122 Design Exceptions and Design Variations

122.1 General

The Department's design criteria and standards contained in the ***FDM*** are usually within the desirable ranges established by AASHTO. The values given have been accepted by the Federal Highway Administration (FHWA) and govern the design process. When it becomes necessary to deviate from the Department's criteria, early documentation and approval are required. There are two approval processes used by designers: Design Exceptions and Design Variations.

A Design Exception or Design Variation is required when the Department's criteria are not met. This requirement applies to all entities affecting planning, design, construction, and maintenance.

For RRR projects, see also ***FDM 114.1.1***.

122.1.1 Safety Improvement Projects

For safety improvement projects developed to solely address documented safety problems, only the elements identified under the scope of work for the safety improvement project are subject to these approval processes. Existing non-compliant features within the limits of a safety improvement project do not require approval to remain if the project does not create a non-compliant condition. For these projects, all Design Variations and Design Exceptions applicable to the project scope must be approved prior to the beginning of the design phase.

122.1.2 Drainage Projects

For drainage projects, only elements identified in the scope of services for the drainage project are subject to these approval processes. The existing features within the limits of the drainage project that do not meet design criteria do not require approval to remain (if the project does not create a nonconforming condition).

122.1.3 Maintenance Projects

Maintenance Resurfacing, Ride Only (a.k.a., Ride Rehabilitation) and Skid Hazard Projects do not require Design Exceptions or Design Variations other than for ADA curb ramp requirements. If compliance with ADA curb ramp requirements is determined to be technically infeasible, documentation as a Design Variation is required. Maintenance Resurfacing Projects can only be programmed on routes that meet the requirements identified in ***Chapter 27*** of the ***Work Program Instructions***.

122.1.4 Landscape Projects

For Landscape-only projects, intersection sight distance Design Variations may be processed by the Responsible Landscape Architect of Record. For design projects with landscaping, intersection sight distance Design Variations must be processed by a Professional Engineer. In cases where intersection sight distance falls below stopping sight distance, a Design Exception for stopping sight distance must be processed by the respective professional according to the above guidelines.

122.2 Identification

Identify the proper approval process as early as possible in the planning and design phases to allow time to research alternatives and begin the analysis and documentation activities. Identification should be done during the PD&E process for major projects and the scope development process for minor projects. Approval must be obtained no later than the Phase I design submittal.

122.2.1 Design Exceptions

Design Exceptions are required when existing or proposed design elements do not meet both the Department's governing criteria and AASHTO's new construction criteria for the Controlling Design Elements.

The 10 Controlling Design Elements for high-speed (Design Speed ≥ 50 mph) roadways and limited access ramps (all design speeds) are:

(1) Design Speed
(2) Lane Width
(3) Shoulder Width
(4) Horizontal Curve Radius
(5) Superelevation Rate
(6) Stopping Sight Distance
(7) Maximum Grade
(8) Cross Slope
(9) Vertical Clearance
(10) Design Loading Structural Capacity

The two Controlling Design Elements for low-speed (Design Speed < 50 mph) roadways are:

(1) Design Speed
(2) Design Loading Structural Capacity

FDM 122.5 provides AASHTO's minimum requirements for the above elements.

122.2.2 Design Variations

Design Variations are required when existing or proposed design elements do not meet the Department's criteria.

There are two methods to document Design Variations:

- Formal Design Variation
- Project Design Variation Memorandum

A **Formal Design Variation** is used for any of the following design elements:

(1) Controlling Design Elements
(2) American with Disabilities Act (ADA)
(3) Design elements requiring signature by individual or office noted in ***FDM 122.7.4***.

A **Project Design Variation Memorandum (*Form 122-B*)** is used to document all Non-Controlling Design elements for projects that do not meet Department criteria and for design elements that are not included in the above list for Formal Design Variations. This document is a stand-alone document prepared by the Engineer of Record and approved by the District Design Engineer and the District Traffic Operations Engineer (as needed).

This form should be submitted early in the design process, as certain items may require more extensive review.

When additional documentation is requested on a **Project Design Variation Memorandum (*Form 122-B*)**, a Formal Design Variation is required for re-submittal of those elements.

When additional design elements arise on a project following approval of the initial Project Design Variation Memorandum, the Memorandum can be appended for approval of the additional elements. An alternative option would be to submit the Design Variation in an additional Project Memorandum.

122.3 Justification for Approval

Sufficient detail and explanation must be provided to those reviewing the request to justify approval. Develop a detailed justification showing good engineering judgement when allowing a design element to remain that does not meet these requirements. At some point, this justification may be used to defend design decisions made by the Department and the designer. All deviations from Department criteria and standards must be uniquely identified, located, and justified; no blanket approvals are given.

Examples of valid justifications are as follows:

(1) The required criteria are not applicable to the site-specific conditions.

(2) The project can be as safe by not following the criteria.

(3) The environmental or community needs prohibit meeting criteria.

In some instances, the required criteria may be impractical, and the proposed design wisely balances all design impacts. The impacts that may be associated with this level of justification are:

(1) Safety and Operational performance

(2) Level of Service

(3) Right of Way impacts

(4) Community impacts

(5) Environmental impacts

(6) Costs

(7) Usability by all modes of transportation

(8) Long-term and cumulative effects on adjacent sections of roadway

The justification should not be developed solely on the basis that:

(1) The Department can save money,

(2) The Department can save time, or

(3) The proposed design is similar to other designs.

122.3.1 Approval Process

Project Design Variation Memorandums, Formal Design Variations, and Design Exceptions should be approved by the Department prior to the Phase II plans submittal.

122.4 Documentation for Approval

Supporting documentation that is generated during the approval process is to accompany each submittal. The level of detail for Design Exceptions and Design Variations should be commensurate with the complexity of the design element and the relevance of information to engineering decisions.

Design Exceptions and **Formal Design Variations** should include the following documentation:

(1) Submittal/Approval Letter (***Form 122-A***, see ***FDM 103)***.

(2) Project Description: general project information, location map, context classification, existing roadway characteristics, project limits (mileposts), county section number, work mix, objectives, and obstacles. Include any associated or future limitations that exist as a result of public or legal commitments.

(3) Project Schedule and Lifespan: Provide (1) the Plans Production date, and (2) the Letting date for the project. Explain why the proposed Design Exception/Variation is either a temporary or permanent condition. Include any future work planned or programmed to address the condition.

(4) Design Exception/Variation Description:

   (a) Specific design criteria that will not be met (provide criteria values from both AASHTO and FDOT). Detailed explanation of why the criteria or standard cannot be complied with or is not applicable. Description of the proposed value and why it is appropriate.

   (b) A plan view, plan sheet, or aerial photo of the location, showing the design speed, posted speed, target speed, right of way lines, and property lines of adjacent property. A photo of the area of the deficiency.

(c) Typical section or cross-section of the location.

(d) The milepost and station location (including left/right side).

(5) Alternative Designs Considered: meeting Department criteria, meeting AASHTO criteria, partial correction, and the no-build (existing) condition.

(6) Impacts of the Design Exception/Variation to:

(a) Safety Performance:

i. Review and evaluation of the most recent 5 years of crash data from the current date of analysis.

ii. A summary listing of the crashes reviewed with crash report numbers is acceptable for documentation. However, if specific crash reports are necessary for clarity, personal information must be redacted from the crash reports per ***F.S. 316.066***.

iii. Description of the anticipated impact on safety, long and short-term effects. Description of any anticipated cumulative effects.

iv. For non-existing or proposed conditions, a comparison of the predicted or expected crash frequency should be included along with a discussion of the 5-year crash history. Some resources that are available for this comparison include:

1. ***Highway Safety Manual (HSM)***

2. Interactive Highway Safety Design Model (IHSDM)

3. Enhanced Interchange Safety Analysis Tool (iSATe)

4. Roadside Safety Analysis Program (RSAP)

(b) Operational Performance:

i. Description of the anticipated impact on operations, long and short-term effects. Description of any anticipated cumulative effects.

ii. Traffic information: Design Year AADT and 24-hour truck volume.

iii. Compatibility of the design with adjacent sections of roadway.

iv. Effects on capacity (proposed criteria vs. AASHTO) using an acceptable capacity analysis procedure and calculate reduction for design year, level of service.

(c) Right of Way.

(d) Community.

(e) Environment.

(f) Usability by all modes of transportation.

(7) Costs: Description of the anticipated costs associated with the Design Exception or Variation. Provide a Benefit-Cost (B/C) ratio, where applicable.

(8) Mitigation Measures: Description and explanation of practical mitigation measures or alternatives that were considered and selected treatments implemented on the project.

(9) Summary and Conclusions.

A ***Project Design Variation Memorandum*** should include the following documentation, which may be presented in the format of succinct bullets:

(1) Submittal/Approval Memo (***Form 122-B***, see ***FDM 103***).

(2) Design criteria versus proposed criteria.

(3) Review of crash history on the project related to the design element.

(4) Abbreviated justification for the proposed criteria.

For Lateral Offset Design Variations, provide a tabulation of stations (or mileposts) and lateral offsets for aboveground fixed objects.

122.5 AASHTO Controlling Elements

AASHTO criteria, required documentation, and mitigation strategies for the controlling elements are provided in the following sections. Detailed discussions on criteria and mitigation are provided in the ***AASHTO Green Book: A Policy on Geometric Design of Highways and Streets, 2018,*** and the ***FHWA Guide: Mitigation Strategies for Design Exceptions, July 2007.*** The AASHTO criteria provided are in no way intended to replace Department design criteria.

The criteria used for determining Design Exceptions on Interstate projects must be based on AASHTO's ***A Policy on Design Standards Interstate System 2016***.

122.5.1 Design Speed

122.5.1.1 AASHTO Criteria

Table 122.5.1 AASHTO Design Speed (Minimum)

Type Facility	Other Factors	Design Speed (mph)	AASHTO
Interstate	Urban Rural	50 70	DSIS pg. 3(1)
Freeways	Urban Rural	50 50	pg. 8-2
Urban Arterials	Major Other	20 15	pg. 2-26 pg. 2-27
Rural Arterials	Rolling terrain Level terrain Rural Town	50 50 20	pg. 7-3
Urban Collectors	Suburban Urban Urban Core	35 30 25	pg. 6-13
Rural Collectors	Level ADT < 400 ADT 400 - 2000 ADT > 2000 Rolling ADT < 400 ADT 400 - 2000 ADT > 2000	40 50 60 30 40 50	pg. 6-3, Table 6-1
Ramps	Highway Design Speeds (mph) 30 35 40 45 50 55 60 65 70	 15 20 20 25 25 30 30 30 35	pg. 10-105, Table 10-1
Loop Ramps	Minimum	20	pg. 10-106
Connections	Direct Semi-Direct	40 30	pg. 10-106
Notes: DSIS = AASHTO's *A Policy on Design Standards Interstate System* (January 2016).			

122.5.1.2 Documentation

Provide the length of section with reduced design speed compared to the overall length of the project. Include any existing or proposed measures used within the transitions to adjacent roadway sections having higher or lower design (or operating) speeds.

122.5.1.3 Mitigation

A potential mitigation strategy is to use cross-sectional elements to reduce operating speeds to the design speed.

122.5.2 Lane Width

122.5.2.1 AASHTO Criteria

Table 122.5.2 AASHTO Lane Width (Minimum)

Type Facility	Lane Width (feet)	AASHTO
Freeway (including Auxiliary)	12	pg. 8-3, 10-90, DSIS pg.4 (1)
Rural Arterial	11	pg. 7-7, Table 7-3
Rural Town	10	Pg. 7-15
Urban Arterial	10	pg. 7-39
Urban Collector	10	pg. 6-16
Rural Collector	10	pg. 6-6, Table 6-5
Low Speed	10	pg. 4-9
Residential	9	pg. 4-10
Auxiliary (Non-Freeway)	10	pp. 4-9
Continuous TWLTL	10	pg. 4-10

Notes:
(1) DSIS = AASHTO's *A Policy on Design Standards Interstate System* (January 2016).

122.5.2.2 Documentation

Provide locations of alternative routes that meet criteria and a proposal for handling drainage. Include a typical section or plan of the proposed signing and pavement markings associated with the lane width exception.

122.5.2.3 Mitigation

Potential mitigation strategies for lane width are:

(1) Select optimal combination of lane and shoulder widths based on site characteristics to optimize safety and operations by distributing available cross-sectional width

(2) Signing to provide advanced warning of lane width reduction

(3) To improve the ability to stay within the lane:

- (a) Wide, recessed, or raised pavement markings
- (b) Delineators
- (c) Object Markers
- (d) Tubular Markers
- (e) Lighting
- (f) Audible and vibratory treatment, (See ***FDM 210.4.6*** for arterials and collectors. See ***FDM 211.4.4*** for LA Facilities.)

(4) To improve the ability to recover if the driver leaves the lane:

- (a) Paved or partially paved shoulders
- (b) Safety edge treatment

(5) To reduce crash severity if the driver leaves the roadway (see ***FDM 215***):

- (a) Remove or relocate fixed objects
- (b) Traversable slopes
- (c) Breakaway safety hardware
- (d) Shield fixed objects and steep slopes

122.5.3 Shoulder Width

122.5.3.1 AASHTO Criteria

Table 122.5.3 AASHTO Shoulder Widths (Minimum)

Type Facility	Other Factors	Median or Left (feet)	Right (feet)	AASHTO
Freeway	4 lanes	4 paved	10 paved	pg. 8-3
	≥ 6 lanes	10 paved	10 paved	pg. 8-3
Rural Arterial	ADT > 2000		8	pg. 7-7, Table 7-3
	ADT 400-2000		6	
	ADT < 400		4	
	4 lane Divided	4 paved	8	pg. 7-16
	6+ lane Divided	8	8	
Urban Arterial	Low Type (Gravel, Other)		2	pg. 4-12
	High Type (Asphalt, Conc.)		10	
	Heavily Traveled/High Speed/High Trucks		10	
Rural & Urban Collector	ADT > 2000		6	pg. 6-6, Table 6-5
	ADT 400-2000		4	
	ADT < 400		2	

Table 122.5.4 AASHTO Bridge Widths (Minimum)

Type Facility	Other Factors	Bridge Widths		AASHTO
Freeway	New Bridges	Approach Roadway Width		pg. 8-5
Rural Arterial	New Bridges (Short)	Approach Roadway Width		pg. 7-9
	New Bridges (Long) (> 200 ft.)	Travel Lanes + 4 ft. each side		
Urban Arterial	New and Existing Bridges (Short)	Curb to curb width of street		pg. 7-50
	New and Existing Bridges (Long) without shoulders or parking on arterial	Curb to curb width of street		
	New and Existing Bridges (Long) with shoulders or parking on arterial	Travel Lanes + 4 ft. each side		pg. 7-51
Type Facility	**Other Factors**	**Bridge Widths**		**AASHTO**
		New or Reconstruction	**To Remain**	
Rural and Urban Collector	ADT Under 400	Traveled Way + 2 ft. each side (1)	22 ft. (2)	pg. 6-8 Table 6-6,
	ADT 400-2000	Traveled Way + 4 ft. each side (1),(3)	24 ft. (2)	
	ADT > 2000	Approach Roadway Width (1),(3)	28 ft. (2)	

Notes:

(1) If the approach roadway has paved shoulders, the surfaced width must be carried across the bridge.
(2) Bridges longer than 100 feet are to be analyzed individually.
(3) For bridges longer than 100 feet, the minimum bridge width of the traveled way plus 3 feet on each side is acceptable.

122.5.3.2 Documentation

Provide a proposal to address stalled vehicles, enforcement activities, emergency operations, and drainage in the documentation for the exception.

122.5.3.3 Mitigation

Potential mitigation strategies for shoulder width are:

(1) Select optimal combination of lane and shoulder width based on site characteristics to optimize safety and operations by distributing available cross-sectional width

(2) Signing to provide advanced warning of lane width reduction

(3) To improve the ability to stay within the lane:

- (a) Wide, recessed or raised pavement markings
- (b) Delineators
- (c) Object Markers
- (d) Lighting
- (e) Audible and vibratory treatment, (See ***FDM 210.4.6*** for arterials and collectors. See ***FDM 211.4.4*** for LA Facilities.)

(4) To improve the ability to recover if the driver leaves the lane:

- (a) Paved or partially paved shoulders
- (b) Safety edge treatment

(5) To reduce crash severity if driver leaves the roadway (See ***FDM 215***):

- (a) Remove or relocate fixed objects
- (b) Traversable slopes
- (c) Breakaway safety hardware
- (d) Shield fixed objects and steep slopes

122.5.4 Horizontal Curve Radius

122.5.4.1 AASHTO Criteria

Table 122.5.5 AASHTO Horizontal Alignment

Minimum Radius (feet) with Superelevation (page 3-34, 3-35, Table 3-7)

Type Facility	Super-elevation e-max	Minimum Curve Radius (feet) for Design Speed (mph)											
		15	20	25	30	35	40	45	50	55	60	65	70
Rural Highway and High-Speed Urban Street	0.04	42	86	154	250	371	533	711	926	1190	1500	---	---
	0.06	39	81	144	231	340	485	643	833	1060	1330	1660	2040
	0.08	38	76	134	214	314	444	587	758	960	1200	1480	1810
	0.10	36	72	126	200	292	410	540	694	877	1090	1340	1630
	0.12	34	68	119	188	272	381	500	641	807	1000	1220	1480

Minimum Radius (feet) for Section with Normal Cross Slope (page 3-47, Table 3-11)

Type Facility	Minimum Curve Radius (feet) for Design Speed (mph)											
	15	20	25	30	35	40	45	50	55	60	65	70
Freeway, Arterial, and Collector	947	1680	2420	3320	4350	5520	6830	8280	9890	11700	13100	14700

Minimum Radius (feet) for Intersection Curves (2001 AASHTO, page 201, Exh. 3-43)

Design Speed (mph)	10	15	20	25	30	35	40	45
Minimum Radius (feet)	25	50	90	150	230	310	430	540
Assumed Minimum Superelevation Rate	0.02	0.02	0.02	0.04	0.06	0.08	0.09	0.10

122.5.4.2 Documentation

No additional documentation beyond what is covered in ***FDM 122.4*** is required.

122.5.4.3 Mitigation

Potential mitigation strategies for horizontal curve radius are:

(1) To provide advanced warning:
- (a) Signing
- (b) Pavement marking messages
- (c) Dynamic curve warning systems

(2) To provide delineation:
- (a) Chevrons
- (b) Delineators
- (c) Tubular Markers
- (d) Linear Barrier Delineators

(3) To improve the ability to stay within the lane:
- (a) Widen the roadway
- (b) Skid-resistant pavement
- (c) Enhanced pavement markings
- (d) Lighting
- (e) Audible and vibratory treatment, (See ***FDM 210.4.6*** for arterials and collectors. See ***FDM 211.4.4*** for LA Facilities.)

(4) To improve the ability to recover if driver leaves the lane:
- (a) Paved or partially paved shoulders
- (b) Safety edge

(5) To reduce the crash severity if driver leaves the roadway (see ***FDM 215***):
- (a) Remove or relocate fixed objects
- (b) Traversable slopes
- (c) Breakaway safety hardware

(d) Shield fixed objects and steep slopes

122.5.5 Superelevation Rate

122.5.5.1 AASHTO Criteria

Table 122.5.6 AASHTO Superelevation (Maximum)

Type Facility	Superelevation Rate	AASHTO
Highways (Rural)	12%	pg. 3-32
Urban	6%	pg. 3-32
Urban: Low Speed w/severe constraints	None	pg. 3-31
Ramps and Turning Roadways at Intersections	10%	pg. 9-83
Note: (1) Maximum Superelevation is pro-rated value (based upon radius) from rate tables cited above.		

122.5.5.2 Documentation

Provide side friction factors for each curve at the PC, Midpoint, and PT of the curve, and at the location of maximum provided superelevation. For multi-lane facilities, provide values for each lane. Use the following equation:

$$f = \frac{V^2 - 15Re}{V^2 e + 15R}$$

where: f = Side Friction Factor

V = Design Speed (mph)

R = Radius (feet)

e = Superelevation (ft/ft) at the station evaluated

122.5.5.3 Mitigation

Potential mitigation strategies for superelevation rate exceptions are:

(1) To provide advanced warning:
   (a) Signing
   (b) Pavement marking messages
   (c) Dynamic curve warning systems
(2) To provide delineation:
   (a) Chevrons
   (b) Linear Barrier Delineators
   (c) Tubular Markers
(3) To improve the ability to stay within the lane:
   (a) Widen the roadway
   (b) Skid-resistant pavement
   (c) Enhanced pavement markings
   (d) Lighting
   (e) Audible and vibratory treatment, (See ***FDM 210.4.6*** for arterials and collectors. See ***FDM 211.4.4*** for LA Facilities.)
(4) To improve the ability to recover if driver leaves the lane:
   (a) Paved or partially paved shoulders
   (b) Safety edge
(5) To reduce the crash severity if driver leaves the roadway: (See ***FDM 215***)
   (a) Remove or relocate fixed objects
   (b) Traversable slopes
   (c) Breakaway safety hardware
   (d) Shield fixed objects and steep slopes

122.5.6 Stopping Sight Distance

122.5.6.1 AASHTO Criteria

Table 122.5.7 AASHTO Stopping Sight Distance (Minimum)
(AASHTO page 3-4, Table 3-1)

Design Speed (mph)												
	15	20	25	30	35	40	45	50	55	60	65	70
Stopping Sight Distance (feet) Computed for Design	80	115	155	200	250	305	360	425	495	570	645	730

Table 122.5.8 AASHTO Vertical Alignment
(AASHTO Table 3-35, Table 3-37, and Table 6-3, and based on a 2' object height)

Design Speed (mph)	Minimum K Value for Vertical Curves	
	Crest	Sag
15	3	10
20	7	17
25	12	26
30	19	37
35	29	49
40	44	64
45	61	79
50	84	96
55	114	115
60	151	136
65	193	157
70	247	181

Note:
(1) Rate of vertical curvature, K, is the length of curve per percent algebraic difference of the intersecting grades. (K = L/A)

Table 122.5.9 AASHTO Minimum Passing Sight Distance (AASHTO page 3-11, Table 3-4)

	Design Speed (mph)										
	20	25	30	35	40	45	50	55	60	65	70
Passing Sight Distance (feet)	400	450	500	550	600	700	800	900	1000	1100	1200

122.5.6.2 Documentation

Provide profiles in the area of vertical alignment related Design Exceptions or Design Variations for stopping sight distance. Provide plan views with sight triangles for horizontal stopping sight distance evaluations.

122.5.6.3 Mitigation

Potential mitigation strategies for stopping sight distance are:

(1) To mitigate sight distance restrictions
- (a) Signing and speed advisory plaques (crest vertical curves)
- (b) Lighting
- (c) Adjust placement of lane within the roadway cross section (horizontal)
- (d) Cross-sectional elements to manage speed

(2) To improve the ability to avoid crashes:
- (a) Cross-sectional elements
- (b) Wider clear recovery area

(3) To improve driver awareness on approach to intersections:
- (a) Advance warning signs
- (b) Dynamic warning signs
- (c) Larger or additional STOP/YIELD signs
- (d) Intersection lighting

122.5.7 Maximum Grade

122.5.7.1 AASHTO Criteria

Table 122.5.10 AASHTO Grades (Maximum)

Type Facility	Type Terrain	Grades (%) for Design Speed (mph)											AASHTO
		20	25	30	35	40	45	50	55	60	65	70	
Freeway (1)	Level	---	---	---	---	---	---	4	4	3	3	3	pg. 8-5,
	Rolling	---	---	---	---	---	---	5	5	4	4	4	Table 8-1
Rural Arterial	Level	5	5	5	5	5	5	4	4	3	3	3	pg. 7-6,
	Rolling	8	8	7	7	6	6	5	5	4	4	4	Table 7-2
Urban Arterial:	Level	8	7	7	7	7	6	6	5	5	---	---	pg. 7-38,
	Rolling	10	10	9	8	8	7	7	6	6	---	---	Table 7-4a
Rural Collector(2)	Level	7	7	7	7	7	7	6	6	5	---	---	pg. 6-4,
	Rolling	10	10	9	9	8	8	7	7	6	---	---	Table 6-2
Urban Collector(2)	Level	9	9	9	9	9	8	7	7	6	---	---	pg. 6-15,
	Rolling	12	12	11	10	10	9	8	8	7	---	---	Table 6-7

Notes:

(1) Grades one percent steeper than the values shown may be used in urban areas.

(2) Short lengths of grade in rural and urban areas, such as grades less than 500 feet in length, one-way downgrades, and grades on low-volume rural and urban collectors may be up to 2 percent steeper than the grades shown above.

122.5.7.2 Documentation

No additional documentation beyond what is in ***FDM 122.4*** is required.

122.5.7.3 Mitigation

Potential mitigation strategies for maximum grade are:

(1) Signing to provide advanced warning

(2) To improve ability to stay within the lane:

- (a) Enhanced pavement markings
- (b) Delineators
- (c) Tubular Markers
- (d) Audible and vibratory treatment, (See ***FDM 210.4.6*** for arterials and collectors. See ***FDM 211.4.4*** for LA Facilities.)

(3) To improve ability to recover if driver leaves the roadway (see ***FDM 215***):

- (a) Paved or partially paved shoulders
- (b) Safety edge
- (c) Remove or relocate fixed objects
- (d) Traversable slopes
- (e) Breakaway safety hardware
- (f) Shield fixed objects

122.5.8 Cross Slope

122.5.8.1 AASHTO Criteria

Table 122.5.11 AASHTO Cross Slope

Type Facility	Other Factors	Minimum	Maximum	AASHTO
Freeways	---	0.015	0.025 (1)	pg. 8-3
Arterials	Rural Urban	0.015 0.015	0.02 0.03	pg. 7-6 pg. 7-38
Divided Highways	---	0.015	0.02 (1)	pg. 7-15
Collectors	Rural Urban	0.015 0.015	0.02 0.03	pg. 6-4 pg. 6-15
Shoulders	Paved Gravel Turf	0.02 0.04 0.06	0.06 0.06 0.08	pg. 4-13 pg. 4-13 pg. 4-13

Note:
(1) Values given are for up to two lanes in one direction. Additional outside lanes may have cross slopes of 0.03.

122.5.8.2 Documentation

Provide a proposal for handling drainage and details on how the cross slope impacts intersections.

122.5.8.3 Mitigation

Potential mitigation strategies for deficient cross slope are:

(1) Signing to provide warning of slick pavement

(2) To improve surface friction:

   (a) Pavement grooving (PCC pavement)

   (b) Open-graded friction courses (HMA pavement)

(3) To improve drainage:

   (a) Transverse pavement grooving (PCC pavement)

   (b) Open-graded friction courses (HMA pavement)

   (c) Pavement edge drains

   (d) Modified shoulder cross slope to mitigate cross slope break on the high side of superelevated curves

122.5.9 Vertical Clearance

122.5.9.1 AASHTO Criteria

Table 122.5.12 AASHTO Vertical Clearance (Minimum)

Type Facility		Vertical Clearance (feet)[2]	AASHTO
Freeways		16 [1],[4]	pg. 8-5, 10-24
Arterials (New Structures):	Rural Urban	16 [1] 16 [1]	pg. 7-9, 10-24 pg. 7-51, 10-24
Arterials (Existing Structures):	Rural Urban	14 14	pg. 7-9, 10-24 pg. 7-51, 10-24
Other Highways		14	pg. 5-9, 8-5
Sign Trusses		17	pg. 7-9,51, 8-5
Pedestrian Overpass		17	pg. 7-9,51, 8-5
Tunnels:	Freeways Other Highways	16 14	pg. 4-62 pg. 4-62
Railroads		23 [3]	pg. 10-25

Notes:

(1) 14 feet allowed in highly developed urban areas if alternate route has 16 feet.

(2) An allowance of 6 inches should be added to vertical clearance to accommodate future resurfacing.

(3) See ***FDM 220.3.4*** and the latest version of ***American Railway Engineering and Maintenance-of-Way Association (AREMA)*** guidelines, or the design office of the high-speed rail line of interest for specific high-speed guidelines and specifications. Over Electrified Railroad, the minimum vertical clearance is 24 feet 3 inches. (See ***Topic No. 000-725-003: South Florida Rail Corridor Clearance***.)

(4) Design Exceptions to the 16-ft vertical clearance standard on rural Interstate routes or on a single Interstate route through urban areas must be coordinated with the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) as described in ***FDM 122.5.9.2***.

122.5.9.2 Documentation

Submit the draft Vertical Clearance Variation or Exception to the State Structures Maintenance Engineer in the State Office of Maintenance for review. Include any feedback received from that review as an Appendix in the Vertical Clearance Variation or Exception submitted for final approval.

Provide locations of alternative routes that meet criteria.

For interstate projects, the District is responsible for completing an ***Interstate Vertical Clearance Exception Coordination*** form for Design Exceptions to vertical clearance requirements above interstate facilities (mainlines and ramps). The District will submit the form to the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) via e-mail for approval, copying the FHWA Florida Division. Allow for 10 working days after SDDCTEA receipt for action before requesting notification of disposition (via email or fax). A copy of the approval must be provided with the Design Exception. A request for coordination must take place before the District Design Engineer can recommend the Design Exception.

122.5.9.3 Mitigation

Potential mitigation strategies for vertical clearance are:

(1) Signing to provide advance warning

(2) To prevent impacts with low structures:

   (a) Alternate routes

   (b) Large vehicle restrictions

   (c) Bridge jacking may be a consideration to address bridges with minor deficiencies

122.5.10 Design Loading Structural Capacity

122.5.10.1 AASHTO Criteria

Table 122.5.13 AASHTO Structural Capacity (Minimum Loadings)

Type Facility	AASHTO
Freeways, Arterials, and Collectors	See *AASHTO LRFD* for minimum loadings.

122.5.10.2 Documentation

(1) Load rating calculations for the affected structure.

(2) Verification of safe load-carrying capacity (load rating) for State unrestricted legal loads or routine permit loads.

(3) Verification of Federal legal loads for bridges and tunnels on the Interstate.

(4) A written evaluation and recommendation by the Office of Maintenance.

122.5.10.3 Mitigation

Potential mitigation strategies for design loading structural capacity are determined on a case-by-case basis.

122.6 Crash Analysis

For areas with crash histories or when a benefit to cost analysis is required, provide a time value analysis between the benefit to society (quantified in dollars) and the costs to society (quantified in dollars) over the life of the Design Exception. The benefit to society is quantified by the savings associated with the projected reduction in crashes. The cost to society is a summary of the construction, operation, maintenance, and other costs anticipated over the life of the project. The Discount (interest) rate to be utilized in benefit/cost analysis is 4%.

Both Historical (HCM) and Predictive (RSAP and ***HSM***) methods are acceptable for performance of a benefit/cost analysis. Perform the analysis early in the design process.

In accordance with the Department's ***Highway Safety Manual Implementation Policy (Topic No. 000-500-001)***, "the transportation analyst is encouraged to use the Highway Safety Manual (HSM) methods, where applicable, to measure safety benefits from proposed improvements."

122.6.1 Historical Crash Method (HCM)

This method can be used for sites with a crash history. The historical crash analysis for Design Exceptions and Design Variations includes a review of crashes from within the Signal Four Analytics (S4A) system database. Department approval is required for access to the data within these systems and can be obtained through the District Offices.

The S4A database includes all currently available crash data for all severity types (KABCO) and all location verified statuses (i.e. verified as well as preliminary). These crashes should be included in all HCM analyses.

The B/C (benefit/cost) ratio is the ratio of the estimated annual reduction in crash costs to the estimated annual increase in combined construction and maintenance costs. The annualized conversion will show whether the projected expenditure of funds for the crash benefit will exceed the direct cost for the improvement.

The HCM uses the ***Highway Safety Improvement Program Guideline (HSIPG)*** cost per crash by facility type in ***Table 122.6.1*** to estimate benefit to society, while the cost to society is estimated by the expected cost of right of way, construction, and maintenance.

Table 122.6.1 FDOT Average Crash Costs by Facility Type

Type Facility	Divided Roadway			Undivided Roadway		
	Urban	Suburban	Rural	Urban	Suburban	Rural
2-3 Lanes	$107,732	$201,527	$355,183	$124,618	$267,397	$523,727
4-5 Lanes	$123,406	$225,315	$473,637	$112,896	$190,276	n/a
6+ Lanes	$123,598	$166,258	$451,492	$41,650	n/a	n/a
Interstate	$153,130	n/a	$327,385	n/a	n/a	n/a
Turnpike	$139,221	n/a	$304,397	n/a	n/a	n/a

Notes:

(1) Average Cost/Crash: **$159,093**

(2) The above values were derived from 2015 through 2019 traffic crash and injury severity data for crashes on state roads in Florida using the formulation described in *FHWA Technical Advisory "Motor Vehicle Accident Costs", T7570.2, dated October 31, 1994. Base costs derived* from a memorandum from USDOT: "*Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in the U.S. Department of Transportation Analyses"*, dated August 8, 2016 updating the value of life saved from $9.4 million to $9.6 million for 2015 data with a growth factor applied to increase the base cost to $9.7 million in the current analyses. Costs are computed for the actively state-maintained State Highway System (SHS) only.

(3) Link to ***Revised Departmental Guidance 2013***

When utilizing predictive methods or crash severity distributions for analysis, the following crash severity level costs should be used:

Table 122.6.2 FDOT KABCO Crash Costs

Crash Severity	Comprehensive Crash Cost
Fatal (K)	$10,890,000
Severe Injury (A)	$888,030
Moderate Injury (B)	$180,180
Minor Injury (C)	$103,950
Property Damage Only (O)	$7,700

Note:

(1) Source: Florida Department of Transportation State Safety Office's Crash Analysis Reporting (CAR) System, analysis years 2015 through 2019. Published by FDOT State Safety Office on 2/23/2022.

122.6.2 Roadside Safety Analysis Program (RSAP)

This method complements the ***AASHTO Roadside Design Guide***, dated June 2011. When hazards cannot be removed or relocated, designers need to determine if a safety device, such as a guardrail or a crash cushion, is warranted to protect motorists from the roadside obstacle. This method can be used to perform a benefit/cost analysis comparing a potential safety treatment with the existing or baseline conditions (i.e., the do-nothing option) or alternative safety treatments. Based on the input of information available to the user (e.g., offsets, traffic, slopes, crash history, traffic accident severity levels), the program will offer results which can be used in comparing design alternatives.

122.6.3 Highway Safety Manual

The ***AASHTO Highway Safety Manual (HSM)*** provides analytical tools and techniques for quantifying the potential effects on crashes as a result of decisions made in planning, design, operations, and maintenance. The new techniques and knowledge in the ***HSM*** reflect the evolution in safety analysis from descriptive (historical) methods to quantitative, predictive analyses. In the ***HSM***, crash frequency is the fundamental basis for safety analysis and is used to reduce crashes and severities through the selection of alternative treatments.

The ***HSM*** includes Safety Performance Functions (SPFs) for many roadway segment and intersection applications. SPFs are equations used to estimate or predict the expected average crash frequency per year at a location as a function of traffic volume and roadway characteristics. Adjust SPFs to local conditions by applying calibration factors shown in ***Table 122.6.3***. The use of HSMSPF and Crash Modification Factors (CMF), with an Empirical Bayes (EB) adjustment, provides research-based solutions for use in benefit/cost comparisons. Crash distributions presented in ***Table 122.6.4*** and KABCO costs as specified in ***Table 122.6.2*** should be used in determining benefits from an ***HSM*** analysis.

Table 122.6.3 HSM Calibration Factors for Florida

Type Facility		Abbreviation	Calibration Factor (Cx)
FDOT Roadway Calibration Factors			
Rural	2-lane Undivided	R2U	1.00
	4-lane Divided	R4D	0.68
Urban	2-lane Undivided	U2U	1.02
	3-lane with a Center Two-Way Left-Turn Lane	U32LT	1.04
	4-lane Undivided	U4U	0.73
	4-lane Divided	U4D	1.63
	5-lane with a Center Two-Way Left-Turn Lane	U52LT	0.70
FDOT Intersection Calibration Factors			
Rural	2-lane 3-Leg Stop-Controlled	RTL3ST	1.27
	2-lane 4-Leg Stop-Controlled	RTL4ST	0.74
	2-lane 4-Leg Signalized	RTL4SG	0.92
	Multilane 3-Leg Stop-Controlled	RML3ST	2.20
	Multilane 4-Leg Stop-Controlled	RML4ST	1.64
	Multilane 4-Leg Signalized	RML4SG	0.45
Urban	3-Leg Stop-Controlled Intersection	USA3ST	1.14
	4-Leg Stop-Controlled Intersection	USA4ST	1.87
	3-Leg Signalized w/o Ped. CMFs	USA3SG w/o Ped.	2.58
	3-Leg Signalized w/ Ped. CMFs	USA3SG w/ Ped.	2.50
	4-Leg Signalized	USA4SG	2.27

Table 122.6.4 HSM Crash Distribution for Florida

Type Facility		Abbreviation	K	A	B	C	O
Rural Roadways	2-lane Undivided	R2U	0.028	0.094	0.181	0.187	0.509
	4-lane Undivided	R4U	0.033	0.093	0.164	0.186	0.524
	4-lane Divided	R4D	0.028	0.090	0.187	0.196	0.499
Urban & Suburban Arterials	2-lane Undivided	U2U	0.009	0.050	0.150	0.224	0.567
	3-lane TWLTL	U32LT	N/A				
	4-lane Undivided	U4U	0.004	0.031	0.110	0.204	0.650
	4-lane Divided	U4D	0.008	0.046	0.142	0.234	0.571
	5-lane TWLTL	U52LT	N/A				
Freeways	Rural		0.017	0.065	0.143	0.163	0.612
	Urban		0.006	0.035	0.113	0.206	0.641
	Ramps		0.004	0.032	0.107	0.210	0.647
All	All Roadways and Ramps		0.007	0.041	0.124	0.217	0.611

Notes:
K – Fatality
A - Incapacitating Injury
B - Non-incapacitating Injury
C - Possible (or minor) Injury
O - Property Damage Only

Data Source: Florida Department of Transportation, State Safety Office's Crash Analysis Reporting (CAR) database, analysis years 2015 through 2019. Publishing by FDOT State Safety Office on 2/23/2022.

Tools and spreadsheets for use with these analytical methods have been developed and are available on the following websites:

https://safety.fhwa.dot.gov/rsdp/hsm.aspx

https://www.fdot.gov/roadway/QA/Tools.shtm

122.7 Design Approval Request

122.7.1 Submittal Package

The submittal package for a Design Exception or a Design Variation will include the same items. However, the required documentation and necessary level of detail will vary depending on the design element being evaluated (as described in ***FDM 122.4***). The Design Exception or Design Variation submittal package is to include the following items:

(1) Submittal/Approval Letter (cover letter): ***Form 122-A*** (see ***FDM 103***).

(2) Signed and Sealed Report: The signed and sealed documents including all required documentation and justification (see ***FDM 122.4*** for documentation requirements). Multiple design elements and signed and sealed reports may be included in one submittal package.

(3) Appendices (as needed): Include any support documentation to facilitate an understanding of the report. Supplemental documents do not alter the sealed analysis or design.

Sign and seal the report in accordance with ***FDM 130***. A Submittal/Approval Letter (***Form 122–A,*** see ***FDM 103***) is to be attached to the signed and sealed report and submitted to the District or Turnpike Design Engineer using the Design Approval Requests Module within Project Suite Enterprise Edition (PSEE). The District or Turnpike Design Engineer then approves or denies the request and notifies the Responsible Engineer. When further approvals are required, the District or Turnpike Design Engineer will forward the Submittal/Approval Letter and the signed and sealed report to the State Roadway Design Office.

122.7.2 Design Exception Approval

The request will be reviewed by the State Roadway Design Engineer and may be forwarded for approval to the Chief Engineer of Production, the State Structures Design Engineer, the Planning Office, and FHWA, as appropriate.

Each request will be reviewed on a case-by-case basis and approved on its merits. When approval is obtained, the State Roadway Design Office will email the disposition to the District or Turnpike Design Engineer along with the signed Submittal/Approval Letter. The State Roadway Design Office will keep an electronic copy filed under the assigned reference number.

When a request is denied, the State Roadway Design Office will notify the District or Turnpike Design Engineer of the disposition. Denied requests can be resubmitted when all deficiencies noted in the denial notification have been addressed. This may require only a new Submittal/Approval Letter if the Sealed Report does not need to be amended; however, if the Sealed Report requires revision, a new Sealed Report and Submittal/Approval Letter must be submitted.

Documentation requirements for Design Exceptions are in ***FDM 122.4***.

122.7.3 Design Variation Approval

Design Variations are typically approved at the District level; however, there are specific elements requiring Central Office approval noted in ***FDM 122.7.4*** (see ***Table 122.7.1***). Design Variations requiring Central Office approval must follow the processes in ***FDM 122.7.2***.

Design Variations approved at the District level may be submitted as either a Formal Design Variation or a Design Variation Memorandum for approval by the District or Turnpike Design Engineer.

Documentation requirements for Design Variations (both Formal and Memorandums) are in ***FDM 122.4***.

122.7.4 Signature Requirements

Obtain all required approvals as described in this section. Approvals from multiple individuals may be required for certain issues. The Director of Design must resolve any approval authority issues if conflicting objectives arise. Approval signatures are required by the following Department and FHWA personnel as specified:

Chief Engineer of Production:

(1) Design Exceptions for Design Speed on SIS facilities, following review by the Chief Planner.

(2) Design Variations for Design Speed on SIS facilities, following review by the Chief Planner.

(3) Design Variations for omission of Emergency Shoulder Use (ESU) evacuation requirements for any phase of construction.

(4) Design Variations for Shared Use Paths in LA R/W not meeting the criteria in ***FDM 224.1.1***, following review by the Chief Planner.

(5) Design Exceptions or Variations involving lateral offsets or vertical clearances for railroads not meeting the requirements of ***Rule 14-57 F.A.C***. or the clearance criteria for the South Florida Rail Corridor (***Topic No. 000-725-003 - South Florida Rail Corridor Clearance Policy for 25 KV service***).

(6) Design Variations for Non-Standard Use of Shoulders. (e.g., Bus on Shoulder Projects, Part-Time Shoulder Use, Hard Shoulder Running, etc.)

(7) Design Exceptions for Paved Shoulder Width on Interstate and Turnpike Facilities.

(8) Design Variations to not install a Railroad Dynamic Envelope (RDE).

FHWA Division Administrator:

(1) Design Exceptions on Projects of Division Interest (PoDIs).

District (or Turnpike) Design Engineer:

(1) Design Exceptions

(2) Design Variations

State Roadway Design Engineer:

(1) Design Exceptions for elements other than Design Loading Structural Capacity.

(2) Design Variations involving the use of fencing around stormwater management facilities.

(3) Design Exceptions or Variations involving lateral offsets or vertical clearances for railroads not meeting the requirements of ***Rule 14-57 F.A.C***. or the clearance criteria for the South Florida Rail Corridor (***Topic No. 000-725-003 - South Florida Rail Corridor Clearance Policy for 25 KV service***).

State Structures Design Engineer:

(1) Design Exceptions for Design Loading Structural Capacity of bridges and Vertical Clearance impacting Category 1 and 2 bridge structures.

(2) Design Variations for Design Loading Structural Capacity of bridges and Vertical Clearance impacting Category 2 structures.

(3) Design Variations for Design Loading Structural Capacity due to deficient load ratings impacting both Category 1 and 2 bridge structures.

(4) Design Variations for Traffic Railing impacting Category 1 and 2 bridge structures.

(5) Design Exceptions or Variations involving lateral offsets or vertical clearances for railroads not meeting the requirements of ***Rule 14-57 F.A.C***. or the clearance criteria for the South Florida Rail Corridor (***Topic No. 000-725-003 - South Florida Rail Corridor Clearance Policy for 25 KV service***).

(6) Design Variations for noise walls on bridges and retaining walls.

District (or Turnpike) Structures Design Engineer:

(1) Design Exceptions for Design Loading Structural Capacity of all structural items and Vertical Clearance impacting Category 1 and 2 bridge structures.

(2) Design Variations for Design Loading Structural Capacity of all structural items and Vertical Clearance impacting Category 1 bridge structures.

Table 122.7.1 Central Office Approvals

Design Element	State Roadway Design Engineer	State Structures Design Engineer	Chief Planner	Chief Engineer of Production
	Approval	Approval	Review	Approval
Design Speed Exception	X			
Design Speed Exception-SIS	X		X	X
Design Speed Variation-SIS			X	X
Design Variation: ESU Omission during Construction				X
Design Variation: Shared Use Path in LA R/W			X	X
Design Variation: Non-Standard Shoulder Use				X
Design Variations to not install an RDE				X
Lane Width Exception	X			
Shoulder Width Exception	X			
Paved Shoulder Width Exception (Interstate and Turnpike)	X			X
Maximum Grade Exception	X			
Cross Slope Exception	X			
Superelevation Rate Exception	X			
Horizontal Curve Radius Exception	X			
Stopping Sight Distance Exception	X			
Design Variation: Traffic Railing (Category 1 and 2 Structures)		X		
Design Variation: Fencing on Traffic Railing between pedestrians and travel lanes on LA Facilities		X		
Design Variation: Crossovers on Limited Access Facilities	X			
Design Variation: Patterned Pavement Technical Special Provisions	X			
Design Variation: Use of fencing around stormwater management facilities	X			

Table 122.7.1 Central Office Approvals (Cont.)

Design Element	State Roadway Design Engineer	State Structures Design Engineer	Chief Planner	Chief Engineer of Production
	Approval	Approval	Review	Approval
Design Loading Structural Capacity				
-Design Exception for Bridges		X		
-Design Variation: Category 2 Structures		X		
-Design Variation: Deficient Load Ratings (Category 1 and 2 Structures)		X		
-Design Variation: Noise walls on bridges and retaining walls		X		
Vertical Clearance Exception				
- Non-Bridge Items	X			
- Bridge Structures (Category 1 and 2)	X	X		
-RR-South Fla Rail Corridor	X	X		X
Vertical Clearance Variation				
-Category 2 Structures		X		
-RR-South Fla Rail Corridor	X	X		X
Lateral Offset Variation				
-Category 1 and 2 Structures	X			
-RR-South Fla Rail Corridor	X	X		X