THE MODERN ROUNDABOUT – TRANSITION FROM RURAL TO URBAN ENVIRONMENT?

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ABSTRACT

Historically, the transition from rural routes, with typically high speeds, to urban routes with speeds of up to half of the latter, has resulted in excessive speeding in such, as well as the corresponding high accident rates. The purpose of this paper is to present the applicability of modern roundabouts to manage these transitions, possible enhancements and the perceptions of road users.

On the R60 approaching Robertson from Ashton, a modern roundabout was constructed in 2003. The roundabout was identified as a measure to control the rural/urban transition and contribute to controlling speeds through the town thus improving safety. This paper determines whether the objective for the construction of the roundabout has been achieved. A post-implementation review was embarked upon to establish if the holistic design application was appropriate. Further what, if any, additional measures could be implemented to improve operation. Interviews have been undertaken with responsible authorities and road users, both regular and incidental, to determine their perceptions.

The paper concludes with recommendations regarding the suitability of modern roundabouts as a measure to manage the transition between the rural and urban environment, possible design improvements and present the road-user's perceptions.

1. INTRODUCTION

Typical of many small towns, the town of Robertson struggled with high travel speeds of vehicles entering the town from a rural environment. The high travel speeds led to unsafe conditions at the Bonnievale intersection, the entrance to Nkqubela township (high pedestrian movements) and the first corner in Robertson opposite the Distillers Corporation (refer to Figure 1). During the upgrading of Trunk Road 31, Section 1 (R60) the problem high travel speeds in the transitional area was investigated. The recommendation for resolving the problem was to construct a modern roundabout. The recommendation was accepted by the Provincial Government of the Western Cape (PGWC) and construction completed in 2003.

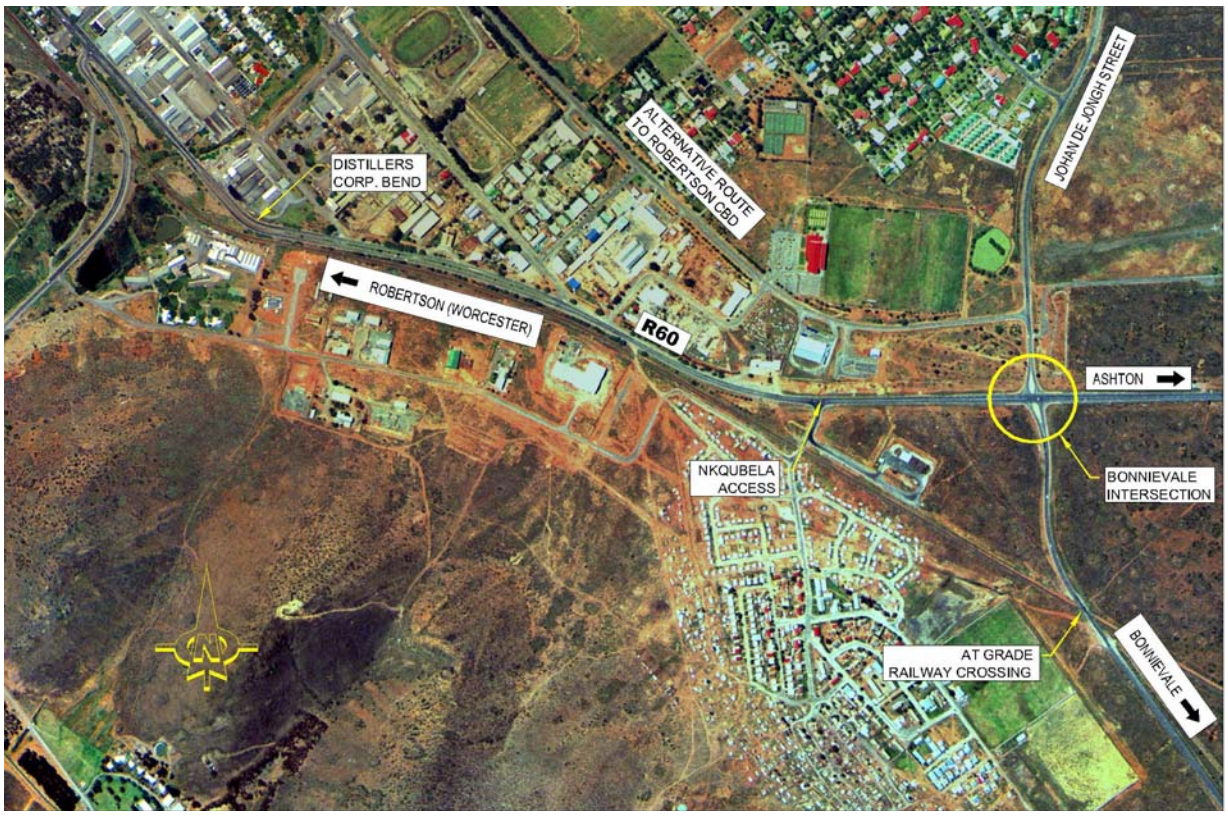

FIGURE 1: General layout of study area

The aim of this paper is to determine:

- How effective the roundabout has been in achieving the objective of reducing travel speeds of vehicles entering Robertson and thus improving safety;
- Can the modern roundabout be considered an appropriate measure for the transition from a rural environment to an urban environment; and
- To determine what, if any, geometric improvements to this roundabout could be implemented to improve the operation and secondly to enhance the design of roundabouts in general.

To answer the above, surveys were done to determine travel speeds and traffic volumes. Interviews were held with drivers and with the road and traffic authorities. A topographical survey was done to confirm if the roundabout was constructed in accordance with the design. Crash records were obtained from the South African Police Services office in Robertson.

2. IMPLEMENTATION OF ROUNDABOUT

2.1 Selection of roundabout

The Bonnievale intersection is the first intersection within the Robertson municipal boundary, which prior to the construction of the roundabout was a priority controlled intersection with priority given to traffic on the R60. Figure 2 shows the layout of the roundabout.

The decision to construct the roundabout was taken after an evaluation of the intersection that considered various methods of intersection control. Two additional factors taken into account in the evaluation was the access to Nkqubela Township, approximately 400 metres to the west of the Bonnievale intersection. Significant pedestrian movements

together with the loading/off-loading of taxis are experienced on the R60. The second factor is the sharp bend outside Distillers Corporation, approximately 1 450 metres to the west of the Bonnievale intersection (see Figure 1).

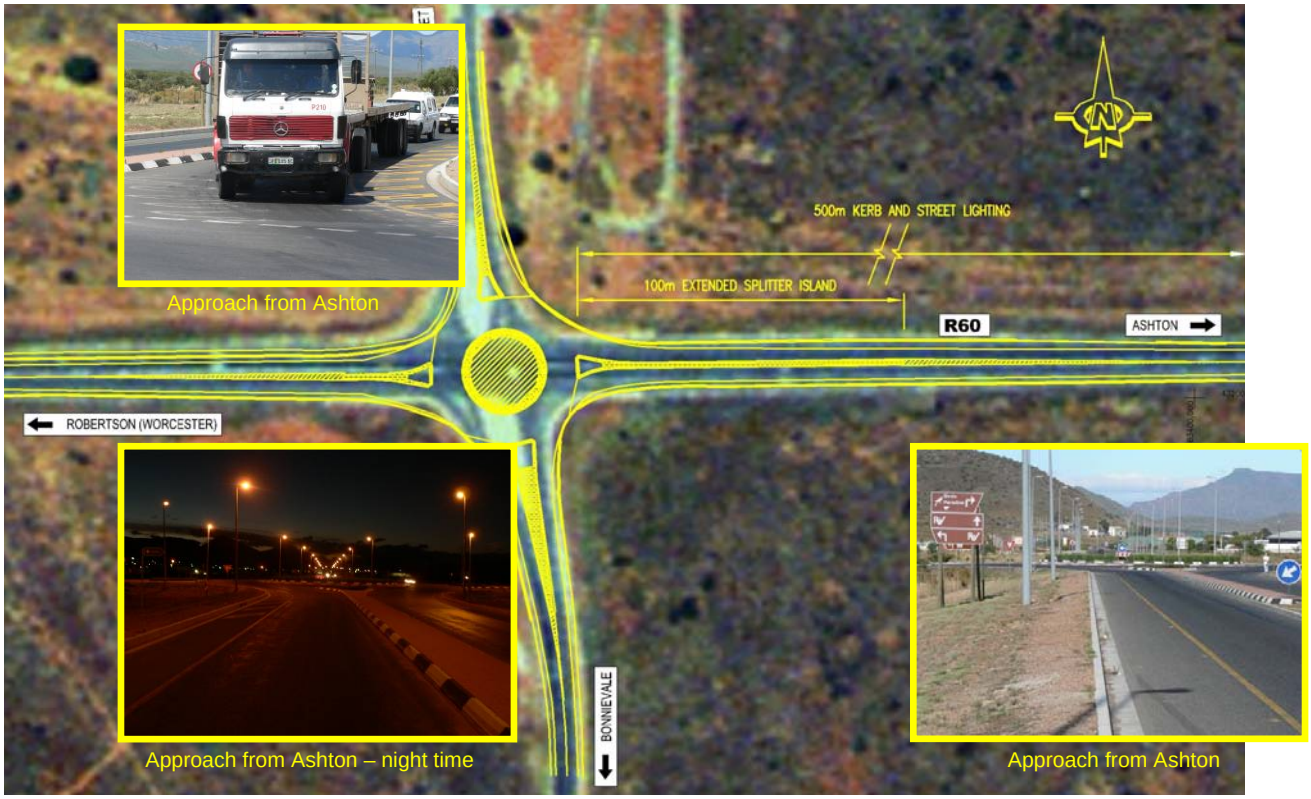

FIGURE 2: Roundabout at Bonnievale intersection

The roundabout was selected as the preferred method of intersection control as all-way stop control and traffic signal control were considered inappropriate/unwarranted for this location. An additional plus for the implementation of the roundabout was the expectation that the roundabout will result in slower travel speeds past the Nkqubela Township entrance and possibly slower speeds on the approach to the sharp bend.

2.2 Special treatment for roundabout approaches

A study on the operating conditions on this stretch of the R60 and on the side-roads revealed that of the four approaches only the Ashton approach (from a rural environment) required special design measures on the approach. Although the Bonnievale approach from the south is also from a rural environment the existence of a stop-controlled at-grade railway crossing approximately 500 metres from the intersection controlled the approach speeds.

On the Ashton approach a number of elements were introduced to warn drivers of the roundabout and to encourage them to reduce speed. Advanced warning was accomplished through the provision of a high visibility advanced warning sign using diamond grade reflective material and flashing lights. The splitter island at the circle was extended 100 metres back along the approach road. The road edge was defined through barrier kerbs and street lighting, both of which extended 400 metres from the end of the splitter island. It was considered that these measures would make a statement to the approaching driver that the environment was changing from rural to urban and the speed at which he/she was traveling is no longer appropriate.

2.3 Unique feature

A unique feature of the roundabout was a political decision to plant vines in the centre island of the roundabout. The vines cover the full area of the centre island except for a 600 mm strip along the outside of the circle.

3. BEFORE – AFTER EVALUATION

3.1 Speeds

Prior to the implementation of the roundabout speed surveys were undertaken on the Ashton approach immediately to the east of the Bonnievale intersection. The posted speed limit in the survey section was 80 kph. The speeds of 226 vehicles were captured with the highest speed being 138 kph and a 85th percentile of 86.0 kph. These results indicated that travel speeds through the intersection were unacceptably high and were a contributory factor to frequency and severity of accidents.

From the post-implementation study the speeds of vehicles were established at the position of the high visibility advanced warning sign (posted speed limit of 120 kph) and at the entrance to the roundabout on the Ashton approach. At the advanced warning sign the maximum speed recorded was 152 kph and the 85th percentile was 95.1 kph. At the entrance to the circle the maximum speed recorded was 63 kph with an 85th percentile speed of 40 kph during the day time and a highest speed of 63 kph with an 85th percentile of 42.2 kph during the night time.

From the comparison of data the roundabout has reduced the travel speed of vehicles through the Bonnievale intersection with the 85th percentile speed reducing from 86.0 kph to between 40.0 and 42.2 kph depending on the time of day.

3.2 Accidents

The comparison of the before accident data and the after accident data proves inconclusive. In the three year period 1999 to 2001, before the construction of the roundabout, there were 15 accidents recorded with one serious injury and 4 slight injuries. In the three year period 2004 to 2006 there were 17 recorded accidents with 1 slight injury. It must be noted that the accident data prior to the implementation of the roundabout is considered incomplete based on discussions with the traffic officials and SAPS. The data for the period after the construction of the roundabout was collected from the SAPS record book, and is more reliable.

The influence of the roundabout on accidents is discussed further when discussing the results of the interviews with the road and traffic authorities.

4. INTERVIEWS

Two different types of interviews were undertaken. Road side interviews were conducted on randomly selected drivers with the assistance of the Traffic Department. The second type of interview was with officials responsible for the maintenance and safe operation of the road i.e. officials from the Provincial Government Western Cape (PGWC), the road authority, Breed River Winelands Municipality (Robertson) Town Engineer and Traffic Officials.

4.1 Road side interviews

Interviews were held with 245 drivers from different vehicle classifications (light, single unit, WB15, WB20 and Interlink) and during the period 07:00 to 21:30. The results of the interviews can be summarized in Table 1 below:

Table 1: Driver's perception of roundabout

Vehicle type	Good	Alright	Indifferent	Not impressed	Bad	Total
Light	150	26	4	7	7	194
Single Unit	9	6	3	0	2	20
WB15	5	0	0	0	0	5
WB20	5	3	0	1	1	10
Interlink	12	3	0	0	1	16
Total	181	38	7	8	11	245
	Acceptable = 89%			Unacceptable = 8%		

It can be seen the majority of drivers, in all vehicle classes, consider the roundabout at the entrance to Robertson to be appropriate.

Additional questions received the following responses:

- 95.1% considered the advanced warning on the Ashton approach to be adequate.
- 97.1% were of the opinion that the road markings and signs guided them safely through the roundabout.
- The design of the roundabout, together with the treatment on the Ashton approach, allowed for a comfortable transition from a rural (120 kph) to urban environment according to 96.1% of the respondents.
- In response to the question of whether the motorist considered the roundabout to be an appropriate measure at the entrance to the town 95.9% were supportive.

An interesting anomaly to the last question was that 37.1% of those interviewed felt that traffic signals could be an acceptable alternative to the roundabout. Among the reasons given for this was that there is a perception that motorists do not know how to use a roundabout, the vines grew too high blocking sight distance and for a small number the roundabout is too dangerous.

4.2 Interviews with road and traffic authorities

All officials interviewed responded with consensus about the following:

- No written complaints have been received from the public.
- Considered the roundabout to be operating satisfactorily and contributing to improved safety.
- Generally the geometric design is sound. The height of the kerbing on the truck apron was a concern to most.
- The modern roundabout as a transition between a rural and urban environment has a place, although each location must be evaluated on its merits.

Specific issues that the officials mentioned are:

- The influence of the roundabout on reducing both the number and severity of accidents has been positive. Although the accident data discussed earlier in this report does not reflect any fatalities the traffic officers could think of at least three occasions in the recent past, before the construction of the roundabout, where there were fatalities. Accidents at the roundabout tend to be single vehicle accidents caused by too high an entry speed and alcohol abuse.
- The local officials considered that the posted speed limit of 60 kph in advance of the roundabout on the Ashton approach could be contributing to the too high approach speed. This is discussed further in the geometric evaluation section.
- The original agreement when the vines were planted was that the height of the vines would be kept under control. During growing season the vines are not trimmed frequently enough with a negative impact on sight distance. This is discussed further in the geometric evaluation section.

5. GEOMETRIC EVALUATION

5.1 Traffic volumes

Traffic counts have been conducted during the period when the road side interviews where conducted. Noticeable is the increase in the right turn movement from Ashton towards Johan de Jongh Street after implementation of the roundabout. It seems as though motorists considered this a dangerous movement in the past, and with the implementation of the roundabout, this perception has changed.

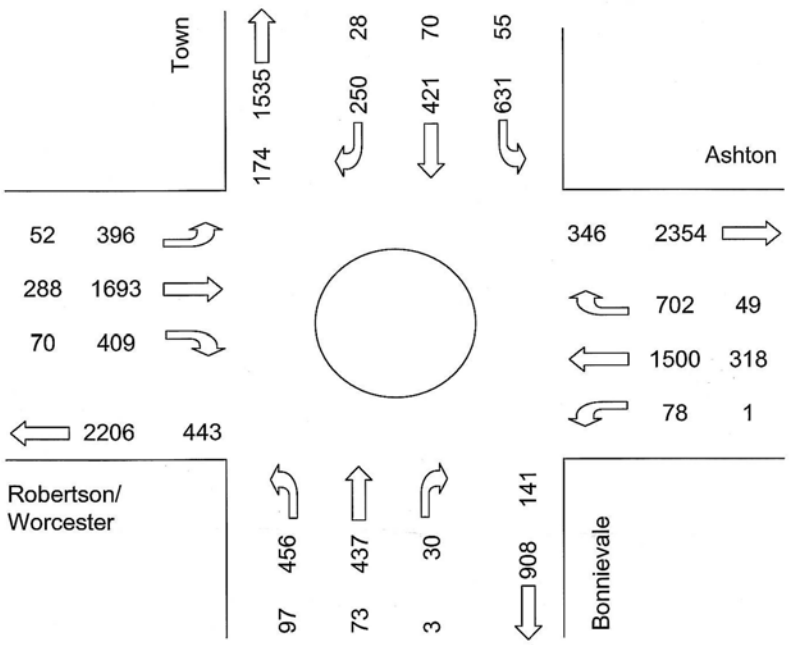

Figure 3: 13 hour traffic counts

5.2 Basis for the design

5.2.1 Design manuals

As South African design manuals were not available for the design of roundabouts in 2002, two overseas manuals and one local research manual have been used to base this design on.

5.2.2 Decisions by engineering team

Although the above manuals do give sufficient guidance to the design of the roundabout itself, the approaches especially from a rural environment are not discussed in great detail, and therefore the engineering team had to make decisions on the most appropriate measures in this regard. The engineering team consisted of transportation and geometric designers, as well as the electrical engineers.

The purpose of the project dictated that a safe transition be introduced at the entrance to the roundabout especially from the rural end, change the approaching motorists perception of the environment through which he/she is travelling. The visual aspects play an important role in this regard. For this purpose it was decided to implement the following measures on the Ashton approach:

- Provision of street lighting in advance and through the roundabout. In the design of street lighting the length required for the adaptation from total darkness to acceptable lighting at the roundabout of 500 m;
- Provision of kerb lines along the edges of the road to reinforce the change in the environment (so the engineers believe). The length of kerbing was chosen to be the length for the street lighting;
- The extension of the splitter island was also proposed, as this provides a less open (more urban) feel. The extent was decided to be 100 m with another 90 m of painted island before the start of the splitter island;
- The road signs on the approach to the roundabout were designed with a high class reflecting material to emphasize the measures ahead, and flashing lights added to the high visibility advanced warning sign to focus the motorist on the roundabout ahead.

The engineering team has deviated from the design recommended in the manuals in one aspect on the entries and exits to the roundabout. The engineering team were concerned about safety on the approach to the roundabout for vehicles decelerating from 120 kph to 40 kph and considered that the demarcation of the entry radius by a painted yellow line preferable to a barrier kerb. On all entries and exits the barrier kerb has been set back and the radii demarcated with yellow lines.

5.3 Design versus construction

During site investigation after the construction of the roundabout an observation was made that in some areas the traffic is not operating in a way that the design envisaged. For this purpose a detailed topographical survey was done to evaluate the differences. Only if the construction deviated from the design and was considered to influence the operation, it is discussed further in the text below.

5.4 Evaluation of design

5.4.1 Approach to roundabout

- Observations on site

The approaches to the roundabout do operate as envisaged. Site observations, confirmed by speed surveys, indicated that the approach speeds are not too high.

From the Ashton side there is evidence of accidents as a result of vehicles entering the roundabout too fast and continuing straight on into the centre island. The reason for these

accidents is not clear but according to traffic police a large percentage of these motorists were driving under the influence of alcohol (see discussion below).

All other approaches to the roundabout appear to operate satisfactorily.

- Engineering intuition

All the elements (i.e. road signs, road furniture, kerbs, road markings, street lighting, etc.) together do create the impression that the environment is changing and therefore considered appropriate.

5.4.2 Roundabout

- Observations on site

On the approach from Ashton, the path of vehicles entering the roundabout did not follow the yellow edge line provided for guidance. Vehicles were cutting across the yellow line (visible on the top photo insert on Figure 2). The survey revealed that the yellow line has not been painted according to the design. The design yellow line would have been in the correct position for the observed vehicle travel path. It must be noted that the normal design standard of the kerb defining the inside line of the entry into the roundabout was deviated from in order to cater for the shoulder on the approach.

The results of the speed survey at the entry to the roundabout do not suggest that the use of the yellow line instead of a barrier kerb has adversely affected the operation and safety of the roundabout.

Similarly the guiding yellow edge line on the Johan de Jongh Street approach has not been painted in accordance with the design with the result that vehicles are cutting across the yellow line. The yellow line should be remarked as per the original design.

- Feedback from authorities

An issue of concern for the traffic authorities was that two or three times a heavy vehicle has overturned on the exit to Robertson (travelling from Ashton towards Robertson on the R60). Too high an entry speed into the roundabout was a contributory factor according to the authorities. An evaluation of this revealed:

- Site inspection and the topographical survey showed that the maximum cross-fall in the roundabout is 2.7% (outfall), more than the maximum 2.5% (outfall) recommended in the design manuals. It is however considered that the cross-fall is not a contributory factor to the accidents.
- The semi-mountable kerb on the truck apron could however contribute to heavy vehicles overturning when entering the roundabout too fast and the back wheels being lifted by the semi-mountable kerbs.
- The posted speed limit prior to the entry into the roundabout at the municipal boundary is 60 kph. This could misinform the approaching driver about the required approach speed to the roundabout.

It must be noted that the truck apron was designed for abnormal vehicles, and therefore the decision to use semi-mountable kerbs. Visibility of this kerb line was also a consideration. Taking all into consideration, it must however be concluded that the use of mountable kerbs instead of semi-mountable kerbs are preferred.

The vines planted in the centre island form an obstruction to sight distance due to the vertical alignment of the approaches, hiding vehicles in the roundabout particularly on the Johan de Jongh and Bonnievale approaches. Design criteria states that 50 m of the travelling path in advance of the give-way line must be visible. Drawing this line, the outer 7.4 m of vines are in the way, and should either be cut back considerably, or removed and exchanged with low level shrubs or crushed stone to provide the necessary sight distance. The remaining 3.4 m radius in the centre of the roundabout is not considered a problem, even with bigger/ higher items.

- Engineering intuition

Motorists are not driving according to paint markings (yellow line), but use the kerb line as a guide for their vehicle path. The introduction of rumble strips in the shoulder is not considered effective in keeping the motorist out of the shoulder (as was done on the Ashton and Robertson approaches).

5.5 Improvement suggestions

5.5.1 Apron kerbs

From a safety point of view the truck apron kerbs should be changed to mountable kerbs, as this could be cause of a trucks overturning in the roundabout (although not proven). This does make the visible area for GM8 road markings smaller, but the barrier kerbs on the inside of the truck apron should be sufficiently visible for the motorist.

5.5.2 Cross-fall

Generally a cross-fall of 2% outwards is considered the norm for a design. Due to the geometry of the surrounding roads it dictates that other cross-falls be implemented. From observations one should aim at a maximum cross-fall of 2.5% (as per design manuals).

5.5.3 Vines

The outer ring of the vines should be closely monitored and maintained (especially in the growing season), but at this stage the trimming thereof or the replacement with smaller shrubs is proposed for the outer 7.4 m, while the inside 3.4 m radius area of the roundabout is not critical.

5.5.4 Posted speed limit

A posted speed limit of 60 kph when entering the municipal area of a town is a necessary practice. It is recommended that an advisory speed of 40 kph be introduced in conjunction with a W201 (roundabout warning sign). These signs to be located between the 60 kph posted speed limit sign and the roundabout on the Ashton approach.

6. CONCLUSIONS

From the engineering surveys and the site observations the conclusion can be made that the original objective of providing a safe transition from a rural to urban environment which results in lower travel speeds on entering the town of Robertson, has been achieved.

The interviews with the public and authorities involved in the roundabout all considered this measure to be acceptable and an appropriate measure.

Although this roundabout has been found to be an appropriate measure for the transition between the rural and urban environments, this measure might not be appropriate in all instances and each location should be evaluated on its merits.

Based on the results of this investigation the following enhancements/alterations should be implemented:

- Yellow edge line road markings must be marked as per the original design;
- The semi-mountable kerbs on the truck apron should be replaced with mountable kerbs;
- The outer 7.4 m of vines must be trimmed and great effort put into the maintenance thereof.
- Introduce combined advisory speed limit of 40 kph and W201 sign in advance of the roundabout on the Ashton approach.

7. REFERENCES

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[2] US Department of Transportation, Federal Highway Administration, FHWA-RD-00-067, June 2000. Book title “Roundabouts: An Informational Guide“

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