Instructor Notes
Roadway Geometric Design

Module Overview

This module focuses on **how roadway geometry influences safety and performance**, covering:

- Alignment design (horizontal and vertical)
- Sight distance requirements
- Curve design principles

Key Message for Instructors

Geometric design is about designing the road to match human capabilities—especially visibility and reaction time.

Learning Objectives

By the end of this lecture, students should be able to:

- Describe the role of highway geometric design in providing safe and efficient roadways.
- Identify the main components of roadway alignment: horizontal, vertical, and cross-sectional.
- Interpret stationing notation to locate points along a roadway alignment.
- Recognize key terminology and geometry of vertical curves, including PVC, PVI, and PVT.
- Explain the concept of stopping sight distance and how it differs for crest and sag curves.
- Identify common horizontal curve types and their basic geometric elements.

Teaching Flow / Suggested Lecture Structure

A. Introduction to Geometric Design (10–15 min)

Core Philosophy

- Two main goals:
  - **Safety**
  - **Efficiency**

Key Design Factors

- Design driver
- Design vehicle
- Design environment

Standards

- AASHTO "Green Book" (primary reference)

Instructor Prompt:

- "Who are we designing the road for?"

B. Roadway Alignment (15 min)

3D Nature of Roads

- Roads exist in **three dimensions**

Three Components

1. **Horizontal alignment** (plan view)
2. **Vertical alignment** (profile view)
3. **Cross-section**

Key Insight

Design is simplified by analyzing each dimension separately

C. Stationing (10 min)

Purpose

- Locate positions along roadway

System

- U.S.: 1 station = 100 ft
- Example:
    - 6 + 85.30 → 685.3 ft

Instructor Tip:

Students often struggle here—use visual examples

D. Vertical Alignment (25–30 min)

Key Points

- **PVC**: Beginning of curve
- **PVI**: Intersection of tangents
- **PVT**: End of curve

Curve Types

- **Crest curves**
    - PVI above curve
- **Sag curves**

- PVI below curve

Important Concept

- Curve length measured along **horizontal projection**, not arc

---

E. Stopping Sight Distance (SSD) (25–30 min)

Definition

Distance required for a driver to:

1. Perceive hazard
2. React
3. Stop vehicle

Components

- Reaction distance
- Braking distance

Crest Curves

- Limited by line-of-sight obstruction
- Depends on:
  - Eye height
  - Object height
  - Curve geometry

Sag Curves

- Governed by **headlight visibility (nighttime)**
- Depends on:
  - Headlight height
  - Beam angle

Design Principle

- Provide **minimum curve length** while ensuring SSD

Instructor Tip:

Emphasize cost vs safety tradeoff

F. Passing Sight Distance (PSD) (10–15 min)

Key Points

- Required for **two-lane highways**
- Much longer than SSD

Components

- Acceleration distance
- Passing distance
- Clearance distance

Instructor Prompt:

- "Why is passing sight distance more than stopping sight distance?"

G. Horizontal Alignment (25–30 min)

Types of Curves

- Simple circular
- Reverse
- Compound
- Spiral

Basic Elements

- Radius (R)
- Central angle (Δ)
- Tangent length (T)
- Curve length (L)

Vehicle Dynamics

Vehicles experience:

- Centripetal force
- Friction
- Superelevation

Minimum Radius Concept

Determined by:

- Speed
- Friction
- Superelevation

H. Sight Distance on Horizontal Curves (10–15 min)

Key Issue

Obstructions may limit visibility

Design Requirement

- Clear area must allow **adequate SSD**

Important Term

- Middle ordinate (line-of-sight clearance)

I. Future Considerations: Autonomous Vehicles (10 min)

Key Idea

AVs may:

- Detect hazards earlier
- Reduce human limitations

Implication

- Potential changes in:
  - Sight distance requirements
  - Design standards

Discussion Prompt:

- "Will AVs allow tighter curves or shorter sight distances?"

Key Concepts to Reinforce

- Geometry directly affects **driver perception and safety**
- Sight distance is the **most critical design constraint**
- Vertical and horizontal designs must be coordinated
- AASHTO provides **guidelines, not strict rules**
- Design must consider **real human limitations**

Common Student Misconceptions

- Confusing **vertical vs horizontal curves**
- Assuming design is purely mathematical (ignoring human factors)
- Not understanding why SSD governs design
- Misinterpreting stationing notation

- **Suggested Examples / Activities**

- Draw:
  - Vertical curve with PVC, PVI, PVT
- Compute:

    - Station locations
- Case study:
    - Evaluate if a curve meets SSD requirements

Assessment Ideas

- Quiz on horizontal and vertical alignment concepts

- Conceptual:
    - Explain crest vs sag curves
- Numerical:
    - Compute curve parameters
- Design:
    - Select appropriate curve type

Closing Summary for Instructors

Emphasize:

- Good geometric design **prevents crashes before they happen**
- It is a balance of:
    - Safety
    - Cost
    - Efficiency
- Future technologies may **reshape traditional design assumptions**

References

- AASHTO Green Book
- Standard traffic engineering textbooks