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NZ TRANSPORT AGENCY
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TRAVELLERS WANT BETTER, TIMELIER INFORMATION

Real-time location-specific travel information is the most valuable tool for people on the move, recent research shows.

While waiting at a train station or bus stop, real-time information giving the actual arrival times, delays and/or the location of the train or bus was generally the information people wanted the most, says the Transport Agency-funded report, *Customers' requirements of multimodal travel information systems*.

The research concluded that providing better information before and during travel would improve the experiences of customers by allowing them to make smarter travel choices, such as using a different mode of transport or travelling at a different time of the day.

To achieve this, the research confirmed that travel information must be accurate, timely, relevant and easy to access, preferably from one central source. The information must also be easy to understand and ideally customisable to individuals, such as allowing users to save 'favourite' routes, which they can receive or request information about.

Other important aspects are trust and awareness. 'If information fails to meet users' expectations they will quickly stop using that source – therefore it is critical that any new information provision systems are fully tested before they go live,' says researcher Jo Chang from Opus International Consultants. The research also found that travellers seeking information often lack awareness of all of the information currently available to them. Users indicated that they will not check multiple sites to get travel information, which is further exacerbated by information providers often failing to implement appropriate marketing to support new systems.

The researchers (Opus International Consultants and Opus Research) aimed to identify customers' key information needs that would help them use a combination of transport options (and the best ways of offering this information) through data collected from an online survey, focus groups, interviews and a review of international best-practice examples.

The online survey showed that people were already changing their travel behaviour based on the information they were currently accessing – 46 percent had done so at least once in the previous month.

continued on page 2

Commuter trips were altered most often, especially in Christchurch, which could have been a result of road disruptions after the Canterbury earthquakes. Changes were most commonly made to route and departure times for commuters, leisure and recreational trippers and tourists alike.

The report comments that online survey respondents indicated they were willing to alter their travel behaviour to improve their travel experiences, particularly if they were provided with improved travel information. This reveals an information need to be filled in New Zealand.

Providing more information to travellers would not only allow them to make better travel choices but could also improve road network performance and safety by spreading demand throughout the day and onto different routes and reduce customer frustration with congestion and delays. Customers indicated a preference for information to be more real time, comprehensive and multimodal.

'High-quality real-time information offering multimodal information for travellers faced with unexpected travel impediments, such as traffic crashes, public transport delays and poor weather, could be investigated for larger centres,' says Jo.

High-quality travel information could include alternative routes, comparative trip times for different travel times or days, directions and pictures or names of key landmarks.

People could also compare different modes of transport if this was combined with information on public transport timetables, travel times and costs, and the facilities available on different routes, such as parking, points of interest, public toilets, rest areas and walking or cycling tracks.

Different travellers have different information needs, capabilities and preferences. At the very least, information should be targeted at both novice travellers (new to a city or the mode of transport) and the experienced. Experienced travellers tend to be more interested in specific events that impact on their journeys, such as a bus or train arriving late, or a crash on the motorway on the way to or from work. On the other hand, novice travellers want to know more about their travel options, such as where the train/bus stops are located and the best ways of getting to them.

'Information should also be delivered in both digital and traditional formats as people have strong preferences depending on their comfort/ability with technology,' says Jo. 'This suggests using several channels for information delivery, rather than focusing on just a select few.'

Before a trip, the best way to give information is via the internet, smartphone or radio. During a trip, radio and variable message signs are considered better options than phones, which have safety issues.

Freight operators could receive information via their dispatchers while mobile phones and smartphones would be appropriate for travel by public transport.

The report recommends investigating the provision of information to freight operators, such as on road closures, weight and height restriction locations, rest areas and toilets, as this would help with route selection.

Information should be easy to understand and use common terms for locations, directions and landmarks. This is important because 42 percent of people who frequently use public transport do not know the exact name of the stops where they get on and off, for example.

The system must also be able to withstand an emergency.

'Experience after the Canterbury earthquakes and snow events reinforced the importance of being able to remotely access/change information on websites as events unfold,' the report says.

Following the 22 February 2011 earthquake, the Environment Canterbury internal servers went down and could not be accessed. This meant although the Metro Info travel information website was accessible to users, the information on it could not be changed. Environment Canterbury had to act quickly to make changes so the website could be remotely updated. Improvements included upgrading its journey planner and moving to a 'cloud' virtual server to make the system more robust during emergency or unplanned events.

The report noted that overall New Zealanders had realistic expectations regarding information provision.

'They are aware of the importance of population density to the success of initiatives such as real-time travel time indicators, and only want them introduced where they would be affordable, reliable and useful.'

The researchers recommend developing a strategy for rural areas that have trouble with data, GPS or mobile phone reception and mapping, as they could receive misleading or no information.

Another option to explore is how to use the rapidly growing concept of crowd sourcing, whereby online communities or organisations volunteer content, skills or problem-solving abilities. Trials in rural areas overseas show crowd sourcing could provide low-cost real-time public transport information.

There is also a need for some overarching strategies to clarify the roles of government agencies, such as the Transport Agency, and the private sector, and which groups would provide the different types of information. These strategies could also define how traffic operation centres and information provision would interact and address issues around data sharing and privacy.

Customers' requirements of multimodal travel information systems, NZ Transport Agency research report 540

Available online at **www.nzta.govt.nz/resources/research/reports/540**

EXPLORING WAYS TO TRACK THE GROWING FREIGHT TASK

Moving freight efficiently is vital to our economy, so better understanding of New Zealand's increasing and evolving flow of goods will allow us to adapt and manage the transport system to meet these changes.

To assist with this, the Transport Agency commissioned research into the best way to collect ongoing data about national freight movements. The research concluded there was unlikely to be any simple automated approach and instead proposed a hybrid approach that should provide a comprehensive ongoing picture of freight movements with the help of those who own and move New Zealand's freight.

As our economy and population grow so will the volume of freight and the trips needed to move it. In 2012, freight volumes nationally were estimated at 236 million tonnes (or 26.3 billion tonnes/kilometres), which by 2042 is forecast to rise to 373 million tonnes (40 billion tonnes/kilometres). Moving freight efficiently will remain vital to our economic wellbeing and to ensuring a prosperous economy.

The government sees improving the efficiency of freight supply chains as a key transport policy outcome. Local government is also recognising the importance of moving freight efficiently for the health and future prosperity of their communities.

To be able to plan effectively for the future freight task, comprehensive and reliable information about freight movements is needed, and this information needs to be kept up to date. This is true both for agencies and organisations providing infrastructure, and those providing services to support the sector; and was recognised in the New Zealand Productivity Commission's 2012 report, *International freight service inquiry*, which stressed the importance of good freight data collection to inform good decision making.

At the time of this research project (2012 to 2013), the main source of data on freight movements was the National Freight Demand Study (2008), which, although it provided a reasonably comprehensive picture of freight movement in New Zealand in 2006 and 2007, had become outdated.

The purpose of the research project was, therefore, to consider how the national survey might best be updated, with the project's findings subsequently incorporated by the Ministry of Transport in its updated National Freight Demand Study, released early 2014.

EXPLORING THE OPTIONS

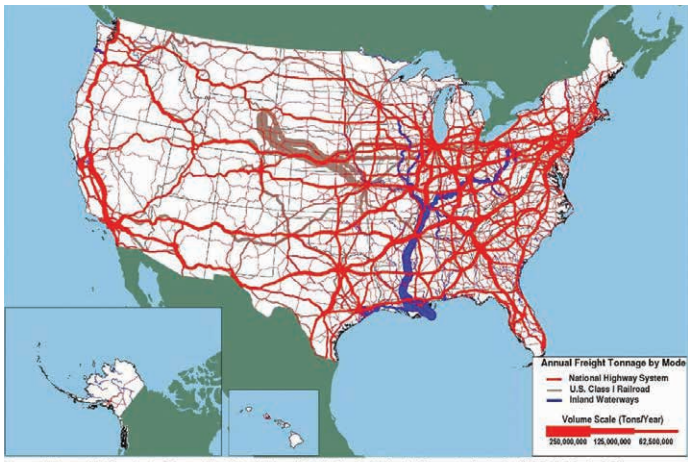
Data collection can impose costs (time and other resources) on those who are providing the information, and the research team (Richard Paling Consulting, Murray King & Francis Small Consultancy, Traffic Design Group and Statistics Research Associates) was keen to explore ways by which these costs could be minimised, and the data collection process made repeatable and hence updatable.

Richard Paling says, 'Since the 2008 National Freight Demand Study, there has been substantial growth in the use and sophistication of electronic systems for tracking vehicles and for managing freight information. We wanted to explore how we might be able to use these systems to collect and update national freight movement data.'

An examination of freight data collection overseas revealed that different countries adopted differing approaches, although there were common elements among them. All, for example, made use of mandatory surveys, either of transport operators or the producers or shippers of goods, the results of which were then combined with information drawn from a wide range of other sources. This hybrid approach was considered necessary to build a comprehensive picture of freight movements.

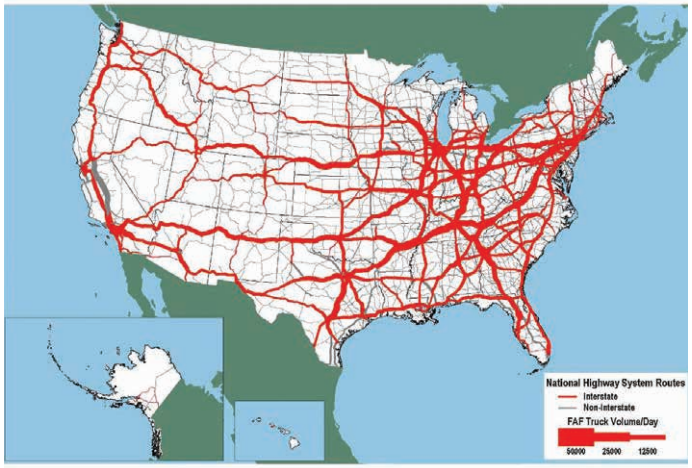
The United States has the most comprehensive approach, based on a large Commodity Flow Survey. Data from this and other sources is brought together into an interactive website, allowing freight flows to be identified by commodity, mode, and origin or destination. Like the outcomes of the New Zealand National Freight Demand Study, this information is publically available; the only overseas country looked at as part of the project where this was the case.

TONNAGE ON HIGHWAYS, RAILROADS AND INLAND WATERWAYS 2007



Sources: Highways: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework, Version 3.1, 2010. Rail: Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory. Inland Waterways: U.S. Army Corps of Engineers (USACE), Annual Vessel Operating Activity and Lock Performance Monitoring System data, as processed for USACE by the Tennessee Valley Authority, and USACE Institute for Water Resources, Waterborne Foreign Trade Data, Water flow assignments done by Oak Ridge National Laboratory.

AVERAGE DAILY LONG-HAUL FREIGHT TRUCK TRAFFIC ON THE NATIONAL HIGHWAY SYSTEM 2007



Note: Long-haul freight trucks typically serve locations at least 50 miles apart, excluding trucks that are used in movements by multiple modes and mail.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.1, 2010.

Data about freight movements in the United States is publically available on an interactive website

Despite the reliance on mandatory surveys overseas, it became apparent early on in the project that such surveys were not a favoured option among members of the freight industry here, due to the compliance costs. Any form of data collection included would have to be voluntary and enjoy industry support.

Hopes for the usefulness of electronic freight data collection, based on global positioning system (GPS) vehicle tracking information and data derived directly from companies' own information management systems, were also found to be unsupported.

In the case of GPS, although the systems are now widely used, the information they provide is limited. By themselves, for example, such systems are unable to provide information about the commodity being moved or its weight, and present some difficulties in providing information about ultimate origins and destinations for freight movements.

However, the research team recognised that, although GPS could only make a limited contribution at present, the technology was rapidly and constantly evolving, and 'may have potential in the future'.

The team also looked at in-house information management systems operated by the companies. While extracting the data from these systems was 'technically feasible', commercial confidentiality concerns and the complexity of the processes needed to address these concerns, meant their use was 'extremely unlikely to be achievable'.

TRIALLING THE PROPOSED APPROACH

Based on their review of the freight data collection approaches used overseas, the research team concluded that a hybrid approach that draws data together from a number of sources would be the most appropriate and would provide the best opportunity to update the National Freight Demand Study most effectively.

Such an approach would involve collecting information from:

- producers and transporters of commodities
- a variety of different sources, reflecting those who are most easily available to supply the data.

The team suggested that a hierarchy of data collection, from these disparate sources, would include the following steps:

- collect data that is freely available from public sources
- purchase data that is available from public sources
- acquire unpublished data from key commodity producers, transport operators and other parties who have demonstrated their willingness to participate in exercises such as these
- aim to acquire data from firms who have not so far demonstrated their willingness to participate
- where gaps still remain, identify alternative approaches, such as synthetic modelling based on high-level economic inputs.

The general approach set out in the research report was applied in the collection of data and its analysis in the 2014 National Freight Demand Study. With the increased understanding of the sources of data on the freight tasks, a feature of this work was the increase in the number of separate commodities considered: up from 17 in the earlier study to 29 in the current study. This allowed a more detailed breakdown of current flows and provided an improved basis for forecasting flows into the future.

It was also possible to take advantage of new sources of information collected for other purposes, such as the very detailed National Animal Identification and Tracing database, which covers the movement of livestock and has been developed to improve biosecurity.

For the future, participating firms and organisations could be encouraged to enter into long-term agreements to provide the data requested at periodic intervals. This would facilitate regular updating of the National Freight Demand Study, with the information collected in agreed and readily repeatable formats.

Richard says, 'In summary, we recommended that data on freight movements needs to be obtained from a number of sources, with different formats, if it is going to be anything like comprehensive or accurate.

'In our view, there is unlikely to be any simple process that will allow the national patterns of freight movement to be generated automatically from the various sources of information that are realistically going to be available. The production of national freight matrices will, therefore, always require a substantial element of judgement from those who were pulling together the information available from the disparate sources.'

Ongoing domestic freight volume information study, NZ Transport Agency research report 542

Available online at **www.nzta.govt.nz/resources/research/reports/542**

TOOL PINS DOWN BENEFITS OF INTEGRATING TRANSPORT MODES

A research project has developed a framework for estimating the cost–benefit analysis of integrating public transport with walking and cycling.

The project examined the available national and international evidence on interventions that could improve the integration between public transport and walking and cycling, in order to provide decision makers with a tool for appraising the value of potential interventions, using cost-benefit analysis.

Tom Small of researchers Sinclair Knight Merz Ltd (now Jacobs) says the research was needed to fill gaps in the understanding about the benefits of integrated cycling and walking, and how to enable these.

'Cycling, walking and public transport as individual transport modes have clear and well-understood benefits in terms of transport efficiency and their wider economic, social and environmental impacts. It is also known that better integration between the three modes of transport can benefit public transport, leading to higher patronage and revenue, and reduced congestion,' explains Tom.

'What is less well understood is the quantum of the walking and cycling benefits when well integrated with public transport facilities, and how effective specific interventions are in encouraging cycling and walking. This is particularly true in New Zealand, where there is a lack of evidence on the types of measures, both individually and collectively, that can increase people's uptake of active transport modes.'

To this end, the research sought to understand:

- how provision for walking or cycling at either end of a public transport trip affects how attractive public transport is as a viable mode
- the wide range of initiatives and measures that can be used to improve the integration between public transport and cycling and walking
- how demand for public transport was likely to be affected by the introduction of particular initiatives to improve integration
- the relative costs and benefits of the various initiatives.

EVALUATING INTEGRATION MEASURES

The research found there were many measures that could improve integration between walking, cycling and public transport. Among the most promising were:

- land use planning, which encourages densities that are conducive to short walking and cycling trips
- walking and cycling networks that are attractive, safe and offer a direct journey between trip attractors and generators, and stations or stops
- secure bicycle parking at public transport nodes
- provision for bicycles to be carried on public transport
- bicycle rental systems, including bicycle share systems such as Vélib (Paris), and systems dedicated to rail travellers such as OV-Fiets (Netherlands).

The research team developed a spreadsheet evaluation tool (available with the report at www.nzta.govt.nz/resources/research/reports/537), for estimating the cost-benefit ratio (as a dollar value) of potential initiatives to improve walking and cycling access to and egress from public transport. The economic evaluation parameters used in the tool are consistent with international business case guidance and valuations in the Transport Agency's Economic evaluation manual.

To test the tool, the team applied it in a case study of access to Puhinui rail station in Papatoetoe. The station forms part of Kiwirail's project to replace a number of rail bridges as part of the Auckland electrification project. The project incorporates improved cycling and walking facilities on bridges and approaches to Puhinui station. The case study used the evaluation tool to test three different options for this work, including Kiwirail's current agreed option and two enhanced options with additional cycle parking and pedestrian facilities. Findings from the case study are used throughout the research report to illustrate application of the evaluation tool.

The report includes a review of how walking and cycling at either end of public transport trips are taken into account in data collection, transport planning and modelling, and also makes practical recommendations to aid integrated planning in the future.

HOW POPULAR IS WALKING AND CYCLING?

As background to the research, the team reviewed the international evidence on the mode shares of the various types of transport that people use to get to (access) and travel on from (egress) public transport.

The modes people use to access public transport vary significantly. In urban areas dominated by car travel, as in many New Zealand cities, private cars are the main means of access. This contrasts with many European and Asian cities, where higher population densities and more expansive public transport networks mean that walking accounts for over half of all public transport access trips.

Cycling is a marginal access mode in many places, except for cities that feature high-quality cycling infrastructure, facilities at stations and stops, and a wider cycling culture, where it could account for over 20 percent of access trips.

At the destination end of public transport trips, walking is universally the predominant egress mode, with cycling playing only a minor role.

The research also compared New Zealand and international evidence of walking and cycling catchment areas: that is, the distance people are prepared to walk and cycle to access public transport services. In New Zealand, the median walk-to-bus trip length is 200m, with 75 percent of walk-to-bus trips being less than 500m. These distances are low compared with those cited in the selected international research, which show that people will often walk distances of between 400m and 800m to reach bus services.

However, in both New Zealand and overseas, people will walk further to access faster transport modes, such as rail or ferry services. The median walk-to-rail distance in New Zealand is over 1km, similar to that cited internationally.

The catchment area for cycling trips to public transport stations or stops is larger than for walking. Although based on a small sample, in New Zealand the mean distance cycled is 1.42km, with 25 percent of people cycling more than 1.35km to reach public transport.

Many factors were found to influence the use of walking and cycling as access modes for public transport. The research discovered that cycling was used more than walking as part of trips taken for commuting and education purposes, and certain demographic and socio-economic groups (eg adult males) were more likely to cycle.

Improving the cost–benefit analysis of integrated public transport, walking and cycling, NZ Transport Agency research report 537

Available online at **www.nzta.govt.nz/resources/research/reports/537**

THE INTEGRATION EVALUATION TOOL

Sinclair Knight Merz's (now Jacobs)The spreadsheet evaluation tool will assist practitioners appraise proposed measures to integrate public transport and walking or cycling. It aims to:

- provide an easy-to-use method for estimating the demand for walking and cycling as a public transport access mode
- calculate the monetary costs and benefits of alternative options to improve integration at individual stations and stops.
- The tool is intended to be flexible, so that it can adapt to different levels of data availability. The minimum data requirements for using the tool are:
- estimates of daily boarding and alighting at the station or stop
- an estimate of the number of passengers interchanging between public transport modes
- population and employment data for the surrounding area (eg from census data)
- cost estimates for the proposed measures (some unit values are included in the report).

If data is available on access mode shares, a station-specific profile of access and egress can be employed. Alternatively, the tool can estimate the access and egress mode shares based on station typology, or regional averages in New Zealand.

The evaluation tool can be applied to a single bus stop or a major multimodal interchange. The tool uses one spreadsheet for each station or stop and is designed to enable the user to evaluate several alternative options for the station or stop.

The economic evaluation should be conducted over a specified evaluation period linked to the life of the asset. The evaluation tool is designed to estimate passenger impacts for a single year – either the proposed implementation year or a future-year scenario. If users want to test the impacts of integration measures, combined with forecast population or employment growth scenarios, they can complete separate spreadsheets for the implementation year and any future-year scenarios. This will make it possible to disaggregate the impacts of the integration measures from the impacts of population or employment growth.

ADDING CAPACITY TO RURAL TWO-LANE ROADS

With traffic volumes on strategic rural roads set to increase in the future, researchers have looked at the potential for three-lane configurations to increase the capacity of rural two-lane roads.

New Zealand's rural strategic road network carries about 30 percent of the country's total annual road travel (calculated by vehicle kilometres travelled). The network is crucial for linking rural towns and other urban areas, for the tourist industry and access to visitor destinations, and for carrying freight.

At present, the network is mainly made up of two-lane two-way roads, with the majority carrying lower volumes of traffic. However, on the key strategic highways, traffic volumes are already increasing and it is likely that more of the network's roads will carry higher numbers of vehicles in the future. In addition, the number of slower or longer vehicles, such as trucks carrying freight, using the network is likely to increase.

Research by the Traffic Design Group (TDG) and the University of Canterbury looked at a three-lane road configuration – known as a 2+1 roadway – as a means of bridging the gap between two and four-lane roads. A review of the international experience enabled the team to develop a 2+1 roadway concept that is potentially suitable for New Zealand.

THE 2+1 ROADWAY

A 2+1 roadway has alternating passing lanes in either direction, and often involves a continuous three-lane road configuration over an extended stretch of a particular route.

Several countries are already using 2+1 configurations for their moderate to higher-volume rural roads, and the research team drew on this international experience in formulating their recommendations. Although, the configuration has not been well used in New Zealand, the NZ Transport Agency's 2007 national passing lane strategy recognises 2+1 roadways as an intermediate step when increasing sections of particular routes to four lanes.

Bevan Wilmshurst of TDG says, 'Increasing traffic flows and numbers of longer heavy commercial vehicles on the rural strategic road network meant we needed to take a closer look at the facilities used on these roads to allow vehicles to pass each other, and how they were performing.

'In general, it's a spectrum, from the isolated passing lanes used on lower volume roads, through to access control, four lanes and grade separation at the upper end of the spectrum. There is a growing tendency, particularly at moderate and higher volumes, to no longer treat passing lanes as isolated facilities, but rather as a route or corridor treatment, where a number of passing lanes are placed in sequence to improve flows and reduce delays on certain sections of the route. Such intermediate treatments are important in New Zealand where, for topographical and design reasons, widening a road into four lanes is an expensive option.'

In addition to being cost effective, typical experience overseas has been that 2+1 roadways improve the levels of service being delivered by two-lane roads and significantly improve road safety. They also provide:

- additional capacity for sections of a route between intersections
- more reliable journey times
- increased opportunities for overtaking
- more 'civilised' driver behaviour on stretches of two-lane single carriageways, due to reduced driver frustration and better road safety
- an effective interim measure until upgrading a route to four lanes can be justified (socially, economically or environmentally)
- on roads with moderate traffic volumes, a permanent or long-term intervention.

THE RESEARCH AND PROPOSED DESIGN

The main focus of the current research project was on the operation of passing lanes at higher volumes, the establishment of methods for evaluating the economic benefits of passing lanes, and as an outcome, the relative merits of various passing lane and 2+1 roadway configurations.

The research looked at the cost implications, operational and design performance, and safety benefits of the various configurations, and examined driver merging behaviours (including when using a range of intelligent transport system merging techniques), in order to develop an economic evaluation methodology and a New Zealand 2+1 roadway design.

The research report discusses the characteristics of the proposed design. The recommended characteristics all come within the range of those adopted by other countries, although are generally at the more conservative end (eg shoulder, lane and central median widths are generous).

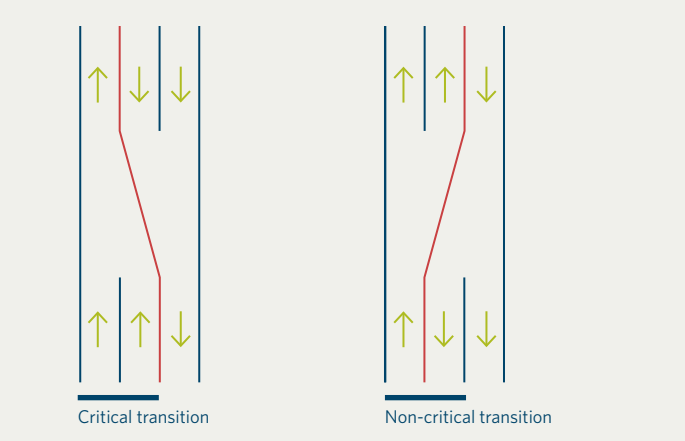
The research team stresses, however, that other current Transport Agency funded research is addressing related matters, which when complete will also be used to inform decisions about the design of future 2+1 roadway layouts.

The proposed design is based on upgrading an existing two-way two-lane highway with a 10m carriageway, to a 2+1 roadway with a carriageway of up to 16.5m. The design includes shoulder widths of 1.0m to 1.5m and a central 2m median to house a wire rope barrier between the opposing lanes.

The proposed cross-section is still conservative compared with cross-sections overseas, where 2+1 roads are achieved on carriageways as narrow as 11m.

The incorporation of the wire rope or cable barrier between opposing traffic lanes is a significant feature of the proposed design, reflecting a substantial body of research that demonstrates the safety benefits of using barriers to reduce fatal and serious injury crashes.

Barry Dowsett, Principal Advisor Highways Network Operations at the NZ Transport Agency, says, 'Although 2+1 layouts without wire rope barriers have also produced good crash reductions, options with barriers generally have far better safety performance. For this reason, we considered wire rope barriers to be a valuable component of 2+1 roadways, especially at higher traffic volumes, and through areas of the route where there are critical transitions.'



A critical transition is the section of the roadway where vehicles are merging between passing lanes. The transitions are 'critical' because merging vehicles in the central lane are travelling toward each other. A 'non-critical transition' is the diverge section of the roadway, where vehicles in the central lane at the ends of the transition are travelling away from each other. For safety reasons, the length allowed for a critical transition is significantly longer than that provided within a non-critical transition.

The research also developed a draft procedure for establishing the optimal (from an economic evaluation point of view) passing lane length and spacing combinations for 2+1 roadways in a range of traffic (5,000 to 25,000 vehicles per day) and terrain situations. The report includes a series of charts that transport practitioners can use to calculate an indicative benefit-cost ratio for a given scheme, based on the preferred combination of passing lane lengths and spacing.

The research team used a specific traffic model to assess the benefits of using intelligent transport systems to manage merge conflicts when vehicles reach the end of passing lanes, particularly during peak operating periods.

Although the exercise confirmed that the use of intelligent transport systems could be effective in managing the operation of passing lanes via certain mechanisms (eg managing speeds and headways), the specification of these systems, the potential range of driver responses and regulatory aspects all require further investigation to establish whether these systems are economically justified.

Operating characteristics and economic evaluation of 2+1 lanes with or without intelligent transport systems assisted merging, NZ Transport Agency research report 549

Available online at **www.nzta.govt.nz/resources/research/reports/549**

TAILORED FATIGUE LOADINGS FOR NEW ZEALAND BRIDGES

A fatigue loading spectrum and procedures based on New Zealand data, and tailored for New Zealand steel bridges, is now available for the first time

In the past, New Zealand has not had a national specification for fatigue loadings for road bridges, relying instead on standards for fatigue design criteria from overseas.

A recent study by Beca Ltd sought to address this by identifying a fatigue loading spectrum appropriate for application in New Zealand and by developing a process for applying this to the design of steel road bridges.

The aim was to enable the NZ Transport Agency's Bridge manual to be updated. In the past, the manual has relied on British and Australian standards. The current edition of the Bridge manual was updated in 2013 to incorporate interim guidelines based on the Australian standards, following the introduction (into New Zealand) of high-productivity motor vehicles in 2010.

Mike Beamish of Beca says, 'Through our research, we've been able to recommend fatigue loadings for New Zealand bridges that have steel or composite steel construction for inclusion in a future edition of the Transport Agency's Bridge manual. The loadings are based on New Zealand conditions and heavy vehicle characteristics, and draw on the Australian and Eurocode bridge design standards.

'They also include allowances for predicted long-term growth in both freight volumes and vehicle masses. Average vehicle masses are expected to increase significantly over the coming years and it's important for bridge design standards to respond to this.'

The research report will be of interest to bridge engineers, with the information on current and future heavy vehicle fatigue loading models also potentially of interest to road pavement engineers. The report assumes some prior knowledge of fatigue assessment and design standards.

ABOUT FATIGUE

Fatigue is 'damage, by gradual cracking of a structural part, caused by repeated applications of a stress which is insufficient to induce failure by a single application'.

In metal components, such as those used in steel and composite steel bridges, fatigue cracking tends to start with an existing flaw in the metal, which slowly grows as it is subjected to normal cycles of loading. Bridge superstructures are repeatedly subjected to such cycles from the passage of trucks and other heavy vehicles. On busy New Zealand roads, the research team estimated that bridges may be subjected to more than 100 million cycles of loading from heavy vehicles over their design life, demonstrating how important it is for bridge design to take fatigue resistance into account.

Fatigue design criteria for bridges typically consist of three separate elements:

- a vehicle loading spectrum, together with the repetition counts over the design fatigue life
- analysis procedures to determine the corresponding design stress ranges and cycle counts for the selected vehicle loading spectrum
- material-specific fatigue life calculation methods for the assessment of components.

The focus of this research was the vehicle loading spectrum, with an assumption made that the spectrum was for use in designing steel and composite steel-concrete bridges. (Fatigue life assessment methods for concrete bridges were outside the project's scope, but are available in some international codes. It is envisaged that further work will develop the appropriate, material-dependent, higher-mass vehicle adjustments.)

With respect to the second and third elements, analysis procedures for determining the corresponding design stress were adapted from existing design standards; while fatigue life calculation methods for structural steel components were considered to be adequately covered by existing material design standards.

CURRENT AND FUTURE FATIGUE LOADINGS

The baseline bridge fatigue loading used in the study was derived from heavy vehicle data recorded at weigh-in-motion stations on New Zealand state highways between 2007 and 2011.

This base fatigue loading was then adjusted for increases in legal vehicle masses permitted under a 2010 Land Transport Rule amendment (which introduced high-productivity motor vehicles onto New Zealand roads). The research team used published estimates of future take-up rates for the higher-mass vehicles to calculate the average increase in fatigue damage per vehicle.

The team used a single-vehicle fatigue load model, as this was easier to use than other vehicle spectrum models. The recommended fatigue design vehicle was a 54-tonne 8-axle truck and trailer, which represents the dominant freight vehicle currently used on New Zealand roads, scaled up to reflect the higher mass limits that apply to high-productivity motor vehicles. This vehicle was found to provide a more consistent fit to fatigue effects over a wide range of bridge span lengths than the fatigue design vehicle used in the Australian standards.

In the report, the research team recommends amending the third edition of the Bridge manual to provide guidance on fatigue loadings for New Zealand road bridges of steel or steel composite construction. The guidance is based on the relevant Australian standard, but with modifications to include the preferred truck-and-trailer fatigue vehicle identified in the report, and to reflect the New Zealand data collected in the study.

Fatigue design criteria for road bridges in New Zealand, NZ Transport Agency research report 547

Available online at **www.nzta.govt.nz/resources/research/reports/547**

NEW RESEARCH REPORTS

Travel time predictability

NZ Transport Agency research report 554

Researcher: Jacobs NZ Ltd

Available online at www.nzta.govt.nz/resources/research/reports/554

Reliable journey time is a key parameter in travellers' route choice and has important applications in transport planning and modelling. For transport users, it affects their choice of mode, journey route and also their activity patterns. For transport planners and policy makers, journey time estimates are used to provide key indicators for performance monitoring, congestion management, travel demand modelling and forecasting, traffic simulation, air quality analysis, evaluation of travel demand and traffic operation strategies.

This research aimed to clarify how historical baseline data combined with near real-time data including environmental conditions, incidents and traffic flow could contribute to the calculation of reliable and timely delivered travel time predictions.

A comprehensive literature review was undertaken to establish existing methods for predicting travel time. Based on the findings of the literature review, and using sample data from Auckland's strategic road network, a model was developed to determine if these methods could be applied to strategic roads throughout New Zealand.

Optimising drainage maintenance for pavement performance

NZ Transport Agency research report 555

Researcher: Opus Research, Opus International Consultants Ltd

Available online at www.nzta.govt.nz/resources/research/reports/555

This project was designed to investigate the importance of drainage maintenance for pavement performance and to recommend a maintenance strategy. With restrained funding for pavement renewals, drainage maintenance is a cost-effective method to ensure optimum pavement performance.

A combination of repeated load triaxial testing and modelling of water movement has shown that once water has infiltrated the basecourse it can take weeks for the water content to return to its equilibrium condition. During this time significant damage can take place and there is a high probability that further rainfall will occur and thus re-saturate the pavement.

A drainage risk rating score card was developed and it is recommended that this be adopted by road controlling authorities.

OBTAINING TRANSPORT AGENCY RESEARCH REPORTS

All research reports published since 2005 are available free of cost for downloading from the Transport Agency's website www.nzta.govt.nz/planning/programming/research.

PDF scans of research reports published prior to 2005 are available by emailing research@nzta.govt.nz.

A NOTE FOR READERS

NZTA research newsletter

NZTA research is published quarterly by the NZ Transport Agency. Its purpose is to report on research invested in through the Transport Agency'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 Transport Agency's Research Programme, see www.nzta.govt.nz/planning/programming/research.html.

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

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

All general correspondence, queries related to conference notices, and requests for additions or amendments to the mailing list, should be made to research@nzta.govt.nz

The current edition of the newsletter, NZTA research, is available in hard copy and on the Transport Agency website at www.nzta.govt.nz/resources/nzta-research/. Back editions are available online only.

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 Transport Agency or of any agency of the New Zealand Government.

Email alerts of newly published research reports

Email notifications are provided when new issues of *NZTA research* are published. Notification is also provided when new Transport Agency research reports are published on the Transport Agency's website at www.nzta.govt.nz/planning/programming/research.html. Please email research@nzta.govt.nz if you would like to receive these email alerts.

Do we have your correct details?

We would like to hear from you at research@nzta.govt.nz if you wish to update your name, email or address details, to alter the number of hard copies of *NZTA research* you'd like to receive or to go on to the email list for alerts of the publication of newsletters and research reports.

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DID YOU KNOW...

That there is a spreadsheet on the Transport Agency website listing all published Transport Agency research reports?

The spreadsheet is searchable by several criteria and can be found at **www.nzta.govt.nz/planning/programming/research.html.**

The spreadsheet has two worksheets; the first worksheet lists research reports with associated key words and the second lists research reports with the report abstracts.

NZ TRANSPORT AGENCY WAKA KOTAHI

New Zealand Government