



NZ TRANSPORT AGENCY
WAKA KOTAHI

NZTA
research

Issue 04
June 2009

ISSN 1174-0523 (Print)



Revisiting the glass in roads equation

Surprising results for tests on the amount of crushed glass that can be added to basecourse aggregates without affecting performance have opened up opportunities for greater use to be made of the country's recycled glass resources.

Growing environmental consciousness among governments and the public is creating new issues with how to safely use accumulated waste that can no longer be sent to landfill. Huge stockpiles of waste such as glass, tyres, plastics, steel slag, and demolition and construction waste are accumulating worldwide, as they prove both financially and environmentally expensive to dispose of.

Research into new and innovative ways to use waste and recycled materials in road construction has been underway both in New Zealand and internationally for some time. But the desire to use these resources must always be balanced against the need not to compromise the quality and performance of highway infrastructure. Avoiding the creation of new environmental issues is also a concern.

The NZ Transport Agency (NZTA) recently revisited the use of glass in basecourse aggregate with Pavespec Ltd and the University of Canterbury.

David Alabaster, an NZTA project manager, says that international studies have focused on matching society's need for safe and efficient disposal of waste materials with the highway industry's need for better and more cost-effective construction materials.

'In the past, only nominal research had been done in New Zealand into the availability of feasible waste materials, to determine if they would be suitable for use in roads. We wanted to explore this further, because the ability to use these materials would benefit the road industry by providing it with an alternative source of materials. Road construction companies may even be able to charge a fee in some cases for using waste materials that would otherwise require alternative disposal,' says David.

'The NZTA currently allows up to 5 percent, by mass, of crushed glass to be mixed into basecourse aggregate used in road building. Given the potential

PAGE 1 Exploring the use of glass in basecourse aggregates

PAGE 3 Investigating accessibility planning in New Zealand

PAGE 5 New standard designs for bridge beams

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

benefits for the road industry and councils in using glass, we wanted to investigate whether this percentage could be pushed out to allow more glass to be safely incorporated, and if so, how far.'

Taking the test

The NZTA with the assistance of Dr Greg Arnold of Pavespec Ltd developed a repeated load triaxial test (RLT test) to determine whether particular pavement materials are suitable for use as base materials in high, medium and low traffic situations, in either dry or saturated conditions. RLT testing can be used to assess a range of materials, including industrial by-products such as recycled crushed glass. From the test, the best environments for particular materials to be used in, according to their rut resistance in wet and dry conditions, can be stated.

Based on the test, a 2006 Transit NZ specification allowed road controlling authorities to add 5 percent by mass of crushed glass to basecourse aggregate. This provision followed international practice where, in general, amounts of up to 15 percent were allowed.

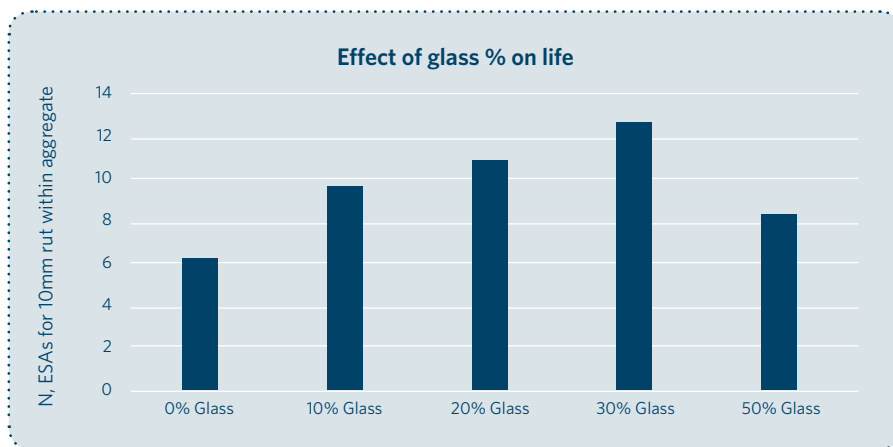
David explains, 'The Transit specification chose the more conservative 5 percent, because in New Zealand basecourses are only covered by a relatively thin layer of chip seal. This is compared to roads in the northern hemisphere, which is where the 15 percent limit generally applies, where basecourses tend to be covered by at least 100mm of structural asphalt'.

'Our objective for the research project was essentially to revisit the 2006 specification by testing what percentages of recycled glass could be added to a basecourse aggregate used under the thin surfaces typical of New Zealand roads, without reducing the road's performance or rut resistance.'

Both RLT testing and associated rut depth modelling were used in the research. Tests were carried out on the same aggregate (a high rut-resistant aggregate from Pound Road Quarry in Christchurch) mixed with a range of percentages of crushed glass, from 0 to 50 percent.

David says, 'What Dr Arnold's testing and rut depth prediction found was that adding crushed glass in quantities of up to 30 percent by mass had little or no effect on aggregate rut depth performance'.

'Given the support in international literature and studies for a maximum of 15 percent by mass of crushed glass to be added, we recommended that the



New Zealand specification be raised to follow suit. That limit may be able to be pushed up even further if further RLT testing supports it.'

'With an altered specification, we would be providing councils with an attractive and sustainable means of dealing with their recycled glass and hence addressing the current problem and importantly, wouldn't be deterring alternative high-value uses for the glass from being developed or adopted in the future. Ultimately, we think that the effects would be beneficial, both financially and environmentally, for local communities.'

Contact for more information

David Alabaster
NZ Transport Agency
Phone 03 372 1802
Email david.alabaster@nzta.govt.nz

The effect of adding recycled glass on the performance of basecourse aggregate, NZ Transport Agency research report 351.

Freely available online at
<http://www.landtransport.govt.nz/research/reports/index.html#environmental>

Hard copy \$20.00
Email research@nzta.govt.nz to order.

A glassy issue

Glass in New Zealand is an important industrial material, used mainly for glazing and food packaging. At present, New Zealanders use around 250,000 tonnes of glass each year, approximately 185,000 tonnes of which is used for containers such as bottles and jars. Consumption has increased significantly over the past decade and the upward trend is continuing.

In 2004, the Packaging Council of New Zealand adopted a packaging accord, which sets out targets for recovering packaging to 2008. However, the target of 55 percent for glass is proving difficult to achieve, with actual recovery rates to date fluctuating around the 49 percent mark. One of the reasons for this is the difficulty of recycling glass into new glass products cost effectively.

As a result, many councils are looking for cost-effective local solutions for recycling their glass. The ability to use significant amounts of this glass in road building would have benefits for councils and communities as well as road construction companies. If crushed glass could be incorporated into basecourse aggregate,

colour separation would be unnecessary and the resulting labour cost avoided. Glass could be processed and used locally, with the potential for large quantities to be absorbed in a sustainable way. Local authorities would not need to invest in any special equipment, and expensive disposal to landfill and unsightly stockpiling could be eliminated.

However, incorporating glass in aggregate is not without its own costs. Whether the glass is crushed separately and later mixed with rock, or whether the glass and rock are crushed together, the cost is roughly the same. The glass and aggregate blended product costs around \$2 more per tonne than conventional mineral aggregate, meaning that using the presently allowed limit of 5 percent by mass glass in the aggregate mix may cost up to 30 percent more.

David says that for the crushed glass option to be viable for councils a 'whole of life' approach is required.

'Once councils add the potential alternative costs of, for example, sending the glass to landfill into the equation, then using glass in basecourse aggregate becomes more attractive, as the savings in landfill costs will outweigh the extra costs of incorporating the glass.'

Holistic approach eases people's way

Improving New Zealanders' access to key services and activities lies behind a recent research report commissioned by the NZ Transport Agency (NZTA) into a specialised and holistic field of planning – accessibility planning.

Accessibility planning is used in various forms in many countries around the world. It ranges from a comprehensive approach, where it is integrated into a country's land use and transport planning systems, to more limited approaches for specific ends. Accessibility planning has the ability to improve individual and community wellbeing by ensuring people can access the places and services they need.

In New Zealand though, the approach to date has been somewhat piecemeal. Although accessibility, and the need to improve it, appears on the agendas of many government agencies and policymakers, approaches so far have been largely uncoordinated and the focus has been on monitoring access, rather than actively assessing and planning to improve it.

A research report investigating accessibility planning methods has recently been completed by transportation specialists Booz & Company. Richard Hancy of Booz & Company says, 'Although we've got government agencies in the transport, health, housing and education sectors all saying that we need to improve access and setting strategic objectives relating to this, these efforts are not in general linked'.

'Through the project, we were interested in exploring accessibility planning as a tool to reach across what have often been three quite disparate disciplines – transport, land use and social services. Accessibility is about more than just mobility or physical access issues, and accessibility planning takes a whole-of-system approach to addressing access

issues, which importantly enables non-transport perspectives and solutions to be brought in.'

Having looked at accessibility planning as it is applied overseas, the researchers came up with an accessibility planning framework that they saw as best addressing New Zealand's access planning needs.

Richard says, 'We're proposing that a comprehensive accessibility framework, with nationwide application, would deliver the access-related policy outcomes of the government's transport, health, education, housing, social services and economic development portfolios, amongst others'.

What is accessibility planning?

Accessibility relates to ease of access, with personal accessibility defined as the ease with which people can reach or use activities, economic or social. Accessibility is not the same as mobility, which relates to ease of movement, be it by car, public transport, walking or cycling, and as such is an aspect of accessibility.

Defined simply, accessibility planning is a structured process for assessing, and planning for, accessibility. It enables planners to evaluate the trade-offs and relationships between land use, transport and social needs, and focuses attention on the level of service provided by the system as a whole, rather than just by isolated aspects of the transport system.

Accessibility planning uses quantitative and qualitative data and tools, such as geographical information systems, to assess accessibility-related information. These include trip origins, the location of key activities and how and when they are delivered, and the transport links to and from them. Accessibility planning makes use of indicators, which accessibility can be assessed against to identify, address and monitor issues.

As a transport and land-use planning tool, accessibility planning offers benefits such as:

- coordinating transport and other public policy objectives (for example, housing, education, health and social services)
- providing a means of assessing equity of access between different social groups
- identifying the social implications of land-use projects or changes in transport services
- a tool for delivering positive social, economic and environmental outcomes.

'The first step would be to develop a national accessibility policy and we're suggesting a collaborative process to be led by the Ministry of Transport to ensure that the relevant priorities and outcomes of all the partner agencies are agreed and incorporated. The policy would clearly state the whole-of-government position on accessibility, including how and when any policy actions would be introduced, resourced and funded. It would be used to inform subsequent policy development and work programmes of the partner agencies, and enable regional councils to coordinate partnerships for regional accessibility planning.'

The proposed New Zealand framework draws on a comprehensive five-stage framework already used in England. The approach requires collaboration across all levels and sectors of government, with the first stage carried out by national and regional accessibility partnerships, and the four following stages put into practice regionally.

- Stage one: strategic accessibility assessment – identifying strategic priorities for accessibility at national and regional levels, defining the requirements for future, detailed assessments, and developing core national indicators of accessibility monitoring.
- Stage two: regional accessibility assessment – gathering detailed information about regional/accessibility problems (including their scale), focusing on the previously identified national and regional priority areas.
- Stage three: option appraisal – assessing the options to address identified accessibility problems.
- Stage four: regional accessibility strategy and plan preparation – producing an accessibility strategy and associated action plan, which together set out a specific path for improving regional accessibility.
- Stage five: performance monitoring, evaluation and feedback – monitoring accessibility on an ongoing basis using standard national and regional indicators and targets.

Richard says, 'We were particularly interested in the English approach because it applies equally in urban and rural areas and is implemented across all levels of a government structure that is similar to what we have here in New Zealand. It was the most comprehensive of the international approaches, which we concluded was necessary if we are going to achieve the goals and objectives for access and mobility set out in the *New Zealand Transport Strategy*, along with those of other government sectors'.

'We've adapted the English model to suit conditions here, in particular by incorporating private motor vehicles in assessments. This was a necessity given the geographical isolation and lack of other transport alternatives in many parts of New Zealand. We've also recommended the New Zealand framework be led at the national and regional levels, rather than by local councils as is the case in England.'

Under the proposed New Zealand framework, the Ministry of Transport would be responsible for developing the national accessibility policy and an accessibility planning process. Once completed, the NZTA would facilitate and monitor the process's implementation at a regional level.

Accessibility planning partnerships of key stakeholders with an interest in accessibility issues would be formed at the national and regional levels. Regional councils would coordinate the regional partnerships, and lead the development and application of regional strategies and action plans.

Local government, social services and other agencies would provide information towards regional assessments. They will identify options to address ascertained problems, while existing national, regional and local monitoring frameworks would be tapped into to provide indicators. Additional indicators would be developed where necessary to monitor local accessibility for employment, education, health, food shopping and social services.

Looking to the future, the research team foresee a direct relationship developing between the regional accessibility plans and the regional land transport planning process. Actions will be identified in the accessibility plans and become the transport proposals put up for prioritisation and funding under the National Land Transport Programme.

Richard says, 'Implemented in a comprehensive way, accessibility planning has the potential to improve the quality of life of all New Zealanders by improving their day-to-day access to key services and activities'.

'Further research is needed into the costs, financial and otherwise, of developing and implementing a nationwide framework. Once the framework is up and running, there will be scope to look into including accessibility planning at a project level, for example, as part of national infrastructure projects or in regional and local resource consent processes.'

Contact for more information

Richard Hancy
Booz & Company
Phone 09 354 7800
Email richard.hancy@booz.com

Accessibility planning methods,
NZ Transport Agency research report 363.

Freely available online at
<http://www.landtransport.govt.nz/research/reports/index.html#sustainable>

Hard copy \$20.00
Email research@nzta.govt.nz to order.

New standard drawings available for precast concrete bridge beams

An NZ Transport Agency funded research project has produced a set of standard drawings for precast concrete bridge beams to update earlier standard designs.

A set of precast concrete bridge beam designs, adopted in the 1970s as industry standards, were required to be bought up to date to reflect changes in design codes and the higher strength materials now available.

Transfund NZ commissioned research to instigate and update the standard designs, with the work carried out by BECA and Opus, supported by CCANZ and an industry steering group.

The result was the retention of two existing beam types as standard beam shapes (hollow core and I girder beams), and the addition of a third shape commonly used in Australia (super T beam).

The research report contains standard drawings for the three beam types, together with bridge deck arrangements. Designs have been developed for a two-way carriageway arrangement, and are suitable for bridge skews of up to 15 degrees. The decks are designed to support TL4 rigid concrete barrier edge protection.

The beam designs include partial pre-stressing to ensure that cost-effective solutions were found for standard bridge beams that fully meet the requirements of *NZS 3101 - Concrete structures standard and the Transit New Zealand bridge manual*.

Further beam designs may be added, and alterations made, as bridge technology, products and materials develop.

Contact for more information

Jamil ur Rahman Khan
Beca Carter Holling and Ferner Ltd
Phone 04 473 7551
Email jamil.khan@beca.com

Standard precast concrete bridge beams,
NZ Transport Agency research report 364.

Freely available online at
<http://www.landtransport.govt.nz/research/reports/index.html#asset>

Hard copy \$30.00
Email research@nzta.govt.nz to order.



New research publications

Obtaining our research reports – These research reports are freely available online at www.landtransport.govt.nz/research. They can also be purchased in hard copy from about \$15 to \$40 each. To order any of these reports, or with questions regarding the NZ Transport Agency's research programme, please email research@nzta.govt.nz.

A literature review on driver fatigue among drivers in the general public

Research Report 342

S. McKernon, Supplejack Ltd

In 2007, Land Transport NZ commissioned a review of international driver fatigue literature (2000–2007) to assess measures against driver fatigue that would be effective for general public drivers.

The review first notes that a number of disciplines study driver fatigue, each using its own definitions and so emphasising different measures. This constrains the development of measures and longer term programmes for the general public. The review notes the need for evidence-based theory specific to general-public driver fatigue. This would enable a clearer understanding and facilitate the design, management and evaluation of programmes.

This review distinguishes between fatigue from weariness through driving (acute fatigue) and fatigue from prior sleep deprivation (chronic fatigue). It also distinguishes between interventions (measures used prior to driving) and countermeasures (measures used during driving).

It then links specific fatigue problems (acute or chronic), as experienced by specific driver groups, to the most effective measures against them (interventions or countermeasures) for that driver group.

Finally, it suggests a guideline for best practice in the design of measures and programmes to counter driver fatigue within the general public.

Valuing the health benefits of active transport modes

Research Report 359

J. A. Genter, S. Donovan and B. Petrenas, McCormick Rankin Cagney; H. Badland, Centre for Physical Activity and Nutrition Research, Auckland University of Technology
– \$15.00

This report seeks to provide a per-kilometre value for the health benefits of active transport modes (such as walking and cycling) that is compatible with Land Transport New Zealand's *Economic evaluation manual* volume 2 (EEM2). The first two sections of the report begin by explaining the scope of the project and the background. Section 3 investigates the evidence of the connection between physical activity and health outcomes. Section 4 clarifies the role of active transport modes as physical activity, and reports the New Zealand-specific data about active transport mode engagement. Section 5 gives a brief comparative summary of the

literature review of cost-benefit analyses and valuation techniques used overseas to value the health benefits of active modes.

This report uses population attributable fractions (PAF) to estimate the annual burden of mortality and morbidity costs per inactive adult. Annual estimates of the costs of inactivity are applied to the New Zealand adult population using a weighted sum to establish a per-kilometre value for each mode.

The valuation presented in this report is limited by a poverty of data, but the final values are considered to be a reasonable estimate of the health benefits of active modes. While further research is recommended to obtain more precise estimates of the costs of inactivity in New Zealand, it is considered that the values presented in this report are a sound interim estimate for inclusion in the EEM2.

The usability and safety of audio tactile profiled road markings

Research Report 365

J.P. Edgar, John Edgar Consulting; H.W. Mackie and P.H. Baas, TERNZ Ltd

Audio tactile profiled (ATP) road markings (also known by road users as rumble strips) have been used at selected locations on New Zealand roads in recent years. However, a recent Land Transport NZ Research Report established that more extensive use of these markings over a wider range of traffic volumes and roadway situations would result in cost-effective crash reductions. The potential benefit of ATP road markings is recognised by KiwiRAP, the New Zealand Automobile Association's New Zealand Road Assessment Programme partnership with government and transport agencies, dedicated to helping achieve the government's Road Safety to 2010 Strategy through road driver awareness and improvement measures. Land Transport NZ commissioned this project to investigate possible impediments to the wider use of ATP road markings and to consider whether the existing guidelines for their use needed to be reviewed.

Based largely on consultation, the report provides an overview of practice and technology currently applied to the use of ATP road markings in New Zealand. It recommends best practice guidelines and changes to decision-making processes, technical standards and some further research.

The project provides information needed by highway managers and ATP road marking installation contractors. The recommendations inform the development of changes to rules and decision-making procedures and, when adopted, should result in significantly increased usage of ATP road markings and a corresponding increase in crash savings.

Long-term dust suppression using the Otta seal technique

Research Report 368

J. C. Waters, Fulton Hogan Ltd

A 2004 trial of the Otta seal technique in various locations in New Zealand showed that it may be a better option for dust minimisation and, based on life cycle costing, could be a lower cost option when compared with traditional short-term dust palliatives.

A research trial was funded by Land Transport NZ to set up four trial sites around New Zealand, to compare the performance and life cycle costs of the Otta seal with waste oil and other dust minimisation techniques.

In spite of environmental issues, waste oil was used in this research, as it has been widely regarded as the most cost-effective dust minimisation treatment for unsealed roads in New Zealand, and its use is still allowed by a number of territorial local authorities throughout the country.

The research concludes that the Otta seal is the most effective dust minimisation technique available and the most cost-effective treatment based on life cycle costing. The report also concludes that the use of waste oil as a dust minimisation treatment should be banned.

A guideline for the construction of these seals was developed as part of the research.

Trends in older people's travel patterns

Research Report 369

C. O'Fallon, Pinnacle Research and Policy Ltd; C. Sullivan, Capital Research

Land Transport NZ commissioned this research about the trends in older people's travel patterns. The authors explain, 'We updated our earlier study of older people's travel patterns using the 1997/98 New Zealand Household Travel Survey (NZHTS) with a comparative analysis using the recently compiled 2004-07 Ongoing NZHTS database (ONZHTS)'.

'We found that older people (60+) travelled considerably less than the general adult population (aged 25-59), whether one looked at the total or mean number of trip segments per day, the typical distance per trip segment, mean distance per day using 'surface transport' or mean distance per day driven. The total number and mean number of trip segments and distances travelled declined steadily across the age groups (25-59, 60-64, 65-74 and 75+).'

'Between 1997/98 and 2004-07, older people as a group increased their volume of travel considerably, especially their driver trips (from 174.5 million per year to 364 million) and distance driven (from 1040 million km to 2500 million km). Older drivers (60+)

formed a significantly higher proportion of the vehicle traffic stream (18% compared with 15%) in 2004-07. As the mean distance driven per day per person did not change significantly for older drivers, the increased share of the traffic stream appeared to result from the greater number of older drivers in particular.'

Promoting sustainability in New Zealand's rail system

Research Report 370

P. McGimpsey, J. Havemann and J. Sutcliffe, Beca Carter Hollings and Ferner Ltd

This report presents the findings of research investigating the opportunities and barriers to promoting sustainability in New Zealand's rail system. The research involved two main aspects - exploring what sustainability means in a New Zealand rail context and investigating what opportunities and barriers might exist to achieving a sustainable rail system. Opportunities and barriers were considered in terms of their likely timescale and whether they were internal (systemic) or external (non-systemic) to the rail system.

The research is intended to stimulate discussion about the role of rail in New Zealand's transport system in the future. As part of this ongoing discussion, this report concludes with a number of recommended actions that could be undertaken to promote sustainability in the rail system.

Relationship between road geometry, observed travel speed and rural accidents

Research Report 371

S. Turner, Beca Infrastructure Ltd; F. Tate, MWH

Speed is a major contributing factor in fatal and serious crashes in the rural environment (35 percent of fatal and 28 percent of serious crashes in 2003). In such crashes, drivers are generally described as travelling too fast for the conditions. Based on the premise that drivers do not deliberately travel too fast for conditions, what aspects of the road alignment affect drivers' speed choices?

Using highway geometry, speed and crash data collected during 2005-2006 on six 20km road sections located in Canterbury (SH73), Blenheim (SH1), Wanganui (SH3) and Whangarei (SH1), this research investigates the relationship between curve radii, the preceding speed environment and drivers' observed curve negotiation speeds. The observed free speeds are compared to the 'safe' speed, and measured as a function of the design speed of each curve. The relationship between speed and crash occurrence is examined by relating crashes to the difference between observed and 'safe' speed.

Research Programme Coordinator joins team

The NZTA recently appointed Virginia Skilton as the Research Programme Coordinator.



Virginia has joined Patricia McAloon, Manager and Nigel Curran, Senior Analyst to coordinate and develop the Research Programme. Virginia is the first point of call for research programme matters and can be contacted on 04 894 6160 or virginia.skilton@nzta.govt.nz.

Prior to joining the NZTA, Virginia was a Project Analyst for the Department of Internal Affairs where she gained her Prince2 practitioner qualification in project management. She has a varied background in programme coordination, finance and customer service.

2009 Australasian Road Safety Research, Policing and Education Conference

11-13 November 2009
Sydney, New South Wales, Australia

Overview

The NSW Centre for Road Safety in Sydney is hosting this year's Australasian Road Safety Research, Policing and Education Conference. The conference provides an opportunity for professionals from across Australia, New Zealand and the Asia/Pacific region to come together to disseminate and exchange new research and practical management insights for the purpose of reducing road trauma.

The themes for the conferences will include:

- data and analysis
- education
- enforcement
- environment and urban planning
- human factors
- policy and legislation
- technology and engineering
- vulnerable communities and road users.

The conference programme will be available shortly.

Further information is available at:

<http://www.roadsafetyconference2009.com.au/index.htm>

Contacts

Tulips Meetings Management
Sarah Mason
Conference Organiser and Secretariat
Ph: (00612) 4984 2554
Fax: (00612) 4984 2755
Email: roadsafety@pco.com.au

NZTA research

NZTA contacts

Virginia Skilton
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 research programme, to act as a forum for passing on national and international information, and to aid collaboration between all those involved. It also aims to stimulate inquiry, discussion and solutions concerning land transport and NZTA's key research areas - namely, integrated land use and transport systems, transport demand management, activity management, sustainable land transport, safety, security and public health, environmental impacts of land transport and economic development.

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.

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 independent 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. Please also let us know if you or others you know wish to begin receiving *NZTA research*.

Email research@nzta.govt.nz

Back issues

Available, upon request, from NZTA.

This newsletter is printed on environmentally-responsible paper manufactured using FSC-certified, mixed-source pulp harvested from sustainable well-managed 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