Land Transport NZ
Ikiiki Whenua Aotearoa
research

ISSN 1176-9157 May 2006 Issue 5

Developments in urban toll roads

Interest has been growing, both internationally and more recently in New Zealand, in the policy of charging tolls to contribute to the funding of major new roading projects in larger urban areas.

To date, the experience with urban road toll routes in New Zealand has been very limited, the main examples so far being the Auckland and Tauranga Harbour Bridges. Potential tolled roads now being considered here include three in the Auckland area — ALPURT B2, PenLink and the Western Ring Route — and Wellington's Transmission Gully route.

Australia is one of the world leaders in this field and is well ahead of New Zealand in the development of urban toll roads. Toll roads are already operational in Sydney (several schemes, including the Sydney Harbour Bridge/Tunnel), Melbourne (the City Link project) and Brisbane. Some of these schemes have proved very controversial, eg Sydney's cross-city tunnel scheme.

Why tolling?

In New Zealand the tolling of new routes is seen as one solution to the desire to increase urban road network capacity, particularly in the Auckland area, in a climate of limited government funding. The issue has been given greater prominence with the recent introduction of the *Land Transport Management Act 2003*, which facilitates the implementation of toll roads subject to certain conditions. These include that the schemes must essentially relate to new infrastructure, not the tolling of existing roads.

continued on page 2

$4.13 million research programme approved. See details on page 8.

Contents

Your views

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

The Editor,
Land Transport Research,
Land Transport NZ,
P O Box 2840,
Wellington,
New Zealand.
www.landtransport.govt.nz

land transport research

Land Transport NZ contact:
Neil Bennett
Editor:
Eric Turner

Land Transport Research is published quarterly by Land Transport New Zealand. Its purpose is to report the results of research funded through the Land Transport New Zealand research programme, and to act as a forum for passing on national and international information to aid collaboration between all those involved – to stimulate inquiry, discussion and solutions concerning road, traffic, safety and land transport problems in New Zealand.

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. *Land Transport Research* reserves the right to edit, abridge or decline any article.

Advertisements of forthcoming conferences and workshops which are within this publication's field of interest may be published free of charge, where space permits.

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

Inquiries on specific articles should be made to the author. Otherwise, all general correspondence, and those queries related to conference notices and mailing list requests, should be made to:

Land Transport New Zealand,
P O Box 2840, Wellington.
www.landtransport.govt.nz
Phone: 04 916 4220
Fax: 04 916 0028

Tolling urban roads

(from page 1)

In response to the Act, Transit New Zealand has been working intensively over the last few years to formulate policies and approaches in relation to toll roads, and also to undertake market research, traffic modelling and economic/financial appraisal of potential toll projects. Transit NZ has stated:

'Funding repaid from user tolls is the only genuine alternative that increases funding levels over time. It is therefore the only alternative that allows more projects to be built.'

Some implications of tolling

A number of significant implications arise from the differential charging policies inherent in having individual tolled routes in an urban network of otherwise 'free' routes. These include:

- **traffic diversion** — some motorists who would use the new route if 'free' might be deterred from using it by the charges, and continue to use the existing network, resulting in the extent of congestion relief provided by the new route being less than if it were 'free'
- **environmental** — any traffic diversion towards existing roads will typically, but not necessarily, result in adverse environmental impacts relative to a 'free' new route
- **economic** — such traffic diversion, if it occurs, would typically, but not necessarily, have adverse effects on road user benefits and hence the underlying economic merits of the project, although the scheme funding costs to the public sector would generally be reduced
- **financial** — the existence of more-or-less parallel free routes limits the maximum feasible toll charges, the associated toll revenue and hence the 'fundability' of the new road project.

Until now, very limited studies have been undertaken in New Zealand and internationally on the

Editorial

This issue of *Land Transport Research* is somewhat smaller than usual as we will be publishing a larger June issue, containing full details of next year's research programme, to coincide with the launch of the 2006/07 National Land Transport Programme.

With the very large infrastructure programme facing us for the next few years, the report in this issue on the application of tolling policies is timely and instructive, and has identified areas of deficiency in current modelling/forecasting and economic evaluation procedures for toll schemes.

We also report on recent tests to study the effect of different binders on the rate of chipseal texture or loss under traffic, and there are details of a number of newly published research reports.

Wayne Donnelly
Chief Executive
Land Transport New Zealand

significance of these issues for urban road tolling policies have been very limited (in New Zealand and internationally), as have their their implications for decisions on whether a proposed new route should be tolled, how the toll charges should be set, the design of the scheme, and so on.

In particular, relatively little attention has been paid to the implications of tolling on scheme economics and on overall socio-economic welfare.

Exploring the case for tolls in New Zealand

A Land Transport New Zealand research project completed in mid-2005 was designed to fill this knowledge gap by combining theoretical considerations with empirical evidence, thus providing better information to assist policy formulation on urban road tolling in New Zealand.

The overall objective of the project was *'to examine the implications of road tolling policies applying to selected major roading projects in larger urban areas, and in particular the traffic, environmental, economic and financial implications.'*

The first task was to review current New Zealand and international practice on traffic modelling and economic evaluation for urban toll road schemes, and hence to formulate a best practice framework with guidelines for assessing tolling policies.

The researchers then made a selection of appropriate toll road case studies in New Zealand and overseas (principally Australia), and examined the modelling and evaluation studies undertaken for these schemes. Findings were summarised for each scheme on the traffic/environmental and economic implications of tolling.

Based on the outcomes from the first two stages, conclusions were developed on:

- best practice in urban toll road traffic modelling and economic appraisal
- issues to be considered in the development of potential new toll schemes, including whether or not to toll, price setting, design aspects, etc
- the development work undertaken to date for proposed New Zealand tolling schemes, in particular relating to the traffic and economic implications of tolling.

Because New Zealand legislation only allows for tolling of new road schemes, and because economic evaluations had been undertaken for a selection of such schemes, the main emphasis was on new road proposals already under consideration as tolled schemes.

However, most of the issues examined and conclusions drawn would be generally applicable to the tolling of existing roads.

Economic merits of tolling selected urban roads

The project's review of international literature on urban road pricing policies indicated that the economic case for pursuing selected urban road tolling policies (involving individual tolled routes in a network of 'free' roads) is generally weak.

- Any selected road pricing tolling will raise only a small proportion of the revenue and generate a small proportion of the welfare benefits that would result from 'first best' pricing — that is, when all roads are priced on an economic optimal (marginal social cost) basis. By contrast, some other urban road pricing policies — eg parking surcharges, CBD toll rings — can generate a much larger proportion of the welfare benefits achieved through 'first best' pricing.
- The impacts of selected road tolling policies are dependent on the level and structure of the prices charged. Welfare-maximising ('second best') policies perform substantially better in economic welfare terms than revenue-maximising (or profit-maximising) policies, which are typically pursued under private ownership.
- However, welfare-maximising toll levels are typically less than half the level of revenue-maximising tolls, and raise only half as much revenue.
- The structure of prices under welfare-maximising policies and those under revenue-maximising policies are also in conflict — revenue-maximising prices involve higher tolls when the 'free' road is most congested and when demand elasticity is lower; welfare-maximising policies involve the converse.

Tolling of selected (new) roads in an urban network results in the diversion of some potential traffic to the alternative (old) routes. Typically in urban situations, this causes both road user and environmental disbenefits — the tolled road is likely to be under-utilised and the remaining network over-utilised (relative to the economic optimum). This effect is often substantial — for some schemes the extent of traffic diversion can be as much as half (or more) of the users of the road if it were 'free', and the economic benefits of the scheme can reduce by a similar proportion.

Criteria for tolling

While the economic case for selected road tolling policies may generally appear rather weak, the project report clearly identifies that some urban road schemes are much more 'suitable' for tolling than others. The prime measure of economic 'suitability' proposed is the (net) revenue raised through

continued on page 4

Tolling urban roads

(from page 3)

tolling relative to the resulting loss in economic welfare (NPV).

The researchers recommend that a set of economic-based performance indicators should be developed and applied to assess the suitability of proposed road schemes for tolling, ie trading-off the revenue impacts of tolling against the economic and related impacts (traffic, environmental). The measure suggested above — revenue raised relative to NPV loss — would be one of the primary indicators in this set.

Recommendations on the full set of such indicators are provided in the report (see purchasing details for reports on page 8 of this issue).

Modelling and evaluation of toll schemes

The review of case studies and modelling/evaluation practices for tolling schemes in New Zealand and Australia highlighted that:

- in many cases, there has been little or no consideration of the relative merits (from traffic and economic aspects) of tolled and non-tolled options, and even less consideration of alternative toll levels or structures — this is particularly the case for the Australian schemes
- in the relatively few cases where both tolled and un-tolled options have been assessed on a comparable basis, deficiencies in both the modelling and evaluation aspects cast considerable doubt on the veracity of the outputs provided
- minimal post-implementation market research has been carried out — this could potentially be used to develop improved forecasts and economic appraisals
- the practice guide developed by Transit NZ covering traffic/toll modelling aspects is generally sound, but would benefit from greater detail on a number of significant issues relating to tolling schemes.

Modelling deficiencies

The review of the various tolling case studies in the report helped to identify the main areas of deficiency in current modelling/forecasting and economic evaluation procedures and practices for toll schemes in particular, as distinct from the standard procedures for road schemes in general.

These main areas of deficiency (not all applying in all cases) are summarised in the report. There are recommendations on future practices that would overcome the identified deficiencies and achieve best practices in the traffic modelling and economic valuation of tolling schemes.

Contact for more information:

Ian Wallis
Booz Allen Hamilton
Phone 04 915 7777
Email wallis_ian@bah.com

Land Transport New Zealand Research Report 270, *Implications of selected urban road tolling policies for New Zealand*, $25.00. See details on page 8 for purchasing copies of reports.

The Land Transport Management Act 2003 allows tolls to be used as a way of advancing some projects that might otherwise be delayed because of funding and other constraints. Tolling can be used to fund new roads as outlined in subpart 2 of the Land Transport Management Act, which includes the availability of alternative non-tolled routes. Roads may be entirely funded by tolls, or toll revenue may just be one element of a project's funding alongside money provided by Land Transport New Zealand.

Toll charges will vary for individual projects, depending on the level of toll required to encourage people to use the toll road while meeting the costs of building and operating the road and repaying debt finance. The toll for ALPURT B2 will be $1.80 (in 2004 dollars, to be CPI indexed to opening day) charged in each direction.

Under the current criteria used to determine the allocation of public funding for roads, ALPURT B2 has in the past received a lower priority than other urban Auckland motorway projects, meaning its construction would not have been completed for many years. The Land Transport Management Act 2003 enables Transit to bring forward the completion of ALPURT B2 by funding its construction through debt finance repaid by tolling. Tolling will allow the project to be completed earlier than is possible under existing criteria for full public funding of roads.

On 11 April 2005 an Order in Council by the Governor-General was awarded to allow tolling of ALPURT B2, enabling the project to move from preliminary works to full construction. This was made after wide consultation with the local community on the proposal to bring forward the construction of ALPURT B2 by tolling.

An alternative non-tolled route will be available for motorists who do not wish to pay a toll, however this free route will be unlikely to offer the time and distance advantages offered by ALPURT B2. The alternative route will be clearly signposted to enable motorists to make a choice before entering the toll road.

ALPURT B2 will use an electronic toll collection system with the ability to be interoperable with future toll road projects. Transit expects to have the toll road open by mid-2009.

NZ bitumen binders — are they too soft?

Standard chipseals in New Zealand are constructed using 80/100, 130/150 and 80/200 penetration grade bitumens. Polymers are sometimes added where high traffic stresses are anticipated.

Some practitioners have suggested that sealing with harder bitumens may reduce sealing chip loss (caused by binder-softening in hot weather) and consequent binder pickup. This would clearly be an advantage in built-up areas, where it is essential to avoid the tracking of binder and chip indoors.

Using harder bitumens may also reduce binder pickup and tracking on open roads in hot weather, thus making the surface safer to drive on in subsequent wet weather.

Harder bitumens may also reduce the rate of texture loss caused by traffic, thus extending the seal lifetime. This possibility was raised as a result of wheelpath testing of seal samples at controlled laboratory temperatures (Ball & Patrick 1998), where the rate of compaction increased with increased temperature (and consequently with reduced binder viscosity), up to a limiting temperature where it stabilised.

In addition, a field trial study of very heavily trafficked forestry roads (Arnold & Pidwerbesky 1996) showed that premature flushing can be delayed by use of harder binders. The size of the effect on the road under different climates and traffic conditions and its dependence on binder physical properties remain to be determined.

On the other hand, the rate of set-up of the bond between a hard binder and sealing chip will be slower than for standard binders. Consequently, such seals may be more subject to early chip loss.

Binder effects

In order to try and resolve these issues, a Land Transport New Zealand research project was set up to study the effect of different binders on the rate of chipseal texture or loss under traffic. Specific objectives were:

- to compare the requirements of several hard binder types for satisfactory bonding to aggregate in chipseals; and
- to ascertain the effect of hard binder properties on the rate of chipseal texture reduction and hence on the potential chipseal lifetime.

A laboratory test was developed to assess the setting up of the bond between binder and sealing chip for roads in New Zealand. A reciprocating tyred wheel was passed over loose chip on binder on a plate and the amount of chip that had bonded was assessed at intervals.

The test was sensitive to the different performance of standard bitumen grades, but had to be carried out at 20°C and below, as bonding to 180/200 bitumen is too fast to observe at higher temperatures. The rate of bonding was strongly related to the binder viscosity at the test temperature.

Field trials

Five road trials were set up — near Pukepapa on State Highway 3 (SH3), north of Bulls, Otakiri on SH34 near Tauranga, at Kaiwhatiwhati on SH38 near Rotorua, and in the South Island at The Wilderness on SH94 near Te Anau and Kingston Crossing on SH94, both in Southland.

The trials were set up with a range of binder grades and types to compare the effects of binder properties on the rates of sealing chip compaction and chipseal texture reduction.

The rheological (flow) properties of several of the binders used in the trials were characterised. Adding SBS (styrene-butadiene-styrene) polymer to a bitumen produced a product which was less temperature sensitive than the original 130/150 bitumen, and so was softer than 130/150 bitumen at low temperatures.

The site near Pukepapa suffered drastic chip loss on three of its four test sections when the first autumn frost occurred, approximately three months after sealing. The fourth test section, unlike the others, had been sealed with a mix of SBS polymer and kerosene with the bitumen, which probably prevented binder fracture as chip moved under traffic at low temperatures, thus preventing stripping. As a result of the stripping the Pukepapa trial was discontinued.

continued on page 6

NZ bitumen binders

(from page 5)

Both kerosene and SBS polymer additives have the potential to minimise the chance of first winter chip loss in seals. Textures were measured periodically on the four surviving sites. Considerable differences in rates of texture loss were noted.

Rates of texture reduction

The principal factor affecting rates of texture loss with trafficking was the site itself. Variations in the hardness of the underlying surface and/or surface geometry (which affect the impact of traffic) are suggested as possibly being important in determining amounts of texture loss. Binder properties had no measurable effect.

Since the penetration grade of the binder had no measurable effect on the rate of texture reduction in seals, use of harder binders than is current practice is not recommended. The softer the original bitumen, the less it will harden under oxidation, and long-term pavement performance is likely to be better.

In spite of these findings, the project report does not recommend that there be a general movement towards use of softer bitumens for sealing work, as this could increase the occurrence of high temperature induced bleeding.

In some parts of New Zealand, the occurrence of bleeding was reduced by changing from soft 180/200 to harder 130/150 bitumens for sealing.

In situations where frost will occur, some kind of additive may be needed to prevent early stripping. Both kerosene and elastomeric products such as SBS polymer can do this job.

Yet, in situations where the climate ranges between very low winter and very high summer temperatures, or for sealing late in the season, SBS (with some kerosene to ensure initial adhesion to chip) may be recommended rather than high kerosene content, in order to stop bleeding in the first spring after sealing.

Contact for more information:

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

Land Transport New Zealand Research Report 284, *Effect of binder hardness on texture change in chipseals,* $20.00. See details on page 8 for purchasing copies of reports.

Letters to the editor

Dear Sir,

Carolyn O'Fallon's amplification of the New Zealand Household Travel Survey (Land Transport Research Issue 4, March 2006) is to be commended for correcting transport myths which have managed to inveigle themselves into important policy assumptions. However I would suggest that her work actually suggests that the problem with these interpretations of the surveys results comes back to the units of measure used throughout the travel survey.

In real life people do not measure the distance between two places in metres but in time. Obviously the time taken to traverse a certain distance depends on the mode selected, the nature of the terrain and conditions and the level of congestion they expect to encounter.

In the stampede to seek alternatives to the car researchers have forgotten some basic facts of human nature. People who make short trips by car are obviously seeking to optimise their time expenditure on the trip — not their energy use or even cost.

It is very simple to state that targeting vehicle tours of less than 10km is a reasonable proposition when the value of time is discounted to zero. Unfortunately most people are not in this happy financial position. A 10 km trip in a car at 30 km/h will take 20 minutes. At 5km/h it will take two hours. That is a 500% increase in time cost.

This is even before other factors such as topology and climate are taken into account.

In short, there are reasons why people make the kinds of mode choices they do and the travel survey should capture these as realistically as possible.

Peter King
Research Editor,
New Zealand Automobile Association

Carolyn O'Fallon comments as follows:

Mr King's letter may suggest to some that the NZ Travel Survey only collects distance measures and not time. In fact, it does collect data about how long each trip takes. Indeed, for walking trips it is data on the time, not the distance, that is collected.

The focus on distance in our report was merely a means to clearly make our key points (which he commends). I don't believe our report, or indeed any other report we have seen, suggests that the value of time for short trips is zero. Indeed, there has been substantial research effort in New Zealand and elsewhere to estimate the dollar value of travel time savings (some of which we have been actively involved with) because such time savings are recognised as a key component of major transport investment decisions.

New research publications

Harmonising automated rut depth measurements - stage 2

Research Report 277

Raj Mallela, Data Collection Ltd

Price $25

A computer simulation study carried out between July 2002 and June 2004 investigated harmonising rut depth measurements from different profilometers.

Software was written which allowed for a standard reference transverse profile to be analysed by different sensor numbers and spacings. This was used to investigate the effect of the number of sensors on predicted rut depth. Accuracy of rut depth was proportional to the number of sensors.

This sampling effect results in underestimation of 2-4 mm for the profilometers used in New Zealand. Some configurations appear to have inadequate coverage towards the kerb, so may miss important data if the first sensor measures outside the pavement area. Variation in rut depth which arises from lateral placement can be greater than the change caused by pavement deterioration, which may explain problems found when trying to use profilometer rut depth data for monitoring pavement deterioration trends. Rearrangement of sensors in profilometers could significantly increase accuracy. The error in measurements tends to overestimate rut depths.

Measurement error is dependent on the number of sensors used to measure rather than the extent of rut depth. The error caused by progressive sampling of the ultrasonic sensors is systematic and positive, and increases with the speed of the profilometer.

Investigation of implementation issues for congestion charging

Research Report 286

Ian Wallis, Booz Allen Hamilton

Price $25

The success of the recently introduced congestion-charging scheme in London has raised urban congestion charging to the fore of the transport policy debate. Also, recent legislation in New Zealand has formalised the toll road financing option, and Auckland's congestion is increasingly seen as a major issue.

This project, carried out in 2003 and 2004, sought to develop best practice guidelines for developing congestion charging schemes by interviewing those involved in such systems across the world to ascertain which issues were critical to their success or failure. There was a significant degree of consensus as to what these critical success factors are, namely:

- a public perception of the need
- an appropriately resourced promotional campaign
- a single empowered agency
- a strong political position
- a robust business case.

The project then looked at three suggested schemes in New Zealand and asked whether the critical success factors were present by consulting with key stakeholders and agencies. It became clear that objections are fuelled by the lack of sufficient detail for any of the schemes, which in turn prevents a clear political position. There are also questions in relation to agency roles and responsibilities.

Assessment of hazard warning signs used on New Zealand roads

Research Report 288

Peter Baas, TERNZ Ltd.

$30

This study, carried out in 2004 at the Traffic and Road Safety Research Laboratory, University of Waikato, assessed driver reactions to 16 road hazard warning signs of various formats. A range of measures, including attentional and search conspicuity, implicit and explicit recognition, dynamic and static comprehension, and sign priming were collected for hazard warning signs for road works, schools, slippery surfaces and curves. Conclusions are presented about the effectiveness of hazard warning signs, and the method for evaluating new and existing hazard warning signs used on New Zealand roads.

Relationship between design and predicted performance of New Zealand pavements

Research Report 259

John Patrick, Opus International Consultants

$20

Both the design of new pavements in New Zealand and their

continued on page 8

New publications

(from page 7)

rehabilitation treatments are currently performed in accordance with the Austroads Pavement Design Guide and its New Zealand Supplement. New Zealand is also adopting pavement deterioration modelling based on the World Bank HDM models. The research carried out in 2002-03 demonstrates how the modelling of roughness progression can supplement pavement design. It also demonstrates that over the life, sometimes more than 50 years, of many pavements on New Zealand roads, it is not uncommon to find little significant roughness or rutting.

The conclusion is that a combination of deterioration modelling and mechanistic design can be a powerful tool to supplement mechanistic design, and that the rehabilitation of most of the network is associated with failure other than that caused by classic roughness and rutting.

Aquatic toxicity of cutback bitumen

Research Report 285
Phil Herrington, Opus International Consultants
$20

Under the New Zealand regulations established by the *Hazardous Substances and New Organisms (HSNO) Act (1996)*, bitumen to which between 2.5 and 20 percent by weight kerosene is added is classified as a 9.1C substance that is 'eco-toxic to the aquatic environment'. This research aimed to establish whether this classification is warranted for cutback bitumens.

A cutback with 9.8 percent kerosene (13.6 pph) was used to prepare water accommodated fraction (WAF) samples for aquatic eco-oxicity testing. This concentration of kerosene is the highest actually used on roads. The concentration of kerosene components in the water phase was measured spectrophotometrically at 215 nm after extraction with pentane. Equilibration was achieved after 24 hours at 20° C.

The eco-toxicities of two cutback loadings in water were tested with Daphnia magna and freshwater algae. Daphnia 48 hr acute tests indicate that toxicity occurs at levels >100 mg/L. The 72 hour algal tests showed the average growth rate in the l00 mg/L WAF to be 81 percent of the blank. The 1 mg/L loading showed no significant effect on growth rate. The algal results indicate that chronic toxicity occurs at a level >1 but <100 mg/L.

The results show that the current classification for cutback bitumens is too stringent and indicate that cutback bitumen may meet the 'not classified' criteria.

Research publications by Land Transport NZ and Transfund New Zealand can be ordered direct from Land Transport NZ, Southern Regional Office, P O Box 13-364, Christchurch.

Phone: +64 3 964 2866
Fax +64 3 964 2855
Email
research@landtransport.govt.nz

2006/2007 Research programme

The Land Transport New Zealand Board has approved a research programme totalling $4.13 million. This includes $3.22 million for 33 new and 19 committed projects for 2006/07, as listed below, and $0.91 million for projects that will roll over into successive years.

Key topic area	Asset Management	Natural Hazard Risk Management	Safety & Personal Security	Environmental Effects	Travel Behaviour	Traffic Management	Sustainable Land Transport
2006/07 allocation	$ 828,950	--	$332,700	$471,204	$426,000	$205,000	$261,800
2006/07 previously committed	$ 422,500	$ 42,100	$ 13,000	$ 28,000	$144,500	--	$ 49,000
TOTAL	$1,251,450	$ 42,100	$345,700	$499,204	$570,500	$205,000	$310,800
Forward commitment	$ 636,625	--	$ 94,800	$ 75,400	$ 82,500	$ 20,000	--