New Zealand Country Report

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Sub-title – A beautiful place to live, but a tricky one in which to develop a safe and effective road network!

SYNOPSIS

Part of the Austroads Consortium, New Zealand lies in the Pacific Ocean some 2,250 km to the east of Sydney and is blessed with a uniquely diverse range of topographical characteristics. Developing the transport network in New Zealand therefore necessitates the amalgamation of a variety of factors from across the full spectrum of issues that the new Austroads Guide to Road Design addresses. Although different in scale of magnitude from most Australian projects, the nature of engineering issues faced and the solutions proposed are equally challenging and imaginative; often more so in the light of generally tighter budgetary constraints. The Austroads Consortium ensures that such differences are accommodated simply and effectively within the Design Guides by providing the designer with flexibility within defined engineering boundaries.

This presentation will examine the challenges facing Engineers in Consultant and Contractor organisations as they work with those from Road Controlling Authorities to provide New Zealand with a safe, sustainable and environmentally sensitive road network. It will detail the issues faced in attempts to provide consistency throughout the network; highlighting the ingenuity, flexibility and sensitivity of the designers, not only in relation to the immediate problems but also to the requirements of future generations and changes to the environment.

The presentation will stress the importance of the Austroads Consortium to New Zealand, not only in the production of the Design Guides, but also as a knowledge forum for Oceania and the World.

INTRODUCTION

With a population of around 4.5 million people, over half of which live in rural areas, New Zealand depends on the rest of the world for support in the field of highway engineering; indeed, the author is an import of some 3-years. It would have required an extreme stroke of fortune for this to be any other way. Far from being a dis-benefit, however, I doubt whether the wealth of experience and disparate views and ideas that this brings to the field has parallel anywhere else in the world.

Ordinarily, ‘design by committee’ is not an harmonious route to choose, as engineers have the reputation of being ‘wedded’ to their own designs. However, it is likely that any engineer, be they Brunel, Telford or Stephenson, would have sought advice on some of their trickier decisions. It has been my experience, both in my day to day work within the New Zealand Transport Agency and as a member of the Austroads Consortium, that well thought, robust engineering discussions are welcomed and embraced.

This constant review and checking of engineering concepts and principles results in guidelines and guidance that is focussed where it should be; on safety, with a keen eye on level of service and value engineering against a backdrop of what is practical and achievable.

I WOULDN'T START FROM THERE!

New Zealand's evolutionary road network is not unique in the world. It has evolved out of necessity, rather than design. The bronze plaque on the monument in the photograph below, records the journey of William Rees and Nicholas von Tunzelman, driving their sheep for the first time from Wānaka to Wakatipu; south over the range, some 1100m above sea level, in 1859. The road remained predominantly unsealed until only a few years ago.

Photo :Bob DeMay

The impression the country fosters with the rest of the world is one of spectacular outdoor focus, sympathetically combined with the trappings of the finer things associated with a sophisticated and artistic culture. Generally, this is very much the case and the main centres of Auckland, Wellington and Christchurch, for example offer the very best of hospitality and entertainment. The universities in New Zealand have the reputations to match much larger and older establishments. The problem is that the transport network also mirrors the reputation; to enhance the artistic and entertaining, rather than providing an effective and efficient means of getting from A (Awanui) to B (Bluff); in this case, a distance of around 1,980 km. As a relatively young country, we are only in the early stages of 'upgrading' our network to meet the aspirations and expectations of our network users.

Wildlife vs Romans

The desire lines of these two groups manifest themselves in very distinctive ways. The difference between the two is well represented by a sheep's apparent reluctance to walk to the top of a hill and assess the best route forward. Their apparent tunnel-vision results in a very flat vertical alignment who's corresponding horizontal geometry matches contours of the existing topography:

The 'Roman' approach was the result of some bright spark heading for the local high point to assess the most direct route between two points – the straight line:

As we all know, the European network has been greatly influenced by the historical desire of humans to move themselves and their goods between two points as quickly as possible. Usually, the motive behind this was a military one and normal economic models didn't therefore apply. It has to be said that, in some terrain, this approach is seriously flawed.

The issue for road designers has always been which approach is the more appropriate, not only in the local context, but in that of the wider network requirements. A most recent example of this from New Zealand, is the development of more stringent requirements for Roads of National Significance (RoNS), referred to in more detail later on in this paper..

New Zealand – Sheep or Centurion?

While sheep out-number humans at a ratio of 9 to 1 (20 to 1 on the south island!) we try not to be swayed by the weight of such odds. However, our network is a legacy from times when the ratio was greater than 20 to 1 all over the country and despite best efforts, getting the sheep to go where required of them inevitably involved compromise. As a result, with the possible exception of the Canterbury Plains, our approach could be considered more sheep than Roman. It must also be noted that, though the country's history is dominated by civil wars, no one protagonist had the desire to march far across their island, or move between islands, in the quest for greater dominance.

These approaches served the travelling public of New Zealand very well. If you consider the performance of sheep; their acceleration from a standing start, their stability when cornering and their ability to stop quickly; then this is no surprise. However, at some stage, probably sometime just after the second world war (but it is difficult to be precise), when the desire surfaced to travel faster than 10 km/h and in groups numbering less than fifty, performance of imported cars exceeded that of sheep and drivers started to 'fall off' our network.

There is also a third 'hybrid' method for establishing a route. Setting off in the general direction of the intended destination and then adjusting the route as suitable vantage points are reached. Although not very efficient, it is a very effective and pragmatic approach to route-finding. While this could be considered a step in the right direction, unfortunately it leaves a legacy of alignments whose main changes in direction occur at the highest point on the crest. As traveller speeds increase, route delineation and the importance of being able to see, or at least predict the route ahead becomes vital for safe travel.

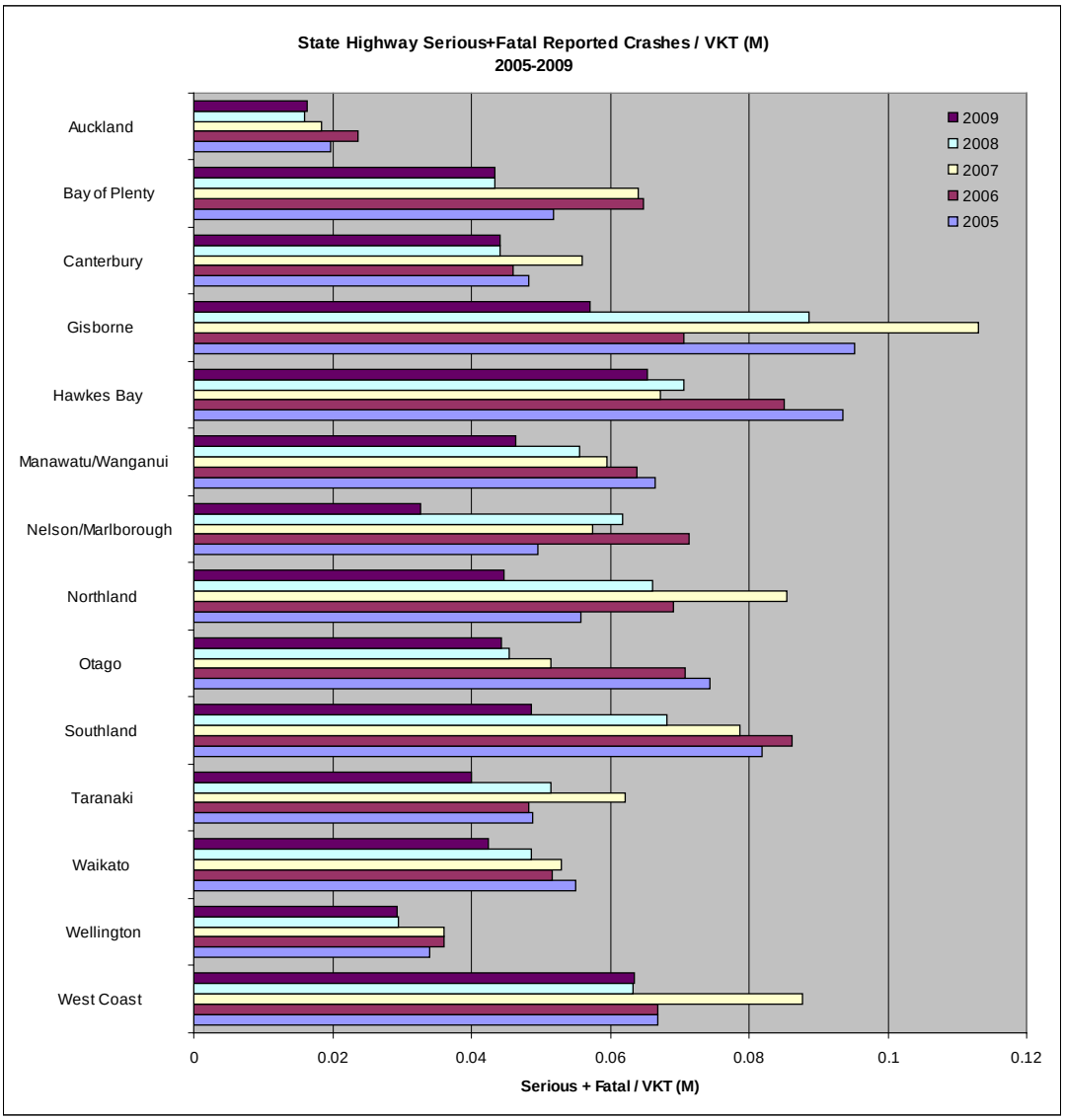
Challenges

The real challenge to the New Zealand Transport Agency is to bring consistency and predictability to all parts of the country. The great regional differences in terrain mean that an homogenous network is impractical. Indeed, a major part of the country's character lies in the aforementioned natural variety. The primary objective of giving clear and unambiguous messages to the network users through appropriate context sensitive design, however, is very much achievable and may be considered to be largely independent of the topography.

For the great majority of the New Zealand network, drivers successfully match their speed and driving behaviour to the road environment (excluding weather conditions). The implication is therefore that the messages received by drivers are timely, consistent and predictable and a 'no surprises' network predominates. This does not, however, reflect the level of service provided, or indeed the security of parts of key routes. This is illustrated by parts of the network whose good safety record is, paradoxically, mainly attributable to the fact that they are so dangerous.

In fact, paradoxically, there is little to deduce from the accident records between the extreme regional examples of topographical environments. The very gentle undulations of the Canterbury plains have a similar crash record to the Far North Region or the more mountainous parts of the Wellington Region. Where a disproportionate amount of injury accidents occur per km travelled in New Zealand is in the more rural, coastal regions of both Islands; Hawkes Bay and Gisborne; West Coast; Southland. This is largely due to the relatively low length of state highway and low number of journeys resulting in the more significant impact of any accidents. In other words this is more of a statistical blip than a significant safety issue.

The key factor in considering these regional requirements is that improvements to lower volume roads generate fewer tangible benefits. Too much store is put in our Benefit/Cost ratio method of assessing project viabilities, rather than a more holistic network approach. There is also a considerable amount of driver education investment to modify behaviour and expectation.



Uniquely New Zealand

Despite significant differences in the dominant topography, there is little variation in the accident statistics, per kilometre travelled, outside the main population centres. This makes sense in terms of exposure to risk per kilometre travelled. Within the segregated regions, there is certainly a great variety of road corridor conditions to keep the motorists on their toes, even on the State Highway network.

The New Zealand network accommodates a high number of foreign visitors who use it extensively every year. While this is by no means a unique problem, quite often the preferred mode of transport of these visitors is the Campervan. We therefore have the compounded issue of drivers on unfamiliar roads in unfamiliar vehicles, more often than not, on an unfamiliar side of the road! The handling associated with such vehicles, though improving all the time, is generally very poor compared to the driver's normal car. As such, their ability to predict and prepare for the road ahead is greatly impaired; in addition to their ability to select the appropriate course of action when things start to go wrong. Combine this with the high level of distraction afforded by our countryside and the prognosis is not great.

For example, a couple of years ago, a European (drive on the right) campervan driver drove too close to the left edge of the sealed road, their wheels ran into the verge whereupon they panicked, over-corrected and swerved fatally into the path of four oncoming motorcyclists. There is always the feeling that a 'loss of control to the right' is the end result of the real cause of an accident which, at any other time of day, could well have resulted in a 'head-on' collision similar to this one.

Another issue for driver's all over the world and particularly in New Zealand is driver fatigue. Local and national transport rules allow drivers to spend 10 hours a day at the wheel. Notwithstanding the normal issues of long distance driving on highways with varying operating speeds and demands, the country itself is a long way from anywhere. Visitors have therefore, generally travelled through one or more time zones to get here and are particularly vulnerable to fatigue. Those not familiar with the effects of long-haul flight fail to factor these in to their packed itineraries, sometimes with disastrous consequences.

However, contrary to the above logic, visitors comprise a very small part of the accident statistics. The road surfaces in New Zealand are predominantly of a high quality and, also paradoxically, this is one of the contributors to the accident record. The minds of the drivers associate the appearance of the surface with that of the route itself. By appearing safer than they

are, this lulls the drivers into a false sense of security and a state of alertness that is entirely inappropriate. The ability of the network to deliver surprises to the relaxed motorist is all too evident in the analysis of our statistics and it is essential that we look deeper into the accident reports rather than just accepting the crash locations.

The real issue for New Zealand is addressing the 'Number 8 Wire', pioneering 'can do' attitude that serves the country so well in the eyes of the world, but does not encourage a conservative approach to driving. As a recent (3 year) immigrant to the country, the aggressive nature of the drivers was immediately noticed. It is a well publicised, worldwide issue that a person's psyche changes the second they get behind the wheel of a car; in New Zealand however, this seems to be far more evident. I am sure this effect is exaggerated because the general demeanour here is one of welcoming friendliness; the whole spirit of which disappears as the Kiwi driver's focus shifts as soon as they get behind the wheel (or on their bicycle). This fact is not better illustrated than by the unfortunate position of New Zealand as a world leader in child fatalities on private driveways.

Reasons for this have been discussed and debated. My own preferred theory is that it is a combination of factors that precipitate this worrying, but I believe transitional, stage in the network development:

1. The level of traffic on our network is increasing faster than the drivers' tolerance to delay.
2. Availability of low-cost high performance vehicles and the New Zealanders' passion for them.
3. Self-confidence and 'she'll be right' (it'll be fine) attitude.
4. Single mindedness

Adopting the Safe System approach to the network changes the focus to one of shared responsibility between the network designers, vehicle manufacturers, legislators (speed limits) and drivers. This brings together all the influences on a driver with the intent of reducing body trauma, will highlight the importance of driver education in association with the more regular, mainstream approach to network safety. This should also include public information about the use of the highway and the expectation of the engineers in respect of the project's purpose.

Austroads Variations

Austroads is a vital organisation for New Zealand. Not only does it provide the opportunity to contribute to the development of guidelines and standards using a pool of experience way beyond the capabilities of our small country, but also provides access to the wealth of research available through ARRB – the Australian Road Research Board in addition to our own funded research programme. From a personal perspective, being a member of the Austroads Road Design Review Panel provides a unique opportunity to discuss and debate not only the details in the guides, but also the real life project-related issues frequently brought to the table by the panel members.

The aim of the Guide to Road Design is to bring together best practice from each jurisdiction and combine that with a perpetuation of the guides that have been used successfully for the past 15 years. In New Zealand, we developed a State Highway Geometric Design Manual (SHGDM) that was published in 2000 in draft form. This was done as a way of acknowledging and formalising the way in which roads are designed in New Zealand. Although there are very few differences in the majority of the design parameter values, much of the SHGDM provides

commentary on design methods and advises on practical limits and variations to the Austroads Guides based on our experience, driving expectations and topographical limitations. This remained in draft form primarily because of the (then thought to be) imminent release of the new Austroads Guides. Ten years later, the SHGDM is still in draft form and serves the country well. In spite of the best efforts of the Road Design Review Panel, there are some differences that are simply irreconcilable with the norms across the Tasman Sea (affectionately known as 'the Ditch'). Some key differences in the Road Code (the NZ driving manual) account for the way in which intersections and interchanges have different road signs and road markings. For example, in New Zealand, drivers are encouraged to use the hatched area of the road to move out of the main traffic stream. While this allows increased efficiency gains where space is a premium, there are clear safety implications of this behaviour in the context of flush medians and protection for turning traffic.

Examples of Key Design Issues

1. Roads of National Significance (RoNS)

An important initiative in the standard of New Zealand's highway network is that of the RoNS. These have been identified by our political leaders as routes that are vital to the short-term economic recovery and longer-term economic prosperity of the nation. As such, these have been afforded specific attention, both in terms of accelerated programming and also design standard. Advice has been given to the industry around acceptable minima of design criteria, focusing on service provision without compromising safety.

This is intended to 'raise the bar' in terms of the standard of road and any deviations from these standards must be accompanied by sound engineering rationale, rather than simple cost reductions.

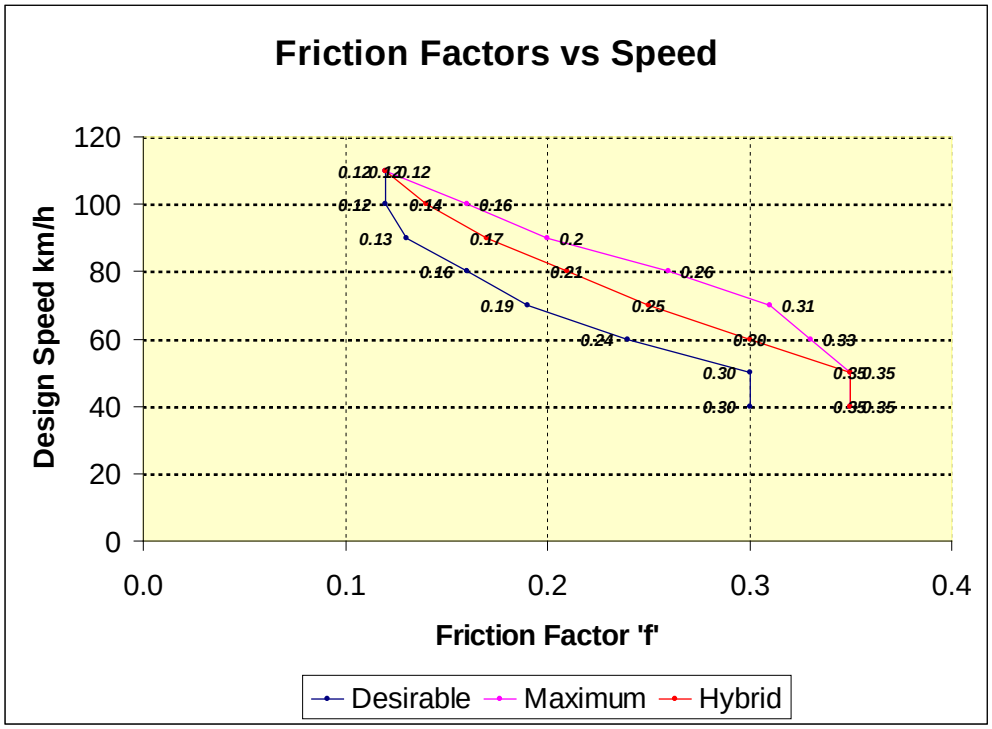
2. Superelevation

One of the key differences for New Zealand is that our allowable maximum superelevation is 10%, whereas Austroads recommends 6%, when calculating the maximum side-friction demand and therefore the operating superelevation for the curve.

The following table compares the different approaches and the impact that this has on the actual designs. In New Zealand, we have a large number of our 'single-vehicle loss of control' crashes on curves in the 300-500m radius range for 80-100km/h. From the table it can be seen that adopting the desirable Austroads side friction values would result in a decrease in the superelevation for these curves; using the same side friction demand (f_{abs}) makes matters even worse. The table therefore includes a 'hybrid' solution that adopts a more linear distribution of the side friction demand. This results in an increase in the superelevation for these curves and therefore, in theory, would reduce the loss of control events.

The introduction of a maximum superelevation of greater than 10% would highlight the issue of truck stability and bitumen 'creep'. ***A work in progress.***

Design Speed	Radius	NZ SHGDM R_{min} ($e_{max=10\%}$)	New Austroads $f_{(des)}$	New Austroads $f_{(abs)}$	New Austroads $e_{(des)}$	New Austroads $e_{(abs)}$	NZ SHGDM $e_{(des)}$	NZ SHGDM $e_{(abs)}$	Hybrid $f_{(h)}$	Hybrid $e_{(h)}$	Hybrid R_{min}
40	28	28	0.3	0.35	7.50	6.58	11.25	10.00	0.35	10.00	28
50	44	44	0.3	0.35	7.46	6.55	11.18	9.94	0.35	9.94	44
60	66	66	0.24	0.33	8.59	6.61	12.63	9.99	0.30	10.74	71
70	94	94	0.19	0.31	9.85	6.66	14.15	10.01	0.25	11.73	110
80	140	140	0.16	0.26	9.82	6.75	13.84	10.00	0.21	11.61	163
90	213	213	0.13	0.2	9.46	6.91	13.02	9.98	0.17	11.09	236
100	303	303	0.12	0.16	8.66	7.09	11.81	9.99	0.14	10.83	329
110	433	433	0.12	0.12	7.33	7.33	10.00	10.00	0.12	10.00	433



3. Desired or Operating Speed

With the variety of environments along any ones stretch of highway in New Zealand, it is important that the design is appropriate for the context within which it sits. New Zealand has a de-restricted or open road speed limit of 100km/h and all too often this is seen as a target, rather than a legal maximum. A key part of context sensitive design involves setting and delivering an appropriate driver expectation. If this is not successfully achieved, highway improvements can simply result in accident migration as excessive speeds encouraged on the new piece of road cannot be accommodated by the network in the immediate vicinity. All to often we see the creation of isolated pieces of network that are 'out of context'. This may be justified as part of an overall 'route strategy', where isolated upgrades to the network are part

of addressing an entire corridor. However it is often the case that other associated network improvements may not be delivered in an appropriate timeframe and the impact either side of the improvement should therefore be taken into account.

Having given due consideration to a design speed, the designer is then faced with the task of communicating this to the driver. Our experience shows that drivers tend to take their speed cues primarily from the horizontal clues, including the roadside features. As a result, our projects often include the insertion of natural or artificial features to help define the road corridor from the drivers' perspective. Advice has long been to design vertically 10km/h higher than the horizontal alignment in order to give more latitude to react to the hidden hazards. However, in the extreme example, where the obvious improvement to the horizontal alignment would be using a straight or large radius curves, yet the vertical restrictions are such that this is economically and contextually constrained to a lower design speed, it is very difficult to control driver speeds without a plethora of signs and markings. Already, New Zealand drivers could be considered to be 'over-advised' in this respect.

It is important that designers assess their designs in the context of the route corridor, taking into account the effects of the geometry, both upstream and downstream, on driver behaviour.

4. Road Rule Variations

One of the largest influences on driver behaviour, particularly at intersections, is the rule that allows drivers to use hatched areas of the carriageway. This may be to ease their approach to an intersection, allow them to leave the main traffic stream early or, in the case of a flush median, to safely wait for a gap in opposing traffic to turn right. While these examples all demonstrate an increase in efficiency and implied safety, this must be tempered with the increased unpredictability this produces.

There are clear benefits to allowing traffic to cross the hatching when approaching a protected right turn bay, for example. It enables the designer to minimise pavement widening and potentially have much sharper tapers and shorter storage lengths. However this also clearly compromises the safety of these layouts as drivers will often see this area of carriageway as additional overtaking space, particularly where these facilities precede publicised passing lanes.

By the same token, controlling multiple lane merges, with their inherently large pavement areas, without being able to rely on the assistance of the pavement markings makes the task very difficult. Particularly when coupled with the tendency for drivers to 'merge aggressively'.

5. International Best Practice

In general, those concerned with the road network in New Zealand are very outward looking in seeking to replicate best practice from around the world. However, this desire must also be tempered with the aforementioned variations in rules and behaviour if we are to improve road safety rather than confuse our network users with conflicting or ambiguous messages. We must carefully adapt and adjust the implementation details of all international concepts to local requirements and expectations.

This is particularly true where we introduce mixed use areas that expect pedestrians, cyclists and motorists to figure priorities out for themselves from intentionally subtle clues.

Education has a vital part to play in setting appropriate expectation for all users. Engineers should openly communicate their expectation of the performance characteristics of their designs, no matter how obvious they may seem, rather than leaving it up to the road users to figure out for themselves.

Examples of Kiwi Ingenuity

The presentation will supplement this report with examples of engineering creativity from around New Zealand.