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Investigating the Conversion of a Signalized Intersection to a Turbo Roundabout

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Introduction

Roundabouts are increasingly popping up across the United States as a tool to improve traffic flow and safety, but one type of roundabout—despite its popularity in European countries—has yet to be implemented widely in the U.S.: the turbo roundabout. This research evaluated the operational and safety benefits of a turbo roundabout built on State Route 25/Highway 156 in the City of Hollister, CA (Caltrans District 5). Turbo roundabouts are multilane roundabouts with helical pavement markings and raised structures to separate the ingress and circulating roadways. The concept of the turbo roundabout was first proposed and implemented in the Netherlands to mitigate congestion by improving traffic flow efficiency and addressing safety concerns in conventional multilane roundabouts. Several different turbo roundabouts exist, including the basic turbo roundabout, the egg turbo roundabout, the knee turbo roundabout, the spiral turbo roundabout, and the rotor turbo roundabout. Caltrans implemented the largest turbo roundabout design, the rotor roundabout, at the intersection to accommodate the existing demand for passenger cars and heavy vehicles. The roundabout studied in this research is the first-ever turbo roundabout in CA (and only the second in the U.S., with the other being in Jacksonville, FL).

Study Methods

The study used detailed vehicle trajectory data to assess the performance of the newly installed turbo roundabout relative to the formerly used signalized intersection. The trajectory information was estimated in two ways: detailed microscopic simulation models and analysis of video recordings of the real-world movement of traffic through the signalized intersection and roundabout. The trajectory data were then used to estimate the number and nature of conflicts, i.e., potentially dangerous interactions that may lead to collisions between vehicles traversing the intersection. The measures used to define these conflicts are called surrogate safety measures. Surrogate safety measures were used in this study in lieu of real collision data because crash data-based safety evaluation requires multiple years (at least three) of collision data for both before- and after-installation periods. This evaluation was conducted within a few months of the turbo roundabout installation. To enable Caltrans to perform this collision data-based evaluation when future crash data are available, this study also used the Empirical Bayes (EB) method recommended by the Highway Safety Manual to estimate a baseline of expected crashes for the counterfactual scenario, i.e., one where the intersection was left as a 4-legged signalized intersection. This baseline will support future further research on long-term safety evaluation.

Data collected in the aftermath of the opening of the first turbo roundabout in the state of California shows reduced queuing delay and potential for crash reduction.

Findings

The simulation model showed a meaningful reduction in queuing-related delay for all approaches to the intersection after the installation of the turbo roundabout. On the approaches to the intersection, the queuing delay reductions ranged from 82.20% to 99.02% during morning and afternoon peak hours. This means that vehicles the roundabout led to vehicles waiting less time to enter the intersection. While the real-world trajectory analysis showed higher interactions between vehicles at the turbo roundabout compared to the signalized 4-legged design, the most dangerous of interactions (with speed differential between interacting vehicle(s) more than 40 MPH and/or time to collision less than 1.5 seconds) were substantially reduced. The turbo roundabout also eliminated dangerous high-speed crossing conflicts that lead to the most severe T-bone type crashes on 4-legged signalized intersections. The EB method from the Highway Safety Manual also estimated ~15.38 crashes per year for the counterfactual scenario (in which the turbo roundabout was not implemented into the former intersection). In the future, Caltrans can monitor the crash data and compare the long-term annual frequency of crashes at the turbo roundabout with this counterfactual estimate of ~15.38 crashes per year to conduct a crash data-based long-term safety evaluation.

Policy Recommendations

A turbo roundabout should be considered as an alternative wherever a multilane roundabout is used. Initial research indicates turbo roundabouts increase traffic flow and reduce conflicts that can lead to severe collisions, making our communities efficient and safer. Since the real-world vehicle trajectory data used in this research were collected soon after roundabout installation, long-term safety performance using crash data should be examined as soon as three years of post-installation collision data become available to ensure these improvements are sustained in the long term. It would also be appropriate to continuously monitor speeds at the turbo roundabout to ensure that the speed reduction observed post-roundabout installation is not eliminated as the drivers become more familiar with navigating the redesigned intersection.

About the Principal Investigator

Dr. Anurag Pande is a Professor in the Department of Civil and Environmental Engineering at California Polytechnic State University, San Luis Obispo. His research interests include traffic safety, analysis of data to improve transportation decision-making, and service-learning

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/2233**

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