CYCLISTS AND MULTI-LANE ROUNABOUTS

Authors:

Duncan Campbell CPEng ME (Hons) MIPENZ, Senior Traffic Engineer, Waitakere City Council
Ivan Jurisich NZCE (Civil) BSC MPhil (Civil Eng), Principal Traffic Engineer TES Ltd
Deborah Asmus BE (Civil) (Hons), Traffic Engineer TES Ltd

Email: Duncan.Campbell@waitakere.govt.nz; Ivan.Jurisich@tes.net.nz; Deborah.Asmus@tes.net.nz

ABSTRACT

Traffic Engineering Solutions Ltd is currently undertaking two NZTA research projects that should be of interest to both cyclists and transport professionals in New Zealand. Although these projects are not due for completion until around mid 2010, this paper presents an overview of some of the findings thus far.

The first titled “Improved Multi-lane Roundabout Designs for All Road Users”, is studying topics that include the following:

1. Which is the safer design for an arterial road intersection - traffic signals or a multi-lane roundabout? Research has demonstrated that roundabouts are significantly safer overall and should generally be the preferred option on this basis, the only notable exception being cyclists who can sometimes fare off worse.

2. Visibility guidelines at roundabouts – is excessive visibility a desirable feature or a contributor to crashes? Design guidelines differ internationally on this subject, and there is some evidence that whilst restricting sightlines can have a speed reducing effect this does not always result in a safety benefit.

3. An evaluation of options for pedestrian facilities at multi-lane roundabouts, including for the visually and mobility impaired. Pedestrian safety and amenity can be a motivating factor to install traffic signals in urban areas, but can this also be adequately provided at busy multi-lane roundabouts?

The second is entitled “Evaluation of the C-Roundabout – a new design tool for economically improving safety and capacity at urban road intersections”. The C-Roundabout is a new type of two-lane roundabout which has been designed to reduce vehicle speeds specifically for the benefit of cyclists, but is also anticipated to improve pedestrian and driver safety. An example has been constructed in Waitakere City, Auckland for evaluation, and the results so far are positive. The C-Roundabout will potentially give Road Controlling Authorities a tool to improve safety for cyclists and pedestrians, and also to increase roundabout capacity at minimal cost.
IMPROVED MULTI-LANE ROUNDABOUT DESIGNS FOR ALL ROAD USERS

Introduction

Until recent decades roundabouts have largely been ignored as a design option in the United States and mainland Europe. However they are now being increasingly used there, in large part due to the growing recognition that roundabouts can experience fewer serious injury and fatal crashes than traffic signals. In the United Kingdom they have long been the design option of choice, and are sometimes fully or partially signalised for capacity reasons. But in New Zealand their installation in larger cities appears to be declining, and one important factor seems to be the safety concerns that road planners have with regard to pedestrians and cyclists.

Comparison of overall safety between multi-lane roundabouts and traffic signals

There is ample evidence from both overseas and New Zealand to demonstrate that for a junction with four arms or more, a roundabout control will experience significantly fewer injury crashes (especially serious and fatal type) than if traffic signal controlled. Results for a given location will depend on features particular to that site, but an analysis of 40 junctions in the Auckland region did demonstrate a 47% reduction in vehicle occupant injuries and some overseas studies demonstrated even larger savings than this. For this reason, some North American jurisdictions have in recent years introduced ‘Roundabout First’ policies that require road controlling authorities to provide justification before traffic signals are installed at intersections.

However the safety and amenity of cyclists and pedestrians at roundabouts does need to be addressed more thoroughly at roundabouts, as evidence does show that cyclists in particular can be adversely affected. Measures to either reduce vehicle speed or physically separate cyclists from vehicle traffic can mitigate this to a degree, and signalised roundabouts in the United Kingdom have also demonstrably improved cyclist safety. Regarding pedestrian safety the evidence is less prevalent, but earlier research from the United Kingdom and Sweden have not found a substantial difference in safety performance between roundabouts and traffic signals.

Visibility guidelines at roundabouts

The objective of this exercise was to resolve this important roundabout design issue, and potentially to prepare a preliminary design guide for application in New Zealand. British guidelines for roundabouts emphasize that sightlines between intersecting legs on a roundabout should not be excessive, ‘so as not to encourage high vehicle entry speeds on roundabout approaches’, which is contrary to Austroads guidelines as currently applied by New Zealand practitioners. There are also some published accounts in New Zealand which appear to demonstrate that the reduction of excessive visibility at a junction can improve safety.

Excessive sightlines to the right can contribute to higher than desirable driver speeds at a roundabout, which evidence suggests can subsequently increase crash types including loss-of-control, rear-end, and possibly entering versus circulating vehicles. In the United Kingdom visibility barriers have been successfully used to address the first two of these crash types at higher speed rural locations, and British design guidelines suggest this measure as an optional treatment for higher speed roads.

---

3 Hall (1986) Accidents at four-arm single carriageway urban traffic signals, Transport and Road Research Laboratory (TRL), Contractor Report 65; Maycock & Hall (1984) Accidents at 4-arm roundabouts, Transport and Road Research Laboratory Report 1120
7 Charlton (2002) Restricting intersection visibility to reduce approach speeds
8 Institute of Traffic Engineers Journal (August 2009) Safety Improvements at Roundabouts in Britain
There is also some evidence from Christchurch, New Zealand that indicates excessive sightlines can be an aggravating factor for crashes between entering drivers with cyclists circulating on the roundabout.

However, the findings of this research demonstrate that a greater understanding of the speed reduction effects of visibility restrictions is desirable. After closely studying driver behaviour at one particular roundabout location in Otahuhu, Auckland, it was concluded that if sight lines to the right are restricted too much relative to the speed of circulating vehicles then entering versus circulating vehicle crashes may potentially increase. This was the case at the Otahuhu roundabout, and the crashes there are considered to be mainly due to the proportion of drivers who still drive at inappropriately high speeds for road conditions.

Evaluation of options for pedestrian facilities at multi-lane roundabouts

The objective of this exercise was to evaluate a practical range of pedestrian facility options for roundabouts and develop a preliminary design guide for their application.

Facilities for pedestrians can include pedestrian refuge islands, zebra crossings, raised speed platforms, traffic signals and various forms of alerting devices to drivers to be aware of pedestrians.

In New Zealand one of the most common pedestrian facility to be found near roundabouts is the zebra crossing. An evaluation of a number of these facilities in Auckland demonstrated a range of crash histories, but a clear finding is that multi-lane crossings located further than around 20 metres from roundabout circulating lanes can pose safety problems for pedestrians. This is considered to be mainly due to the higher vehicle speeds there relative than closer to the roundabout, and one expected recommendation of this study will be that when multi-lane zebra crossings are provided further than 20 metres from roundabout circulating lanes then either additional warning devices to drivers, a speed platform or traffic signal controlled crossing be provided.
Visually impaired pedestrians can find it difficult to judge in noisy traffic situations when vehicles are stopping to let them cross at zebra crossings, and in general would prefer traffic signals or at least for the crossing points to be located further from roundabout circulating lanes. Conversely, some mobility-impaired users prefer zebra crossings to traffic signals as they find drivers can be impatient when they are still crossing during the vehicle green phase.

Pedestrian facilities at multi-lane roundabouts will ideally:

(i) Suit all types of pedestrian users including able-bodied, mobility and vision impaired, the elderly and children;
(ii) Minimise disruption to roundabout traffic flow; and
(iii) Be reasonably economical to install and operate.

In practice, the selected solution will inevitably be a balance between these often conflicting objectives.
EVALUATION OF THE C-ROUNDABOUT – A NEW DESIGN TOOL FOR ECONOMICALLY IMPROVING SAFETY AND CAPACITY AT URBAN ROAD INTERSECTIONS

Introduction

This project is a follow up to the 2005 Land Transport New Zealand project “Improved Multi-lane Roundabout Design for Cyclists”, and potentially gives Road Controlling Authorities a tool to improve safety for cyclists and pedestrians, and also to increase roundabout capacity at minimal cost. This previous research showed that adult commuter cyclists (whom are generally more able and confident riders), would prefer to stay on the road rather than use some kind of off-road facility – provided that vehicle speeds were around 30 km/h or less. The C-Roundabout uses European-style confined geometry to achieve this low speed environment, and consequently requires larger vehicles such as trucks or buses to travel through single file. Cyclists are not provided with a separate facility, instead they are expected to travel through as if they were a car user in the specifically designed narrow traffic lanes of around 2.6 metres wide. Speed differential between cyclists and car traffic is expected to be a maximum of around 10-15 km/h, or less in busy peak hour periods.

A C-Roundabout was constructed in April 2009 in Waitakere, Auckland and is currently being road-tested and evaluated.

Simplified diagram showing redesign of the Sturges Road / Palomino Drive roundabout in Waitakere City, Auckland. Construction was complete in April 2009.

The C-Roundabout concept is potentially applicable to any new multi-lane roundabout design, and is expected to substantially improve the road environment for cyclists. The following benefits can also be attributed to other road users:

- Pedestrians – the lower speed environment means that any pedestrian facilities in the vicinity of the roundabout should be safer. This includes zebra crossings, traffic signals and informal crossing points at roundabout throat islands.
- Vehicle drivers – even though well-designed roundabouts generally have a good safety record in terms of injury-related crashes, an even lower speed environment means that any crashes that do occur will be less severe. Motorcyclists should particularly benefit, as they are also a vulnerable road user group.
However, it is recognised that these benefits alone may not justify relatively expensive reconstruction of an existing multi-lane roundabout. For economic reasons many Road Controlling Authorities may find the C-Roundabout more realistically viable for:

- Smaller intersections or single-lane roundabouts being upgraded for capacity reasons. The C-Roundabout concept can achieve compact designs compared to a typical multi-lane arrangement, and for this reason may potentially be the best economic solution available for a capacity improvement.

- Treating existing multi-lane roundabouts on particularly important cyclist routes. Unless there are a substantial proportion of trucks (which is usually not the case in peak hour periods), the capacity of the C-Roundabout compared to a standard multi-lane configuration is not expected to be significantly affected.

- New intersections in green field developments.

Summary Diagram of crash data for cyclists at multi-lane roundabouts in Auckland (non-injury and injury) 1995 to 2004 (59 reported crashes)\(^9\). Note that the ‘entering vehicle versus circulating cyclist’ is the most prevalent crash type, and is considered to be best addressed by an overall decrease in the traffic speed environment. The C-Roundabout is an attempt to achieve this.

**Sturges Road / Palomino Drive Roundabout Evaluation Results**

Since the roundabout was constructed in March 2009, an analysis of video-taped operation during peak hours indicates that the C-Roundabout is operating very well. Signs have been erected in order to educate large vehicle drivers that they should use both approach lanes, and in combination with the narrow lanes these appear to be working well.

Preliminary comparison of unopposed through-vehicle speeds before and after the roundabout was constructed, show that 85% operating speeds have been reduced to between 28 – 33 kph. This appears to demonstrate that the key objective of the C-Roundabout project has been achieved, which is to provide a low speed environment for cyclists to be able to share the road safely with car drivers.

The next stage in the evaluation is to get feedback from cyclists, pedestrians and drivers. This is currently in the process of being undertaken.

---

Photo of the C-Roundabout approach showing information sign to motorists indicating that large vehicles should straddle both lanes.

Photo showing a bus straddling both traffic lanes whilst waiting at the roundabout limit line to turn right. Note the entry lanes are narrow enough to dissuade car drivers from entering alongside, and the inset diagram which shows typical tracking for a semi-trailer vehicle demonstrates why.
Photos showing a cyclist travelling through the C-Roundabout using the middle of the traffic lane as desired.