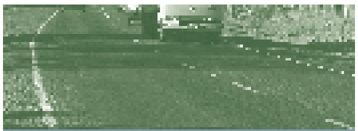
NZTA research

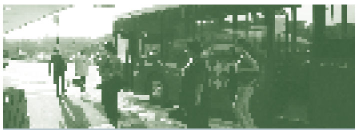
Supplementary issue
May 2011

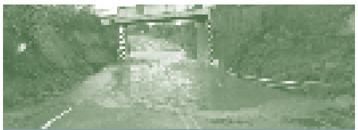
ISSN 1174-0523 (print)
ISSN 1174-0566 (online)

NZ TRANSPORT AGENCY
WAKA KOTAHI

The field trial site on State Highway 57







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

All lined up to reduce speed

Trials of transverse road markings, the first time they have ever been formally used in situ in New Zealand, have demonstrated their potential as a cost-effective means of reducing crashes on high-speed approaches on rural roads.

Field trials at two sites on the state highway network recorded and assessed vehicle speeds before and after transverse road markings had been laid. The markings signalled to drivers that they were approaching a hazard that required them to reduce their speeds. It was found that the markings caused drivers to slow down, particularly on first entering the marked area, and that this trend was evident in the short term and continued in the long term.

Although only an initial trial, the research highlighted the need for more extensive research into the effectiveness of transverse road markings, so that a standardised procedure could be developed for their use in the New Zealand transport environment.

Andrew Martindale of Opus International Consultants explains how the research project, which the trials formed part of, grew out of the need to find an alternative speed mitigation measure to signs.

'As a way of getting drivers to reduce their speeds, road signs and markings are the most cost effective and are widely implemented here in New Zealand,' says Andrew. 'But we are now facing the situation where the sheer quantity of signs being used is creating a clutter effect, which is reducing their effectiveness. We wanted to explore using transverse road markings as an alternative, because trials and studies overseas had demonstrated their effectiveness in other countries' transport environments.'

continued on page 2

continued from page 1

The New Zealand field trials

Transverse road markings fall into the group of treatments known as speed perceptual countermeasures, which use the road layout and its associated features to subconsciously inform the driver about upcoming road conditions. They use a series of either raised or flat markings placed across the road in the direction of traffic flow to raise driver awareness of a pending hazard and encourage them to reduce their speed. (Other common names for the treatments are herringbone, yellow bar and Wundt Illusion markings.)

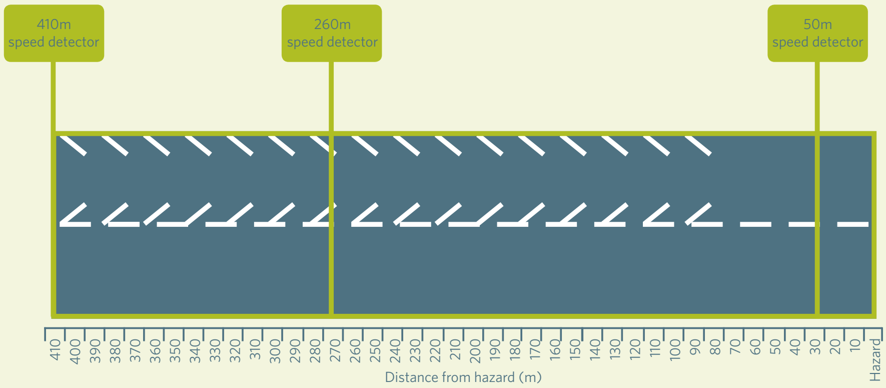
No transverse road marking arrangement had ever previously been formally applied in New Zealand (although research had tested their effectiveness in simulator trials), and there is no current guidance on their use in legislation, guidelines or standards.

Andrew says, 'For this reason, we looked initially to trials and studies overseas to inform our project. Countries such as the UK have made extensive use of transverse road markings, particular in relation to motorway roundabouts and off-ramps. Australia has also assessed them in relation to rural intersections. We saw the latter as having more direct relevance here, with the greatest potential for their use being to reduce serious and fatal crashes, as a result of speeding, on approaches to rural hazards, such as intersections and bridges.'

Two field trials were conducted: on the southbound approach to the Kimberley/Arapaepae Road intersection on State Highway 57; and on the eastbound approach to the Waihenga River bridge on State Highway 53. Both sites are high-speed rural environments, where drivers need to reduce their speeds in order to safely negotiate the hazards posed by both an intersection and a bridge respectively at each site. Both sites also feature a long straight approach to the hazard, no extensive speed treatments or existing speed mitigation features that could affect the performance of the markings, and a noteworthy crash history where excessive speed was a potential factor.

The marking arrangement consisted of 100mm transverse bars extending at a 60° angle for 1m from the edgeline and centreline. The bars were evenly spaced at 3m over a 300m stretch of road, ending 110m before the hazard. White reflector road marking paint was used, in accordance with existing NZTA specifications.

Transverse road markings and speed assessment locations used during the field trials



The field trial site on State Highway 53

Overall speed results for each trial site

Period	Statistic	Distance from hazard		
		410m	260m	50m
SH57 Arapaepae Road/Kimberley Road intersection				
Before installation	Mean speed (km/h)	91.0	80.6	56.0
	85th percentile (km/h)	103.3	95.0	69.4
2 weeks after	Mean speed (km/h)	89.7	80.0	57.6
	85th percentile (km/h)	102.2	94.7	69.9
Short-term speed change	Marginal mean speed (km/h)	-1.3*	-0.6	1.6*
	85th percentile (km/h)	-0.8*	-0.3	0.5*
6 months after	Mean speed (km/h	87.1	77.8	53.2
	85th percentile (km/h)	100.0	92.5	67.1
Long-term speed change	Marginal mean speed (km/h)	-3.9*	-2.7*	-2.8*
	85th percentile (km/h)	-3.3*	-2.5*	-2.3*
SH53 Waihenga River Bridge				
Before installation	Mean speed (km/h)	82.3	82.3	78.8
	85th percentile (km/h)	97.4	96.5	90.8
2 weeks after	Mean speed (km/h)	79.7	83.1	78.6
	85th percentile (km/h)	94.5	97.2	91.6
Short-term speed change	Marginal mean speed (km/h)	-2.6*	0.9	-0.2
	85th percentile (km/h)	-2.9*	0.7	0.8
6 months after	Mean speed (km/h	70.1	83.5	70.7
	85th percentile (km/h)	94.2	99.7	84.6
Long-term speed change	Marginal mean speed (km/h)	-12.2*	1.2	-8.1*
	85th percentile (km/h)	-3.2*	3.2	-6.2*

* speed change is statistically significant

Andrew says, 'We assessed driver speeds at three points over the relevant stretch of road, both before we installed the transverse road markings and after. Speed was measured 410m out from the hazard, 260m out and 50m out, with measurements taken for seven continuous days two weeks before we made the installation, then two weeks after and six months after.

'What we found was that drivers tended to reduce their speeds as they approached the hazards, whether or not the transverse lines were in place. The main effect of the markings seemed to be to reduce driver speeds at the start of the treatment area, from which we assumed that the lines had an alerting property that caused drivers to lower their speeds in preparation for a hazard ahead.

'Interestingly, there was no significant difference in drivers' speed at the 260m mark, that is, once they were 150m into the treatment area, so it's possible that, having reacted initially, drivers become accustomed to the lines and revert to their habitual driving behaviour. But the 50m measurements reverse that trend, showing that drivers were arriving at the hazard at slower speeds after the installation of the lines than before. This suggests that the heightened perception of risk created when drivers first entered the marked area better prepares them to react when they pick up subsequent visual clues about the approaching hazard, so that they are prepared to slow down.'

The data was also analysed to see if the road markings had different effects on regular users of the road (commuters), as opposed to casual weekend users, and on drivers of heavy, as opposed to light, vehicles. No difference was found.

Andrew says, 'Both the literature review and the trials showed that transverse road markings could be a promising speed mitigation measure for use here in New Zealand for high-speed approaches to rural hazards. We've recommended further trials to enable more comprehensive evidence to be collected, particularly with respect to treatments with different lengths and layouts.

'Having said that, the best assessment of the markings' effectiveness will come over time, when we begin to see reduced crash rates at the sites where markings are used. In the meantime, though, our research indicates promising potential, which we believe warrants further exploration.'

Contact for more information

Andrew Martindale
Opus International Consultants
04 471 7000
andrew.martindale@opus.co.nz

Effectiveness of transverse road markings on reducing vehicle speeds
NZ Transport Agency research report 423

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

Hard copy $15.00 – email research@nzta.govt.nz.

The speed–crash equation

Speeding, either travelling over the speed limit or driving too fast for the conditions, is a significant cause of safety problems on New Zealand roads. On average, speeding was a factor in over one-fifth of fatal crashes on the open road between 2006 and 2008. New Zealand is not alone in this trend, with speeding recognised as one of the dominant causes of fatal road crashes worldwide. In the United States, for example, 31 percent of fatal road crashes include speeding as a contributing factor.

Consequently, the search for effective speed mitigation measures remains prominent, both here and overseas, with devices such as signs, road markings and variable message systems receiving ongoing research attention, in the quest to find the best ways to get drivers to slow down.

No relationship found between pavement density and early failure

Early failure in three high-profile pavements prompted research to investigate the effect of pavement layer densities on the likelihood of rutting.

John Patrick of Opus Central Laboratories, who led the research, explains that, 'All of the pavements that had failed were greenfield pavements, which means that they had not been subject to compaction by traffic during their construction. The failure took the form of ruts with depths of greater than 20mm forming quite early on in the pavements' lives.

'All the pavements also had granular layers that were greater than 400mm thick. This made it difficult to determine if the early failure was because of poor control during their construction or difficulties with accurately measuring the densities of such thick layers, or was somehow related to the lack of traffic on the pavements during their construction.'

The research focused on the density aspect of the equation, using Captif in Christchurch (the NZ Transport Agency's accelerated testing facility for pavements) to investigate the effect that constructing basecourse and sub-base layers to a range of densities would have on the potential for failure.

continued on page 4

continued from page 3

Controlling compaction

Most pavements in New Zealand have a granular base with chipseal surfacing. Their construction is guided by specifications that call for the compaction levels of their various layers to be closely controlled and monitored using nuclear density meters.

The NZ Transport Agency's *Specification for the construction of unbound granular pavement* (TNZ B/2: 2005; available on our website) sets out the requirements for compaction of the granular sub-base and basecourse layers. To be considered acceptable, a pavement layer must have been 'compacted to a uniform, dense, stable condition' and must either have reached its plateau density (the maximum density that the layer reaches under controlled rolling trials) or otherwise have achieved a minimum compaction level (expressed as a percentage of the aggregate's maximum dry density).

Mean and minimum value of pavement layer compaction as percentage of maximum dry density specified in TNZ B/2

Value	Sub-base	Basecourse
Mean	≥95%	≥98%
Minimum	≥92%	≥95%

All three of the pavements that failed were state highways and had been constructed in compliance with TNZ B/2. Yet despite this, all had developed ruts with depths of between 15mm and 20mm within six months of opening to traffic.

Details of three premature rutting failure sites

	Site 1	Site 2	Site 3
Surfacing	30 Open Graded Porous Asphalt	30 Open Graded Porous Asphalt	Chipseal
Basecourse	150mm	180mm	150mm
Sub-base	450mm	390mm	200mm
Vehicles/ lane/day	9000	5000	6000
Rut depth at 6 months	20mm	20mm	15mm
Approx ESA* at 6 months	2.3×10^5	1.2×10^5	1.3×10^5

* equivalent standard axles

The research testing

The test pavements constructed at Captif had basecourse and sub-base maximum dry densities ranging between 88% and 95%. Three sections were constructed on a prepared subgrade, with the pavement consisting of a 450mm basecourse with a maximum particle size of 40mm (this would be considered a premium material under the NZ Transport Agency's *Specification for base-course aggregate* (TNZ M/04; available on our website). The basecourse was constructed in three 150mm lifts, with the final surfacing consisting of a 25mm layer of dense graded asphaltic concrete.

John says, 'While we intended to construct three sections with densities of 85%, 90% and 95% of their maximum dry densities, in practice we found it impossible to achieve these specific densities for each layer. This was particularly true for the pavement with the 85% target, where even with light compaction the density was 88% of maximum dry density. In the end, we accepted and referred to the three sections by the density that we achieved on their bottom layer, which was 88%, 95% and 98% of their maximum dry density respectively.'

Basecourse densities as percentage of maximum dry density

Depth from subgrade	Site 1	Site 2	Site 3
0-150mm	88.0	95.0	98.4
150-300mm	89.0	93.2	97.3
300-450mm	93.8	94.4	94.3
Average	90.6	94.2	96.7

The testing resulted in rapid failure of two sections of the pavement where the lower 150mm of basecourse had been compacted to 88% of its maximum dry density. However, other than these short sections there was no significant difference in the rut progression for all the pavements.

John says, 'There appeared to be no relationship between the density of the layers and the potential for failure. The two areas that did fail did not have significantly different density profiles from the rest of the section. The difference in the rut progressions for the pavements with 88% and 95% maximum dry densities was only a few millimetres.'

A more theoretical analysis, which compared the stress and strain distribution under a vibratory roller and a standard heavy vehicle, was also performed. This demonstrated that, as the compaction system (vibratory roller) does not build up residual stresses in the pavement, when traffic loading does occur the granular material is moved in such a way that there is a build-up of those stresses, which can resist wheel loading.

John says, 'Overall, we concluded that some post-construction deformation of greenfield pavements is inevitable using conventional New Zealand construction techniques and specifications. Also, larger rut depths will develop as a result of post-construction strain in pavements with thicker granular layers. However, the rut depths should be nowhere near those that were found in the three pavements that failed prematurely and prompted this research, namely ruts of 20mm or more.

'What we postulated is that the failure of these pavements was not associated with the thickness of their granular material, but rather was because they were on roads with high traffic volumes and the initial consolidation of 5mm to 8mm that occurred after they were opened to traffic was sufficient to allow a film of water to develop in wet conditions. It's possible that under the action of traffic this water was pushed through the seal, resulting in premature shear failure. However, obviously this is just a theory at this stage, and further research into the phenomena of water being pushed through a first-coat seal is underway at the moment, as is research into the influence that the compaction methodology used has on the likelihood of failure.'

Contact for more information

John Patrick
Opus Central Laboratories
04 587 0600
john.patrick@opus.co.nz

Compaction of thick granular layers
NZ Transport Agency research report 411

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

Hard copy $20.00 – email research@nzta.govt.nz

Report cards to improve public transport's accessibility

A research project to develop a methodology for auditing the accessibility of public transport routes has produced an easy-to-use report card suitable for use by operators and local authorities.

Drawing on international experience and consultation with local stakeholders, the project has developed and piloted a New Zealand-specific methodology for auditing public transport routes and corridors.

Carolyn O'Fallon of Pinnacle Research who developed the methodology says, 'To audit the accessibility of a journey, you need to take into account all the steps that a person needs to take to get from their home to their destination, then home again. Each step is regarded as linked and of equal importance. If any link between the steps is broken or inadequate, then the whole journey is considered impractical or impossible.'

The audit methodology takes a whole-of-journey approach to accessibility. This includes assessing how simple it is for public transport users to:

- access information about the service
- get to the service
- pay for the service (including accessing information about the cost of the service and having the physical ability to pay for the service, but excluding questions of affordability)
- get on board
- enjoy the ride
- get to their final destination (including ensuring that services in the network take people where they want to go, when they want to be there)
- make the return trip.

The outcome from the research is a public transport accessibility audit, report card, instructions for auditors and best practice guide. All adopt a wide scope, assessing the accessibility of services from the point of view of six categories of public transport users, who range from able users (people who experience no personal impediments to accessing services) to wheelchair users (as the people most likely to experience the greatest difficulty in accessing public transport).

Carolyn says, 'The audit is designed for use on regional-council-scheduled bus networks and large buses, and regional-council-scheduled rail networks and carriages. In the future, we'd like to see it extended to incorporate the accessibility of other public transport modes and vehicles, such as ferry vessels, stations and wharves, airplanes and airports, long-distance rail services, and inter-city, small and medium-sized buses. The affordability of public transport for various categories of users is another factor that could potentially be included.'

Designed for use on a route or corridor basis, the audit and its report card use a simple yes/no checklist to assess and summarise the number of barriers to access along the route or corridor for each of the six categories of public transport users. Barriers are rated from none to severe, depending on the impact that they will have on users.

Fine tuning the audit's purpose

Discussions with stakeholders pinned down the reasons why authorities and operators should carry out an accessibility audit of their public transport routes and corridors. These included to provide:

- a baseline statement of accessibility against which future progress could be monitored through repeat audits
- a basis for comparing the accessibility of public transport in different areas
- an indication of which aspects of a given public transport system or network are not accessible, and hence where more work is required
- local examples of good or best practice with respect to accessibility.

Categories of people with disabilities

Able users	Regular, occasional and new public transport users with no disabilities
Wheelchair users	People who are injured or disabled and use a wheelchair for moving from place to place
Physical limitations	People with ambulatory/physical disabilities, whether temporary or long term (eg pregnant women, elderly people, people on crutches or with a cane, people with babies/small children in pushchairs, people with poor dexterity or little strength)
Comprehension	People with mental/cognitive disabilities, as well as those with language difficulties (eg ethnic minorities and new immigrants)
Visual	People with sight impairments
Auditory	People with hearing impairments

continued on page 6

continued from page 5

The report card is designed to be self-completing, in the sense that once the auditor has answered yes or no to each of the audit questions, Excel will sum the responses and assign an appropriate rating for each of the six user categories.

Carolyn says, 'What we were aiming for was a simple, easy-to-use audit tool, which nonetheless provides a useful and reasonably comprehensive assessment of accessibility. Accessibility is only one aspect of a public transport route or corridor that may need auditing. If the tool required too much time or other resources to complete, then we were conscious it just wouldn't get used.'

Report card rating for severity of 'barriers to access'

Rating	Value	Definition
None	0	Little or no hindrance to people in this user category using public transport
Slight	1	All people in this user category wishing to use public transport will be able to do so, but there will probably be some hindrance or inconvenience in accessing it
Moderate	2	Some people in this user category are likely to be dissuaded from making journeys by public transport because it will be more time consuming or less convenient, and they may require assistance
Severe	3	People in this user category are likely to be deterred from making public transport journeys. In some cases, the potential user will be totally unable to travel independently by public transport

There is undoubtedly scope for different auditors to review a given route in slightly different ways, as many of the factors that are assessed are matters for individual judgement. However, extensive testing of the auditing framework (on three pilot routes in the greater Wellington region) demonstrated a high degree of consistency among different people using the tool.

Suitable for use by both public transport operators and local authorities, testing shows that it takes around 10 minutes to audit a bus stop and 30 minutes to audit the access routes around it (assuming a 200m diameter around the stop). A complete audit includes assessment of all the stops and stations along the length of a route or corridor, although Carolyn states that, 'For public transport accessibility to be audited in its fullest sense, all of the routes and corridors in the region should be included in the programme. This would enable both accessibility of, and accessibility by, public transport to be assessed.'

The public transport accessibility audit, report card, instructions for auditors and best practice guide are available in the full report (see below).

Contact for more information

Carolyn O'Fallon, Pinnacle Research and Policy
027 240 4196, carolyn@pinnacleresearch.co.nz

Auditing public transport accessibility in New Zealand, NZ Transport Agency research report 417

Freely available online at www.nzta.govt.nz/research. Hard copy $50.00 – email research@nzta.govt.nz.

Best practice guide

The accessibility audit and report card are backed up by a best practice guide. Designed to provide regional councils and others with guidance about the factors that make a public transport journey accessible (for each of the six categories of users), the chapters in the guide match the various sections that are assessed in the audit and report card.

The guide covers best practice for service coverage (service availability, frequency, span, area and information) and how to enable public transport users to :

- get to the service by themselves (pedestrian and wheelchair access routes to bus and rail stops and stations)
- get to the service by car (access routes for private passenger vehicles and parking availability at the stop or station)
- wait for the service at a bus stop (bus stop and shelter characteristics)
- wait for the service at a station (access to and within station buildings)
- be on board a bus (passenger service vehicle characteristics)
- be on board a train (train carriage characteristics).

A tool for RCAs to assess their civil defence readiness

A project to develop a tool that road controlling authorities (RCAs) can use to assess how well they are doing under the Civil Defence Emergency Management Act 2002 revealed that many authorities have a high level of readiness. However, some areas still need more work, if the road network is to function to the 'fullest possible extent' when a civil defence emergency strikes.

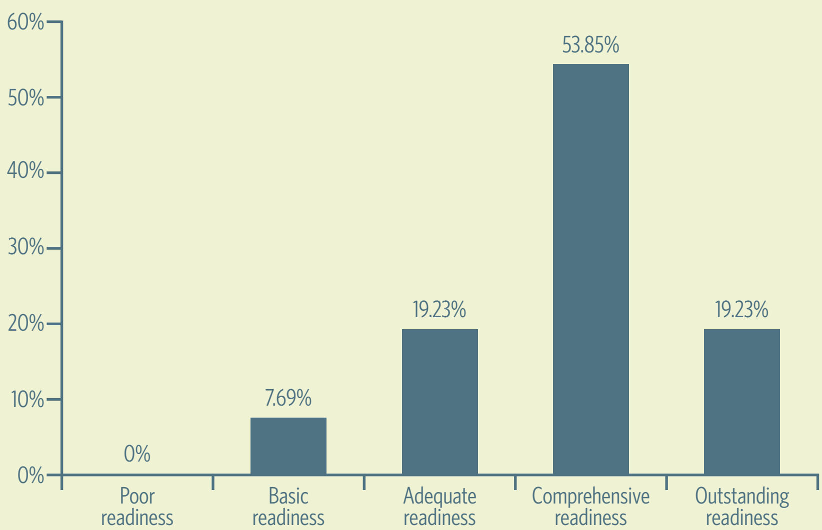
RCAs have a fundamental role to play should a civil defence emergency occur. For a start, the Civil Defence Emergency Management Act 2002 states that the road network, along with the other lifeline utilities, should be able 'function to the fullest possible extent during and after an emergency'. And as part of their local or regional civil defence emergency group, RCAs are required to use their resources to help minimise disruptions and keep the community safe.

That properly functioning road networks are important in an emergency is obvious. Flooding and earthquake events in recent years have demonstrated that land transport networks are vital to save lives, reduce costs and help communities recover. However, while individual RCAs have made significant efforts to improve their preparedness, there was a need for a more holistic nationwide assessment of exactly how ready authorities were, and what the priority actions should be if all authorities were to fulfil their responsibilities under the act.

Sonia Giovinazzi was part of the team, led by Dr Andre Dantas, from the University of Canterbury that set out to enable this assessment. Sonia says, 'We aimed to develop a conceptual framework and a self-assessment tool that RCAs can use to gauge how ready they are to meet their civil defence obligations. The tool that we developed and trialled was very effective, and the RCA Forum is now proposing that it should be incorporated into standard practice for authorities.'

Twenty-six valid responses were received in the trial. While Sonia says this is not sufficient to assess the readiness of all RCAs, it demonstrates that some authorities have a significant commitment to and understanding of their obligations under the act, and as a result have an 'outstanding' level of preparedness.

Breakdown of the readiness performance of road controlling authorities



continued on page 8

continued from page 7

What the act requires

The Civil Defence Emergency Management Act 2002 creates a framework within which New Zealand can prepare for, deal with and recover from local, regional and national emergencies. In particular, the act:

- promotes sustainable management of hazards
- encourages and enables communities to cope with acceptable levels of risk
- provides for planning and preparation for emergencies, and for response and recovery
- requires local authorities to coordinate their planning and activities
- provides a basis for integrating national and local civil defence emergency management
- encourages coordination across a range of agencies, recognising that emergencies are best dealt with on a multi-agency basis.

The act requires a risk-management approach to dealing with all hazards (not only natural ones). In New Zealand, the primary hazards are flooding, earthquake, volcanic eruption, and technological and other man-made hazards (such as the 1998 Auckland power crisis).

Lifeline utilities, of which the national road network (including the state highway network) is one, play a significant role under the act. This includes:

- strengthening relationships within and across sectors
- committing to actions that will ensure the continuity of operations
- delivering services to essential civil defence emergency management activities, both during and after the emergency event.

Specific obligations of lifeline utilities (and the authorities controlling them) under section 60 of the act include:

- ensuring that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency
- making its plans for functioning during and after an emergency available to the director of civil defence emergency management
- participating in the development of the national civil defence emergency management strategy, and civil defence emergency management plans
- providing, free of charge, any technical advice that is reasonably required to any civil defence emergency management group or the director of civil defence emergency management
- ensuring that any information disclosed to the lifeline utility is only used by the utility, or disclosed to another person, within the guidelines in the act.

'There were also authorities who were not doing so well,' says Sonia. 'One of our aims through the research was to look at what specific aspects of these authorities' planning arrangements were in the most serious need of improvement, and potential ways for authorities to share best practice, so that all authorities could bring themselves up to speed.'

The most common areas of significant shortcomings included:

- emergency response plans – RCAs should improve the inter- and intra-agency distribution and practice of their response plans
- information sharing – RCAs should improve how information is collected, processed and distributed before and during a civil defence declaration
- experience, training, awareness and leadership of decision-makers –authorities need to improve their professional development strategies and assessment programmes to enhance staff's capability to deal with civil defence declarations and the complexities of major disruptions to road network services
- robustness and redundancy of the road network – organisations need to improve their processes and procedures for assessing the robustness of the road network in their area, both as a whole and its components
- management of existing resources – organisations need to improve how they manage their human resources and budget allocated to enhancing civil defence emergency readiness. In particular, there should be a full-time staff member working on emergency management structures and arrangements, and a specific budget for creating, practising and maintaining emergency management plans. Capacity was also needed, before an event happened, to independently review the organisation's response following either a real event or a simulation exercise.

Sonia says, 'Overall the research was a success, in that the benchmarking framework and tool for self-assessment worked well, and were comprehensive and quick for participating authorities to use.

'Possibilities for further development and improvement that emerged from industry feedback included auditing schemes to assess the accuracy of authorities' self-assessments, including whether there is evidence to back up their perceptions of readiness, and examination of the main differences in readiness between the RCAs, given their different characteristics, such as population, area covered and types of road assets under their control.

Contact for more information

Sonia Giovinazzi
University of Canterbury
03 366 7001
sonia.giovinazzi@canterbury.ac.nz

Benchmarking the readiness of road controlling authorities to meet their obligations under the Civil Defence and Emergency Management (CDEM) Act 2002
NZ Transport Agency research report 409

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

Hard copy $25.00 – email research@nzta.govt.nz

New research publications

Obtaining our research reports – These research reports may be profiled in future editions of *NZTA research* but are already freely available online at www.nzta.govt.nz/research. They can also be purchased in hard copy from about $15 to $40 each. Email research@nzta.govt.nz to order any of these reports, or to ask any questions regarding the NZTA's research programme.

Demand responsive passenger transport in low-demand situations

Research report 425

Booz & Company

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

Demand responsive passenger transport (DRT) services are seen as a cure for high-cost bus services in low-demand areas. DRT services cover a wide spectrum and international experience shows mixed success. In 2009/10 Booz & Company investigated DRT services to understand common success and failures. An international literature review was conducted, as well as assessing three New Zealand/Australian case studies as follows.

- community vans in Katikati and Te Aroha
- commercial DRT service RE-LI-ON-US Mobility Services in Auckland
- Melbourne Telebus.

DRT services have been used in areas with street patterns that cannot be efficiently navigated by foot or by bus and prove to be inherently more expensive to serve than multimodal networks. The conflicting objectives of service efficiency and coverage can be balanced by serving areas where demand is concentrated, by limiting the service area and by reducing flexibility as demand increases. Providing DRT services to commuters, schoolchildren and shoppers caters for most journey purposes. Many-to-one DRT service operations are more successful than many-to-many DRT services. Limited stop services are more successful than hail and ride or door-to-door services. DRT services have a role to play in New Zealand by adopting best practices of successful services and avoiding common pitfalls.

Trialling pedestrian countdown timers at traffic signals

Research report 428

MWH

Freely available online at www.nzta.govt.nz/research
Hard copy $20.00

The overall research objective was to evaluate changes in pedestrian safety and traffic efficiency as a result of installing pedestrian countdown timers. The study analysed pedestrian behaviour and safety before and after the installation of a trial countdown timer at the intersection of Queens Drive, Bunny Street and Margaret Street in Lower Hutt in July 2007. The results were compared with the 2006/07 trial at the Queen Street/Victoria Street intersection in the Auckland central business district and showed very different results. The Auckland trial indicated that, if placed in suitable locations, pedestrian countdown signals were associated with pedestrian behaviour change that enhanced safety. The study in Lower Hutt demonstrated that the observed pedestrian safety decreased because the percentage of both late starters and late finishers increased. However, this was likely to be due to the nature of the intersection, with one particularly long diagonal crossing coupled with the allocated phase times. In contrast, perceived pedestrian safety increased with the installation of the countdown timers.

Development of a basecourse/sub-base design criterion

Research report 429

Pavespec Ltd, Technische Universität, Dresden, Germany, and New Zealand Institute of Highway Technology, Hamilton

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

The Austroads pavement design guide is currently used in New Zealand for pavement design. It includes a design criterion for the subgrade limiting the subgrade strain value. In the last few years a significant number of early granular pavement failures on high-volume roads have occurred. Investigations into these failed pavements found that most of the surface rutting was from deformation of the granular layers with little or no visible contribution from the subgrade. Therefore, the Austroads design criterion for the subgrade is adequate in terms of providing enough pavement depth to protect the underlying subgrade soil but does not prevent failure in the granular layers. In a parallel research project on rut depth prediction for granular pavements (Arnold and Werkmeister 2010) a range of pavement lives was determined using models derived from repeated load triaxial (RLT) tests. These predictions were applied in this project to validate a simple method for obtaining a design strain criterion for basecourse and subbase aggregates from RLT tests and for use in CIRCLY to predict pavement life.

continued on page 10

continued from page 9

Identifying pavement deterioration by enhancing the definition of road roughness

Research report 430

Doug Brown, Wei Liu and Theunis F P Henning

Freely available online at www.nzta.govt.nz/research
Hard copy $30

Current road roughness deterioration modelling and analysis tends to focus on the prediction of roughness progression in terms of change in the IRI over time. Since the IRI is simply a summary index of the actual roughness, which simulates the response of a specific type of vehicle (quarter-car), it is difficult to identify the factors that contribute to the deterioration of road roughness. Understanding the factors that lead to the deterioration of roads and identifying the actual mode of road roughness deterioration will help road controlling authorities refine their specifications on road roughness requirements for road design, construction and maintenance to reduce their adverse influence on roughness.

This research project looked at an alternative method to analyse and define the roughness deterioration modes of different pavement sections of the New Zealand road network by analysing the characteristics of the longitudinal profile of the road surface using wavelet analysis.

This characterisation process was used to analyse the effects of pavement type, traffic loading, environment and maintenance regime on the deterioration of road roughness and ultimately should lead to the development of a strategy for maintaining road roughness of different pavement types commonly found in New Zealand road networks.

Abrasion resistance of aggregates in asphalt

Research report 433

Bartley Consultants Ltd and University of Auckland, Geology Department

Freely available online at www.nzta.govt.nz/research
Hard copy $15

The objective of this project was to investigate the durability and mechanical integrity of aggregate with a high polished stone value (>60) used in hot mix asphalt, particularly chips or coarse aggregates in stone-on-stone mixes such as stone mastic asphalts and open graded porous asphalts. The research was carried out in Auckland, New Zealand, in 2009–2010.

Test sections were constructed within a roading contractor's yards at Auckland and Taupo. The aggregates used were drawn from four different sources. Significant degradation took place during laying and compaction, but trafficking produced little further breakdown, if any. However, a slight decrease in air voids and texture depth was apparent.

Most of the source property tests could not predict the degradation that occurred in the test sections. The Los Angeles and micro-deval abrasion tests were probably the most useful. The gyratory compactor test was also evaluated as a prediction tool without a great deal of success. The micro-deval abrasion test ranked the aggregates in a similar sequence to that achieved using the gyratory compactor test.

Supplementary issues of the *NZTA research* newsletter

The significant number of research reports recently published has resulted in the need for two supplementary issues of *NZTA research*. This current issue is the first, and we plan to release the second in August 2011.

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

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/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.

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