TMC – Tinni Management Consulting

PAVEMENT INFORMATION NOTE

Issue No. 32

Edited by Arvo Tinni. Email arvo@tinni.com.au

15 10 2009

Every now and then I am asked to comment on Consultant pavement designs for roundabouts. It is quite common that there are issues that have been overlooked, which can create performance problems and additional construction and maintenance costs.

The purpose of this PIN, which I wrote some time ago, is to provide basic background information to our people dealing with design, Tenders and subsequent construction.

NOTES ON ISSUES WITH TYPES OF PAVEMENT OPTIONS FOR ROUNDABOUTS

A. GENERAL

1. All pavement design guidelines refer or prefer rigid pavements for roundabouts. Flexible pavements have not been ruled out.

2. There are no clear guidelines for any type of flexible pavement designs.

3. Rigid pavement geometric and structural design parameters are well documented, but for flexible pavements a number of assumptions need to be made.

4. It has been established that the overturning moments on the vehicles impact loads onto the outer wheels of as high as 60–80% of the total axle loading. This is a significant additional load. For rigid pavements this is catered for by the specified higher load safety factors (L_{SF}), but for flexible pavements it must be assumed that actual loads or ESAs have to be adjusted accordingly.

5. RTA seem to consider only rigid pavements and depending on the radius of the roundabout, SFRC (Steel Fibre Reinforced Concrete) predominates.

6. RTA provides the following "Vague Classifications" for the roundabouts:

Category	Inner Radius	Outer Radius
Small	<10m	<20m
Medium	10-20m	20-30m
Large	>20m	>30m

B. RIGID PAVEMENT DESIGNS

1. PCP (Plain Concrete Pavement) and JRCP (Jointed Reinforced Concrete Pavement) are feasible only on very large radius roundabouts where the slab corner angles can be maintained about 84º.

2. CRCP (Continuously Reinforced Concrete Pavement) is generally unsuitable. There appears to be no feedback from the only known trial undertaken in Belgium some years ago.

3. SFRC is the commonly used material.

4. Flexural fatigue is the dominant joint distress mode. Adjusted L_{SF}'s (Load Safety Factors) have been derived to cater for this.

5. As erosion analysis is not considered, a lean mix concrete (LMC) subbase becomes mandatory.

6. In all designs an edge drain is a must. These may also be required on the "high" side depending on the treatment of the inner area.

7. SFRC through its higher flexural strength (5.5 MPa) results in substantial reduction of the base thickness. (It might be noted that this does not result from the steel fibre reinforcement, but from the significantly higher cement content which is required for purposes such as the fibre bond and mix workability.

8. SFRC is ideal for handling acute angles in slabs. Slab widths of up tp 6 m are allowed.

9. RTA has been increasing the minimum thickness for SFRC pavements over the years and now specifies it as 190mm (VicRoads – 150mm).

10. The L_{SF}'s (Load Safety Factors) for roundabouts are tied to the specified L_{SF}'s for the adjacent roads and then adjusted as follows:

L_{SF} on through pavement	**L_{SF} for roundabout on through pavement**
1.0	1.3
1.1	1.4
1.2	1.5

11. A concrete pavement will have minimal maintenance requirement.

C. FLEXIBLE PAVEMENTS

1. It is assumed that it follows conventional design using the higher loadings.

2. Similar to the much higher wheel loads due to the overturning moments, significant lateral forces are also imparted by the wheels due to the centrifugal forces on the vehicle created by the small radius curves.

3. Further, the tri-axle combinations tend to skid and slide around the curves and this cause scuffing and also heaving of the surface.

4. For the above reasons, chip seals and thin asphalt surfacings are unsuitable for roundabouts.

5. To counter these significant transverse forces, high modulus asphalt should be used. I consider 5000 MPa at 30ºC as a minimum.

6. For stage construction, there are often compaction problems as the use of large rollers may be restricted and odd shaped edges cannot be properly accessed. (This is partially overcome if a LMC subbase being placed over the full width of the excavation).

7. If the design requires a LMC subbase then 175mm of asphalt will be required as a minimum. That being the case, the base could well be concrete also. The latter could be trafficked when its compressive strength reaches 20MPa.

CONSIDERATIONS

For the selection of the structural pavement the following should be considered:

1. The HV design traffic and especially the percentage of tri-axles.

2. The radius of the roundabout.

3. Assumptions and confidence in the flexible pavement design parameters, including the maximum pavement temperature as distinct from the WMAPT (Weighted Mean Annual Pavement Temperature).

4. At what radius do the sideways forces lose significances?

5. Constructability issues like staging, quality, time etc.

6. Cost comparison, including traffic switches of the options.

7. Subsequent likely maintenance requirements, interference with traffic and costs. This can be developed from the LCC analysis for the through pavement.

8. Lead time required for various maintenance actions compared to the response time based on safety issues.

D. <u>CONCLUSION</u>

The selection of any pavement other than SFRC requires detailed analysis and highly informed handling of the design.