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Intersection Geometric Design I

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INTRODUCTION

This course summarizes and highlights the geometric design process for modern roadway intersections. The contents of this document are intended to serve as guidance and not as an absolute standard or rule.

When you complete this course, you should be familiar with the general guidelines for

at-grade intersection design. The course objective is to give engineers and designers an in-depth look at the principles to be considered when selecting and designing intersections.

Subjects include:

General design considerations – function, objectives, capacity

Alignment and profile

Sight distance – sight triangles, skew

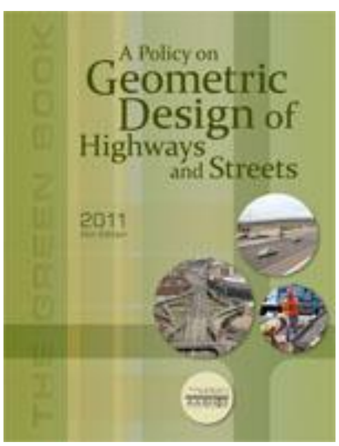
Turning roadways – channelization, islands, superelevation

Auxiliary lanes

Median openings – control radii, lengths, skew

Left turns and U-turns

For this course, Chapter 9 of **A Policy on Geometric Design of Highways and Streets** (also known as the "Green Book") published by the American Association of State Highway and Transportation Officials (AASHTO) will be used primarily for fundamental geometric design principles. This text is considered to be the primary guidance for U.S. roadway geometric design.



This document is intended to explain some principles of good roadway design and show the potential trade-offs that the designer may have to face in a variety of situations, including cost of construction, maintenance requirements, compatibility with adjacent land uses, operational and safety impacts, environmental sensitivity, and compatibility with infrastructure needs.

Geometric design is the assembly of the fundamental three-dimensional features of the highway that are related to its operational quality and safety. Its basic objective is to provide a smooth-flowing, crash-free facility. Geometric roadway design consists of three main parts: **cross section** (lanes and shoulders, curbs, medians, roadside slopes and ditches, sidewalks); **horizontal alignment** (tangents and curves); and **vertical alignment** (grades and vertical curves). Combined, these elements provide a three-dimensional layout for a roadway.

Effective geometric design transmits knowledge from research and operational experience to the user. It reflects both human and vehicular characteristics and capabilities.

The practice of geometric design will always be a dynamic process with a multitude of considerations: driver age and abilities; vehicle fleet variety and types; construction costs; maintenance requirements; environmental sensitivity; land use; aesthetics; and most importantly, societal values.

Despite this dynamic character, the primary objective of good design will remain as it has always been – **to provide a safe, efficient and cost-effective roadway that addresses conflicting needs or concerns.**

INTERSECTIONS

Intersections are unique roadway elements where conflicting vehicle streams (and sometimes non-motorized users) share the same space. This area encompasses all modes of travel - *pedestrian*

bicycle

passenger vehicle

truck

transit

as well as auxiliary lanes, medians, islands, sidewalks and pedestrian ramps. These may further heighten the accident potential and constrain the operational efficiency and network capacity of the urban street system. However, *the main objective of intersection design is to facilitate the roadway user and enhance efficient vehicle movement.* The need to provide extra time for drivers to perceive, decide, and navigate through the intersection is central to intersection design controls and practices.

Designing to accommodate the appropriate traffic control are critical to good intersection design. Warrants and guidelines for selection of appropriate intersection control (including stop, yield, all-stop, or signal control) may be found in the MUTCD.

Basic Elements of Intersection Design

Human Factors

Driver habits, decision ability, driver expectancy, decision/reaction time, paths of movement, pedestrian characteristics, bicyclists

Traffic Considerations

Roadway classifications, capacities, turning movements, vehicle characteristics, traffic movements, vehicle speeds, transit, crash history, bicycles, pedestrians

Physical Elements

Abutting properties, vertical alignments, sight distance, intersection angle, conflict area, speed-change lanes, geometric design, traffic control, lighting, roadside design, environmental factors, crosswalks, driveways, access management

Economic Factors

Improvement costs, energy consumption, right-of-way impacts

A range of design elements are available to achieve the functional objectives, including horizontal and vertical geometry, left- and right-turn lanes, channelization, etc.

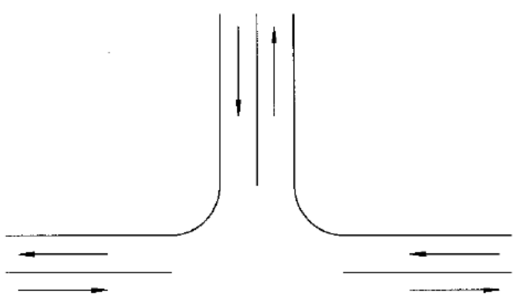
Level of service analysis and roadway capacity are critical considerations in intersection design. Capacity is determined by constraints at intersections. Vehicle turns at intersections interrupt traffic flow and reduce levels of service.

AASHTO defines intersection capacity as “the maximum hourly rate at which vehicles can reasonably be expected to pass through the intersection under prevailing traffic, roadway, and signalization conditions”. The Highway Capacity Manual (HCM) provides various analysis techniques for comparing different conditions at intersections.

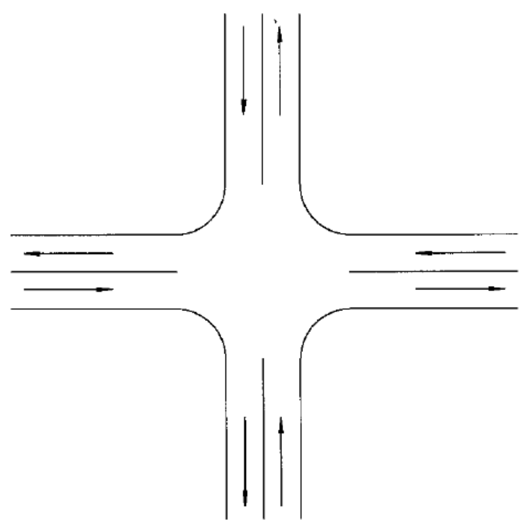
A well-designed intersection is clear to the driver with design dimensions supporting operational requirements, traffic control devices functioning as intended, and nonmotorized vehicle users operating safely through the intersection.

Basic Types of Intersections

- Three-leg (T)
- Four-leg
- Multi-leg
- Roundabout



THREE-LEG INTERSECTION



FOUR-LEG INTERSECTION

These types may vary based on scope, shape, flaring (for auxiliary lanes), and channelization (separation/regulation of conflicting traffic).

Variables for determining the type of intersection to be used at a location include:

Topography

Traffic characteristics

Number of legs

Type of operation

Roadway character

Three-leg

The typical three-leg intersection configuration contains normal paving widths with paved corner radii for accommodating design vehicles. The angle of intersection typically ranges from 60 to 120 degrees.

Auxiliary lanes (left or right-turn lanes) may be used to increase roadway capacity and provide better operational conditions.

Channelization may be achieved by increasing corner radii to separate a turning roadway from the normal traveled ways by an island.

Four-leg

Many of the three-leg intersection design considerations (islands, auxiliary lanes, channelization, etc.) may also be applied to four-leg intersections.

Multi-leg

Intersection designs with multiple legs (5 or more) should not be used unless there is no other viable alternative. If multi-legs must be used, a common paved area where all legs intersect may be desirable for light traffic volumes and stop control.

Operational efficiency can also be increased by removing major conflicting movements.

Multi-leg Reconfiguration Options

- Realigning one or more legs
- Combining traffic movements at subsidiary intersections
- Redesigning as a roundabout
- Converting legs to one-way operation