Selecting Design Criteria

Design Criteria

Project design criteria are established before beginning a project. Although specific criteria are developed for each project, the worksheets linked from this section contain criteria reflecting the best practices for most projects. Best practice criteria come from:

- Requirements defined in the federal law governing highway design are found in 23 CFR Sec 625.4. These requirements are highlighted in the criteria tables.
- Requirements defined in other state or federal laws.
- Guidance provided in AASHTO documents.
- Research findings.
- Provisions from the 3R Agreement with FHWA.
- Departmental decisions to balance initial costs, maintenance costs, mobility, safety, and other concerns.

Quick Tips:

Complete a Project Design Criteria Worksheet for each project or corridor and submit it to the Bureau Director or ADE responsible for the design for approval.

Refer to Section 1C-8 for information on documenting design decisions.

Design decisions exceeding the design criteria require approval of the Bureau Director or ADE responsible for the design. Design decisions that increase project cost are discussed at Project Review.

Controlling Criteria

The Code of Federal Regulations (23 CFR Sec 625.4) lists the design standards for highways. On NHS projects, federal law requires formal design exceptions when the 10 controlling criteria listed in Federal Register Vol. 81, No. 87, page 27187 are not met. These controlling criteria are listed in Table 1 and are highlighted (as explained in Table 1) in the design criteria tables. Refer to Section 1C-8 for guidance related to writing a formal design exception.

Table 1: Controlling Criteria for Design*

all NHS roadways	Interstates and freeways as well as other NHS roadways with design speed ≥ 50mph
design speed	lane width
design loading structural capacity	shoulder width
	horizontal curve radius
	superelevation rate
	maximum grade
	stopping sight distance
	cross slope
	vertical clearance

* Yellow highlight in the design criteria worksheets means design exception required if acceptable value is not met. Green highlight in the design criteria worksheets means design exception required if design speed ≥ 50mph and acceptable value is not met.

Selecting Project Design Criteria

In the past, designers typically began with a list of standard features that were incorporated into all projects. These features were only omitted if unique physical or financial constraints were identified. New research and the recent focus on substantive safety measures have demonstrated this standards-based design approach normally yields suboptimal results. In a fiscally constrained condition, designing to these standards can result in a decrease in the safety and operations of the overall system, because when funds are invested in areas that do not provide a return on the investment, funding isn't available to correct more critical locations.

When selecting design criteria for a project within an existing corridor, designers should consider the safety and operations of the existing route for all users including bicyclists and pedestrians. Designers should identify areas with crash histories, locations where delays are common, and infrastructure durability problems, and analyze solutions for these problems. These solutions should be identified in the project design criteria. Designers should avoid investing in features that don't solve tangible problems and don't provide a cost effective improvements. They should instead focus on upgrading features that will solve tangible problems and provide cost effective improvements. Some features that don't show up on standardized criteria lists, such as intersection type, can provide significant improvements and should be considered for incorporation into the project.

A benefit-cost (B/C) analysis is the most reliable method to determine the cost effectiveness of design solutions. For a project that is not within an existing corridor, a direct safety analysis of the system is not available, but similar routes can be evaluated. The Highway Safety Manual and CMF Clearinghouse are useful tools designers should consult when determining the correct design criteria for a given project.

Design Criteria Worksheets

For each project, a project design criteria worksheet is developed by the project PMT or developed with a project concept statement. A completed Project Design Criteria Worksheet is approved by the Office Director or ADE responsible for the design of the project.

The following design criteria worksheets contain design elements based upon various roadway types:

Rural Interstates	Rural Expressways	Rural Two-lane Highways	Ramps
Urban Interstate	Urban Expressways	Urban Two-lane Roadways	

Secondary Roads

The design criteria worksheets apply to the primary roadway system. Secondary roads are designed to guidelines within Instructional Memorandum (I.M.) No. 3.210 or guidelines specifically requested by a county or city.

The following worksheet is for project documentation:

Secondary Roads

Rural Areas

Roadways in rural areas are usually designed for higher speeds, serve longer trips with minimal interruption to through movements, and are usually located outside of boundaries established by state and local officials.

Urban Areas

Urban roadways are usually designed for lower speeds, have a high number of access points which interrupt through movements, usually serve multiple modes of travel, and have a higher traffic density. Designers need to consider future growth, as it could change the limits of the existing urban area.

A roadway within a corridor may change from a rural environment to an urban environment. Designers should understand criteria from both types of roadways in order to blend the two areas together as the roadway transitions from one area to the other.

Designers should also understand the differences between reconstruction and 3R projects.

Reconstruction

Reconstruction projects include overlays adding more than 4″ (typically) of pavement structure, inlays, new construction, and conversion of a two lane roadway to a four lane roadway, or any project on the Interstate. The same design criteria worksheets listed above are used for reconstruction projects.

Resurfacing, Rehabilitation, and Restoration (3R)

3R projects include overlays adding 4 inches or less (typically) of pavement structure (not on the Interstate system). The 3R Agreement outlines allowable exceptions to the reconstruction design criteria. Contact the Methods Engineer for a copy of the current 3R Agreement.

3R Project Design Criteria Worksheet

Working within Project Constraints

To meet the constraints of a project, a roadway element may need to be designed using values less than the acceptable values listed in the worksheets. A case such as this requires judgment and serious consideration of many factors:

- The type of project (i.e., new construction, reconstruction, or 3R).
- The functional classification of the road, the amount and character of the traffic, and the crash history of the road. A crash analysis may need to be performed.
- The degree of variance from the acceptable value.
- The effect the variance has on the safety and operation of the facility, and its compatibility with adjacent sections of the roadway.
- How the feature will affect other criteria.
- The introduction of mitigating features (e.g. pavement markings, signing, delineation, or rumble strips).
- The impact of the full variance on scenic, historic, or other environmental features.

During the concept field review, record existing features such as foreslopes, provided clear zone distance, shoulder cross-slopes, and shoulder widths to aid in the selection of an appropriate design concept. Having a record of the features is important since meeting the initial design criteria for one feature may require significant improvements to other features. Understanding how all the features affect each other will help to avoid designing projects that can escalate beyond their initial scope, both in cost and in type of work. Consider all design options and select the best overall design that will balance safety and funding.

Safety Repairs

Safety repairs should be addressed whenever possible. Expecting safety repairs to be included in future resurfacing projects can lead to a steady degrading of the highway system as repairs are continually delayed. Because funds are limited, targeting funds towards projects that will provide the best value is very important. Funding spent completing repairs that provide marginal safety benefits in one area may be better spent repairing more pressing safety issues in other areas.

Mitigation Strategies

If a project element cannot be designed to meet the acceptable values recommended in the criteria worksheets, designers should consider how mitigation strategies may help to reduce operational or safety problems. A list of possible mitigation strategies is included in Chapter 4 of Mitigation Strategies for Design Exceptions at
http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/index.htm

Examples: Adjusting for Overlays

Typically, repair projects involve an overlay which consequently adds height to the roadway. This can result in a vertical drop at the edge of a paved shoulder. Erosion and settlement tend to increase this drop. To avoid vertical drops at the edge of a paved shoulder, the foreslope and the shoulder should be adjusted to meet at the same elevation. To achieve this balance, three options are available: steepening shoulders, steepening slopes, and narrowing shoulders. The first step for determining the appropriate design for the project is to evaluate which features can be adjusted and still maintain, at a minimum, the acceptable values in the design criteria tables listed above.

- Steepening shoulders to 6%.

  Table 2 shows the thickness of overlay that can be accommodated by building 6% shoulders rather than 4%.

Table 2

shoulder width (feet)	thickness gained by changing from 4% to 6% shoulder slope (inches)
1	0.24
2	0.48
3	0.72
4	0.96
5	1.20
6	1.44
7	1.68
8	1.92
9	2.16
10	2.40
11	2.64
12	2.88

Note: Where bicyclists currently are, or are expected to be, accommodated shoulders should not be steepened beyond 4%.

- Steepening foreslopes.

  4:1 foreslopes are generally considered acceptable; however, many types of guardrail, including some cable guardrail, are not designed for slopes steeper than 6:1. Existing guardrail should be analyzed if slopes are steepened. In some situations, 3:1 slopes are acceptable, but clear zone and many other factors need to be considered prior to designing a 3:1 slope. Slopes steeper than 4:1 will not typically be approved on Interstate routes. Table 3 shows the width of foreslope reconstruction required to tie into an existing slope for various overlay depths. To avoid erosion issues and the expense of erosion control features, rock fillets are desirable if the width of the fillet does not exceed 4 feet. When the width is greater than 4 feet, a rock fillet can appear to be a shoulder, so earth fill is more desirable. Whenever earth fill is required, consider upgrading the foreslopes to the preferred values since the equipment and erosion control measures will already be in place.

Table 3

width required to intersect existing slope (in feet)			
existing slope	6:1	6:1	4:1
proposed slope	4:1	3:1	3:1
Inches of added height			
1	1	0.5	1
2	2	1.0	2
3	3	1.5	3
4	4	2.0	4
5	5	2.5	5
6	6	3.0	6
7	7	3.5	7
8	8	4.0	8
9	9	4.5	9
10	10	5.0	10
11	11	5.5	11
12	12	6.0	12

- Narrowing shoulders.

  In some situations, e.g. interstate inside shoulders, Iowa DOT builds shoulders wider than AASHTO minimums. In that case, the inside shoulder can be narrowed; however, the outside shoulder needs to be reviewed as well.

  Note: Do not narrow shoulders where bicyclists currently are, or are expected to be, accommodated.

Example 1C-1_1: Overlay Project

Example 1C-1_2: Interstate Overlay Project

Chronology of Changes to Design Manual Section:

001C-001 Selecting Design Criteria

11/17/2021 Revised

Revised Selecting Project Design subsection to state designers should consider the safety and operations of the existing route for all users including pedestrians and bicyclists.

4/29/2019 Revised

No changes within the text of the section. Updated design criteria worksheet references to AASHTO Greenbook 7th edition. Adjusted preferred outside lane width for Rural Expressways, Urban Multilane Roadways, and Rural Interstates from 14 feet to 12 feet. For Rural Expressways and Urban Multilane Roadways, adjusted preferred 4 foot paved shoulder width to 6 feet, and adjusted acceptable 2 foot paved width to 0 feet. Adjusted preferred lane widths for Rural Two-Lane Highways and Urban Two-Lane Roadways from 14 feet to 12 feet. Adjusted preferred effective shoulder widths for urban roadways from 6 feet to 4 feet and from 2 feet to 0 feet. Adjusted acceptable effective shoulder widths for urban roadways from 2 feet to 0 feet.

5/26/2017 Revised

Retitled Urban Multi-lane Roadways as Urban Expressways. Modified the new bridge width for the curb and gutter sections for the Urban Two Lane Roadway and Urban Expressway Arterials in the spreadsheet.

12/8/2016 Revised

Added in information regarding controlling criteria.
Added information regarding selecting project design criteria.
Added information into tables to contact FHWA if width bridge does not meet acceptable criteria.

5/6/2014 Revised

Revised Design Criteria Sheet (not filling in correctly and hyperlinks not working). Added worksheet and guidance for secondary roads.

8/5/2013 Revised

Revise Design Criteria Worksheets - worksheets were not filling in correctly. No values were changed.

7/18/2013 Revised

Replaced tables with new tables containing preferred and acceptable values. New tables eliminate design criteria for transitional facilities (now handled by rural and urban criteria) and SUDAS functional class roadways (to avoid potential mismatches with published SUDAS design guidance). Rewrote discussion of project design criteria to better clarify process of establishing and documenting criteria. Added definitions for Rural and Urban areas. Moved example problems out of main text and added in hyperlinks to example problems instead.

6/13/2012 Revised

The following changes occur on the ByRoadway sheet:
Acceptable Design Criteria Based Upon Roadway Type under SUDAS Functional Class: effective shoulder width and type (see Section 3C-4)
--Local-Residential rewritten for clarification
--Local-Commercial/Industrial rewritten for clarification between rural and urban with curb & gutter added
--Collector-Residential rewritten for clarification - changed curb & gutter from 2 to 1.5
--Collector-Commercial/Industrial rewritten for clarification between rural and urban with curb & gutter added
--Arterial-Residential rewritten for clarification - changed curb & gutter from 3 to 2
--Arterial-Commercial/Industrial rewritten for clarification between rural and urban with curb & gutter added

Preferred Design Criteria Based Upon Roadway Type under Roadway Type: change normal median width (ft) (if applicable)
--changed Expressways/Freeways from 82 to 64

Preferred Design Criteria Based Upon Roadway Type under SUDAS Functional Class: effective shoulder width and type (see Section 3C-4)
--Collector-Commercial/Industrial rewritten for clarification - changed curb & gutter from 3 to 2
--Collector-Commercial/Industrial rewritten for clarification between rural and urban with curb & gutter added
--Arterial-Commercial/Industrial rewritten for clarification between rural and urban with curb & gutter added

The following change occurs on the BySpeed sheet:
Acceptable Values: Design Element
-- changed wording in parens of header

The following change occurs on the ShoulderPreferred_1 sheet:
Preferred Effective Shoulder widths for Two-Lane Highways (values shown in feet)
-- Added line at the bottom for non-NHS routes with an existing ADT <3000

7/29/2011	Revised Changed formatting, headers, and removed horizontal curve row.
5/13/2011	Revised Updated bridge clearances and removed the yellow highlighting from the acceptable tables for minimum horizontal curve length
4/29/2011	Revised Updated examples to reflect recent changes to criteria tables
4/27/2010	Revised Revised the shoulder widths within the preferred tables for Auxilary Lanes from 4' to 6' and Median Side effective shoulder width for Expressways from 10' to 6'.
4/15/2010	Revised Correct misspelling and grammar