MICHIGAN DESIGN MANUAL
ROAD DESIGN

CHAPTER 3

INDEX

ALIGNMENT AND GEOMETRICS

3.01 REFERENCES

3.02 DEFINITION OF TERMS

3.03 ALIGNMENT - GENERAL
A. Horizontal Alignment
B. Vertical Alignment
C. Combined

3.03.01 Horizontal Alignment - Design Controls
A. Minimum Radius
B. Minimum Curve Lengths
C. Compound Curves
D. Sight Distances
E. Horizontal Curve Computations
F. Spirals

3.03.02 Vertical Alignment - Design Controls
A. Minimum / Maximum Grades
B. Minimum Vertical Curve Lengths
C. Stopping Sight Distance
D. Drainage
E. Other Considerations
F. Computations

3.04 SUPERELEVATION AND CROSS SLOPES

3.04.01 Point of Rotation

3.04.02 Superelevation Transitions

3.04.03 Superelevation Using a Straight Line Method

3.05 Section Deleted

3.06 DESIGN SPEED

CHAPTER 3 ALIGNMENT AND GEOMETRICS INDEX (continued)

3.07 GEOMETRICS

3.07.01 Lane Width, Capacity and Vehicle Characteristics
- A. Lane Width and Capacity
- B. Vehicle Characteristics

3.07.02 Interchange Geometrics
- A. Rural and Urban
- B. Interchange Layout
- C. Crossroads Over Freeways
- D. Ramp Radii
- E. Single Lane Ramp Widths

3.07.03 Speed Change Lanes and Transitions

3.07.04 Intersections

3.08 AASHTO GREEN BOOK (GB7) PROJECT TYPES

3.08.01 General
- A. Definitions
- B. General
- C. Corridor Minimum Geometric Standards
- D. Other Work Categories
- E. Design Exceptions / Design Variances
- F. Safety Review / Crash Analysis
- G. National (Truck) Network (NN) Lane Widths

3.09 CONSTRUCTION ON EXISTING ROAD CONTROLLING CRITERIA (NON-FREEWAY)

3.09.01 Geometric Controlling Criteria
- A. Non-Freeway, NHS
- B. Non-Freeway, Non-NHS

3.09.02 Design Exceptions / Design Variances

3.10 NEW CONSTRUCTION AND RECONSTRUCTION CONTROLLING CRITERIA (NON-FREEWAY)

3.10.01 Geometric Controlling Criteria

3.10.02 Design Exceptions / Design Variances

CHAPTER 3 ALIGNMENT AND GEOMETRICS INDEX (continued)

3.11 ADDITIONAL NON-FREEWAY DESIGN CRITERIA

3.11.01 General
- A. Signing
- B. Evaluation of Guardrail and Bridge Railing
- C. Tree Removal
- D. Roadside Obstacles
- E. Cross Section Elements

3.12 GUIDELINES FOR PASSING RELIEF LANES
- A. General
- B. Truck Climbing Lanes (TCL)
- C. Passing Lane Sections (PLS)

3.13 CONSTRUCTION ON EXISTING ROAD CONTROLLING CRITERIA (FREEWAY)

3.13.01 Geometric Controlling Criteria

3.13.02 Design Exceptions / Design Variances

3.14 NEW CONSTRUCTION AND RECONSTRUCTION CONTROLLING CRITERIA (FREEWAY)

3.14.01 Geometric Controlling Criteria

3.14.02 Design Exceptions / Design Variances

3.15 ADDITIONAL FREEWAY DESIGN CRITERIA

3.15.01 General
- A. Signing
- B. Ramp Geometrics, Acceleration/Deceleration Lanes and Taper Lengths
- C. Vertical Curbs
- D. Crown Location/Pavement Cross Slope
- E. Guardrail and Concrete Barrier
- F. Attenuation
- G. Clear Zones & Fixed Objects
- H. Culvert End Treatments
- I. Bridges

3.16 UNDERCLEARANCES - VERTICAL CLEARANCE ANALYSIS

3.17 PERFORMANCE BASED-PRACTICAL DESIGN

Appendix 3A Geometric Design Elements – New Construction / Reconstruction

Appendix 3B National Network – Federally-Designated Routes

CHAPTER 3

ALIGNMENT AND GEOMETRICS

3.01 (revised 11-28-2022)

REFERENCES

A. ***A Policy on Design Standards - Interstate System***, AASHTO, 2005

B. ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition

C. ***Highway Capacity Manual***, 2000, published by Transportation Research Board, National Research Council.

D. MDOT Geometric Design Guides

E. ***Michigan Manual of Uniform Traffic Control Devices***, current edition, by the Michigan Department of Transportation

F. ***Roadside Design Guide***, AASHTO, 2006

G. Standard Plan R-107-Series, Superelevation and Pavement Crowns

H. MDOT Sight Distance Guidelines

3.02 (revised 9-22-2025)

DEFINITION OF TERMS

Acceleration Lane - An auxiliary lane, including tapers, for the acceleration of vehicles entering another roadway.

Arterial Road – A roadway which provides a high speed, high volume, network for travel between major points.

Auxiliary Lane – Portion of the roadway adjoining the traveled way for speed change, turning, storage for turning, weaving, truck climbing, passing and other purposes supplementary to through-traffic movement.

Average Daily Traffic (ADT) - The average 24 hour traffic volume, based on a yearly total.

Broken Back Curve - Two curves in the same direction joined by a short tangent distance.

Compound Curve - Two connecting horizontal curves in the same direction having different radii.

Collector Road – Roadway linking a Local Road to an Arterial Road, usually serving moderate traffic volumes.

Crash Analysis - A site specific, predictive Highway Safety Manual safety review of crash data performed to identify whether or not a specific geometric design element has either caused or contributed to, or could cause or contribute to a pattern or concentration of crashes at the location in question. The analysis is a critical component used in determining the appropriate application of geometric design criteria and in the evaluation of design exception / variance approval requests.

3.02 (continued)

DEFINITION OF TERMS

Critical Grade - The grade and length that causes a typical truck or other heavy vehicle to have a speed reduction of 10 mph or greater.

Cross Slope – Transverse slope rate of traveled lane or shoulder.

Cross Slope Break - Algebraic difference in rate of adjacent lane cross slopes having slopes in same direction (eg., between thru lanes or thru and auxiliary lanes).

Crown Line Crossover – The algebraic difference in rate of adjacent lane cross slopes at the crown point.

Crown Runout - **(also called Tangent Runout)** - The distance necessary to remove adverse crown before transitioning into superelevation on curves. (Referred to as “C” distance in Standard Plan R-107-Series.)

Deceleration Lane - An auxiliary lane that enables a vehicle to slow down and exit the highway with minimum interference from through traffic.

Design Hour Volume (DHV) - The hourly volume used to design a particular segment of highway.

Directional Design Hour Volume (DDHV) - The directional distribution of traffic during the DHV.

Free Access Highway - A highway, with no control of access, usually having at-grade intersections, which may or may not be divided.

Freeway - A divided arterial highway with full control of access and grade separations at intersections. Freeway includes the ramps.

3.02 (continued)

Gore Area - The "V" area immediately beyond the convergence or divergence of two roadways bounded by the edges of those roadways.

Grade Separation - A structure that provides for highway traffic to pass over or under another highway or the tracks of a railway.

Horizontal Clearance – An operational offset providing clearance for external vehicle components such as mirrors on trucks and buses and for opening curbside doors of parked vehicles. A minimum 1’-6" horizontal clearance from the face of curb to an obstruction is required on curbed roadways. If the roadway and curb are separated by a shoulder, the shoulder width is included as part of the clearance.

Interchange - A system of interconnecting roadways in conjunction with grade separations providing for the interchange of traffic between two or more intersecting roadways.

Level of Service - A qualitative measure describing operational conditions within a traffic stream; generally described in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Levels of service are given letter designations, from A to F, with LOS A representing the best operating conditions and LOS F the worst.

Local Road – A road which serves primarily to provide access to farms, residences, business, or other abutting properties.

3.02 (continued)

DEFINITION OF TERMS

Passing Lane Section (PLS) - Extra lane(s) to provide additional capacity and reduce delay caused by slow moving vehicles, such as recreational vehicles, during peak periods. These are often desirable in areas where slower vehicles are not necessarily the result of long steep grades.

Passing Relief Lane (PRL) - Common, all-inclusive reference to a traffic lane provided for increased passing opportunities along a route, can be a Truck Climbing Lane (TCL) or a Passing Lane Section (PLS).

Ramp - A connecting roadway between two intersecting roadways, usually at grade separations.

Reverse Curve – Horizontal curves in the opposite direction joined by a short tangent distance or common point.

Roll-over - Algebraic difference in rate of cross slope between traveled lane and shoulder.

Rural - Rural areas are those which are outside of urban areas.

Safety Review - A general safety review of a project performed to identify potential safety enhancements within the limits of a proposed New Construction, Reconstruction, or Construction on Existing Road project type.

Service Road (also Frontage Road) - A roadway usually parallel and adjacent to a highway which provides access to abutting properties by separating local and through traffic.

Sight Distance - The unobstructed distance that can be viewed along a roadway - usually referenced to decision points for drivers.

3.02 (continued)

Spiral Curve Transition - A variable radii curve between a circular curve and the tangent. The radii of the transition and the curve are the same at the curve and increase to infinity at the tangent end of the transition.

Superelevation – The banking of the roadway in the direction of the curve to help counter balance the centrifugal force on the vehicle.

Superelevation Transition (sometimes referred to as superelevation runoff) – The distance needed to change the pavement cross slope in the direction of the curve from a section with adverse crown removed to a fully superelevated section, or vice versa. (Referred to as “L” distance in Standard Plan R-107-Series.)

Truck Climbing Lane (TCL) - An extra lane for heavy vehicles slowed by the presence of a long steep “critical grade”, that provides passing opportunities for non-slowed vehicles.

Urban - An urban area is one in which there is a population of 5,000 or more within a boundary defined by State or local officials (23 CFR Part 101).

Vehicles Per Hour (vph) - A measurement of traffic flow.

3.03 (revised 1-23-2023)

ALIGNMENT-GENERAL

The geometric design of a roadway consists of horizontal alignment, vertical alignment, and a combination of the two. A properly designed alignment (horizontal and vertical) leads to the safe and efficient movement of all modes of travel.

A. Horizontal Alignment

Horizontal alignment is a major factor in determining safety, driving comfort, and capacity of a highway.

Some important factors to consider when designing for horizontal alignment:

1. Passing sight distance on two-lane, two-way roadways should be maximized.

2. Curves should be as flat as physical conditions permit. Abrupt changes in alignment introduce the element of surprise to the driver and should be avoided.

3. Broken back curves should be avoided because they are unsightly and drivers do not expect succeeding curves to be in the same direction.

4. If possible, the minimum distance between reverse curves should be the sum of the superelevation transitions, outside the curves, plus the crown runout lengths. The crown runout can be eliminated in some situations. See the Geometrics Unit (Design Division) for additional guidance. When it isn't possible to obtain the desired distance between reverse curves, up to 40% of the transition may be placed in the curves.

3.03 (continued)

B. Vertical Alignment

Vertical alignment establishes the profile grade of a proposed road construction project. The grade can be over virgin land as in the case of a relocation project or along an existing roadway, as in the case of a resurfacing project. In either case and in most proposed construction projects, a profile grade should be established.

Obviously a profile grade must always be established for new construction or relocation projects. Most reconstruction and rehabilitation projects will require new profile grades if improvements for sight distance, superelevation, and drainage are included. A simple resurfacing project can usually be constructed without establishing a new vertical alignment.

Establishing the vertical alignment is based on many factors, including terrain, existing conditions, soils, drainage, coordination with the horizontal alignment, location of bridges, culverts, crossroads, design speed, earthwork balance, etc. The Designer must work with available resources such as the Geometrics Unit of the Design Division to provide the best possible vertical alignment. The final product should be safe, functional, aesthetically pleasing, and economical.

3.03 (continued)

ALIGNMENT-GENERAL

C. Combined

Horizontal and vertical alignments are permanent design elements. It is extremely difficult and costly to correct alignment deficiencies after the highway is constructed.

A proper combination of horizontal and vertical alignment is obtained by engineering study using the following general controls.

1. Vertical curvature superimposed on horizontal curvature, generally results in a more pleasing appearance. Successive changes in profile not in combination with horizontal curvature may result in a series of humps visible to the driver for some distance.

2. Sharp horizontal curvature should not be introduced at or near the top of a pronounced crest vertical curve. This condition may make it difficult for the driver to perceive the horizontal change in alignment. This can be avoided if the horizontal curvature leads the vertical curvature, i.e., the horizontal curve is made longer than the vertical curve.

3. Sharp horizontal curvature should not be introduced at or near the low point of a pronounced sag vertical curve. Because the road ahead would appear to be fore-shortened, a relatively "flat" horizontal curve should be used to avoid this undesirable phenomenon.

4. Horizontal curvature and profile should be made as flat as possible at intersections where sight distance along both roads or streets is important.

See Chapter 3 of ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition for elements of design.

3.03.01 (revised 11-28-2022)

Horizontal Alignment - Design Controls

A. Minimum Radius

The minimum radius is a limiting value of curvature for a given design speed and is determined from the maximum rate of superelevation and the maximum side friction factor. The minimum radius of curvature should be avoided wherever practical. Attempt to use flatter curves, saving the minimum radius for the most critical conditions. The minimum radius (R_{min}) is shown in the Standard Plan R-107-Series superelevation tabulation at the bottom of each column for each design speed. Values for R_{min} are also tabulated for the straight line superelevation table in Section 3.04.03.

B. Minimum Curve Lengths

Curves should be sufficiently long for small deflection angles to avoid the appearance of a kink.

Curves on rural free access trunklines should be at least 500 feet long for a central angle of 5° and the minimum length should be increased 100 feet for each 1° decrease in the central angle. The minimum should be approximately 15 times the design speed with a desirable length of at least 30 times the design speed. For example, a design speed of 60 mph multiplied by 15 gives a minimum curve length of 900’.

3.03.01 (continued)

Horizontal Alignment - Design Controls

C. Compound Curves

Compound curves should be used with caution. Although compound curves give flexibility to fitting the highway to the terrain and other controls, designers should avoid them whenever possible. When curves with considerably different radii are located too close together, the alignment will not have a pleasing appearance. On one-way roads such as ramps, the difference in radii of compound curves is not so important if the second curve is flatter than the first. On compound curves for open highways, the ratio of the flatter radius to the sharper radius should not exceed 1.5 to 1. On ramps the ratio of the flatter radius to the sharper radius may be increased to a 2 to 1 ratio.

D. Sight Distances

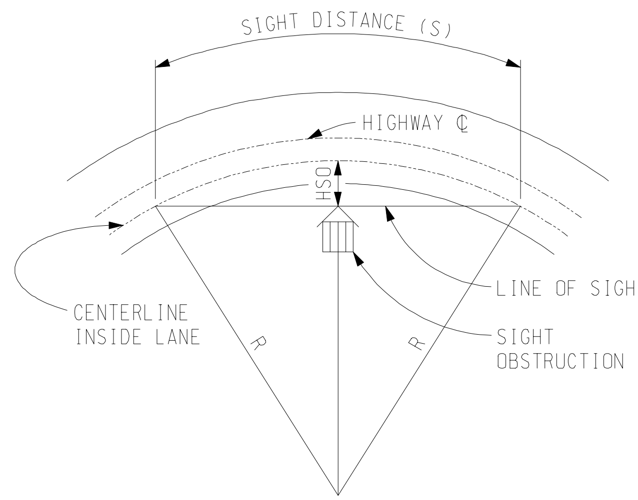
Both stopping sight distance and passing sight distance must be considered for two-way roadways. On one-way roadways only stopping sight distance is required. The designer must be aware that both horizontal and vertical alignments need to be considered when designing for sight distance.

From Table 3-1 of ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition stopping sight distance can be determined from design speed.

Design Speed	Stopping Sight Distance (Design)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
75	820

3.03.01 (continued)

For general use in the design of a horizontal curve, the sight line is a chord of the curve and the stopping sight distance is measured along centerline of the inside lane around the curve



COMPONENTS FOR DETERMINING HORIZONTAL SIGHT DISTANCE

Knowing the stopping sight distance (SSD) and the radius of curve (R) the horizontal sightline offset (HSO) can be calculated from:

$$HSO = R\left(1 - \cos\frac{28.65SSD}{R}\right)$$

or to verify that SSD is met for a given HSO:

$$SSD = \frac{R\cos^{-1}\left(1 - \frac{HSO}{R}\right)}{28.65}$$

(R, SSD, HSO measured in feet)

These equations are exact only when the vehicle and sight obstruction are within the limits of a circular curve.

3.03.01 (continued)

Horizontal Alignment - Design Controls

When determining sight distances, use ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition. The MDOT Sight Distance Guidelines also provide detailed information on sight distance calculation.

The four types of sight distances given are stopping, passing, decision, and intersection.

1. Stopping Sight Distance is defined as the sight distance available on a roadway that is sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

2. Passing Sight Distance is defined as the length needed to complete a passing maneuver as described in ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition.

3. Decision Sight Distance is the distance required for a driver to detect an unexpected or otherwise difficult-to-perceive information source or condition in a roadway environment that may be visually cluttered, recognize the situation or its potential threat, select an appropriate speed and path, and initiate and complete the required maneuver safely and effectively.

3.03.01 (continued)

4. Intersection Sight Distance is the distance that allows drivers sufficient view from a minor road to safely cross or turn on a major road.

   Generally 7.5 seconds of entering sight distance is used for passenger vehicles stopped on a minor road grade of 3% or less to turn left onto a two-lane roadway. An additional 0.5 seconds is added for each additional lane

   Adjustments for other varying conditions that may increase or decrease the time gap are provided in ***A Policy on Geometric Design of Highways and Streets*****,** AASHTO, 2018 7th Edition.

   The designer is cautioned that the element of Clear vision for at-grade intersections is very important, for safety reasons, particularly on high speed trunklines.

3.03.01

Horizontal Alignment - Design Controls

E. Horizontal Curve Computations

Δ = Deflection or Central Angle (Delta), degrees

R = Radius of Curve, ft

T = Length of Tangent (P.C. to P.I. or P.I. to P.T.) = R Tan (Δ/2), ft

E = External Distance = R [Sec (Δ/2) - 1] or T Tan (Δ/4), ft

M = Middle Ordinate Distance = R Versine (Δ/2) or E Cos (Δ/2), ft

L = Length of Curve = Δ x R ÷ 57.2958, ft

P.C. = Point of Curvature

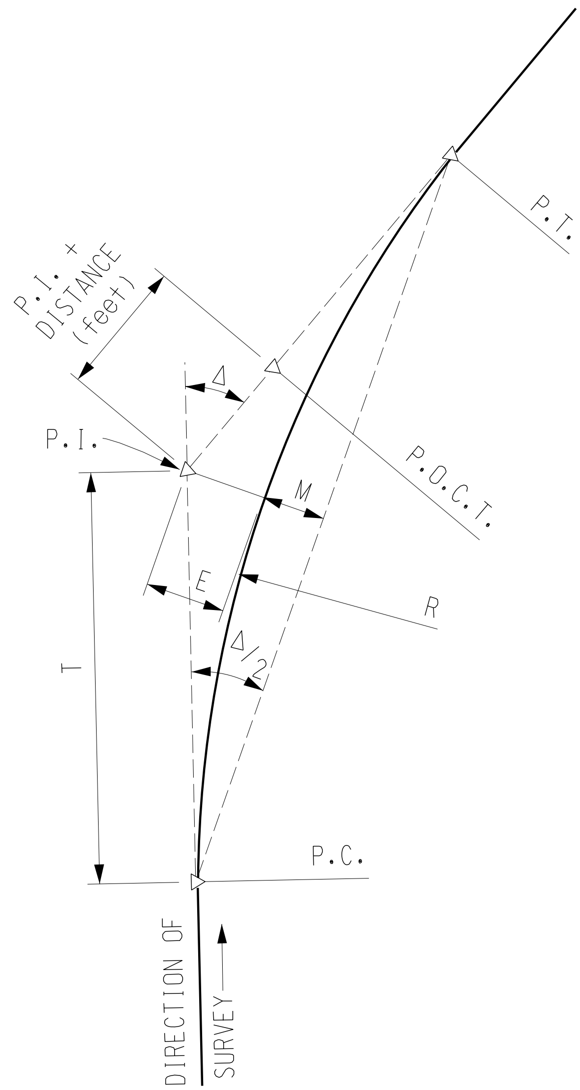
P.I. = Point of Intersection of Tangents

P.O.C.T. = Point on Curve Tangent

P.T. = Point of Tangency

D = Degree of Curvature =

$$\frac{5729.58}{R\ \text{(ft)}} \text{ degrees}$$

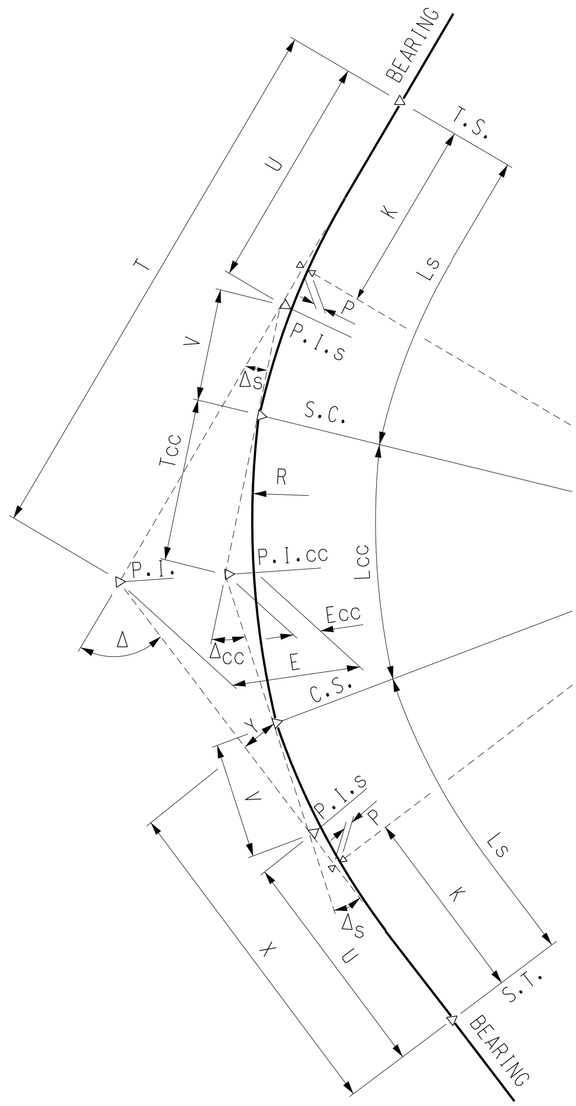


3.03.01

Horizontal Alignment - Design Controls

F. Spirals

Spiral curves are used to transition into circular curves and should be used on new alignments based on the design speed and radius of the curve, as shown on the table in Standard Plan R-107-Series. Spiral curve lengths are normally equal to the superelevation transition length. The relationship between the various elements of spiral curves and their methods of computation are shown below and on the following pages.



Usually the P.I. station and the deflection angle (Δ) are established. The spiral length (Ls) equals the length of superelevation runoff; appropriate values for (Ls) can be obtained using Standard Plan R-107-Series. The remaining curve data can then be computed or read from the tables of spiral curve functions found in the Construction Manual.

T.S. Sta. = P.I. Sta. - T (Sta.)
S.C. Sta. = T.S. Sta. + Ls (Sta.)
C.S. Sta. = T.S. Sta. + Ls (Sta.)+ Lcc (Sta.)
S.T. Sta. = T.S. Sta. + 2Ls (Sta.) + Lcc (Sta.)

The radius of Central Angle (R) should be specified to the nearest 15 feet; all other curve data will be calculated and shown to the nearest one-hundredth of a foot or to the nearest second, whichever is applicable.

P.I. = Point of Intersection
T.S. = Tangent to Spiral
S.C. = Spiral to Curve
C.S. = Curve to Spiral
S.T. = Spiral to Tangent

3.03.01F (continued)

Horizontal Alignment - Design Controls

LEGEND AND FORMULAS FOR SPIRALS

R =	Radius of Central Angle, ft
T =	Tangent Length of Entire Curve, ft
Tcc =	Tangent Length of Central Curve, ft
U =	Long Tangent Length of Spiral, ft
V =	Short Tangent Length of Spiral, ft
Ls =	Spiral Length, ft
Lcc =	Central Curve Length, ft
Δ =	Deflection Angle of Entire Curve, degrees
Δcc =	Deflection Angle of Central Curve, degrees
Δs =	Deflection Angle of Spiral, degrees
E =	External of Entire Curve, ft
Ecc =	External of Central Curve, ft
X,Y =	Coordinates of S.C. (or C.S.) , ft
K,P =	Coordinates of Offset P.C. Referenced the Same as X & Y, ft

$$Throw = P\ (Sec\frac{\Delta s}{2}\ )$$

$$T = (R + P)\,Tan\frac{\Delta}{2} + K$$

$$E = (R + P)\,Tan\frac{\Delta}{2}\,Tan\ \frac{\Delta}{4} + P$$

T and E may be computed from tables of unit length spirals by taking the corresponding T & E values of the required deflection angle and multiplying them by Ls.

$$V = \frac{Y}{Sin\ \Delta s}$$

$$U = X\ \text{-}\ Y\ Cot\ \Delta s$$

$$\Delta s = \frac{28.6479\ Ls}{R}$$

$$\Delta = \Delta cc + 2\Delta s$$

For Δs Between Zero and 5°

$$Y = Ls\ Sin\frac{\Delta s}{3}$$

$$X = Ls\ \text{-}\ \frac{Y^2}{2Ls}$$

$$P = \frac{Y}{4}$$

$$K = \frac{X}{2}$$

For Δs Between 5° and 15°

$$P = Ls\ Sin\frac{\Delta s}{12}$$

$$Y = 4P$$

$$K = \frac{Ls}{2}\ \text{-}\ \frac{4P^2}{Ls}$$

$$X = K + R\ Sin\ \Delta s$$

3.03.02 (revised 9-22-2025)

Vertical Alignment – Design Controls

Vertical curves are in the shape of a parabola. The basic equation for determining the minimum vertical curve length is:

$$L = KA$$

WHERE:

L = length of vertical curve, feet
K = horizontal distance to produce 1% change in gradient, feet
A = Algebraic difference between the two tangent grades, percent

(Refer to ***A Policy of Geometric Design for Roads and Streets,*** AASHTO, 2018 7th Edition for additional Vertical Curve Formulas). Also refer to the MDOT Sight Distance Guidelines for more detailed information on sight distance calculation.

3.03.02 (continued)

A. Minimum / Maximum Grades

See the "Grade" section of Appendix 3A, the Geometric Design Elements table.

B. Minimum Vertical Curve Lengths

Minimum length (in feet) of a vertical curve should be three times the design speed in mph.

3.03.02 (continued)

Vertical Alignment – Design Controls

C. Stopping Sight Distance

Stopping Sight Distance (SSD) is the principal control of the design of both crest and sag vertical curves. ***A Policy on Geometric Design of Highways and Streets,*** AASHTO, 2018 7th Edition gives values for K and lengths of vertical curves for various operational conditions. See MDOT Sight Distance Guidelines for more detailed information on sight distance calculation.

D. Drainage

Minimum grades correlate with adequate drainage. A desirable minimum grade is typically 0.5%, but grades of 0.3% may be used for paved roadways. On curbed roadways, when it is necessary to use grades that are flatter than 0.3%, provide enclosed drainage with compensating decreased inlet spacing. In addition, close attention to inlet spacing is critical for sag and crest vertical curves when the K value (rate of grade change) is greater than 167.

Uncurbed roads with ditch drainage can have a level longitudinal grade if the crown adequately drains the pavement. Independent ditches should be used when the grade is less than 0.3%. However, efforts to achieve minimum roadway grades of 0.5% would be of great benefit in the event that future curb and gutter or concrete barrier may be installed.

3.03.02 (continued)

E. Other Considerations

Comfort criteria is sometimes a consideration for sag vertical curves. The equation for length of curve for comfort is:

$$L = \frac{AV^2}{46.5}$$

WHERE:

L = length of vertical curve, feet
A = algebraic difference of tangent grades, percent
V = design speed, mph

Passing sight distance must be considered on two way roadways. Passing sight distance is the distance required for a motorist to safely perform a passing maneuver as described in AASHTO.

Intersection Sight Distance is the distance that allows drivers sufficient view from a minor road to safely cross or turn on a major road. See Section 3.03.01.D4.

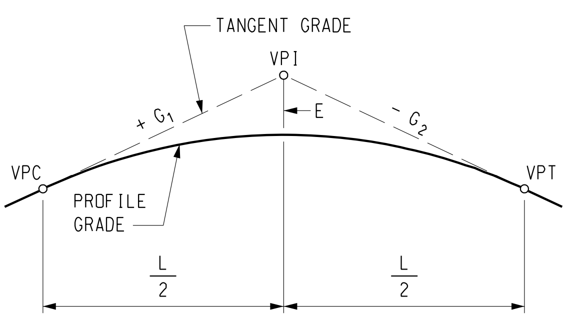
F. Computations

The following pages show mathematical details used in the design of vertical curves. This section includes definitions, formulas, and examples.

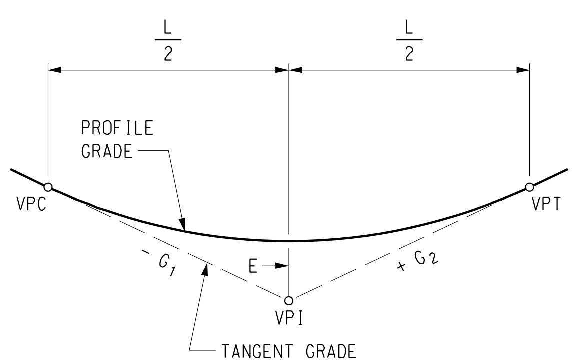
3.03.02F (continued)

Computations

ELEMENT	ABBREVIATION	DEFINITION
Vertical Point of Curvature	VPC	The point at which a tangent grade ends and the vertical curve begins.
Vertical Point of Tangency	VPT	The point at which the vertical curve ends and the tangent begins.
Vertical Point of Intersection	VPI	The point where the extension of two tangent grades intersect.
Grade	G_1G_2	The rate of slope between two adjacent VPI's expressed as a percent. The numerical value for percent of grade is the vertical rise or fall in feet for each 100 feet of horizontal distance. Upgrades in the direction of stationing are identified as plus (+). Downgrades are identified as minus (-).
External Distance	E	The vertical distance (offset) between the VPI and the roadway surface along the vertical curve.
Algebraic Difference in Grade	A	The value A is determined by the deflection in percent between two tangent grades.
Length of Vertical Curve	L	The horizontal distance in feet from the VPC to the VPT.



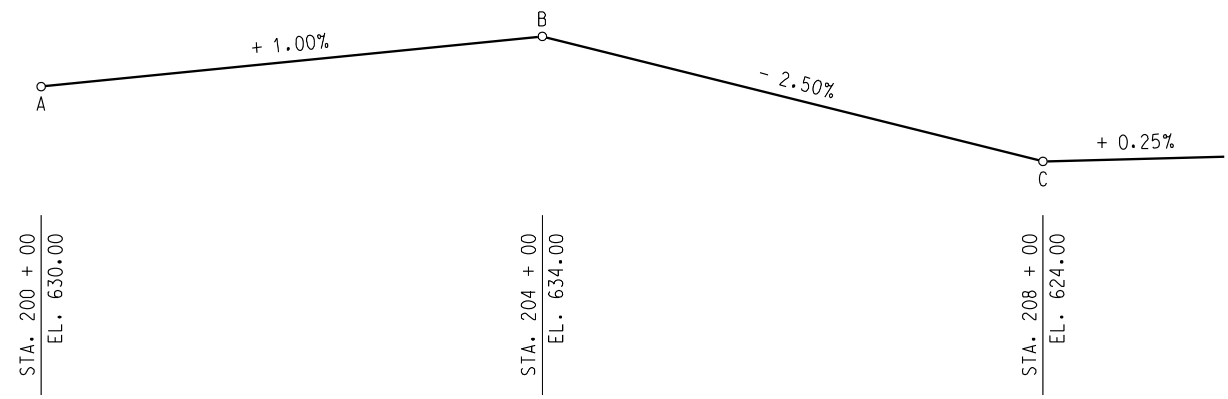
CREST VERTICAL CURVE



SAG VERTICAL CURVE

3.03.02F (continued)

Computations

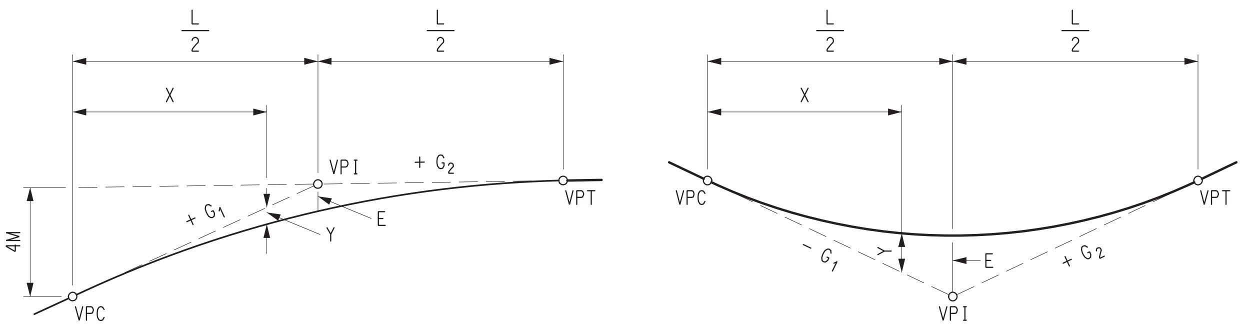


FORMULA: $\dfrac{\text{DIFFERENCE IN ELEVATION BETWEEN ANY KNOWN STATIONS ON TANGENT}}{\text{DISTANCE BETWEEN THOSE STATIONS}} = \%\ \text{GRADE}$

EXAMPLE: GRADE A TO B: $\dfrac{\text{ELEVATION AT B} - \text{ELEVATION AT A}}{\text{DISTANCE A TO B}} = \dfrac{634.000 - 630.000}{400} = 1.0\%$

3.03.02F (continued)

Computations



CREST VERTICAL CURVE
FIGURE 1

SAG VERTICAL CURVE
FIGURE 2

FORMULAS:

$$E = \frac{A}{800}(L)$$

$$Y = \frac{4M}{L^2}(X^2) \text{ or } \frac{A}{200L}(X^2)$$

WHERE:

E = External distance, feet
A = Algebraic difference of grades (G_1 and G_2), %
L = Length of curve in feet
Y = Offset at distance X from VPC or VPT, feet

GIVEN:
In Figure 1, G_1 = + 4.45% and G_2 = + 1.15%. The length of curve L = 600 ft. The distance x = 150 ft.

REQUIRED: E and offset Y

$$E = \frac{3.3}{800}(600) = 2.48 \text{ ft.}$$

$$Y = \frac{4 \times 2.48}{600^2}(150^2) = 0.62 \text{ ft.}$$

GIVEN:
In Figure 2, G_1 = − 4.55% and G_2 = + 3.00%. The length of curve L = 500 ft. The distance x = 150 ft.

REQUIRED: E and offset Y

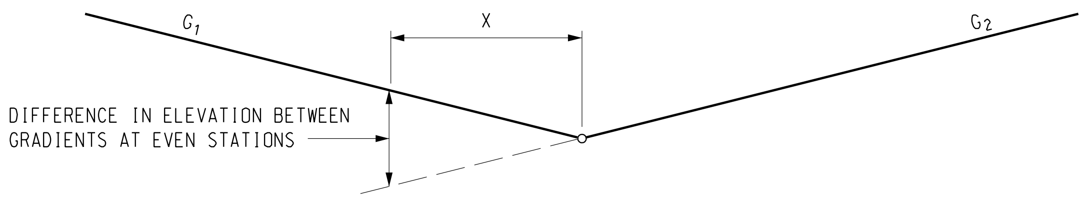
$$E = \frac{7.55}{800}(500) = 4.72 \text{ ft.}$$

$$Y = \frac{4 \times 4.72}{500^2}(150^2) = 1.7 \text{ ft.}$$

3.03.02F (continued)

Computations

COMPUTATIONS FOR ODD PI



The distance X from any even 100 feet (1 Station) to an odd PI is equal to :

$$\frac{\textit{Difference in Elevation at Even Station}}{\textit{Algebraic Difference of Gradients}} \times 100$$

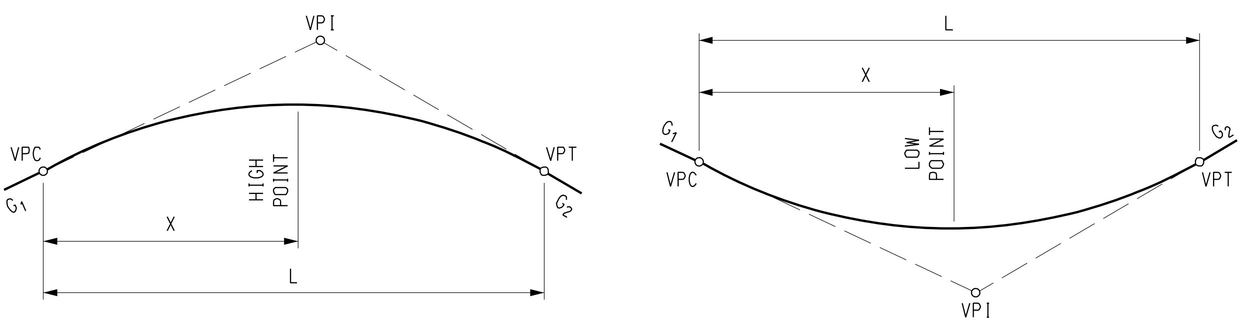
GIVEN:

G_1 = − 2.0% and G_2 = + 3.0%. Difference in Elevation of 2.5 ft. between gradients at Station 100 + 00.

REQUIRED: Distance X

$X = \frac{2.5}{5}(100)$ VPI is at Station 100 + 50

COMPUTATIONS OF LOWEST OR HIGHEST POINT ON VERTICAL CURVE



X = Distance to lowest or highest point from VCP in feet

G_1 = % of grade back of VPI

L = Length of vertical curve in feet

A = Algebraic difference of grades

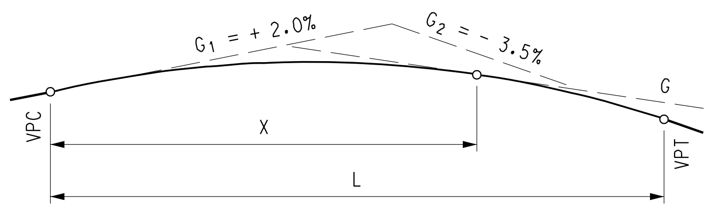
THEN

$$X = \frac{100G_1L}{A}$$

3.03.02F (continued)

Computations

TO FIND % OF GRADE AT ANY POINT ON A VERTICAL CURVE



L = Length of vertical curve in feet

x = Distance from VPC in feet

$$a = \frac{G_2 - G_1}{L}$$

Gradient at a point on a curve x distance from VPC

$$G = ax + G_1$$

EXAMPLE:

Find gradient at a point 500 ft. from VPC for a 800 ft. vertical curve.

$G_1 = + 2.0\%$ $\quad L = 800$

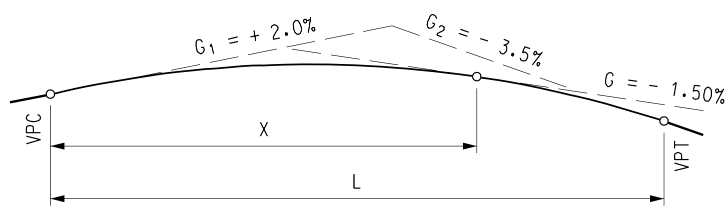
$G_2 = - 3.5\%$ $\quad x = 500$

$$a = \frac{-3.5 - 2.0}{800} = - 0.007$$

$$G = - 0.007 (500) + 2.0 = - 1.50\%$$

Gradient at a point on a curve x distance from VPC

TO FIND A POINT ON CURVE WHERE A GIVEN % OF GRADE OCCURS



Distance x from VPC to point on selected gradient.

$$x = \frac{G_1 - G}{a}$$

EXAMPLE:

Find point on curve where gradient is - 1.50%.

$G_1 = + 2.0\%$ $\quad L = 800$

$G_2 = - 3.5\%$ $\quad G = - 1.50\%$

$$a = \frac{-3.5 - 2.0}{800} = - 0.007$$

$$x = \frac{2.0 + 1.5}{0.007}$$

$$x = 500 \text{ ft.}$$

3.04 (revised 9-22-2025)

SUPERELEVATION AND CROSS SLOPES

The maximum rate of superelevation is determined from the design speed, curve radii, and the maximum allowable side friction factor.

Michigan, because of its climate, limits superelevation to 7% maximum on rural freeways, free access trunklines, and rural ramps. For maximum superelevation on urban freeways and urban ramps see Standard Plan R-107-Series.

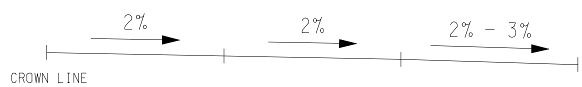
Standard Plan R-107-Series (7% E_{max}) is the preferred method for obtaining superelevation rates. Please note that interpolating between the AASHTO 6% and 8% E_{max} charts to obtain an estimated value for 7% E_{max} criteria is not appropriate. Standard Plan R-107-Series should be used. When it is not possible to use the rates provided in Standard Plan R-107-Series, the straight line method may be used on a curve by curve basis as needed. See Section 3.04.03. This method employs a distribution that generally produces more moderate superelevation rates and uses a maximum rate of superelevation of 6%.

3.04 (continued)

The department uses a standard cross slope of 2% as shown on Standard Plan R-107-Series and Appendix 3A Geometric Design Elements. See Section 6.09 for more information on pavement crowns and cross slope.

Cross slopes up to and including 2% are barely perceptible in terms of vehicle steering. A maximum cross slope of 2% should be used on the two lanes adjacent to the crownline. This will translate to crownline crossover of 4%.

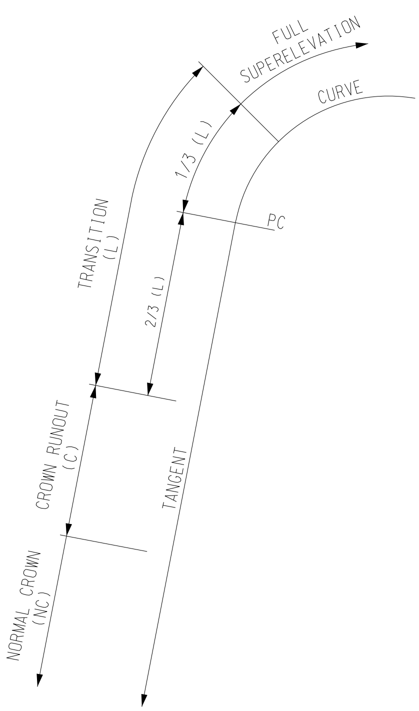
When three or more lanes are inclined in the same direction on free access curbed highways, each successive lane or portions thereof, outward from the first two lanes adjacent to the crown line, may have an increased slope. The cross slope rate may be increased up to 1%. This helps facilitate parabolic crown modifications when existing side conditions do not allow the preferred uniform standard crown rate. This use of multiple crown rates requires additional transition in superelevated sections. See sketch below.



3.04.01 (revised 2006)

Point of Rotation

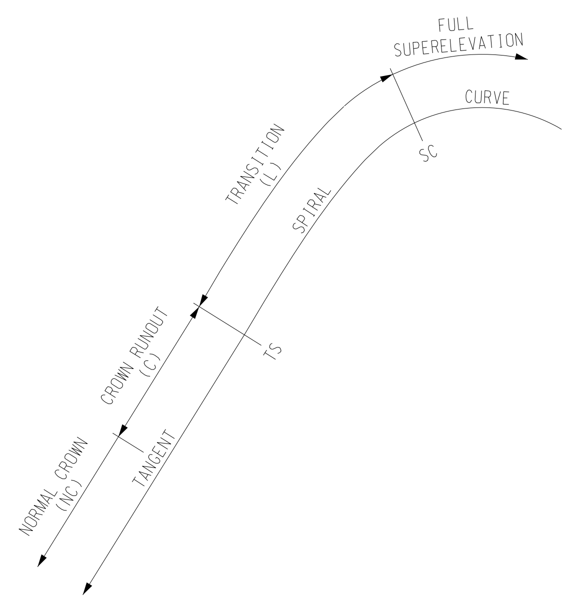
Superelevation may be obtained by rotating about the center or about inside or outside pavement edge profiles. Currently our crowned two-way and two-lane roadways are rotated about the pavement centerline per Standard Plan R-107-Series. This method reduces the edge distortion because the required change in elevation is distributed along both pavement edges rather than all on one edge. Uncrowned or straight cross slope pavements, such as ramps, are rotated about the alignment edge. Special consideration should be given to superelevating wider pavements (i.e., three-lane or five-lane sections) as the point of rotation should be determined by site conditions. See Standard Plan R-107-Series.



3.04.02 (revised 2-21-2017)

Superelevation Transitions

The superelevation transition consists of the superelevation runoff (or transition (L)) and tangent runout (or crown runout (C)). The superelevation runoff section consists of the length of roadway needed to accomplish a change in outside-lane cross slope from zero (flat) to full superelevation, or vice versa. The superelevation runoff is determined by the width of pavement (W), superelevation rate (e), and the relative gradient along the edges of pavement (Δ%). As indicated in Standard Plan R-107-Series, one third of the superelevation runoff length is located in the curve. When this cannot be achieved, the runoff length can be adjusted to a 30% minimum and 40% maximum inside the curve. The tangent runout section consists of the length of roadway needed to accomplish a change in outside-lane cross slope from the normal cross slope rate to zero (flat), or vice versa. The tangent runout is determined by the width of pavement (W), normal cross slope/normal crown (N.C.), and the relative gradient. Relative gradient values correspond to the superelevation rates. The gradient may be increased as needed up to the maximum relative gradient for the design speed. A design variance is required for values exceeding the maximum relative gradient.



3.04.03 (revised 2006)

Superelevation Using a Straight Line Method

STRAIGHT LINE SUPERELEVATION																						
RADIUS Feet	30 mph		35 mph		40 mph		45 mph		50 mph		55 mph		60 mph		65 mph		Freeways				Urban Freeways and Urban Ramps	
																	70 mph		75 mph		60 mph	
	e	Δ%	E	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%	e	Δ%
20000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--
17000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	2.0	0.30	N.C.	--
14000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	2.0	0.32	2.0	0.31	2.0	0.30	N.C.	--
12000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	2.0	0.36	2.0	0.32	2.0	0.31	2.0	0.30	2.0	0.36
10000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	N.C.	--	2.0	0.38	2.0	0.36	2.0	0.32	2.0	0.31	2.0	0.30	2.0	0.36
8000	N.C.	--	N.C.	--	N.C.	--	N.C.	--	2.0	0.40	2.0	0.38	2.0	0.36	2.0	0.32	2.0	0.31	2.0	0.30	2.0	0.36
6000	N.C.	--	N.C.	--	N.C.	--	2.0	0.40	2.0	0.40	2.0	0.38	2.0	0.36	2.0	0.32	2.0	0.31	2.5	0.31	2.0	0.36
5000	N.C.	--	N.C.	--	2.0	0.40	2.0	0.40	2.0	0.40	2.0	0.38	2.0	0.36	2.0	0.32	2.5	0.32	3.0	0.32	2.0	0.36
4000	N.C.	--	2.0	0.45	2.0	0.40	2.0	0.40	2.0	0.40	2.0	0.38	2.0	0.36	2.5	0.33	3.1	0.33	3.8	0.34	2.0	0.36
3500	N.C.	--	2.0	0.45	2.0	0.40	2.0	0.40	2.0	0.40	2.0	0.38	2.3	0.37	2.8	0.34	3.5	0.34	4.3	0.35	2.0	0.36
3000	2.0	0.50	2.0	0.45	2.0	0.40	2.0	0.40	2.0	0.40	2.1	0.38	2.7	0.38	3.3	0.36	4.1	0.36	5.0	0.36	2.4	0.37
2500	2.0	0.50	2.0	0.45	2.0	0.40	2.0	0.40	2.0	0.40	2.5	0.39	3.2	0.39	4.0	0.37	4.9	0.38	6.0	0.38	2.8	0.38
2050	2.0	0.50	2.0	0.45	2.0	0.40	2.0	0.40	2.4	0.41	3.1	0.40	3.9	0.40	4.8	0.40	6.0	0.40			3.4	0.39
1800	2.0	0.50	2.0	0.45	2.0	0.40	2.1	0.41	2.8	0.42	3.5	0.41	4.4	0.42	5.5	0.42					3.9	0.40
1675	2.0	0.50	2.0	0.45	2.0	0.40	2.3	0.41	3.0	0.42	3.8	0.42	4.8	0.42	5.9	0.43					4.2	0.41
1425	2.0	0.50	2.0	0.45	2.0	0.40	2.7	0.42	3.5	0.44	4.5	0.44	5.6	0.44							5.0	0.43
1350	2.0	0.50	2.0	0.45	2.2	0.41	2.9	0.43	3.7	0.44	4.7	0.44	5.9	0.45								
1150	2.0	0.50	2.0	0.45	2.5	0.42	3.4	0.45	4.3	0.46	5.5	0.46										
1075	2.0	0.50	2.0	0.45	2.7	0.43	3.6	0.46	4.7	0.47	5.9	0.47										
850	2.0	0.50	2.4	0.47	3.4	0.46	4.5	0.49	5.9	0.50												
820	2.0	0.50	2.5	0.47	3.5	0.47	4.7	0.49														
800	2.0	0.50	2.6	0.47	3.6	0.47	4.8	0.50														
720	2.0	0.50	2.8	0.49	4.0	0.49	5.4	0.52														
650	2.1	0.51	3.1	0.50	4.5	0.51	5.9	0.54														
600	2.3	0.51	3.4	0.51	4.8	0.53																
500	2.8	0.53	4.1	0.54	5.8	0.57																
450	3.1	0.54	4.5	0.56																		
400	3.5	0.56	5.1	0.58																		
345	4.0	0.58	5.9	0.62																		
300	4.6	0.61																				
232	6.0	0.66																				
$\Delta\%_{max}$		0.66		0.62		0.58		0.54		0.50		0.47		0.45		0.43		0.40		0.38		0.45
Rmin	232		340		485		643		833		1061		1333		1657		2042		2500		1412	

Use 7% superelevation for loop ramps (see Standard Plan R-107-Series). However, special consideration should be given to curves which approach a ramp terminal (stopping condition). If relative gradient (Δ%) values from the tables cannot be obtained for the design radius, use $\Delta\%_{max}$ for the corresponding design speed.
For radii less than those tabulated (but not less than Rmin) use e_{max} and $\Delta\%_{max}$.
Maximum superelevation for urban freeways and urban ramps (with 60 mph design speed) is 5%, otherwise e_{max} = 6%.

3.05

Section deleted.

3.06 (revised 9-22-2025)

DESIGN SPEED

Design speed is a selected speed used to determine the various geometric design features of the roadway for all modes of travel. Once selected, all of the pertinent design features of the highway should be related to the design speed to obtain a balanced design.

New Construction and Reconstruction Projects:

Where practical, it is MDOT desirable practice to design roadway geometrics based on a recommended project design speed 5 mph greater than the posted speed. This practice is founded in research that shows actual operating speeds are typically greater than the posted speeds. Design speeds shown in Appendix 3A are applicable for New Construction and Reconstruction projects.

Construction on Existing Road Projects:

For freeway projects, the minimum design speed is the design speed approved at the time of the latest New Construction or Reconstruction project.

Design speeds used for non-freeway Construction on Existing Road projects are shown in Section 3.09.01. However, if the original posted speed has been raised, the designer may use the design speed approved at the time of the latest New Construction or Reconstruction project.

Also See Section 3.08.01B for information on combined project types.

3.06 (continued)

The project design speed to be recorded on the title sheet is the predominant selected design speed.

3.07

GEOMETRICS

3.07.01 (revised 9-22-2025)

Lane Width, Capacity and Vehicle Characteristics

A. Lane Width and Capacity

The lane width of a roadway greatly influences the safety and comfort of driving. In urban areas, designers should consider the safety of all users when determining lane widths.

B. Vehicle Characteristics

There are two general classes of vehicles: passenger and commercial (trucks). The geometric design requirements for trucks and buses are much more severe than they are for passenger vehicles. Consult the Geometrics Unit in the Design Division for the appropriate design vehicle to be used on the job. Intersection radii for various types of commercial vehicles are given on Geometric Design Guide GEO-650-Series, "Flares and Intersection Details". Also, for short radii loops, additional ramp width may be needed to accommodate these vehicles. Generally, the AASHTO WB-67 is the design vehicle to be used in determining the radii to be used in turning movements at trunkline to trunkline intersections and interchanges.

Acceleration and deceleration rates of vehicles are often critical in determining highway design. These rates often govern the dimensions of design features such as intersections, freeway ramps, speed change lanes, and climbing or passing lanes.

3.07.02 (revised 2-24-2020)

Interchange Geometrics

General: Contact the Geometrics Unit in the Design Division for the recommendations / requirements of all geometric features of highway facilities.

A. Rural and Urban

Geometric Design Guides, developed by the Geometrics Unit in the Design Division show approved criteria for ramp and interchange design. See Geometric Design Guides.

B. Interchange Layout

The following items should be considered in conjunction with the Geometric Design Guides for interchange design.

1. Exit ramps should be designed for adequate visibility for the motorist exiting the freeway. Sight distance along a ramp should be at least as great as the design stopping sight distance. There should be a clear view of the entire exit terminal, including the exit nose and a section of the ramp roadway beyond the gore.

2. Exit ramps should begin where the freeway is on a tangent, when possible.

3. Drivers prefer and expect to exit in advance of the structure. Loop ramps that are located beyond the structure, usually need a parallel deceleration lane.

4. Left-hand entrances and exits are contrary to the concept of driver expectancy. Therefore, extreme care should be exercised to avoid left-hand entrances and exits in the designing of interchanges.

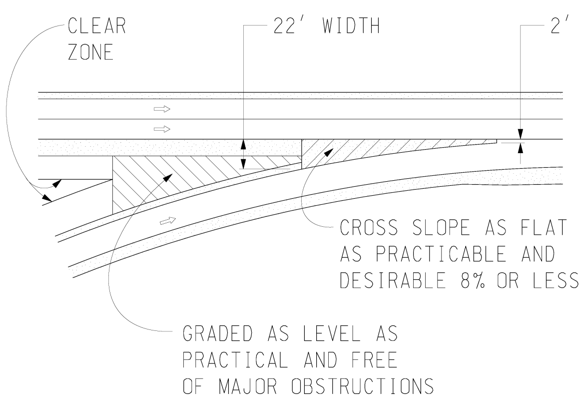
5. The geometric layout of the gore area of exit ramps should be clearly seen and understood by the approaching drivers.

3.07.02B (continued)

Interchange Geometrics

6. Potential conflicts with pedestrians and bicycles should be considered when using free flow ramps in urban areas.

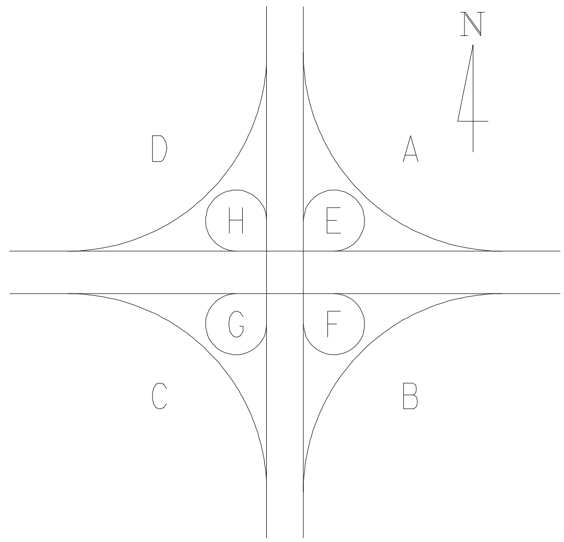
7. The cross slope in the gore area between the 2' point and the 22' point should be as flat as practicable and desirably 8% or less. It is also desirable that the algebraic difference in grades between the gore and the adjacent lane be 5% or less to minimize the effect on vehicles inadvertently crossing the gore area. It is recommended that detail grades for the above paved portion of the gore area be provided to verify both cross slopes and algebraic differences. The unpaved portion beyond the 22' point (to the extent the clear zone from each roadway overlaps) should be graded as level with the roadway as practical and be clear of major obstructions. See sketch below.



3.07.02B (continued)

8. In order to identify the location of ramps at interchanges, the following system of lettering ramps should be used on projects insofar as possible:

   The northeasterly quadrant is designated ramp A. Ramps B, C, & D follow in sequence in a clockwise direction. Interchange interior loops would similarly follow with clockwise designations E, F, G, & H.



3.07.02 (continued)

Interchange Geometrics

C. Crossroads Over Freeways

Local or county roads over freeways should be designed for stopping sight distance based on the project design speed.

In interchange areas, the intersection sight distance and clear vision areas at diamond ramp terminals must be according to current Department practice. See MDOT Sight Distance Guidelines, Section 3.03.02E and the Geometric Design Guide GEO-370-Series. The driver's eye position, for a vehicle on a ramp, is assumed to be between 14.5 feet minimum and 18 feet desirable from the edge of the crossroad.

D. Ramp Radii

The speeds at which ramps may be driven, if they are free flowing, is determined primarily by the sharpest curve on the ramp proper. Loop ramps, because of their design restrictions, have the sharpest curvature, and if possible the designer should not use a radius of less than 260 feet. For radii less than 260 feet, contact the Geometrics Unit of the Design Division.

E. Single Lane Ramp Widths

Single lane ramp widths are normally 16'-0". The total paved width including paved shoulders should not exceed 28’. Wider paved widths invite undesirable passing of slow-moving vehicles or invite two-lane operation.

Current ramp widths are shown in Chapter 6, Appendix 6-A.

3.07.03

Speed Change Lanes and Transitions

The change in vehicle speed between highways and ramps is usually substantial, and provision should be made for acceleration and deceleration. Therefore, in order to minimize interference with through traffic on highways, speed change lanes (deceleration and acceleration lanes) are added at turning roadways.

The Geometric Design Guides allow for either parallel or tapered deceleration lanes for exit ramps. Parallel deceleration lanes should be used where the ramp exit is on a freeway curve.

3.07.04 (revised 2006)

Intersections

An intersection is defined as the general area where two or more highways join or cross, including the roadway and roadside facilities for traffic movements within the area.

Intersections are an important part of a highway facility because, to a great extent, the efficiency, safety, speed, cost of operation, and capacity of the facility depends on their design. Although many of the intersections are located in urban areas, the principles involved apply equally to design in rural areas.

The angle of intersection between the approach road and the trunkline should not be less than 60° or more than 120°, with desirable values between 75° and 105°.

The gradient of the intersecting roads should be as flat as practical on those sections that are to be used for storage of stopped vehicles. If possible, side roads should have a "landing" of no more than 3 percent grade. Even though stopping and accelerating distances for passenger cars, on grades of 3 percent or less differ little from the distances on the level, larger vehicles need the flatter landing area.

Where two roadways intersect, crown manipulation of both roadways can be used to improve the drivability of both roadways. In this case, to insure proper drainage, detail grades should be provided. See Geometric Design Guide GEO-650-Series for allowable approach road grades.

3.07.04 (continued)

Intersection sight distance should be provided on all intersections legs. Clear vision corners should be provided when it is practical. See Section 5.24.

Center lanes for left turns or passing flares may be required at certain intersections. See Geometric Design Guide GEO-650-Series.

Ramp terminals should be according to Geometric Design Guide GEO-370-Series.

3.08 (revised 9-22-2025)

AASHTO GREEN BOOK (GB7) PROJECT TYPES

3.08.01 (revised 9-22-2025)

General

A. Definitions

Basic Roadway Type: the general geometric character of an existing highway. The project objective may prompt changes to the basic roadway type, such as (but not limited to):

- Providing additional motor vehicle through lanes.
- Adding a raised or depressed median where none currently exists.
- Any change to vertical or horizontal alignment that requires a Design Exception or Design Variance.
- Any geometric change that results in a net decrease in safety performance.

Roadway improvements that can be accomplished without changes to the basic roadway type may include lane reconfigurations (road diets), adding turn lanes, adding channelizing islands, or adding median curbs for access management.

3.08.01 (continued)

B. General

The 7th Edition of AASHTO's Policy on Geometric Design of Highways and Streets ("Green Book" or "GB7") categorizes projects into three different project types, with the historic 3R/4R classifications following in parentheses:

- New Construction (4R)
- Reconstruction (4R)
- Construction on Existing Roads (3R)

Previously, Title 23 of the Code of Federal Regulations (CFR) and the Road Design Manual (RDM) classified projects as being one of two types; resurfacing, restoring, or rehabilitating (3R) or resurfacing, restoring, rehabilitating, and reconstructing (4R). While these classifications are still used in multiple areas, the GB7 project types will determine the appropriate geometric design criteria to be applied.

Design projects which include multiple project types default to either the more conservative requirements or require the identification of the logical limits of each type on the project information sheet. A consistent corridor may be determined as a design priority when logical and appropriate for each GB7 project type; for example, establishing a constant lane width throughout a corridor to enhance the driver experience versus patchwork geometrics.

Consider Performance-Based Practical Design (refer to Section 3.17) initiatives for each project type given the needs of each user and transportation mode. Specific applications are provided as follows for each GB7 project type.

Refer to the Road and Bridge Project Classifications Table in this section for common projects and their associated project types.

In the event a project type is unclear, contact the Geometric Design Unit to determine the appropriate classification.

3.08.01 (continued)

General

New Construction (4R)

New Construction projects are those in which the majority of the project length is on a new alignment where no existing roadway is present within the existing right-of-way. Design considerations for this project type are included in Section 3.10 for Non-Freeway and Section 3.14 for Freeway.

Unlike the other GB7 project types, New Construction project types do not have any existing performance data for which deviations to the geometric controlling criteria can be justified. Any application of Performance-Based Practical Design on New Construction project types is focused on assessing design alternatives and selecting the most justifiable option using the data that is available. This information would be documented in a Design Exception or Design Variance for any deviations from geometric controlling criteria. Refer to Section 3.08.01E.

3.08.01 (continued)

Reconstruction (4R)

Reconstruction projects are those in which the existing project involves a change in the Basic Roadway Type. Design considerations for this project type are included in Section 3.10 for Non-Freeway and Section 3.14 for Freeway.

Reconstruction project types have more Performance-Based Practical Design flexibility than New Construction project types, but less flexibility than Construction on Existing Road project types. Due to the nature of Reconstruction project types, and the change to the Basic Roadway Type, there will be a portion of the geometric controlling criteria for which existing performance data cannot be applied to the project. For example, accommodating a new center left-turn lane by reducing existing lane widths below criteria cannot be justified in a Design Exception or Variance by citing the existing lack of sideswipe crashes; lane widths are associated with sideswipe crashes in the MDOT Safety Programs Guide. Therefore, unless additional justification is provided (such as through a predictive crash analysis), the default lane width is that which is detailed in Appendix 3A.

Consistent with Performance-Based Practical Design, Design Exceptions or Design Variances will generally be approved when supported by performance data and not citing cost as the single or main consideration. Reconstruction project types can rely on both existing (where applicable) and predicted crash data, whereas New Construction project types will only have predicted crash data available. Performance-Based Practical Design can also be used to forecast performance of design alternatives.

3.08.01 (continued)

General

Construction on Existing Roads (3R)

Construction on Existing Road projects are those in which the project utilizes an existing or improved alignment and maintains the existing Basic Roadway Type. Any project that does not meet the criteria for New Construction or Reconstruction is considered Construction on Existing Roads. These types of projects are those in which the existing performance history (such as crash history, level-of-service, etc.) can be used to predict future performance. Design considerations for this project type are included in Section 3.09 for Non-Freeway and Section 3.13 for Freeway.

Performance-Based Practical Design initiatives for Construction on Existing Roads is the most flexible of all categories, as the existing road performance can be applied to the proposed project because the Basic Roadway Type remains the same. This allows for a targeted approach to determine when geometric improvements are necessary based on existing and future performance and avoids investments in upgrades where there is not supporting data that showcases an underlying problem. Chapter 1 of the 7th Edition of the AASHTO Green Book (GB7) states "*Every dollar spent on a road that is performing well and anticipated to continue performing well is a dollar that is not available to be spent on a road that is performing poorly.*"

Projects undertaken because of asset condition (such as those for which the design life has been exceeded or rehabilitation is necessary) will always utilize the existing geometrics as the basis of design for both freeway and non-freeway projects, with targeted improvements required when any of the following conditions exist:

- A crash pattern involving existing fatal and/or serious injuries has been identified that can be corrected by design modifications of the specific applicable geometric controlling criteria (regardless of project scope, budget, etc.). Crash patterns that exist entirely independent of the geometric controlling criteria are excluded from this requirement. This analysis will be performed by the Region/TSC Traffic and Safety Engineer. Refer to the MDOT Safety Programs Guide for the correlation between crash type and geometric element.
- A benefit-cost analysis (such as that present in NCHRP 876 or IHSDM) indicates that a geometric improvement would cost-effectively mitigate fatal and/or serious injury crashes over the design life of the project. This analysis can be based on risk elements that may be present, but which have not yet manifested themselves into an existing crash pattern. This analysis will be performed at the discretion of the Project Manager and is not mandatory for every project. This will be a collaborative effort between the design team and Region/TSC Traffic and Safety Engineer. Any deviations from existing geometrics proposed through this analysis require approval from the Engineering Operations Committee (EOC).
- If project scoping has identified the need for a Level-of-Service (LOS) analysis that results in an existing or projected unacceptable operational Level-of-Service.
- The Project Manager and the project team determines that improvements are cost-negligible to the project, such as for superelevation rate or cross-slope adjustments.

3.08.01 (continued)

General

Section 3.09.01 contains the geometric design criteria for non-freeways when existing geometrics are unable to be retained. Because the MDOT Safety Programs Guide indicates that crash types may be attributable to multiple geometric elements, only those elements that are below the criteria in Section 3.09.01 require improvements. If all existing geometric elements attributable to the crash pattern already meet the criteria in Section 3.09.01, those specific elements are required to be improved to the criteria present in Appendix 3A.

Appendix 3A contains the geometric design criteria for freeways when existing geometrics are unable to be retained.

Improve only the geometric elements that address the identified problems; it is possible that projects may require a combination of improvements. Note that this paragraph does not apply to Level-of-Service deficiencies.

Projects undertaken because of inadequate Level-of-Service or safety performance will utilize the Highway Capacity Manual or the Highway Safety Manual, respectively, to influence design decisions. However, similar to projects undertaken because of asset condition, required geometric design changes are limited to those that meet the project objectives or are cost-negligible to the project.

3.08.01 (continued)

When the project's scope and objective has identified the need for multimodal facilities in accordance with the Department's Complete Streets and/or Context Sensitive Solutions policies, individual geometric elements may be modified after a predictive crash analysis has been performed and indicates a net safety benefit (reduction in fatal and serious injuries) of all users. Multimodal facilities may be either included directly in the project or the project designed so as not to preclude such facilities in the future; this includes both road and bridge assets. Additionally, consideration must be given to geometric design modifications that would help facilitate the mitigation of an existing missing link in a multimodal network.

3.08.01 (continued)

General

Road and Bridge Project Classification Examples[1]

Example Road Project	GB7 Project Type
New Road	New Construction
Adding lanes for Vehicular Through Traffic	Reconstruction
Addition of a Raised or Depressed Median	Reconstruction
Complete Removal and Replacement of Pavement	Construction on Existing Road
Resurfacing, Milling, or Profiling, Concrete Overlays, and Inlays	Construction on Existing Road
Lane and/or Shoulder Widening	Construction on Existing Road
Passing Relief Lanes	Construction on Existing Road
Adding Auxiliary Lanes (Center-Turn Lanes, Right-Turn Lanes, etc.)	Construction on Existing Road
Roadway Base Correction	Construction on Existing Road
Roadside Safety Improvements (guardrail, delineators, etc.)	Construction on Existing Road
Pedestrian Refuge and Access Management Islands	Construction on Existing Road
Signing, Pavement Marking and Traffic Signals	Construction on Existing Road
Intersection and Railroad Crossing Upgrades	Construction on Existing Road
Pavement Joint Repair	Construction on Existing Road
Crush, Shape, and Resurfacing	Construction on Existing Road
Rubblize and Resurfacing	Construction on Existing Road
Introduction of Curb and Gutter	Construction on Existing Road
Example Bridge Project	**GB7 Project Type**
New Bridge	New Construction
Bridge Replacement	Reconstruction
Complete Superstructure Replacement	Reconstruction
Partial Superstructure Replacement with Additional Lanes	Reconstruction
Bridge Widening to Accommodate Additional Lanes or Non-Motorized Needs	Reconstruction
Deck Replacement with Bridge Widening to Accommodate Additional Lanes	Reconstruction
Deck Replacement without Additional Lanes	Construction on Existing Road
Partial Superstructure Replacement without Additional Lanes	Construction on Existing Road
Partial Substructure Replacement (can include the complete removal of an entire substructure element but not the replacement of all the substructure elements)	Construction on Existing Road
Barrier Replacement	Construction on Existing Road

[1] GB7 Project Classifications must be taken in the context of all requirements listed in Section 3.08.01.

3.08.01 (continued)

General

C. Corridor Minimum Geometric Standards

Minimum corridor-wide geometric standards may be established within a corridor plan to ensure uniformity of the driver experience, promote Context Sensitive Solutions, facilitate maintenance-of-traffic operations, execute Performance-Based Practical Design, and provide a consistent corridor from beginning to end. The Associate Region Engineer-Development (System Manager) and/or Region Planner will be able to assist in determining if a corridor plan is present. Refer to the Scoping Manual for additional information.

Note: Corridor-wide standards are a minimum criteria; when conflicts exist with Section 3.08.01.B, the most conservative design will govern. Document these design decisions in the project file.

3.08.01 (continued)

D. Other Work Categories

Projects categorized by other work types (such as Capital Preventive Maintenance (CPM), M-Funded Non-Freeway or Freeway Resurfacing, Signal Corridor, Pavement Marking, and Signing Corridor projects) are governed by guidelines that may differ from the three GB7 project types. For information related to specific requirements for these categories of work, other appropriate references must be used. When other work types are packaged with a GB7 project type, the portion of the project that is outside the GB7 project type work limits is governed by the guidelines pertaining to the other work type. Work type overlap may cause a default to more conservative requirements. Engineering judgement will be required to determine the controlling classification when considering how the different included work types will affect the applicability of the existing performance measures to the post-project performance measures.

Note that the applicability of CPM minimum design requirements is contingent on the program eligibility of the roadway. Regardless of funding source used to design and construct CPM work, CPM minimum design requirements can only be applied to work done on roadways that would otherwise be eligible for funding under the CPM program.

3.08.01 (continued)

General

E. Design Exceptions / Design Variances

Where indicated, a Design Exception (DE) or Design Variance (DV) must be submitted and approved when the geometric controlling criteria cannot be met (where required as determined by the GB7 project type). The Geometric Design Unit will review plans during the review process and identify the need for these submissions.

In general, the following conditions apply for freeway and non-freeway projects:

- Reductions of geometric elements from existing conditions that still result in meeting the posted speed of the project do not require a DE or DV provided there is not a crash history present attributable to those specific elements.
- Blanket DEs or DVs are never provided for projects when the design speed is less than the posted speed. Each individual element that does not meet the posted speed requires its own DE or DV.
- Design Exceptions or Design Variances are required when the specific geometric elements that could correct crash patterns are unable to be improved as required.

3.08.01 (continued)

For underclearance, the following conditions apply:

- Underclearance requirements are located in the Bridge Design Manual Chapter 7. For any projects that could potentially affect bridge underclearance, refer to the Bridge Design Manual as that contains requirements not included here.
- Thin HMA overlays, pavement grinding, concrete joint repair, slurry seal (shoulders only), and seal coat (shoulders only) can maintain the existing vertical clearance without a Design Exception.
- All proposed Design Exceptions pertaining to vertical clearance on Interstate routes (including shoulders) and all ramps and collector distributor roadways of Interstate-to-Interstate interchanges will be coordinated with the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) using MDOT Form 0333. Refer to Bridge Design Manual Section 7.01.08B.

Design Exception and Design Variance applicability is listed in the following table with their corresponding level of documentation and/or approval.

3.08.01 (continued)

General

AASHTO Controlling Criteria	Applicability of Design Exception (DE) or Design Variance (DV) with project Posted Speed (PS) Considerations					
	New Construction (4R)		Reconstruction (4R)		Construction on Existing Road (3R)	
	PS ≥ 50 MPH	PS < 50 MPH	PS ≥ 50 MPH	PS < 50 MPH	PS ≥ 50 MPH	PS < 50 MPH
Lane Width	DE	DV[1]	DE	DV[1]	DE[2]	DV[1,2]
Shoulder Width	DE	DV	DE	DV	DE[2]	DV[2]
Horizontal Curve Radius	DE	DV	DE	DV	DE[2]	DV[2]
Superelevation Rate	DE	DV	DE	DV	DE[2]	DV[2]
Stopping Sight Distance (Horizontal and Vertical)	DE	DV	DE	DV	DE[2]	DV[2]
Maximum Grade	DE	DV	DE	DV	DE[2]	DV[2]
Cross Slope	DE	DV	DE	DV	DE[2]	DV[2]
Vertical Clearance[3]	DE	DE	DE	DE	DE	DE
Design Loading Structural Capacity	DE	DE	DE	DE	N/A[4]	N/A[4]
Other Criteria						
Superelevation Transition[5]	DV	DV	DV	DV	DV[2]	DV[2]
Ramp Acceleration / Deceleration Length[6]	DV	DV	DV	DV	DV[2]	DV[2]

[1] Lane width reductions from existing conditions on the National Network require the Design Exception process be followed regardless of design speed.
[2] Applies only when the proposed design either reduces geometric elements below both the existing conditions ***and*** Appendix 3A, or there is an existing crash history that is not being remediated by improving the contributing criteria.
[3] Refer to Bridge Design Manual Chapter 7.
[4] Design loading structural capacities are not evaluated on Construction on Existing Road (3R) projects.
[5] Refer to Section 3.04.02.
[6] Use Geometric Design Guides for appropriate lengths.

3.08.01 (continued)

General

F. Safety Review / Crash Analysis

An existing crash analysis is required for all Reconstruction and Construction on Existing Road projects (refer to Section 14.24). The Project Manager should contact the TSC Traffic and Safety Engineer during scoping to request a crash analysis be performed throughout the project limits. On corridor projects, only one analysis that includes roadways and bridges is required. Utilize the most recent 5 years of crash data available on RoadSoft to determine where safety enhancements would be beneficial and supported by the data. Crash analyses more than 3 years old must be updated to verify the original results.

A site-specific predictive Highway Safety Manual (HSM) Crash Analysis is required as justification for any Design Exception or Design Variance. It is also required in determining appropriate design criteria (including Crash Modification Factors) according to Section 3.09.01A and 3.09.01B. If a specific HSM model does not exist for that roadway type, then perform a crash analysis using the most recent 5 years of crash data available on RoadSoft for the existing conditions and the geometric element in question. Site specific crash analyses more than 3 years old must be updated to verify the original crash analysis.

G. National (Truck) Network (NN) Lane Widths

23 CFR Part 658 requires that lane widths on the Interstate System and portions of the Federal-Aid Primary System are designed to be 12'-0" unless otherwise consistent with highway safety. The portions of the Federal-Aid Primary System that are on the National Network are identified on the MDOT Truck Operators map.

3.08.01 (continued)

Designers must strive to ensure that all New Construction, Reconstruction, and Construction on Existing Road projects on the National Network have 12'-0" lane widths (excluding turn lanes that would take a vehicle off of the network). Existing truck lane widths that do not meet 23 CFR Part 658 may be retained (not reduced) if they otherwise meet the standards relative to the project work type (New Construction, Reconstruction, and Construction on Existing Roads). The requirements in this paragraph for lane width on National Networks take precedence over other PBPD and design flexibility decisions.

In rare circumstances, the designer may have to reduce the lane widths on the National Network from existing conditions. This decision should only occur after all other reasonable accommodations have been explored. Because 23 CFR Part 658 requires that National Network lane widths are 12'-0" unless otherwise consistent with highway safety, any reduction from existing widths requires Design Exceptions with additional evidence that the proposed cross-section will cumulatively improve safety. The Design Exception must include the following:

- A predictive crash analysis that indicates a decrease in all vehicular, bicycle, and pedestrian serious injury and fatal crashes over existing conditions.
- Any mitigative measures necessary to ensure the decrease in vehicular, bicycle, and pedestrian serious injury and fatal crashes.
- An analysis that concludes that a WB-67 is capable of navigating all turns necessary to remain on the National Truck Network without encroaching on adjacent lanes.

Note that all lane width reductions on the National Network must be submitted as a Design Exception regardless of design speed.

3.09 (revised 9-22-2025)

CONSTRUCTION ON EXISTING ROAD CONTROLLING CRITERIA (NON-FREEWAY)

3.09.01 (revised 9-22-2025)

Geometric Controlling Criteria

The criteria present in this section provide the minimum dimensional targets for the geometric controlling criteria if existing geometrics are unable to be retained (Refer to Section 3.08.01B) for Non-Freeway Construction on Existing Road project types. Improve the necessary geometric elements; it is possible that projects may require a combination of improvements.

The geometric elements are divided into NHS and Non-NHS tables. Some geometric elements may be divided into Urban and Rural areas (Refer to Section 3.02). These definitions are provided as guidance; specific project context will be established by the Project Manager and project team.

3.09.01 (continued)

A. Non-Freeway, NHS

Geometric Elements	Non-Freeway, NHS - Construction on Existing Road Project Types			
Design Speed (see Section 3.06)	Posted Speed Minimum			
Shoulder Width *Minimum shoulder widths apply for:* ***Rural**: Posted speeds greater than 45 mph.* ***Urban**: Posted speeds greater than 45 mph where sufficient right-of-way exists to include shoulders.* *At lower speeds minimum shoulder widths are desirable.*	Current ADT Two-Way		Inside Shoulder	Outside Shoulder
	Two Lane and Three Lane with a Center Left Turn Lane	<750 750 to 5000 >5000 to 10,000 >10,000		3' -0" Gravel 6' -0" (3' -0" Paved) 8' -0" (3' -0" Paved) 8' -0" (7' -0" Paved)
	Multilane Undivided	≤ 10,000 > 10,000		6' -0" (3' -0" Paved) 8' -0" (3' -0" Paved)
	Multilane Divided	≤ 10,000 > 10,000	3' -0" Paved 3' -0" Paved	6' -0" (3' -0" Paved) 8' -0" (3' -0" Paved)
	Refer to Bridge Design Manual Appendix 12.02 for Bridge Widths			
Lane Width	ADT	Lane Width		
	≤750 >750	10' -0" 11' -0" 10'-0" lanes may be considered in urban areas for multi-lane undivided (regardless of ADT) and multi-lane divided (ADT < 10,000). 12'-0" lanes are desirable on the Priority Commercial Network (PCN). 12'-0" lanes are required on the National Network (also known as the National Truck Network). Refer to 3.08.01G for retention or reduction of existing National Truck Network lane widths. Refer to the Truck Operator's Map for the Priority Commercial Network (Green) and National Truck Network (Gold) classifications.		
Design Loading Structural Capacity	Refer to Bridge Design Manual Appendix 12.02. Design loading structural capacities are not evaluated on Construction on Existing Road (3R) projects.			
Horizontal Curve Radius	Refer to Standard Plan R-107-Series. The design speed used for a ramp vertical alignment should meet or exceed the design speed used for the ramp horizontal alignment.			
Stopping Sight Distance	Refer to 2018 7th Edition AASHTO Green Book or MDOT Sight Distance Guidelines.			
Maximum Grade	Refer to Appendix 3A.			
Cross Slopes	Traveled way: 1.5%-2%. Shoulder: 4% (6% allowed per Section 6.05.05)			
Superelevation Rate	Standard Plan R-107-Series or reduced maximum (6%) Straight Line Superelevation Chart.			
Vertical Clearance	Refer to Bridge Design Manual Chapter 7.			

3.09.01 (continued)
B. Non-Freeway, Non-NHS

<table>
<tr><th>Geometric Elements</th><th colspan="3">Non-Freeway, Non-NHS - Construction on Existing Road Project Types</th></tr>
<tr><td>Design Speed</td><td colspan="3">Posted Speed Minimum</td></tr>
<tr><td rowspan="5">Shoulder Width
Minimum shoulder widths apply for:
Rural: Posted speeds greater than 45 mph.
Urban: Posted speeds greater than 45 mph where sufficient right-of-way exists to include shoulders.
At lower speeds minimum shoulder widths are desirable.</td><td>Current ADT Two-Way</td><td colspan="2">Inside and Outside Shoulder Width</td></tr>
<tr><td>≤750
750 to 2000
> 2000</td><td colspan="2">2' -0" (Gravel)
3' -0" (Paved)
6' -0" (3' -0" Paved)</td></tr>
<tr><td rowspan="2">Multilane (Divided & Undivided)</td><td>Inside (Divided)</td><td>Outside (Both sides for undivided)</td></tr>
<tr><td>3' -0" Paved</td><td>6' -0" (3' -0" Paved)</td></tr>
<tr><td colspan="3">Refer to Bridge Design Manual Appendix 12.02 for Bridge Widths</td></tr>
<tr><td rowspan="2">Lane Width</td><td>ADT</td><td colspan="2">Lane Width</td></tr>
<tr><td>≤750
>750</td><td colspan="2">10' -0"
11' -0"
10' -0" lanes may be considered in urban areas for multi-lane un-divided (regardless of ADT) and multi-lane divided (ADT < 10,000).
12' -0" lanes are required for National Network (also known as the National Truck Network). Refer to 3.08.01G for retention or reduction of existing National Truck Network lane widths.
Refer to the Truck Operator's Map for the National Truck Network (Gold) classifications.</td></tr>
<tr><td>Design Loading Structural Capacity</td><td colspan="3">Refer to Bridge Design Manual Appendix 12.02. Design loading structural capacities are not evaluated on Construction on Existing Road (3R) projects.</td></tr>
<tr><td>Horizontal Curve Radius</td><td colspan="3">Refer to Standard Plan R-107-Series. The design speed used for a ramp vertical alignment should meet or exceed the design speed used for the ramp horizontal alignment.</td></tr>
<tr><td>Stopping Sight Distance</td><td colspan="3">Refer to 2018 7th Edition AASHTO Green Book or MDOT Sight Distance Guidelines.</td></tr>
<tr><td>Maximum Grade</td><td colspan="3">Refer to Appendix 3A.</td></tr>
<tr><td>Cross Slopes</td><td colspan="3">Traveled way: 1.5%-2%. Shoulder: 4% (6% allowed per Section 6.05.05)</td></tr>
<tr><td>Superelevation Rate</td><td colspan="3">Standard Plan R-107-Series or reduced maximum (6%) Straight Line Superelevation Chart.</td></tr>
<tr><td>Vertical Clearance</td><td colspan="3">Refer to Bridge Design Manual Chapter 7.</td></tr>
</table>

3.09.02 (revised 9-22-2025)

Design Exceptions / Design Variances

When the geometric controlling criteria are unable to be met or retained for the specific elements requiring improvement, request a Design Exception or Design Variance in accordance with Section 3.08.01E. Refer to Section 3.06 for posted speeds that have changed since the most recent reconstruction.

When requesting exceptions or variances to design elements on Heritage Routes, it is important to address the fact that the requested exception is based on historic, economic, or environmental concerns for the preservation of the natural beauty or historic nature of the facility.

Note that retaining a parabolic crown or split-plane superelevation requires a Design Exception.

3.10 (revised 9-22-2025)

NEW CONSTRUCTION AND RECONSTRUCTION CONTROLLING CRITERIA (NON-FREEWAY)

3.10.01 (revised 9-22-2025)

Geometric Controlling Criteria

The criteria present in Appendix 3A provides the minimum dimensional requirements for the geometric controlling criteria for both Non-Freeway New Construction and Reconstruction project types.

Some geometric elements may be divided into Urban and Rural areas (Refer to Section 3.02) These definitions are provided as guidance only; specific project context will be established by the Project Manager and project team.

3.10.02 (revised 9-22-2025)

Design Exceptions / Design Variances

Design Exceptions or Design Variances are required for both New Construction and Reconstruction project types whenever the design criteria in Appendix 3A cannot be met for controlling design elements. Refer to Section 3.08.01E.

3.11 (revised 9-22-2025)

ADDITIONAL NON-FREEWAY DESIGN CRITERIA

3.11.01 (revised 9-22-2025)

General

Deviation from the additional design criteria presented in this section does not require Design Exceptions and/or Design Variances, as these are not geometric controlling criteria.

A. Signing

Contact the Region/TSC Traffic and Safety Engineer to identify desirable enhancements and sign upgrading needs.

B. Evaluation of Guardrail and Bridge Railing

1. Inspect height, length, and overall condition to determine if guardrail should be upgraded.

2. Upgrade existing Type A guardrail to current standards (refer to Chapter 7) at all locations, except that Type A guardrail in good condition may be used at cul-de-sacs, "T" intersections, and in front of the opening between twin overpassing structures.

3. Upgrade blunt ends and turned down endings to current standard terminals.

4. Connect or upgrade to current standards any unconnected guardrail to bridge railing transitions.

3.11.01 (continued)

5. If existing bridge railing does not meet AASHTO static load requirements or has an unacceptable crash history, upgrade or retrofit the bridge railing with thrie-beam guardrail to current standards. (Refer to Bridge Design Manual Section 12.05 for any new railing or complete railing replacement).

6. Remove all existing Breakaway Cable Terminals (BCT). Refer to Section 7.01.41B for upgrading guardrail terminal guidelines.

C. Tree Removal

The AASHTO Roadside Design Guide presents ideal clear zone distance criteria; however, these distances are not always practical in Michigan. Consequently, consider removing trees within the clear zone subject to the following criteria:

1. Where there is evidence of vehicle tree crashes either from actual crash reports or scarring of the trees.

2. Trees in target position on the outside of curves with a radius of 3000 feet or less.

3. Trees that are obstructing adequate sight distance or are particularly vulnerable to being hit at intersections or railroads.

4. Trees that break the continuity of a generally established tree line within the clear zone.

5. Refer to Section 7.01.11B for obstacles inside the calculated project clear zone. Review crash history for need of spot or corridor improvements.

3.11.01 (continued)

General

D. Roadside Obstacles

Consider roadside improvements to enhance safety and mobility for all users. Improvements may include removal, relocation, redesign, or shielding of obstacles such as culvert headwalls, utility poles, and bridge supports that are within the clear zone as referenced in Section 3.09.03C.

Review crash history for guidance on possible treatments. Include in the project those obstacles that are specifically related to crashes or can be economically justified to reduce future risk. Consider blending ends of culverts within the clear zone into the slope. Refer to the MDOT Drainage Manual.

E. Cross Section Elements

1. For thru lanes, consider relocating the pavement crown to the standard location when the amount of resurfacing is four (4) inches or greater.

2. Consider modifying side slopes to be recoverable (1:6 preferred).

3.12 (revised 9-22-2025)

GUIDELINES FOR PASSING RELIEF LANES

A. General

The construction of Passing Relief Lanes (PRL) is not intended to connect existing multilane sections but to provide a safe opportunity to pass slower vehicles.

Contact the Geometric Design Unit to assist in project selection, location, and design.

B. Truck Climbing Lanes (TCL)

The Highway Capacity Manual (HCM) states that the presence of heavy vehicles on two-way, two-lane highway grades can cause a problem because traffic is slowed and platoons form simultaneously as passing restrictions increase.

Warranting Criteria (TCL)
(For Information Only)

Use Design Hour Volumes (DHV) to identify candidate locations. Request specific classification counts when requiring more comprehensive analysis. Consider a combination of the following in identifying the need for a TCL:

1. Upgrade traffic flow rate exceeds 200 vph.

2. Upgrade truck flow rate exceeds 20 vph.

3. One of the following conditions exists:

    a. Level of Service E or F exists on the grade.
    b. A reduction of two or more levels of service is experienced when moving from the approach segment to the grade.
    c. A typical heavy truck experiences a speed reduction of 10 mph or greater on the grade.

3.12 (continued)

GUIDELINES FOR PASSING RELIEF LANES

Location Consideration (TCL)

TCLs should be in areas:

1. On the upgrade side of "critical grades".

2. Along sections relatively free from commercial or residential development (driveways) and away from major intersections.

Design Consideration (TCL)

1. A TCL may be introduced beyond the beginning of the upgrade because the truck speed will not be reduced enough to create undesired conditions for following drivers until it has traveled a certain distance up the grade.

2. Extend TCLs beyond the crest to the point where a truck can attain a speed that is within 10 mph of the speed of other traffic and where decision sight distance is available when approaching the transition (taper) area.

3. The taper length L (feet) is approximately W×S, where W is the shift in feet and S is the posted speed in mph.

4. TCLs should be 12' wide.

5. TCL shoulders should be as wide as the shoulders on the adjacent two-lane sections but no less than 4' (3' paved). Limit 4' shoulders to areas where wider shoulders are not feasible or environmental concerns prohibit wider shoulders.

3.12 (continued)

C. Passing Lane Sections (PLS)

Passing Lane Sections (PLS) along two-way, two-lane rural routes can be desirable even in the absence of "critical grades" required for TCLs. PLSs are particularly advantageous where passing opportunities are limited because of traffic volumes with a mix of recreational vehicles and/or roadway alignment. It is preferable to have a four lane cross section for a PLS where right of way or environmental reviews permit.

Warranting Criteria (PLS)
(For Information Only)

Use design hour volumes (DHV) in identifying candidate locations. Request specific classification counts when required for comprehensive analysis. Consider a combination of the following in identifying the need for a PLS:

1. Combined recreational and commercial volumes exceed five percent of total traffic.

2. The level of service drops at least one level and is below Level B during seasonal, high-directional splits.

The two-way DHV does not exceed 1200 vph. In situations where volumes exceed 1200 vph, investigate other congestion mitigating measures.

3.12 (continued)

GUIDELINES FOR PASSING RELIEF LANES

Location Considerations (PLS)

PLSs should be in areas:

1. That can accommodate four lanes (PLS for each direction of traffic) to minimize the number of three lane sections.

2. With rolling terrain where vertical grades (even though not considered "critical grades") are present to enhance:

   a. Visibility to readily perceive both a lane addition and lane drop.

   b. Differential in speed between slow and fast traffic. This occurs on upgrade locations and produces increased passing opportunities.

   c. Slower vehicles regaining some speed before merging by continuing the PLS beyond the crest of any grade.

3. Relatively free of commercial and/or residential development (driveways) and away from major intersections.

4. Where radii of horizontal curves are greater than or equal to 1900 feet.

5. With no restrictions in width resulting from bridges or major culverts, unless structure widening is done in conjunction with PLS construction.

6. That are further than 750 feet from a railroad crossing.

7. Where directional spacing of approximately 5 miles can be maintained.

3.12 (continued)

Design Considerations (PLS)

1. The beginning and ending transition (tapers) areas of a PLS should be located where adequate decision sight distance is available in advance.

2. The added lanes should continue over the crest of any grade so that slower traffic can regain some speed before merging.

3. The taper length L (feet) is approximately W×S, where W is the shift in feet and S is the posted speed in mph.

4. PLSs should be 12' wide.

5. PLS shoulders should be as wide as the shoulders on the adjacent two-lane sections but no less than 4' (3' paved). Limit 4' shoulders to areas where wider shoulders are not feasible or environmental concerns prohibit wider shoulders.

6. The desirable minimum length of any PLS is 1 mile with an upper limit of about 1½ miles.

3.13 (revised 9-22-2025)

CONSTRUCTION ON EXISTING ROAD CONTROLLING CRITERIA (FREEWAY)

3.13.01 (revised 9-22-2025)

Geometric Controlling Criteria

The criteria in Appendix 3A provides the dimensional targets to be used for the geometric controlling criteria if existing geometrics are unable to be retained for Freeway Construction on Existing Road project types (Refer to Section 03.08.01B). Improve the necessary geometric elements; it is possible that projects may require a combination of improvements.

Some geometric elements may be divided into Urban and Rural areas (Refer to Section 3.02) These definitions are provided as guidance only; specific project context will be established by the Project Manager and project team.

3.13.02 (revised 9-22-2025)

Design Exceptions / Design Variances

When the geometric controlling criteria are unable to be met or retained for the specific elements requiring improvement, request a Design Exception or Design Variance in accordance with Section 3.08.01E. Refer to Section 3.06 for posted speeds that have changed since the most recent reconstruction.

Note that retaining a parabolic crown or split-plane superelevation requires a Design Exception.

3.14 (added 9-22-2025)

NEW CONSTRUCTION AND RECONSTRUCTION CONTROLLING CRITERIA (FREEWAY)

3.14.01

Geometric Controlling Criteria

The criteria in Appendix 3A provide the dimensional requirements to be used for the geometric controlling criteria for both Freeway New Construction and Reconstruction project types. Design criteria for freeways are established in the AASHTO publications A Policy on Design Standards Interstate System and A Policy on Geometric Design of Highways and Streets.

Use Standard Plan R-107-Series to upgrade freeway projects as directed by the AASHTO project type. When it is not possible to use Standard Plan R-107-Series, use the straight-line method on a curve-by-curve basis. Refer to Section 3.04.03. A Design Exception or Design Variance is required if neither of these options can be met.

Some geometric elements may be divided into Urban and Rural areas (Refer to Section 3.02) These definitions are provided as guidance only; specific project context will be established by the Project Manager.

3.14.02

Design Exceptions / Design Variances

Design Exceptions or Design Variances are required for both New Construction and Reconstruction project types whenever the design criteria in Appendix 3A cannot be met for controlling design elements. Refer to Section 3.08.01E.

Note that retaining a parabolic crown or split-plane superelevation requires a Design Exception.

3.15
ADDITIONAL FREEWAY DESIGN CRITERIA

3.15.01 (revised 9-22-2025)

General

Deviation from the additional design criteria presented in this section does not require Design Exceptions or Design Variances, as these are not geometric controlling criteria.

A. Signing

Contact the Region/TSC Traffic and Safety Engineer to identify desirable enhancements and sign upgrading needs.

B. Ramp Geometrics, Acceleration/Deceleration Lanes, and Taper Lengths

Analyze the need for additional lanes on the ramp terminals (both off and on) for capacity improvements and associated safety impacts with the additional lanes and with consideration for the existing intersection control method (off ramps). Check radii for adequacy. Flatten gore areas where feasible.

C. Vertical Curb

Remove vertical curb on freeway mainlines, high-speed turning roadways, and collector-distributor roads. Additionally, remove vertical curb on other ramps for a minimum distance of 200 feet from the 2’ point.

3.15.01 (continued)

D. Crown Location/Pavement Cross Slope

For thru lanes, consider relocating the pavement crown to the left edge of the outside lane when the amount of resurfacing is four inches or greater. Where less than four inches, retain the crown point but establish or maintain a 2.0% cross slope. Obtain a 2.0% cross slope by reducing thickness on the median lane; however, this may not be feasible when the entire pavement is sloped in one direction. The desirable rollover or algebraic difference between the pavement and shoulder cross slopes is six percent or less. Maximum rollover between lanes is five percent. Refer to Section 6.03.04B(1).

E. Guardrail and Concrete Barrier

Shield piers and other obstacles near the center of medians that are 70' or less in width (edge to edge) from both sides. Refer to Standard Plan R-56-Series. Shield obstacles in the median near the edge of pavements from the near side; the far side will be shielded on a case-by-case basis as determined by the Geometric Design Unit.

When it is not possible to maintain both current guardrail offsets and the required distance from shoulder hinge line to the front face of the guardrail post, the additional offset between the guardrail and pavement edge takes precedence. The shoulder width can be maximized by using longer posts and relocating the guardrail to the shoulder hinge line. Refer to Section 7.01.41D.

Included in Section 7.01.12 are guardrail types for upgrading freeways when replacing entire runs.

The need for median barrier will be reviewed with the Geometric Design Unit.

The elimination of guardrail must be considered when slopes can be economically flattened or where fixed objects can be removed or relocated outside the clear zone.

3.15.01 (continued)

F. Attenuation

Where physical conditions prohibit the use of barriers, but shielding is needed, install attenuation devices. Contact the Geometric Design Unit for attenuation design.

G. Clear Zones & Fixed Objects

Refer to Section 7.01.11 for the current clear zone criteria to be used when upgrading freeways. Shield or remove obstacles within the clear zone. Remove obstacles beyond these limits but within the recovery area as determined by the Geometric Design Unit.

H. Culvert End Treatments

Replace existing culvert ends within the clear zone on projects with sloped-end sections in accordance with the MDOT Drainage Manual.

I. Bridges

Contact the Structure Design Section in the Bureau of Bridges and Structures (BOBS) for any additional requirements.

3.16 (revised 9-22-2025)

UNDERCLEARANCES - VERTICAL CLEARANCE ANALYSIS

In addition to a Design Exception, a vertical clearance analysis is required when the minimum underclearance in Section 7.01.08 of the Bridge Design Manual is unable to be obtained for Freeway New Construction and Reconstruction project types.

3.16 (continued)

A vertical clearance analysis includes the following:

- A determination of the most effective means of obtaining the vertical clearance standard that contains:
  - A benefit/cost analysis to achieve the standard, either in full or with incremental progress.
  - The alternatives of obtaining all vertical clearances with the road project, a bridge project, or some combination of road and bridge work to meet the clearance requirements.
  - Preliminary grades for the bridge and approaches, the route under the structure, and ramps if appropriate.
- Location of existing structure foundations related to the proposed grade changes.
- Impact evaluation on existing drainage.
- Evaluation of other deficient geometric features.
- Determination of ROW needs.
- Impacts on the environment.
- Cost estimates for alternatives to meet vertical clearances.
- Proposed time frame when the remainder of vertical clearance will be achieved (rough estimate).
- Crash analysis where appropriate.
- Soils (cut and fill information) and ground water information.
- Impact on local businesses and residences.
- User costs, constructability, maintaining traffic scheme, and maintenance cost.

Complete the vertical clearance analysis as early as possible, preferably during project scoping. This information is also required if a Design Exception is submitted.

3.17 (revised 9-22-2025)

PERFORMANCE BASED-PRACTICAL DESIGN

Performance Based-Practical Design (PBPD) is a decision-making approach that uses quantitative analyses to guide decision-making through the project development process. It is the combination of Practical Design and Performance-Based Design encompassing the what (economic efficiency) and the how (performance-based, data-driven methodology), either of which is incomplete without the other.

The general premise of PBPD is that proposed improvements should be targeted and right-sized based on project specific goals and needs. This philosophy places less emphasis on strict adherence to standards and more significance on safety and mobility performance. PBPD can be utilized in every step of the project development process from planning/scoping to final design. While applicable to any project and can occur at various phases of the project development process, some projects will have limited opportunities for PBPD applications.

PBPD is a design-up philosophy that makes the necessary improvements to a roadway or structure to address specific performance issues. The goal of PBPD is to fix what is broken and to not unnecessarily spend scarce resources solely for the purpose of meeting published standards when those deficient features defined per standards and guidance are not causing safety, mobility, reliability, or similar problems. By scrutinizing each element of a project's scope relative to value, need, and urgency, a PBPD approach seeks a greater return on infrastructure investments.

3.17 (continued)

The building blocks of PBPD will be as follows:

- Safety will not be compromised.
- For Construction on Existing Road projects, the minimum design will be the existing condition.
- Project scoping should focus on addressing specific problems supported by data.
- Design solutions should focus on adherence to the project's scoping package.
- Solutions should be an optimized combination of mobility, operations, and other modes.
- Designs should be consistent with the context of the corridor.
- Designs should strive to maximize benefit and cost.

Appendix 3A
GEOMETRIC DESIGN ELEMENTS
New Construction / Reconstruction

Element		Urban	Rural			
Design Speed	**Freeway**	55 mph minimum but not less than posted speed.	The greater of posted speed, or 70 mph.			
	Non-Freeway (Arterial)	30 mph but not less than posted speed.	The greater of posted speed, or 50 mph minimum.			
	Collector Roads	Posted speed (minimum).	Posted speed (minimum).			
Lane Width	**Freeway**	12 ft.	12 ft.			
	Non-Freeway (Arterial)	12 ft. lanes are desirable and should be used where practical, especially on high-speed arterials. Where 12 ft. lanes are not practical, 11 ft. lanes are often used. Lane widths of 10 ft. may be used in more constrained areas where truck and bus volumes are relatively low, and speeds are less than 35 mph. Auxiliary lanes may be 10 –12 ft. 12 ft. lanes on the National Network (NN). Refer to 3.08.01G for retention or reduction of existing National Network lane widths.	Design Speed, (mph)	Minimum Lane Width, ft. ADT, vehicles/day Under 400	Minimum Lane Width, ft. ADT, vehicles/day 400 to 2000	Minimum Lane Width, ft. ADT, vehicles/day Over 2000
			40	10	11	12
			45	10	11	12
			50	11	11	12
			55	11	12	12
			60	11	12	12
			65	11	12	12
			70	11	12	12
			75	11	12	12
	Collector Roads	Through lanes & Auxiliary lanes, 10-12 ft. Industrial Areas 12 ft., but where right-of-way is restricted, 11 ft.	Design Speed, (mph)	Minimum Lane Width, ft. ADT, vehicles/day Under 400	Minimum Lane Width, ft. ADT, vehicles/day 400 to 2000	Minimum Lane Width, ft. ADT, vehicles/day Over 2000
		Where shoulders are used, see guidelines for Rural Collectors ☞	20	10	10	11
			25	10	10	11
			30	10	10	11
			35	10	11	11
			40	10	11	11
			45	10	11	11
			50	10	11	11
			55	11	11	11*
			60	11	11	11*
			65	11	11	11*
			*Consider using 12 ft. with substantial truck volumes or frequent agricultural equipment use.			

Appendix 3A
GEOMETRIC DESIGN ELEMENTS
New Construction / Reconstruction

<table>
<tr><th>Element</th><th></th><th colspan="6">Urban & Rural</th></tr>
<tr><td rowspan="14">Shoulder Width</td><td rowspan="4">Freeway</td><td colspan="3">Mainline</td><td colspan="3">Ramp (one lane and two lanes)</td></tr>
<tr><td colspan="2">Median</td><td>Outside</td><td colspan="2">Left</td><td>Right</td></tr>
<tr><td colspan="2">8 ft. (4ft. paved minimum)
(8 ft. paved at bridge and barrier sections)

For 6 or more lane sections (3 or more lanes directional) use 10 ft. paved minimum and consider 12 ft. paved where truck traffic exceeds 250 DDHV.</td><td>10 ft. minimum (paved)

Consider using 12 ft. paved where truck traffic exceeds 250 DDHV.</td><td colspan="2">6 ft. (4 ft. paved minimum)</td><td>8 ft. (7 ft. paved minimum)</td></tr>
<tr><td colspan="6">See Appendix 6-A for shoulder width dimensions in relation to various freeway and ramp cross section elements (edge of lane, hinge point, etc.).</td></tr>
<tr><td rowspan="6">Non-Freeway (Arterial)</td><td>Urban</td><td colspan="5">Rural</td></tr>
<tr><td rowspan="4">In those instances where sufficient right-of-way exists to include shoulders, refer to the guidance for non-freeway rural shoulders.*
☞</td><td colspan="5">Minimum paved shoulder, ft. for specified ADT, vehicles/day
Undivided Roadways*</td></tr>
<tr><td colspan="2">Under 400</td><td colspan="2">400 to 2000</td><td>Over 2000</td></tr>
<tr><td colspan="2">4</td><td colspan="2">6</td><td>8</td></tr>
<tr><td colspan="5">Use 8 ft. right and 4 ft. left for divided arterials.
Use full width (8 ft.) on both sides of divided arterials with 3 lanes in each direction.

For new construction and reconstruction and when feasible on shoulder widening, the paved shoulder is extended with 1 ft. of aggregate to the shoulder hinge for stabilization.</td></tr>
<tr><td colspan="6">A minimum 4 ft. (3 ft. paved) shoulder or curb and gutter is acceptable adjacent to right turn lanes.
* Minimum shoulder widths apply for posted speeds greater than 45 mph. At lower speeds, minimum shoulders are desirable.</td></tr>
<tr><td rowspan="4">Collector Roads</td><td colspan="2" rowspan="4">Where shoulders are used, refer to requirements for rural arterials.
☞</td><td colspan="4">Minimum shoulder, ft. for specified ADT, vehicles/day</td></tr>
<tr><td>Under 400</td><td colspan="2">400 to 2000</td><td>Over 2000</td></tr>
<tr><td>2</td><td colspan="2">4</td><td>6</td></tr>
<tr><td colspan="4">The above ranges apply on uncurbed roads and when shoulders are feasible on curbed roads. A minimum paved width of 1 ft. is desirable.</td></tr>
</table>

Appendix 3A
GEOMETRIC DESIGN ELEMENTS
New Construction / Reconstruction

Element		Urban & Rural	
Design Loading Structural Capacity (Also see Bridge Design Manual)	**Freeway**	HL93-Mod/ HS-25	
	Non-Freeway	State Trunkline	HL93-Mod/ HS-25
		Local Roads Over Freeways and State Trunkline	HL93-Mod/ HS-25
		Local Roads and Streets	Design according to county or city standards, HL93-Mod/ HL93/ HS-20 minimum.
		Use HL93-Mod/ HS-25 for all structures in an interchange regardless of route type	
Horizontal Curve Radius	**Freeway**	***See Standard Plan R-107-Series and Section 3.04.03***	
	Non-Freeway (Arterial)		
	Collector Roads		
	Non-Freeway (Arterial)		
	Collector Roads		

Appendix 3A
GEOMETRIC DESIGN ELEMENTS
New Construction / Reconstruction

Maximum Grade — Urban & Rural

Maximum Grade (%) for specified design speed (mph)

Freeway

Type of Terrain	50	55	60	65	70	75
Level	4	4	3	3	3	3
Rolling	5	5	4	4	4	4

Grades 1% steeper may be provided in urban areas.

Non-Freeway (Arterial)

Type of Terrain	Urban							Rural				
	30	35	40	45	50	55	60	40	45	50	55	60
Level	7	7	7	6	6	5	5	5	5	4	4	3
Rolling	9	8	8	7	7	6	6	6	6	5	5	4

Collector Roads

Type of Terrain	Urban									Rural								
	20	25	30	35	40	45	50	55	60	20	25	30	35	40	45	50	55	60
Level	9	9	9	9	9	8	7	7	6	7	7	7	7	7	7	6	6	5
Rolling	12	12	11	10	10	9	8	8	7	10	10	9	9	8	8	7	7	6

Element	
Stopping Sight Distance	Follow 2018 7th Edition of AASHTO “A Policy on Geometric Design of Highways and Streets” (AKA AASHTO Green Book). The MDOT Sight Distance Guidelines also provide detailed information on sight distance calculation.
Cross Slope	Traveled way cross slope = 2.0%, Paved shoulder cross slope = 4.0% (Also see Section 6.05.05)
Superelevation Rate	AASHTO Method 5 “Curvilinear Relation” is used for new construction/reconstruction. Maximum rate of 7%. (See Standard Plan R-107-Series.)
	AASHTO Method 1 “Straight Line Relation” is allowed when Method 5 is not feasible. Maximum rate of 6%. (See Section 3.04.03)
	The above methods also apply to urban freeways and urban ramps, except the maximum rate is 5% for 60 mph design speed.

Vertical Clearance

	NHS	Non NHS
Freeway	16’-0”	14’-6”
Non-Freeway (Arterial)	16’-0”	14’-6”
Collectors & “Special Routes"	14’-6” (1 ft. greater than Michigan legal vehicle height.)	14’-6”

For pedestrian bridges provide 1 ft. additional clearance over non-freeway and 17 ft. minimum under clearance over freeways. A vertical clearance of 23’-0” is required for grade separations over railroads. *(See Bridge Design Manual 7.01.08 and Bridge Design Guides 5.24.03-04.)*

Appendix 3B National Network – Federally-Designated Routes

Route	From	To
I-75 Conn	US 24BR Pontiac	I-75.
US 2	WI State Line Ironwood	WI State Line S. of Crystal Falls.
US 2	WI State Line Iron Mountain	I-75 St. Ignace.
US 8	US 2 Norway	WI State Line.
US 10	Ludington	I-75 Bay City.
US 12	IN State Line	I-94 W. Jct. Ypsilanti.
US 23	OH State Line	I-75 Mackinaw City.
US 24	OH State Line	MI 15 Waterford.
US 24BR	US 24 S. of Pontiac	MI 1 Pontiac.
US 27	IN State Line	I-75 S. of Grayling.
US 31	IN State Line	I-75 Mackinaw City.
US 33	IN State Line	US 12 Niles.
US 41	WI State Line	Houghton.
US 45	WI State Line	MI 26 Rockland.
US 127	OH State Line	I-69/US 27 N. of Lansing.
US 131	IN State Line	US 31 Petoskey.
US 141	WI State Line S. of Crystal Falls	US 41/MI 28.
US 223	US 23	US 12/127 Somerset.

Appendix 3B National Network – Federally-Designated Route (continued)

Route	From	To
MI 10	I-375 Detroit	Orchard Lake Road.
MI 13	I-69 Lennon	I-75 Saginaw (via MI 81).
MI 13	I-75 Kawkawlin (via I-75 Conn.)	US 23 Standish.
MI 14	I-94 Ann Arbor	I-96/275 Plymouth.
MI 15	US 24 Clarkston	MI 25 Bay City.
MI 18	US 10	MI 61 Gladwin.
MI 20	US 31 New Era	MI 37 White Cloud.
MI 20	US 27 Mt. Pleasant	US 10 Midland.
MI 21	I-96 near Grand Rapids	I-69 Flint.
MI 24	I-75 Auburn Hills (via I-75 Conn.)	I-69 Lapeer.
MI 24	MI 46	MI 81 Caro.
MI 26	US 45 Rockland	MI 38.
MI 27	I-75	US 23 Cheboygan.
MI 28	US 2 Wakefield	I-75.
MI 32	Hillman	Alpena.
MI 33	Mio	Fairview.
MI 35	US 2/41 Escanaba	US 2/41 Gladstone.
MI 36	US 127 Mason	Dansville.

Appendix 3B National Network – Federally-Designated Route (continued)

Route	From	To
MI 37	MI 55	US 31/MI 72 Traverse City.
MI 37	I-96 Grand Rapids	MI 46 Kent City.
MI 38	US 45 Ontonagon	US 41 Baraga.
MI 39	I-75 Lincoln Park	MI 10 Southfield.
MI 40	MI 89 Allegan	US 31BR/I-196BL Holland.
MI 43	MI 37 Hastings	US 127 Lansing.
MI 46	US 131 Howard City	MI 25 Port Sanilac.
MI 47	I-675 Saginaw (via MI 58)	US 10.
MI 50	MI 43/66 Woodbury	MI 99 Eaton Rapids.
MI 50	US 127 S. Jct	I-75 Monroe.
MI 51	US 12 Niles	I-94.
MI 52	OH State Line	US 12 Clinton.
MI 52	I-96 Webberville	MI 46 W. of Saginaw.
MI 53	MI 3 Detroit	MI 25 Port Austin.
MI 55	US 31 Manistee	I-75.
MI 55	MI 65	US 23 Tawas City.
MI 57	US 131 N. of Rockford	US 27.
MI 57	MI 52 Chesaning	I-75 Clio.
MI 59	US 24 BR Pontiac	I-94.

Appendix 3B National Network – Federally-Designated Route (continued)

Route	From	To
MI 60	MI 62 Cassopolis	I-69/US 27.
MI 61	MI 115	US 27 Harrison.
MI 61	MI 18 Gladwin	US 23 Standish.
MI 63	US 31 Scottdale	I-196.
MI 65	US 23 Omer	MI 55.
MI 65	MI 72 Curran	MI 32.
MI 65	Posen	US 23 N. of Posen.
MI 66	IN State Line	US 12 Sturgis.
MI 66	Battle Creek	MI 78.
MI 66	MI 43/50 Woodbury	MI 46 Edmore.
MI 67	US 41 Trenary	MI 94 Chatham.
MI 68	US 31/131 Petoskey	US 23 Rogers City.
MI 69	US 2/141 Crystal Falls	MI 95 Sagola.
MI 72	US 31/MI 37 Traverse City	US 23 Harrisville.
MI 77	US 2	MI 28 Seney.
MI 78	MI 66	I-69 Olivet.
MI 81	MI 24 Caro	MI 53.
MI 82	MI 37 S. Jct. Newago	US 131.

Appendix 3B National Network – Federally-Designated Route (continued)

Route	From	To
MI 83	Frankenmuth	I-75.
MI 84	I-75	MI 25 Bay City.
MI 89	MI 40 Allegan	US 131.
MI 94	US 41	MI 28 Munising.
MI 95	US 2 Iron Mountain	US 41/MI 28.
MI 104	US 31 Grand Haven	I-96.
MI 115	US 27	MI 22 Frankfort.
MI 117	US 2 Engadine	MI 28.
MI 123	I-75 N. of St. Ignace	MI 28.
MI 142	MI 25 Bay Port	MI 53.
MI 205	IN State Line	US 12 W. of Union.