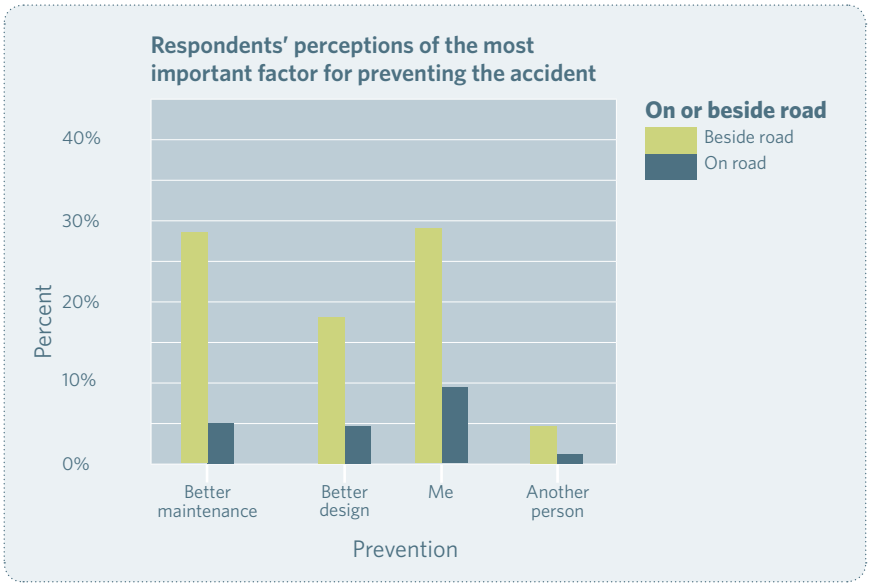
- although injuries occurred across all the age groups, there was a definite bulge towards the older age groups
- more women suffered accidents than men, reflecting the fact that more women walk
- most injuries occurred on the roadside in residential areas, followed by the central business district and smaller shopping areas
- very few injuries happened in rural or industrial areas (again reflecting the fact that less people tend to walk in these places)
- more accidents happened on the roadside (nearly 80 percent) than on the actual road, with most of these happening on the footpath

continued on page 6

continued from page 5







- where accidents did happen on the road, these tended to be places where the infrastructure was designed for people to cross (such as traffic signals, zebra crossings and central islands)
- kerbs and other changes in height (such as steps or ramps) were a main cause of trips and falls, particularly when a pedestrian is stepping up rather than down
- the most common reported hazard involved was unevenly constructed pathways
- most pedestrians slipped, tripped or fell on asphalt or bitumen, followed by concrete (reflecting how commonly these types of surfaces are used)
- the most common injuries were sprains and strains (43 percent)
- more serious injuries, such as fractures, occurred less frequently (between 12 percent and 15 percent), and only 3 percent of injuries were to people's heads (head injuries were more common among the older age groups)
- factors identified as contributing to the accident included the walking surface, not paying attention, footwear (especially high heels, jandals, sandals and bare feet), and speed (particularly when running)
- distraction played a major part, with nearly half of all respondents saying they had some distraction when the accident happened
- very few respondents identified health, fitness or another condition as a contributing factor.

What the research tells us

Bill says, 'What the research clearly demonstrated is that the causes of pedestrian accidents are complex and certainly cannot all be attributed to the walking environment. When people carry loads, are distracted or hurry, they are more likely to have an accident, irrespective of where they are walking.

'However, there can be no doubt that infrastructure and environment do play a part, and that if road controlling authorities are to take effective steps to prevent pedestrian accidents, they need better information about how and when these accidents are occurring.

'As an initial measure we're recommending that pedestrian injury incidents should be recognised as an integral part of road safety, and brought into the mainstream under the Safe System approach. This might include a policy that road safety strategies, management systems and actions plans should include these incidents, on a par with motor vehicle crashes. This would lead to a demand for more effective countermeasures, which we foresee could be aimed at both the infrastructure

issues and the contributing behavioural factors we've identified.'

Further recommendations focus on the need to create predictability in the walking environment. 'Walking environments should be designed to avoid the unexpected as the unexpected increases the likelihood of a mishap,' says Bill.

The study also found a need for more data, and better analysis and data tools to enable countermeasures to be prioritised against other potential uses of road safety funds, as well as a national guide on road safety audits and inspections, which should include non-motor-vehicle-related risks.

Contact for more information

Bill Frith
Opus International Consultants
04 587 0690
william.frith@opus.co.nz

The mechanisms and types of non-motor vehicle injuries to pedestrians in the transport system and indicated infrastructure implications,
NZ Transport Agency research report 431

Freely available online at www.nzta.govt.nz/resources/research/reports/431/

Cycling as a practical answer for day-to-day transport

A study has used a novel approach to encourage more people to take up cycling for short trips.

In New Zealand, two-thirds of all driving trips are less than 6km long; one-third are less than 2km. Both these distances would be easily covered by many people on a bike, yet the car remains New Zealanders' preferred mode of transport for short journeys.

Despite this, both local authorities and communities have expressed a clear desire to encourage more practical cycling as part of creating a more sustainable approach to transport. Practical cycling can be defined as riding a bike as transport to achieve another purpose (such as getting to work or the shops), and is in contrast to recreational cycling, which is riding a bike for pleasure or leisure (and no other practical purpose).

Dr Paul Smith of Inspiring Riding (previously of Massey University), who conducted the study into encouraging practical cycling, says that in the past cycling was a popular means of transport in New Zealand.

Paul says, 'Over the past 50 years we've seen the rise in dominance of the car, and as a result practical cycling has fallen off sharply. This contrasts with countries that have actively pursued positive cycling and walking policies since the 1960s and 1970s, such as Denmark and the Netherlands, where cycling remains a popular means of getting around. Cities such as London, Portland and Melbourne have managed to reverse the decline in practical cycling by implementing programmes of interventions in the past decade. However, although New Zealand communities and local authorities now want to resurrect cycling, there is very little understanding of what type of people should be targeted and how to encourage them.

continued on page 8

Summary of the practical cycling system model

Planting the cycling seed

Practical cycling is a normal activity.

Government, councils, employers, community groups and the mass media portray cycling as a socially acceptable, normal activity.

Practical cycling is positively visible.

Seeing cyclists and cycling tools in the environment creates a good impression of the activity.

Making it easy to choose to ride a bicycle

A wide range of relevant practical cycling tools are available and are easily accessible.

There is a choice of tools that meet basic needs for transportation and generate excitement about practical cycling. The tools, and information about them, can be found easily and offer flexibility to be fitted into life.

Creating a pleasurable experience

The first experience of practical cycling is perfect.

The expectations of practical cycling are met or exceeded by direct experience, and any negative perceptions are removed.

The continuing experience of practical cycling is positive.

The feasibility of regular practical cycling is addressed by providing an ongoing positive experience.

'In the study, we applied an affective design methodology to develop a model to increase practical cycling in New Zealand. Affective design is usually used for designing products and services, and focuses on desirability, experience and appreciation of products. It is based on the principle that product appeal changes over time as people's level of immersion with the product progresses. Applying affective design in this context was a novel approach, as in our case the product that we were trying to encourage greater use of was practical cycling, specifically for short trips of less than 5 kilometres. The competition was all other modes of transport, but particularly driving.'

In this context, the first concept of affective design – desirability – focuses on understanding the identity, cultural and social values of potential practical cyclists and ensuring that practical cycling is an aspirational activity for them. The second – experience – seeks to meet or exceed potential users' expectations about practical cycling, while the third – appreciation – aims to introduce long-term appeal.

Following this design model, the study took a three-prong approach:

- a literature and market review to identify future practical cyclists and how they can be targeted, and a solution review of products and services available in New Zealand to meet practical cyclists' needs
- a survey to gauge people's attitudes to practical cycling, which revealed telling differences in how respondents viewed recreational cycling (firmly in the realm of young fit males) and practical cycling (strange, risky and of lower status than driving a car)
- workshops where respondents could gain hands-on experience of practical cycling. The workshops allowed the study to monitor how people's attitudes towards, and understanding of, practical cycling changed once they'd actually done it.

From these sources the study developed a practical cycling system model. The model has three stages – planting the cycling seed, making it easy to choose to ride a bicycle, and creating a pleasurable experience – and aims to build understanding about, and encourage, practical cycling and position it as an aspirational activity. Paul says, 'The practical cycling system model describes a complex multi-level system for encouraging practical cycling. The system contains a series of initiatives, which will affect participation in practical cycling. These might be products, services, facilities, infrastructure, policies or social marketing activities. They might relate directly to cycling (for example a public bicycle scheme), or they might affect overall travel demand in the system without being specifically about cycling (for example increased parking prices). It is the cumulative effect of all these initiatives in the system that matters: the effect that, overall, they have on people's perception of and participation in practical cycling.'

One option for implementing such a model is to appoint a local coordinator or group who would be responsible for applying the model within their particular environment. This might be a small environment, such as a workplace or school, or a larger one, such as a town or local authority area. Either way, the model can be scaled to fit, and the criteria in it developed to reflect the environment's specifications.

The coordinator would monitor and link all the initiatives coming under the model, and develop it (by encouraging new initiatives) to achieve the goal of more people using practical cycling. Examples of the model as it is applied to individual workplaces are given in the full research report.

Contact for more information

Dr Paul Smith
021 754 756
paul@inspiring-riding.co.nz
www.inspiring-riding.co.nz

'I'll just take the car': improving bicycle transportation to encourage its use on short trips,
NZ Transport Agency research report 426

Freely available online at www.nzta.govt.nz/resources/research/reports/426/

New modelling updates existing guidance on optimum granular pavement thicknesses

Extensive pavement testing at CAPTIF, the NZ Transport Agency's test track in Canterbury, has led to a new pavement thickness design chart for unbound thin-surfaced granular pavements.

At present, Austroads' *Pavement design: A guide to the structural design of road pavements* (2004) is used in New Zealand for designing pavements. The guide includes a pavement design chart for unbound thin-surfaced granular pavements. This chart is used to set the granular thickness of pavements when the pavements' design traffic volume and subgrade California bearing ratio (CBR) are known.

Research conducted by Pavespec and the University of Canterbury set out to test the accuracy of and, if necessary, update the Austroads guide and tables.

Repeated load triaxial tests were carried out on pavement subgrade, sub-base and basecourse materials used at the NZ Transport Agency's Canterbury accelerated pavement indoor testing facility (CAPTIF). Permanent strain relationships found from the testing were then used to develop models to predict rutting behaviour and magnitude of subgrade and granular materials used in the tested pavements.

Full-scale pavement tests were subsequently carried out to validate the models as a method for assessing rutting in granular materials; actual rut depth measurements from the tests were found to be close to the rutting behaviour and magnitude predicted by the models.

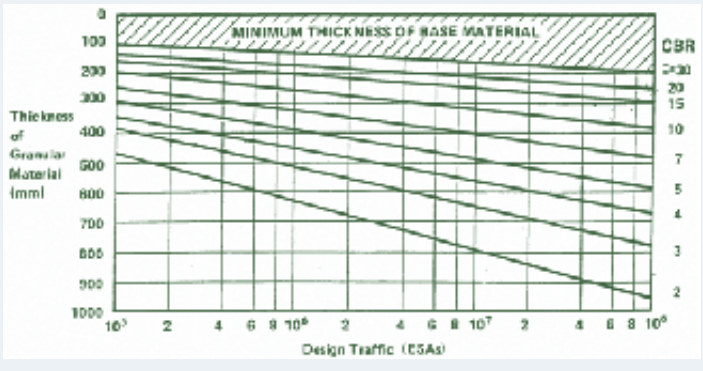
Once validated, the models were used to predict the number of axle passes needed to produce a rut depth that would mean the end of a pavement's life (for a range of pavement thicknesses and subgrade types).

These predictions (and the pavement thickness design charts produced from them) showed different results to those contained in the Austroads guide. When the two sets of design specifications are compared, for low traffic volumes, the new rut depth model requires thinner pavements than the Austroads guide, while for high traffic volumes, the rut depth model shows that significantly thicker pavements are required, indicating an upper traffic-loading limit for thin-surfaced granular pavements.

In fact, the rut depth prediction models showed that traffic loading limits for granular pavements were around 7 million equivalent standard axle passes (ESAs) for subgrades with CBRs of 2 percent and 11 million ESAs for subgrades with CBRs of 8 percent. These are substantially shorter lives than those that would be predicted using the Austroads pavement thickness design chart, where lives can be in excess of 50 million ESAs provided the granular pavement layers are thick enough. The difference is due to the Austroads method not considering rutting in the granular pavement layers for high traffic loads, while the modelling found a significant amount of the rutting occurred in the aggregate layers and that adding more aggregate did not decrease the amount of rutting nor increase the pavement's life. By combining the Austroads and rut depth prediction model results, a new pavement thickness design chart was produced (the new chart uses the largest pavement thickness from the two methods).

Appendix C of the full research report sets out in depth the new design charts, and the modelling and assumptions behind them. The research team is recommending that these are added as changes to the *NZ supplement to the 2004 Austroads pavement design guide*.

The current Austroads pavement thickness design chart



Contact for more information

Greg Arnold
Pavespec Ltd
021 0323117
greg.arnold@pavespec.co.nz

Pavement thickness design charts derived from a rut depth finite element model,
NZ Transport Agency research report 427

Freely available online at www.nzta.govt.nz/resources/research/reports/427/

New research publications

Wider economic impacts of transport investments in New Zealand

Research report 448

D Kernohan, L Rognlien
Steer Davies Gleave

Freely available online at www.nzta.govt.nz/resources/research/reports/448/

This paper develops a methodology and evidence to enable the assessment of the wider economic impacts of transport. Quantifying these wider economic impacts is important as they are likely to be non-trivial in magnitude and they are currently excluded from the current appraisal methods. The paper derives New Zealand-based values of key parameters on imperfect competition benefits, increased competition benefits, labour supply benefits and job relocation benefits. The methodology and the key parameters are then applied to a transport project to demonstrate how the wider economic impacts can be quantified.

Assessment of the type of cycling infrastructure required to attract new cyclists

Research report 449

S Kingham, K Taylor – Department of Geography
G Koorey – Department of Civil and Natural Resources Engineering
University of Canterbury Te Whare Wānanga o Waitaha

Freely available online at www.nzta.govt.nz/resources/research/reports/449/

This research, which was conducted from July 2008 to January 2010, investigated the type of cycling infrastructure that would encourage 'new cyclists' (ie people who either do not currently cycle at all, or people who do not currently cycle for utilitarian trips) to use cycling as their mode of transport for daily activities in New Zealand. The research involved undertaking an international literature review followed by national surveys and Christchurch-based focus groups, to gain an understanding of some of the motivations and barriers associated with utilitarian cycling, and to evaluate a range of cycling facilities. The research showed that safety was the most significant issue for potential cyclists, particularly in relation to vehicle driver behaviour and traffic volume. Other significant issues included enjoyment, having facilities at the destination for showering and changing, and the perception that car drivers are not courteous. The solutions that were most likely to effect a significant change in cycle numbers related to the nature and consistency of infrastructure, and education for motor vehicle drivers and cyclists on how to best and safely use it. The researchers recommended that, along with a number of other cycling-supportive steps, planners could develop a comprehensive, consistent network of cycle-only paths with separation from motor vehicles, and with dedicated intersection facilities such as hook turns and cycle signals.

Evaluation of the value of NZTA research programme reports to end users

Research report 450

M Roorda
Evalue Research

Freely available online at www.nzta.govt.nz/resources/research/reports/450/

This evaluation assesses how valuable the findings of NZTA research reports, published from 2005 to 2009, have been for end users in New Zealand. The evaluation also identifies the barriers and enablers that make the difference between successful and less successful uptake and use of findings from the research reports, and the extent to which current NZTA mechanisms for disseminating and promoting research findings represent the best possible use of available resources.

The findings suggest the research is of substantial value to end users in all areas of the transport sector. The research is highly regarded because it provides practical, innovative New Zealand-based solutions to their issues.

Currently there is more use occurring at the conceptual end of the 'use' continuum and less evidence of research being used to inform decision making, programme/policy formation and/or improvement. More value could be gained by considering, up front, how research findings can be linked to policy and programme decision making.

Good communication of research findings is an important enabler of research use. The email and newsletter notifications of newly completed research are valued by those who receive them. Online access to reports is also valued; however, the NZTA website was not considered user friendly.

Tools for assessing exposure to land transport emissions

Research report 451

I Longley, G Olivares, S Harper, K Shrestha
National Institute of Water and Atmospheric Research Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/451/

Exposure to elevated concentrations of road traffic air pollutants mainly occurs within a few hundred metres of major roads, or while travelling in road vehicles.

Existing roadside air assessment tools are either crude and conservative, or complex and demanding with no guarantee of improved accuracy. Neither approach is well suited to health risk assessment and both present substantial uncertainty for regulatory use.

A third approach was developed aimed at delivering moderate accuracy in a simple, accessible package, better suited to health risk applications. The roadside corridor model is a parameterised implementation of a more complex emission-dispersion model. It is implemented as a spreadsheet, suitable for integration into a GIS-based tool. Several practical applications of the model are demonstrated, including road project assessment, risk 'corridor'

definition, and disaggregation of local and remote sources in roadside air quality monitoring data. Much less is currently known about exposure inside vehicles. Ultrafine particles were measured in cars on Auckland roads. Concentrations varied over an order of magnitude between 'trips' and were larger than outdoors at non-trafficked locations. Concentrations within the vehicle cabin were reduced when the air was recirculated. Exposures were generally higher during periods of motorway driving.

Predicting walkability

Research report 452

S Abley – Abley Transportation Consultants Ltd

Dr S Turner – Beca Infrastructure Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/452/

This research provides a number of mathematical formulas for predicting the quality of the walking environment from the perspective of the user using operational and physical variables. The formulas were derived by combining the perception data gathered from participants in the community street reviews with measurements of the walking environment.

The two main areas that were researched to enable the derivation of formulas were:

- when walking along the road (path length)
- when crossing the road (road crossing).

This research describes the process for obtaining the data and deriving the formulas, and recommends the formulas most suitable for practitioner use. This research and the background resource material can be referenced at www.levelofservice.com.

Concrete pile durability in South Island bridges

Research report 454

SA Freitag, SM Bruce – Opus International Consultants Ltd, Lower Hutt, New Zealand

A Shayan – ARRB Group Ltd, Melbourne, Australia

Freely available online at www.nzta.govt.nz/resources/research/reports/454/

Alkali silica reaction (ASR) has, until recently, been considered to present a low risk to concrete in the South Island of New Zealand. The discovery in 2006 of evidence of ASR and delayed ettringite formation (DEF) associated with extensive deterioration of precast piles on two South Island structures prompted further investigation to identify the extent and severity of ASR and DEF in other South Island precast concrete bridge piles. The aim was to ensure affected structures could be managed effectively and thereby remain safe and serviceable, and to help identify effective means of minimising the risk of ASR/DEF in future structures. The work was carried out in New Zealand between 2008 and 2011.

The research found that despite the availability and use of potentially alkali reactive concrete aggregates in the Southland and Nelson areas, ASR/DEF was relatively uncommon and associated damage was generally minor, although cleaning of piles prior to routine inspection may reveal more cases in future. The findings suggested that ASR/DEF may be associated with the use of curing temperatures higher than those now specified, and recommended that current industry guidelines be amended to acknowledge the existence of alkali reactive aggregate in the South Island and the risk associated with elevated curing temperatures.

Performance of open graded porous asphalt in New Zealand

Research report 455

E Fletcher, AJ Theron – MWH New Zealand Ltd, Hamilton

Freely available online at www.nzta.govt.nz/resources/research/reports/455/

The objective of this research, which was carried out between 2006 and 2007, was to propose methods to disseminate and incorporate local as well as international knowledge of OGPA performance into the current New Zealand asset management systems.

Compared with asphalt overlay practices in Europe and the UK, the current New Zealand maintenance practice of multiple OGPA overlays is not considered to be optimal from a structural point of view. This study undertook a literature and database review, and determined the terminal stiffness of OGPA mixes.

An analysis of the South Auckland State Highway dataset showed that the life of multiple OGPA overlays shortens with successive overlays. Statistical evidence suggested that binder ageing was the limiting factor in this phenomenon, and a correlation was found between pavement surface condition and mix stiffness. Repeated-load indirect tensile strength (ITS) tests were undertaken on cores retrieved from network pavements and on production mixes from the 2006/07 resurfacing contract. Terminal OGPA mix stiffness was found to be in the order of 2300MPa at 25°C, with corresponding binder penetration of 11Pen as determined from back-calculation through the use of the Shell nomograph.

This research recommends a gradual move away from the current multiple-overlay approach, and the utilisation of OGPA for its functional rather than structural integrity.

Improved rate-of-rotation design limits

Research report 456

PD Cenek, NJ Jamieson, RJ Henderson – Opus Central Laboratories

RB Davies – Statistics Research Associates Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/456/

Rate of rotation, or 'warp factor', is a measure of the variation in crossfall of a road surface, and typically relates to a change in crossfall from that of a normal straight road to that chosen for a curve to enhance forces assisting a vehicle to stay on the road. The range of road geometries (crossfall, curvature, transition length and superelevation) typically found on the state highway network were determined, and the crash database interrogated to determine whether a critical rate-of-rotation limit corresponding to the onset of loss of control of vehicles could be established. On-road tests with instrumented vehicles were used to provide information on rates of rotation corresponding to occupant comfort and to provide calibration input to computer modelling. The computer modelling was used to establish rates of rotation resulting in loss of control for different vehicle types over ranges of road geometry and travel speed. Design criteria for rate of rotation were derived from this body of work from the perspectives of vehicle occupant comfort and safety.

Have you seen the NZTA's new research webpage?

The NZTA's Research Programme webpage has been revamped and the following link will take you directly to the page: www.nzta.govt.nz/planning/programming/research.html. Alternatively, go to the NZTA homepage at www.nzta.govt.nz, click on the 'planning, management & funding' tab near the top of the page, mouse over 'The programming process' on the dark blue bar just below the tab, then click on 'How we invest in sector research' from the drop-down list that appears.

The page provides links to:

- the NZTA's Research Programme Framework
- published research reports
- a list of active research projects, including those currently being procured
- *NZTA research* newsletters
- a spreadsheet listing all published research reports with keywords – easy to search for research on particular topics
- the Australasian Road Research Register database and the Transportation Research Board (US) newsletter
- information for researchers involved in the NZTA's Research Programme.

Supplementary issues of the *NZTA research* newsletter

The significant number of research reports recently published has resulted in the need for supplementary issues of *NZTA research*. This is the third of the supplementary issues published in 2011. The first supplementary issue was published in May 2011 and the second was published in August 2011.

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

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

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

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

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

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

NZTA research

NZTA contacts

Karen Johnson
Nigel Curran
Patricia McAloon

For any enquiries, email research@nzta.govt.nz.

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/planning/programming/research.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 coloured, 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.

Articles may be reproduced and reference made to any part of this publication, provided appropriate credit is given.

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.

Disclaimer

The views expressed in *NZTA research* are the outcome of research and should not be regarded as being the opinion, responsibility or policy of the NZTA or of any agency of the New Zealand Government.

Do we have your correct details?

We would like to hear from you if you wish to update your name or address details or alter the number of copies of *NZTA research* you'd like to receive.

Email research@nzta.govt.nz

Back issues

Are available on the NZTA website www.nzta.govt.nz/resources/nzta-research/

This newsletter is printed on environmentally responsible paper manufactured using FSC-certified, mixed-source pulp harvested from sustainable well-managed and legally harvested forests and bleached using an elemental chlorine-free process. All inks in this document are vegetable based and sealers are water based.

New Zealand Government

NZ TRANSPORT AGENCY
WAKA KOTAHI