Design Flexibility

CE 595A, NC State, Fall 2006
Context Sensitive Solutions

Main Message

- Designers have flexibility! Not wedded to “Green Book” or any other guide

- This presentation will cover:
  - Why designers have flexibility
  - Some important design criteria
  - Examples of flexibility in action
Design Criteria

- Flexibility in Highway Design, FHWA 1999
- MUTCD, FHWA, November 2004
- NCDOT 3 R Guide, April 2004
- NCDOT Design Standards

Proper Role of Design Criteria

- Assure minimum quality
- Assure some uniformity
- Assure compliance with some basic physical principles
- Reflect some driver concerns
  - Reinforce driver expectations
Legal Role of Design Criteria

• Critical importance in case of lawsuit resulting from crash
  – Not every state or agency liable
• To be legally secure, must adhere to criteria applicable at time of design
• Why the huge emphasis by the legal system?

Changing Philosophy

• Need to balance impacts, consider context
• Public skeptical
  – Suspicious of smoke-filled room
  – Criteria reasoning not always tight
• Increasing flexibility allowed
  – Within existing criteria
  – In new criteria (3R, FHWA Flexibility document)
Other Issues with Design Criteria

- Is designing more road than required better?
- How unsafe is designing less road than required?
- Better information and methods are available

Design Exceptions

- Formal way to ask authorities for permission to violate policy
- Creative design often eliminates need for design exceptions
- Successful CSS can occur without design exceptions
- Pilot CSS states report no increase in use of design exceptions (MD, KY)
- Where you do use design exceptions, mitigation can be effective
Normative and Substantive Safety

- Normative: design meets standard
- Substantive: design will result in relatively low number of crashes

- Concepts popularized by Ezra Hauer in early 1980s
  - Why has it taken so long to adopt these ideas?

Source: CH2M Hill
Is This Road Safe?

Which of These Alts. is Safer?
Substantive Safety Relates to…

- Traffic volume
- Location (urban, suburban, rural)
- Functional classification
- Facility type
- Terrain
- Roadway segment (mid-block, intersection, etc.)
- Surrounding land uses
- Cross-section
- Roadside
- Access control

Why is Substantive Safety Possible Now?

- What has changed in the past 20 years to allow this more sophisticated approach?
Need to Consider All Users

- Design criteria often single-minded
  - Rarely consider multimodal aspects
- Safety for whom?
- Should weigh safety of innocent bystanders higher than drivers who might be at fault?

Particular Design Controls

- Functional class
- Design speed
- Level of service
- Cross sections
Role of Functional Class

- Classification of roadway describes character of services roadway is intended to serve, its **purpose**
- Used for communicating ideas among engineers, administrators, and public
- Functional class is **not** an absolute means of defining specific geometric standards

*Source: KTC CSD Workshop*

What Is the Correct Functional Class Here?

*Source: KTC CSD Workshop*
What About This?

Other Thoughts on Functional Class

- Four traditional classes do not apply well to a large number of roads
- Many agencies developing multidimensional street and road classes
  - Charlotte DOT good example
  - Boulevard, avenue, lane, etc.
  - Considers context more fully
  - Also considers future build-out
Design Speed

- Single most important choice
- Design speed does not equal design quality
- Design speed factors
  - Topography
  - Adjacent land uses
  - Functional class of highway
- Drives many geometrics and resulting impacts

Relationship to Other Factors
Sometimes it is appropriate to maximize speed

Source: KTC Case Studies – RT 68, AZ

Sometimes changing speeds fits context better

Source: KTC Case Studies – Highway 61, MN
More on Design Speed

• Choice of lower design speed can result in substantively safer roadway with lower impacts and costs
• Page 58 in FHWA’s Flexibility in Design Guide provides a table of design speed options for different terrain
• Lower design speed sometimes helps address:
  – Pedestrian conflicts
  – Immoveable objects
  – Urbanized or developing areas

Questions on Design Speed

• How can we get motorists to understand our choice?

• Are there good models for predicting operating speed?
Level of Service

- A-F scale for quality of service
- Choice is function of
  - Community opinion
  - Facility type
  - Facility purpose
  - Location
  - Future traffic

Published LOS Criteria

- **Freeway**
  - Rural = B/C
  - Urban = C
- **Arterial**
  - Rural = B/C
  - Urban = C/D
- **Collector**
  - Rural = C/D
  - Urban = D
- **Local**
  - Rural = D
  - Urban = D

Note: The Green Book allows consideration of “appropriate degrees of congestion.”
Remember that LOS MOEs change by facility type

- Two–lane rural highway
  - Percent time following and average travel speed
- Multilane urban arterial
  - Average through-vehicle speed
- Signalized intersection
  - Average total delay (all vehicles)
- Unsignalized Intersection
  - Average control delay (only stopped/impeded movements)
- Freeway section
- Freeway ramp
  - Density of traffic
  - Density of traffic in lanes 1-2
- Pedestrian facilities
  - Average pedestrian space and flow rate (under study now)

Also Remember with LOS

- Only as good as travel forecast
- Typically assumes no metering, spillback, etc.
- Calculated in peak period (typically 15 minutes)
- Calculated in design year
- Need to look at lane group estimates
- Sometimes tough to get LOS A-C
Design Vehicle

- Largest common vehicle on facility in design year
- Big influence on intersection geometry
- Need to consider context
  - Land uses and right of way
  - Pedestrians
- Can tolerate occasional encroachments?

Examples of Flexibility in MLK Case

- Class discussion to recall examples of flexibility from field trip
Example of Flexibility on Hillsborough Street--Current

Hillsborough St. Proposal

Drawing by Kimley-Horn
Made Possible by Compromising on LOS at Roundabouts

Summary

• Designers have flexibility
  In all important design controls
• Consider context
• Satisfy substantive and normative safety
• Have good reasons for choices