Median Barriers in North Carolina -- Long Term Evaluation

Brian Murphy, PE

North Carolina DOT - Traffic Engineering Branch

Missouri Traffic & Safety Conference

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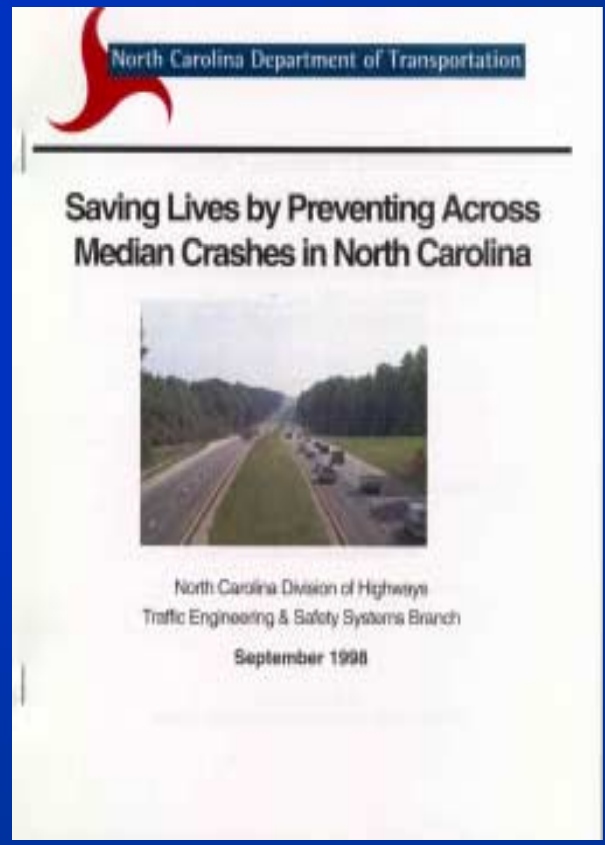
Background

- In 1998 North Carolina began a three pronged approach to prevent and reduce the severity of Across Median Crashes on freeways
  - Add median protection to freeways with historical crash problems (*Phase I*)
  - Systematically protect all freeways with median widths of 70 feet or less (*Phase II*)
  - Revise Design Policy to protect all future freeways with median widths of 70 feet or less *(Phase III)*

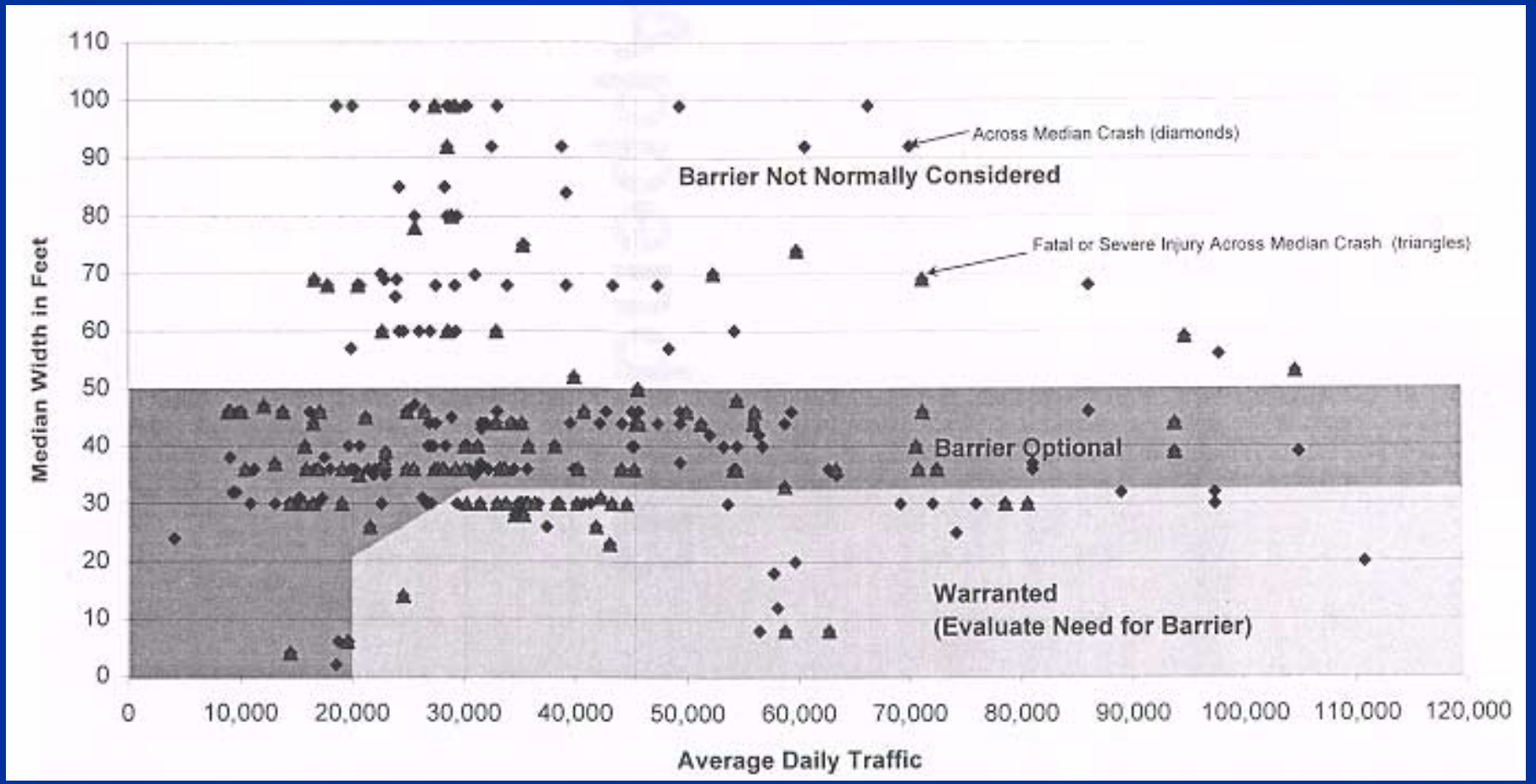


Background

- Initial Crash Data analyzed was from 1994 through 1997
  - Over 1,375 Miles of Full Control Sections of Freeway were reviewed
  - Over 10,000 Total Crashes were reviewed
  - Over 1,000 Across Median Crashes were Identified
  - For every one Fatal Across Median Crash there were 10 Non-Fatal Across Median Crashes
  - Across Median Crashes were 3 times more severe than other types of Freeway Crashes

Background

- Why was the 70 feet or less median width significant?



Background

- Why was the 70 feet or less median width significant (cntd.)?
  - There was no correlation to speed, median width, volume, time of day, or weather conditions for Across Median Crashes
  - Potential to eliminate approximately 95 percent of all Across Median Crashes

Background

- 2000 - 2006 TIP included 58 Median Barrier Projects
  - Approximately 1000 miles of freeway
  - All Projects have been let or complete
  - Initial Projects were over a $120 million dollar investment, not including reoccurring maintenance costs

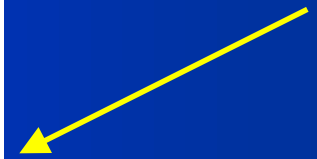
Median Barrier Benefits

- Effect on Fatal Crashes and Fatalities

PHASE I AND PHASE II MEDIAN BARRIER PROJECT LOCATIONS

Year	Fatal Crashes	Across Median Fatal Crashes	Percent of Total	Fatalities	Across Median Fatalities	Percent of Total
1990	145	33	**22.8**	177	47	**26.6**
1991	144	26	18.1	188	44	23.4
1992	128	22	17.2	147	31	21.1
1993	158	20	12.7	196	38	19.4
1994	146	23	15.8	179	36	20.1
1995	150	18	12.0	177	28	15.8
1996	159	26	16.4	189	40	21.2
1997	147	33	22.4	194	47	24.2
1998	198	33	16.7	229	47	20.5
1999	178	24	13.5	207	30	14.5
2000	191	23	12.0	226	36	15.9
2001	160	7	4.4	183	11	6.0
2002	152	13	8.6	173	14	8.1
2003	129	12	9.3	146	13	8.9
2004	146	10	6.8	179	18	10.1
2005	144	4	**2.8**	165	6	**3.6**

Median Barrier Projects Started Here

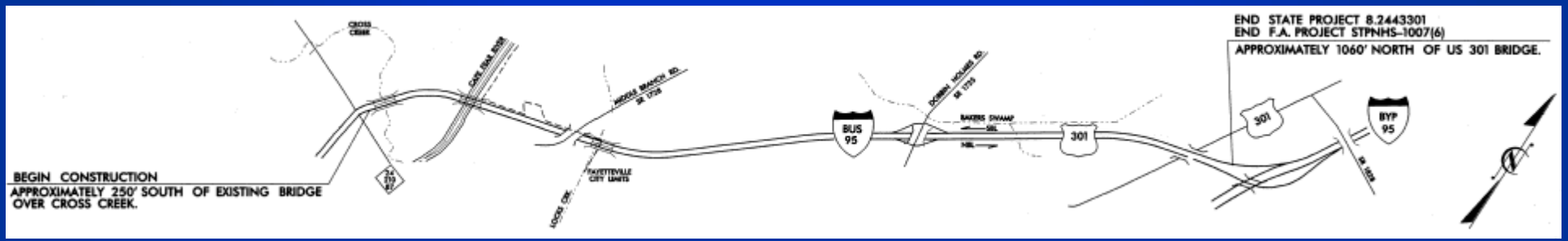


Median Barrier Benefits

- Effect on Fatal Crashes and Fatalities (cntd.)
  - Estimated 95 Fatal Across Median Crashes have been avoided and 145 lives saved from January 1999 to December 2005
  - Results in crash costs savings of more than $350 million in fatal crash cost alone

Median Barrier Benefits

- Long Term Median Barrier Evaluation
  - Before and After Crash Analyses
    - > Project locations being evaluated have at least three years of after crash data available from installation
  - Progress thus far:
    - > Analyzed 400 miles of median barrier projects



Median Barrier Benefits

- Long Term Median Barrier Evaluation (cntd.)
  - Median Barrier Types on 400 Miles Evaluated

Barrier Type	Mileage
Cable	175
W-Beam	132
Weak Post	31
W-Beam / Cable Mix	44
W-Beam / Weak Post	18
Total	***400***

  - Plan to provide a Before and After Analysis for each Median Barrier Type

Median Barrier Benefits

- Long Term Median Barrier Evaluation (cntd.)

	All Barrier Types			Cable			Weak Post			W-Beam		
	Before	After	Percent Change	Before	After	Percent Change	Before	After	Percent Change	Before	After	Percent Change
Mileage	428			203			31			132		
Average ADT	26,600	34,300	29%	22,000	29,400	34%	31,700	40,100	26%	28,800	36,700	27%
Total Crashes	2,048	3,718	82%	793	1,688	113%	192	323	68%	695	1,044	50%
Severe Injury (K & A) Crashes	120	98	-18%	47	41	-13%	14	8	-38%	38	28	-25%
Moderate / Minor Injury (B & C) Crashes	696	1,103	58%	267	448	68%	61	101	82%	242	347	43%
Property Damage	1,232	2,517	104%	479	1,199	150%	118	213	82%	414	668	61%
Across Median Crashes	152	30	-80%	60	23	-62%	20	1	-96%	41	3	-94%
Fatal Across Median Crashes	13	2	-80%	4	2	-56%	3	0	-100%	3	1	-82%
Severe Injury (K & A) Across Median Crashes	20	3	-87%	7	2	-74%	2	0	-94%	7	1	-91%
Crashes Involving Median Barrier	--	1,218	--	--	568	--		115	--	--	309	--
Percent of Crashes Involving Median Barrier	--	33%	--	--	34%	--	--	36%	--	--	30%	--
Breach Rate	--	2.4%	--	--	4.0%	--	--	0.6%	--	--	0.9%	--

* All Crash Numbers are Crashes / Per Year

Fatal & Severe Injury Crashes
Across Median Crashes

Severity vs. Frequency

ADT
Total Crashes
Minor Injury Crashes
Property Damage Only Crashes

Median Barrier Benefits

- Long Term Median Barrier Evaluation (cntd.)
  - Median Barrier Breaching Crashes (All Barrier Types)
    - > After Period Breaches 110
    - > Construction and After Period Breaches 125
      - Fatal Crashes 7 (6%)
      - A-Injury Crashes 9 (7%)
      - B-Injury Crashes 20 (16%)
      - C-Injury Crashes 26 (21%)
      - PDO Injury Crashes 63 (50%)
    - Vehicle Breaches 98
    - Debris/Tire Breaches 27

Median Barrier Benefits

- Long Term Median Barrier Evaluation (cntd.)
  - Average Crash Severity by Median Barrier Type

Barrier Type	Hits	Avg Severity
Cable	1,592	1.31
Weak Post	567	1.44
W-Beam	1,266	1.63
Concrete	67	1.64
Total	***3,486***	***1.45***

  - The lower the Average Severity the safer the median barrier type (Scale => 1 = PDO …. 5 = Fatal)

Median Barrier Issues

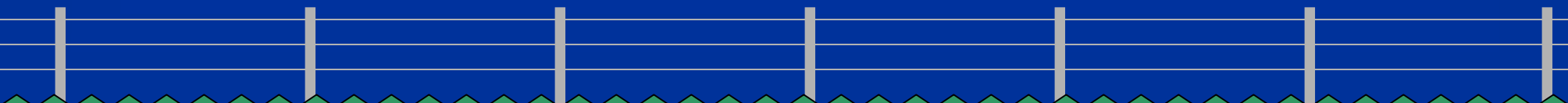
- Maintenance Concerns

Barrier Type	Hits	Total Property Damage	State Property Damage
Cable	1,592	$9,599,568	$955,763
Weak Post	567	$3,669,675	$419,775
W-Beam	1,266	$8,778,927	$488,260
Concrete*	67	$379,900	$3,250
Total	***3,486***	***$22,428,070***	***$1,867,048***

  - Recovery of maintenance cost from drive-away vehicles
  - Frequency of repairs to cable guardrail
  - Mowing

Median Barrier Issues

- Cable Penetration Evaluation
  - Purpose of Project
    - To identify common characteristics that may influence the probability of a vehicle traveling over, under or through the cable guardrail
  - How?
    - Thorough investigation of each cable breaching crash
    - Factors Examined: Vehicle Type, Impact Angle, Initial Contact Between Vehicle and Barrier, and Site Characteristics



Median Barrier Issues

- Cable Penetration Evaluation
  - Monitored 238 miles of freeway
  - Reviewed over 91 potential penetration crashes
  - Only 23 of these crashes qualified for this project.
    - Needed crash report, site visit, and vehicle inspection to qualify
    - The project goal was 30 crashes.

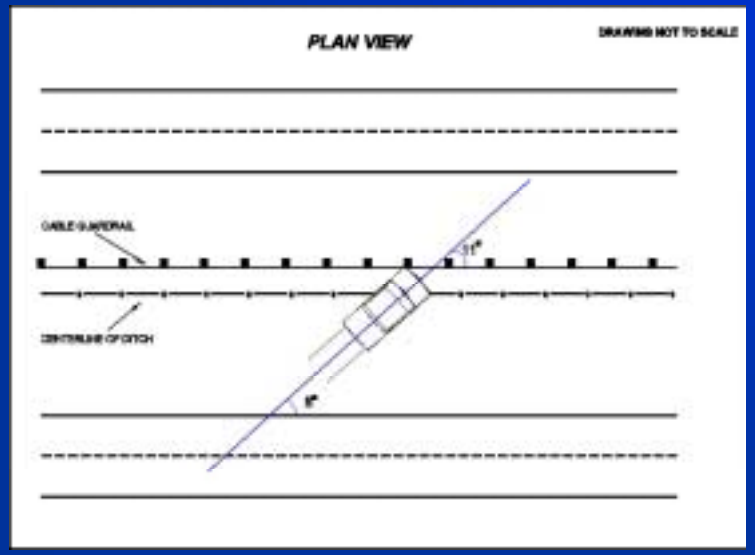
– Potential Crashes	**91**	Usable Crashes	**23**
> Front Side Hits	**30** (33%)	> Front Side Hits	**8** (35 %)
> Back Side Hits	**61** (67%)	> Back Side Hits	**15** (65 %)

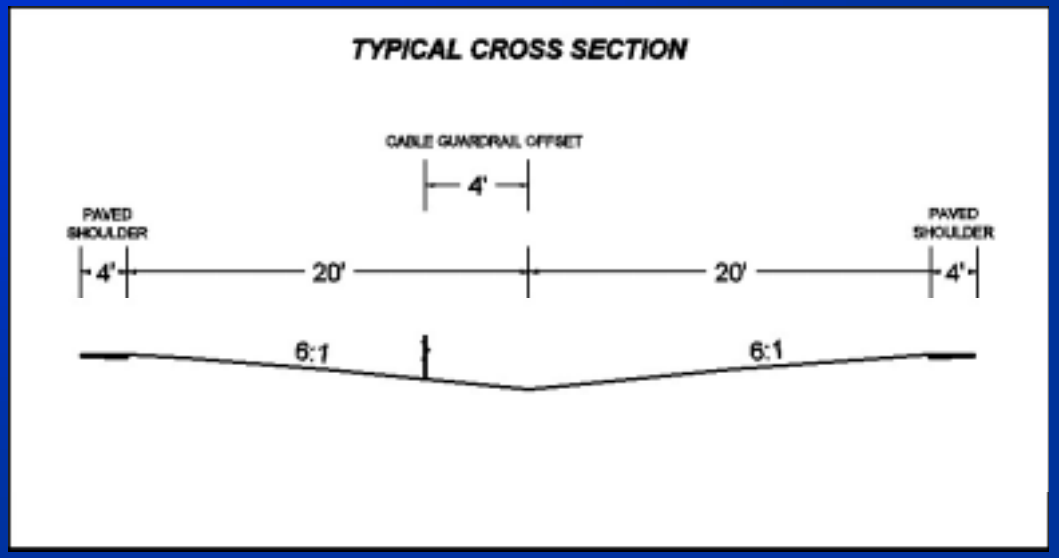
Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Vehicle Characteristics
    - > Full size sedans, sport utility vehicles, full size vans, tractor trailers, etc…..

Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Site Characteristics
    - > Typically 4’ offset from the ditch centerline
    - > Two strands closest to traffic and one strand on ditch side
    - > Vast majority occur on tangent sections
    - > Impact angle 11 to 90 degrees



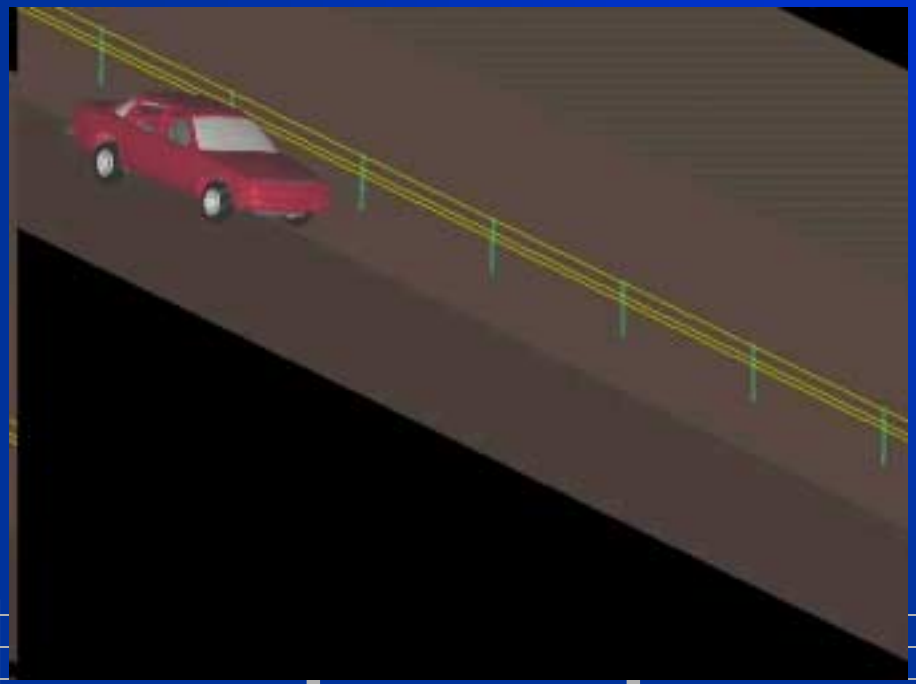


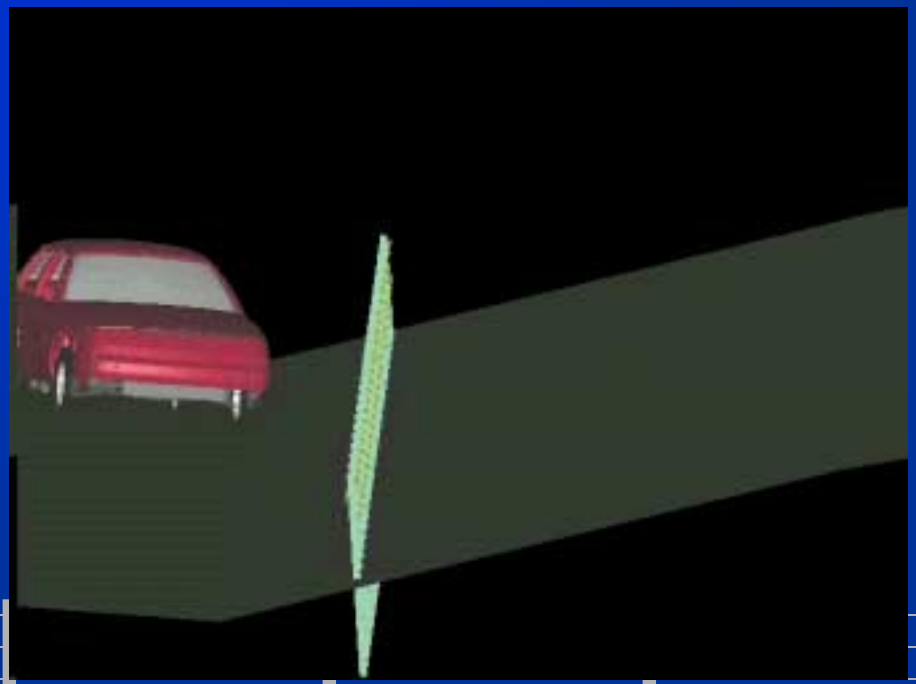
Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Common Themes
    - > Under-rides account for vast majority of the breaching crashes

Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Analysis Results
    - > George Washington University has taken NCDOT data and placed it into a Finite Element Analysis Software to model our under-ride crashes
    - > Vehicles under-rode cable in the computer simulation



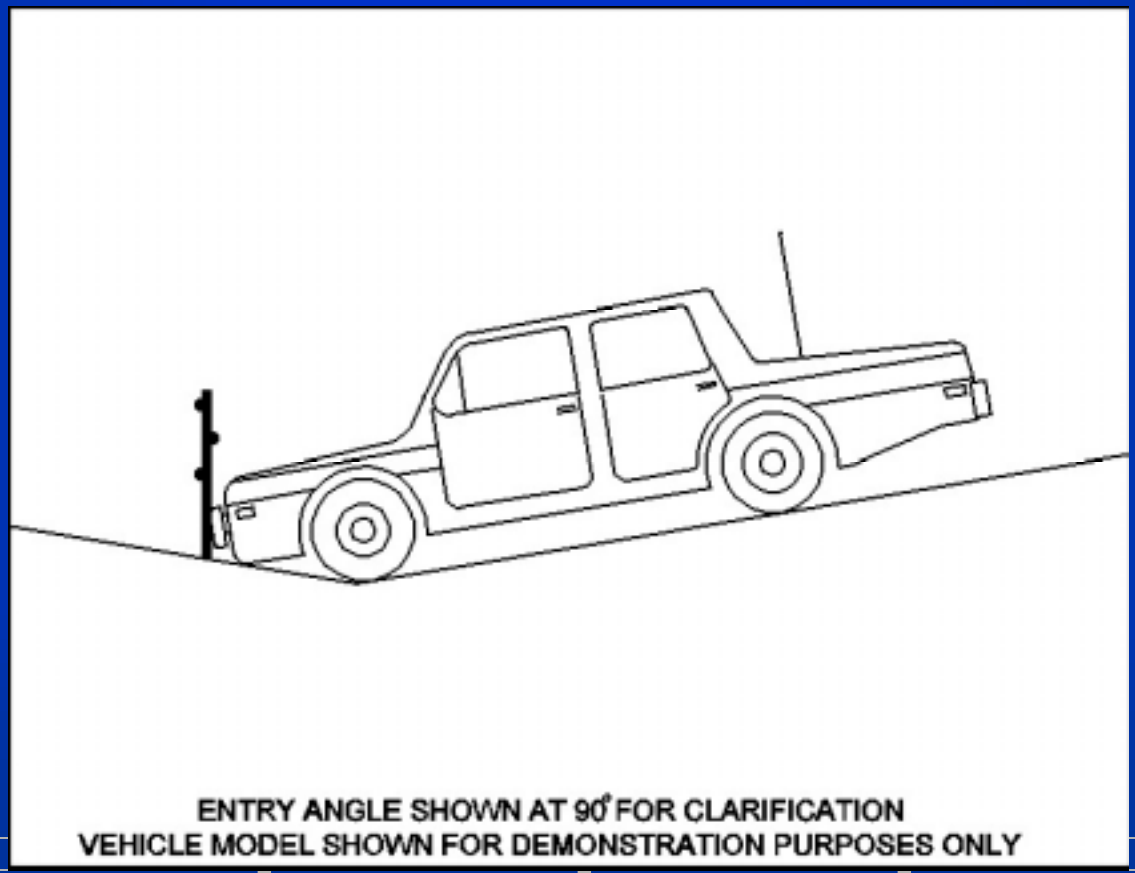


Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Analysis Results
    - > A Crown Victoria under-rode the cable in an actual crash test performed at Turner Fairbanks (4’ offset)

Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Analysis Results
    - > Vehicles Suspension Dynamics are the key to under-ride crashes



Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - Analysis Results
    - > A Crown Victoria did not under-ride the cable in an actual crash test performed at Turner Fairbanks (1’ offset)

Median Barrier Issues

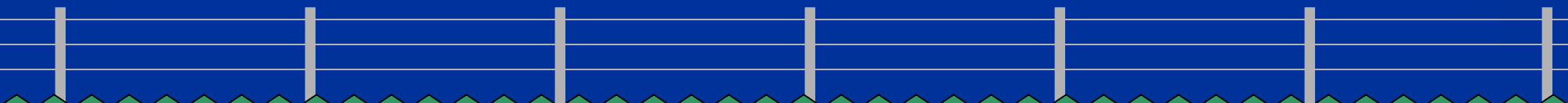
- Cable Penetration Evaluation (cntd.)
  - Analysis Results
    - > A Crown Victoria did not under-ride the cable in an actual crash test performed at Turner Fairbanks (1’ offset)

Median Barrier Issues

- Cable Penetration Evaluation (cntd.)
  - GWU Analysis Recommendations
    - > Add an additional cable - a fourth cable at a lower height
    - > Simulation shows that maximum redirection can be achieved if the area from 1’ to 8’ from the ditch bottom is avoided
      - > This language is present in Ch 6 of the DRAFT Roadside Design Guide
    - > Tie the three strands of cable together in some fashion to react like a netting system
  - TSSMU Analysis Recommendations
    - > Keep three strands of cable and increase the current 6” gap between cables to an 8” or 9” gap. Example for 8” gapping, keep the top cable at 33” and the middle cable at 25”, placing the bottom cable at 17”

Median Barrier Issues

- Effects of Median Barrier on Highway Speeds
  - Highway Safety Research Center Study
    - > Spot speed data was collected from 51 freeway segments during off peak periods
    - > Data collected from this study did not seem to support the hypothesis that continuous median barriers lead to speeding
    - > Also, there was no evidence to indicate that continuous median barriers are associated with more speed related crashes



Median Barrier Issues

- Effects of Median Barrier on Emergency Response Times
  - Highway Safety Research Center Study
    - > Many emergency operators argue that continuous median barriers without emergency crossovers do lead to an increase in response times
    - > Very little data was available for response times
    - > The lack of data makes it very difficult to make a quantitative assessment of continuous median barrier effects on emergency response times
    - > With limited observations, Illegal Use of emergency crossovers did not seem to be a significant problem

Median Barrier Issues

- AASHTO Technology Implementation Group - Cable Median Barrier
  - Purpose
    - Development of Cable Median Barrier Best Practices / Guidelines
  - Emphasis Areas
    - Background and Problem Identification
    - Roadway Design Issues
    - Maintenance Issues
    - Benefits and Evaluation
    - System Threats
  - Deliverables
    - Brochure
    - Website - Clearinghouse for Cable Barrier Information
      - Similar to FHWA's Rumble Strip website

http://www.ncdot.org/doh/preconstruct/traffic/reports/AASHTO/

QUESTIONS?

For more information please contact:

Traffic Safety Systems Management Section

TSSMS

Traffic Engineering and Safety Systems Branch (TESSB)
Division of Highways (DOH)
North Carolina Department of Transportation (NCDOT)

Mail:
P.O. Box 25201
Raleigh, NC 27611-5201

Address:
122 N. McDowell Street
Raleigh, NC 27603

Brian Murphy, PE

Phone Number: (919) 733-3915
Fax Number: (919) 733-2261

e-mail:
bgmurphy@dot.state.nc.us

Web Site:
http://www.ncdot.org/doh/preconstruct/traffic/Safety/