When and What for Level One Design Exceptions

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Overview

- Why are design exceptions needed?
- When is a design exception required?
- Types of Design Exceptions
- Design Exception Resources
- Open Roads impact on design exceptions
- References

Why are design exceptions needed?

"It is to be emphasized that "good" design will not necessarily result from the direct use of the policy values. To form a segment of highway that will be truly efficient and safe in operations, be well fitted to the terrain and other site controls and be acceptably amenable to the community environment it must be a carefully tailor-made design for the unique set of conditions along that segment."

- AASHTO 1973

When are design exceptions required?

- **A design exception is required when a geometric feature that does not meet applicable standards is created or perpetuated.**
- **The geometric features that require a design exception are called controlling criteria.**
- **The applicable standards are the Indiana Design Manual (IDM) or the AASHTO Green Book.**

Controlling Criteria

- The geometric criteria that require a design exception where minimum values are not met are called controlling criteria.
- FHWA established 13 controlling criteria in 1985
  - Design Speed
  - Lane Width
  - Shoulder Width (usable)
  - Bridge Width
  - Horizontal Alignment
    - Minimum radius
  - Superelevation (rate)
  - Vertical Alignment
    - Grade and vertical curvature
  - Grade (min. and max.)
  - Stopping Sight Distance
    - Horizontal
    - Crest/Sag Vertical
  - Cross Slope
  - Vertical Clearance
  - Horizontal Clearance
    - Not clear zone, recently clarified as lateral offset to obstruction
  - Structural Capacity

Controlling Criteria

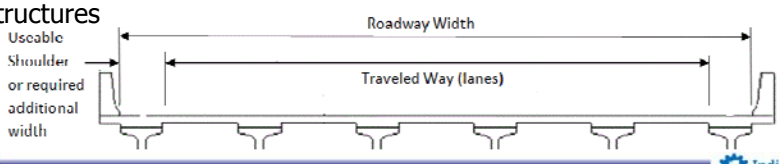
- INDOT identifies controlling criteria as Level One.
- There are criteria in addition to the FHWA 13 that must be evaluated.
  - Curb Offset
  - Superelevation Transition (length)
  - Paved Shoulder Width
  - Bridge Railing Test Level
    - Determining the bridge railing safety performance criteria (test level) is not applicable to underfill structures regardless of span; however, the test level of the barrier provided should be in accordance with IDM 49-5.01 Roadside-Barrier Types. A roadside barrier used on an INDOT-maintained route should be at minimum TL-3.
    - Minimum test level for any barrier (guardrail or bridge railing) on the NHS is TL-3.
  - Americans with Disabilities Act (ADA) criteria

Bridge Clear-Roadway Width

- When determining if a design exception is required, the minimum width depends on functional classification of the roadway and whether bridge is being replaced or rehabilitated.
  - Roadway width = traveled way (lane) + useable shoulder (without guardrail), or
  - Traveled way (lane) + additional width

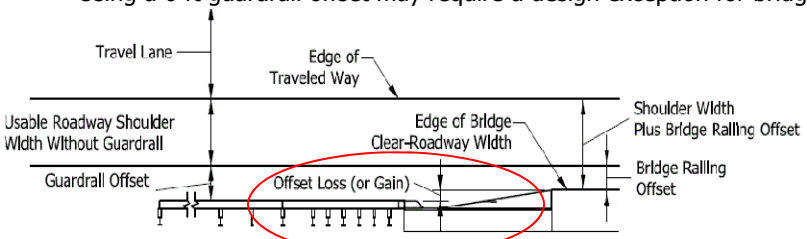

Bridge Clear Roadway Width

- Where the approach roadway is substandard and the bridge width requirement is full roadway width, carrying the full (substandard) roadway across the bridge will require a design exception for bridge width *and* the substandard roadway elements.
- Bridge Clear-Roadway Width criteria does not apply to underfill structures



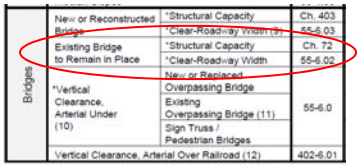
Bridge Clear-Roadway Width

- When *establishing* bridge clear-roadway width other factors must be considered
  - Guardrail offset
    - operational offset that allows for the full width of the shoulder to be utilized. 2 ft is recommended, 0 ft is acceptable in restricted conditions
    - Offset is in addition to the *useable* shoulder width.
    - Should be carried across the structure.
  - Losses due to connection at bridge rail to guardrail transition
    - Using a 0 ft guardrail offset may require a design exception for bridge



Existing Bridge to Remain in Place

- Structural Capacity (design loading)
  - The IDM and the Green Book have minimum requirements for structural capacity when an existing bridge is to remain in place.
  - For bridge rehabilitation, use the live-load specified in original design, as a minimum.
  - Where the existing capacity is less than the minimum from the IDM or the Green Book, replacement should be evaluated or a design exception is required.
  - It is acceptable to exceed the requirement, e.g. deck/superstructure replacements can be designed for HL-93, but the structure will be load rated according to the original design loading.



Bridges	New or Reconstructed Bridge	*Structural Capacity	Ch. 403
		*Clear-Roadway Width (9)	55-6.03
	Existing Bridge to Remain in Place	*Structural Capacity	Ch. 72
		*Clear-Roadway Width	55-6.02
	*Vertical Clearance, Arterial Under (10)	New or Replaced Overpassing Bridge	55-6.0
		Existing Overpassing Bridge (11)	
		Sign Truss / Pedestrian Bridges	
	Vertical Clearance, Arterial Over Railroad (12)		402-6.01

Existing Bridge to Remain in Place

- Bridge Clear-Roadway Width
  - The IDM and the Green Book have minimum requirements for bridge width when an existing bridge is to remain in place.
  - Using the bridge clear-roadway width requirement for existing bridge to remain in place is appropriate where the deck remains in place. Examples include:
    - Deck overlay projects that are 3R due to not meeting the minimum condition requirements for preventative maintenance
    - Coping reconstruction not associated with widening

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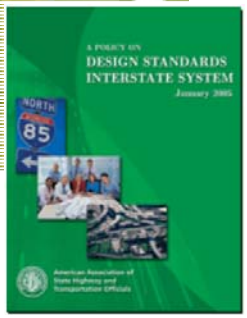
Applicable Standards

- The design standards that establish minimum values for controlling criteria are the Indiana Design Manual (IDM) and the AASHTO Green Book.
- The Green Book by itself is not a standard unless adopted by a governing agency.
- Federal, State and local agencies establish standards.
- **23 CFR 625.4 establishes standards for the NHS and are applicable regardless of funding.**
  - Green Book for the NHS – 4R non-interstate and 3R Freeway projects
  - AASHTO *Policy on Design Standards for the Interstate* – 4R and 3R interstate projects

code of federal regulations



Applicable Standards

- **States are responsible for establishing their own standards for 4R non-NHS projects and 3R NHS Non-Freeway.**
  - INDOT's design standards are in the IDM, but values closely mirror the Green Book.
  - Design Memo 14-10 (Practical Design) allowed the use of AASHTO Green Book minimum criteria in lieu of the values shown in the IDM without a design exception.
- **Federal projects must be designed and built in accordance with approved design standards**
  - FHWA approves IDM criteria
  - INDOT uses the same standards for federal projects as for State-funded projects.

Design Exceptions by Project Type

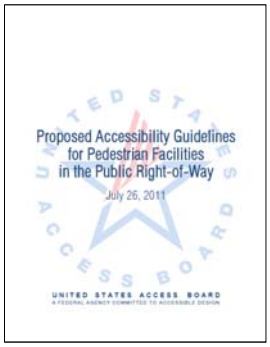
- **IDM 40-8.0 Adherence to Design Criteria, describes design exceptions**
- The need for a design exception and the amount of documentation required can vary by project type.
  - **4R (New Construction/Reconstruction) and 3R Freeway projects**
    - Formal Design Exception, IDM 40-8.04(01) item 1
  - **3R Non-Freeway projects**
    - Streamlined Design Exceptions, IDM 40-8.04(01), item 2
    - Intended to be one page with emphasis substantive safety, i.e. documenting the existing condition is performing as expected.
    - Focus on compatibility with adjacent sections, evaluation of planned expansion, crash analysis, and inclusion of low cost mitigation measures.

Design Exceptions by Project Type

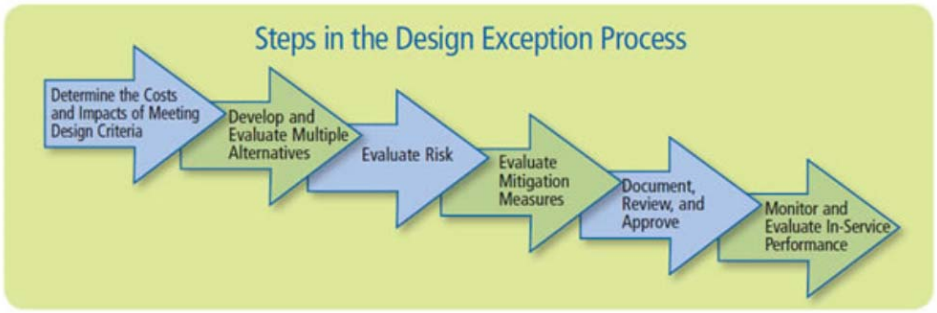
- **Preservation or Preventative Maintenance projects**
  - These projects are intended to extend the life of the existing highway and do not require an evaluation of, or design exceptions for geometric criteria.
  - Preservation work must not degrade any existing safety of geometric aspects of the facility.
  - Level One evaluation and design exceptions are required for MOT.
  - ADA compliance regarding alterations is required.
- Exempting the evaluation of Level One criteria must come with the understanding that appropriate safety and geometric enhancements will be an integral part of future 3R/4R projects.
- Bridge Preservation activities eligible for Federal participation are in the BCPI. LMC Overlays that meet certain condition requirements were recently added.

Design Exceptions by Project Type

- **Design Exceptions for ADA – there aren't any.**
  - ADA exceptions require a Determination of Technical Infeasibility. IDM 40-8.04(01), item 3
  - The Public Right of Way Accessibility Guidelines (PROWAG) should be used as the standard for curb ramp compliance (IDM and Standard Drawing revisions are in progress).
- As a reminder bridge overlays meet the DOJ/DOT definition of an alteration and require the installation or retrofit of curb ramps as part of the project scope of work.



Design Exception Process

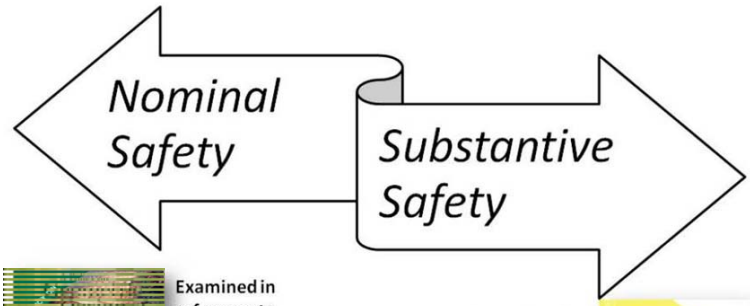


- *Mitigation Strategies for Design Exceptions*

Design Exception Considerations

- The project purpose and need will reflect the basic intent of the project and will determine the overall level of highway improvement. Use it to guide whether a DE is appropriate.
- Consideration of safety is the central theme of accepting/approving a design exception – nominal and substantive safety.
  - What is the effect of the not meeting the design standard on safety and operation of the facility?
  - What is the degree to which a standard is being reduced?
  - If it is an existing substandard roadway segment, how is it performing?
- How does the design exception affect compatibility with adjacent sections?
- Will the exception affect other standards, e.g. substandard sight distance blocks the view of an intersection?
- Are there any additional features being introduced, e.g., signing or delineation, that would mitigate the deviation?

Nominal vs. Substantive Safety

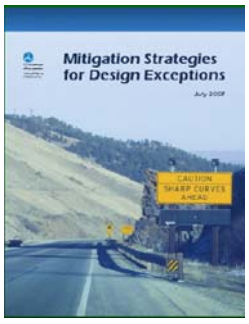


Examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures

The expected or actual crash frequency and severity for a highway or roadway

Design Exception Resources

- **Mitigation Strategies for Design Exceptions**
  - Can help answer **"**What is the effect of the not meeting the design standard on safety and operation of the facility?" and provide mitigation measures for each controlling criteria.
- **NHCRP 783 –** Evaluation of the 13 Controlling Criteria for Geometric Design
- **NCHRP 581 -** Design of Construction Work Zones on High-Speed Highways
- **NCHRP synthesis 316 –** Design Exception Practices
- **NCHRP synthesis 327 –** Cost-Effective Practices for Off-System and Local Interest Bridges

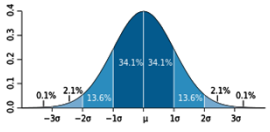


Design Exception Analysis Tools

- **Road Hazard Analysis Tool (RoadHAT)**
  - Evaluates crash frequency and severity for a given road segment and compares to similar road segments in Indiana.
- **Highway Safety Manual (HSM)**
  - Quantify the safety effects of design decisions.
  - HSM Part C presents a predictive method to estimate future crash frequency and severity for highways and streets, and the potential effects of proposed design alternatives on future crash frequency and severity.
- **IHSDM – suite of software analysis tools used to evaluate the safety and operational effects of geometric design decisions.**
  - Crash Prediction module uses HSM Part C methodology.
  - Operation effects include speed reduction due to radius of horizontal curves and grade.

RoadHAT Form 1

RoadHAT was developed for INDOT as part of a research project and is used to prioritize traffic safety projects. It can also be used to evaluate how a segment of roadway is performing relative to similar sections of roadway in Indiana.

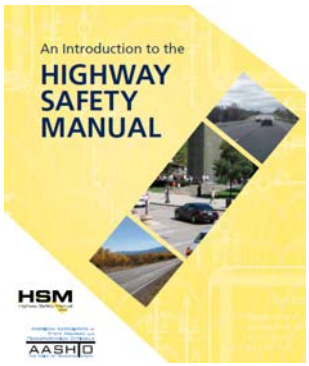


Index of Crash Frequency:
The difference between expected (nominal) crash frequency and the actual amount of crash frequency reported. For example, I_{CF} =2 indicates that the number of crashes at the location exceeds the expected number of crashes for that location by two standard deviations.

Index of Crash Cost: The difference between expected (nominal) crash cost and the actual amount of costs accumulated by reported crashes. For example, I_{CC} =2 implies that the crash cost at the location exceeds the expected crash cost for that location by two standard deviations.

Highway Safety Manual

- **HSM is a <u>resource</u> that provides safety knowledge and tools to facilitate decision making based on safety performance.**
  - Part C – Predictive Method contains Safety Performance Functions (SPFs).
  - SPFs are equations that estimate expected average crash frequency as a function of traffic volume and roadway characteristics.
  - Crash Modification Factors (CMFs) quantify the change in expected average crash frequency as a result of geometric or operational modifications to a site that differs from set base conditions.
  - Designers can use SPFs with CMFs to evaluate design options. For example 12-ft lane, no shoulder vs. 11-ft lane, 1-ft shoulder



Open Roads (Practical Design)

"Practical design relies on a strong purpose-and-need project statement, and a clear process for approving and <u>documenting the rationale for important decisions</u>. It requires good engineering judgment to assess the severity of adverse consequences, evaluate design tradeoffs, and mitigate risks as much as possible."

OPENROADS

Open Roads (Practical Design)

- Open Roads emphasizes tailor-made approach to every project much like the AASHTO Green Book language regarding 'good' design.
- Design exceptions are an integral part of Open Roads.
- Design exceptions are approved on a project-by-project basis.
- Design exceptions cannot be approved for general application to an entire corridor or geographic region.
- Policy Review Team recommendations to improve/streamline the design exception process are under review.

OPENROADS

References

- FHWA *Mitigation Strategies for Design Exceptions - free* http://www.fhwa.dot.gov/design/standards/140501.cfm
- *NCHRP Report 783 – Evaluation of the 13 Controlling Criteria for Geometric Design* http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_783.pdf
- FHWA *Guidance on NHS Design Standards and Design Exceptions (FAQ)* http://www.fhwa.dot.gov/design/standards/qa.cfm#a09
- AASHTO *Flexibility in Highway Design*
- AASHTO *A Policy on the Geometric Design of Highways and Streets* (Green Book)
- AASHTO *A Policy on Design Standards for the Interstate System*
- AASHTO *Guidelines for the Geometric Design of Very Low Volume Local Roads (ADT≤400)*
- AASHTO *Roadside Design Guide*
- *Public Right of Way Accessibility Guidelines (PROWAG)* – NPRM July 26, 2011 (free)
- AASHTO *Highway Safety Manual*
- Road Hazard Analysis Tool (RoadHAT) – free through INDOT Technical Applications Pathway (ITAP)
- Code of Federal Regulations (CFR) - http://www.ecfr.gov/cgi-bin/ECFR?page=browse

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