

Effects of Automated Driving on Traffic Flow in Roundabouts

Master's Thesis of Mohamed Arshad Sheik

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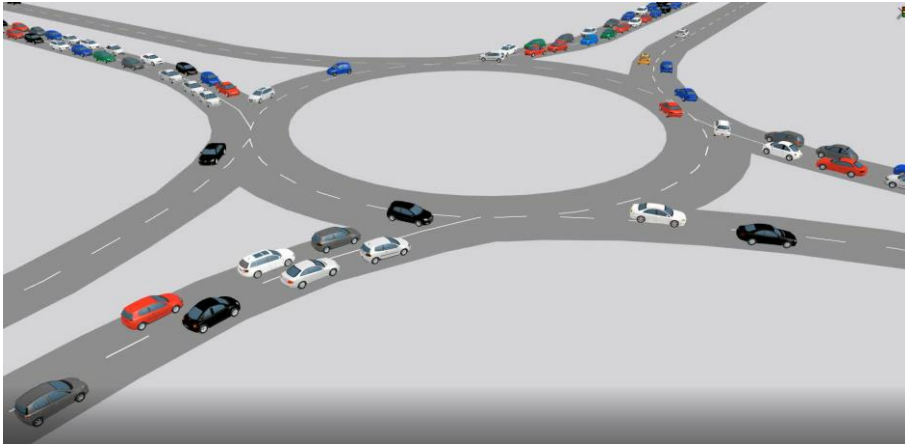


Fig.1: Screenshot of the two-lane roundabout model on VISSIM

Research Objectives:

- Investigate the possible improvements in traffic performance of the different roundabout configurations under various demand levels and MPR of AVs.
- Investigate the capacity improvements due to the introduction of AVs on roundabouts with pedestrian crossings.
- Understand the implication of changes in AV driving behaviours on traffic flow.

This thesis considers both AVs with and without vehicle-to-vehicle communication capabilities. Internal modelling on VISSIM was considered for CAV behaviour. Minimum gap times for the roundabout entry for AVs were taken from the study by Atkins (2016).

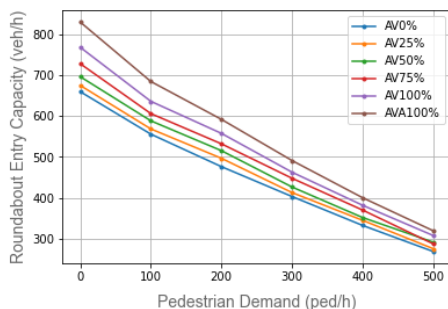


Fig.5: Capacity curves for the one-lane roundabout with pedestrian crossings

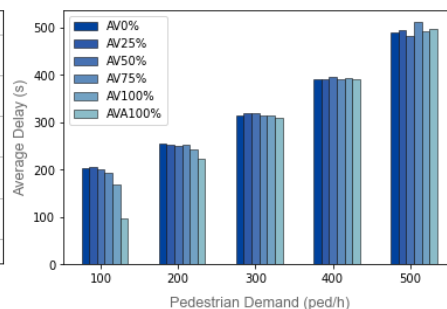


Fig.6: Average delays for the roundabout with pedestrian crossings

At higher pedestrian demand levels, no significant capacity improvements due to AVs can be expected because pedestrians have priority over vehicles.

References

Atkins (2016). Research on the Impacts of Connected and Autonomous Vehicles (CAVs) on Traffic Flow (Stage 2: Traffic Modelling and Analysis, Technical Report).
WHO (2018). Global Status Report on Road Safety, World Health Organization.

Introduction

Road traffic congestion is a frequent problem faced in all major cities across the world. According to WHO (2018), road traffic injury is the number one cause of death in children and young adults. With the advancement of vehicle automation technology, Automated Vehicles (AVs) are expected to solve traffic congestion issues and reduce road accidents. The Market Penetration Rate (MPR) of AVs in traffic will increase gradually over a long time period and it requires an understanding of the interaction between AVs and Human-Driven vehicles (HVs). The impacts of AVs on roundabouts have received much less focus compared to motorways or signalized intersections. This thesis aims to study the impact of AVs on traffic flow in one-lane roundabouts, two-lane roundabouts, two-lane roundabouts with one-lane exits and the effects of pedestrian crossings in roundabouts with AV traffic. For this purpose, the microscopic traffic simulation software PTV VISSIM was used.

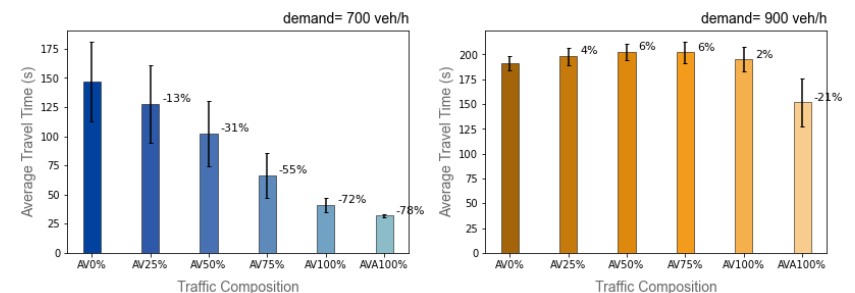


Fig.2: Average travel times for the one-lane roundabout in saturated and congested flows

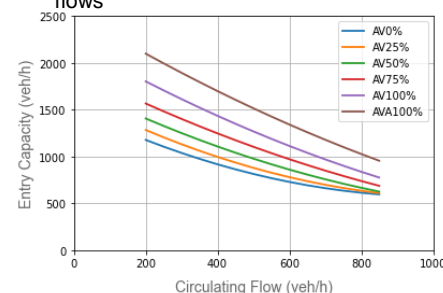


Fig.3: Capacity curves for the one-lane roundabout under different MPR of AVs

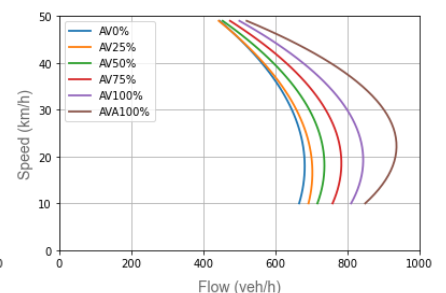


Fig.4: Speed-flow curve under different MPR of AVs

Results

The traffic performance indicators such as average speeds, average travel times and roundabout entry capacities were found for the different roundabout configurations and various MPR of AVs. The results indicated that the expected benefits due to AVs can be limited by the traffic demand levels and driving behaviour characteristics of AVs. It was also found that two-lane roundabouts with one-lane exits had a limited scope of capacity improvement with the introduction of AVs compared to the same roundabout with two-lane exits. AVs showed significant improvement in capacity for roundabouts with pedestrian crossings under low pedestrian demand levels, but the capacity improvements were smaller for higher pedestrian demands. Finally, a sensitivity analysis was also performed for the roundabout simulation model.