Capacity and Design of Traffic Circles in Australia

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The Australian design standards for traffic circles were developed during the last decade. Early standards borrowed heavily from British research and techniques as well as the Australian practices for analyzing and designing unsignalized intersections. Recently, techniques for analyzing the performance of a traffic circle have been developed from Australian empirical relationships for gap-acceptance parameters as a function of traffic circle geometry. This has improved the ability to account for differences resulting from the geometric design. The design of traffic circles in Australia is a function of their use which may be different from other countries. Locations where and reasons why traffic circles are likely to be effective are described. In addition, the Australian technique for analyzing traffic circle performance by estimating capacity and average delay is described. The main geometric design principles are outlined as well. Traffic circles are considered to be safe intersection control devices; accident experience at traffic circles is also described.

The Australian road system differs from the road system in North America and in many parts of Europe. For instance, the Australian road system places a much higher emphasis on the use of arterial roads that are not grade-separated from other roads. Traffic engineers must be aware of different driver attitudes because they will influence the acceptability of a road-element type by another country. Small differences in the design of road elements often will be necessary to accommodate the different roles of road-element types in other countries and to allow for different driver behavior. Consequently, Australian traffic circles cannot be expected to be best for all other countries.

WHY ARE TRAFFIC CIRCLES EFFECTIVE?

Traffic circles are effective because all vehicles are slowed to a reasonable speed and decisions are simple and separated. If either of these factors is compromised, then the performance of the traffic circle will be degraded.

At a cross intersection, there are 32 decision points for which drivers are required to cross, merge, or diverge from another stream. At a traffic circle there are eight. These decision points are illustrated in the Figure 1. The traffic circle, with fewer decision points, is therefore likely to have fewer accidents. The throughput could also be increased as drivers have to do fewer tasks.

Drivers are slowed as they travel around a curved path. Their speed can be adjusted using horizontal curves of different radii for the approach and the entry. The maximum radius of the driver's path is governed by deflection, which will be described later. Suffice it to say that traffic circles must be designed to encourage drivers to travel slowly. This is also influenced by the ability of drivers to recognize that they are approaching a traffic circle and that they will be required to slow down. This requirement correctly suggests that traffic circles on high-speed roads need to be designed with a great deal of care.

WHERE SHOULD TRAFFIC CIRCLES BE USED?

Traffic circles can be used satisfactorily at a wide range of sites for which the intersection roads have roughly the same classification and purpose. These include on local and collector roads in urban areas, on arterial roads in urban areas, on rural roads, and at freeway terminals. However, traffic circles are best suited to subarterial roads for which each road has about the same importance.

Driver delays can be reduced at traffic circles that replace some intersections with two-way stop control, give-way (yield) control, or signalization. Examples of such intersections include

- Intersections that have more than four legs, and
- Intersections for which there are high proportions of left-turning traffic. Unlike most other intersection treatments, traffic circles operate most efficiently for high volumes of left-turning vehicles. For example, a left turner from the north would stop the through movement from the south, thus allowing traffic from the east to enter the traffic circle. These vehicles from the east would then stop the through movement, preventing traffic from the north from entering the traffic circle. This action reduces delays.

Traffic circles can also offer a safer intersection control as relative vehicle speeds are contained and because vehicle paths merge and not cross. Accident experience has been found to be better.

- At cross intersections of local, collector, or both local and collector roads for which a disproportionately large number of accidents occur that involve either crossing traffic or turning movements.
- At rural cross intersections (including those in high-speed areas) at which there is an accident problem that involves crossing traffic.
- At arterial-roads intersections for which traffic speeds are high and left-turning traffic flows could also be high. A traffic

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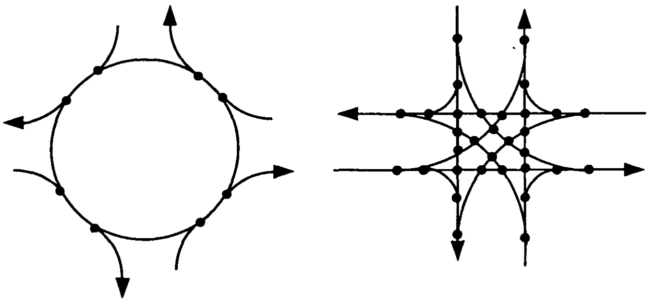

FIGURE 1 Decision points at a traffic circle (*left*) and at a conventional cross intersection (*right*).

circle could have fewer left-turn-opposed accidents than over traffic-signal-controlled intersections.

- At major roads that meet at Y- or T-intersections.
- At T- or cross-intersections for which the major traffic route turns through a right angle. Here, the turning movements are major ones.

Traffic circles can improve the amenity of a local street or residential street network. In these cases priority is not given to either road. Traffic circles can also enable flexible design. Traffic circle performance adjusts as traffic patterns or volumes change.

Traffic circles can be inappropriate in some cases.

- If a satisfactory geometric design cannot be provided owing to insufficient space or unfavorable topography;
- If traffic flows are unbalanced with high volumes on one or more approaches, and some vehicles would experience long delays (this could be improved by metering with traffic signals);
- If a major road intersects a minor road (a traffic circle would cause delay and deflection to all traffic, whereas control by signs or T-junction rule would result in delays to the minor road traffic only);
- If there is considerable pedestrian activity or if high traffic volumes would make it difficult for pedestrians to cross either road;
- If at an isolated intersection in a network of linked traffic signals, a similarly linked signalized intersection would generally provide a better level of service;
- If peak-period reversible lanes may be employed; or
- If traffic flows leaving the traffic circle would be interrupted by a downstream traffic control, which could result in queueing back into the traffic circle (a high pedestrian movement at a nearby pedestrian crossing could cause queueing into the traffic circle).

The use of traffic circles at these sites should not be completely discounted, but their effectiveness must be closely evaluated.

ELEMENTS OF A TRAFFIC CIRCLE

The major elements of traffic circles are shown in Figure 2. The definitions are self-evident from this figure.

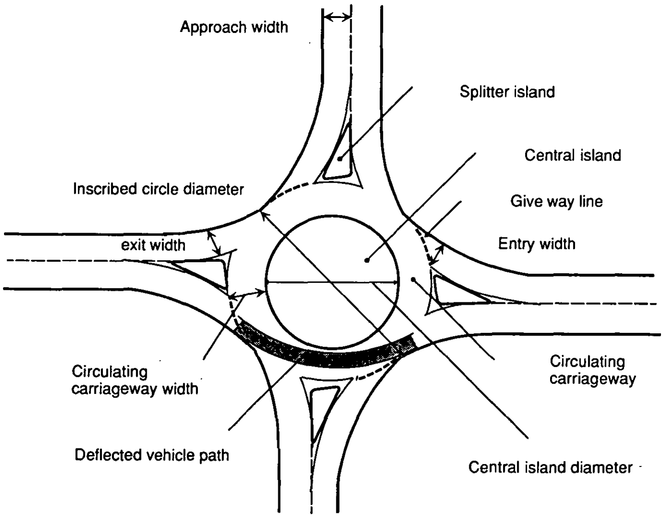

FIGURE 2 Major elements of a traffic circle.

AUSTRALIAN METHOD OF ANALYZING TRAFFIC CIRCLES

The Australian method of predicting the performance of a traffic circle is presented by AustRoads (*1*). The capacity of a traffic circle is evaluated as a series of T-intersections. This is a standard technique used in most design standards around the world. The circulating traffic is the traffic flow past the entering vehicles that opposes their entry. The entry-lane flows are the other traffic inputs. The capacity of the T-subintersection is calculated using gap-acceptance techniques.

The gap-acceptance theory can be considered to have two elements. The first is a measure of the usefulness of a gap, t sec, to an entering driver. The second element is an estimation of the frequency of acceptable gaps of duration t in the opposing traffic streams (*2*). These two elements will be discussed subsequently.

Usefulness of a Gap

The usefulness of a gap is measured by gap-acceptance parameters; that is, by the critical acceptance gap and the follow-up time. The shorter these parameters, the more useful the gaps are to entering drivers. In the AustRoads guide (*1*), the critical acceptance gap parameters are functions of the circulating flow and the road geometry.

From field studies, it has also been found that drivers in different entry lanes, at one approach, performed differently. The differences in behavior were introduced by the concepts of dominant and subdominant streams (*2*). The dominant stream is defined as the stream that has the greatest entry flow. Drivers in this stream had lower critical gap parameters, which resulted in a higher entry lane capacity. Drivers in the other entry streams (the subdominant streams) at the same leg had larger critical gap parameters. These streams also had a lower capacity. There is only one dominant stream at each entry, but there may be many subdominant streams. If there is only one entry stream, it will be a dominant stream (*3*).

A critical acceptance gap and follow-up time were calculated for each lane (*1,2*). The follow-up time for the dominant stream, t_{fdom}, was calculated first using the equation

$$t_{\text{fdom}} = 3.37 - 0.000394Q_c - 0.0208Di + 0.0000889Di^2 - 0.395n_e + 0.388n_c \qquad (1)$$

where

Q_c = circulating flow (veh/hr)
Di = inscribed diameter, the largest diameter that can be drawn inside traffic circle (m),
n_e = number of entry lanes, and
n_c = number of circulating lanes.

The follow-up times for the subdominant stream, t_{fsub}, were a function of the dominant stream follow-up time values, t_{fdom}, and the ratio of the dominant stream entry flow, Q_{dom}, to the subdominant stream entry flow, Q_{sub}.

$$t_{\text{fsub}} = 2.149 + 0.5135t_{\text{fdom}}\frac{Q_{\text{dom}}}{Q_{\text{sub}}} - 0.8735\frac{Q_{\text{dom}}}{Q_{\text{sub}}} \qquad (2)$$

The larger the dominant stream follow-up time, the larger is the subdominant stream follow-up time. The dominant stream follow-up time also increases with larger variations in the lane entry flows.

The critical gap is dependent on the follow-up time, the circulating flow, the number of circulating lanes, and the average entry lane width $\bar{e}$. An expression for the ratio of the critical gap, t_a, to the follow-up time, t_f, was found to decrease with an increased circulating flow, the number of circulating lanes, and the average entry lane width. This equation was applied to the conditions in all entry lanes.

$$t_a/t_f = 3.6135 - 0.0003137Q_c - 0.3390\bar{e} - 0.2775n_c \qquad (3)$$

Number of Useful Gaps

The number of useful gaps in the circulating traffic stream is influenced by the degree of bunching in the circulating stream. The distribution of gaps in the circulating stream are modeled by Cowan's M3 model (*4*). This model provides a good description of the headways between the nonbunched (or free) vehicles. It models the headways between bunched vehicles rather poorly because it considers that all bunched vehicles have the same short headway, τ. This deficiency is not a concern because headways between bunched vehicles are not accepted by entering drivers.

The entering drivers were found to give way to all circulating vehicles regardless of whether the circulating vehicle was in the inner or outer circulating lane. The characteristics of the circulating traffic were developed on the basis of a single-lane flow. Troutbeck (*3,5*) has indicated that it is acceptable to model the combined influence by a single lane.

The two terms used to define the circulating stream characteristics are the proportion of nonbunched (free) vehicles, α, and the minimum headway between bunched vehicles, τ. For multiple lanes, τ is the average headway between closely following vehicles in all lanes. Because τ and α are interrelated, values of τ were chosen on the basis of the number of circulating lanes. Expressions for α were then derived from field data for traffic circles with single- and multiple-circulating lanes. The regression equations were found to be similar and the following generalized equation was developed:

$$\alpha = 0.75(1 - \tau Q_c/3{,}600) \qquad (4)$$

where τ equals 1.0 if there are more than one circulating lanes and 2 if there is one circulating lane.

Entry Capacity

Entry capacity is defined as the maximum entry flow for a particular lane, intersection geometry, and other opposing flows. Entry capacity depends on the opposing flows: as the opposing flows increase, the entry capacity decreases. This definition is similar to the British definition (*6*) but is quite different from the definition used by Kyte et al. (*7*), who defined capacity in terms of when flows in all streams were increased, and the intersection had reached the maximum level of performance. Kyte's definition is appropriate for all-way stop intersections.

The entry capacity–circulating flow curves have the shape shown in Figures 3 and 4 for single-lane and multilane traffic circles. The shape of these curves are similar to the curves obtained by Kimber (*6*).

The entry capacity for each entry lane is given by

$$C = \frac{\alpha q_c e^{-\lambda(t_a - \tau)}}{1 - e^{-\lambda t_f}} \qquad (5)$$

where

C = absorption capacity of an entry lane (veh/sec)
α = proportion of free vehicles in circulating streams,
q_c = flow of vehicles in circulating streams (veh/sec) or $Q_c/3600$,
t_a = critical acceptance gap,
t_f = follow on time, and
τ = minimum headway in circulating streams, and these are related by

$$\lambda = \alpha q_c/(1 - \tau q_c) \qquad (6)$$

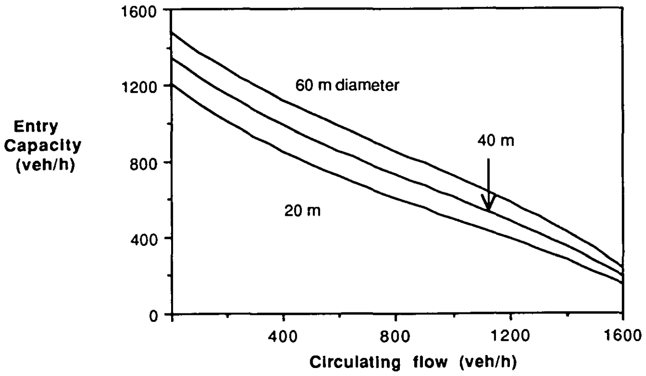

FIGURE 3 Effect of increasing inscribed diameter of traffic circles with a single circulating lane (entry lane width is 4 m).

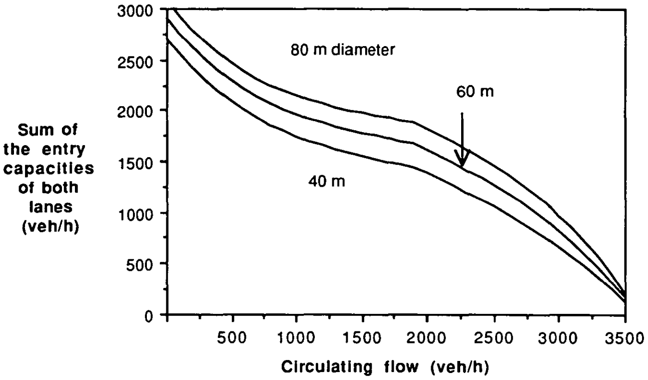

FIGURE 4 Effect of increasing inscribed diameter of traffic circles with multiple circulating lanes (entry lanes are 4 m wide).

The inscribed diameter and the average entry-lane width had the greatest influence on the estimates of capacity. The larger the inscribed diameter, the easier the entry turn is likely to be. This will translate into shorter critical-gap parameters and a larger capacity. Figures 3 and 4 illustrate the effect of the inscribed diameter on the capacity of a single circulating lane and a multiple circulating lane traffic circle. The effect is significant. A 20-m increase in the inscribed diameter results in an increase of between 10 and 25 percent in the capacity.

Estimates of Delay

Two types of delay should be considered. The first is queueing delay and is the delay for drivers while they wait for an acceptable gap. The second delay is geometric delay, which is the delay incurred as drivers slow to approach a traffic circle or stop at the end of a queue. Geometric delay also includes the delay traveling around the traffic circle and accelerating to the departure speed.

Queueing Delay

Queueing delay is a function of gap-acceptance parameters and flows on circulating and entry lanes. AustRoads (*1*) introduced the Akçelik and Troutbeck nonsteady state solution (*8*). This solution requires the user to estimate the duration of the peak period. It assumes that the flow is zero before the peak period, and the average delay is estimated for all vehicles arriving in this period.

An equation for the average delay per vehicle is

$$D = D_m + 900T\left[x - 1 + \sqrt{(x - 1)^2 + \frac{D_m x}{450T}}\right] \qquad (7)$$

where

D = average delay per vehicle in seconds;
D_m = average delay when the entry stream flow is low, that is, when x is close to zero;
T = duration of the peak flow period in hours (typically 1 hr); and
x = degree of saturation.

$$D_m = \frac{e^{\lambda(t_a - \tau)}}{\alpha q_c} - t_a - \frac{1}{\lambda} + \frac{\lambda\tau^2 - 2\tau(1 - \alpha)}{2(\lambda\tau + \alpha)} \qquad (8)$$

$$x = q_e/C \qquad (9)$$

where q_e is entry flow.

Equation 7 is always less than the steady-state delay equation.

$$D = \frac{D_m}{1 - x} \qquad (10)$$

This is illustrated in Figure 5. Note that the average queueing delay is strongly dependent on the chosen value of T. The designer must be careful to select the appropriate value of T.

The equations presented in this paper give estimates of capacity and delay. These equations are now included in the computer routines SIDRA 4 (*8*) and KREISEL (*9,10*).

Geometric Delay

The average geometric delay is dependent on the proportion of drivers stopped and the distance traveled around the traffic circle at the slower negotiation speed. The average delay was calculated using the assumption that drivers accelerated at 1.2 m/sec^2 and decelerated at 1.8 m/sec^2. The negotiation speed was a function of the drivers' turn radius in the traffic circle. Geometric delays can be substantial.

The chances of being stopped at an intersection depends on two factors. The probability of being stopped increases as the traffic on the major road increases. However, the probability of being stopped is also proportional to the degree of saturation on the minor road. If the degree of saturation is high, there would be heavy queueing and the probability of being stopped also increases (*11*).

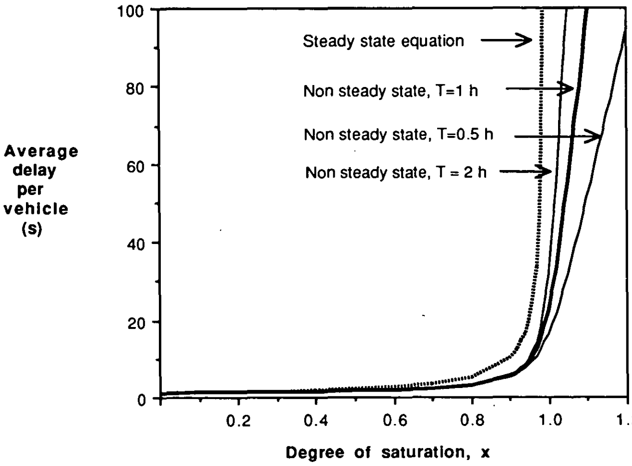

FIGURE 5 Average delay per vehicle as a function of degree of saturation for a traffic circle entry when w_h term is equal to 2 sec.

Estimates of the proportion of stopped vehicles of saturation were obtained from a simulation program for gap-acceptance behavior. Given that the geometric delays to vehicles stopped and not stopped were not well defined, it was decided to calculate the proportion of stopped vehicles from either a traffic circle with two circulating lanes (a 60-m inscribed diameter and two 4-m entry lanes), or a single-lane traffic circle with a 40-m inscribed diameter. The expected proportions of stopped vehicles are shown in Figure 6 for a multilane traffic circle. The results for a single-lane traffic circle are similar (*12*).

The average geometric delay, d_g, for each turn type and from each approach is given by the equation

$$d_g = P_s d_s + P_n d_n \tag{11}$$

where

P_s = probability of being stopped,
P_n = probability of not being stopped = $1 - P_s$,
d_s = average delay if stopped, and
d_n = average delay if not stopped.

Performance Measures

The performance measures are the average delay, including both the geometric and the queueing delay, and the degree of saturation, which is the entry flow divided by the entry capacity. There is no limiting value for the average delay, but it is recommended that the degree of saturation be less than 0.85.

DESIGN OF TRAFFIC CIRCLES

Deflection Through Traffic Circles

Adequate deflection of the paths of vehicles entering a traffic circle is the most important factor to influence their safe operation. Traffic circles should be designed so that the speed of all vehicles within the intersection is as slow as reasonable but certainly less than 50 km/hr. This is done by ensuring that through-vehicle paths are significantly deflected by positioning a suitably sized central island, using splitter islands, and adjusting the alignment of the entrances and exits. The splitter island is the small, roughly triangular island that is in the entry road and separates the entering vehicles from the exiting vehicles.

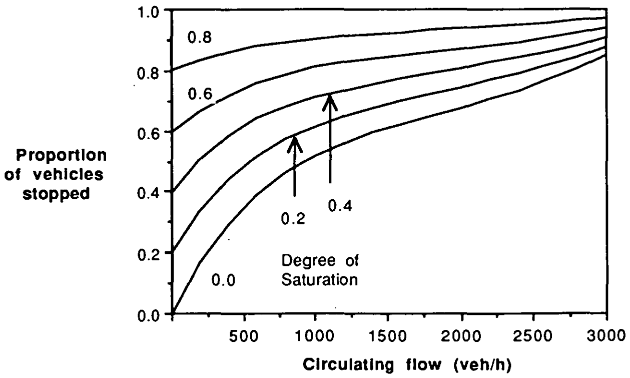

FIGURE 6 Proportion of stopped vehicles based on the simulation results for a traffic circle with multiple circulating lanes, an inscribed diameter of 60 m, and two 4-m entry lanes.

The importance of achieving adequate deflection cannot be overemphasized. It is required to reduce vehicle speeds. British research (*13*) has indicated that the frequency of casualty accidents is increased at sites for which the deflection has been reduced. Australian practice also confirms the importance of adequate deflection and geometric layout, to control vehicle speeds on the entry to a traffic circle.

The maximum desired design speed is obtained if no vehicle path (assumed 2 m wide, with the vehicle using all the available road width) has a radius greater than 100 m. This degree of curvature corresponds approximately to 50 km/hr with a sideways acceleration of 0.2 *g*. Here the central island size and the approach geometry are the controlling factors.

Central Island

Circular central islands are preferable, otherwise the driving task demand changes as the driver negotiates the traffic circle. The size of the central island is determined principally by the space available and the need to obtain sufficient deflection to reduce through-vehicle speed. Traffic circles with a larger inscribed diameter, and consequently a larger central island, have a slightly larger entry capacity. In areas in which drivers are likely to be unfamiliar with traffic circle operation, the central island should have a diameter of at least 4 m and preferably more than 10 m.

Width of Circulating Highway

The width of the circulating highway depends on the number of entry lanes and the radius of vehicle paths within the traffic circle. The width is generally greater than the widths of the approach lanes simply because vehicles must turn. For instance, a single-lane traffic circle with a 10-m central island needs a 7-m circulating highway width to enable an articulated vehicle to turn right.

Splitter Islands and Entrance and Exit Curves

Splitter islands should be provided on all traffic circles installed on arterial roads. They provide shelter for pedestrians, guide traffic into the traffic circle, and deter wrong movements. The Australian approach is to design splitter islands that provide a smooth curve with the circulating highway. On arterial road traffic circles the splitter island should be at least 8 m^2 to present a reasonable target to be seen by approaching drivers.

Entry and exit lane widths are generally in the range of 3.4 to 4.0 m. Exceptions are for curbed single-lane entrances and exits where a minimum of 5.0 m between curbs is required to allow traffic to pass a disabled vehicle. The exit from a traffic circle should be as easy to negotiate as practicable. After having been slowed by the curved entry path, vehicles should be able to accelerate out of the circulating highway in the exit lane.

The approach curves to traffic circles are upstream of the entry curve and should be used if the upstream approach speed is more than 10 km/hr greater than the entry speed defined by the entry radius. It is important to advise drivers that they are approaching a traffic circle and to slow down. This is best achieved with horizontal curves.

Sight Distance

Several sight-distance criteria should be applied to both the vertical and horizontal geometries at traffic circles. These criteria also affect the positioning of signs and plantations and so on. The approaching driver must have a good view of the splitter island, the central island, and desirably the circulating highway. Adequate approach–stopping-sight distance should be provided, preferably to the give-way (yield) lines and, at an absolute minimum, to the nose of the splitter island.

A driver, stationary at the yield line, should have a clear line of sight to approaching traffic for a distance representing at least the travel time equal to the critical-acceptance gap. A value of 5 sec is typical for traffic circles operating with low circulating flows, and 4 sec would be acceptable at the traffic circles with higher flows but slower speeds.

When drivers reach 40 m before the yield line on approach to a traffic circle, they should be able to see other entering vehicles, although in urban areas it may not always be possible.

Visibility Considerations

At any traffic circle, designers must provide the sight distance just described, but they must ensure that the traffic circle is conspicuous. The driver must be readily able to assess the driving task. To enhance the prominence of the traffic circle, the curbs on both the splitter island and central island should be light colored or painted white. As with other types of intersections, it is better to position a traffic circle in a sag vertical curve. The circulating highway must be conspicuous. This is best achieved with negative crossfall; that is, by sloping the crossfall away from the central island.

Superelevation of Circulating Highway

Normal curve superelevation through the traffic circle is generally not necessary as speeds are constrained, and drivers tolerate higher values of the coefficient of sideways friction traveling through an intersection. It is important, however, that the layout of the traffic circle is clearly visible to approaching drivers and provides for adequate drainage. As a general design practice, a minimum pavement crossfall of 0.025 to 0.03 m^2 should be adopted for the circulating highway. A crossfall as low as 0.02 m^2 has been found to allow for pavement drainage and also provides additional driver comfort. Designing superelevation to slope away from the central island often simplifies the detailed design of pavement levels and avoids drainage pits around the central island.

Exceptions to this requirement include larger traffic circles with an inscribed diameter more than 100 m and traffic circles on a slope. These latter traffic circles have a crossfall across the whole of the traffic circle rather than a crossfall away from the central island. Traffic circles should not be used on grades greater than about 3 percent.

Pavement Markings at Entry and Exit

The linemarking used at the give-way point consists of a 300-mm striped line across the entry. The markings follow the circumference of the traffic circle to allow the curb side drivers to see past entering vehicles on their left. There are no lines across the exits.

There is divided opinion on whether lane lines should be used to delineate circulating lanes within a traffic circle. There is no definitive research on the subject. AustRoads (*1*) recommends that lane marking in the circulating highway be used only in the shadow of the splitter islands on larger traffic circles (inscribed diameter of 50 m or more). The absence of linemarking between the entry and exit, where most lane changing occurs, minimizes confusion about the drivers' requirement for lane change signaling.

Direction arrows are not necessary in the entry lanes on the approach to the yield line, except when exclusive left-turn lanes (right turns in the United States) are provided. Some arrows may mislead some drivers into making incorrect turns before the central island.

Traffic Signs

An inverted triangular regulatory sign is used to identify a traffic circle. On the splitter islands, signs are used to advise drivers to drive on the correct side of the island. For large splitter islands, particularly for traffic circles in high-speed areas, hazard boards are used to emphasize the curved approach and deflection into the traffic circle.

SAFETY RECORD OF TRAFFIC CIRCLES

The safety performance of traffic circles has been documented in a number of Australian and U.K. studies. Before and after accident studies carried out at intersections that involve a wide range of site and traffic conditions, at which traffic circles have been constructed, indicate very significant reductions in casualty rates.

The good safety record of properly designed traffic circles can be attributed to the following factors:

- Traffic circles result in general reduction in conflicting traffic speeds of all vehicles (limited to less than 50 km/hr).
- Traffic circles eliminate high angles of conflict, ensuring low relative speeds between conflicting vehicles.
- Traffic circles provide for relative simplicity of decision making at the point of entry.
- Long splitter islands provide good advance warning of the presence of the intersection on individual roads in high-speed areas.
- Splitter islands provide refuge for pedestrians and permit them to cross traffic from one direction at a time.

- Traffic circles always require a conscious action on the part of all drivers passing through the intersection, regardless of whether other vehicles are present or not.

In 1981 VicRoads carried out a before and after study to assess the safety performance of 73 traffic circle sites throughout Victoria (*14*). The form of control during the before period was either Stop or Give Way sign controls, or in one case, police control. The sites were primarily in urban areas, although some rural sites were included.

The study results indicated that the average casualty accident rate decreased by 74 percent after traffic circle installations. Sites were grouped according to entering traffic volumes. All groups showed statistically significant reductions in accident rates. The sites with lighter traffic volumes had a 95 percent reduction, and the moderate to heavy sites had a 59 percent reduction. There was a 32 percent reduction in property-damage accidents recorded at the study sites. This is inconclusive because all property-damage accidents are not reported. In the 3 yr following the installation of two traffic circles on high-speed roads in Victoria (with 100 km/hr speed limits), there were no casualty accidents. The cross intersections had been controlled by Give Way or Stop signs. There was a 68 percent reduction in casualty accidents per year that involved pedestrians following traffic circle installation for all sites combined. This result is encouraging. However, owing to the low number of pedestrian accidents, the reduction was not statistically significant at the 0.10 level. Pedestrian and cyclists are often more at risk at traffic circles. Jordan (*15*) reported that pedestrian accidents were reduced at traffic circles, although traffic circles generally present increased difficulty to crossing pedestrians. Similarly, cyclists also encounter difficulty when riding through traffic circles. Jordan reports that the accident rate for cyclists is increased at traffic circles. Methods to improve traffic circle safety are being investigated.

Arndt is currently investigating the influence of traffic circle geometry on accident rates (*16*). Arndt's preliminary results have revealed several useful trends.

- Traffic circles with no left-hand (right-hand in the United States) approach curvature and high approach speeds have an above-average number of accidents with entering and circulating vehicles colliding.
- Traffic circles with no through deflection provided have a large number of accidents that involve collisions between entering and circulating vehicles.
- Traffic circles with a small approach radius and high approach speeds produce single-approaching-vehicle accidents.
- Traffic circles for which there is poor recognition of the central island from approach legs will lead to accidents between approaching vehicles and other approaching vehicles. Single-approaching-vehicle accidents will also occur.
- Traffic circles that are large in diameter, elliptical, and located in high-speed areas with adverse crossfall on circulating lanes lead to instability for larger vehicles.
- Traffic circles that have exit legs with very small splitter islands and a small radius will lead to some accidents that involve exiting vehicles that collide with approaching vehicles.

CONCLUDING REMARK

After many thousands of traffic circles have been constructed in Australia, traffic circles have been demonstrated to be very useful devices in controlling traffic at road intersections. Major advantages include the provision of adequate throughput and driver safety, basically through slower vehicle speeds and low conflict angles. Their use in other parts of the world is encouraged.

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