APPENDIX A- METRIC VALUES FOR STANDARDS

This section provides the corresponding standard values in metric units for the critical design elements stated in Section M2.7. There are technical discrepancies between the metric and U.S. customary values in AASHTO’s *A Policy on Geometric Design of Highways and Streets*. Guidance on this issue is provided in Section M2.8.2 of this chapter.

M2.7.1 Interstates and Other Freeways

M2.7.1.1 Interstates

The design criteria for interstate highways are detailed in sections A to P below.

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section M5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Area Character</th>
<th>Terrain</th>
<th>Minimum Design Speed (km/h)</th>
<th>Maximum Design Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Level</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Rural</td>
<td>Rolling</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Rural</td>
<td>Mountainous</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Urban</td>
<td>All</td>
<td>80</td>
<td>110</td>
</tr>
</tbody>
</table>

* For consistency with adjacent sections and anticipated off-peak 85th percentile speeds higher than the maximum values tabulated above, a 120 km/h maximum speed may be used for rural (level & rolling) freeways and a 110 km/h maximum speed may be used for rural mountainous freeways.

B. Lane Width

Travel lanes = 3.6 m minimum.

C. Shoulder Width

Determine from Exhibit M2-2.

D. Bridge Roadway Width
DESIGN CRITERIA

Determine from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Determine maximum from Exhibit M2-2.

F. Horizontal Curvature

Determine minimum radius from Exhibit M2-2. For curves flatter than the minimum radius, the radius and superelevation on each horizontal curve shall be correlated with the design speed in accordance with the appropriate \( e_{\text{max}} \) table (Exhibit M2-13 for \( e_{\text{max}} = 6\% \) or Exhibit M2-14 for \( e_{\text{max}} = 8\% \)).

G. Superelevation

8% maximum. A 6% maximum may be used in urban and suburban areas to minimize the effect of negative side friction during peak periods with low travel speeds.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum distances from Exhibit M2-2.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the edge of traveled way) is 4.6 m where no barrier is provided. Where barrier is provided, the minimum is the greater of the shoulder width or 1.2 m, except:

- On bridges where the NYSDOT Bridge Manual, Section 2 allows less than 1.2 m.
- In depressed sections where the minimum is the shoulder width plus 0.6 m.

J. Vertical Clearance

Determine minimum from NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope
DESIGN CRITERIA

Travel lanes = 1.5% minimum to 2% maximum.

L. Rollover

Between travel lanes = 4% maximum. At edge of traveled way = 8% maximum. When the superelevation rate exceeds 6%, a maximum rollover rate of 10% at the edge of traveled way may be permitted. Refer to Chapter 3, Section 3.2.5.1 Shoulder Cross Slopes and Rollover Limitations of this manual for further guidance.

M. Structural Capacity

Determine from NYSDOT Bridge Manual, Section 2.

N. Level of Service (LOS)

A minimum of four traffic lanes shall be provided on the Interstate System. The number of lanes shall be sufficient to accommodate the selected DDHV (directional design hourly volume) at an acceptable level of service as listed below, and shall be determined on the basis of design year volumes. On ascending grades which exceed the critical design length, a climbing lane analysis shall be made in accordance with TRB’s Highway Capacity Manual, and AASHTO’s A Policy on Geometric Design of Highways and Streets, and climbing lanes added where warranted.

The following levels of service are the criteria for interstates:

| Rural, level terrain | LOS = B minimum |
| Rural, rolling terrain | LOS = B minimum |
| Rural, mountainous terrain | LOS = C minimum |
| Urban and suburban * | LOS = C minimum |

* **Note:** In heavily developed sections of metropolitan areas, conditions may necessitate LOS = D minimum. Scoping and design approval documents should include documentation of the heavily developed metropolitan area conditions.

Some interstate projects, especially in urban areas, will provide levels of service below those shown above due to social, economic, and environmental and/or policy/intergovernmental decisions during project scoping and design. Such decisions for lesser levels of service should be made in accordance with National Environmental Policy Act (NEPA) and/or State Environmental Quality Review Act (SEQR) procedures and, where applicable, with the Major Metropolitan Transportation Investment process. These decisions should be supported and documented in the design approval documents.

O. Control of Access

Access to the interstate system shall be fully controlled. Access is to be achieved by

7/30/2010
interchanges at selected public highways. Access control shall extend the full length of ramps and terminals on the crossroad. Such control shall either be acquired outright prior to construction or by the construction of frontage roads or by a combination of both.

Control for connections to the crossroad should be provided beyond the ramp terminals by purchasing access rights or providing frontage roads. Such control should extend beyond the ramp terminal at least 30 m in urban areas and 90 m in rural areas (see Chapter 6 of this manual for more specific details).

The interstate highway shall be grade separated at all railroad crossings and selected public crossroads. All at-grade intersections of public highways shall be eliminated. To accomplish this the connecting roads are to be terminated, rerouted, or intercepted by frontage roads.

P. Median Width

Medians in rural areas in level or rolling terrain shall be at least 11.0 m wide and desirably 15 m to 30 m wide. Medians in mountainous terrain or in urban areas shall be at least 3.0 m wide.

M2.7.1.2 Other Freeways

The design criteria for freeways other than interstates are the same as Section M2.7.1.1 Interstates with the exception that Section M2.7.1.1N Level of Service is not a critical design element. Level of service for other freeways should be included as an Other Design Parameter. When the LOS is not met, it should be addressed as a nonconforming feature per Chapter 5, Section 5.1 of this manual.
Exhibit M2-2  Design Criteria for Interstates and Other Freeways

### Shoulders

<table>
<thead>
<tr>
<th>Description</th>
<th>Width, m</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Desirable 3</td>
<td></td>
</tr>
<tr>
<td><strong>Right side:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>3.0</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>In mountainous terrain involving high cost for additional width</td>
<td>2.4</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>For noninterstate parkways that exclude truck and bus traffic</td>
<td>2.4</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Where trucks exceed 250 DDHV (directional design hourly volume)</td>
<td>3.0</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td><strong>Left side:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>For interstates of six or more lanes</td>
<td>1.2</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>For interstates of six or more lanes where trucks exceed 250 DDHV</td>
<td>1.2</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>

### Maximum Percent Grade

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Level 2</th>
<th>Rolling 2</th>
<th>Mountainous</th>
<th>Minimum Stopping Sight Distance, m</th>
<th>Minimum Radius Curve, m $e_{\text{max}} = 6%$</th>
<th>Minimum Radius Curve, m $e_{\text{max}} = 8%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>130</td>
<td>252</td>
<td>229</td>
</tr>
<tr>
<td>90</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>160</td>
<td>336</td>
<td>304</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>185</td>
<td>437</td>
<td>394</td>
</tr>
<tr>
<td>110</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>220</td>
<td>560</td>
<td>501</td>
</tr>
<tr>
<td>120</td>
<td>3</td>
<td>4</td>
<td>-</td>
<td>250</td>
<td>756</td>
<td>667</td>
</tr>
</tbody>
</table>

**Notes:**
1. For bridges, determine the shoulder width from the NYSDOT Bridge Manual, Section 2.
2. Grades 1% steeper may be used for one-way downgrades and for extreme cases in urban areas where development precludes the use of flatter grades.
3. For shoulder widths of 10 ft. or less, an additional 2 ft. is desirable where barrier is used.
M2.7.2 Arterials

M2.7.2.1 Rural Arterials

The design criteria for undivided and divided rural arterials are:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Terrain</th>
<th>Minimum Design Speed</th>
<th>Maximum Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>60 km/h</td>
<td>100 km/h</td>
</tr>
<tr>
<td>Rolling</td>
<td>60 km/h</td>
<td>100 km/h</td>
</tr>
<tr>
<td>Mountainous</td>
<td>60 km/h</td>
<td>80 km/h</td>
</tr>
</tbody>
</table>

B. Lane Width

Determine from Exhibit M2-3.

C. Shoulder Width

Determine from Exhibit M2-3.

D. Bridge Roadway Width

Determine from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Determine maximum from Exhibit M2-3.
F. Horizontal Curvature

Determine minimum radius from Exhibit M2-3. For curves flatter than the minimum radius, the radius and superelevation on each horizontal curve shall be correlated with the design speed in accordance with the appropriate $e_{\text{max}}$ table (Exhibit M2-13 for $e_{\text{max}} = 6\%$ or Exhibit M2-14 for $e_{\text{max}} = 8\%$).

G. Superelevation

8% maximum. A 6% maximum may be used in suburban areas to minimize the effect of negative side friction during peak periods with low travel speeds.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum distances from Exhibit M2-3.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the edge of traveled way) is 3.0 m where no barrier is provided. Where barrier is provided, the minimum is the greater of the shoulder width or 1.2 m, except:

- On bridges where the NYSDOT Bridge Manual, Section 2 allows less than 1.2 m.

J. Vertical Clearance

Determine minimum from NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope

1.5% minimum to 2% maximum.

L. Rollover

Between travel lanes = 4% maximum.

At edge of traveled way = 8% maximum. When the superelevation rate exceeds 6%, a maximum rollover rate of 10% at the edge of traveled way may be permitted. Refer to Chapter 3, Section 3.2.5.1 Shoulder Cross Slopes and Rollover Limitations of this manual for further guidance.
M. Structural Capacity

Determine from NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodation

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.

O. Median Width (only for multilane, divided, rural arterials)

Median = 1.2 m minimum without left turn lanes. Where left turn lanes are provided, the median = 3.6 m minimum (3.0 m left turn lane with 0.6 m median separation).
### Exhibit M2-3  Design Criteria for Rural Arterials

<table>
<thead>
<tr>
<th>Design speed (km/h)</th>
<th>Travel Lane Width (m)</th>
<th>Maximum % Grade</th>
<th>Min. Stopping Sight Distance (m)</th>
<th>Min. Radius Curve (m) $e_{\text{max}}=6%$</th>
<th>Min. Radius Curve (m) $e_{\text{max}}=8%$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADT Under 400</td>
<td>ADT 400 to 1500</td>
<td>ADT 1500 to 2000</td>
<td>ADT over 2000</td>
<td>Level</td>
</tr>
<tr>
<td>60</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>5</td>
</tr>
<tr>
<td>70</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>5</td>
</tr>
<tr>
<td>80</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>3.6</td>
<td>4</td>
</tr>
<tr>
<td>90</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>3.6</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
<td>3</td>
</tr>
<tr>
<td>110</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
<td>3</td>
</tr>
</tbody>
</table>

### Shoulder Width (m)³

<table>
<thead>
<tr>
<th></th>
<th>Un-divided (right shoulder)</th>
<th>Divided</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Width of travel lane may remain 3.3 m on reconstructed highways where accident history is satisfactory and the route is not designated as a Qualifying Highway.
2. Routes designated as Qualifying Highways on the national network of Designated Truck Access Highways require 3.6 m travel lanes.
3. For bridges, determine the lane and shoulder width from the NYSDOT Bridge Manual, Section 2.
4. For turning lanes, use Exhibit M2-4 of this chapter.
5. Refer to Section M2.6.17 of this chapter for a definition of divided.
M2.7.2.2 Urban Arterials
The design criteria for urban arterials are:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Area Character</th>
<th>Minimum Design Speed</th>
<th>Maximum Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban and Developing Areas</td>
<td>60 km/h</td>
<td>100 km/h</td>
</tr>
<tr>
<td>Central Business District</td>
<td>50 km/h</td>
<td>100 km/h</td>
</tr>
</tbody>
</table>

B. Lane Width

Determine from Exhibit M2-4.

C. Shoulder Width

Determine from Exhibit M2-4.

D. Bridge Roadway Width

Determine from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Determine maximum from Exhibit M2-4.
F. Horizontal Curvature

Determine minimum radius from Exhibit M2-4. For curves with radii larger than the minimum radius, the radius of curve and superelevation on each horizontal curve shall be correlated with the design speed in accordance with Exhibit M2-12 for $e_{\text{max}} = 4\%$. The superelevation distribution in this table provides a gradual increase in the unresolved lateral forces on a vehicle as the curve radii decreases. This distribution of superelevation is based on Method 5 in Chapter III of AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2004.

For low-speed (70 km/h and below) urban streets in heavily built-up residential, commercial, and industrial areas (where building fronts, drainage, sidewalks, or driveways would be substantially impacted by added superelevation), the use of superelevation can be minimized by placing greater reliance on side friction to counter lateral acceleration. This distribution of superelevation is based on Method 2 in Chapter 3 of AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2004. Below are the minimum radii at 4% superelevation using this method.

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Minimum Curve Radius ($e_{\text{max}} = 4%$) (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>50</td>
<td>86</td>
</tr>
<tr>
<td>60</td>
<td>135</td>
</tr>
<tr>
<td>70</td>
<td>203</td>
</tr>
</tbody>
</table>

For radii larger than the above minimum radius for $e_{\text{max}} = 4\%$, determine the superelevation rate using Exhibit M2-11.

G. Superelevation

4% maximum.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum and desirable from Exhibit M2-4.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the face of curb) is 0 m if barrier is provided, 0.5 m in areas without barrier, and 1 m at intersections.

J. Vertical Clearance

Determine minimum from NYSDOT Bridge Manual, Section 2.
K. Travel Lane Cross Slope

Travel lanes = 1.5% minimum to 2% maximum.

Parking lanes = 1.5% minimum to 5% maximum.

L. Rollover

Between travel lanes = 4% maximum.
At edge of traveled way = 8% maximum.

M. Structural Capacity

Determine from the NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodations

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.
### Exhibit M2-4  Design Criteria for Urban Arterials

**Lanes**

<table>
<thead>
<tr>
<th></th>
<th>Width (m)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Desirable</td>
<td></td>
</tr>
<tr>
<td>Travel Lanes -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low speed (&lt;80 km/h)</td>
<td>3.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>High speed (&gt;80 km/h)</td>
<td>3.6</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>For highly restricted areas with no or little truck traffic (0 to 2%)</td>
<td>3.0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Routes designated as Qualifying Highways on the national network of Designated Truck Access Highways</td>
<td>3.6</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Wide travel lane adjacent to curbing or parking lane to accommodate bicyclists in low-speed segments</td>
<td>3.6</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning Lanes -</td>
<td>Maximum</td>
<td>Desirable</td>
<td></td>
</tr>
<tr>
<td>Left and Right, Truck volume, ≤ 2%</td>
<td>3.0</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Left and Right, Truck volume &gt; 2%</td>
<td>3.3</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Two-way left-turn lanes</td>
<td>3.3</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking Lanes -</td>
<td>Minimum</td>
<td>Desirable</td>
<td></td>
</tr>
<tr>
<td>Future provision for travel lane</td>
<td>3.3</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Future provision for turn lanes</td>
<td>3.0</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Future provision for turn lane on 60 km/h or less arterial</td>
<td>2.7</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>No future provisions for turn lanes</td>
<td>2.4</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulders<strong>1</strong></td>
<td>Width (m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curbed -</td>
<td>Maximum</td>
<td>Desirable</td>
<td></td>
</tr>
<tr>
<td>Left shoulder for divided arterials</td>
<td>0</td>
<td>0.3 - 0.6</td>
<td></td>
</tr>
<tr>
<td>Right shoulder for bicycling, lateral offset, etc.</td>
<td>1.5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Right shoulder for breakdowns and turning movements in addition to bicycling, lateral offset, etc.</td>
<td>1.8</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Uncurbed -</td>
<td>Refer to Exhibit M2-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. For bridges, determine lane and shoulder width from NYSDOT Bridge Manual, Section 2.
2. Wide travel lanes may be used in low-speed segments. Refer to Chapter 17 of this manual for bicycle accommodations. Note that bicyclists have the same rights and responsibilities as motorists except as provided in Sections 1230 - 1236 of the New York State Vehicle and Traffic Law. A 0 to 1.2 m minimum shoulder may be used where a wide outside travel lane (3.6 m minimum) or separate provisions (e.g., multiuse path) are provided.
M2.7.3 Collector Roads and Streets

M2.7.3.1 Rural Collectors

The design criteria for rural collectors are:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Range of Design Speeds (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design Year ADT</td>
</tr>
<tr>
<td></td>
<td>0 to 400</td>
</tr>
<tr>
<td>Level</td>
<td>60 - 100</td>
</tr>
<tr>
<td>Rolling</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Mountainous</td>
<td>30 - 100</td>
</tr>
</tbody>
</table>

B. Lane Width
Determine minimum from Exhibit M2-5.

C. Shoulder Width
Determine minimum from Exhibit M2-5.

D. Bridge Roadway Width
Determine minimum from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade
Determine maximum from Exhibit M2-5.
F. Horizontal Curvature
Determine minimum radius from Exhibit M2-5. For curves flatter than the minimum radius, the radius and superelevation on each horizontal curve shall be correlated with the design speed in accordance with the appropriate $e_{\text{max}}$ table (Exhibit M2-13 for $e_{\text{max}} = 6\%$ or Exhibit M2-14 for $e_{\text{max}} = 8\%$).

G. Superelevation
8% maximum. A 6% maximum may be used in suburban areas to minimize the effect of negative side friction during peak periods with low travel speeds.

H. Stopping Sight Distance (Horizontal and Vertical)
Determine minimum distances from Exhibit M2-5.

I. Horizontal Clearance
The minimum horizontal clearance to obstructions (measured from the edge of traveled way) is 3.0 m where no barrier is provided. Where barrier is provided, the minimum is the greater of the shoulder width or 1.2 m, except:

- On bridges where the NYSDOT Bridge Manual, Section 2 allows less than 1.2 m.

J. Vertical Clearance
Determine minimum from the NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope
Travel lanes = 1.5% minimum to 2% maximum.

L. Rollover
Between travel lanes = 4% maximum.
At edge of traveled way = 8% maximum. When the superelevation rate exceeds 6%, a maximum rollover rate of 10% at the edge of traveled way may be permitted. Refer to Chapter 3, Section 3.2.5.1 Shoulder Cross Slopes and Rollover Limitations of this manual for further guidance.

M. Structural Capacity
Determine from the NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodations
To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.
## Exhibit M2-5  Design Criteria for Rural Collectors

### Design Speed (km/h)

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Travel Lane Width (m)</th>
<th>Turn Lane (m)</th>
<th>Maximum Percent Grade</th>
<th>Min. Stopping Sight Distance (m)</th>
<th>Min. Radius Curve (m) (e_{max}=6%)</th>
<th>Min. Radius Curve (m) (e_{max}=8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADT Under 400</td>
<td>ADT 400 to 1500</td>
<td>ADT 1500 to 2000</td>
<td>Min. Des. Level</td>
<td>Rolling</td>
<td>Mountainous</td>
</tr>
<tr>
<td>30</td>
<td>3.0⁴</td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>3.0⁴</td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>50</td>
<td>3.0⁴</td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>60</td>
<td>3.0⁴</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>70</td>
<td>3.0⁴</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>80</td>
<td>3.0⁴</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>90</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>3.6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>100</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6</td>
<td>3.6</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

### Shoulder Width (m)

<table>
<thead>
<tr>
<th>Shoulder Width (m)</th>
<th>All Speeds</th>
<th>0.6⁵</th>
<th>1.5⁶</th>
<th>1.8</th>
<th>2.4</th>
</tr>
</thead>
</table>

**Notes:**

1. Routes designated as Qualifying Highways on the national network of Designated Truck Access Highways require 3.6 m travel lanes.
2. Short lengths of grade in rural areas, such as grades less than 150 m in length, one-way downgrades, and grades on low-volume (<1500 vpd) rural collectors may be up to 2% steeper than the grades shown above.
3. 3.3 m lanes may be retained where accident rates are acceptable.
4. 2.7 m lanes may be used for design volumes under 250 vpd.
5. Minimum width is 1.2 m if roadside barrier is utilized. 1.2 m shoulder is desirable if the shoulder is intended for occasional pedestrian and/or bicycle use.
6. Shoulder width may be reduced to 1.2 m for design speeds of 60 km/h to 100 km/h.
7. For bridges, determine the shoulder width from the NYSDOT Bridge Manual, Section 2.
M2.7.3.2 Urban Collectors

The design criteria for urban collectors are:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 km/h</td>
<td>100 km/h</td>
</tr>
</tbody>
</table>

B. Lane Width

Determine minimum from Exhibit M2-6.

C. Shoulder Width

Determine minimum from Exhibit M2-6.

D. Bridge Roadway Width

Determine minimum from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Determine maximum from Exhibit M2-6.

F. Horizontal Curvature

Determine minimum radius from Exhibit M2-6. For curves with radii larger than the minimum radius, the radius of curve and superelevation on each horizontal curve shall be correlated with the design speed in accordance with Exhibit M2-12 for $e_{\text{max}} = 4\%$ table. The superelevation distribution in this table provides a gradual increase in the unresolved lateral forces on a vehicle as the curve radii decreases, with a bias that minimizes the unresolved lateral forces on a vehicle as for curves with large radii. This distribution of superelevation is based on Method 5 in Chapter 3 of AASHTO’s *A Policy on Geometric Design of Highways and Streets, 2004*. 
DESIGN CRITERIA

For low-speed (≤70 km/h) urban streets in heavily built-up residential, commercial, and industrial areas (where building fronts, drainage, sidewalks, or driveways would be substantially impacted by added superelevation), the use of superelevation can be minimized by placing greater reliance on side friction to counter lateral acceleration. This distribution of superelevation is based on Method 2 in Chapter 3 of AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2004. Below are the minimum radii at 4% superelevation using this method.

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Minimum Curve Radius (e_{max} = 4%) (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>50</td>
<td>86</td>
</tr>
<tr>
<td>60</td>
<td>135</td>
</tr>
<tr>
<td>70</td>
<td>203</td>
</tr>
</tbody>
</table>

For radii larger than the above minimum radius for $e_{max} = 4\%$, determine the superelevation rate using Exhibit M2-11.

G. Superelevation

4% maximum.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum from Exhibit M2-6.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the face of curb) is 0 m if barrier is provided, 0.5 m in areas without barrier, and 1 m at intersections.

J. Vertical Clearance

Determine minimum from the NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope

Travel lanes = 1.5% minimum to 2% maximum.

Parking lanes = 1.5% minimum to 5% maximum.

L. Rollover

Between travel lanes = 4% maximum.

At edge of traveled way = 8% maximum.
M. Structural Capacity

Determine from the NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodations

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.
Exhibit M2-6  Design Criteria for Urban Collectors

<table>
<thead>
<tr>
<th>Lanes 1,4</th>
<th>Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Lanes (curbed) -</td>
<td>Minimum</td>
</tr>
<tr>
<td>Residential &amp; Commercial</td>
<td>3.0 m</td>
</tr>
<tr>
<td>Industrial areas without severe ROW limitations</td>
<td>3.6</td>
</tr>
<tr>
<td>Industrial areas with severe ROW limitations</td>
<td>3.3</td>
</tr>
<tr>
<td>Wide travel lane adjacent to curbing or parking lane to accommodate bicyclists in low-speed segments</td>
<td>3.6</td>
</tr>
<tr>
<td>Travel Lanes (uncurbed)</td>
<td>Refer to Exhibit M2-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turning Lanes -</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck volume ≤ 2%</td>
<td>3.0</td>
</tr>
<tr>
<td>Truck volume &gt; 2%</td>
<td>3.3</td>
</tr>
<tr>
<td>Two-way left-turn lanes (trucks ≤ 2%)</td>
<td>3.0</td>
</tr>
<tr>
<td>Two-way left-turn lanes (trucks &gt; 2%)</td>
<td>3.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parking Lanes -</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial / Industrial</td>
<td>2.4</td>
</tr>
<tr>
<td>Residential</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shoulders 2</th>
<th>Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curbed -</td>
<td>Minimum</td>
</tr>
<tr>
<td>Left shoulder for divided urban collectors</td>
<td>0</td>
</tr>
<tr>
<td>Right shoulder for bicycling, lateral offset, etc. 2</td>
<td>1.5</td>
</tr>
<tr>
<td>Right shoulder for breakdowns and turning movements in addition to bicycling, lateral offset, etc.</td>
<td>1.8</td>
</tr>
<tr>
<td>Uncurbed</td>
<td>Refer to Exhibit M2-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Maximum Percent Grade 3</th>
<th>Minimum Stopping Sight Distance (m)</th>
<th>Minimum Radius Curve (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>Rolling</td>
<td>Mountainous</td>
</tr>
<tr>
<td>50</td>
<td>9</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>60</td>
<td>9</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>70</td>
<td>8</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>80</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>90</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>6</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Notes:
1. For bridges determine the lane and shoulder width from the NYSDOT Bridge Manual, Section 2.
2. Wide travel lanes may be used on low speed (< 70 km/h) urban collectors. Refer to Chapter 17 of this manual for bicycle accommodations. Note that bicyclists have the same rights and responsibilities as motorists except as provided in Sections 1230 - 1236 of the New York State Vehicle and Traffic Law. A 0 to 1.2 m minimum shoulder may be used where a wide outside travel lane (3.6 m minimum) or separate provisions (e.g., multiuse path) are provided.
3. Maximum grades of short length (less than 150 m) and on one-way down grades may be 2% steeper.
4. Routes designated as Qualifying Highways on the national network of Designated Truck Access Highways require 3.6 m travel lanes.
M2.7.4 Local Roads and Streets

M2.7.4.1 Local Rural Roads

The design criteria for local rural roads are as follows:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85th percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Design Year ADT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under 50</td>
</tr>
<tr>
<td>Level</td>
<td>50 – 90</td>
</tr>
<tr>
<td>Rolling</td>
<td>30 – 90</td>
</tr>
<tr>
<td>Mountainous</td>
<td>30 – 90</td>
</tr>
</tbody>
</table>

B. Lane Width

Determine minimum from Exhibit M2-7.

C. Shoulder Width

Determine minimum from Exhibit M2-7.

D. Bridge Roadway Width

Determine minimum from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Determine maximum from Exhibit M2-7.
F. Horizontal Curvature

Determine minimum radius from Exhibit M2-7. For curves flatter than the minimum radius, the radius and superelevation on each horizontal curve shall be correlated with the design speed in accordance with the appropriate \( e_{\text{max}} \) table (Exhibit M2-13 for \( e_{\text{max}} = 6\% \) or Exhibit M2-14 for \( e_{\text{max}} = 8\% \)).

G. Superelevation

8% maximum. A 6% maximum may be used in suburban and developing areas to minimize the effect of negative side friction during peak periods with low travel speeds.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum and desirable from Exhibit M2-7.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the edge of traveled way) is:

<table>
<thead>
<tr>
<th>Without Barrier</th>
<th>With Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 m</td>
<td>The greater of the Shoulder width or 1.2 m, except on bridges where the NYSDOT Bridge Manual, Section 2 allows less than 1.2 m.</td>
</tr>
<tr>
<td>for low-speed (( \leq 70 ) km/h) segments</td>
<td></td>
</tr>
<tr>
<td>3.0 m</td>
<td>For high-speed (( \geq 80 ) km/h) segments</td>
</tr>
<tr>
<td>for high-speed (( \geq 80 ) km/h) segments</td>
<td></td>
</tr>
</tbody>
</table>

J. Vertical Clearance

Determine minimum from the NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope

Travel lanes = 1.5% minimum to 2% maximum.

L. Rollover

Between travel lanes = 4% maximum.

At edge of traveled way = 8% maximum. When the superelevation rate exceeds 6%, a maximum rollover rate of 10% at the edge of traveled way may be permitted. Refer to Chapter 3, Section 3.2.5.1 Shoulder Cross Slopes and Rollover Limitations of this manual for further guidance.

M. Structural Capacity

Determine from the NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodations

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.
## DESIGN CRITERIA

### Exhibit M2-7  Design Criteria for Local Rural Roads

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Travel Lane Widths (m) Based on Design Year ADT</th>
<th>Turn Lane (m)</th>
<th>Max. Percent Grade</th>
<th>Minimum Stopping Sight Distance (m)</th>
<th>Minimum Radius Curve (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADT under 400</td>
<td>ADT 400 - 1500</td>
<td>ADT 1500 to 2000</td>
<td>ADT 2000 &amp; Over</td>
<td>Min.</td>
</tr>
<tr>
<td>30</td>
<td>2.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>8</td>
</tr>
<tr>
<td>40</td>
<td>2.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>7</td>
</tr>
<tr>
<td>50</td>
<td>2.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>7</td>
</tr>
<tr>
<td>60</td>
<td>2.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>7</td>
</tr>
<tr>
<td>70</td>
<td>3.0</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td>3.0</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>6</td>
</tr>
<tr>
<td>90</td>
<td>3.3</td>
<td>3.3</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3.6&lt;sup&gt;4&lt;/sup&gt;</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For bridges determine the lane and shoulder width from the NYSDOT Bridge Manual, Section 2.</td>
</tr>
<tr>
<td>2. Minimum travel lane width is 3.0 m for routes designated as Access Highways and for routes within 1.6 km of Qualifying Highways on the national network of Designated Truck Access Highways.</td>
</tr>
<tr>
<td>3. For roads in mountainous terrain with design volume of 400 to 600 ADT, use 2.7 m lanes (except when note 2 applies).</td>
</tr>
<tr>
<td>4. Lanes - 3.3 m lanes may remain where accident history is acceptable.</td>
</tr>
<tr>
<td>5. Minimum width is 1.2 m if roadside barrier is used on low-volume roads.</td>
</tr>
<tr>
<td>6. For roads in mountainous terrain with design volume of 400 to 600 ADT, use 0.6 m shoulders.</td>
</tr>
<tr>
<td>7. Shoulder may be 1.2 m where speeds are &gt; 60 km/h (i.e. shoulder adjusted to achieve a minimum roadway width of 9 m).</td>
</tr>
</tbody>
</table>

### Width of Shoulder (m)<sup>1</sup>

| All Speeds | 0.6<sup>5</sup> | 1.5<sup>6,7</sup> | 1.8 | 2.4 |

---

<sup>1</sup> Minimum width is 1.2 m if roadside barrier is used on low-volume roads.

---

<sup>2</sup> For bridges determine the lane and shoulder width from the NYSDOT Bridge Manual, Section 2.

<sup>3</sup> Minimum travel lane width is 3.0 m for routes designated as Access Highways and for routes within 1.6 km of Qualifying Highways on the national network of Designated Truck Access Highways.

<sup>4</sup> For roads in mountainous terrain with design volume of 400 to 600 ADT, use 2.7 m lanes (except when note 2 applies).

<sup>5</sup> Lanes - 3.3 m lanes may remain where accident history is acceptable.

<sup>6</sup> Minimum width is 1.2 m if roadside barrier is used on low-volume roads.

<sup>7</sup> For roads in mountainous terrain with design volume of 400 to 600 ADT, use 0.6 m shoulders.

<sup>8</sup> Shoulder may be 1.2 m where speeds are > 60 km/h (i.e. shoulder adjusted to achieve a minimum roadway width of 9 m).
M2.7.4.2 Local Urban Streets

The design criteria for local urban streets are:

A. Design Speed

The design speed is either: maximum functional class speed or a speed based on the anticipated (post-construction) off-peak 85th percentile speed within the range of functional class speeds as shown below. Refer to Section M2.6.1 for guidance on design speed and Chapter 5 of this manual, Section 5.2.4 for methods to determine the off-peak 85\textsuperscript{th} percentile speed. The following are the range of design speeds.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 km/h</td>
<td>50 km/h</td>
</tr>
</tbody>
</table>

B. Lane Width

Determine minimum from Exhibit M2-8.

C. Shoulder Width

Determine minimum from Exhibit M2-8.

D. Bridge Roadway Width

Determine minimum from NYSDOT Bridge Manual, Section 2. Note that the bridge roadway width includes the lane and shoulders and is often based on the approach lane and shoulder width determined from Sections B and C, above.

E. Grade

Grades for local streets = 15\% maximum in residential areas and 8\% maximum in commercial and industrial areas.

F. Horizontal Curvature

Determine minimum radius from Exhibit M2-8. For curves with radii larger than the minimum radius, the radius of curve and superelevation on each horizontal curve shall be correlated with the design speed in accordance with Exhibit M2-12 for $e_{\text{max}} = 4\%$ table,. The superelevation distribution in this table provides a gradual increase in the unresolved lateral forces on a vehicle as the curve radii decreases. This distribution of superelevation is based on Method 5 in Chapter 3 of AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2004.
Local urban streets in heavily built-up residential, commercial, and industrial areas (where building fronts, drainage, sidewalks, or driveways would be substantially impacted by added superelevation), the use of superelevation can be minimized by placing greater reliance on side friction to counter lateral acceleration. This distribution of superelevation is based on Method 2 in Chapter 3 of AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2004. Below are the minimum radii at 4% superelevation using this method.

<table>
<thead>
<tr>
<th>Design Speed, km/h</th>
<th>Minimum Curve Radius ($e_{\text{max}} = 4%$) (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>50</td>
<td>86</td>
</tr>
</tbody>
</table>

For radii larger than the above minimum radius for $e_{\text{max}} = 4\%$, determine the superelevation rate using Exhibit M2-11.

G. Superelevation

4% maximum.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum and desirable from Exhibit M2-8.

I. Horizontal Clearance

The minimum horizontal clearance to obstructions (measured from the face of curb) is 0 m if barrier is provided, 0.5 m in areas without barrier, and 1 m at intersections.

J. Vertical Clearance

Determine minimum from the NYSDOT Bridge Manual, Section 2.

K. Travel Lane Cross Slope

Travel lane = 1.5% minimum to 2% maximum.

Parking lanes = 1.5% minimum to 5% maximum.
L. Rollover

Between travel lanes = 4% maximum. At edge of traveled way = 8% maximum.

M. Structural Capacity

Determine from the NYSDOT Bridge Manual, Section 2.

N. Pedestrian Accommodations

To assure access for persons with disabilities, pedestrian facilities shall be located and constructed in accordance with Chapter 18 of this manual.
Exhibit M2-8  Design Criteria for Local Urban Streets

<table>
<thead>
<tr>
<th>Lanes 1</th>
<th>Width (m)</th>
<th>Minimum</th>
<th>Desirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Lanes (with curbing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential without severe ROW limitations &amp; Commercial</td>
<td>3.0</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Residential with severe ROW limitations</td>
<td>2.7</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Industrial areas with out severe ROW limitations</td>
<td>3.6</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Industrial areas with severe ROW limitations</td>
<td>3.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Wide travel lane adjacent to curbing or parking lane to accommodate bicyclists in low-speed segments 2</td>
<td>3.6</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Travel Lanes (Without curbing)</td>
<td>Refer to Exhibit M2-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning Lanes -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck volume ≤ 2%</td>
<td>2.7</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Truck volume &gt; 2%</td>
<td>2.7</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Two-way left-turn lanes</td>
<td>3.0</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Parking Lanes -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial &amp; Industrial</td>
<td>2.4</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>2.1</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Shoulder 1</td>
<td>Width (m)</td>
<td>Minimum</td>
<td>Desirable</td>
</tr>
<tr>
<td>Curbed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left shoulder for divided urban streets</td>
<td>0</td>
<td>0.3 - 0.6</td>
<td></td>
</tr>
<tr>
<td>Right shoulder for bicycling, lateral offset, etc. 2</td>
<td>1.5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Right shoulder for breakdowns and turning movements in addition to bicycling, lateral offset, etc.</td>
<td>1.8</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Uncurbed</td>
<td>Refer to Exhibit M2-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>Maximum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial / Industrial</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Design Speed (km/h)

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Min. Stopping Sight Distance (m)</th>
<th>Minimum Radius Curve (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>35</td>
<td>22</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>47</td>
</tr>
<tr>
<td>50</td>
<td>65</td>
<td>86</td>
</tr>
</tbody>
</table>

### Notes:
1. For bridges, determine the lane and shoulder width from the NYSDOT Bridge Manual, Section 2.
2. Wide travel lanes may be used on local urban streets. Refer to Chapter 17 of this manual for bicycle accommodations. Note that bicyclists have the same rights and responsibilities as motorists except as provided in Sections 1230 - 1236 of the New York State Vehicle and Traffic Law. A 0 to 1.2 m minimum shoulder may be used where a wide outside travel lane (3.6 m minimum) or separate provisions (e.g., multiuse path) are provided.
M2.7.5 Other Roadways

M2.7.5.1 Parkways
Parkways that are multilane, divided freeways, or expressways with occasional at-grade intersections should follow the standards in Section M2.7.1.2 Other Freeways. Parkways that are two-lane highways or multilane, divided highways with signalized intersections should follow the standards of the design classification established for the subject parkway.

M2.7.5.2 Ramps (Turning Roadways for Grade-Separated Highways)
Ramps are turning roadways to accommodate high volumes of turning movements between grade-separated highways. Ramps are functionally classified based on the higher-type highway they service. For example, all the ramps to and from an interstate are considered part of the Interstate System. The design criteria for ramps are:

A. Design Speed

A ramp speed study is not required to determine the ramp design speed. The ramp design speed for the design criteria applies to the sharpest ramp curve, usually on the ramp proper. The ramp design speed does not apply to the ramp terminals, which should include transition curves and speed change lanes based on the design speeds of the highways and ramps involved.

Desirably, ramp design speed should approximate the off-peak running speeds (50th percentile speeds) on the higher speed intersecting highway, but not exceed 80 km/h. Ramps with design speeds over 80 km/h should be designed using Section M2.7.1 of this chapter. The minimum design speeds based on ramp type (as illustrated in Exhibit 10-55 of AASHTO’s *A Policy on Geometric Design of Highways and Streets, 2004*) are:

- Loop ramps - 40 km/h minimum for highways with design speeds of more than 80 km/h.
- Semidirect connection ramps - 50 km/h minimum.
- Direct connection ramps - 60 km/h minimum; 80 km/h preferred.
- Diagonals, outer connections, and one-quadrant ramps - Below is the minimum ramp design speed related to the highway design speed. The highway design speed is the higher design speed of the interchanging roadways.

<table>
<thead>
<tr>
<th>Highway Design Speed (km/h)</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Ramp Design Speed (km/h)</td>
<td>30</td>
<td>40</td>
<td>40</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>
B. Traveled Way Width

Determine minimum traveled way width from Exhibits M2-9a or M2-9b, as appropriate. Use Exhibit M2-9a for interstate ramps and Exhibit M2-9b for non-interstate ramps and turning roadways, including non-interstate highways that are designated as Qualifying Highways.

C. Shoulder Width

Determine minimum shoulder widths from Exhibit M2-10.

D. Bridge Roadway Width

The lane and shoulder widths are to be carried across all ramp structures.

E. Grade

Determine maximum from Exhibit M2-10.

F. Horizontal Curvature

Determine minimum radius from Exhibit M2-10. For curves flatter than the minimum radius, the radius and superelevation on each horizontal curve shall be correlated with the design speed in accordance with the appropriate $e_{\text{max}}$ table (Exhibit M2-13 for $e_{\text{max}} = 6\%$ or Exhibit M2-14 for $e_{\text{max}} = 8\%$).

G. Superelevation

$8\%$ maximum. A $6\%$ maximum may be used in urban and suburban areas to minimize the effect of negative side friction during peak periods with low travel speeds.

H. Stopping Sight Distance (Horizontal and Vertical)

Determine minimum and desirable stopping sight distance from Exhibit M2-10.

I. Horizontal Clearance

Right side = greater of shoulder width or $1.8$ m and left side = $1.0$ m minimum. Where ramps pass under structures, there should be an additional $1.2$ m clearance beyond the outside of shoulders to bridge piers or abutments.
J. Vertical Clearance

Determine minimum from the NYSDOT Bridge Manual, Section 2. Ramps should have the same vertical clearance as the higher functional classification of the interchanging roadways.

K. Travel Lane Cross Slope

1.5% minimum to 2% maximum.

L. Rollover

Between travel lanes = 4% maximum. At edge of traveled way = 8% maximum. When the superelevation rate exceeds 6%, a maximum rollover rate of 10% at the edge of traveled way may be permitted. Refer to Chapter 3, Section 3.2.5.1 Shoulder Cross Slopes and Rollover Limitations of this manual for further guidance.

M. Structural Capacity

Determine from the NYSDOT Bridge Manual, Section 2.

N. Level of Service (interstate ramps only)

Exit ramps with poor levels of service can cause backups onto the mainline. Ramps shall meet acceptable levels of service, as listed below, and shall be determined on the basis of design year volumes in accordance with TRB’s *Highway Capacity Manual*.

The following levels of service are the criteria for interstates:

- Rural, level terrain LOS = B minimum
- Rural, rolling terrain LOS = B minimum
- Rural, mountainous terrain LOS = C minimum
- Urban and suburban \(^1\) LOS = C minimum

\(^1\) In heavily developed sections of metropolitan areas, conditions may necessitate LOS D minimum. Scoping closure and design approval documents should include documentation of the heavily developed metropolitan area conditions.

Some interstate projects, especially in urban areas, will provide levels of service below those above due to social, economic, and environmental and/or policy/intergovernmental decisions during project scoping and design. Such decisions for lesser levels of service should be made in accordance with National Environmental Policy Act (NEPA) and/or State Environmental Quality Review Act (SEQR) procedures and, where applicable, with the Major Metropolitan Transportation Investment process. These decisions should be supported and documented in the design approval documents.
O. Control of Access (interstate and other freeway ramps only)

Access along freeway ramps and terminals on the crossroad shall be fully controlled. Such control shall either be acquired outright prior to construction or reconstruction.

Access along the crossroad should be provided beyond the ramp terminals by purchasing access rights or providing frontage roads. Such control should extend beyond the ramp terminal at least 30 m in urban areas and 90 m in rural areas (see Chapter 6 of this manual for more specific details).

P. Pedestrian Accommodation

To assure access for persons with disabilities, pedestrian facilities located at the ramp terminal with a crossroad shall be located and constructed in accordance with Chapter 18 of this manual.

2.7.5.3 Speed Change Lanes

Acceleration lanes, deceleration lanes, and combination acceleration-deceleration lanes have the same lane width as the adjacent travel lanes. The minimum shoulder width is 1.8 m on interstates and other freeways and 1.2 m on other roadways. All other critical design elements (grades, stopping sight distance, etc.) are the same as apply for the adjacent roadway.

The lengths of acceleration and deceleration lanes are not critical design elements. However the lengths, as determined from Chapter 10 in AASHTO's, *A Policy on Geometric Design of Highways and Streets*, 2004 should be provided. If these lengths are not provided an explanation must be included in the design report.
**Exhibit M2-9a Traveled Way Widths for Interstate Ramps**

<table>
<thead>
<tr>
<th>Radius on Inner Edge of Traveled Way, R (m)</th>
<th>Traveled Way Width (m)</th>
<th>One-Lane, One-Way Operation</th>
<th>Two-Lane Operation&lt;sup&gt;(3)&lt;/sup&gt; – One-Way or Two-Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>See note 4</td>
<td>See note 4</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>See note 4</td>
<td>See note 4</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>See note 4</td>
<td>See note 4</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>6.7 (5.0)&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>5.9 (4.8)&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>5.5 (4.8)&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>5.3 (4.8)&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>5.2 (4.5)&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Tangent (≥300 m)</td>
<td>4.5</td>
<td>7.9</td>
<td></td>
</tr>
</tbody>
</table>

**Width Modification for Edge Conditions**

<table>
<thead>
<tr>
<th>No Stabilized Shoulder</th>
<th>None</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloping Curb</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Vertical Curb</td>
<td>Add 0.3 m</td>
<td>Add 0.3 m</td>
</tr>
<tr>
<td>One Side</td>
<td>Add 0.6 m</td>
<td>Add 0.6 m</td>
</tr>
<tr>
<td>Two Sides</td>
<td>Add 0.6 m</td>
<td>Add 0.6 m</td>
</tr>
<tr>
<td>Paved Shoulder, one or both sides</td>
<td>Traveled way width for tangent (R≥300 m) may be reduced to 3.6 m where the combined left and right shoulder width is 1.2 m or wider.</td>
<td>Deduct 0.6 m where the combined left and right shoulder width is 1.2 m or wider.</td>
</tr>
</tbody>
</table>

---

<sup>1</sup> For non-interstate ramps and turning roadways use Exhibit 2-9b.

<sup>2</sup> The ramp traveled way width may vary according to the radius encountered. In general, the least width is selected, with the width increased in curved segments of the ramp. Taper between different widths in accord with HDM Chapter 5.

<sup>3</sup> These widths (from AASHTO Green Book 2011 Table 3-29) reflect a combination of separate design vehicles, and will only accommodate two WB-12 design vehicles passing one another. For the rare cases where the design must accommodate WB-20 design vehicles passing one another, use AASHTO Green Book 2011 Table 3-28a to determine the required width.

<sup>4</sup> These radii are associated with design speeds lower than the minimum required for interstate ramps in New York State. Retaining these radii or proposing them for new/reconstructed ramps requires Non-Standard Feature Justification(s) with a safety and operational analysis of the impact on larger vehicles. New or reconstructed ramps should not use less than a 50 m radius.

<sup>5</sup> The reduced traveled way width included in parenthesis may be used instead if BOTH of the following apply:

a) Right and left shoulders are full depth (required for new or reconstructed ramps only) and widths meet or exceed the minimum shoulder widths from Exhibit 2-10.

b) The cross slope of traveled way and shoulders is on a single plane, as shown in HDM Figure 3-5, 3<sup>rd</sup> section from top, with no rollover.
### Exhibit M2-9b Traveled Way Widths for Non-Interstate Ramps and Turning Roadways

<table>
<thead>
<tr>
<th>Radius on Inner Edge of Traveled Way, R (m)</th>
<th>Traveled Way Width (m)</th>
<th>Design Traffic Condition (see definitions below)</th>
<th>Width Modification for Edge Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case I One-Lane, One-Way Operation – no provision for passing a stalled vehicle</td>
<td>Case II One-Lane, One-Way Operation – with provision for passing a stalled vehicle</td>
<td>Case III Two-Lane Operation – One-Way or Two-Way</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>15</td>
<td>5.4</td>
<td>5.5</td>
<td>7.0</td>
</tr>
<tr>
<td>25</td>
<td>4.8</td>
<td>5.0</td>
<td>5.8</td>
</tr>
<tr>
<td>30</td>
<td>4.5</td>
<td>4.9</td>
<td>5.5</td>
</tr>
<tr>
<td>50</td>
<td>4.2</td>
<td>4.6</td>
<td>5.0</td>
</tr>
<tr>
<td>75</td>
<td>3.9</td>
<td>4.5</td>
<td>4.8</td>
</tr>
<tr>
<td>100</td>
<td>3.9</td>
<td>4.5</td>
<td>4.8</td>
</tr>
<tr>
<td>125</td>
<td>3.9</td>
<td>4.5</td>
<td>4.8</td>
</tr>
<tr>
<td>150</td>
<td>3.6</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Tangent (≥300 m)</td>
<td>3.6</td>
<td>4.2</td>
<td>4.2</td>
</tr>
</tbody>
</table>

#### Width Modification for Edge Conditions

<table>
<thead>
<tr>
<th>No Stabilized Shoulder</th>
<th>None</th>
<th>None</th>
<th>None</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloping Curb</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Vertical Curb One Side</td>
<td>Add 0.3 m</td>
<td>None</td>
<td>Add 0.3 m</td>
<td>Add 0.3 m</td>
</tr>
<tr>
<td>Two Sides</td>
<td>Add 0.6 m</td>
<td>None</td>
<td>Add 0.3 m</td>
<td>Add 0.6 m</td>
</tr>
<tr>
<td>Paved Shoulder, one or both sides</td>
<td>Traveled way width for tangent (R≥300 m) may be reduced to 3.6 m where the combined left and right shoulder width is 1.2 m or wider.</td>
<td>Deduct the combined left and right shoulder width, but the traveled way width cannot be less than that required under Case I.</td>
<td>Deduct 0.6 m where the combined left and right shoulder width is 1.2 m or wider.</td>
<td></td>
</tr>
</tbody>
</table>

#### Design Traffic Condition Definitions

- **A** = Predominantly P vehicles, but some consideration for SU trucks
- **B** = Single-Unit (SU) Truck and Semitrailer vehicles comprise 5-10% of traffic volume
- **C** = Bus and Semitrailer vehicles comprise over 10% of traffic volume

1. For non-interstate highways designated as Qualifying Highways (see section 2.5.3.2), use Design Traffic Condition **C** and ensure that the design permits a WB-20 design vehicle to negotiate the non-interstate ramp/turning roadway using the full width of the roadway (traveled way plus shoulders).
2. Values are from AASHTO Green Book 2011 Table 3-29.
3. For example, for R=50 m, Case II, Condition B and combined left and right shoulder width of 3 m, the width required is 6.3 – 3 =3.3 m. However, it cannot be less than that required under Case I so 4.6 m is required.
### Exhibit M2-10  Design Criteria for Turning Roadways

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Shoulder ¹ (m)</th>
<th>Maximum Percent Grade</th>
<th>Minimum Stopping Sight Distance (m)</th>
<th>Minimum Radius (m) (measured to inside edge of the traveled way)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right ²</td>
<td></td>
<td>e&lt;sub&gt;max&lt;/sub&gt; = 4%&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>15 ⁴</td>
<td>1.0</td>
<td>2.0</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>‡</td>
<td>‡</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>‡</td>
<td>‡</td>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td>40</td>
<td>‡</td>
<td>‡</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>50</td>
<td>‡</td>
<td>‡</td>
<td>7</td>
<td>65</td>
</tr>
<tr>
<td>60</td>
<td>‡</td>
<td>‡</td>
<td>6</td>
<td>85</td>
</tr>
<tr>
<td>70</td>
<td>‡</td>
<td>‡</td>
<td>5</td>
<td>105</td>
</tr>
<tr>
<td>80</td>
<td>‡</td>
<td>‡</td>
<td>5</td>
<td>130</td>
</tr>
</tbody>
</table>

**Notes:**
1. For urban turning roadways with curbing, no shoulder is required. A 0.6 m curb offset is desirable.
2. For direct connection ramps with design speeds over 60 km/h, use a 2.4 m minimum right shoulder.
3. Only for Free-Flow Turning Roadways for at-grade intersections. See §M2.7.5.4.B.
M2.7.5.4 Turning Roadways - Channelized for At-Grade Intersections

Channelized right-turning roadways are sometimes called right-turn slip lanes or right-turn bypass lanes. There are two types of channelized right-turning roadways for at-grade intersections: right-turning roadways with corner islands and free-flowing, right-turning roadways. Further information on these roadways is provided in Chapter 5, Section 5.9.4 of this manual.

A. Turning Roadways with Yield, Stop, or Signal Control

Turning roadways with yield, stop, or signal control often have channelized islands and do not include taper- or parallel-type acceleration lanes. Design criteria is not required for these types of turning roadways.

For layout, the design speed may range from 15 km/h to 40 km/h. Refer to Chapter 5, Section 5.9.4.6 A of this manual for additional guidance.

B. Free-Flow Turning Roadways

Free-flow turning roadways are essentially ramps for at-grade intersections. They generally include speed-change lanes. The design speed may be equal to or as much as to 30 km/h less than the design speed of the higher speed intersecting highway. The acceptable range of design speeds is 15 km/h to 80 km/h.

- Determine the lane widths from Exhibit M2-9.
- Determine the shoulder widths, grade, stopping sight distance, and minimum radii from Exhibit M2-10.
- A maximum superelevation rate of 4% is used for urban areas, 6% for rural areas where traffic is likely to stop on the turning roadway, and 8% for rural areas where traffic is unlikely to stop on the turning roadway. For superelevation rates on curves with radii above the minimum radius, use Exhibits M2-12, M2-13, or M2-14 for $e_{\text{max}}$ equal to 4%, 6%, or 8%, respectively.
- The minimum horizontal clearance to obstructions (measured from the edge of traveled way) on the right side is the larger of the shoulder width or 1.8 m.
- The minimum horizontal clearance to obstructions (measured from the edge of traveled way) on the left side is 1.2 m.
- Determine the remaining critical design elements from Section M2.7.5.2.
M2.7.5.5 Collector-Distributor Roads

The difference between the design speed of a collector-distributor road and the adjacent mainline roadway should not exceed 20 km/h. However, for freeways with 80 km/h or 90 km/h design speeds, the minimum design speed for the collector-distributor road is 80 km/h. The design criteria should be the same as that of the adjacent mainline roadway. However the other critical design elements (horizontal curve, stopping sight distance, etc.) should be modified appropriately if a design speed less than the mainline design speed is used.

M2.7.5.6 Frontage Roads (Service Roads)

The design criteria for frontage roads should be consistent with the design criteria for the functional class of the frontage road.

M2.7.5.7 Climbing Lanes

Climbing lanes should have the same lane width as the adjacent travel lanes. The minimum shoulder width for a climbing lane is 1.2 m, or the shoulder width of the highway, whichever is less. Desirably the climbing lane shoulder should match the shoulder for the adjacent segments of highway. All other critical design elements (grades, stopping sight distances, etc.) are the same as applies for the adjacent roadway.

M2.7.5.8 Tunnels

The design criteria used for tunnels should not differ materially from those used for grade separation structures. Refer to AASHTO’s *A Policy on Geometric Design of Highways and Streets, 2004* for further guidance regarding tunnel design.

M2.7.5.9 Shared Roadway

A roadway which is open to both bicycle and motor vehicle travel upon which no bicycle lane is designated. Examples may include roads with wide curb lanes and roads with shoulders. Refer to various tables within Section M2.7 of this chapter as well as Chapters 17 and 18 of this manual for shoulder / lane width guidance.
Exhibit M2-11 Minimum Radii and Superelevation for Low-Speed Urban Streets

<table>
<thead>
<tr>
<th>e (%)</th>
<th>$V_d = 20$ km/h</th>
<th>$V_d = 30$ km/h</th>
<th>$V_d = 40$ km/h</th>
<th>$V_d = 50$ km/h</th>
<th>$V_d = 60$ km/h</th>
<th>$V_d = 70$ km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
</tr>
<tr>
<td>-2.0</td>
<td>10</td>
<td>27</td>
<td>60</td>
<td>116</td>
<td>189</td>
<td>297</td>
</tr>
<tr>
<td>-1.5</td>
<td>9</td>
<td>27</td>
<td>59</td>
<td>113</td>
<td>183</td>
<td>286</td>
</tr>
<tr>
<td>0</td>
<td>9</td>
<td>25</td>
<td>55</td>
<td>104</td>
<td>167</td>
<td>257</td>
</tr>
<tr>
<td>1.5</td>
<td>9</td>
<td>24</td>
<td>51</td>
<td>96</td>
<td>153</td>
<td>234</td>
</tr>
<tr>
<td>2.0</td>
<td>9</td>
<td>24</td>
<td>50</td>
<td>94</td>
<td>149</td>
<td>227</td>
</tr>
<tr>
<td>2.2</td>
<td>8</td>
<td>23</td>
<td>50</td>
<td>93</td>
<td>148</td>
<td>224</td>
</tr>
<tr>
<td>2.4</td>
<td>8</td>
<td>23</td>
<td>50</td>
<td>92</td>
<td>146</td>
<td>222</td>
</tr>
<tr>
<td>2.6</td>
<td>8</td>
<td>23</td>
<td>49</td>
<td>91</td>
<td>145</td>
<td>219</td>
</tr>
<tr>
<td>2.8</td>
<td>8</td>
<td>23</td>
<td>49</td>
<td>90</td>
<td>143</td>
<td>217</td>
</tr>
<tr>
<td>3.0</td>
<td>8</td>
<td>23</td>
<td>48</td>
<td>89</td>
<td>142</td>
<td>214</td>
</tr>
<tr>
<td>3.2</td>
<td>8</td>
<td>23</td>
<td>48</td>
<td>89</td>
<td>140</td>
<td>212</td>
</tr>
<tr>
<td>3.4</td>
<td>8</td>
<td>23</td>
<td>48</td>
<td>88</td>
<td>139</td>
<td>210</td>
</tr>
<tr>
<td>3.6</td>
<td>8</td>
<td>22</td>
<td>47</td>
<td>87</td>
<td>138</td>
<td>207</td>
</tr>
<tr>
<td>3.8</td>
<td>8</td>
<td>22</td>
<td>47</td>
<td>86</td>
<td>136</td>
<td>205</td>
</tr>
<tr>
<td>4.0</td>
<td>8</td>
<td>22</td>
<td>47</td>
<td>86</td>
<td>135</td>
<td>203</td>
</tr>
</tbody>
</table>

**Notes:**
1. For low-speed (<70 km/h) urban streets in heavily built-up residential, commercial, and industrial areas (where building fronts, drainage, sidewalks, or driveways would be substantially impacted by added superelevation), sharper curves are allowed.
3. For segments using a normal crown of 2%, curves with radii that are larger than those required for $e = -2.0\%$ may retain normal crown. Curves with radii requiring superelevation rates between $e = -2.0\%$ to $e = 0\%$ require removal of the adverse cross slope. Curves with radii requiring superelevation rates between $e = 0\%$ and $e = 2\%$ require superelevation at $e = 2\%$.

For segments using a normal crown of 1.5%, curves with radii that are larger than those required for $e = -1.5\%$ may retain normal crown. Curves with radii requiring superelevation rates between $e = -1.5\%$ to $e = 0\%$ require removal of the adverse cross slope. Curves with radii requiring superelevation rates between $e = 0\%$ and $e = 1.5\%$ require superelevation at $e = 1.5\%$. 

§M2.7.5.9 1/30/2009
### Exhibit M2-12  Minimum Radii for Design Superelevation Rates, Design Speeds, and $e_{\text{max}} = 4\%$

<table>
<thead>
<tr>
<th>$e$ (%)</th>
<th>$V_d=20$ km/h</th>
<th>$V_d=30$ km/h</th>
<th>$V_d=40$ km/h</th>
<th>$V_d=50$ km/h</th>
<th>$V_d=60$ km/h</th>
<th>$V_d=70$ km/h</th>
<th>$V_d=80$ km/h</th>
<th>$V_d=90$ km/h</th>
<th>$V_d=100$ km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
</tr>
<tr>
<td>1.5</td>
<td>163</td>
<td>371</td>
<td>679</td>
<td>951</td>
<td>1310</td>
<td>1740</td>
<td>2170</td>
<td>2640</td>
<td>3250</td>
</tr>
<tr>
<td>2.0</td>
<td>102</td>
<td>237</td>
<td>441</td>
<td>632</td>
<td>877</td>
<td>1180</td>
<td>1490</td>
<td>1830</td>
<td>2260</td>
</tr>
<tr>
<td>2.2</td>
<td>75</td>
<td>187</td>
<td>363</td>
<td>534</td>
<td>749</td>
<td>1020</td>
<td>1290</td>
<td>1590</td>
<td>1980</td>
</tr>
<tr>
<td>2.4</td>
<td>51</td>
<td>132</td>
<td>273</td>
<td>435</td>
<td>626</td>
<td>865</td>
<td>1110</td>
<td>1390</td>
<td>1730</td>
</tr>
<tr>
<td>2.6</td>
<td>38</td>
<td>99</td>
<td>209</td>
<td>345</td>
<td>508</td>
<td>720</td>
<td>944</td>
<td>1200</td>
<td>1510</td>
</tr>
<tr>
<td>2.8</td>
<td>30</td>
<td>79</td>
<td>167</td>
<td>283</td>
<td>422</td>
<td>605</td>
<td>802</td>
<td>1030</td>
<td>1320</td>
</tr>
<tr>
<td>3.0</td>
<td>24</td>
<td>64</td>
<td>137</td>
<td>236</td>
<td>356</td>
<td>516</td>
<td>690</td>
<td>893</td>
<td>1150</td>
</tr>
<tr>
<td>3.2</td>
<td>20</td>
<td>54</td>
<td>114</td>
<td>199</td>
<td>303</td>
<td>443</td>
<td>597</td>
<td>779</td>
<td>1010</td>
</tr>
<tr>
<td>3.4</td>
<td>17</td>
<td>45</td>
<td>96</td>
<td>170</td>
<td>260</td>
<td>382</td>
<td>518</td>
<td>680</td>
<td>879</td>
</tr>
<tr>
<td>3.6</td>
<td>14</td>
<td>38</td>
<td>81</td>
<td>144</td>
<td>222</td>
<td>329</td>
<td>448</td>
<td>591</td>
<td>767</td>
</tr>
<tr>
<td>3.8</td>
<td>12</td>
<td>31</td>
<td>67</td>
<td>121</td>
<td>187</td>
<td>278</td>
<td>381</td>
<td>505</td>
<td>658</td>
</tr>
<tr>
<td>4.0</td>
<td>8</td>
<td>22</td>
<td>47</td>
<td>86</td>
<td>135</td>
<td>203</td>
<td>280</td>
<td>375</td>
<td>492</td>
</tr>
</tbody>
</table>

**Notes:**
   Curves with radii greater than that needed for $e = 1.5\%$ may retain normal crown. Curves with radii requiring $e = 1.5\%$ to less than $e = 2.0\%$ require removal of the adverse cross slope.
### Exhibit M2-13 Minimum Radii for Design Superelevation Rates, Design Speeds, $e_{max} = 6\%$

<table>
<thead>
<tr>
<th>E (%)</th>
<th>$V_d=20$ km/h</th>
<th>$V_d=30$ km/h</th>
<th>$V_d=40$ km/h</th>
<th>$V_d=50$ km/h</th>
<th>$V_d=60$ km/h</th>
<th>$V_d=70$ km/h</th>
<th>$V_d=80$ km/h</th>
<th>$V_d=90$ km/h</th>
<th>$V_d=100$ km/h</th>
<th>$V_d=110$ km/h</th>
<th>$V_d=120$ km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
<td>R(m)</td>
</tr>
<tr>
<td>1.5</td>
<td>194</td>
<td>421</td>
<td>738</td>
<td>1050</td>
<td>1440</td>
<td>1910</td>
<td>2360</td>
<td>2880</td>
<td>3510</td>
<td>4060</td>
<td>4770</td>
</tr>
<tr>
<td>2.0</td>
<td>138</td>
<td>299</td>
<td>525</td>
<td>750</td>
<td>1030</td>
<td>1380</td>
<td>1710</td>
<td>2090</td>
<td>2560</td>
<td>2970</td>
<td>3510</td>
</tr>
<tr>
<td>2.2</td>
<td>122</td>
<td>265</td>
<td>465</td>
<td>668</td>
<td>919</td>
<td>1230</td>
<td>1530</td>
<td>1880</td>
<td>2300</td>
<td>2670</td>
<td>3160</td>
</tr>
<tr>
<td>2.4</td>
<td>109</td>
<td>236</td>
<td>415</td>
<td>599</td>
<td>825</td>
<td>1110</td>
<td>1380</td>
<td>1700</td>
<td>2080</td>
<td>2420</td>
<td>2870</td>
</tr>
<tr>
<td>2.6</td>
<td>97</td>
<td>212</td>
<td>372</td>
<td>540</td>
<td>746</td>
<td>1000</td>
<td>1260</td>
<td>1540</td>
<td>1890</td>
<td>2210</td>
<td>2630</td>
</tr>
<tr>
<td>2.8</td>
<td>87</td>
<td>190</td>
<td>334</td>
<td>488</td>
<td>676</td>
<td>910</td>
<td>1150</td>
<td>1410</td>
<td>1730</td>
<td>2020</td>
<td>2420</td>
</tr>
<tr>
<td>3.0</td>
<td>78</td>
<td>170</td>
<td>300</td>
<td>443</td>
<td>615</td>
<td>831</td>
<td>1050</td>
<td>1290</td>
<td>1590</td>
<td>1870</td>
<td>2240</td>
</tr>
<tr>
<td>3.2</td>
<td>70</td>
<td>152</td>
<td>269</td>
<td>402</td>
<td>561</td>
<td>761</td>
<td>959</td>
<td>1190</td>
<td>1470</td>
<td>1730</td>
<td>2080</td>
</tr>
<tr>
<td>3.4</td>
<td>61</td>
<td>133</td>
<td>239</td>
<td>364</td>
<td>511</td>
<td>697</td>
<td>882</td>
<td>1100</td>
<td>1360</td>
<td>1600</td>
<td>1940</td>
</tr>
<tr>
<td>3.6</td>
<td>51</td>
<td>113</td>
<td>206</td>
<td>329</td>
<td>465</td>
<td>640</td>
<td>813</td>
<td>1020</td>
<td>1260</td>
<td>1490</td>
<td>1810</td>
</tr>
<tr>
<td>3.8</td>
<td>42</td>
<td>96</td>
<td>177</td>
<td>294</td>
<td>422</td>
<td>586</td>
<td>749</td>
<td>939</td>
<td>1170</td>
<td>1390</td>
<td>1700</td>
</tr>
<tr>
<td>4.0</td>
<td>36</td>
<td>82</td>
<td>155</td>
<td>261</td>
<td>380</td>
<td>535</td>
<td>690</td>
<td>870</td>
<td>1090</td>
<td>1300</td>
<td>1590</td>
</tr>
<tr>
<td>4.2</td>
<td>31</td>
<td>72</td>
<td>136</td>
<td>234</td>
<td>343</td>
<td>488</td>
<td>635</td>
<td>806</td>
<td>1010</td>
<td>1220</td>
<td>1500</td>
</tr>
<tr>
<td>4.4</td>
<td>27</td>
<td>63</td>
<td>121</td>
<td>210</td>
<td>311</td>
<td>446</td>
<td>584</td>
<td>746</td>
<td>938</td>
<td>1140</td>
<td>1410</td>
</tr>
<tr>
<td>4.6</td>
<td>24</td>
<td>56</td>
<td>108</td>
<td>190</td>
<td>283</td>
<td>408</td>
<td>538</td>
<td>692</td>
<td>873</td>
<td>1070</td>
<td>1330</td>
</tr>
<tr>
<td>4.8</td>
<td>21</td>
<td>50</td>
<td>97</td>
<td>172</td>
<td>258</td>
<td>374</td>
<td>496</td>
<td>641</td>
<td>812</td>
<td>997</td>
<td>1260</td>
</tr>
<tr>
<td>5.0</td>
<td>19</td>
<td>45</td>
<td>88</td>
<td>156</td>
<td>235</td>
<td>343</td>
<td>457</td>
<td>594</td>
<td>755</td>
<td>933</td>
<td>1190</td>
</tr>
<tr>
<td>5.2</td>
<td>17</td>
<td>40</td>
<td>79</td>
<td>142</td>
<td>214</td>
<td>315</td>
<td>421</td>
<td>549</td>
<td>701</td>
<td>871</td>
<td>1120</td>
</tr>
<tr>
<td>5.4</td>
<td>15</td>
<td>36</td>
<td>71</td>
<td>128</td>
<td>195</td>
<td>287</td>
<td>386</td>
<td>506</td>
<td>648</td>
<td>810</td>
<td>1060</td>
</tr>
<tr>
<td>5.6</td>
<td>13</td>
<td>32</td>
<td>63</td>
<td>115</td>
<td>176</td>
<td>260</td>
<td>351</td>
<td>463</td>
<td>594</td>
<td>747</td>
<td>980</td>
</tr>
<tr>
<td>5.8</td>
<td>11</td>
<td>28</td>
<td>56</td>
<td>102</td>
<td>156</td>
<td>232</td>
<td>315</td>
<td>416</td>
<td>537</td>
<td>679</td>
<td>900</td>
</tr>
<tr>
<td>6.0</td>
<td>8</td>
<td>21</td>
<td>43</td>
<td>79</td>
<td>123</td>
<td>184</td>
<td>252</td>
<td>336</td>
<td>437</td>
<td>560</td>
<td>756</td>
</tr>
</tbody>
</table>

**Notes:**
2. Curves with radii greater than that needed for $e = 1.5\%$ may retain normal crown. Curves with radii requiring $e = 1.5\%$ to less than $e = 2.0\%$ require removal of the adverse cross slope.
## DESIGN CRITERIA

### Exhibit M2-14 Minimum Radii for Design Superelevation Rates, Design Speeds, $e_{\text{max}} = 8\%$

<table>
<thead>
<tr>
<th>$e(%)$</th>
<th>$V_d=20$ km/h</th>
<th>$V_d=30$ km/h</th>
<th>$V_d=40$ km/h</th>
<th>$V_d=50$ km/h</th>
<th>$V_d=60$ km/h</th>
<th>$V_d=70$ km/h</th>
<th>$V_d=80$ km/h</th>
<th>$V_d=90$ km/h</th>
<th>$V_d=100$ km/h</th>
<th>$V_d=110$ km/h</th>
<th>$V_d=120$ km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>184</td>
<td>443</td>
<td>784</td>
<td>1090</td>
<td>1490</td>
<td>1970</td>
<td>2440</td>
<td>2970</td>
<td>3630</td>
<td>4180</td>
<td>4900</td>
</tr>
<tr>
<td>2.0</td>
<td>133</td>
<td>322</td>
<td>571</td>
<td>791</td>
<td>1090</td>
<td>1450</td>
<td>1790</td>
<td>2190</td>
<td>2680</td>
<td>3090</td>
<td>3640</td>
</tr>
<tr>
<td>2.2</td>
<td>119</td>
<td>288</td>
<td>512</td>
<td>711</td>
<td>976</td>
<td>1300</td>
<td>1620</td>
<td>1980</td>
<td>2420</td>
<td>2790</td>
<td>3290</td>
</tr>
<tr>
<td>2.4</td>
<td>107</td>
<td>261</td>
<td>463</td>
<td>644</td>
<td>885</td>
<td>1190</td>
<td>1470</td>
<td>1800</td>
<td>2200</td>
<td>2550</td>
<td>3010</td>
</tr>
<tr>
<td>2.6</td>
<td>97</td>
<td>237</td>
<td>421</td>
<td>587</td>
<td>808</td>
<td>1080</td>
<td>1350</td>
<td>1650</td>
<td>2020</td>
<td>2340</td>
<td>2760</td>
</tr>
<tr>
<td>2.8</td>
<td>88</td>
<td>216</td>
<td>385</td>
<td>539</td>
<td>742</td>
<td>992</td>
<td>1240</td>
<td>1520</td>
<td>1860</td>
<td>2160</td>
<td>2550</td>
</tr>
<tr>
<td>3.0</td>
<td>81</td>
<td>199</td>
<td>354</td>
<td>496</td>
<td>684</td>
<td>916</td>
<td>1150</td>
<td>1410</td>
<td>1730</td>
<td>2000</td>
<td>2370</td>
</tr>
<tr>
<td>3.2</td>
<td>74</td>
<td>183</td>
<td>326</td>
<td>458</td>
<td>633</td>
<td>849</td>
<td>1060</td>
<td>1310</td>
<td>1610</td>
<td>1870</td>
<td>2220</td>
</tr>
<tr>
<td>3.4</td>
<td>68</td>
<td>169</td>
<td>302</td>
<td>425</td>
<td>588</td>
<td>790</td>
<td>988</td>
<td>1220</td>
<td>1500</td>
<td>1740</td>
<td>2080</td>
</tr>
<tr>
<td>3.6</td>
<td>62</td>
<td>156</td>
<td>279</td>
<td>395</td>
<td>548</td>
<td>738</td>
<td>924</td>
<td>1140</td>
<td>1410</td>
<td>1640</td>
<td>1950</td>
</tr>
<tr>
<td>3.8</td>
<td>57</td>
<td>144</td>
<td>259</td>
<td>368</td>
<td>512</td>
<td>690</td>
<td>866</td>
<td>1070</td>
<td>1320</td>
<td>1540</td>
<td>1840</td>
</tr>
<tr>
<td>4.0</td>
<td>52</td>
<td>134</td>
<td>241</td>
<td>344</td>
<td>479</td>
<td>648</td>
<td>813</td>
<td>1010</td>
<td>1240</td>
<td>1450</td>
<td>1740</td>
</tr>
<tr>
<td>4.2</td>
<td>48</td>
<td>124</td>
<td>224</td>
<td>321</td>
<td>449</td>
<td>608</td>
<td>766</td>
<td>948</td>
<td>1180</td>
<td>1380</td>
<td>1650</td>
</tr>
<tr>
<td>4.4</td>
<td>43</td>
<td>115</td>
<td>208</td>
<td>301</td>
<td>421</td>
<td>573</td>
<td>722</td>
<td>895</td>
<td>1110</td>
<td>1300</td>
<td>1570</td>
</tr>
<tr>
<td>4.6</td>
<td>38</td>
<td>106</td>
<td>192</td>
<td>281</td>
<td>395</td>
<td>540</td>
<td>682</td>
<td>847</td>
<td>1050</td>
<td>1240</td>
<td>1490</td>
</tr>
<tr>
<td>4.8</td>
<td>33</td>
<td>96</td>
<td>178</td>
<td>263</td>
<td>371</td>
<td>509</td>
<td>645</td>
<td>803</td>
<td>996</td>
<td>1180</td>
<td>1420</td>
</tr>
<tr>
<td>5.0</td>
<td>30</td>
<td>87</td>
<td>163</td>
<td>246</td>
<td>349</td>
<td>480</td>
<td>611</td>
<td>762</td>
<td>947</td>
<td>1120</td>
<td>1360</td>
</tr>
<tr>
<td>5.2</td>
<td>27</td>
<td>78</td>
<td>148</td>
<td>229</td>
<td>328</td>
<td>454</td>
<td>579</td>
<td>724</td>
<td>901</td>
<td>1070</td>
<td>1300</td>
</tr>
<tr>
<td>5.4</td>
<td>24</td>
<td>71</td>
<td>136</td>
<td>213</td>
<td>307</td>
<td>429</td>
<td>549</td>
<td>689</td>
<td>859</td>
<td>1020</td>
<td>1250</td>
</tr>
<tr>
<td>5.6</td>
<td>22</td>
<td>65</td>
<td>125</td>
<td>198</td>
<td>288</td>
<td>405</td>
<td>521</td>
<td>656</td>
<td>819</td>
<td>975</td>
<td>1200</td>
</tr>
<tr>
<td>5.8</td>
<td>20</td>
<td>59</td>
<td>115</td>
<td>185</td>
<td>270</td>
<td>382</td>
<td>494</td>
<td>625</td>
<td>781</td>
<td>933</td>
<td>1150</td>
</tr>
<tr>
<td>6.0</td>
<td>19</td>
<td>55</td>
<td>106</td>
<td>172</td>
<td>253</td>
<td>360</td>
<td>469</td>
<td>595</td>
<td>746</td>
<td>894</td>
<td>1100</td>
</tr>
<tr>
<td>6.2</td>
<td>17</td>
<td>50</td>
<td>98</td>
<td>161</td>
<td>238</td>
<td>340</td>
<td>445</td>
<td>567</td>
<td>713</td>
<td>857</td>
<td>1060</td>
</tr>
<tr>
<td>6.4</td>
<td>16</td>
<td>46</td>
<td>91</td>
<td>151</td>
<td>224</td>
<td>322</td>
<td>422</td>
<td>540</td>
<td>681</td>
<td>823</td>
<td>1020</td>
</tr>
<tr>
<td>6.6</td>
<td>15</td>
<td>43</td>
<td>85</td>
<td>141</td>
<td>210</td>
<td>304</td>
<td>400</td>
<td>514</td>
<td>651</td>
<td>789</td>
<td>982</td>
</tr>
<tr>
<td>6.8</td>
<td>14</td>
<td>40</td>
<td>79</td>
<td>132</td>
<td>198</td>
<td>287</td>
<td>379</td>
<td>489</td>
<td>620</td>
<td>757</td>
<td>948</td>
</tr>
<tr>
<td>7.0</td>
<td>13</td>
<td>37</td>
<td>73</td>
<td>123</td>
<td>185</td>
<td>270</td>
<td>358</td>
<td>464</td>
<td>591</td>
<td>724</td>
<td>914</td>
</tr>
<tr>
<td>7.2</td>
<td>12</td>
<td>34</td>
<td>68</td>
<td>115</td>
<td>174</td>
<td>254</td>
<td>338</td>
<td>440</td>
<td>561</td>
<td>691</td>
<td>879</td>
</tr>
<tr>
<td>7.4</td>
<td>11</td>
<td>31</td>
<td>62</td>
<td>107</td>
<td>162</td>
<td>237</td>
<td>318</td>
<td>415</td>
<td>531</td>
<td>657</td>
<td>842</td>
</tr>
<tr>
<td>7.6</td>
<td>10</td>
<td>29</td>
<td>57</td>
<td>99</td>
<td>150</td>
<td>221</td>
<td>296</td>
<td>389</td>
<td>499</td>
<td>621</td>
<td>803</td>
</tr>
<tr>
<td>7.8</td>
<td>9</td>
<td>26</td>
<td>52</td>
<td>90</td>
<td>137</td>
<td>202</td>
<td>273</td>
<td>359</td>
<td>462</td>
<td>579</td>
<td>757</td>
</tr>
<tr>
<td>8.0</td>
<td>7</td>
<td>20</td>
<td>41</td>
<td>73</td>
<td>113</td>
<td>168</td>
<td>229</td>
<td>304</td>
<td>394</td>
<td>501</td>
<td>667</td>
</tr>
</tbody>
</table>