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TRIALLING SLIPPERY ROAD SURFACE SIGNS

Drivers' understanding and responses to slippery road surface signs have been investigated as a first step towards introducing more consistent and effective signs.

In recent years, the number of areas being identified on New Zealand roads as having inadequate skid resistance has increased. This is largely due to changes in 2010 to the NZ Transport Agency's (the Transport Agency's) specification for measuring road surface friction. (The current version of the specification is *NZTA T10 2013*.) The changes raised the minimum standards for skid resistance on high-risk curves.

Where skid resistance was below the desired limits, it was standard practice to erect slippery road surface signs. However, previous research has suggested the signs currently used in New Zealand to warn drivers of lower than desired road surface friction are not well understood and it was not clear whether these signs resulted in a change in driver behaviour at these sites.

As a result of these factors, the Transport Agency identified there was a need to develop a consistent, understandable and cost-effective way of warning drivers of the potential for lower skid resistance. The method could be used both on high-risk curves and in other areas renowned for periodic slippery conditions.

As a first step in developing such an intervention, Opus Research completed an investigation into drivers' comprehension of and behavioural responses to slippery road surface signs. The findings have been reported in NZ Transport Agency research report 607: 'Drivers' understanding of temporary and permanent slippery road signage'. The investigation involved workshops with both road users and industry experts, and comprehensive on-road trials of the favoured signage options. From this, the report puts forward a number of recommendations for how slippery road surface signs should be designed and used in the future.

A FOCUS ON SLIPPERY ROADS

Skid resistance, or road slipperiness, can affect the grip between vehicle tyres and the road, and consequently the ability of drivers to maintain control of their vehicles.

Skid resistance varies depending on road conditions and is most often an issue when roads are wet. However, the exact conditions that can result in lower than desired road surface friction are often non-permanent and unpredictable in terms of their location, duration and the nature of the hazard they represent to drivers.

In New Zealand, road surface friction for the state highway network and a number of lesser roads is measured using the sideway-force coefficient routine investigation machine (SCRIM) methodology. The machine measures the sideway-

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force coefficient of particular sections of road with reference to pre-determined investigatory and threshold levels of skid resistance. In areas where the SCRIM coefficient falls below the investigatory level for macrotexture and microtexture, the road section is prioritised for further investigation and potential treatment.

At present, those locations where skid resistance is confirmed to be lower than desired are signposted by either an orange sign for temporary situations (such as roadwork activities, where skid resistance is temporarily reduced), or a yellow sign for situations where non-temporary conditions, such as climatic conditions (ice, shade) can reduce surface friction.

New Zealand permanent (code WR3) and temporary (code TR2) slippery road surface signs

TESTING THE SIGNS

The research began with a literature review to identify the features that influenced both how conspicuous and how easy it was to comprehend road signs.

Based on these findings, the research team held workshops with a public focus group, and subsequently with an industry expert focus group, to discuss, compare and develop current and alternative sign designs. The groups identified issues with the current signs, and explored ways the drivers' understanding and responses to the signs could be improved, whether through the sign's design, image or accompanying message.

From this process, two alternative supplementary plates were designed. The supplementary plates would be used together with the main sign plate. This approach was taken, rather than testing completely new sign designs, as both the literature review and the focus groups had indicated this was likely to be more effective than changing the main sign.

The effectiveness of the two supplementary plates was then compared with the current temporary slippery road surface signage in an on-road trial.

The three options trialled were:

- main plate only (currently in use)
- main plate, plus new supplementary plate reading: 'Slow when wet'
- main plate, plus new supplementary plate reading: 'Slippery when wet'.

All signs were constructed using the current design specifications for temporary road signs.

The signs were trialled in three locations, featuring differing curve radii.

Metrocounters were used to measure the vehicle speeds associated with each of the signs, at each of the three different curves, in both wet and dry conditions. The speeds associated with each sign were compared against a baseline option, where no sign at all was erected. The three sign designs and no-sign option were rotated between the three locations over a four-month period.

The results showed that, in dry conditions, the signs made no practical difference to vehicle speed. In wet conditions, however, the presence of a sign resulted in significant reduction in vehicle speeds at all three curves. What was less clear was the effectiveness of each type of sign, as comparisons showed the sign that led to the greatest speed reduction differed at each of the curves.

USING SIGNS IN THE FUTURE

The main outcome of the research was a suite of recommendations about how slippery road surface signs could be used on New Zealand roads in the future. Some of the main recommendations are given below. These and other recommendations are discussed in more depth in the research report.

- The presence of any slippery road surface sign, irrespective of its design, significantly reduced driver speed in wet conditions. It was recommended to continue to signpost all areas where reduced surface friction is likely to impact on driver safety.
- For two of the three curves tested in the on-road study, adding a supplementary plate to the main sign resulted in a significantly greater speed reduction than with the main plate alone. It was therefore recommended that one of the supplementary plates tested in this study should be added to the current sign in areas where there is a temporary reduction in surface friction.
- The supplementary plate 'Slow when wet' was associated with the greatest level of speed reduction at all three sites tested, when compared with no sign at all. Overall, vehicle speeds were approximately 7km/h slower when the 'Slow when wet' sign was in place than when no sign was in place. Given these results, it was recommended the existing main plate could be accompanied by the 'Slow when wet' supplementary plate in both temporary and permanent situations.
- Slippery road signs are also used in situations where surface friction may be reduced by factors other than wet, such as frost, gravel, concrete roads, and ice and grit. Supplementary signs already exist for each of these conditions and should continue to be used. However, it was recommended the same message format as that tested in the study should be adopted for these conditions too. For example, 'Slow when frosty' or 'Slow: ice/grit'.
- There is no need to change the existing signs in all locations immediately, as the study showed the current sign is effective at reducing drivers' speeds. Instead, the recommended changes could be made in conjunction with scheduled maintenance and when new signs are erected. Higher risk locations could be targeted earlier, if this is financially and logistically feasible.

Drivers' understanding of temporary and permanent slippery road signage, NZ Transport Agency research report 607

Available online at **www.nzta.govt.nz/resources/research/reports/607**

FACTORS EFFECTING SEAL LONGEVITY

Research has sought to identify the reasons why some seals and reseals have very long lives. The aim was to pinpoint factors that could economically be applied in future resealing contracts, in order to reduce the whole-of-life costs of chipsealing and pavement maintenance.

The study by Opus Research found seal lifespan was most influenced by the seal design, the quality of the workmanship at time of construction, and the properties of the materials used, such as the bitumen and aggregate, and the underlying pavement.

In particular, long-life seals are more likely to:

- be a single-coat seal
- have a large chip size
- use a 180/200 penetration grade bitumen
- be located on roads with average daily traffic (ADT) of less than 2,000 vehicles
- be based on a good quality, strong, durable, well-drained pavement
- be located in areas where the demand for skid resistance is lower.

Another variable found to have a significant influence on the lifespan of a reseal was the quality of the reseal at the time it was laid: longer life reseals generally showed an aggregate mosaic that was flat and tightly packed, suggesting good workmanship during construction.

Kym Neaylon of Opus Research says, 'Our research found that long seal lives relate to a specific treatment selection (single coat) on a sound well-drained pavement with traffic less than 2,000 ADT. To obtain longer lives in future work, it will be vitally important to repeat this good quality workmanship in seal construction.

'However, to extend long-life seals to roads with traffic volumes greater than 2,000 ADT will require more than repeating the best practices from the past, and possibly a quantum change in practices. This is of particular importance if traffic volumes continue to grow, resulting in more and more roads carrying volumes greater than 2,000 ADT. It is also important if the percentage of heavy commercial vehicles grows, as these are known to be hard on seal lives.'

PROVIDING VALUE FOR MONEY

The Government policy statement on land transport 2015/16 – 2024/25 establishes that transport infrastructure and services must provide value for money.

The current research came about as a result of the identification of a number of second-coat seals and reseals in various parts of New Zealand that were 15 years old or more. There was an obvious opportunity to improve value for money in the procurement of road maintenance services if more seals, reseals and renewals could be engineered to have these extended lives.

The research looked at findings from the international and national literature on seal life, and compared the factors that emerged from this review with the data in the New Zealand road asset management database (RAMM), backed up by site inspections.

The RAMM database was interrogated to extract details of all chipseals 15 years old or more. In total, 930 lengths of chipseal were identified, totalling 780km. The database did not indicate what type of condition these older seals were in, though, which was the function of the site visits.

This process confirmed the factors that contributed to long seal life identified in the literature (namely chip size, low traffic volumes and attention to detail at the time of construction) were valid in the New Zealand context.

A CLOSER LOOK AT THE FACTORS

The research report examines in detail the factors that emerged as the most significant, and makes recommendations for how they should be incorporated in resealing projects in the future. These included the following findings (among others).

- Chip size and treatment selection – chipseals that used larger sized chips tended to last longer. One possible explanation for this may be that the larger sealing chips require a larger bitumen application rate, which in turn leads to a greater bitumen film thickness. As the bitumen ages (through exposure to air and sunlight), a greater proportion of the bitumen remains un-aged, and thus the bitumen can last longer.
- Treatment selection – the research agreed with the findings of other recent New Zealand research that had found single seals were significantly over-represented, and two-coat seals significantly under-represented, among long-life seals, compared with the national average.
- Binder type – although seals with penetration grade 180/200 bitumen were over-represented among older seals, it was not possible to conclude softer binders give longer lives. In practice, long-life seals were found to contain a range of binders.
- Traffic volumes – findings in the literature that seals subject to lower traffic loadings tended to last longer were borne out in the research.
- Timing – most of the long-life seals had been constructed between November and March. The research found it is important to lay chipseals in summer, as the air and pavement temperatures are higher, so the bituminous binder stays warmer, enabling the chip particles to re-orient sooner. Sealing in summer also means less cutter is required, which is desirable as seals that include large amounts of cutter tend to flush and bleed.

Another interesting finding of the report is, contrary to what might be expected, climatic factors had negligible impact on the longevity of seals. The research team had expected areas with low air and pavement temperature, low rainfall and low sunshine hours would be more favourable for seal life, as these conditions would minimise bitumen aging. The data showed otherwise, however, with long-life seals found equally in high or low pavement temperatures, in wider as much as in narrower temperature extremes, in high and low rainfall areas, and in high or low sunshine hours.

FOCUS ON QUALITY

A main finding of the report was: 'A pre-requisite for a long-life seal is a good quality pavement'. This relates to both the quality of the workmanship and quality or appropriateness of the treatment selection and seal design. Data about these factors is not held in the RAMM database, and could not be examined within the scope of the research project.

However, the report acknowledges the Transport Agency's recently implemented Quality Right, No Defects Project will be important for embedding a quality culture within the roading industry The report recommends the momentum gained from the project should be maintained by extending expectations for on-site quality management to sealing operations, as well as pavement construction.

Lessons to be learned from 15-year-old second-coat seals and reseals, NZ Transport Agency research report 612

Available online at **www.nzta.govt.nz/resources/research/reports/612**

GIVING WAY TO BUSES POTENTIALLY A GOOD IDEA

A Transport Agency-funded research project undertaken by Abley Transportation Consultants has examined and quantified the economic and other benefits that would result if buses were given priority when exiting bus stops.

The study provides an evidence base from which to review existing regulations, and to inform future policy decisions about increasing the priority of buses on the New Zealand road network.

THE NEED TO GIVE WAY

Buses in New Zealand are finding it progressively difficult to re-enter traffic when leaving bus stops in urban areas.

The government has a key strategic goal of improving the efficiency and effectiveness of public transport, and there has been a focus in recent years on measures to achieve this, such as electronic ticketing, bus lanes and priority traffic signals. Despite these measures, buses still rely solely on other road users' courtesy in order to merge back into general traffic flow when leaving a bus stop.

Over the course of a route, the delays involved in waiting for a gap can have a significant compounding effect, which impacts on a bus's travel time reliability and ability to stick to schedules, and on the overall efficiency of bus network operations. This in turn affects public transport patronage, as reliability and punctuality have been consistently rated in previous research as the most important factors that influence whether or not people use public transport.

UNDERSTANDING DELAYS

The research sought both to identify the nature and extent of the delays experienced by buses, and to quantify the benefits of introducing measures to avoid or mitigate them.

As a starting point, the project used a literature review and focus groups to explore questions related to the potential benefits and dis-benefits of giving buses priority when leaving bus stops, for example: What were drivers' attitudes to 'give way to buses' rules? What were the safety ramifications of making a rule change? What trade-offs would be involved for buses and bus passengers, and for general traffic?

Focus groups with stakeholders and road users built understanding about current practices for bus egress movements and the likely implications of any change in the legislation.

Comprehensive data, gathered from Auckland and Christchurch, about the delays experienced by buses on a typical day was compiled. The data was then used in a simulation to calculate the passenger and vehicle travel time benefits of removing these delays.

The simulation calculated there was a network-wide total of 29.5 hours per day of delays to buses, across all scheduled services in the Auckland region. The total gives an indication of the potential travel time savings that could be achieved through a change in the give-way legislation to give buses priority, if the change achieved 100% compliance. The results for the Auckland network were expanded to calculate nationwide benefits.

The preliminary stages of the research indicated there was a combination of tangible and intangible benefits arising from bus priority schemes. Some of the tangible benefits, such as travel time, vehicle operating cost and public transport reliability benefits, could be given a monetary value. Other, more intangible benefits included reducing driver stress and frustration, clarifying driver obligations, providing a catalyst towards improved road courtesy, and improving the profile of public transport for all road users.

THE ECONOMIC PERSPECTIVE

The results gained from the simulation were used in the Transport Agency's economic evaluation framework to quantify the tangible benefits of a legislative change.

The evaluation showed the tangible costs of any such change would largely relate to implementation costs and the dis-benefits to other general traffic, as well as any road marking and signage costs.

The literature on give-way-to-bus schemes introduced overseas clearly showed that their success and the degree of compliance achieved was directly related to the extent of the signage and education campaigns implemented alongside them.

The literature also identified that the on-bus signage used for a scheme was likely to be a significant portion of its implementation costs. With this in mind, the research assessed three signage options – LED signs, decals and no signage – both in terms of their costs and of their likelihood of achieving the desired give-way compliance outcomes.

Overall the assessment concluded (p8):

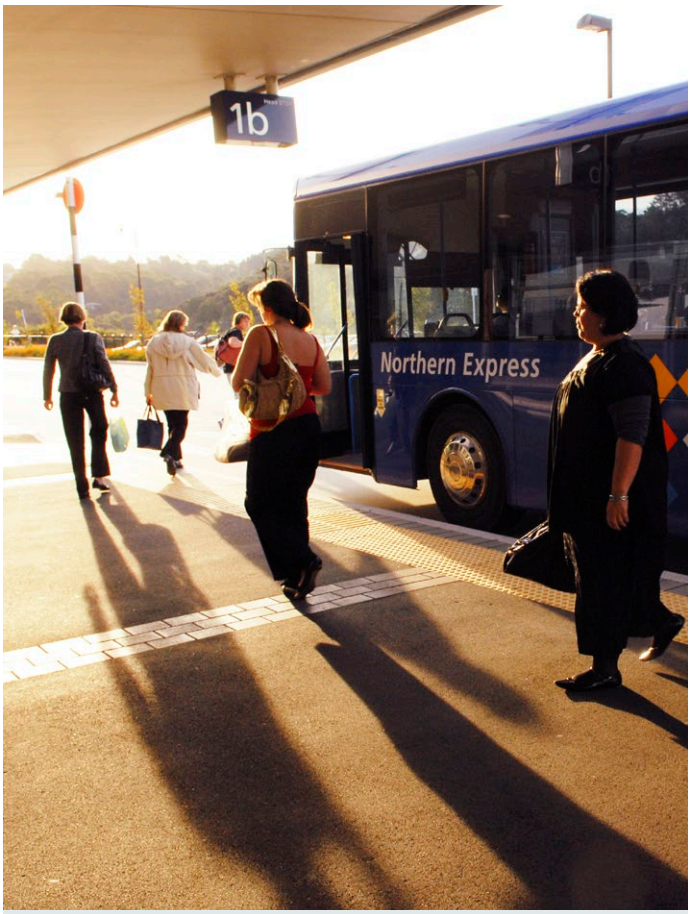
Give way to bus legislation provided a viable investment opportunity with resultant nationwide benefit–cost ratios (BCRs) ranging from 4.0 using LED signage to 4.5 using bus decals. A number of sensitivity test scenarios were assessed to ascertain the likely range of BCRs when a number of input assumptions were changed. This sensitivity analysis provided confidence in the robustness around the BCR calculations, with the BCRs being within a range of 2.9 through 8.7 as outlined in the table below. The significant up-front cost of investing in LED technology results in lower BCRs for the corresponding scenario; however the decal and no signage options yield similar ranges of BCR.

SCENARIO	LED BCR	DECAL BCR	NO SIGNAGE BCR
Default analysis	4.0	4.5	4.3
Maximum BCR	4.8	5.7	8.7
Minimum BCR	3.3	3.7	2.9

Other indications from the research that introducing bus-priority measures might be a good idea, included feedback from stakeholders and focus group participants, who were invariably supportive of a move to review and change the existing legislation. Both motorists and commercial road users considered if a law change did take place, there would be no significant dis-benefits for general traffic.

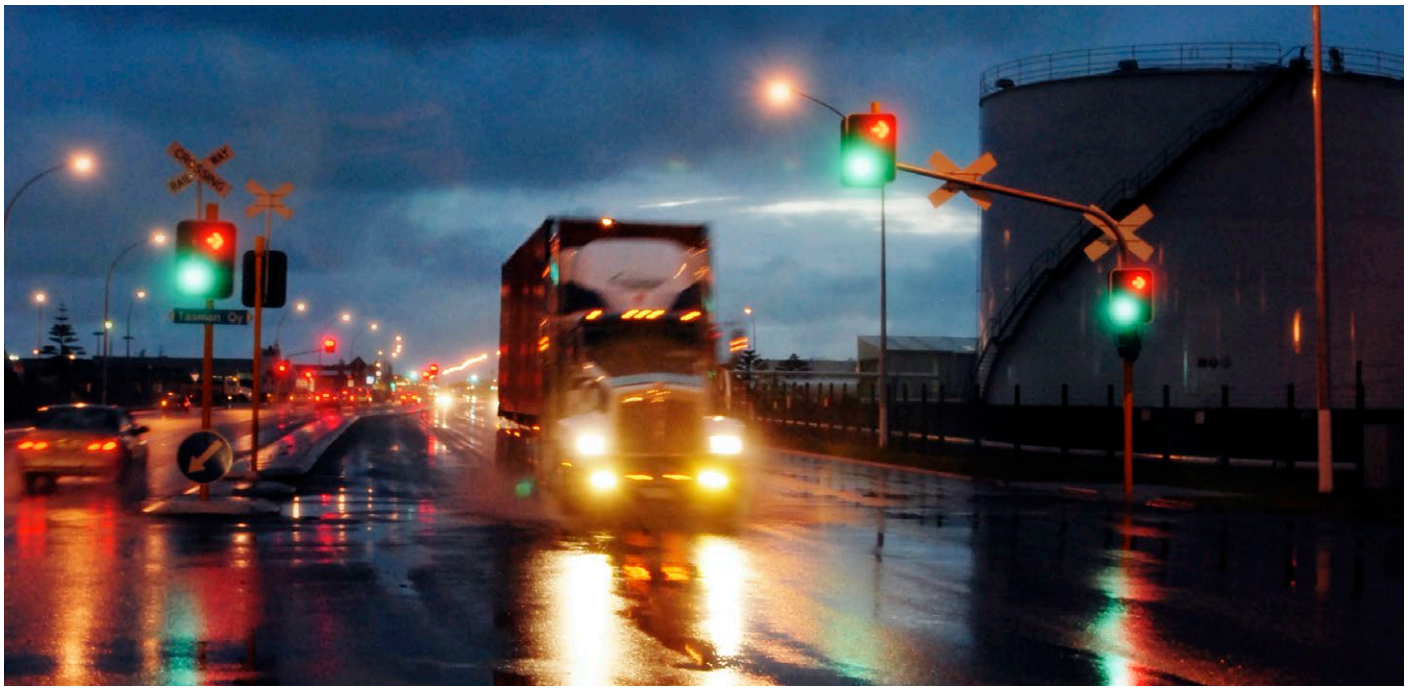
On the safety side, there was no conclusive evidence to suggest making a legislative change would also result in better or worse road safety outcomes. Suggestions in some of the international literature that there may be positive safety impacts required further investigation.

Recommendations for building on the findings from the research included a review of possible give-way-to bus-schemes, and ways of implementing them, to identify those that would best suit the New Zealand road environment. A further review could focus on the most effective signs and road markings for achieving the greatest compliance levels. An assessment of the likely costs associated with amending the existing give-way legislation would also be useful, and would verify the findings as to costs and benefits that emerged from the research project.



Quantifying the economic and other benefits of enabling priority bus egress from bus stops, NZ Transport Agency research report 609

Available online at **www.nzta.govt.nz/resources/research/reports/609**



UNDERSTANDING THE RISKS OF URBAN SIGNALISED INTERSECTIONS

Some urban signalised intersections carry a much higher risk of serious injury or death than others, but the reasons are not well understood.

Recent research undertaken by Abley Transportation Consultants compared signalised intersections that have good safety records, with those that do not, in order to understand the reasons for the differences.

The research arose out of the development of the Transport Agency's *High-risk intersections guide* (2013), which revealed some urban signalised intersection were performing better, in terms of safety, than others, despite using the same types of signal controls.

The reasons why this should be the case were not immediately apparent, and an initial review of the literature confirmed that, despite a large body of literature being available on safety, very little of it addressed the underlying variables that contribute to crash risks at intersections, other than traffic flow.

The research collated a list of 36 operational, physical and environmental factors that could potentially have an impact on an intersection's safety performance.

The research qualitatively analysed a number of urban signalised intersections in terms of how these factors might influence their safety. Unlike more common statistical approaches for modelling crash risk, the research used a qualitative whole-system approach to identify factors that might normally be missed due, for example, to the random nature of crashes and their severity, or the processes used to define variables for mathematical analysis.

The aim was to help practitioners select effective safety treatments for urban signalised intersections. The results of the research will enable practitioners to:

- identify factors or combinations of factors that should be implemented or avoided to enhance safety outcomes
- specify potential safety issues when designing urban signalised intersections
- indicate the likely reduction in fatal and injury crashes when installing remedial treatments at urban signalised intersections.

THE RESEARCH

The research was conducted in three broad stages.

The first stage involved qualitative analysis of a broad range of intersections in Auckland, Christchurch and Dunedin. The analysis looked at the crash history of the sites, including the operational, environmental and physical factors that had been coded for the crashes in the Crash Analysis System. The analysis suggested although some factors contribute to crashes at all intersections (for example, alcohol and drugs, failing to look for or see other vehicles when changing lane position or direction, and loss of control when turning), they are proportionally less common at poorly performing intersections, where other factors become more prevalent. Other factors (such as horizontal alignment, striking an object, and crashes involving pedestrians and cyclists) that were expected to influence safety outcomes, actually had a negligible effect on the intersections' performance.

A significant finding of this stage of the research was that no single factor appeared to contribute overwhelmingly to poor safety performance. However, around half of all crashes, across intersections with all levels of safety performance, could be attributed to 10 top crash factors, with the remaining crashes apportioned between a further 200 factors.

At the second stage of the research, the number of intersections analysed was refined to 40. Site visits were used to analyse these intersections for non-coded factors contributing to their safety performance.

This stage of the research found recurring themes in the causes of crashes, with a number of key factors being present in at least half of the poorly performing intersections. None of the factors identified were present in all the poorly performing intersections, but some were present in at least half of those intersections that had experienced two or more crashes of the same type.

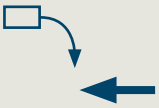
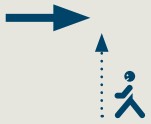
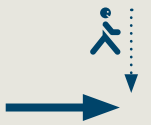
Overall, the causes of poor safety performance appeared to differ, depending on the intersection and its characteristics. Some of the worst performing intersections had combinations of factors that appeared to interact to give a worse outcome than could be explained by the sum of the individual factors. This observation led the research team to recommend that intersections with a poor safety performance should be assessed on a case-by-case basis to identify the underlying factors and most appropriate treatment strategy.

The final stage of the research involved analysing the crash performance of 100 different intersections. The analysis focused on whether any of the factors identified in the previous research stages were more common at intersections with higher rates of certain types of crashes:

- crossing (no turns) crashes
- right-turn against crashes
- crashes involving pedestrians.

Only crashes causing injury or death were included.

The table below shows the factors found to be significant for each crash type, their effect on injury crashes and the degree of confidence for each factor.

CRASH TYPE		FACTOR FOUND TO BE SIGNIFICANT	EFFECT ON NUMBER OF INJURY CRASHES	DEGREE OF CONFIDENCE
HA	 RIGHT ANGLE (70° TO 110°)	Number of signal displays less than 5	Increase	>95%
		No mast arms	Increase	>95%
LB	 MAKING TURN	Either filtering banned or part-time	Decrease	>90%
	 STOPPING WAITING TO TURN	Angle of skew less than or equal to 15°	Decrease	>90%
		Single opposed through lane	Decrease	>95%
NA/NB	 RIGHT SIDE	Either shared left/through or right/through lane	Increase	>90%
		Appreciable gradient on intersection approach	Decrease	>95%
	 LEFT SIDE	Angle of skew on intersection approach less than or equal to 5°	Increase	>95%

ND/NF	 RIGHT TURN RIGHT SIDE	Right-turn filtering not allowed full time	Decrease	>95%
		Right-turn filtering not allowed at all	Decrease	>95%
		No shared right/through lane	Decrease	>90%
	 RIGHT TURN LEFT SIDE	No right-turn red arrow	Increase	>95%
		No left-turn red arrow	Increase	>95%
		Angle of skew on intersection approach less than or equal to 5°	Increase	>95%

From this stage of the research, 10 factors were found to be statistically significant at greater than 95% confidence and four factors were found to be statistically significant at greater than 90% confidence. Some findings were counter to expectations and the research report recommends further research into these factors. With respect to the other factors, the report concludes that this stage of the research demonstrated the value of introducing remedial intersection treatments, at poorly performing intersections, to modify these factors.

Overall, the research found intersection form and traffic volumes are the main predictors of crash performance. Other factors and combinations of factors can help to further explain good or poor crash performance; however, these are very minor in relation to the primary explanatory variables.

The research also showed that, at times, the safety performance of an intersection cannot be accurately predicted or explained based simply on its form, design features or operating characteristics.

There may also be no individual set of treatments to reduce crashes at every intersection approach. For this reason, tailored studies and safety audits remain a useful technique at intersections exhibiting poor safety performance, to help identify site-specific problems and appropriate remedial measures.

Concluding recommendations include incorporating the research results into guides for practitioners who design signalised intersections in urban areas. The research report contains a summary table presenting the key conclusions from the research alongside findings from previous research, which will be useful for this purpose.

Why are some urban traffic signals much less safe than others?, NZ Transport Agency research report 588

Available online at **www.nzta.govt.nz/resources/research/reports/588**

REVISITING REGULATION TO ENSURE ITS ONGOING EFFECTIVENESS

New Zealand has a bias towards government regulation, including within the land transport sector. It is less strong, however, on ensuring that regulations, once set, continue to be effective and necessary.

A Transport Agency research project undertaken by Covec has developed a framework for assessing how effective regulatory interventions in the road transport sector are, and hence whether they are still required.

The five-step evaluation looked at the problem behind the regulation in question and why it was considered necessary in the first place; how effective the regulation has been at addressing that problem; what other options are available and whether regulation remains the best one; how the costs and benefits of regulation and other potential approaches stacked up; and, if the regulation was retained, how it could be improved.

Not all regulatory interventions aiming to mitigate land transport risks were included in the study. Instead, the analysis was limited to risks associated with:

- road construction impacts on the environment
- road use, including safety and environmental impact risks.

Other major risks, for which regulatory measures exist, but that were excluded from the study, included financial risks and anti-competitive behaviour risks.

THE REGULATORY ENVIRONMENT IN NEW ZEALAND

The regulation of New Zealand's land transport system has developed over time and includes measures to address the safety of drivers and other road users, and measures to reduce the system's environmental impacts, among other things. Regulation is itself a broad concept, encompassing a range of government actions and initiatives that are designed to influence people's behaviour. Legislation, rules, education and other means of establishing social norms are all forms of regulation.

In 2013, the New Zealand Government agreed to a set of expectations for regulatory stewardship; that is, 'how departments should be designing and implementing regulatory regimes and their stewardship responsibilities in administering those regimes, such as undertaking monitoring and review'. These include expectations that government departments and agencies will:

- regularly check if regulations remain fit for purpose
- clearly articulate the objectives of regulations
- clearly articulate the factors that impose the greatest risk to regulatory performance
- have processes to improve their regulatory regimes
- only propose regulatory change where this is supported by a robust case built on impact analysis.

Despite this clear statement of expectations, New Zealand has yet to establish a systematic approach for how regulations are reviewed. This contrasts with the situation in a number of other countries that have established systems and approaches in place. Such systems might include:

- sunset clauses requiring deliberate re-regulation after a specified time, with the default option being that a regulation will discontinue if not specifically readopted
- scheduled reviews after a specified period
- unscheduled reviews, for example in response to monitoring or public comment.

While New Zealand requires some of these approaches to occur for some of its primary regulations, they are by no means unanimous across all regulations or sectors.

With regards to transport, previous research has suggested there is a tendency for transport regulations to be introduced and not revisited. The New Zealand Productivity Commission has found this 'set and forget' mentality is common for New Zealand regulatory regimes, yet there appears to be a national bias in favour of more regulation (rather than less) and a greater public demand for regulation, particularly to reduce risks.

SETTING A METHOD FOR EVALUATING REGULATIONS

The research report states, based on the review of the existing regulatory review regime, 'a more periodic and systematic approach to ex-post (after-the-event) analysis to ensure that land transport regulation is fit for purpose' is required.

The report examines the different components that might go into such an analysis and, with reference to international approaches, recommends those components that would provide the best basis for 'a systematic ex-post analysis of transport regulation in New Zealand'. These components are summarised in the table below.

The report concludes that adopting the components and evaluation approach outlined in the table would enable the Transport Agency and government to 'have greater confidence that existing regulations were fit for purpose or if there was scope for regulatory change or regulatory improvement to increase the net benefits of regulation'.

The research report also contains a detailed discussion on the rationale for regulating the land transport sector in the first place. This includes regulation in response market failures that are creating risks within the sector. These failures might be due to imperfect information (people using roads with information gaps relating to the safety risks they face and the performance expectations of their vehicle etc) or externalities (the risks or impacts created by a person who causes a safety or environmental issue within the sector, are not just borne by that person, but also by others who might, for example, be involved in a crash or affected by emissions).

COMPONENT	QUESTION(S)	ANALYTICAL TASKS
1 Problem definition	Q1 (a) What is the problem, the underlying justification for the regulation? (b) Has it changed? This includes new scientific developments, changed social trends, etc?	A.1 (a) Market failure analysis. Is there a market failure and of what form? (b) Analysis of trends in the physical problem and the underlying causal factors.
2 Effectiveness of current regulation	Q2 (a) How effective is the regulation in addressing the problem(s)? (b) Were expected benefits achieved? (c) Have there been unintended consequences?	A.2 (a) Analysis of outcomes compared with some counterfactual with no regulation (or some alternative) to isolate the effects of regulation. (b) Comparison of expected and actual outcomes.
3 Regulatory options	Q3 (a) Is regulation still the best way to achieve objectives? (b) Are there regulatory and non-regulatory options?	A.3 (a) Analysis of regulatory response suggested by market failure identification. (b) Regulatory review – literature review and international comparative review.
4 Regulatory analysis	Q4 (a) Do the benefits still exceed the costs? (b) Do alternatives exist with lower costs for the same objective? Can greater cost-effectiveness be achieved?	A.4 (a) Cost–benefit analysis (or review of existing cost–benefit analysis) of current regulation and alternatives (initial high-level analysis).
5 Regulatory improvement	Q5 (a) Can the regulation be modified to better partner with other regulatory areas or levels of government? (b) Does it have time-consuming requirements, eg paperwork, that can be reduced? (c) Flexibility: is it highly prescriptive?	A.5 Transaction cost analysis.

A review of methods for analysis of regulatory effectiveness, NZ Transport Agency research report 604

Available online at **www.nzta.govt.nz/resources/research/reports/604**

RECENTLY PUBLISHED RESEARCH REPORT ABSTRACTS

Evaluation of the effectiveness of NZTA procurement policy

NZ Transport Agency research report 591

Freely available online at www.nzta.govt.nz/resources/research/reports/591

This report presents the results of an independent evaluation undertaken by Allen and Clarke between January and July 2015 on the effectiveness of the NZ Transport Agency (the Transport Agency) procurement policy framework and its implementation by four road controlling authorities (RCAs) in physical works and professional services procurement.

A review of international and national literature identified key success factors for good practice in outsourced procurement and informed the development of an evaluation framework.

The Transport Agency's policy governance and implementation by RCAs in Auckland, Ruapehu, Dunedin and Central Otago were assessed against the framework using stakeholder interviews and site document data.

Key evaluation recommendations were to: strengthen policy alignment with Ministry of Business Innovation and Employment regulations; revise and reformat the NZ Transport Agency's Procurement manual to enhance usability and impact; increase support for RCA strategy development; drive system innovation and value for money; enhance monitoring of national supplier markets in local roading and measurement and reporting processes; and further research to profile RCA procurement nationally.

The report will inform ongoing review by the Transport Agency of its policy framework and will support future improvement of the policy procedures and guidelines for the sector.

Towards a safe system for cycling

NZ Transport Agency research report 606

Freely available online at www.nzta.govt.nz/resources/research/reports/606

Making urban cycling a safer and more attractive transport choice is now a NZ Transport Agency strategic priority.

Currently, road trauma for cycling is lower than other modes; however, unless a safer system for cyclists is developed, including more effective cycling education, an increase in road trauma is likely with increased investment and promotion.

The research first identified key cycle safety interventions through the development and application of a cycling safety system model. The development of this model, a first for New Zealand, was informed by contemporary models of crash causation, which examined distal and proximal crash causation factors. Key findings were the need for a strong mandate and strategic direction for cycling, and improved systems to provide for cyclists in road design.

Second, the report provides guidance on how best to prepare New Zealanders for utility cycling, drawing on key literature and engagement with stakeholders and end users. The need for consistent and comprehensive approaches, involving a variety of initiatives and touch points over the course of people's lives, were indicated.

Together, these two distinctly different, yet complementary, pieces of work provide actionable recommendations that can improve safety for cyclists and facilitate increased cycling uptake.

The economic impacts of connectivity

NZ Transport Agency research report 608

Freely available online at www.nzta.govt.nz/resources/research/reports/608

Two econometric models were built to test the effects of reduced travel time between regions within New Zealand. A gross value added (GVA) model showed productivity was positively related to population density and to accessibility to international airports across New Zealand. A spatial computable general equilibrium model built for a subset of these regions near the major city of Auckland enabled estimation of the spatial and employment effects of both the direct time savings achieved in a road improvement and the subsequent productivity improvement derived from the GVA model. The findings included that road improvements favoured residence and work in the major centres, albeit this advantage was reduced by the productivity improvements, that marginal gross domestic product (GDP) and utility gains as a result of the road improvement would be higher with population growth and that utility effects exceeded GDP and employment effects. These results confirm for a scenario of changing land use there can exist benefits from a transport improvement that exceed those measured by the standard transport cost–benefit analysis, even with the current NZ Transport Agency add-ons for wider economic benefits. However, these situations are likely to apply only to large projects.

The assessment of the effects of small scale development proposals on the transport network

NZ Transport Agency research report 610

Freely available online at www.nzta.govt.nz/resources/research/reports/610

The national integrated transport assessment guidelines used by practitioners in New Zealand only provide guidance for the assessment of significant sized developments, setting out the approach to be taken with varying assessment levels relative to size. It is becoming increasingly evident there are cases when small-scale developments, which do not trigger the lower thresholds for assessment, are having an effect either individually or cumulatively on the transportation network. In these instances, it may be necessary for the impacts of these small-scale developments to be assessed in an appropriate manner.

This research investigated if and how the potential effects of small-scale developments should be identified and in doing so has provided an opportunity to fully understand if the absence of national guidelines is limiting the opportunity for effective network management and land use planning. Both Auckland and Christchurch have gone through a process of identifying appropriate thresholds that will trigger the need for an integrated transport assessment through a high trip generator rule. This has resulted in extensive discussions amongst practitioners regarding the appropriate extent of assessment based on the size, scale and location of development. This research assists the debate by resolving a number of core issues.

Pavement moisture measurement to indicate risk to pavement life

NZ Transport Agency research report 611

Freely available online at www.nzta.govt.nz/resources/research/reports/611

High moisture within pavements accelerates pavement deterioration. Ensuring water is kept out of these pavement layers increases life and saves maintenance costs. A high-speed moisture survey technique employed overseas, utilising ground penetrating radar combined with video and laser LIDAR, was used on a range of roads in the lower North Island.

A unique moisture damage index was developed for use in New Zealand to enable the identification of high moisture levels at three different depths (top; middle; bottom) in 2m increments along the road using results from the ground and air coupled radar. In the free viewer software the road cross section can also be displayed to determine the rut depth, ditch depths, cross fall and high lip, which aid in determining the most appropriate improvement in drainage.

The New Zealand trial of the moisture detection equipment showed higher rutting in road sections with high moisture, while low moisture was detected in areas of nil or low rutting. Ten test pits measuring moisture at top, middle and bottom depths showed the moisture detection survey conducted seven months earlier was correct in the assessment of high and low moisture for 80% of the time.

Lessons to be learned from 15-year-old second-coat seals and reseals

NZ Transport Agency research report 612

Freely available online at www.nzta.govt.nz/resources/research/reports/612

The purpose of this research was to isolate and identify the reasons why some reseals have very long lives, and to identify which of these factors could economically be applied to reseals in future contracts, thus leading to a reduction in whole-of-life costs of chipsealing and pavement maintenance.

The life of a seal can be influenced by the seal design, quality of workmanship at time of construction, and material properties such as bitumen, aggregate and the pavement.

This study of the New Zealand road asset maintenance management database found a long-life seal is most likely to:

- be a single-coat seal
- have a large chip size
- use a 180/200 penetration grade bitumen
- be located on roads with average daily traffic (ADT) of less than 2,000 vehicles
- be based on a good quality, strong, durable, well-drained pavement
- be located in areas where the demand for skid resistance is lower.

The aggregate mosaic is also usually flat and tightly packed, suggesting good quality of workmanship at the time of laying.

It was interesting to find long-life seals can be applied in any temperature extreme, in any rainfall category and in any degree of sunshine hours.

Seismic design and performance of high cut slopes

NZ Transport Agency research report 613

Freely available online at www.nzta.govt.nz/resources/research/reports/613

A review of the performance of slopes in historical earthquakes, a review of relevant literature describing recent research, consideration of New Zealand's distinctive topography and seismicity, and limited numerical analyses were carried out in this research. Steep slopes have failed in past earthquakes, with the initiation of failures in the upper part of slopes indicating the contribution of topographical amplification of earthquake motions. Landslides have been concentrated in hanging wall areas relative to fault rupture, particularly in thrust fault rupture earthquakes.

Past research and numerical analyses show topographical amplification at the crest of a ridge and terrace slopes is likely, with the magnitude of the amplification being dependent on the frequency of the earthquake motions relative to the shape of the topography. The presence of weathered rock (or soil) overlying unweathered rock was shown to rise to larger amplifications of ground shaking. Amplification was also found to be likely at the top of cut slopes, even when the cut slopes do not extend to the ridge/terrace crest.

Guidelines have been developed for the seismic design of high cut slopes along transportation routes. A resilience-based design approach is proposed, to achieve an economical design, consistent with the resilience expectations for the transportation route.

Establishing the value of resilience

NZ Transport Agency research report 614

Freely available online at www.nzta.govt.nz/resources/research/reports/614

Resilience is universally understood to be a 'good' concept. Improving the ability to prevent, or respond to, disruption is objectively desirable. However, the means by which we look to achieve resilience is more subjective and debatable.

- What do we want to be resilient to?
- How do we prioritise investment to improve resilience to disruption?
- How should stakeholders be consulted when making decisions about resilience?

In addition to the subjectivity of resilience is a plurality of terms, definitions and understanding of the various concepts relating to resilience. A lack of consistency in this regard makes it more difficult for decision makers to do what is right for communities of interest.

With this in mind, the NZ Transport Agency commissioned research to 'establish a consistent approach to transport resilience; terminology, levels of service, valuation and responses'. The scope of the research also included the development of an updatable Decision Support Tool to weigh up different controls consistently and to create an acceptable level of resilience in (transport) infrastructure – in a way that achieves desired community outcomes.

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 GREAT OPPORTUNITY...

The fourth Transport Knowledge Conference is being held in Auckland in November 2017 in conjunction with two prestigious international transport fora – the 39th Australasian Transport Research Forum (ATRF) Conference, see at **www.atrf2017.nz**, and an OECD/International Transport Forum (OECD/ITF) Roundtable. The conferences will be held the week beginning Monday 27 November, and all three events will provide opportunities for many to present, learn about cutting edge developments, and to be involved and network.

The theme of this year's Transport Knowledge Conference is 'Managing transport demand: Technologies, social and economic impacts'. The conference will feature data, information and research to contribute to our understanding of the fiscal, infrastructure, business, economic, social and access impacts of transport demand management interventions. Keep an eye on the Ministry's website at **www.transport.govt.nz/research/** for more information.

We expect high calibre of speakers from across the New Zealand and Australian public sector, academic community, and research organisations will contribute to the events. There will also be the higher presence of international transport experts. The week will provide an excellent opportunity for people working across the transport sector to share, build and maintain their transport knowledge.

The Transport Knowledge Conference and ATRF Conference are to be held at the Grafton Campus of The University of Auckland. The venue for the OECD/ITF Roundtable is yet to be confirmed.

A NOTE FOR READERS

NZTA research newsletter

The *NZTA research* newsletter is published quarterly by the NZ Transport Agency. Its purpose is to profile research funded 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.

Disclaimer

The views expressed in the *NZTA research* newsletter 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.

Availability of *NZTA research*

The current edition of the *NZTA research* newsletter is available in hard copy or on the Transport Agency website, along with all previous editions of the newsletter, at www.nzta.govt.nz/resources/nzta-research/.

Email alerts of newly published research reports

Email notifications are provided when new issues of the *NZTA research* newsletter 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:

- add or update names, email or address details
- receive the *NZTA research* newsletter in hard copy format
- receive email notification of the publication of the *NZTA research* newsletter and research reports
- alter the number of *NZTA research* newsletter hard copies you receive.

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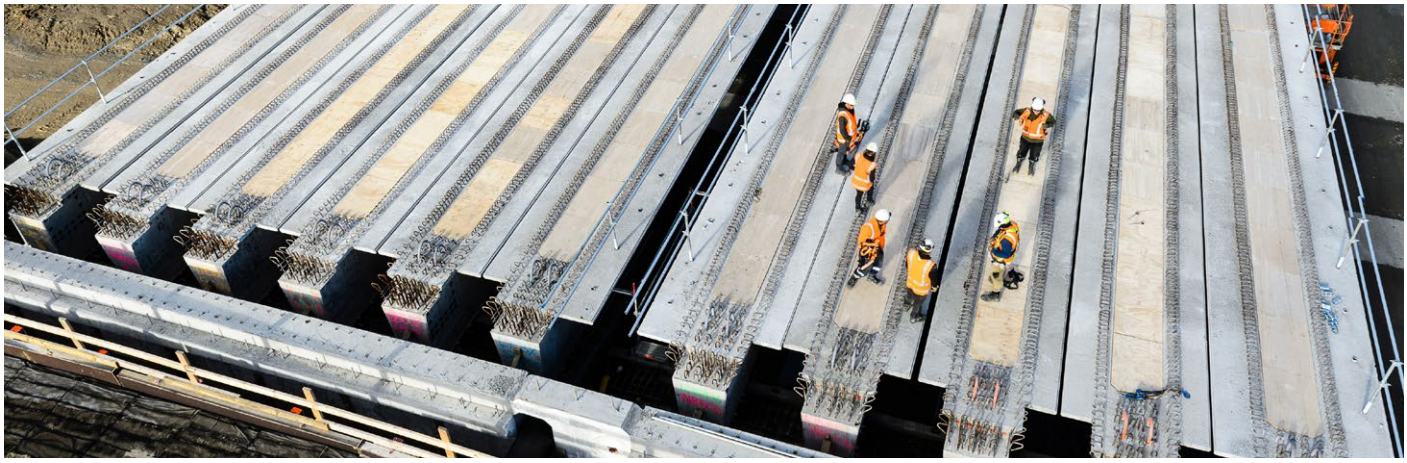
DID YOU KNOW...

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