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Agglomeration and transport in New Zealand

To evaluate the potential economic benefits of large transport projects, it is important to assess the wider economic benefits that arise from agglomeration. A new study presents, for the first time, a set of agglomeration elasticities for New Zealand, allowing us to estimate more accurately what economic effect greater densities might have, and what this means for transport planning.

Links between density of activity and economic performance have been well established and explored by studies internationally. Although the exact sources or causes of these agglomeration effects have proved harder to pin down, it is generally accepted that when firms locate close to each other a number of tangible benefits emerge. Benefits can include more opportunities for labour market pooling, opportunities to share knowledge and technologies, and ease of process specialisation within an industry.

Given that transport investments can increase the scale and efficiency of interactions between firms and industries, by lowering travel times and improving their connectivity, then agglomeration economies (or the productive advantages that flow from firms locating close together) can be listed as one of the positive external effects to flow from such investments.

Ernest Albuquerque of the NZ Transport Agency (NZTA), who was project manager of the recent

NZTA-funded study of agglomeration elasticities in New Zealand explains, 'Agglomeration economies are driven by the access that firms have to other firms in similar or dissimilar industries, to labour markets and to markets more generally. We call this having access to the economic mass. Transport is obviously an important factor in this accessibility, with a crucial influence on the level of agglomeration that firms can enjoy.

'If there are constraints on the transport system or if it functions inefficiently, this has negative consequences for agglomeration economies. Likewise, when we invest in transport, we can change the economic mass that firms have access to, in order to positively influence the agglomeration economies they enjoy.

'This is the essence of the case for including agglomeration benefits in transport proposals and appraisals. It's recognition that this is one of the external economic benefits that may flow from transport projects.'

The study, which uses data at the firm level over time, provides the first set of agglomeration elasticities for New Zealand at the industry sector level and on a regional basis. In deriving the agglomeration elasticity estimates, a range of conceptual and empirical issues were addressed.

The main focus of the study's report is to estimate agglomeration elasticities for New Zealand for use in the economic evaluation of transport investments.

The NZTA already includes guidelines on how to quantify agglomeration impacts as a benefit of transport investment in its *Economic evaluation manual*. However, the estimates of the relationship between density and productivity in the manual are based on estimates from the UK, adjusted to reflect the lower densities found in New Zealand.

'What the current study provides is the first set of empirical estimates of agglomeration elasticities based on New Zealand data,' says Ernest.

'Overall, as a very high-level summary, we can estimate that firms in an area with 10% higher effective density will have productivity that is 0.69% higher, once we control for industry-specific production functions and the sorting of more productive firms across industries and locations.

'This figure varies from industry to industry, with industry-specific estimates ranging from 0.032 (for agriculture, forestry and fishing) to 0.087 (for finance and insurance). Other high-elasticity industries are wholesale trade (0.086), retail trade (0.086), and health and community services (0.083). There is evidence of decreasing returns to agglomeration within all industries.

'Agglomeration elasticities also vary across the regions, from a low of 0.048 in Canterbury to a high of 0.177 in Northland. High-density regions, such as Canterbury, Wellington and Auckland, all had lower agglomeration elasticities than less dense regions, which is consistent with the finding that there are decreasing returns to agglomeration.

'We also examined the interaction of agglomeration with capital, labour and other inputs, and found that in general the productivity of these inputs was increased through agglomeration.

'We believe that the current study represents a significant advance in what we know about the relationship between agglomeration and productivity in New Zealand, but it also throws up several areas that need further exploration. Examples of areas that could be looked at further include the effects that increased industry localisation (as opposed to just increased density) might have on productivity, how we measure density and the dynamics of agglomeration effects. Building our understanding of these factors would in turn improve our understanding of the complex relationship between agglomeration and productivity, so that we can quantify it better when it comes to transport investment for the future.'

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Agglomeration elasticities in New Zealand, NZTA research report 376

Freely available online at *www.nzta.govt.nz/resource/research/reports/376.index.html*

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‘What impact will this have?’
Taking a closer look at transport investment

Pinning down the economic development benefits of transport investments can be a tricky business. New research canvassing the evidence and approaches will give decision makers more guidance in this difficult area.

The 2002 New Zealand Transport Strategy was explicit about the need to better understand the relationship between economic development and transport. More recently, the 2008 New Zealand Transport Strategy states that ‘transport is generally recognised as being one of the principal factors in supporting economic growth and productivity. The relationship between transport and the economy, however, is complex. Work will be undertaken to improve the understanding of this relationship.’

A recent NZ Transport Agency research project makes a significant contribution towards this improved understanding, taking an in-depth look at economic development and transport investment, how any benefits flowing from investments are assessed, and the role that investment plays, nationally and regionally, in fostering economic development.

Richard Hancy of Booz and Company (NZ) Ltd says, ‘There’s been a lot written, both locally and internationally, about the link between transport and economic development and how best to assess it. What we set out to do was appraise the available evidence and from that develop recommendations and guidelines that would help New Zealand transport authorities to assess the economic development benefits of their potential transport investment projects.’

To this end, the research took a three-pronged approach:

- To review the major approaches to assessing the national economic benefits of transport investment, in particular, the social cost benefit analysis (SCBA) approach.
- To review the role of transport investment in national and regional economic development, focusing on whether it has a special role to play.
- To review approaches for assessing regional economic and other distributional effects of transport investment.

Assessing national economic benefits

The project’s first task was to identify the most appropriate approach, or approaches, for assessing the national economic benefits of transport investment.

Richard says, ‘Traditionally SCBA has been used to assess the economic benefits of transport projects, but in recent years doubts have been raised about the adequacy, or inadequacy, of this approach. For us then, the key questions were, in what circumstances does SCBA fail to capture all the national economic costs and benefits arising from a transport investment, and what are the alternative approaches to assessment and how do they compare to SCBA. We also looked at how transport investment’s impact on national economic growth should be measured, and how this compares to the assessment provided by SCBA and the other approaches we looked at.

‘What we found after looking at SCBA’s shortfalls and the other assessment options available is that there is no strong case for abandoning SCBA. One of the main criticisms of SCBA is that it misses, or fails to pick up, the indirect or flow-on benefits for the broader economy from transport investment. However, what we found was that as long as a transport SCBA allows for induced and diverted demand effects, the extent to which it misses these economic benefits will be small or modest.

‘On large projects, where there are other factors that need to be taken into account, which do not lend themselves to being included in the SCBA, these could be considered on a less formal case-by-case basis, perhaps as a below-the-line qualitative analysis.

‘But this does not amount to justification for replacing SCBA with other more complex assessment approaches, especially as none of the approaches we looked at provided a reliable substitute. What we recommended was that SCBA be retained as the primary decision-making tool, but in certain circumstances it could be combined with other approaches, for example input–output analysis or general equilibrium modelling, which provide national macroeconomic information. Taking this type of combined approach could provide policy makers with a broader view of the overall impacts of a project.’

What is SCBA?

Social cost benefit analysis (SCBA) can be defined as a policy assessment method that quantifies, in monetary terms, the value of all policy consequences to all members of society. Social benefits are subtracted from social costs to derive net social benefits, measuring the value of the policy. A distinguishing feature of SCBA is its focus on the need to maximise economic efficiency by maximising societal welfare. SCBA also provides clear decision rules, which indicate the extent to which society is better off (in economic efficiency terms) from undertaking a project. It also measures the marginal effects of a given project to society. SCBA is not intended as a broad strategic tool.

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Exploring transport's role

The next area to receive scrutiny was whether there were any particular features of transport investment that made it especially effective for promoting or increasing national and regional economic growth.

'In general, development of transport infrastructure is a necessary but not sufficient condition for national and regional economic development and growth,' says Richard. 'And in developed economies, it seems likely that any incremental benefits flowing from transport investment will be small. However, where strong contextual (and material) evidence exists, consideration of the relevance of additional factors such as specific regional development issues could be considered on a less formal, case-by-case basis. This could involve consultation with key affected industries and stakeholders.

'In the past, SCBA's purported inadequacy as a tool for picking up on the incremental or flow-on benefits of transport investment has supported beliefs that the investment was in fact delivering higher returns. Knowing what we now do about SCBA's ability to pick up on these "missing" benefits demonstrates the importance of having robust analytical processes to ensure these benefits are captured.'

Looking at regional and other effects

Other areas explored by the research included:

- examining the effect that upgrading transport links within disadvantaged regions might have on the region's economic development
- considering how best to assess the distributional impacts of transport investment on particular regions or areas
- taking a closer look at assessing the non-geographic distributional impacts of transport investment on different social, demographic and market segments
- considering whether assessments of distributional impacts would be useful as additional information for transport investment decision makers.

Richard says, 'There are issues with using SCBA in a regional context, and we looked at some of the other assessment methods that could be used in this context and to measure the impact of transport investments on particular socioeconomic groups. Overall, we found that while these methods may provide some useful data to policy makers, they should be seen as complementary to the broader use of SCBA in the first instance.'

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Economic development benefits of transport investment,
NZTA research report 350

Freely available online at
www.nzta.govt.nz/resources/research/reports/350/index.html

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Let's take a trip: the changing face of how New Zealanders travel

A reformulation of a major travel database has revealed some interesting trends in New Zealanders' travel behaviour over the past 10 years.

A research project undertaken during 2008 and 2009 has reformulated the 2004–2007 ongoing New Zealand household travel survey database into trip chains and tours. The reformulation brings the database into line with an earlier reformulation of the 1997/98 New Zealand household travel survey dataset, enabling researchers to draw comparisons and comment on trends in New Zealanders' travel patterns over time.

However, as research leader Carolyn O'Fallon of Pinnacle Research and Policy explains, what's important about the project is not so much the trends we've seen so far, but the potential future uses of the data that the reformulation has enabled.

Carolyn says, 'Now that the reformulation is complete, the programming we have developed can be readily applied to future datasets and modified to highlight different activities or demographics. What this means is that there are many more potential applications for the datasets than were possible in the past.

'We've explored a couple of these in the report, but other researchers may be interested in focusing on other areas or trends in travel, and with the reformulation that data is now accessible. We believe the most important output from the project has probably been the programming, and what this enables us to do with the datasets, rather than the initial report on trends.'

What's the survey about?

The ongoing New Zealand household travel survey has been carried out as a continuous survey since 2003. People in over 2200 households in 280 different areas throughout New Zealand are invited to participate in the survey each year. Every person normally resident in the household is then visited and interviewed about all of their travel over two consecutive days specified by the interviewer. A complete dataset, representing all the survey results for all of New Zealand, is compiled every four years, with the latest being 2004–2007.

The 1997/98 New Zealand household travel survey was a discrete one-year

survey, following a similar format. It was reformulated in 2003/04 into two datasets: one made of trip chains and the other of tours. The reformulation of the ongoing survey database has followed the same lines.

Trip chains describe how New Zealanders link their travel between significant locations, such as home, work, education and other activities where they remain for 90 minutes or more. After 90 minutes, the chain is considered to have ended and, if the person travels on, a new chain starts. A trip from home, stopping to pick up a newspaper and travelling on to work is an example of a trip chain.

A trip segment (or leg) is one part of a trip chain. So, in the example above where the stop made is insignificant, the journey from home to the newspaper shop is one segment, and from the shop to work another, and together the two trip segments make one trip chain.

A tour describes how New Zealanders link their trip segments in a round trip that begins and ends at home. A simple tour could consist of leaving home, travelling to work and returning home again at the end of the day. Tours can consist of multiple segments, either for the same purpose (such as work) or a mix of purposes (such as work, recreation and education).

What's in an average?

Knowing the number of trips, segments and tours that New Zealanders on average take each day can be useful when making sense of the survey's data:

- On average, respondents made 4.3 trip segments per day in 2004–2007 compared with 4.4 segments in 1997/98.
- People often only complete one tour a day, with the average of 1.3 tours per day being the same in 1997/98 and 2004–2007.
- Trips chains are a useful intermediate measurement between segments and tours, and survey respondents took an average of 2.4 trip chains in 2004–2007, similar to the average of 2.3 taken in 1997/98.

Putting the data to use

Reformulating the 2004–2007 dataset enabled comparisons to be drawn with the 1997/98 dataset, and the research project report contains extensive analysis of trends in how New Zealanders' travel behaviour has changed over time. Examples include the following:

- The mean number of trip chains per day (2.3) and the mean number of tours per day (1.3) were essentially unchanged.
- Both trip chains and tours were increasingly likely to have fewer segments.
- Most trip chains and tours were non-work and non-education (eg they were for personal business, shopping or social reasons).
- Walk-only trip chains declined to 11% from 13%.
- Vehicle driver only trip chains increased significantly to 53% of all trip chains from 48%, while vehicle driver only tours also increased significantly to 50% from 47%.

Carolyn says, 'Analysing changes over a period of time is useful for detecting travel patterns that could lead to future problems with quality or infrastructure (for example, where we can see that trends will lead to bottlenecks or pressure in a particular area in the future) and for forecasting future travel demand. It also enables policy and decision makers to better select and target their travel demand management or behaviour change programmes.

'By looking at trends in the data, we are able to answer questions such as – Are New Zealanders' travel patterns becoming more complex? Are walking and cycling trip chains increasing compared with car-based trips and tours? Have the types of people making different types of trips changed at all?

'All this type of information is invaluable for calibrating existing transport models so that we can better predict future travel patterns and how these might be affected by changes in the transport network.'

As an example of how the newly reformulated database might be put to use, the researchers devised a new classification of tours that distinguished shopping as an activity within a tour or even as the basis for an entire tour. Using the 2004–2007 dataset, they found that shopping of one kind or another was the reason for 22% of all tours taken by New Zealanders. Most (61%) of these tours were completed by the person as a vehicle driver.

Carolyn says, 'This is just one example of how the reformulated datasets can be used for specific purposes. Now we can explore travel behaviour and trends for any number of activities or demographic variables purely by modifying the programming.'

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Trends in trip chaining and tours
NZTA research report 373

Freely available online at
www.nzta.govt.nz/resources/research/reports/373/index.htm

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Rural drink-drive enforcement in the Southern Police District

Research report 377

New Zealand Police

Freely available online at
www.nzta.govt.nz/resources/research/reports/377/index.html
Hard copy $15.00

Drink-driving is a serious road safety issue, particularly in the rural environment, with a significant number of road users killed or injured on rural roads annually. In order to address this, in 2008, the New Zealand Police carried out a qualitative case study within a rural community in the Southern Police District. The main purpose of this study was to consider the problem of rural drink-driving, as understood by various local and district-level stakeholders. The study also examined stakeholder perceptions around the effectiveness of police countermeasures in responding to this problem.

This study found that stakeholders had diverse understandings of the drink-drive problem within the case study area. While police enforcement was understood to play an important role in addressing rural drink-driving, for some stakeholders there was no community-wide problem that warranted the investment of significant police resources. In terms of enforcement's effectiveness, stakeholders identified numerous barriers that reduced the ability of enforcement to change drink-driving behaviours, including local police resourcing, enforcement predictability and the need for a more holistic approach to the problem.

Climate change effects on the land transport network – volume one: literature review and gap analysis

Research report 378 volume 1

MWH New Zealand Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/378/index.html
Hard copy volume one $35.00

This two-stage project (undertaken in 2008/09) aims to identify and assess the impacts climate change may have on New Zealand's land transport networks (road, rail, ports and coastal shipping), and provides recommendations, including adaptation options, to address identified information gaps and risks. Stage one includes a review of research in New Zealand and overseas on climate change risks and adaptation responses for land transport. A stakeholder survey was used to determine work being carried out by local, regional and central government agencies, Crown research institutes and universities. Key climate change risks and knowledge gaps for each mode, and prioritised aspects requiring further research, were identified by climate science, planning and transport engineering experts in a risk assessment workshop. The report summarises findings from the literature review and gap analysis in the context of potential trends in climate change in New Zealand over the next 50 and 100 years. Gaps in climate research, policy and legislation, and individual transport modes are described alongside recommendations for areas needing further research. These include three national transport profiling studies (inland flooding, coastal inundation and rail heat stress) that were taken forward in the second stage of the project.

Climate change effects on the land transport network – volume two: approach to risk management

Research report 378 volume 2

MWH New Zealand Ltd

Freely available online at
www.nzta.govt.nz/resource/research/reports/378/index.html
Hard copy volume two $30.00

This project (undertaken in 2008/09) aims to identify and assess the impacts climate change may have on New Zealand's land transport networks (road, rail, ports and coastal shipping), and provides recommendations, including adaptation options, to address information gaps and risks. Stage one comprised a literature review and gap analysis. Stage two deals with regional effects of climate extremes on the networks, and considers how these vary by region, when and where these risks emerge and which parts of the land transport networks are most at risk. The study describes three national climate change profiles, covering rail heat buckle from extreme temperature, flood risk from extreme rainfall and coastal inundation risk for low-lying sections of the networks. Data from the NZ Transport Agency, ONTRACK and port authorities were used to assess the current vulnerability of networks to extreme weather. Extrapolation was used to predict future effects based on modelling of climate extremes for 10-, 50- and 100-year projections using a mid-range (A1B) scenario. Regional impacts were determined from GIS maps by overlaying climate change predictions with transport infrastructure. Priority adaptation responses are discussed for each national profile in the context of design, operation, research and policy issues, and related emerging climate change research.

Organising integrated urban development projects

Research report 379

RJ Dunbar, PJ McDermott and B Mein, CityScope Consultants Ltd

Freely available online at
www.nzta.govt.nz/resource/research/reports/379/index.html
Hard copy $20.00

This report examines how to enhance the integration of transport and land use at the implementation stage of urban development projects. In particular, the focus is on how to increase the likelihood that planned land use developments are implemented and thereby deliver the intended benefits of integrated strategies. The research demonstrated the interdependencies between planning and implementation of urban development strategies. Impediments can be anticipated at the planning stage and addressed through an implementation plan. Such a plan will include specification of governance structures to enhance interagency and cross-sector coordination.

Urban development planning needs to be comprehensive, recognising the interdependence of transport and land use. Constituent plans should include not only traditional transport project analysis, but also commercial feasibility analysis (dealing with funding and returns on investment) and economic analysis (dealing with costs and benefits of resource use). The feasibility analysis should cover the risks associated with assumptions used in justifying an individual project. The economic analysis will identify how much public subsidy, if any, is required to maximise the likelihood of securing the outcomes sought.

The integrated plan for an urban development project should contain specific outcome objectives linked to the objectives of multi-project, higher-order strategies, usually developed at a regional level.

Significant changes are recommended in the way that integrated urban development projects are approached in New Zealand. These changes will affect the way all levels of government approach their responsibilities in this area, although there is some flexibility around how the conditions for effective implementation of integrated urban development will be achieved.

'I want to ride my bike': overcoming barriers to cycling to intermediate schools

Research report 380

Hamish Mackie, TERNZ Ltd

Freely available online at
www.nzta.govt.nz/resource/research/reports/380/index.html
Hard copy $35.00

Transport modes such as walking and cycling, including cycling to school, could play a key role in combating obesity, climate change and traffic congestion as well as restoring 'social capital' within communities. The objective of this research was to identify the specific barriers to school students cycling to school for six intermediate schools and recommend interventions that would be effective, acceptable to parents and schools, and favourable to school students for each of the schools. These specific barriers and solutions were then used to identify common themes, issues and solutions that might be considered at a national level, and give more confidence to those who are responsible for considering and acting on school cycling initiatives. Four stages of data collection were carried out, including the collection of existing school travel information, site visits, interviews, focus groups and questionnaires.

In order to overcome barriers to cycling to school, it is proposed that the development of genuinely safe and attractive school cycle networks, cycle training, effective bike storage and the continued implementation of slow zones around schools (or widespread lower speed limits) be implemented or given higher priority.

Using risk analysis to assess treatments for frost and ice

Research report 382

NJ Jamieson, Opus Central Laboratories

Freely available online at
www.nzta.govt.nz/resource/research/reports/382/index.html
Hard copy $40.00

The comparative effects on skid resistance of the two commonly used treatments for frost and ice on New Zealand roads – mineral grit and the anti-icing/de-icing agent calcium magnesium acetate (CMA) – were examined through an on-road test programme.

This involved locked-wheel braking tests on selected test sites under a variety of conditions using an instrumented car. Tests were conducted for various treatments, including dry (no treatment), wet, application of grit and application of CMA. Road surface types included fine and coarse chipseal, open-graded porous asphalt, asphaltic concrete and slurry seal. Comparisons of skid resistance were made between the different surfaces and different road surface treatments.

Additional laboratory tests were conducted to assess the comparative variation of skid resistance with time following treatment. Typical traffic levels were also obtained for the test sites. These were combined with the changes in skid resistance for the different treatments at different times to provide an assessment of the relative levels of risk for road users. Some implications for managing the use of CMA and mineral grit were also examined.

Measurement of the reflection properties of road surfaces to improve the safety and sustainability of road lighting

Research report 383

MJ Jackett and WJ Frith, Opus International Consultants

Freely available online at
www.nzta.govt.nz/resource/research/reports/383/index.html
Hard copy $30.00

This study reports on a New Zealand-wide evaluation of road surfaces for reflection properties relevant to road lighting design. The sections of road to be surveyed were chosen from the National Road Assessment and Maintenance Management (RAMM) Database on the basis of location, age and surfacing material. The measurement device was the portable reflectometer known as 'Memphis'.

Road lighting for safety in New Zealand is currently based on the Australian and New Zealand standards AS/NZS 1158.1.1:2005 and AS/NZS 1158.2:2005, and use modified Commission Internationale de l'Eclairage (CIE) tables of pavement reflectance based on New Zealand measurements made in 1982.

The study measured 140 sites, from Auckland to Christchurch, over a six-week period from October to December 2008. It found an average Qo of 0.050 and an average S1 of 0.57, which are significantly different to the values being used in design today (Qo = 0.090 and S1 = 0.58 and 1.61). The low Qo value (44% below the current design value) means that New Zealand lighting designs will be darker than expected and often produce high levels of glare.

If adopted in full, the new design figures are likely to increase the capital and operating costs of new traffic route lighting (Category V) by around 50%. This figure may reduce in time as luminaire optics better align with the new road surface design figures.

Tyre/road contact stresses measured and modelled in three coordinate directions

Research report 384

RA Douglas, Golder Associates Ltd

Freely available online at
www.nzta.govt.nz/research/reports/384/index.html
Hard copy $45.00

To enable the improvement of the modelling of pavement response and performance, the measurement of full-scale tyre surface contact stress distributions in all three of the coordinate directions was undertaken. An apparatus comprising strain-gauged pins housed in a strong steel box, mounted flush with the pavement surface, was built. The pins were designed to sense the contact forces imposed on them by the tyres.

A programme of full-scale load testing was carried out (single and dual tyres, wheel loads of 40 and 50kN, and inflation pressures of 280, 550 and 690kPa).

Typical results for the vertical pin loads agreed with patterns seen in the literature. However, this was not the case for the longitudinal and transverse pin loads.

Comparisons were made between pavement response predicted by a finite element model for two loading cases: (1) a uniformly distributed pressure on the tyre contact patch, and (2) the non-uniform contact stresses derived from the experimental results. Differences in pavement response were generally measurable but not great. The difference in pavement performance was significant.

The report includes a comprehensive literature search. All measured experimental results have been posted to a publicly available website at www.golder.com/contact_stress_study.

Roundabout crash prediction models development benefits of transport investment

Research report 386

Beca Infrastructure Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/386/index.html

The management of speed is considered an important safety issue at roundabouts. The approach speed and negotiating speed through roundabouts depends on the geometric design of the roundabout and sight distance. In New Zealand and in Australia, the design standards recommend long approach sight distances and provision of relatively high design speeds. This is in contrast to European roundabouts, where visibility is normally restricted and the geometric design encourages slow approach and negotiation speeds. This work, undertaken in 2006, extends previous research by the authors developing crash prediction models at roundabouts to include sight distance, intersection layout and observed speed variables.

Models have been produced for the major motor vehicles only, pedestrians versus motor vehicles and cyclists versus motor vehicle crash types. Flow-only models have also been produced for roundabouts on roads with high speed limits. The models produced indicate that roundabouts with lower speeds (observed and speed limit), fewer approach lanes and reduced visibilities have lower crash rates.

Optimisation of heavy vehicle performance

Research report 387

TERNZ

Freely available online at
www.nzta.govt.nz/resources/research/reports/387/index.html

Operational requirements, vehicle dimensions and mass limits, other regulations and road user charges all influence on the type of vehicle used for passenger and freight transport in New Zealand. The aim of this research was to improve the performance of

continued on the back page

Surprising finds brings new thinking on flushing

A project aimed at reducing premature seal failure through flushing did not find what it was looking for, but made other relevant discoveries and raised several interesting questions for investigation along the way.

Started in 2007, the NZ Transport Agency (NZTA) funded project originally set out to produce seal selection guidelines for resealing flushed seals. Flushed seals, or flushing, is when bitumen appears at the surface of a road's seal, rather than remaining embedded around the aggregate it is intended to contain.

The NZTA hoped that the guidelines would eliminate or reduce premature seal failure through flushing. Surprising discoveries about how chips degrade within the seal pavement, and the role that fine particles may play in premature failure, required a completely new take on the project before it could proceed.

Ian Wells of Opus International Consultants explains, 'Our original working hypothesis was that there was a maximum compaction level for any particular multi-layer chipseal, with a corresponding void content. If the total binder content is greater than this maximum then flushing will eventually occur.'

Premature flushing is an ongoing problem for New Zealand's sealed roads. A 2005 study found that around half of all state highway chipseal surfaces had significantly reduced lifetimes due to seal flushing, with around one-third failing before they even reached half their intended age. Flushing is also a major cause of seal failure in urban areas.

In the same year, another study found that premature failure through flushing could be associated with inadequate compaction of the surface underlying the seal. In instances where bitumen was applied to highly textured surfaces, insufficient voids were created to accommodate the bitumen as the surface was compacted by traffic, causing flushing to occur.

In the present study, the void content of artificial chipseals was measured in the laboratory. Void contents of around 40% to 50% were found. When compared with typical spray rates this meant that there would typically be twice the volume of voids available to accommodate the volume of bitumen sprayed.

On this basis, there should never be a problem with flushing, leading the researchers to look further afield for an explanation of why flushing was actually occurring.

Samples taken from road surfaces showed that road surfaces typically had binder content of around 15% by volume, air voids of around 5% and a further 15% made up of fine materials. The total volume of the binder, air voids and fines came to around the same amount (40% to 50%) as the total volume of voids found in the laboratory trials.

This accounted for why the laboratory void volumes were so much greater than the typical volumes of bitumen sprayed. It also meant that if the fines came mainly from breakdown of the larger chips, due to traffic and weather, then around one-fifth of the original chip was being degraded in this way – a finding totally at odds with the study's original hypothesis.

Ian says, 'The breakdown of aggregate by traffic and weather is just one possible source of the fines in seals. Other sources might be from the basecourse material that has migrated, windblown particulate and vegetable matter, materials transferred onto the surface by traffic, and grit deliberately put on the road.

'But however the fine particles get to be on the road and in the seal, what it means is that the void content of the surface is changed. Until we understand more about these fines, and how they vary for different combinations of seals and over time, we cannot predict the void content of a completely compacted multilayer chipseal surface, which is what we set out to do.'

A revision of the study proposed that a more complete understanding of the processes producing fines in seals needed to be developed before the research could be taken further.

Ian says, 'It may well be that generation of fines is in fact contributing significantly to premature flushing, especially in seals where the void content between large chips appears, at first sight, to be too high for this to take place.

'The origin of the fine materials needs to be examined and in the study we came up with at least six different processes that may be contributing. Relative contributions from these processes might also vary from site to site.'

The report recommended two questions to be answered in subsequent research.

- Are the fines amounts and gradings predictable, given the initial aggregate gradings, chip sources and traffic?
- Does the fines content significantly affect the tendency of seal to flush early, and if so, to what degree?

'With this understanding to hand,' says Ian, 'we'll be able to revisit our aim of developing a way to predict compaction and liability to flushing through loss of voids in seals.'

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Resealing strategies to increase seal life and prevent seal layer instability,
NZTA research report 372

Freely available online at
www.nzta.govt.nz/resource/research/reports/372/index.html

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continued from page 8

New Zealand's heavy vehicle fleet in protecting the road and bridge infrastructure, improving safety, reducing environmental impact and reducing congestion. To achieve this aim, typical vehicles used in six transport tasks in New Zealand were benchmarked against vehicles undertaking those same tasks in Australia, Canada, Southeast Asia, and the United Kingdom. The six transport tasks analysed were passenger coach transport, bulk liquids and materials transport, 40 foot ISO intermodal container transport, and livestock and refrigerated goods transport. A more optimal New Zealand truck and full trailer is presented, and ways to optimise other vehicle configurations are discussed.

Reconstruction of coal tar contaminated roads by in-situ recycling using foamed bitumen stabilisation

Research report 388

NIWA

Freely available online at
www.nzta.govt.nz/resources/research/reports/388/index.html

Coal tar-derived roading material contains over 1000 times more polycyclic aromatic hydrocarbons (PAHs) than equivalent bitumen pavements and has been identified as a major source of PAHs in both Christchurch and Auckland aquatic receiving environments. Many old streets containing coal tar will soon require reconstruction, and therefore the excavation and potential disposal of contaminated road construction layers represents a significant financial and environmental problem. To address this problem, we evaluated in-situ foamed bitumen (FB)/cement stabilisation as an environmentally acceptable method to reuse the contaminated tar road material.

Based on contaminant leaching and toxicity, the reuse of tar-contaminated roads as compacted stabilised base material represents minimal risk to the environment. FB decreased PAH leachate concentrations by ca 4–6, although algal toxicity was correlated to leachate copper, which was increased by the co-use of alkaline hydraulic binders. Despite this, the low potential for harm from the leachates combined with a reuse application (ie road base) that limits environmental exposure/risk via being: i) capped with a waterproof seal layer; and ii) located beneath carriageway and thus not being reused in an environmentally significant 'compartment'. A limitation of the method is that many of the older tar-contaminated streets may not be suitable for in-situ FB recycling without additional makeup aggregate being applied.

Cycle safety: reducing the crash risk

Research report 389

Beca Infrastructure Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/389/index.html

Cycling is a sustainable mode of travel and an alternative to motor vehicle trips, particularly for shorter trips. However, the risk of crashing while cycling is typically higher than while travelling in a motor vehicle. To create a safer environment for cyclists, traffic engineers and transport planners can select a number of safety countermeasures. These include: changes to the road layout, such as reducing traffic volumes and speeds; installing cycling lanes and paths; and conducting enforcement and education programmes focused on drivers and cyclists.

The crash benefits to cyclists of reducing traffic volumes and speeds, and constructing cycle lanes and intersection treatments have been investigated during 2006 and quantified based on overseas research and data collected within Christchurch, Palmerston North and Nelson. It was found that cycle lane facilities provided a reduction in cycle crashes of around 10 percent. No suitable New Zealand data is available on the safety of cycle paths and speed reduction measures, so the discussion focuses on international research findings.

NZTA research

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