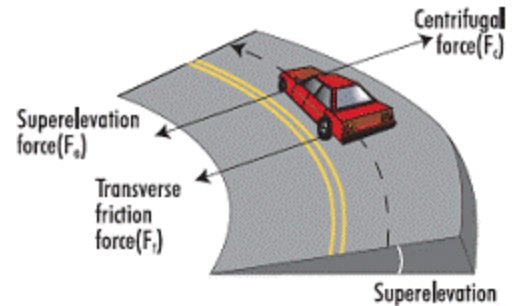


Research Statement

I want to research ways to make horizontal curves on steep grades safer for vehicles and drivers.

Goals and Objectives

The goal of this research is to develop criteria for superelevation on sharp horizontal curves in steep grades. Superelevation is the amount of banking in a curve (see figure to the right); as superelevation is added, the angle at which a vehicle travels increases. There is currently a lack of tangible criteria when it comes to the use of superelevation on horizontal curves with steep downgrades/upgrades and my aim is to help fill that gap by obtaining quantitative evidence from analytical methods and simulations as well as actual field testing.



Project Impact

Everyday, millions of people use roads for travel. A significant amount of travel happens on highways or interstates. On large volume roadways such as interstates, where speeds are high, problems can occur at locations where there are sharp horizontal curves on steep grades. Common examples of this include: interchange ramp movements, curves on mountainous roadways, etc. At locations such as these the various factors of incline, pavement slope, and friction fully tax the driver's ability to control the vehicle. I will research superelevation and associated curvature criteria to make these locations safer. My research will make roads safer for travelers.

Relationship to previous research

The American Association of State Highway and Transportation Officials (AASHTO) is a leader in transportation engineering research. The AASHTO *Green Book* is the industry standard for all matters related to highway and road design. The latest research concerning superelevation can be found in the Green Book. The National Cooperative Highway Research Program (NCHRP) is a part of the Transportation Research Board (TRB) and is an organization that "conducts research in problem areas that affect highway planning, design, construction, operation, and maintenance nationwide" (2). In addition to the Green Book, the NCHRP is a reliable source for superelevation knowledge.

The findings concerning superelevation in the 1994 AASHTO Green Book were updated by NCHRP Report 439: *Superelevation Distribution Methods and Transition Design* (3). This report highlighted the use of superelevation in curves and the transition from a straight roadway to a curve. In 2001 and 2004, the recommendations from Report 439 were incorporated into the Green Book (3).

Serious reduction of friction available for vehicle control occurs on both downgrades and upgrades, according to NCHRP Report 439 (3). Loss of friction is especially tremendous on downgrades that occur during a turn. However, Report 439 did not establish superelevation or horizontal curve standards to correct this common problem. Page 148 of the latest edition of the Green Book recommends an "adjustment in superelevation rates should be considered for grades steeper than 5%" (1). This applies to the banking for both upgrades and downgrades. Unfortunately the Green Book does not go into further detail about how to improve the horizontal curves on steep grades or what exactly this "adjustment" should be.

Project Design

I plan on doing most of the research using computer simulation. I will design a model that accurately represents a real life scenario. A good candidate location for this research is the on-ramp from Greystone Blvd.

to I-26 going towards Spartanburg. The model will have parameters that can be changed to examine the potential effect of changes to the curvature, superelevation, and other geometric data. I will simulate vehicles traveling along this ramp with different conditions using either *Vehicle Dynamics Analysis, Non-Linear* (VDANL) from Systems Technology Inc., or *Vehicle Dynamics Models for Roadway Analysis and Design* (VDM RoAD) from the University of Michigan Transportation Research Institute. I have some computer programming experience in Matlab, and Dr. Huynh has extensive experience in computer programming. Together we will be able to learn and use VDANL/VDM RoAD for our research. From the simulation results of various scenarios I will be able to determine superelevation criteria for improving travel along sharp horizontal curves with steep grades.

Project Timeline

Task	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1												
2												
3												
4												
5												
6												

Legend

- Task 1: Travel to Transportation Research Board Engineering Conference in Washington D.C. to network with other researchers and learn more about highway design.
- Task 2: Review appropriate literature and current practices concerning superelevation.
- Task 3: Identify all critical parameters and variables that may contribute to unsafe horizontal curves.
- Task 4: Develop accurate model and collect field data to confirm model, revise as needed.
- Task 5: Experiment with alternative options and different scenarios using the computer model.
- Task 6: Analyze results and write final report.

Final Results

I anticipate that I will be able to determine criteria for superelevation to make horizontal curves on steep slopes safer. These recommendations will be documented in my final report along with the literature review and model details. As a member of the newly formed student chapter of the Institute of Transportation Engineers I hope to share my results with the South Carolina section of ITE (both the professional chapter and the USC chapter). It is also my goal to publish my research in the TRB’s Journal of Transportation Record, and I plan to present my research at Discovery Day 2011.

Personal Statement

Although I didn’t always know it, I’ve had a serious interest in superelevation and banking in horizontal curves ever since I was a small child. As far back as my memory goes my father and I have watched, attended, and held an interest in NASCAR races. In NASCAR, almost every track uses superelevation in its turns to allow the racecars to go faster. As I started my third year at USC in August I was introduced to the concept of superelevation in Dr. Huynh’s Introduction to Transportation Engineering class. For the first time I actually learned some tangible relationships between horizontal curves and superelevation. I was extremely interested in learning more about superelevation so I spoke with Dr. Huynh about possible research opportunities in this area. Having the opportunity to learn more about a topic I’m interested in is an invaluable prospect. I am excited and eager to do research in an area of engineering I hope to have a career in.

References

1. American Association of State Highway and Transportation Officials (2004). *A Policy on Geometric Design of Highways and Streets*. Washington D.C., AASHTO.
2. Transportation Research Board (2009). *National Cooperative Highway Research Program*. Retrieved from <http://www.trb.org/NCHRP/Public/NCHRP.aspx>
3. Transportation Research Board (2009, August 21). *Superelevation Criteria for Sharp Horizontal Curves on Steep Grades*. Retrieved from <http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2720>

Magellan Scholar BUDGET FORM

Student's Name: _____

Student salary	Hours	Rate	Subtotal
Taking classes			
Not taking classes			

Fringe: Student salary * student fringe rate			
Taking classes			
Not taking classes			

Materials/Supplies	
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Travel	
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TOTAL	
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Budget Justification

Student Salary: Indicate timeframe of student work

Materials/Supplies:

I will need to purchase the simulation model which is estimated to cost about \$450.

Travel: Indicate location, purpose of travel, estimate costs.

I plan on departing January 10 and returning January 13 for the Transportation Research Board Conference. I will need to buy gas to drive to the Charlotte airport for my trip to the TRB conference (200 miles round trip) and I will also use gas when collecting field data on the chosen horizontal curve (50 miles).
 $20 \text{ mpg}/250 \text{ miles} = 12.5 \text{ gallons} * \$2.50 \text{ per gallon} = \$31.25 \text{ for gas costs}$

To store my car at CLT airport for 4 days at \$7/day = \$28 dollars
 Flight costs Charlotte to Washington D.C. (round trip) = \$230 according to expedia.com
 Hotel costs, about \$250 per night according to expedia.com, for 3 nights = \$750
 Subway fares (I will use Washington's METRO system) \$10 a day for 3 days = \$30
 Food Costs, standard rate is \$30 a day, for 3 days = \$30