TECHNICAL NOTE

TRIAL OF VEHICLE ACTIVATED ELECTRONIC SIGNS FOR IMPROVED DRIVER AWARENESS AT KNOWN CRASH SITES IN TASMAN AND MARLBOROUGH DISTRICTS

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ABSTRACT:

This technical paper discusses a recent trial of electronic vehicle activated permanent warning signs installed at sites in Tasman and Marlborough Districts during mid 2009.

In Tasman, electronic bridge cycle warning signs designed to activate as cyclists ride over a sensor were installed for the first time in New Zealand at Appleby Bridge. In Marlborough, three high risk out of context curves were treated with vehicle activated curve warning signs. The signage has been operational since June/July 2009.

It was hypothesised that the installation of the signage would be associated with a reduction in crashes on the curves and an improvement in the comfort and safety of cyclists using the bridge.

It is recommended that, as the signage has only been operational for a short period, further monitoring of the sites and data collection be carried out to assess the effectiveness of this type of technology on driver behaviour and crash incidence.

INTRODUCTION:

NZ Transport Agency (NZTA) Region 10 covers the top of the South Island and includes the Marlborough, Nelson and Tasman Districts.

The opportunity to deploy electronic road safety signs through a national safety funding initiative arose and funding was approved for the proposed trial. The following types of electronic signs were planned for installation:

- Speed indication devices (SIDs)
- Cycle activated cyclist warning signs
- Vehicle activated curve warning signs
- Time specific rural school warning signs

This technical note will focus on two specific types of electronic signage deployed across the region:

- Tasman District:
    - SH60, Appleby Bridge - cycle activated cyclist warning signs.
- Marlborough District:
    - SH1, Dazzle Corner - vehicle activated curve warning signs.
    - SH1, Butter Factory Corner, Riverlands - vehicle activated curve warning signs.
    - SH6, Pak Lim’s Corner, Renwick - vehicle activated curve warning signs.

Figure 1: Cycle activated cyclist warning sign (left), vehicle activated curve warning sign (right).

Two case studies, SH60 – Appleby Bridge and SH1 – Butter Factory Corner, are used as the basis for the discussion.

DISCUSSION:

<u>Case Study 1: SH60 Appleby Bridge</u>

Appleby Straight is a blackspot section of SH60 located to the north of Nelson. It has had 4 fatal crashes over the last five years 2005 to 2009, with a five year annual average crash social cost of $3 million. This section of highway is an identified Network Safety Co-ordination (NSC) site and has been a focus for crash reduction work in the region.

The Appleby State Highway Bridge is 230m long and is 7.3m wide and carries over 12,000 vehicles per day. The bridge has concrete side rails with a 200mm non-mountable vertical kerb face. The approaches have lead in w-section safe barriers for 100m and variable width shoulders between 1m to 2m.

The constrained space on the bridge does not reduce the average vehicle speed when a cyclist is in the lane, and the bridge has an 85% speed of 85km/h regardless of whether or not a cyclist is present.

Table 1: Appleby Bridge Data

Annual Average Daily traffic (AADT): 12,000 veh/day	Cycle Volume: 140 cyclist/day
Heavy Vehicles (HCVs): 7%	Bridge Width: 7.3
Speed Limit : 85km/hr	Posted Speed Limit: 100km/hr

While there was no previous crash history related to cyclists using the narrow 7.3m wide Appleby Bridge situated just prior to the Appleby Straight, the regional cycle strategy identifies the Appleby Bridge as an impediment to peri-urban commuter and recreational cycling and the site was highlighted as the number one priority for State Highway improvements.

A capital project was investigated involving retro-fitting clip-on bridge cycle lanes but the estimate of $1.4 - $2 million (NZ) made it impossible to economically justify the project so alternative safety improvements were investigated.

It was decided to proceed with cycle warning sign to alert both cyclists and vehicles to the cycle pinch point. However conventional static permanent warning signage, even with over-sized backing boards, was not considered sufficient. Real time warning signs, which were activated only when cyclists were using the bridge, were considered the best option.

There was an expectation that, if vehicle drivers were made aware of a cycle in the immediate vicinity as they were driving over the bridge, they would slow to a speed that allowed them to follow a cyclist on the bridge rather than crossing the centreline and passing whether or not there was a vehicle in the opposing lane.

Speed surveys, cycle counts and videos of driver behaviour were undertaken prior to any improvement work at this site.

Cycle Sign Design

Using known technology of electronic flashing light signs attached to permanent warning signs with manual push button or light beam trigger systems as a starting point, a user activated system was investigated.

Recently in New Zealand school zone signs have been developed - time period activated signs which are normally blank and light up with a school zone message during school drop-off and collection time periods. Using this same activated electronic sign approach, an electronic cycle sign with corner flashing lights was developed, approved and legalised for highway use.

The next challenge was developing a suitable detection system. Two options were considered, a signal detector loop and manual push button for the cyclist. It was considered that, with the cycle volume at this site, cyclists would not be prepared to slow down to use a push button. Initially it was proposed to use standard signal detector induction loops placed on a widened shoulder and to direct cyclists to drive over the point on the shoulder of the road marked with green paint. The cost to install these loops, with seal widening works and green paint and marking was in excess of $20,000 (NZ). Also a significant amount of signage would be required which, it was considered, would detract from safety.

An alternative detection system, the eco-counter, was selected. This could detect cyclists in the main vehicle stream. The system had an added advantage of being a continuous cycle counter. The loops had not been used to trigger an electronic sign before and required software to be designed to convert the count signal back to an electronic switch signal.

The final system development was site testing of time period for display, spacing of loop to sign position and selection of sign operation in both directions or in the direction of travel.

It was decided to space the loop 30m prior to the sign to allow approaching cyclists to cross the loop and see the sign activated before crossing the bridge, allowing them a level of confidence that the system is working. The system is currently only activated in the direction of travel.

Case Study 2: SH1 Butter Factory Corner

Butter Factory Corner is an intersection on State Highway 1, located to the south of Blenheim in the suburb of Riverlands. The intersection is a 45km/h curve with a T-junction local road, Alabama Road, intersecting on the outside of the curve. The intersection is complicated by the close proximity of the national rail link and a number of residential houses, along with a primary school. There is no stacking distance for vehicles between the railway crossing and the intersection and sight distances are substandard.

The site has an AADT of approximately 7000 on State Highway 1 and 2000 on Alabama Rd with 15.6% heavy vehicles.

The intersection has had 23 crashes in the 10 year period ending 2009 and, although to date all crashes have resulted in minor or non-injury, the potential is there for a major event should a crash occur in conjunction with a passenger train. Crashes involve a range of causal factors, inattention, fatigue, too fast for corner, trucks too fast or insecure loading, swung wide on bend and failure to give way.

A crash reduction study recommended lowering the speed limit at the site from 80km/h to 70km/h and installing threshold signage. But lowering of the speed limit raises the issue of whether a lesser speed limit would be “credible”, as the crash issues relate to the isolated speed at the corner and there are open rural paddocks just a little further on from the site with 100km/h feel.

The local community have long advocated for a solution to the problems at the site. Proposals include reconstruction at the site easing the curve and installing a right turn bay to address some of the crashes, and a proposal for a localised by-pass removing the curve and the intersecting junction.

All options, except reducing the speed limit, require large funding commitments. The challenge was to find a solution that could improve the intersection and remain within a restricted budget.

The proposed solution included a mix of available tools:

- Reduce the speed limit from 80km/h to 70 km/h (completed on 27-02-09).
- Install large signage and install threshold treatment as funds become available.

- Install guardrail (thriebeam) to protect houses that had previously had crashed vehicles in their front yards (completed May 09).
- Construct shared footpath/cycle path on shoulder from railway crossing near school to safe crossing point on State Highway (completed May 09).

In addition it was decided to investigate the installation of electronic speed advisory signage on both at the curve and to the north of the site.

Winnett and Wheeler (2002) undertook a large scale evaluation of vehicle activated signs for the UK Department for Transport. In that study they found that there was a statistically significant reduction in speeds of between 1 and 14mph associated with the sign. They also found that there was a one-third reduction in accidents against a baseline of what would have been predicted over the time of the study without the signs in place. Winnett and Wheeler suggest that such signs have a greater effect than fixed signs and that there is no evidence of driver habituation to the signs, even over a period of three years.

Austroads (2008) suggests that, due to the lack of habituation of these types of signs, they may have a role to play as an anti-monotony measure. There is a tendency for fatigued drivers to lose track of their speed control on bends and these signs may incline a driver to heed the warning as the activation of the sign “engages” them.

This research suggests that electronic signage has a role to play in addressing crashes relating to speed and possibly fatigue and inattention by engaging the driver with a message prior to entering the corner and it was proposed to:

- Install electronic speed advisory signs as a reminder for drivers in the 70km/h zone as they pass through the open fields (completed June 09).
- Install electronic curve advisory signs at the approaches to the corner in both directions to warn motorists and truck drivers to slow down if they are approaching the corner at speeds faster than the curve advisory on the corner (completed June 09).

Sign Installation and Monitoring

Once the decision was made to install the electronic curve advisory signage at the site, it became obvious that the position of the signs was going to be crucial to their effectiveness – placed too far out from the curve, they would be giving the “slow down” message to all vehicles and placed too close to the corner, any driver travelling too fast would not have time to brake on the straight before entering the curve.

Prior to installation, tube counters were placed for a week to collect pre-installation approach speeds at the corner. It was planned to use this data to ascertain the distance required to decrease speed to the required posted advisory speed allowing for driver reaction times.

Problems arose when siting the signage as calculated distances were not in positions where the displays could be mounted taking into account services both underground and overhead, all requiring clearances from the various utility companies. The next option was to place the signs further out from the calculated spot and increase the thresholds for activation of the sign. Several visits were made to the site and observations made of where most drivers were braking prior to the curve.

Activation of the displays is by speed-activated radar. Signs are set on three modes:

- No display – when vehicles are travelling at the curve advisory speed or less (northbound 55km/h, southbound 45km/h).

- Curve illuminated – when vehicles are travelling between the curve advisory and 10km/h (northbound >55km/h < 65km/h, southbound >45km/h < 55km/h).
- Curve illuminated and Slow Down message – when vehicles are travelling at 10km/h or more above the curve advisory (northbound < 65km/h, southbound < 55km/h).

PROJECT COSTS

Case Study 1: SH60 Appleby Bridge

The SH 60 Appleby installation total project cost inclusive of professional fees was $55,000. This cost is made up of:

- 2 Electronic signs & poles $15,000
- Power connection, surge protection and fuses $15,000
  (will varying on distance to power source)
  Solar alternative would be $1,500 per sign.
- 2xDetection loops, counter and signal controller $20,000
- Professional fees $5,000

Case Study 2: SH1 Butter Factory Corner

The SH1 Butter Factory Corner curve warning signs installation total cost was $34,990 (excl GST). This cost is made up of:

- 2 electronic speed activated curve warning signs,
  solar powered, poles and sockets $18,270
- Data logging option and GSM modem $2,120
- Technical installation and commissioning $1,900
- On-site warranty $400
- Traffic management, rail supervision, site installation $9600
- Professional services $2700

RESULTS:

Case Study 1: SH60 Appleby Bridge

There have been no cycle crashes since installation of the signs at Appleby which have been operational since July 2009.

A video survey of driver behaviour has been completed to evaluate the effectiveness of the cycle warning signs. The behaviour observed by vehicle drivers has been compared with video footage compiled prior to the installation. The footage shows a distinct change from that exhibited prior to installation with vehicles sitting in behind cyclists crossing the bridge, not passing whether the opposing lane was clear or not, as was the previous case. The speed surveys of vehicles were found to be too variable for reliable results.

Case Study 2: SH1 Butter Factory Corner

There have been no crashes since the installation of the signs at SH1 Butter Factory Corner in June 2009.

Tube counts were undertaken to establish 85th percentile speeds before the installation of the signs at the points where the signs were to be installed. Approach speeds to the curve were measured with the 85th percentile speed varying from 64 – 73 depending on the time of day. Tubes were not able to be installed at the curve, to check speeds as vehicles travelled around, to evaluate whether speeds of vehicles negotiating the curve were changed. Tube counters installed again after the installation of speed activated warning signs indicated a change in the mean speeds at the approach to the site. Measured 85^{th} percentile speeds varied from 66 – 68 km/h. The mean speed approaching the corner reduced in range with top mean speeds dropping 5km/h on the approaches after the installation of the signs.

Observations at this site, as well as the other sites in Marlborough with curve warning signs installed, show that vehicles activating the "slow down" message brake when "engaged" by the sign. Further studies are proposed in the area of driver response to the signage.

CONCLUSION

These signs will continue to be monitored for indications of their effectiveness. While there have been no crashes at any of the sites treated, it is too soon to comment on whether the signs have shown to be effective. Driver behaviours will continue to be monitored on Appleby Bridge and an effective method of measuring the speed of vehicles within the corners will be investigated.

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