NCHRP 633
Impact of Shoulder Width and Median Width on Safety

N. Stamatiadis

University of Kentucky

KTC Partnering Conference August 2010

UK

Background (1/2)

- Objectives of roadway designs
  - Safety
  - Efficiency
  - Human and natural environment fit
- Need to evaluate alternatives
- Trade off geometric elements
- Guidelines vs. standards

Background

- Project issues
  - Uniqueness
  - Context
- Safety implications

Research Objectives

- Understand relationships and quantify trade offs for design elements
- Develop information resources and decision tools for designers

Study Approach

- Literature review
- Data acquisition and analysis
- Model development and evaluation
- Guideline development
- Final report

Research Focus

- Multi-lane rural roads
- Data of interest
  - Lane width
  - Shoulder width and type
  - Median width and type
  - Clear zone

Literature Review

- Safety implications from design element trade offs
- Not much on multi-lane rural roads
- Highway Safety Manual AMF values
  - 2 lane rural roads

Data

- Data for MN, CA, KY
- 1991-2002 period
- Data of interest
  - Lane width
  - Shoulder width and type
  - Median width and type
  - Clear zone (KY only)

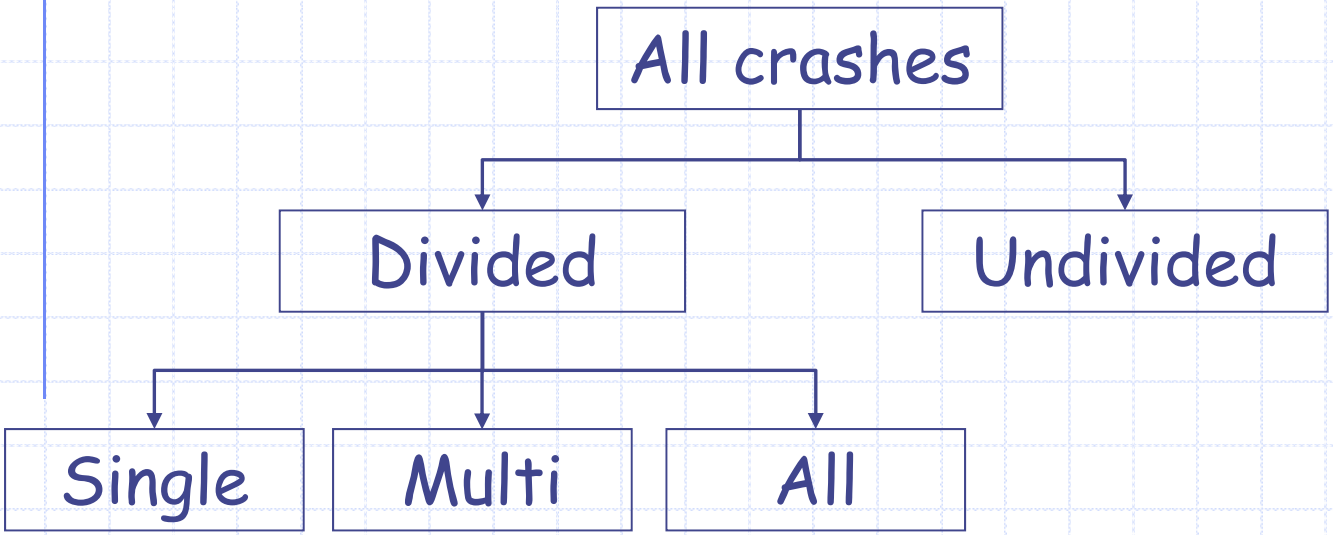
Data Distribution

Variable	CA	MN	KY
Length (mi)	835.84	975.16	576.08
Segments	2,726	4,385	930
Number of crashes	30,413	16,244	30,788
Number of injury crashes	7,676	2,173	10,428
Segments with no crashes	68%	80%	63%

Data Issues

- Data issues
  - Princ. Arterial
  - 4 lanes
  - 12-ft lanes
  - 8-ft shoulders
- Guidelines for 4-lane rural roads with 12-foot lanes

Methodology



Same for Injury only crashes

Methodology (2/5)

- Negative binomial

$$E[N] = Le^{b0+b1\ lnADT+\ b2X2+b3X3+\ldots+bnXn}$$

where E[N] number of crashes per year

L segment length

ADT average daily traffic

Xi explanatory variables

Methodology

- Variables considered
  - Functional class
  - Right shoulder paved
  - Left turn lane presence
  - Median barrier presence
  - Shoulder width
  - Median width

Methodology

- Accident Modification Factors (AMF)
  - Use coefficients
  - $AMF = e^{bi}$
  - $b_i = 0.407$ then $AMF = e^{0.407} = 1.50$

Methodology

- Guidelines
  - Review NCHRP 633 models
  - Appraise current knowledge
  - Consult HSM models
  - Use expert panel review
  - Recommend AMF

Shoulder Width

- Width impacts crashes
- Positive effect
  - Wider shoulders reduce crashes
- Wider shoulders encourage higher speeds
- Interaction with lane width and number of lanes

Shoulder Width AMF

	Average shoulder width (ft)						
Category	0	3	4	5	6	7	8
Undivided	1.22	1.00	0.94	0.87	0.82	0.76	0.71
Divided	1.17	1.00	0.95	0.9	0.85	0.81	0.77

Notes: AMF for all crashes and severities

Divided: Left and right shoulder widths

Undivided: Right shoulders widths

Medians

- Median effect
  - Cross median crashes
  - Median related crashes
  - Total effect unknown
- Median barrier presence

Median Width AMF

	Median width (ft)							
Category	10	20	30	40	50	60	70	80
Multi-vehicle	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.51

Notes: AMF for all severities

No effect on single vehicle crashes

Median Barrier

- Impact on crashes unknown
  - Increase due to presence
  - Decrease on severity
  - Median barrier type
  - Median barrier placement
- Data and models inconclusive

Application

- AMF estimate choice impact
- Single element
  - $\Delta N = [AMF_i/AMF_j] - 1$
- Multiple elements
  - $AMF_i \times AMF_j$

Application Example

Widen shoulder from 4 to 8 ft on a four lane undivided road

$AMF_4 = 0.71$; $AMF_8 = 0.94$

$\Delta N = (0.71/0.94)-1 = -0.24$

24% crash reduction per year per mile

NCHRP 633 vs. HSM (1/2)

- Shoulder width
  - Similar trends
  - Divided: Same magnitude
  - Undivided: Larger differences
  - No AMF for shoulders over 8 feet
  - HSM shoulder related crashes only

NCHRP 633 vs. HSM (2/2)

- Median width
  - Similar trends
  - HSM smaller reductions
  - HSM median related only crashes and barrier present

Conclusions

- AMF can be used for all crashes
- All for 4-lane rural roads with 12-ft lanes
- Supportive of HSM
- Additional work on median barrier
  - Type and placement
  - Crash types and severity