Geometric Design of Roundabouts

An Online Continuing Education Course for Engineers

Course Number: T-6005

Credit: 6 Hours / 6 PDH / 6 CPD

Geometric Design of Roundabouts

1 INTRODUCTION

Roundabout design involves trade-offs between safety, operations, and accommodation of the design vehicle.

The geometric design of a roundabout requires the balancing of competing design objectives. Roundabouts operate most safely when their geometry forces traffic to enter and circulate at slow speeds. Poor roundabout geometry has been found to negatively impact roundabout operations by affecting driver lane choice and behavior through the roundabout. Many of the geometric parameters are governed by the maneuvering requirements of the design vehicle. Thus, designing a roundabout is a process of determining the optimal balance between safety provisions, operational performance, and accommodation of the design vehicle.

Some roundabout features are uniform, while others vary depending on the location and size of the roundabout.

While the basic form and features of roundabouts are usually independent of their location, many of the design outcomes depend on the surrounding speed environment, desired capacity, available space, required numbers and arrange-ments of lanes, design vehicle, and other geometric attributes unique to each individual site. In rural environments where approach speeds are high and bicycle and pedestrian use may be minimal, the design objectives are significantly different from roundabouts in urban environments where bicycle and pedestrian safety are a primary concern. Additionally, many of the design techniques are substantially different for single-lane roundabouts than for roundabouts with two or more lanes.

The contents of this course are intended to serve as guidance, not as a standard or rule.

As described in this course, roundabout design is an iterative process where a variety of design objectives must be considered and balanced within site-specific constraints. Maximizing the operational performance and safety for a roundabout requires the engineer to think through the design rather than rely upon a design template. Throughout this course, ranges of typical valus are given for many of the different geometric elements to provide guidance in the design of individual roundabout components. The use of a design technique not explicitly included in this course or a value that falls outside of the ranges presented does not automatically create a fatal flaw or unsafe condition provided that the design principles presented in Section 2 can be achieved.

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Roundabout design is an iterative process.

Exhibit 1 provides a general outline for the design process, incorporating elements of project planning, prelinimary design, and final design into an iterative process. Information from the operational analysis is used to determine the required number of lanes for the roundabout (single or multilane), which dictates the required size and many other design details. The basic design should be laid out based upon the principles identified in Section 2 to a level that allows the engineer to verify that the layout will meet the design objectives. The key is to conduct enough work to be able to check the design and identify whether adjustments are necessary. Once enough iteration has been performed to identify an optimum size, location, and set of approach alignments, additional detail can be added to the design based upon more specific information provided in sections 4 through 6 related to single-lane, multilane, and mini-roundabouts, respectively.

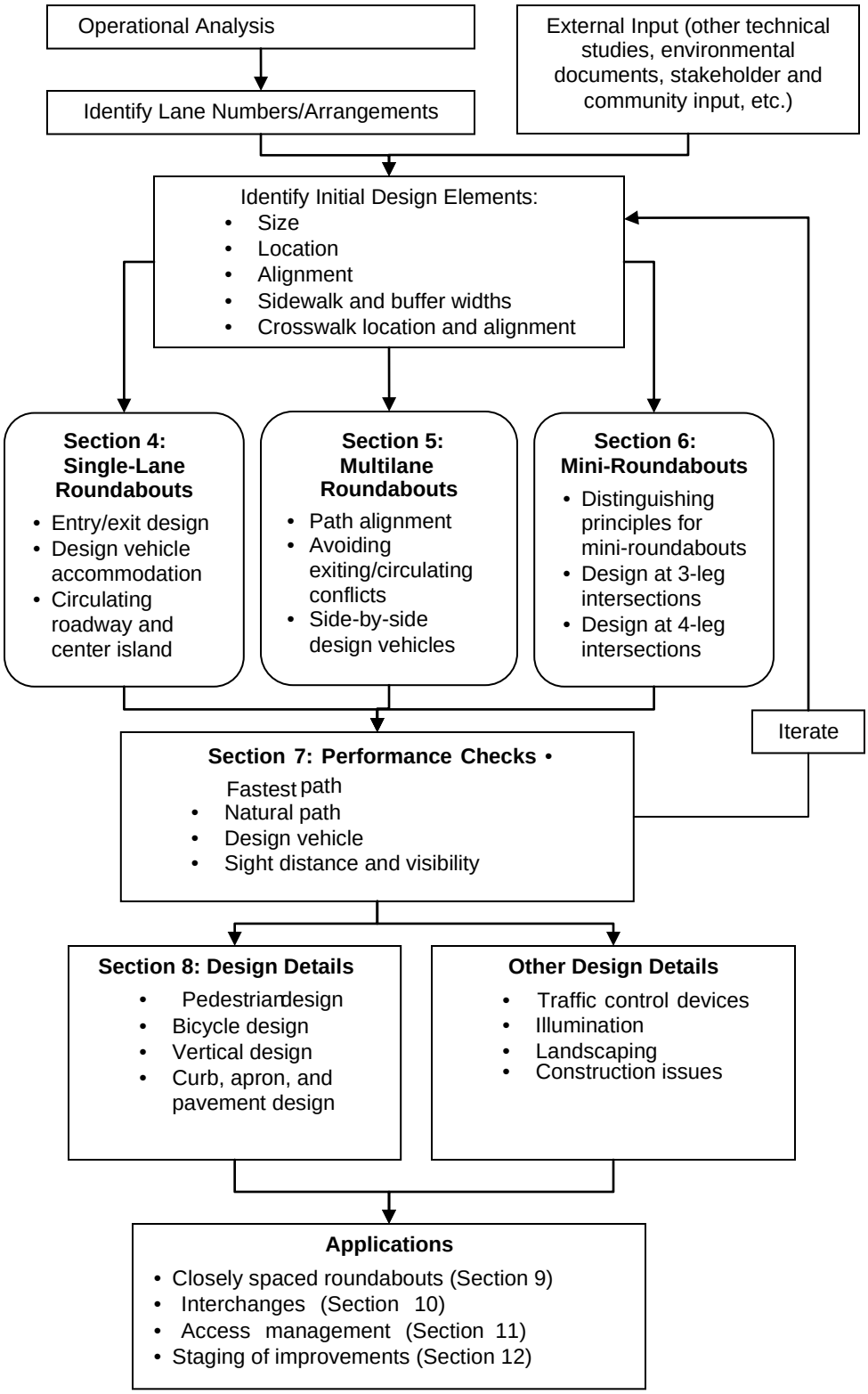

Exhibit 1
General Design Process

This course is organized such that the design principles common among all roundabout types are presented first. Even at the concept level, engineers are encouraged to develop designs that are consistent with the design principles in order to depict realistic impacts and to better define the required geometry. Poor concepts can lead to poor decision-making at the feasibility stage and can make it more difficult to generate large changes to a design at a later stage. More detailed design considerations specific to single-lane, multilane, and mini-roundabouts are given in subsequent sections of the course.

2 PRINCIPLES AND OBJECTIVES

This section describes the principles and objectives common to the design of all categories of roundabouts. Note that some features of multilane roundabout design are significantly different from single-lane roundabout design, and some techniques used in single-lane roundabout design may not directly transfer to multilane design. However, several overarching principles should guide the development of all roundabout designs.

Achieving these principles should be the goal of any roundabout design:

- Provide slow entry speeds and consistent speeds through the roundabout by using deflection.
- Provide the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume balance, and lane continuity.
- Provide smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes.
- Provide adequate accommodation for the design vehicles.
- Design to meet the needs of pedestrians and cyclists.
- Provide appropriate sight distance and visibility for driver recognition of the intersection and conflicting users.

Each of the principles described above affects the safety and operations of the roundabout. When developing a design, the trade-offs of safety, capacity, cost, and so on must be recognized and assessed throughout the design process. Favoring one component of design may negatively affect another. A common example of such a trade-off is accommodating large trucks on the roundabout approach and entry while maintaining slow design speeds. Increasing the entry width or entry radius to better accommodate a large truck may simultaneously increase the speeds that vehicles can enter the roundabout. Therefore, the engineer must balance these competing needs and may need to adjust the initial design parameters. To both accommodate the design vehicle and maintain slow speeds, additional design modifications could be required, such as offsetting the approach alignment to the left or increasing the inscribed circle diameter of the roundabout.

Exhibit 2 provides a review of the basic geometric features and key dimensions of a roundabout.

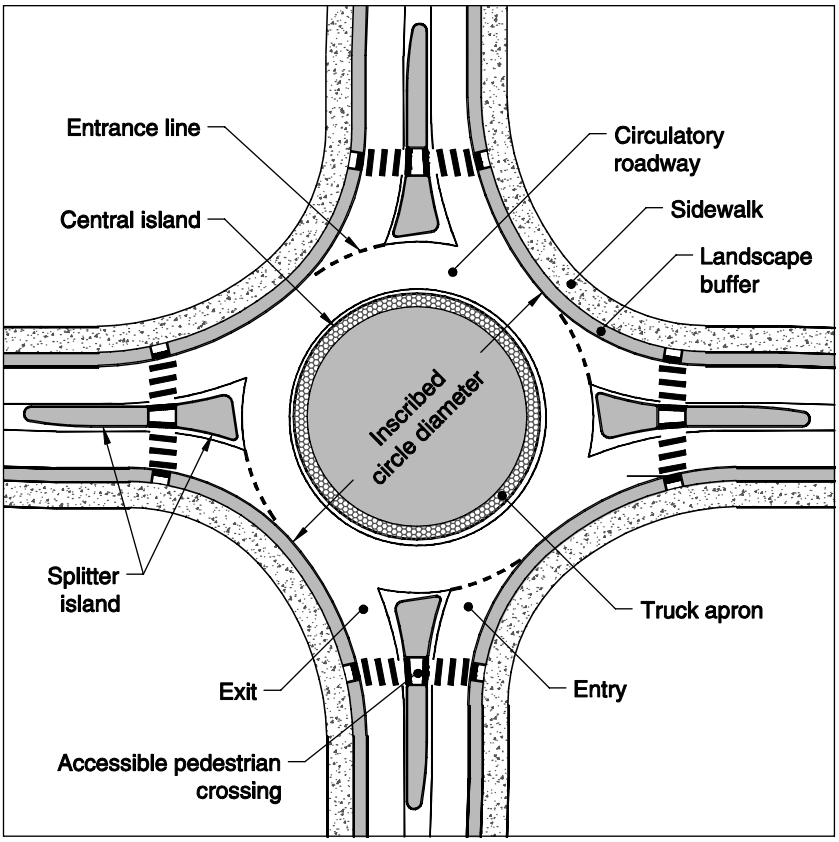

Exhibit 2
Basic Geometric Elements of a Roundabout

2.1 SPEED MANAGEMENT

The most critical design objective is to maintain low and consistent speeds at the entry and through the roundabout.

Achieving appropriate vehicular speeds for entering and traveling through the roundabout is a critical design objective as it has profound impacts on safety of all users; it also makes roundabouts easier to use and more comfortable for pedestrians and bicyclists. A well-designed roundabout reduces vehicle speeds upon entry and achieves consistency in the relative speeds between conflicting traffic streams by requiring vehicles to negotiate the roundabout along a curved path. Exhibit 3 shows an example of a roundabout where the approach alignment and entry geometry manage speeds entering the roundabout.

The operating speed of a roundabout is widely recognized as one of its most important attributes in terms of safety performance (*1*). Although the frequency of crashes is most directly tied to volume, the severity of crashes is most directly tied to speed. Therefore, careful attention to the design speed of a roundabout is fundamental to attaining good safety performance (*2*). Maximum entering design speeds based on a theoretical fastest path of 20 to 25 mph (32 to 40 km/h) are recommended at single-lane roundabouts. At multilane roundabouts, maximum entering design speeds of 25 to 30 mph (40 to 48 km/h) are recommended based on a theoretical fastest path assuming vehicles ignore all lane lines. These speeds are influenced by a variety of factors, including the geometry of the roundabout and the operating speeds of the approaching roadways. As a result, speed management is often a combination of managing speeds at the roundabout itself and managing speeds on the approaching roadways.

Exhibit 3
Example of Using Geometry
to Manage Vehicle Speeds

on

, the vehicle path radius at the
relative speed between enter-
er entering–circulating vehicle
lius at multilane roundabouts
t (path overlap), greater side
er potential for sideswipe
o promote drivers naturally
le fastest path speeds is

ed for the fastest movements,
ds for all movements. Along
help to minimize the crash
le has two implications:

tric elements should be

ween conflicting traffic streams should be minimized.

2.2 LANE ARRANGEMENTS

Part of the planning process involves conducting an operational analysis for a roundabout. An outcome of that analysis is the required number of entry lanes to serve each of the approaches to the roundabout. For multilane roundabouts, care must be taken to ensure that the design also provides the appropriate number of lanes within the circulatory roadway and on each exit to ensure lane continuity.

Exhibit 4 illustrates a two-lane roundabout where the needed lane configurations on the eastbound approach are a left-turn and a shared left-through-right turn lane. For this lane configuration, two receiving lanes are needed within the circulatory roadway. However, the exit for the through movement must be a single lane to ensure proper lane configurations. If a second exit lane was provided heading eastbound, the result would be overlapping vehicle paths between exiting vehicles on the inside lane and left-turning vehicles that continue to circulate around the outside lane.