Road Safety Case Studies

'*Fix Crash Corner*' – A Roundabout Story

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Key Findings

- Raised roundabouts can be very effective at crash reduction at and near a junction.
- Raised roundabouts can provide substantial community benefits for all users.

Abstract

In 2020, a new roundabout was constructed at the intersection of Church and Victoria Streets, Auckland, New Zealand. It replaced a 'Stop' controlled cross-roads junction with adverse crash history, nicknamed 'crash corner' by locals, having 54 crashes reported over five years. The constructed roundabout was the first 'Safe System – Vision Zero' design of its kind in New Zealand, being a fully raised roundabout with four pedestrian crossings. Independent crash analysis determined that the new roundabout had reduced reported crashes at the junction to zero. The 'lifetime' crash cost savings of the new roundabout were estimated at a Present Value of over $NZ 10 million. The roundabout also improved pedestrian amenity, upgraded access to public transport and local shops, encouraged modal shift, improved social well-being, and helped reduce carbon emissions. The project progressed from scheme design to successful construction within six months, and was selected as a finalist in the IPWEA NZ 'Asset Management Excellence Awards' (2022).

Keywords

roundabout, road safety, safe systems, crash savings, project management

Introduction

This paper is about an intersection with big crash beginnings, innovative design, effective project management, great community outcomes, and '*Safe System*' endings. The subject intersection is located at the junction of Church Street and Victoria Street, in Auckland, New Zealand. The area is a mix of residential and industrial development.

The junction was previously a cross-roads with 'Stop' controls on two side roads (Victoria Street). Church Street is a main route to both a motorway and the local town centre. In the vicinity of Victoria Street, Church Street had an annual daily traffic of around 10,500 vehicles per day and 8% heavy vehicles.

The intersection had been nicknamed '*Crash Corner*' by the local residents, local community representatives, and a Member of Parliament (Figure 1). It had a recorded crash incidence of 54 crashes over five years (2015 – 2019), including 23 minor injury crashes and one serious injury crash. Glass and vehicle debris were a semi-permanent fixture on most corners of this intersection (Figure 1), as well as repeated private property damage.

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Figure 1. Fix Crash Corner community signage, and nearby vehicle debris

Due to on-going crashes at the junction and community feedback, Auckland Transport determined that prompt action was needed.

To address the road safety issue, alternative proposals were investigated, including different layouts of signalised intersections and a roundabout. The signalised intersection, whist excellent for controlling the turning/crossing movements prevalent in the existing crash type, required road widening, excessive removal of parking, and adversely affected bus stop access. Also, traffic signals had reduced operational performance as compared to a roundabout (with higher carbon emissions), and were considered less aligned with Safe System principles of design, unless raised. Accordingly, the roundabout layout was preferred, primarily due to it being a 'Safe System' design, having superior operational efficiency, and with lower environmental impact.

A commitment was made to providing a 'Vision Zero' compliant design at the intersection, with a completely raised intersection and pedestrian crossings on all 4 legs.

Innovative Proposal

As far as innovations go, the proposed design, an entirely raised roundabout with 4 legs of pedestrian priority crossings, was the first '*Vision Zero*' inclusive installation of its kind in not just Auckland, but New Zealand wide. A full '*Safe System'* approach was implemented, with a strong commitment to vulnerable road users, particularly in relation to pedestrian priority and amenity.

The final outcome of a completely raised roundabout with 4 approach ramps was expected to greatly improve road safety by reducing traffic to a desired 85th percentile speed of around 30 kph.

Raising the entire intersection rather than providing raised tables on each approach had the added advantage of reducing the number of ramps required to be traversed by all traffic. Regular scheduled bus services operated along the main road, and public transport needed to be accommodated safely while maintaining comfort for passengers. Also, with high volumes of freight traffic turning at the junction, the ramps needed to minimise disruption, noise and vibration often associated with large vehicles traversing vertical deflection.

Delivery

The new roundabout was originally planned for construction in 2021, however construction was brought forward to 2019 due to Auckland Transport's requirement for urgent action, spearheaded through political pressure from the local Member of Parliament, Denise Lee.

A project team was created comprising Auckland Transport, a design consultant, and a local contractor. Early contractor involvement allowed the design to be progressed much faster as the contractor helped identify potential constructability risks early during the design phase. It is understood to be the first time Auckland Transport has facilitated this approach for a safety project of this size. The project team delivered the project 12 months ahead of typical schedule.

The project progressed from scheme design to successful construction within six months, and was selected as a finalist in the IPWEA NZ 'Asset Management Excellence Awards' (2022).

Design

The design consultant formed several project teams to work in parallel to achieve delivery of advanced design and detailed design plans within the required short timeframe, being one month. Teams were set up for geometric design, road-marking and sign details, pavement design, and street lighting. In addition, a detailed design road safety audit resulted in a design revision (Figure 2).

Detailed design plans were in the process of being road safety audited while construction plans were in progress. Construction plans were still in progress while the contractor was undertaking site setup, utility service

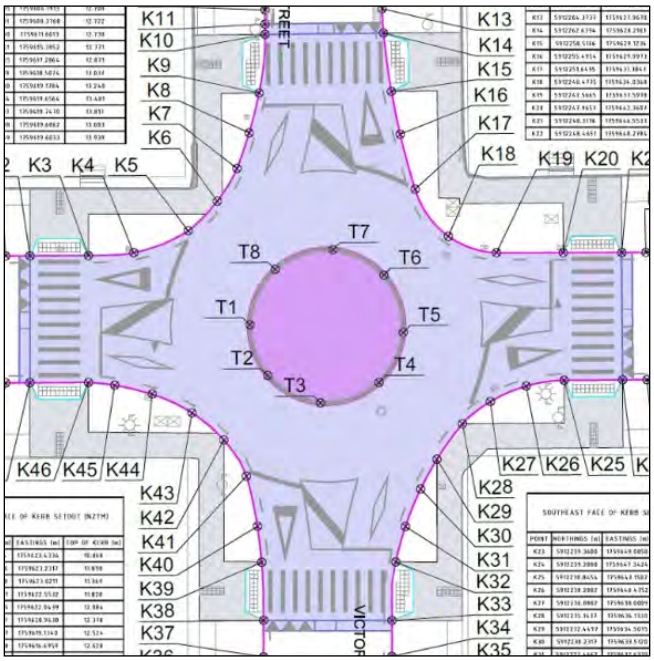

Figure 2 Roundabout design detail (left) and raised central island under construction (right)

investigations, utility service trenches, and road pavement structure test pits.

The proposed delivery timeframes were significantly shorter than previous projects of a similar scale, and went from scheme to construction in only six months. Design expediency was assisted by parallel design review processes, weekly workshops with internal stakeholders, and simultaneous road safety audit.

The team had to deal with the presence of overhead powerlines, shallow depth buried cables, and a large diameter watermain that ran through the centre of the excavations.

As an additional road safety improvement, high friction surfacing was also proposed on all approaches, to further improve pedestrian safety.

With the design advice received from a consultant pavement specialist and Auckland Transport's maintenance team, two stretches of asphalt approaching the new intersection were identified as due for replacement, and pulling them into the project scope to be completed at the same time to eliminate the need for future maintenance closures in the area.

The design process continued right up to and including construction, and design iterations continued during construction. This was partly caused by unexpectedly shallow underground utility services and unusual ground conditions, which could not be investigated thoroughly in advance due to restricted timeframes not permitting in-depth prior investigations. Unsurprisingly, there are risks associated with accelerating a design by reducing prior investigations, though active and collaborative teamwork on-site addressed the surprises encountered.

Construction

Construction planning, including road closures was approached in a unique manner, as the team planned to carry out the works in three stages. In order to minimise the disruption to the community it was proposed that Stage 1 & 2 enabling works be carried out around the intersection (kerb, channel, excavations, footpaths), whilst maintaining two-way traffic in the months approaching the Christmas period. This allowed all the surrounding works to be completed, ready to install the central roundabout in one concrete pour (for adequate curing and structural integrity), using full traffic closures of the intersection (Stage 3). The full closures were carried out over the 2019/2020 New Year's break, when daily traffic volumes were down by up to 40%. The full closures meant that while a large construction impact was created, it was over a much shorter time duration, and during holidays when road network traffic volumes were much lower.

The traffic detours that were available were re-configured to become easy to use, with the design consultant investigating the detour routes and preparing a Traffic Impact Assessment report in relation to the contractor's Traffic Management Plan. The alternative detour routes were confirmed suitable by the consultant engineer for detouring traffic, freight and buses, using vehicle tracking software. Only minor temporary changes were required to side roads to accommodate the detour traffic and large vehicles on the local street network. The full road closures reduced the construction timeline by around 24 weeks.

Figure 3. Roundabout under construction (left and right)

Pedestrian access was maintained throughout the closures at all times. The result was effective for pedestrians with zero complaints received during the entire construction timeline, and zero incidents. In fact, the project received a complimentary letter from a resident within the works area, during the full closure.

During construction, the kerbs and pavement design had to be adjusted due to excessively tough ground conditions, including basalt and volcanic rock at shallow depths. Also, there was an unexpected surprise in the form of 1950's Chorus cables at only 200mm depth. The design consultant managed to turn around revised geometric designs and pavement designs inside of three days, while construction progressed, eliminating project delays while construction continued (Figure 3).

Communication

Communication is key to delivery of any successful project. The appointed Stakeholder Manager ensured that every stakeholder was identified, consulted and involved in the final design and delivery for this project, and could understand and relate to the outcomes delivered.

Environmental

An arborist was engaged at the design and construction stages to ensure all potential trees in the project zone were considered, and root zones protected during footpath excavations. Semi-permeable and flexible surfacing was used for a bus stop upgrade, to avoid affecting the dripline of a large nearby tree.

Recycled water trucks were used on site, and the planning of material sourcing as near to site as possible helped to reduce the number of trips by contractors (reduced carbon emissions). The stormwater system was protected during construction through the use of silt socks on existing catchpits, and as there is a very steep flow down Victoria Street, these were doubled around the downhill catchpits.

Effectiveness – Safe System Benefits

Independent crash analysis (Schischka, 2021) was commissioned by Auckland Transport to examine reported crashes '*before*' and '*after*' at the roundabout, and on nearby surrounding roads.

At the previously existing cross-roads intersection, before the roundabout was installed, 54 crashes were reported over five years (11 reported crashes per year in a 50m vicinity of the junction). Of these 54 crashes, 51 crashes were reported directly at the junction. These reported crashes included 1 serious injury crash and 23 minor injury crashes. The average crash rate was 11 reported crashes per year, equating to almost one reported crash every month.

The vast majority of crashes (about 96%) were right-angle collisions, involving motorists on the side roads failing to stop and give-way to main road traffic. The issue of failure to give-way was considered exacerbated by high volumes of opposing traffic, low conspicuity signage/road-marking on the side roads, restricted inter-visibility between approaching side road and main road motorists, and excessive speeds on all approaches.

Reported crashes only cover a fraction of the estimated total crash history, and exclude crashes that remain unreported, which are typically significantly higher than reported crashes. Based on Waka Kotahi (NZTA, 2013) guidelines, and taking into account unreported crashes,

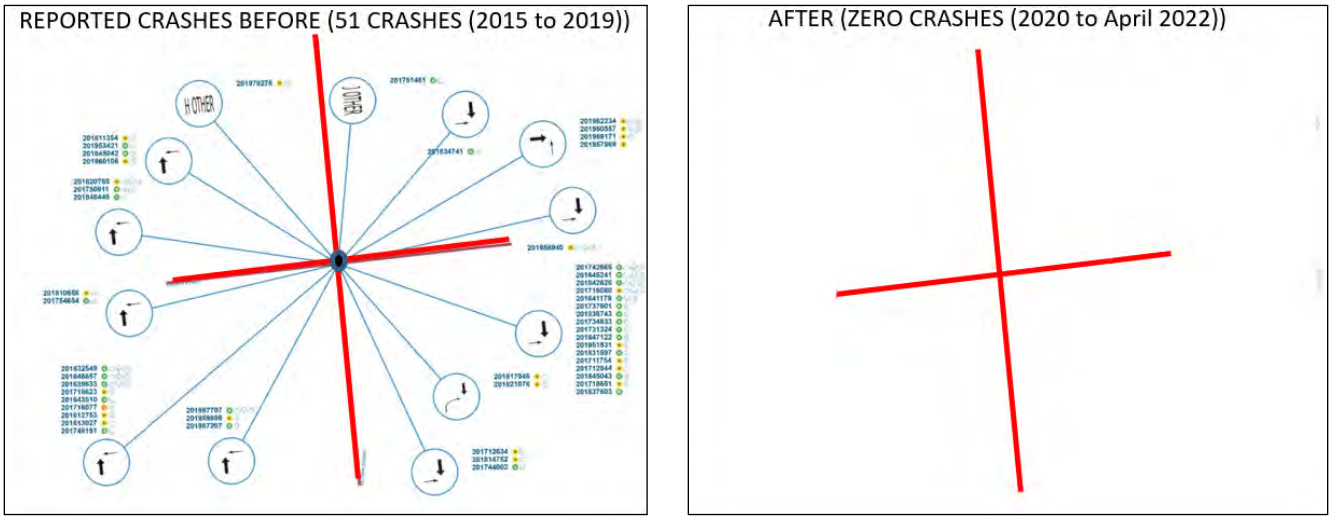

Figure 4. Reported crashes at roundabout 'before' (left) and 'after' (right)

the total crashes occurring at the junction were probably around 295 over a five-year period. Accordingly, crash costs at the previous cross-roads junction were estimated at over NZ $700,000 per year.

Since installation, independent crash analysis determined that there were zero crashes (casualty and non-casualty) reported at the roundabout, over an 18-month period since construction (Figure 4). The independent analysis concluded that "*Given the very high number of recorded crashes of one particular type before the intersection was upgraded and the absence of any crashes post upgrade it can be concluded that the roundabout has been effective at addressing the crash pattern at this intersection.*"

Furthermore, crash statistics were reviewed 'before' and 'after' on the surrounding road network in nearby proximity to the roundabout. This analysis determined that as well as achieving crash reduction at the junction, the roundabout created a 'halo effect' east of the intersection, with crashes nearby reducing from 16 crashes (over five years) to zero at the nearby junction.

It is considered that the substantial crash savings were likely to be derived from the traffic calming impact of the roundabout on all approaches, in combination with enhanced give-way control markings and signage on the minor road approaches. This shows that the project has not only benefited those that live directly near the intersection (Figure 5), but also further along the roads outside the project boundaries. The new roundabout had a traffic calming effect and road safety benefit on the subject junction and nearby intersections.

Community Benefits

Pedestrian numbers were approximately 20 per day in the pre-construction survey in August 2019, and in May 2021 the numbers were 36, showing a clear increase of use after pedestrian safety and amenity was improved at the junction.

Figure 5. Local residents celebrating completion of the roundabout

Figure 6. Drone photo of the roundabout shorty after completion

Also, the bus stops near the intersection were upgraded, and while they previously had an average of six unique trips per day, shortly after construction they were showing an average of seven unique trips per day. This might seem like a negligible increase, but for a bus network that was 30% down on total trips across the board due to COVID-19 effects, this indicated increased utilisation in the short time since installation.

With the area home to several schools, a busy shopping centre, several churches, and also increasing housing intensification, future planning for pedestrian and vulnerable road users was important. Providing improved pedestrian access for the expected population growth in the area through upgraded pedestrian and bus facilities was an important feature. In addition, creating a safer environment for all user types through reduction in vehicle speeds using raised platform ramps and roundabout layout were aligned with '*Safe System*' and a project highlight. A housing development that was under construction nearby on Victoria Street was recently completed, and 500 newly occupied homes will contribute to increased pedestrian volumes benefiting from the roundabout upgrade. Those that live there will be able to experience safer footpaths, better bus stops, access to the bus network, and safer and easier access to nearby retail and commercial facilities.

The community strongly desired a reduction in crashes, and to feel safer when using the intersection both in vehicles, and as vulnerable road users (pedestrians and cyclists). Nearby residents were tired of the danger and stress associated with on-going crashes at the junction, and having to repeatedly repair adjacent private property. There has been no anecdotal evidence suggesting that there have been recent crashes into street furniture or damage to private property along the boundaries since installation of the roundabout. Figure 6 illustrates the roundabout shortly after construction.

Study Limitations

The reported crash monitoring 'after' results relate to a short period of time (28 months) after the roundabout was constructed.

Conclusions

The key conclusions derived from this project were:

- Raised roundabouts can be very effective at crash reduction at and near a junction;
- Raised roundabouts can provide substantial community benefits for all users.

The reduction of reported crashes to zero at this intersection generated a substantial crash saving over time, and benefitted the local residents who no longer need to deal with the stress and damage associated with on-going crashes. In addition, all road users are able to more safely traverse this junction and nearby roads.

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Conflicts of interest

The author declares that there is no conflict of interest.

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