NCHRP 15-39
Superelevation Criteria for Sharp Horizontal Curves on Steep Grades

Research Team:

MRIGlobal
Pennsylvania State University
Objective and Scope

• Develop superelevation criteria for sharp horizontal curves on steep grades
  – consider basic elements of horizontal curve design
• Research based on quantitative analyses
  – theoretical considerations and simulation
  – supported by field data
• Investigate grades of 4% or steeper
Phase II Activities

Task 6 - Execute Approved Phase II Work Plan

6A - Problem assessment, crash analysis, and site selection
6B – Field data collection
6C – Testing of analytical and simulation models
6D – Analysis of results

Task 7 – Develop Design Guidance

Task 8 – Prepare Final Report
Conceptual Approach to Research

• Use field data, crash data, and data from analytical and simulation models to investigate superelevation criteria for sharp horizontal curve on steep grades

• Goal is to refine existing AASHTO policy to provide margins of safety against known conditions that concern horizontal curve design on steep grades
Conceptual Approach to Research (cont)

• Use skid testing to measure friction supply
• Use analytical and simulation models with varying levels of complexity to determine side friction demand and rollover thresholds for range of roadway geometrics, pavement conditions, vehicle types, and maneuvers
• Compare side friction supply to side friction demand/rollover thresholds
Conceptual Approach to Research (cont)

- Develop horizontal curve design guidance to provide sufficient margin of safety to avoid loss of vehicle control due to skidding or rollover
Primary Data Collection Activities

- Speed studies
- Instrumented vehicle studies
- Skid testing
Analytical and Simulation Models: Three General Groups of Models

Models:

- **Point-mass Models**
  - Good for:
    - Simple friction limits
    - Per-vehicle tire forces
    - Linear tire behavior (static models)
    - Planar roads with constant radius curves

- **Bicycle-Type 2D Models**
  - Good for:
    - Per-axle tire forces
    - Transition tire behavior (tire slipping)
    - Planar chassis instabilities (jackknifing)
    - Planar roads with changing-radius curves

- **3D Multi-body Models**
  - Good for:
    - Non-planar instabilities (roll-over)
    - Tire-suspension interaction
    - Per-tire tire forces
    - Limit tire behavior (skidding)
    - Non-planar roads
Status

• Currently conducting site selection in CA, MD, PA, WA, and WV
• Plan to conduct speed and friction studies during summer/fall 2011
• Analytical and simulation modeling during winter 2011 and spring 2012
• Project End Date: 9/30/12
Project Objective

- Develop design guidance for selecting effective geometric, streetscaping, and traffic engineering techniques for transitioning from high-speed to low-speed roadways
  - Particularly rural highways entering communities
  - Focus on speeds through transition zone
  - Consider speeds through community
Speed Study

• Comparison of speed data at sites where transition zone technique has been implemented to sites where no specific transition zone techniques are in place (comparison sites)
  – Project schedule makes before/after evaluation difficult
Higher Priority Transition Zone Techniques for Evaluation

1. Roundabouts
2. Transverse pavement markings
3. Raised medians
4. Center islands
5. Simple gateways Vertical Landscaping
6. Vertical Landscaping
7. Dynamic speed limit signs
8. Transverse rumble strips
9. Roadway narrowing
10. Bicycle lanes
11. Pedestrian crossings

3 to 4 techniques to be evaluated
**Speed Data Locations within Study Site**

**Mandatory Locations for Sensors**
- Loc. C: Transition Zone Perception/Response Speed
- Loc. B: Transition Zone Exit Speed
- Loc. A: Community Speed

**Alternate Locations for Sensors**
- Alt. 1: Mid Transition Zone Speed
- Alt. 2: Free-Flow Speed

Drawing Not To Scale
Site Selection: Multi-Mile Corridor

Study Locations:
- Technique(s) in place
- No technique(s) in place
Status

• Currently conducting site selection

• Conducted pilot speed study in KS

• Project End Date: late 2011
NCHRP 15-42
Recommended Bicycle Lane Widths for Various Roadway Characteristics

Research Team:

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Center for Education and Research in Safety
Objective and Scope

- Develop set of recommendations for bicycle facilities for various roadway and traffic characteristics
  - Guidance will include minimum and recommended widths of bicycle lanes and preferred facility type (i.e., bicycle lane vs. marked shared lane) for roadways with and without on-street parking
  - Focus on bicycle facilities in urban areas
Primary Data Collection

• Install temporary pavement markings and collect surrogate measures (i.e., separation distance) and evaluate effects of alternative allocation of curb-to-curb street width
  – focus on midblock locations with and without on-street parking
Example of Study Scenarios with On-Street Parking

10-12-ft Travel Lane with 5-ft Bike Lane and 7-8-ft Parking Lane

10-12-ft Travel Lane with 4-ft Bike Lane and 7-9-ft Parking Lane

10-12-ft Travel Lane with 3.5-ft Bike Lane and 7-9.5-ft Parking Lane

* Figure not to scale.
Primary Variables of Interest

• Separation distance between bicycle and motor vehicle in travel lane
• Separation distance between bicycle and motor vehicle in parking lane
• Encroachment of vehicles into oncoming lane (or adjacent lane) when encountering bicyclist
• Distance from parked vehicle to curb face
Primary Roadway Characteristics of Interest

- Travel lane width
- Traffic volume (ADT)
- Presence/absence of on-street parking
- Vehicle mix (i.e., percent trucks)
- Speed
- Grade
Status

- Conducted site selection in Cambridge MA and Chicago IL

- Conduct data collection Summer/Fall 2011

- Project End Date: mid-2012