Signalised Roundabout Design for Pedestrian and Cyclist Safety

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Abstract

This technical note describes a review of a large roundabout (60 m diameter) at an intersection of an urban arterial road (with a 50 km/h speed limit) and a rural arterial road (with a 100 km/h speed limit) on the outskirts of a small New Zealand city. Because of sight distance constraints and vehicle speeds, pedestrians and cyclists are unable to cross the 100 km/h road safely at walking speed.

The proposed long-term solution would allow cyclists and pedestrians to cross to the centre of the roundabout and then exit in the desired direction, protected at all stages by traffic signals.

The paper draws an analogy between the conflicting objectives of this intersection and conflicting objectives in the NZ Transport Strategy (NZTS). This roundabout (as currently configured) attempts to optimise economic efficiency by minimising delays to motor vehicles rather than resolving existing intersection motor vehicle safety issues and pedestrian and cyclist severance issues posed by the 100 km/h road. How we resolve design issues at intersections like this (of which many similar examples exist throughout the country) provides an insight into how we trade off the NZTS objectives.

Introduction

This technical note describes the investigation and review of a large roundabout (60 m diameter) on the outskirts of a small New Zealand city. The roundabout controls the intersection of a rural arterial road (with a 100 km/h speed limit) and an urban arterial road (with a 50 km/h speed limit), and has two circulating lanes of traffic.

The 50 km/h road links a medium-sized city to a nearby small town a few kilometres apart. The rural arterial road runs transversely across the corridor, providing convenient motor vehicle access to more remote cities. The investigation was specific to this particular intersection, but as no decisions have been made as to a final solution and further investigation work is required, this technical note has been made abstract and generic to the extent possible. It raises interesting questions of principle about these types of intersection and suggests a novel technical solution which is felt to be worthy of wider discussion amongst transportation professionals at the conference.

The 50 km/h road is a two lane road with a 50 km/h speed limit and carries about 15,000 vehicles per day (vpd). The rural arterial road is a four-lane road, has a speed limit of 100 km/h and carries about 12,000 vpd on one side of the roundabout and 7,000 on the other side.

Pedestrians and cyclists crossing the 100 km/h road are provided for by off-road crossings away from the roundabout (as shown in Figure 1) and off-road paths around the outside of the roundabout linking to the 50 km/h road. The pedestrian and cycle crossing facilities are located some 30 m away from the roundabout's circulating roadway.

Figure 1: Crossing facility for the 100 km/h road . Roundabout located 30 m to the right.

The 50 km/h road is a significant cycle corridor and is identified in the local cycling strategy as a "first priority" project. The 100 km/h road, with its high speed operation, high traffic volumes and significant numbers of trucks, results in concerns for the safety of cyclists (and pedestrians) wishing to cross the road at this point. An average of 10 crashes per year has occurred at the intersection over the last five years; only one crash involved a pedestrian or cyclist.

A review of the intersection, mainly from a pedestrian and cyclist perspective, was undertaken by ViaStrada Ltd in late 2007 and early 2008. The review included the collection and analysis of relevant pedestrian, cyclist and motor vehicle traffic data to understand the issues. Eight options to improve conditions for pedestrians and cyclists were considered. This technical note discusses a solution for the longer term; another solution for short term application was also recommended to deal with an existing safety problem identified for pedestrians and cyclists.

The 85^{th} percentile speed of motor vehicles leaving the roundabout and approaching one of the two pedestrian and cycle crossing points on the 100 km/h road was about 57 km/h. The peak hour motor vehicle traffic volume for this approach to the crossing point was about 750 vehicles, including about 9% heavy commercial vehicles.

Surveys of pedestrian and cyclist activity during morning (3 hours) and afternoon (2.5 hours) peak periods revealed that 36 pedestrians and 112 cyclists (about 30 in the peak hour) crossed the 100 km/h road at this location during these periods on a November 2007 day. Approximately 300 pedestrians and cyclists per day are likely to be crossing the 100 km/h road on the 50 km/h road corridor.

The review established that pedestrians and cyclists crossing the 100 km/h road are unable to cross the road safely without running, because of limited intervisibility. Slower pedestrians and cyclists or people in wheelchairs are likely to have great difficulty crossing the 100 km/h road at either of the two existing crossing facilities. Cyclists have difficulty using the roundabout itself alongside motor vehicles. Accordingly, the “do nothing” option was not recommended.

It is likely that the difficulty in crossing is resulting in “suppressed demand” and that other people would walk and cycle if it were easier and safer to do so.

In the short term, two refuge islands were recommended for installation on the 100 km/h road at the existing crossing points on the departure side of the roundabout (one on either side of the roundabout). These refuge islands would separate the two motor vehicle lanes, allowing pedestrians and cyclist to cross only one lane at a time. A comprehensive review of safety and traffic operations matters was recommended to develop a longer-term solution. One option to be considered should be a signalised roundabout design as described in this technical note.

Signalised Roundabout Design

A number of options were considered for this intersection. These included grade separation and conventional traffic signals. The recommended long-term solution, however, was to signalise the existing roundabout. This would allow for safe and efficient crossing by pedestrians and cyclists by requiring motor vehicles to stop when pedestrians or cyclists are present. Figure 2 indicates where signals, limit lines and crossing points would be located. Every entry to the roundabout would be controlled, as well as the circulating traffic approaching each entry. Crossing points located downstream of the entry points would not require traffic signals (only pedestrian/cycle crossing signals) as all traffic approaching the crossings would be controlled by signals.

Some of the entering traffic and some of the circulating traffic would need to be stopped by red signals during normal operation of the signal control. Some additional delay for motor vehicles would be introduced at times when pedestrians or cyclists were crossing. Based on current pedestrian and cyclist traffic volumes, this additional delay is not expected to be excessive and would significantly reduce the delay currently experienced by pedestrians and cyclists. A capacity performance analysis has not yet been undertaken.

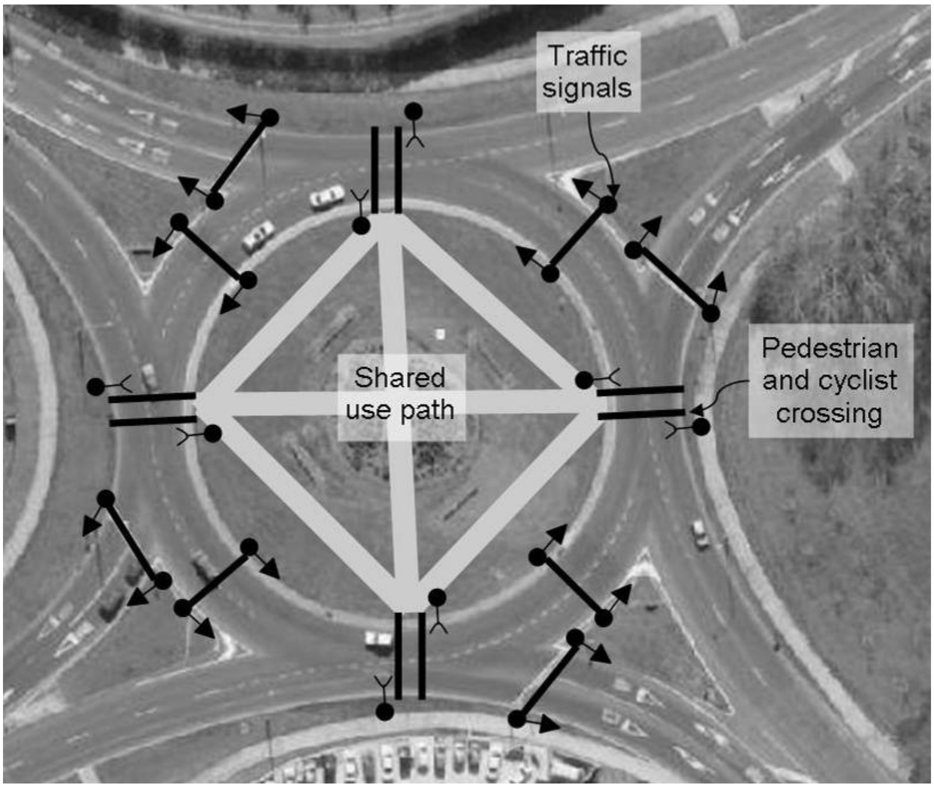

Figure 2: Concept plan for location of signal hardware and crossing points

The phasing diagram shown in Figure 3 shows how the signals could be operated. The operation involves four phases. During each of these, pedestrian and cycle movements are allowed and conflicting traffic movements are prohibited.

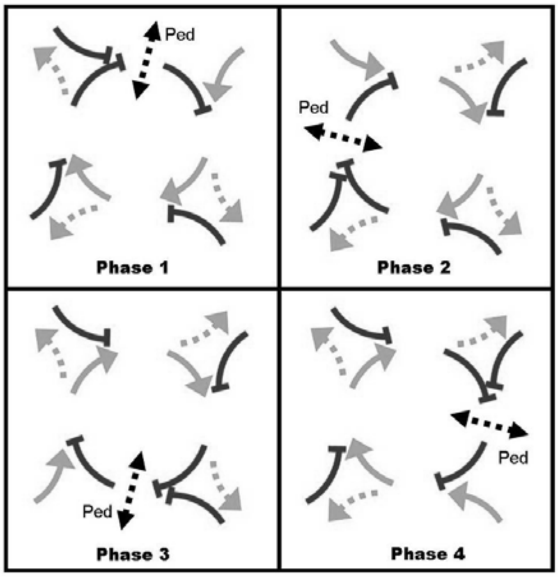

Figure 3: Suggested phasing structure (with crossing demand)

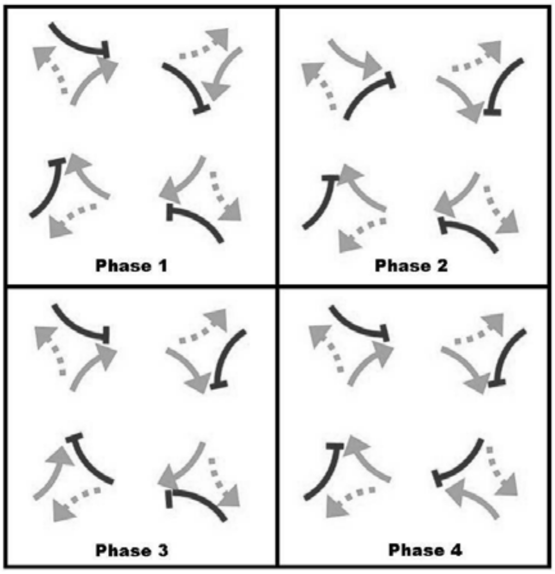

Figure 4: Phase without crossing demand

If in any one phase, the pedestrian crossing demand is not called, an additional circulating flow can be accommodated, as shown in Figure 4.

The signalised roundabout proposed here is in concept very close to signalised roundabouts as they are operated in Europe. The difference is that this scheme accommodates pedestrians and cyclists into and out of the centre of the roundabout, an option which would be particularly attractive on large roundabouts because of the opportunity to provide more direct routes and less detouring for pedestrians and cyclists.

Signalised roundabouts are still uncommon in New Zealand, and we are not aware of a signalised roundabout anywhere in the world that accommodates pedestrians and cyclists as described above. As such, this option would require further detailed analysis (in the form of micro-simulation modelling using the appropriate traffic volumes) to determine expected delays (to motorists, cyclists and pedestrians) and operational settings.

This option would reduce level of service on the 100 km/h road and could be relatively expensive. Nevertheless, it should be investigated further as part of a comprehensive intersection review.

Discussion and Conclusions

This project raised some interesting issues. It can be seen to epitomise the issues facing land transport in New Zealand. The objectives of the NZTS are:

- ensuring environmental sustainability
- assisting economic development
- assisting safety and personal security
- improving access and mobility
- protecting and promoting public health

On one hand, we have a 100 km/h road carrying 12,000 motor vehicles per day including 9% heavy vehicles, representing the economic life blood of the country and "assisting economic development". In addition, the intersecting urban arterial carries significant motor vehicle traffic, some of which crosses the 100 km/h road via the roundabout and some of which uses the 100 km/h road itself. On the other hand, the intersection has a documented safety problem for motor vehicles and demonstrates the phenomenon of "severance" for pedestrians and cyclists, who have difficulty travelling between two close urban communities. The intersection as currently configured does little to "assist safety and personal security" or "improve access and mobility" for pedestrians and cyclists.

Further investigation of this proposed signalised roundabout concept, including micro simulation modelling, may show that the objectives of assisting economic development, assisting safety and personal security and improving access and mobility may not be mutually exclusive. It is most likely that compromises will be required but it is suggested that a small increase in motor vehicle travel time may be an acceptable trade-off to improve safety, personal security and access and mobility.

References

NZTS. New Zealand Transport Strategy, Ministry of Transport, Wellington 2008.

http://www.transport.govt.nz/assets/Downloads/NZTS-final-PDF.pdf