ROUNDABOUT DESIGN

DEFINING THE STAGES OF ROUNDABOUT PLAN DETAIL

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Todd Sanders, PE of Short Elliott Hendrickson (SEH) and Scott Ritchie, PE of Roundabouts and Traffic Engineering (RTE), a nationally recognized roundabout design expert and instructor of roundabout design practices, will co-present recommendations to define the amount of detail required for the appropriate stage of design. Traditionally, intersections have been designed to 30%, 60%, and 90% complete stages. This process is well defined for traditional intersections, but not for roundabouts. Scott and Todd will present design levels they have developed. The focus will be to present guidelines for agencies to follow when working with roundabout designers. Each of the design stages will be defined with an appropriate level of detail. Defining these stages assists in laying out the scope of work and a way to appropriately associate costs with the level of detail required. This presentation will be useful for anyone involved with the implementation of roundabouts.

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INTRODUCTION

As the traffic demand continues to grow within the United States, so does the need to safely and efficiently manage traffic at intersections. Since the invention of the automobile, numerous types of intersection control have been tried and developed. Starting with traffic control officers, progressing to the development of signals, to the introduction of the modern roundabout, the goal has always been the same: to control traffic in a safe and efficient manner. Since the traditional signalized and stop controlled intersections have been the preferred alternative for many years in the United States, plan submittals and reviews have developed around a 30-60-90 percent approach. This methodology has become an industry standard for most jurisdictions to perform quality control and quality assurance at various stages of design. Jurisdictions have developed an expectation of the deliverable and level of effort required for each level of submittal with respect to the complexity of the intersection. The 30-60-90 percent design submittals are well defined for traditional signalized and stop controlled intersections with increasing amounts of detail per submittal stage. However, this method is not as clear when the intersection is a modern roundabout since roundabouts require more initial geometric design efforts to determine proper configuration, feasibility, and impacts.

Although the first modern roundabout was built in the United States in 1990, modern roundabouts did not gain favor until the late 1990s. After the turn of the century in year 2000 an increasing number of jurisdictions started to recognize roundabouts as an acceptable form of intersection control. Because of the recent acceptance of modern roundabouts within this decade, the engineering industry has not had enough experience to identify the deliverables for the various stages of design submittals of the modern roundabout.

As an example, compare the design of a signalized intersection to that of a roundabout intersection. A 30% design plan of a signalized intersection has the horizontal geometrics initially set with simple lane widths. The signal design has not been completed, the vertical design has not been initiated, and, for most projects, the horizontal geometrics are primarily offset parallel lines for striping and curb faces. For a modern roundabout to be completed to the same 30% level design, the horizontal geometrics need to be set fairly rigidly for a robust design functioning well for speeds, trucks, entry angles, capacity, and safety. Because of the sensitivity of the geometrics to the operation of the roundabout, this is a large portion of the overall design efforts. Before the horizontal design is completed, a preliminary step, or a feasibility level design, would typically occur. In this step, the intersection would be evaluated to determine if a modern roundabout is feasible with respect to many factors such as right-of-way impacts, sight distances, and lane configuration before completing the final horizontal geometrics.

The goal herein is not to reinvent the submittal requirements for the modern roundabout, rather, to adopt a similar system for modern roundabout submittals that meet the minimum requirements for proper analyses at various stages of design efforts as well as the expectations of jurisdictions to enable them to make a proper decision and conduct reviews.

PURPOSE

The purpose of this publication is to provide jurisdictions with the proper stages and level of effort required of design submittals for roundabouts in comparison to the current 30-60-90 percent as well as the 100% submittal levels for traditional intersections. Currently, a feasibility analysis of traditional intersections occurs at the 30% design level. This paper proposes a fifth step for modern roundabout design, a step prior to the 30% design submittal to be used to evaluate and compare a roundabout intersection to a signalized intersection.

OBJECTIVE

The objective herein is to clearly define the deliverables at each stage of design for the use of both consultants and jurisdictions in the preparation and review of roundabout design plans.

ROUNDABOUTS VS TRADITIONAL INTERSECTIONS

Characteristically, the design of traditional intersections is based on the offset of parallel lines from centerline depending on the need for the number of turn lanes, storage lengths, curb return radii, and the like. This is a straight forward, simple process and is very insignificant part of the overall design efforts. The feasibility layout for a traditional intersection is usually handled as a part of the 30% design phase. Variations of the lane configuration, reverse curves for turn lane designs, storage lengths, and etcetera can be made based on the capacity requirements of the intersection. These changes are generally minor and can be accomplished by offsetting and/or extending pavement edge and striping alignments. Truck turning templates are analyzed to verify the design vehicle or large trucks can be accommodated, especially for their right turn movements. Design checks are often made to verify opposing left turn vehicles do not impede on each other, an acceptable gap between vehicles is attained, right turn vehicles can stay in there own lane with out driving over islands or curb returns, and stop bars are placed based on the movements of all vehicles so that stopped vehicles are not in the way of turning vehicles. Although sometimes minor variations of the intersection design are completed when these checks are tested, the general layout of the intersection stays intact and unchanged. For example, the start locations of left turn lanes may change, but the offset of the left turn lane will remain in the same place.

The design process for modern roundabouts differs greatly from the design of traditional intersections. The approach geometry, inscribed circular diameter, circle placement, and lane configuration through the roundabout usually have significant impacts to the capacity and safety of the modern roundabout, its public acceptance, function, and operations in the field. For this reason, the initial design levels of effort as well as the coinciding costs are typically much larger than traditional intersections. For a modern roundabout design to match the level of effort and cost expected by the client, it is critical to have the submittal and details within each stage of submittal be well defined and understood by the preparer and the receiving jurisdiction. Using the current 30-60-90 and

100 percent design submittal expectations already in place with most jurisdictions as a standard, the 30 percent submittal must have the placement of the circle for the modern roundabout optimized, design vehicle turning templates shown and verified, capacity design parameters established using traffic analysis software, and fastest path speeds derived and computed. In order to match client expectations for a preliminary submittal, a formal preliminary feasibility level analysis should be completed.

MODERN ROUNDABOUT SUBMITTAL PROCESS

The submittal process for modern roundabouts should include the traditional 30%, 60%, 90%, and 100% submittals, but it would be recommended that a fifth step be added. This fifth step would be completed prior to the 30% submittal and provides the designer and jurisdiction with the opportunity to compare the estimated impacts of implementing a modern roundabout to the estimated impacts of implementing a traditional intersection or traffic signal. The standard submittal process for modern roundabouts is as follows: (1) Feasibility Analysis, (2) 30% Design and Review, (3) 60% Design and Review, (4) 90% Design and Review, (5) 100% Design and Review. In order to manage the expectations of both the designer and the client, the deliverable at each stage of review must be defined.

Feasibility Analysis Stage

The purpose of the Feasibility Analysis Stage is to identify if a modern roundabout is appropriate and feasible for the location as well as to potentially provide a comparison to another intersection control device or type such as a signalized intersection. Since many DOT's throughout the country are adopting modern roundabouts as a credible form of traffic control, engineers now have more options when determining what type of intersection to implement at a location. This is accomplished by identifying the initial lane configuration and analyzing physical constraints of existing or proposed features.

The initial lane configurations are determined by the designer in a pre-design phase. The designer is required to conduct an inventory of future conditions of the intersection.

- Identify future traffic volumes
- Identify any current deficiencies of the operation of the existing intersection
- Determine any potential site scenarios
- Conduct capacity analysis for planning level only using default geometric inputs (AM/PM peak, any off peak flows)
- Estimate Circle Diameter
- Identify the number of lanes/lane balance (entering lanes, exiting lanes, and circulating lanes)
- Identify design vehicle

When determining the analysis of future conditions, it is critical for the designer to coordinate with the client of any commitments with local property owners. A thorough survey is required at this stage to create an inventory of the following existing conditions:

- Access issues/access management
- Grades
- Sight Distance
- Right of Way
- Environmental

Upon completion of this step, the designer can use the plan sketch of the modern roundabout to estimate the impacts to:

- Capacity
- Initial/estimated right of way impacts
- Site constraints through rough sketch of geometry (for example buildings, railways, stopping sight distance, etc)
- Access management
- Emergency Services
- Air Quality – based on delay
- Environmental
- Aesthetics
- Safety
- Any unique considerations for the individual intersection

It is important to stress, that no final design of a modern roundabout occurs during this stage. The goal is to identify if a roundabout is feasible and what the potential impacts are of implementing a modern roundabout. It is also very important to note, that even though the roundabout has not been taken to final design, a thorough understanding of roundabout design is required. The sketch level design, though not final, must be close to where the layout will be in final design. The client has the ability to comment on preliminary sketch level drawings which are easily modified. Design costs are minimized and communication between the client and the designer are maximized. The information compiled at this stage is critical to the successful implementation of a roundabout.

If an alternative form of intersection control is also being considered (signalized intersection or stop control), both intersection types can be compared with each having its own set of advantages and disadvantages. The client is then provided the best information available to quantify the type of intersection control to choose. If the client decides the disadvantages are greater for the implementation of a modern roundabout, then the additional time, energy, and associated costs have not been wasted on going into final design for a roundabout creating a Win – Win situation for both the client and the designer.

30% Design Review

The purpose of the 30% design review is to provide the client with the horizontal design finalized. Changes made to the horizontal design are minor and will not require complete redesign of the modern roundabout. The circle location is optimized and all of the design

parameters are set to acceptable ranges. At this stage of the design, the client would expect to receive:

- Capacity analyses for design with actual measured design parameters
- Final lane configuration(s)
- Finalized face of curb design including crosswalks, splitter islands, bike ramps, truck aprons, etc.
- Design vehicle(s) movement checks
- Locations of all multimodal paths, sidewalks, bike ramps, etc with appropriate widths
- Illustrated lane markings and pavement arrows (multilane only)
- Design file showing actual measurements of the design parameters
- Stopping sight distance
- Intersection sight distance
- Fast Path speed calculations at entry and circulating

With the current 30%, 60%, 90%, and 100% design submittal system, the majority of the review comments are received at the 30% design level. For roundabouts, the Feasibility Analysis is critical to enable the receipt of comments prior to conducting the final design. Small changes of one leg of a roundabout can have major implications to the operation of the other legs of the roundabout and may require the entire roundabout to be redesigned. Since all the constraints are inventoried in the Feasibility Analysis, the designer is able to commence the 30% design with all of the identified constraints. Rework is minimized since the client has already been presented with a sketch level of the approximate location of the roundabout. Comments are received on preliminary drawings which allows for modifications to be completed more easily.

60% Design Review

The purpose of the 60% design submittal is to finalize the vertical geometrics of the roundabout. For a review plan at 60%, the client would expect to see the following:

- Final horizontal design changes implemented
- Roadway profiles for each leg of the modern roundabout
- Circulating roadway profile or alternate
- Cross slopes and/or spot elevations
- Intersection sight distance envelopes
- Landscaping design parameters in central island and around perimeter of the modern roundabout
- Central island grading design/profile
- Lighting placement/design
- Drainage design/inlet locations
- Preliminary construction staging and traffic control plans
- Signing and pavement marking plan and detail sheets
- Development of all appropriate plan sheets

90% and 100% Design Review

The 90% and 100% design submittals are essentially the same. At this stage, the design of the modern roundabout is finalized. Final plans would be submitted at this point. Changes would include:

- Final vertical and drainage design changes implemented
- Final signing, lighting, and landscaping changes implemented
- Final staging and traffic control changes implemented
- Final plans sheets produced

CONCLUSION

Managing the expectations of both the client and the designer is critical to the successful implementation of any project. Clearly identifying the deliverables provides the client exactly what they will be receiving and assists the designer in developing hours and associated costs with each design submittal. The current 30%, 60%, 90%, and 100% design submittals work great for traditional intersections, but are not applied as well to modern roundabout designs. The guidelines laid out within this report, will assist in managing client expectations of costs and expectations on what will be provided.